BMC Medical Education

RESEARCH

Open Access

Assessment of knowledge and perceptions of pharmacy students toward pharmacovigilance activities, and their predictors: a cross-sectional study in Palestine

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Abstract

Background The development of Pharmacovigilance (P.V) systems in Palestine remains in its early stages, with limited national infrastructure and underreporting of Adverse Drug Reactions (ADRs) posing ongoing challenges. Despite the growing global recognition of P.V as essential to ensuring the safety and efficacy of medications, its integration into pharmacy education in Palestine is still insufficient. Bachelor's Degree of Pharmacy (BS Pharm) and Doctor of Pharmacy (Pharm D) students in Palestine as future pharmacists involved in health care profession, play a pivotal role in P.V activities. However, current curricula often lack structured and comprehensive P.V training, leading to significant gaps in students' knowledge and preparedness. Also, researches concerning their knowledge and perceptions of P.V are still limited in Palestine.

Objectives To assess the knowledge and perceptions regarding P.V activities among BS Pharm and Pharm D students in Palestine, and to evaluate influencing factors.

Methods Study design was cross-sectional; it was conducted from September to December 2024 across seven Palestinian universities. A structured, validated online questionnaire was administered among 412 final-year BS Pharm and Pharm D students. The questionnaire encompassed demographic data, assessment of knowledge regarding P.V and ADRs reporting, as well as perceptions of ADRs monitoring and reporting using a 5-point Likert scale. Data were analyzed using Statistical Package for Social Sciences (SPSS V. 28). Thus, descriptive statistics, binary logistic regression, and multiple logistic regression analysis were performed using odds ratios (ORs) with corresponding 95% confidence intervals (CIs) to assess knowledge, perceptions, and associated demographic factors. A P. value < 0.05 was considered statistically significant.

Results Two thirds (67.5%) exhibited poor knowledge regarding P.V, with a mean knowledge score of 4.0 ± 1.3. Female students (OR = 1.698; 95% CI: 1.096–2.629), those aged 21–24 years (OR = 2.874; 95% CI: 1.767–4.675), and students who had prior exposure to P.V concepts (OR = 1.984; 95% CI: 1.182–3.332) demonstrated significantly better

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knowledge ($p < 0.05$). While majority of students (80.8%) recognized the importance of ADRs reporting, substantial gaps were noted in understanding specific practices, such as reporting ADRs from herbal medicines and knowledge of national P.V guidelines.

Conclusion The study highlights the need for structured integration of P.V education into BS Pharm and Pharm D curricula in Palestine. Addressing identified knowledge gaps and demographic disparities through targeted training programs can enhance students' perceptions and professionalism in P.V activities, thus, improving medication efficacy, safety, and health outcomes.

Keywords Adverse drug reactions, Knowledge and perceptions, Palestine, Pharmacy education, Pharmacovigilance

Introduction

Pharmacovigilance (P.V) is a rapidly growing science including the process of identifying and responding to drug safety issues [1]. Thus, P.V includes all activities related to detection, assessment, understanding, and prevention of Adverse Drug Reactions (ADRs) or any other drug-related problem [2]. Recent studies indicated that ADRs are common causes of morbidity and mortality in both hospital and community settings resulting in about 5–20% of hospital admissions [3]. Subsequently, healthcare professionals' involvement and reporting of ADRs are essential for success of P.V programs. Pharmacists can play an important role in these programs due to their involvement in the medical field by dispensing medications and their role in patient counseling in order to achieve health outcomes with efficacy and safety. It was reported that positive perception of community pharmacists is positively associated with the quality of offered healthcare services [4, 5]. Pharmacists are more likely to be involved in P.V programs than other health care professionals [6]. Therefore, the role of pharmacist should involve many important aspects of pharmaceutical care, such as preventing ADRs and medication errors, improving patient satisfaction and quality of life, and improving economic outcomes [6–9].

To achieve these goals, pharmacists should be equipped with theoretical knowledge and practical skills about P.V to prevent, identify, and resolve drug-related problems and counsel patients and families on ADRs issues [10]. So, pharmacy colleges should focus on ADRs and P.V concepts to be involved as integral parts for Intended Learning Outcomes (ILOs) of courses in Bachelor's Degree in the training of Pharmacy (BS Pharm) and Doctor of Pharmacy (Pharm D.), as those students will be future pharmacists [11, 12].

Several studies were conducted in Malaysia, Saudi Arabia, Jordan and Libya to assess the concept of P.V among BS Pharm and Pharm D. students [13–18]. These studies pointed toward insufficient knowledge of students and recommended to involve the concept of P.V in teaching and training curricula in pharmacy schools. Middle Eastern countries including Palestine are still in their infancy in regards to their contribution in promoting the global P.V programs [19]. In Palestine, there is no pharmacovigilance center [20]. A study conducted among Palestinian pharmacists found that only 11.9% could conceptually or actually define P.V correctly, while approximately one quarter of participants defined ADRs correctly [21]. It was concluded that Palestinian pharmacists have poor knowledge about P.V, and these researchers pointed to the urgent need for educational programs to train them about P.V and ADRs reporting scheme [20, 22]. The insufficient knowledge about P.V was associated with underreporting of ADRs as a major challenge in patient management and follow up [19, 23].

To the best of our knowledge no previous studies have evaluated BS Pharm and Pharm D. students' knowledge and perceptions toward pharmacovigilance in Palestine. Therefore, this study aimed to investigate knowledge and perceptions of these students toward P.V as future clinical and community pharmacists. The findings of the study can disclose the educational gap among pharmacy students. This is vital for the design of educational and training programs as essential components in promoting and disseminating pharmacovigilance activities among future pharmacists.

Methods

Study design and setting

This study was cross-sectional; it was conducted after obtaining ethical approval from the Institutional Review Board (IRB) at An-Najah National University (NNU), Nablus, Palestine (Ref. Med August 2023/36). Therefore, this study was performed in compliance with the Helsinki Declaration for research in human. Also, it was carried out among undergraduate pharmacy students enrolled in either Bachelor's degree of Pharmacy (BS Pharm) or Doctor of Pharmacy (Pharm D) programs across seven accredited Palestinian universities in WBP and Gaza Strip of Palestine. These Palestinian universities included NNU, Birzeit University, Alquds University, Arab American University, Hebron University, University of Palestine, and Al-Azhar University, on which their curricula and Intended Learning Outcomes (ILOs) were almost unified [24]. Thus, allowing for a representative sample of BS Pharm and Pharm D students.

Subsequently, the informed consent process was provided in Arabic, which was the native language of all participants, and included both oral and written forms. Furthermore, the form was carefully reviewed for clarity and comprehension; and no translation was needed as all participants are native Arabic speakers and proficient in Arabic. Consequently, all participants provided their oral and written informed consents to participate in this research before they were included in the study.

Study population and sampling

The list of students was obtained from systems and records of universities involved in the study. But, due to logistical constraints related to time, cost, and the unique and extraordinary security challenges present in Palestine, a purposive sampling approach was adopted. Thus, the selected Palestinian universities distributed across WBP and Gaza Strip of Palestine was included due to the fact that those universities are representing the primary institutions providing BS Pharm and Pharm D education in Palestine. So, the study specifically targeted final-year undergraduate students (i.e., 5th year BS Pharm and 5th and 6th year Pharm D students) who had completed core coursework in clinical pharmacy, medication safety, and P.V, thereby ensuring relevant exposure to the study themes. First, second, third, and fourth year pharmacy and pharm D. students, as well as those post graduate level (Master's and Ph.D.) students were excluded from the study, due to the evidence that undergraduate students had no clinical exposure and have not taken courses in P.V subjects and concepts.

Postgraduate students were excluded due to considerable heterogeneity in program specialization across institutions, which often focused on topics not directly relevant to P.V (e.g., microbiology, phytochemistry), and the time elapsed since completing their bachelor's coursework, which could affect recall accuracy regarding drug safety and clinical training [25]. It is important to acknowledge that purposive sampling and the disproportionate representation from NNU, which had a higher number of eligible participants, may limit the generalizability of the findings and introduce potential institutional bias. Furthermore, possible differences in the extent and quality of P.V related training across the participating universities should be taken into account when interpreting the results.

Sample size calculation

The sample size obtained using Raosoft calculator (www.raosoft.com) by considering a 95% confidence level and margin error of 5%. Thus, the calculated sample size was 377, and the estimated minimum sample size was 399 after adding 9% of the calculated sample size. Subsequently, complete data was collected from 412 BS Pharm and Pharm D. students between September and December 2024.

Data collection and assessment tool

The study utilized an online questionnaire adapted from previous research conducted in similar contexts to assess knowledge, attitudes, and perceptions regarding P.V activities [26]. The online copy is available as a Google™ document. The response to the online questionnaire was opened for participants between 1 April and 29 May 2024. At the beginning of the questionnaire, there was an introductory section describing the purpose and objectives of our study. It includes a 31 items encompassing three key domains represented by: (1) demographics; (2) knowledge; and (3) perceptions of final-year BS Pharm and Pharm D. students concerning ADRs reporting and P.V.

Subsequently, the first section included six demographic items regarding age, current university, and gender, as well as questions concerning the students' prior exposure to the terms ADRs and P.V. In addition, this section explored whether students had completed any coursework related to P.V. The second section includes 10 multiple choice questions to measure students' knowledge about P.V and ADRs reporting, and students need to fill up their correct answers. Thus, knowledge concerning ADRs reporting was measured using 10 correct or wrong items. Therefore, a score of 1 was provided to each participant with each correct answer and 0 for each wrong answer, with a maximum score obtained by participants for 10-item survey was 10 scores out of 10, and the minimum obtainable score was 0 out of 10 for 10 survey questions with 10 wrong answers [26, 27].

To evaluate students' knowledge levels, scores were interpreted using a threshold consistent with the academic grading standards commonly applied in Palestinian universities. Specifically, a score below 50% (< 5/10) was categorized as "poor knowledge," while a score of 5 or above (≥ 5/10) was considered "adequate." This cut-off aligns with local academic performance criteria, where < 50% is deemed poor, 50–60% good, 60–69% very good, and ≥ 70% excellent. Although international standards in health professions education often consider 60–70% as the minimum threshold for competence, the 50% benchmark was chosen in this study to reflect local educational norms and maintain contextual relevance [24, 27]. The authors acknowledge this difference and recommend that future comparative studies consider higher cut-offs aligned with international benchmarks [27].

The third part of the questionnaire was developed to assess the perceptions of BS Pharm and Pharm D students toward adverse drug reaction (ADR) reporting. This section was adapted from a previous study conducted in Nigeria [26]. Specifically, it included 15 items

evaluated using a 5-point Likert scale to measure the degree of agreement with statements related to ADR monitoring, reporting, and pharmacovigilance (P.V) within the Palestinian context. Response options ranged from 1 (strongly disagree) to 5 (strongly agree), reflecting an ordinal scale. Most of the items were structured and closed-ended, although some permitted non-mutually exclusive answers.

In addition, the questionnaire was distributed to via email that included a web link to the questionnaire page in a google form (https://docs.google.com/forms/d/e/1FAIpQLSfBb01EaOfTjvi_j65WeGAJIp44Zc7V-vZuBUrH0R0pp42o3g/viewform?) in order to ensure indepen dent responses. Also, students were instructed to complete the questionnaire individually without consulting peers or reference materials. Thus, this approach aimed to reflect the participants' genuine knowledge of P.V activities. Prior to the main study, the questionnaire was translated into Arabic, in order to obtain the Arabic version of instruments to use in this study. Consequently, the Arabic versions were translated back into English by 2 English lecturers holding Masters in English in Birzeit University, Birzeit-Palestine. An English lecturer in NNU who is a native English speaker checked the congruence between the original and the back-translated English versions. Accordingly, those items were revised and retranslated by the researcher. Subsequently, the translated questionnaire was reviewed by three experts in P.V and pharmacy education in WBP to check for appropriateness of the answer choices, the understandability, readability, and clarity of Arabic translated items.

Furthermore, 30 BS Pharm and pharm D. students were invited to join a pilot study, aimed primarily to pretest the Arabic versions of the questionnaire, identify errors and misunderstood questions, and whether or not students had any feedback or valid comments which were taken into consideration by the researcher for the main study to make necessary revisions, including reformatting some questions into a multiple-choice format and expanding abbreviations such as ADRs and P.V for clarity. A pretest was carried out through distribution of an online questionnaire among the participants who were not included in the final analysis by the researcher. Furthermore, feedback from this pilot group was used.

In addition, the pilot study was also conducted to assess the face validity of the questionnaire, ensuring that questions were clear, understandable, and relevant to concepts being evaluated. To establish content validity, efforts were made to verify that questions thoroughly addressed the intended topics related to P.V activities. Reliability was evaluated using Cronbach's alpha, calculated for each section and the overall questionnaire. The finalized instrument was administered to students during in-person sessions conducted by the researchers in coordination with course facilitators. Subsequently, the Cronbach alpha of P.V knowledge and perceptions was 0.72, which indicated consistency in the questionnaire.

Statistical analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS version 22). Descriptive statistics were employed to summarize the demographic characteristics, knowledge levels, and perceptions of BS Pharm and Pharm D students toward ADRs reporting and P.V activities. Categorical variables were reported as frequencies (N) and percentages (%), while continuous variables were presented as means ± standard deviation (SD) and medians with interquartile ranges (25th, 50th, and 75th percentiles). Knowledge score of the participants about P.V was computed based on a 10-item scale, with each correct answer assigned one point. The resulting total score (ranging from 0 to 10) was analyzed as both a continuous and categorical variable. Subsequently, scores were classified and coded as follows: 0 = Poor Knowledge (< 50%), 1 = Good Knowledge (50–59%), 2 = Very Good Knowledge (60–69%) and 3 = Excellent Knowledge (≥ 70%) for categorical analysis. Frequencies, percentages, means ± SD, and median scores were reported.

Associations between knowledge levels and key demographic variables represented by age, gender, university, prior exposure to P.V, and completion of P.V related coursework were examined using binary logistic regression that was initially conducted. Subsequently, variables found to be statistically significant ($p < 0.05$) in the binary logistic regression were consequently included in a multiple logistic regression to determine factors associated with knowledge dimensions and adjust for potential confounders. In addition, academic performance and prior formal training in P.V were considered as additional covariates in the regression models, recognizing their potential impact on students' knowledge levels.

In addition, perceptions of the final year BS Pharm and pharm D. students about P.V activities were presented with descriptive statistics including frequencies, percentages, and median at 50% percentiles. Therefore, the normality of perceptions' scores was tested using Kolmogorov Smirnov test, which were found to be non-normally distributed, non-parametric tests were used for group comparisons. Thus, intergroup differences in scores of each perception's item with age, gender, graduated university, hearing about ADRs and P.V, and courses taken related to P.V were assessed for statistical significance using non-parametric including Mann Whitney U tests and Kruskal-Wallis tests.

The Mann–Whitney U test was used for comparisons between two groups (E.g. gender), while the Kruskal–Wallis test was used for comparisons across three or more groups (E.g. course exposure, and P.V awareness).

These were used in describing their opinion to specified statements in an ordinal scale. The Bonferroni correction was applied where appropriate to reduce the risk of Type I error due to multiple subgroup comparisons. Also, the significance level was set as P. value < 0.05 that might be adjusted as needed after correction for multiple comparisons.

Results

Results have shown that majority of participants were females ($N = 252$, 61.2%). Ages of almost half of participants were between 21 and 24 years old ($N = 209$, 50.7%), followed by age group 18–20 years of age ($N = 144$, 35%). Also, the mean knowledge score in P.V and ADRs reporting by participants was 4.0 ± 1.3. Furthermore, the majority of participants reported that they have poor knowledge about P.V and ADRs reporting ($N = 276$, 67.5%). Furthermore, Binary logistic regression of factors associated with knowledge concerning P.V and ADRs reporting showed that there was a significant association between gender, age, and hearing about P.V with knowledge about P.V and ADRs reporting ($P < 0.05$) (Table 1). However, no significant association was found between knowledge and whether students had taken P.V coursework.

Subsequently, female participants were more likely to have good knowledge about P.V and ADRs reporting ([O.$R = 1.698$; 95% C.I of 1.096–2.629]). Furthermore, participants whom their ages 21–24 years old, and those who reported that they heard about P.V were significantly more likely to have good knowledge about P.V ([O.$R = 2.874$; 95% C.I of 1.767–4.675] and [O.$R = 1.984$; 95% C.I of 1.182–3.332], respectively). However, there were no significant association between receiving courses concerning P.V and knowledge about P.V and ADRs reporting ($P > 0.05$).

Table 2 showed that multiple logistic regressions of factors associated with P.V and ADRs reporting showed that ages were significantly associated with knowledge about P.V and ADRs reporting ($P < 0.05$). Thus, ages 21–24 years old were significantly associated with increased odds of having a good knowledge about P.V and ADRs reporting. Participants who reported that their ages 21–24 years old were significantly more likely to have good knowledge about P.V and ADRs reporting ([O.$R = 2.713$; 95% C.I of 1.660–4.433]) even after controlling for potential confounders. Subsequently Associations between knowledge concerning P.V and ADRs reporting with socio-demographic characteristics and P.V courses and hearing about P.V are clearly stated and presented. To

Table 1 Binary logistic regression of factors associated with good knowledge about pharmacovigilance

Variable	Frequency (%) *N* = 412	Good Knowledge *N* = 134 (32.5%)	Poor Knowledge *N* = 278 (67.5%)	Odds Ratio with 95% C.I	*P*-Value
Age category					
18–20	144 (35.0)	30 (20.8%)	114 (79.2%)	**Reference (1)**	**0.000***
21–24	209 (50.7)	90 (43.1%)		2.874 (1.767–4.675)	
≥ 25	59 (14.3)	14 (23.7%)	119 (56.9%)	1.182 (0.574–2.434)	
			45 (76.3%)		
Gender					
Male	160(38.8)	41 (25.6%)	119 (74.4%)	**Reference (1)**	**0.018***
Female	252 (61.2)	93 (36.9%)	159 (63.1%)	1.698 (1.096–2.629)	
Pharmacovigilance Course					
Yes	100 (24.3)	36 (36.0%)	64 (64.0%)	1.228 (0.765–1.972)	0.394
No	312 (75.7)	98 (31.4%)	214 (68.6%)	**Reference (1)**	
Hearing about Pharmacovigilance					
Yes	308 (74.8)	111 (36.0%)	197 (64.0%)	1.984 (1.182–3.332)	**0.010***
No	104(25.2)	23 (22.1%)	81 (77.9%)	**Reference (1)**	
*University					
AAUP	14 (3.4)	2 (14.3%)	12 (85.7%)	**Reference (1)**	0.136
H.U	36 (8.7)	8 (22.2%)	28 (70.4%)	1.714 (0.316–9.296)	
Q.U	27 (6.6)	8 (29.6%)	19 (70.4%)	2.526 (0.457–13.964)	
NNU	255 (61.9)	96 (37.6)	159 (62.4)		
B.U	48 (11.7)	13 (27.1%)	35 (72.9%)	3.623 (0.794–16.534)	
A.U.	31 (7.5)	6 (19.4%)	25 (80.6%)	2.229 (0.438–11.337)	
				1.440 (0.252–8.221)	
U.P	1 (0.7)	1 (100%)	0 (0)	969 (0.000)	

Abbreviations: *AAUP (Arab American University of Palestine); *HU (Hebron University); *Q.U (Quds University); *NNU (An-Najah National University); *B.U (Birzeit University); *A.U (Azhar University); *U.P (University of Palestine)

*P-value < 0.05 is statistically significant. *Bold P-values are statistically significant

Table 2 Multiple regression of factors associated with good knowledge about pharmacovigilance

Variable	Frequency (%) *N* = 412	Good Knowledge *N* = 134 (32.5%)	Poor Knowledge *N* = 278 (67.5%)	Odds Ratio with 95% C.I	*P*–Value
Age category					
18–20	144 (35.0)	30 (20.8%)	114(79.2%)	**Reference (1)**	**0.000**
21–24	209 (50.7)	90 (43.1%)	119 (56.9%)	2.713 (1.660–4.433)	
≥ 25	59 (14.3)	14 (23.7%)	45 (76.3%)	1.556 (0.704–3.441)	
Gender					
Male	160(38.8)	41 (25.6%)	119 (74.4%)	**Reference (1)**	0.253
Female	252 (61.2)	93 (36.9%)	159 (63.1%)	1.354 (0.805–2.277)	
Pharmacovigilance Course					
Yes	100 (24.3)	36 (36.0%)	64 (64.0%)	1.228 (0.765–1.972)	0.394
No	312 (75.7)	98 (31.4%)	214 (68.6%)	**Reference (1)**	
Hearing about Pharmacovigilance					
Yes	308 (74.8)	111 (36.0%)	197 (64.0%)	1.984 (1.182–3.332)	2.685
No	104(25.2)	23 (22.1%)	81 (77.9%)	**Reference (1)**	

address the institutional bias from overrepresentation of An- NNU (61.9% of the sample), university affiliation was included as a covariate. While NNU students showed higher median scores, no significant adjusted odds ratios were found between universities, suggesting that results, though affected by sample structure, reflect general trends.

According to what is summarized in Table 3, more than half of participants ($N = 234$, 56.8%, $N = 223$, 54.1%, respectively) were able to understand correctly ADRs and P.V. Furthermore, a good performance by participants in the knowledge domain was recorded from the right answer to the question on the type of ADRs to be documented ($N = 268$, 65.0%). However, very poor performance by participants regarding type of ADRs in Palestine was reported. In addition, only less than quarter of participants ($N = 72$, 17.5%) knew that all cases of ADRs should be reported. Also, participants' knowledge regarding guidelines for reporting ADRs in Palestine were low, on which most of participants reported in a wrong answer that "there are no guidelines for reporting ADRs in Palestine" ($N = 276$, 67.0%).

Furthermore, the majority of participants were not able to know correct types of ADRS according to what is reported in their wrong answers regarding types of correct ADRs they know ($N = 300$, 72.8% of answers were wrong). Also, only 103 participants (25.0%, quarter of participants) could provide correct answers to whether or not ADRs caused by herbal medicines are documented or reported, despite 100% of students correctly recognizing the Palestinian Ministry of Health (PMOH) as the responsible authority for P.V in Palestine.

The perception component included 15 items measured on a 5-point Likert scale. The results showed that the majority of participants ($N = 333$, 80.8%) believed that late or non-reporting of ADRs could pose major health problems, and ADRs caused by herbal medicines should be reported (Survey statement no.4 and no. 5 respectively). However, perceptions varied significantly by age, gender, prior exposure to P.V, and university affiliation.

Furthermore, more than two thirds of participants ($N = 329$, 79.8%) believed that ADRs caused by herbal medicines are neither documented nor reported, and that ADRs reporting is an integral part of pharmaceutical care (Survey statements 8 & 9, respectively). Also, just a little below two thirds of participants stated that they were agreeing or strongly agreeing with statement that P.V should be taught at all pharmacy schools, faculties, and departments. Subsequently, this is an important indicator that should be taken into consideration in developing education regarding P.V to improve drug efficacy and safety.

In addition, highest numbers of participants stated that pharmacists' involvement in reporting ADRs would positively impact P.V activities (Survey item 11; $N = 342$, 83.1%), and correctly believed that ADRs caused by cosmetics should not be reported (Survey item 15; $N = 337$, 81.8%, respectively). Also, more than two thirds of participants ($N = 296$, 71.8%) reported correctly that P.V should be taught only at higher levels in pharmacy schools. Subsequently, a low number of participants reported that disclosure of identities of ADRs reporters would increase reporting (Survey item 12; $N = 166$, 40.3%), and that identities of ADRs reporters are not disclosed reporting rate will decrease (Survey item 12; $N = 148$, 35.9%). Results concerning items of BS Pharm and Pharm D. students' perceptions about ADRs reporting in Palestine are presented in Table 3.

Perception scores were found by Kolmogorov–Smirnov test to be non-normally distributed. So, non-parametric tests represented by Mann–Whitney U and Kruskal–Wallis tests were used. Given the multiple subgroup comparisons across items, Bonferroni correction was applied to adjust significance thresholds ($\alpha = 0.05 \ / \ 15 = 0.0033$

Table 3 Pharmacy and Doctor of pharmacy students' perceptions about adverse drug reaction reporting (*N* = 412)

Survey Statement No.	Age Q2 (Q1– Q3)	Gender Q2 (Q1– Q3)	*P.V Course	Hearing about *P.V	University Q2 (Q1-Q3)
N = 412	*P*-Value	*P*-value	Q 2 (Q1– Q3)	Q2 (Q1 - Q3)	*P*-value
* SA *N* (%)			*P*-value	*P*-value	
*A N (%)					
1	18–20: 2 (2–3)	Male: 2 (1–3)	No: 2 (2–3)	No: 2 (1–3)	*AAUP: 1 (1–20)
10 (2.4)	21–24: 3 (2–4)	Female: 3 (2–4)	Yes: 3 (2–4)	Yes: 3 (2–4)	*H.U: 2 (1–2.75)
94 (22.8)	≥ 25: 2 (1–3)	*P* = 0.000	*P* = 0.018	*P* = 0.000	*Q.U: 2 (1–3)
	P = 0.000				*NNU: 3 (2–4)
					*B.U: 2 (1.25–3)
					*A.U: 2 (1–3)
					P = 0.000
2	18–20: 4 (3–4)	Male: 2 (1–3)	No: 4 (3–5)	No: 4 (3–5)	AAUP: 4 (3–5)
128 (31.1%)	21–24: 4 (4–5)	Female: 2 (1–3)	Yes: 4 (3–5)	Yes: 4 (3–5)	H.U: 4.5 (4 – 5)
163 (39.6)	≥ 25: 4 (3–5)	*P* = 0.062	*P* = 0.015	*P* = 0.619	Q.U: 4 (3–5)
	P = 0.011				NNU: 4 (3–5)
					B.U: 4 (3–5)
					A.U: 4 (3–5)
					P = 0.279
3	18–20: 2 (1–3)	Male: 4 (3–5)	No: 2 (1–3)	No: 2 (1–3)	AAUP: 2 (1-3.25)
16 (3.9%)	21–24: 2 (1-2.5)	Female: 4 (3–5)	Yes: 2 (1–3)	Yes: 2 (1–3)	H.U: 2 (1 – 2.75)
34 (8.3%)	≥ 25: 2 (1–3)	*P* = 0.128	*P* = 0.011	*P* = 0.096	Q.U: 2 (1–3)
	P = 0.011				NNU: 2 (1–3)
					B.U: 2 (1–3)
					A.U: 2 (1–3)
					P = 0.755
4	18–20: 4 (4–5)	Male: 4 (3–5)	No: 4 (4–5)	No: 4 (3–5)	AAUP: 4 (3–5)
156 (37.9)	21–24: 4 (4–5)	Female: 4 (3–5)	Yes: 4 (3–5)	Yes: 4 (4–5)	H.U: 4 (4 – 4.75)
177 (43.0)	≥ 25: 4 (2–4)	*P* = 0.000	*P* = 0.011	*P* = 0.096	Q.U: 4 (3–5)
	P = 0.000				NNU: 4 (4–5)
					B.U: 3.5 (2–5)
					A.U: 4 (3–5)
					P = 0.755
5	18–20: 4 (4–5)	Male: 4 (3–4)	No: 4 (4–5)	No: 4 (3–5)	AAUP: 4 (3–4)
148 (35.9)	21–24: 4 (4–5)	Female: 4 (4–5)	Yes: 4 (4–5)	Yes: 4 (4–5)	H.U: 4 (3 – 4)
185 (44.9)	≥ 25: 3 (2–4)	*P* = 0.000	*P* = 0.970	*P* = 0.000	Q.U: 4 (3–5)
	P = 0.000				NNU: 4 (4–5)
					B.U: 4 (3–4.75)
					A.U: 3 (3–4)
					P = 0.000
6	18–20: 3.5(3–4)	Male: 4 (3–4)	No: 4 (3–4)	No: 4 (3–4)	AAUP: 4 (3–4)
65 (15.8)	21–24: 4 (4–4)	Female: 4 (3–4)	Yes: 4 (3–4)	Yes: 4 (3–4)	H.U: 4 (3 – 5)
169 (41.0)	≥ 25: 4 (2–4)	*P* = 0.406	*P* = 0.705	*P* = 0.704	Q.U: 4 (3–5)
	P = 0.049				NNU: 4 (3–4)
					B.U: 4 (2.25-4)
					A.U: 3 (3–5)
					P = 0.041
7	18–20: 4(3–4)	Male: 4 (3–4)	No: 4 (3–4)	No: 4 (3–4)	AAUP: 4 (3–5)
69 (16.7)	21–24: 4 (3–4)	Female: 4 (3–4)	Yes: 4 (3–4)	Yes: 4 (3–4)	H.U: 4 (2 – 5)
178 (43.2)	≥ 25: 3 (2–4)	*P* = 0.131	*P* = 0.704	*P* = 0.833	Q.U: 4 (3–4)
	P = 0.006				NNU: 4 (3–4)
					B.U: 3.5 (3–4)
					A.U: 4 (3–5
					P = 0.294
8	18–20: 4(4–5)	Male: 4 (3–5)	No: 4 (4–5)	No: 4 (3–4)	AAUP: 4.5 (3–5)

Table 3 (continued)

Survey Statement No.	Age Q2 (Q1– Q3)	Gender Q2 (Q1– Q3)	*P.V Course	Hearing about *P.V	University Q2 (Q1-Q3)
N = 412	*P*-Value	*P*-value	Q 2 (Q1– Q3)	Q2 (Q1 - Q3)	*P*-value
* SA *N* (%)			*P*-value	*P*-value	
118 (28.6)	21–24: 4 (4–5)	Female: 4 (4–5)	Yes: 4 (4–5)	Yes: 4 (4–5)	H.U: 4 (4 – 5)
211 (51.2)	≥ 25: 4 (3–4)	*P* = 0.001	*P* = 0.366	*P* = 0.005	Q.U: 4 (3–5)
	P = 0.000				NNU: 4 (4–5)
					B.U: 4 (3–4)
					A.U: 4 (3–5
					P = 0.024
9	18–20: 4(4–5)	Male: 4 (3–5)	No: 4 (4–5)	No: 4 (3–5)	AAUP: 4 (3–5)
165 (40)	21–24: 4 (4–5)	Female: 4 (4–5)	Yes: 4 (3.25–5)	Yes: 4 (4–5)	H.U: 4 (3 – 5)
163 (39.6)	≥ 25: 3 (2–5)	*P* = 0.000	*P* = 0.213	*P* = 0.003	Q.U: 4 (3–5)
	P = 0.000				NNU: 4 (4–5)
					B.U: 4 (3-4.75)
					A.U: 4 (3–5)
					P = 0.003
10	18–20: 4(3–5)	Male: 4 (3–5)	No: 4 (4–5)	No: 4 (3–4)	AAUP: 4 (3–5)
141 (34.2)	21–24: 4 (4–5)	Female: 4 (4–5)	Yes: 4 (4–5)	Yes: 4 (4–5)	H.U: 4 (3.25 – 5)
170 (41.3)	≥ 25: 4 (2–4)	*P* = 0.003	*P* = 0.767	*P* = 0.001	Q.U: 4 (3–5)
	P = 0.000				NNU: 4 (4–5)
					B.U: 4 (3–5)
					A.U: 4 (3–5)
					P = 0.152
11	18–20: 4(4–5)	Male: 4 (3–5)	No: 4 (4–5)	No: 4 (3–5)	AAUP: 4 (2.75-5)
169 (41.0)	21–24: 4 (4–5)	Female: 4 (4–5)	Yes: 4 (4–5)	Yes: 4 (4–5)	H.U: 4 (4 – 5)
173 (42.0)	≥ 25: 4 (2–4)	*P* = 0.000	*P* = 0.272	*P* = 0.008	Q.U: 4 (2–5)
	P = 0.000				NNU: 4 (4–5)
					B.U: 4 (3–5)
					A.U: 4 (3–5)
					P = 0.011
12	18–20: 3(3–4)	Male: 4 (3–5)	No: 3 (2–4)	No: 4 (3–4)	AAUP: 4 (3.75-5)
63 (15.3)	21–24: 3 (2–4)	Female: 3 (2–4)	Yes: 3 (2–4)	Yes: 3 (2–4)	H.U: 4 (2 – 5)
103 (25.0)	≥ 25: 3 (2–4)	*P* = 0.000	*P* = 0.858	*P* = 0.006	Q.U: 3 (2–4)
	P = 0.516				NNU: 3 (2–4)
					B.U: 4 (3–5)
					A.U: 4 (3–5)
					P = 0.000
13	18–20: 3(3–4)	Male: 4 (3–4)	No: 3 (2.25–4)	No: 3 (3–4)	AAUP: 4 (3.75-5)
48 (11.7)	21–24: 3 (2–4)	Female: 3 (2–3)	Yes: 3 (2–4)	Yes: 3 (2–4)	H.U: 4 (2 – 4)
100 (24.3)	≥ 25: 3 (3–4)	*P* = 0.004	*P* = 0.000	*P* = 0.004	Q.U: 3 (2–4)
	P = 0.053				NNU: 3 (2–4)
					B.U: 4 (2–4)
					A.U: 4 (3–5)
					P = 0.000
14	18–20: 4(3–4)	Male: 4 (3–5)	No: 4 (3–5)	No: 4 (3–5)	AAUP: 4 (4–5)
120 (29.1)	21–24: 4 (4–5)	Female: 4 (4–5)	Yes: 4 (3–5)	Yes: 4 (4–5)	H.U: 4 (3 – 5)
176 (42.7)	≥ 25: 4 (3–5)	*P* = 0.451	*P* = 0.474	*P* = 0.070	Q.U: 4 (3–5)
	P = 0.002				NNU: 4 (4–4)
					B.U: 4 (3–5)
					A.U: 4 (3–5)
					P = 0.322
15	18–20: 4(4–5)	Male: 4 (3–5)	No: 4 (3–5)	No: 4 (3–5)	AAUP: 5 (3–5)
181 (43.9)	21–24: 4 (4–5)	Female: 5 (4–5)	Yes: 4 (4–5)	Yes: 4 (4–5)	H.U: 4.5 (3 – 5)
156 (37.9)	≥ 25: 3 (2–4)	*P* = 0.000	*P* = 0.893	*P* = 0.000	Q.U: 4 (2–5)

Table 3 (continued)

Survey Statement No.	Age Q2 (Q1– Q3)	Gender Q2 (Q1– Q3)	*P.V Course	Hearing about *P.V	University Q2 (Q1-Q3)
N = 412	*P*-Value	*P*-value	Q 2 (Q1– Q3)	Q2 (Q1 - Q3)	*P*-value
* SA *N* (%)			*P*-value	*P*-value	
	P = 0.000				NNU: 4 (4–5) B.U: 4 (3–5) A.U: 4 (3–5) *P* = 0.000

Abbreviations: *SA: Strongly Agree.*P.V: Pharmacovigilance. *A: Agree. *AAUP: Arab American University of Palestine. *Hebron University: *Q.U: Quds University. *NNU: An-Najah National University. * B.U: Birzeit University. *A.U: Azhar University

P-values obtained from either Mann-Whitney U test, or Kruskal-Wallis test. *P-value < 0.05 is statistically significant. *Bold P-values are statistically significant (Mann-Whitney U test or Kruskal-Wallis test)

for 15 items). After correction, statistically significant differences remained in key items. So, results in Table 3 showed that almost all items of BS Pharm and Pharm D. students' perceptions about ADRs reporting in Palestine were found to be significant ($P < 0.05$) according to computed medians using Kruskal Wallis and MANN-Whitney U Test for all those items. Subsequently, the median score of perception item 1 was 2 (Q1– Q3: 2–4).

A significant difference was found among participants according to age, and graduated university (Kruskal–Wallis test; $P < 0.05$), gender, P.V courses taken, and hearing about P.V (Mann–Whitney U test; $P < 0.05$). Thus, participants whom their ages 21–24 years old had higher perception item 1 score than those ages 18–20 years old and those their ages 25 years and above. Furthermore, Participants in NNU had highest median score compared to other Palestinian universities.

In addition, female participants had higher median scores of perception about ADRs reporting than male participants. Also, participants who reported that they took P.V courses and those heard about P.V had higher scores compared to those who did not take P.V courses or heard about P.V. Subsequently, the computed Kruskal-Wallis and Mann U values for all the survey items with their P-values are presented in Table 3. Furthermore, a significant different item 2 score was found between participants according to age (Kruskal-Wallis Test, $P < 0.05$) and hearing about P.V (Mann-Whitney U Test, $p < 0.05$). Subsequently, participants whom their ages 21–24 years and 25 years old and above had significantly higher scores than those ages 18–20 years old.

It was found that median score for participants whom their ages 21–24 years old was 5 (Q1-Q3: 4–5), and those whom their ages 25 years old and above was 5 (Q1-Q3: 3–5). Furthermore, a significant difference in median item 3 score was found among participants according to their ages (Kruskal-Wallis test; $P < 0.05$), which is presented in Table 3. In addition, a significant different in item 4 score was found between participants according to age (Kruskal-Wallis test; $P < 0.05$), university, gender, and hearing about P.V (Mann-Whitney U Test; $p < 0.05$). Regarding items 5 and 6, a significant difference was found according to age (Kruskal-Wallis test; $P < 0.05$), university, and gender (Mann-Whitney U test; $P < 0.05$). Therefore, participants whom their ages 18–20 years old and 21–24 years old significantly had a higher median score of item 5 than those their ages 25 years old and above.

Concerning item 7, median score of item 7 for participants whom their ages 18–20 years old and 21–24 years old were 4 (Q1– Q3: 3–4; $P < 0.05$), and for those whom their ages 25 years old and above was found to be 3 (Q1– Q3: 2–4; $P < 0.05$). With regard to items 8 and 9 scores, Table 3 showed that a significant difference was found according to ages, university (Kruskal-Wallis test; $P < 0.05$), gender, and hearing about P.V (Mann-Whitney U Test; $P < 0.05$). In addition, results showed that a significant difference in item 10 median score was found among participants according to their ages, (Kruskal–Wallis test; $P < 0.05$), gender, and hearing about P.V (MANN-Whitney U Test; $P < 0.05$) (Table 3). The computed Kruskal-Wallis and Mann-Whitney U values for all the survey items and statements of perceptions about ADRs reporting are presented in Table 3, on which almost all the survey items and statements were significant at $P < 0.05$.

Discussion

This study provides insight into the knowledge and perceptions of final-year BS Pharm and Pharm D students in Palestine regarding P.V and ADRs reporting. The findings suggest moderate overall knowledge levels, with a substantial proportion of students (67.5%) scoring below 50%. These results highlight the need to strengthen P.V education across BS Pharm and Pharm D programs in the region. Also, this study clearly demonstrated the importance of P.V for development of the reality of pharmaceutical care in Palestine represented by health outcomes related to its importance in achieving safe and effective use of medications. Hence, clearly it is important to take the age of BS Pharm and Pharm D. students into account and its impact on increasing the likelihood and extent of their knowledge regarding P.V, as they progress in their studies and become more familiar with pharmaceutical sciences, which ultimately leads to developing education

related to patient health outcomes related to effectiveness and safe use of medications [28].

The study results also showed that female participants and participants who indicated that they received education about P.V were more likely to have good knowledge about P.V, and this stems from several reasons, the most important of which is the high percentage of females among B.S Pharm and Pharm D. students. Consequently, this results from the educational approach followed in Palestinian universities in order to develop pharmaceutical education and expand students' awareness and the pioneering role of the pharmacist in providing the best health care, as the pharmacist has great importance represented in his role as a basic step in dispensing medications, reviewing medications' prescription sheets, accompanied by patient counseling and follow-up. Hence, the importance of P.V is evident in pharmacy education among B.S Pharm and Pharm D. as well as their role in health care. Although most of study participants reported that they did not receive special courses regarding P.V despite its importance to pharmacy and Pharm D. professions [29, 30].

Only graduate students from various pharmaceutical specialties receive courses regarding P.V in accordance with study plans. However, P.V is explained in courses of plans of the B.S Pharm and Pharm D [28]. However, the multiple logistic regression analysis of factors associated with good knowledge proved that age is related to good knowledge of P.V, and this is mainly related to age and thus progress and development in courses, course plan and content, and its close connection to developing the pharmacist's role in health care, as it has a significant impact on achieving the best health outcomes represented by efficacy and safety of medication use. Subsequently, this study provides significant insights into perceptions of study participants regarding ADRs reporting and P.V, with particular focus on B.S Pharm and Pharm D students in Palestine. The results emphasize critical aspects that need to be addressed to strengthen the P.V system in Palestine [31].

The study finding that the majority of participants (80.8%) recognize the importance of reporting ADRs, including those caused by herbal medicines, indicates a strong foundational awareness. However, the perception that ADRs caused by herbal medicines are often undocumented and unreported highlights a critical gap in the current P.V practices. Thus, addressing this gap is essential for improving drug safety, especially given the widespread use of herbal medicines in Palestine and other developing countries. Furthermore, the consensus that ADRs reporting is integral to pharmaceutical care underscores the need to institutionalize these practices at all levels of the healthcare system [32, 33].

Furthermore, a vital indicator of the need for educational reform is significantly supported by teaching P.V for B.S Pharm and Pharm D students. Thus, P.V need to be systematically integrated in B.S Pharm and Pharm D. curricula, particularly at higher levels of educations. Subsequently, this would ensure that B.S Pharm and Pharm D. students would be as future pharmacists that are adequately equipped with knowledge and skills necessary for ADRs reporting and monitoring, consequently improving efficacy and safety of medication use in Palestine, and enhancing pharmacists' role in health care. A notable finding is the relatively low agreement regarding the disclosure of ADRs reporters' identities as a factor that could either increase or decrease reporting rates [34–36].

This suggests a lack of clarity or consensus among participants about the role of confidentiality in P.V. Addressing these concerns through clear policies and awareness campaigns could enhance reporting rates and foster a culture of transparency and trust. The differences in perceptions based on age, gender, university affiliation, and prior exposure to P.V highlight the need for targeted interventions. For instance, participants aged 21–24 years and females showed higher perception scores, suggesting that these groups may be more receptive to P.V education and practices [37, 38], likely reflecting increased exposure to clinical coursework and practical applications in later years of study. This trend aligns with prior studies in similar educational contexts, such as those from Jordan, Saudi Arabia, and India, where final-year students generally report higher P.V knowledge due to advanced academic exposure and training [39].

While female students exhibited significantly higher P.V knowledge scores, this finding should be interpreted cautiously. The over-representation of female participants (61.2%) and the use of a non-random, purposive sample may have introduced gender-related sampling bias. Additionally, the difference may not reflect inherent gender-based knowledge gaps but rather structural or cultural factors influencing education and engagement in the field. Future studies using stratified random sampling are recommended to more accurately assess gender differences [40].

In addition, participants from NNU had the highest median scores, indicating that certain institutions may have more effective P.V education or awareness programs. Potentially due to more structured P.V content or stronger institutional focus on patient safety. However, the over-representation of NNU students limits the generalizability of this finding. Despite this, the variation highlights the need for standardization and enhancement of P.V curricula across all pharmacy schools in Palestine. In addition, this calls for the dissemination of best practices across other universities in Palestine [41].

The widespread belief that pharmacists' involvement in ADRs reporting is significantly associated with P.V activities in accordance with latest and current global trends and guidelines with positive impact. Pharmacists are often the first health care professional that will be contacted by patients once experiencing ADRs, Therefore, their uniquely role and positioned as a pivotal role in ADRs reporting. Consequently, addressing ADRs reporting and P.V activities among B.S Pharm and Pharm D students as future pharmacist is strengthening pharmacists' roles through their training, resources, and incentives that could significantly enhance P.V efforts in Palestine [42, 43].

A key concern identified was the lack of formal P.V coursework among most participants, even though many acknowledged its importance. Notably, more than 80% of students agreed that pharmacists should play an active role in ADRs reporting and that P.V should be included in the curriculum. These results mirror studies from Egypt, Nigeria, and Pakistan, where pharmacy students expressed positive attitudes but limited practical knowledge due to insufficient curricular integration [44]. Subsequently, Palestinian universities should adopt a more structured and integrated P.V education model based on international examples such as the UK's pharmacy schools integrate P.V including active reporting exercises aligned with guidelines [45]. Furthermore, WHO-Uppsala Monitoring Centre resources can be adapted locally to provide P.V training modules and student certifications [46]. Therefore, P.V should be introduced gradually starting from third year, with integration into clinical pharmacy, patient safety, and pharmacotherapy courses in the Palestinian context.

Mandatory workshops on ADRs documentation and national reporting platforms via the Palestinian official health institutions such as PMOH can reinforce knowledge through practice. Therefore, this presents an opportunity to design targeted P.V engagement strategies for younger students and those less informed about P.V. In addition, responses to confidentiality related items were mixed. Less than half of students agreed that identity disclosure would affect ADRs reporting, indicating confusion or lack of awareness. This highlights the need for clearer communication on reporting confidentiality in educational and regulatory materials among students in Palestinian universities. Consequently, P.V education among BS Pharm and Pharm D students remains insufficient despite high awareness of its importance. Therefore, enhancing P.V knowledge through standardized curricula, active reporting exercises, and targeted workshops is essential. Accordingly, attention should be paid to institutional disparities, ensuring that future holders of BS Pharm and Pharm D are fully equipped to contribute to medication efficacy and safety as an integral part of health care in Palestine.

Study limitations

This study covered an important aspect of university education to prepare BS Pharm and Pharm D students to develop efficacy and safety of health care provided for patients. However, Cross-sectional design limits the ability to assess causality or longitudinal changes in P.V knowledge. Furthermore, purposive sampling and institutional overrepresentation especially from NNU may limit generalizability and introduce institutional bias. Self-reported data are subject to response and recall bias, which was avoided as much as possible particularly in items assessing prior P.V exposure or perceptions. Finally, lack of adjustment for academic performance and other potential confounders, such as cumulative GPA or curriculum differences, may affect interpretation.

Conclusion

The study findings highlight the urgent need for a structured approach to improve P.V in Palestine because it is the cornerstone to achieve health outcomes represented by efficacy and safety of medications use. Accordingly, it is recommended to integrate P.V into B.S Pharm and Pharm D. curricula. Subsequently, to ensure that faculties of pharmacy would incorporate advanced levels of comprehensive P.V training to enhance students' understanding and participation in ADRs reporting. Also, knowledge about P.V and ADRs reporting would be helpful for future pharmacists (B.S Pharm and Pharm D students) to develop national guidelines and systems to streamline the reporting of ADRs, including mechanisms for documenting ADRs of medications, herbal medicines, and cosmetics. Furthermore, the study results emphasized the focus on demographic groups with lower knowledge and awareness, such as younger and male students, thus, ensuring equitable improvement in P.V knowledge and practices. Subsequently, this would empower future pharmacists' role in health care provision through specialized training and recognition programs to take an active role in P.V. Consequently, Palestine can strengthen its P.V framework, thereby improving medication efficacy and safety, and achieving best health outcomes.

Accordingly, this study highlights significant gaps in P.V knowledge and awareness among final-year BS Pharm and Pharm D students in Palestine, particularly in areas related to ADRs reporting for conventional medications, herbal products, and cosmetics. These findings underscore the urgent need for a structured and standardized approach to P.V education within pharmacy programs. Therefore, it is recommended that pharmacy faculties integrate dedicated P.V modules into the BS Pharm and Pharm D curricula, especially during clinical years such

as training in ADRs documentation and use of national reporting systems to address these gaps. Also, Collaboration with PMOH and other official health institutions such as WHO is also essential to align academic training with national P.V objectives and encourage active student involvement in ADRs reporting. So, Palestine can enhance its national P.V system, promote safer medication use, and strengthen the pharmacist's role in ensuring patient safety and therapeutic efficacy.

Abbreviations

ADRs	Adverse drug reactions
BS Pharm	Bachelor of science in pharmacy
Pharm D	Doctor of pharmacy
P.V	Pharmacovigilance
SPSS	Statistical package for the social sciences
OR	Odds ratio
CI	Confidence interval
IRB	Institutional review board
NNU	An-najah national university
AAUP	Arab american university of palestine
HU	Hebron University
Q.U	Quds University
B.U	Birzeit University
A.U	Azhar University
U.P	University of Palestine
ILOs	Intended learning outcomes
PMOH	Palestinian ministry of health
SD	Standard deviation

Acknowledgements
Authors would like to thank An-najah National University for supporting this research.

Author contributions
R.M. Research concept, data collection, data analyses, initial manuscript writing, manuscript editing, and finalizing manuscript. M.G. Research concept, data collection, initial manuscript writing, manuscript editing. A.A. Research concept, data collection, initial manuscript writing, manuscript editing. Y.J. Research concept, initial manuscript writing, manuscript editing, Data analysis, Manuscript submission. A.H. Research concept, data collection, initial manuscript writing, manuscript editing. R.B. Research concept, data collection, initial manuscript writing, manuscript editing. S.S. Research concept, data collection, initial manuscript writing, manuscript editing.

Funding
The current work was supported by Princess Nourah bint Abdulrahman University Researchers Supporting Project number (PNURSP2025R814), Princess Nourah bint Abdulrahman University, P.O. Box 84428, Riyadh 11671, Saudi Arabia.

Data availability
Data are available with the corresponding author upon request.

Declarations

Ethics approval and consent to participate
This study was conducted in accordance with the ethical standards of the Declaration of Helsinki. Ethical approval was obtained from the Institutional Review Board (IRB) at An-Najah National University, Nablus, Palestine (Ref. Med August 2023/36). All participants were informed about the objectives of the study and voluntarily provided both oral and written informed consent before participation.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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Received: 30 March 2025 / Accepted: 20 June 2025
Published online: 17 July 2025

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