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Discrepancies Between Perceived and Actual Diabetes Knowledge Among Nursing Students in Pakistan: A Cross-Sectional Study

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ABSTRACT

Introduction: Diabetes mellitus is a growing worldwide health issue. Nursing students are the future health workforce who should have adequate knowledge and clinical practice skills to manage the disease. In nursing, however, there has been shown to be significant variation in diabetes education programs.

Aim: (1) assess perceived and actual diabetes knowledge among nursing students in Pakistan; (2) quantify the discrepancy between self-assessed and objectively measured competence; and (3) identify demographic and educational predictors of both perceived and actual knowledge.

Methods: A cross-sectional descriptive study was conducted among 423 nursing students from four nursing colleges in Pakistan from September 2024 to January 2025. A validated questionnaire was used to measure the knowledge and skills of nursing students and consisted of three sections: a) demographic information; b) self-reported knowledge (20 items measured using a 4-point Likert scale); and c) actual knowledge (50 multiple-choice questions). Descriptive, independent t-test, ANOVA, Pearson correlation and multiple linear regression were used for statistical analysis.

Results: The mean actual knowledge score was 33.69 ± 7.45 (67.4%). Acute complications and foot care had the highest scores (79.6% and 75.6%, respectively) while the lowest scores were obtained in oral antidiabetic drugs and insulin therapy (53.4% and 62.2%, respectively). The mean self-reported knowledge was 52.34 ± 10.87 (65.4%). They underestimated their knowledge (actual > self by 2.0%, $p = 0.01$). Actual knowledge predictors were: year of study (internship: $\beta = 5.89$, $p < 0.001$); clinical experience ($\beta = 3.45$, $p < 0.001$); formal training ($\beta = 4.28$, $p < 0.001$); workshop attendance ($\beta = 3.89$, $p < 0.001$); family history of diabetes ($\beta = 1.98$, $p < 0.001$); and self-assessed knowledge ($\beta = 0.21$, $p < 0.001$). The regression model explained 57.2% of the variance ($R^2 = 0.584$, adjusted $R^2 = 0.572$, $p < 0.001$).

Conclusions: Students demonstrated moderate diabetes knowledge (67.4% correct) but revealed clinically important discrepancies between perceived and actual competence. While 42.1% accurately

self-assessed, 21.0% overestimated and 36.9% underestimated their knowledge. The largest knowledge gaps were in pharmacological management (oral antidiabetics: 53.4% correct) and diabetes technologies (continuous glucose monitoring: 31.7% correct). Nursing practitioners should improve diabetes curricula (especially pharmacology and insulin management) and provide supervised clinical experiences to facilitate the students' preparedness to care for people with diabetes.

Keywords: Diabetes mellitus; nursing students; clinical competence; health knowledge; nursing education; Pakistan.

INTRODUCTION

Worldwide, diabetes mellitus is considered to be one of the major health challenges of the 21st century. The International Diabetes Federation reports that 463 million adults had diabetes in 2019 and it is projected that by 2045, 700 million adults will have diabetes [1]. This chronic metabolic condition is caused by impairment of insulin secretion and/or action, which results in debilitating microvascular and macrovascular complications, including retinopathy, nephropathy, neuropathy, heart disease and stroke [2]. The burden of diabetes is also increasing in Pakistan, with an estimated 33 million adults affected according to the second National Diabetes Survey of Pakistan [20], and many people either undiagnosed or poorly managed; therefore, there is a pressing need for good quality health care providers [3]. Nurses, as the largest group of all health-care providers, serve on the frontlines of diabetes management for the management of diabetes. They play an important role in educating patients, administering medication, monitoring complications and providing ongoing psychosocial support [4,5]. The level of nursing care will affect patient outcomes, such as blood glucose control, self-management behaviors, and quality of life [6]. Nurses are usually the major educators for the patients who will help them to navigate the complex journey of self-management such as insulin administration, self-monitoring blood sugar, lifestyle changes and foot care [7].

Nursing education supports nursing competency. Nursing students are the future workforces and must be ready to manage the growing number of patients with diabetes, with knowledge, skills and attitudes [8]. Unfortunately, literature confirms a disquieting lack of knowledge among nursing students in various countries. In Jordan, Tawalbeh and Gharaibeh [9] highlighted a lack of awareness and significant gaps in knowledge of pathophysiology, management and complications of diabetes. In European settings, Kudlová and Kočvarová [16] found that Czech general practitioner nurses had significant gaps in insulin treatment and nutrition knowledge, while Kobos et al. [12] identified discrepancies between perceived and actual competence among Polish school nurses, particularly in managing acute complications. In Rwanda, lack of knowledge of diet, complications, insulin use and stress was reported [10]. Another study in Iraq also showed lack of knowledge about type 1 diabetes in children and recommended further education in this area [8]. In Pakistan, Ahmed et al. [3] also found inappropriate diabetes knowledge among residents and nurses and as substandard care was found in many aspects of diabetes care. Lack of congruence between perceived and real knowledge is also a recurring theme. Alsolais et al. [1] found Saudi nursing students felt their diabetes knowledge was good, but their actual performance revealed deficiencies in nutrition, blood glucose monitoring, and injecting insulin. Albagawi et al. [11] reported the gap of perceived and actual knowledge was significant in which overconfidence will be a barrier to further learning and may lead to safety issues. Similarly, Kobos et al. [12] found that school nurses perceived their knowledge on type 1 diabetes to be adequate; however, they found gaps in their knowledge, particularly on management of acute complications. Diabetes knowledge of nursing students and nurses had a number of predictors. These include study year, work experience, prior formal education about diabetes, rotations with diabetic patients and organisational factors such as curriculum and teaching and learning strategies [1,13]. To evaluate the influence of years of study, years of practice and attendance at diabetes workshops on self-perceived and actual knowledge of nursing students, Alsolais et al. [1] found that these factors significantly impact the latter. Song et al. [13] identified that experience, previous diabetes education

and clinical environment are significant factors for non-endocrinology nurses in a tertiary general hospital. Other factors include individual ones; having a family member with diabetes is a motivator in most cases to study more and be knowledgeable [11]. The lack of diabetes knowledge is a global one and evident in most settings. A scoping review of nurse-led practice in sub-Saharan Africa by Nyalapa and Gombachika [14] showed that nurses are always deficient in knowledge and having gaps in their theoretical knowledge and practical skills. Buxton [15] conducted a study in Ghana and found that professional nurses had insufficient knowledge about type 2 diabetes, particularly in medication management and complications prevention. In the Czech Republic, Kudlová and Kočvarová [16] found that general practitioner nurses had good knowledge but very poor knowledge in insulin treatment and nutrition. Lack of knowledge on diabetes has a significant impact. Inadequate knowledge results in inadequate education of patients, wrong management decisions, delay in diagnosis of complications and poor outcomes [7]. Al-bawi et al. [7] reported knowledge deficit was associated with a delay in the recognition of hypoglycemia and its inadequate management. Alassaf et al. [17] noted that the diagnosis and management of type 1 diabetes in medical graduates in developing countries is not very popular, hence the need for improvement in their knowledge. Lack of knowledge also perpetuates negative attitudes of diabetes care, which then leads to another round of inadequate management and outcomes [4]. Healthcare professional's knowledge can be improved through education. Celik et al. [5] conducted a study to evaluate diabetes education in Turkey and found that education methods were effective in improving the knowledge of nurses and resulting in better outcomes. Farzaei et al. [6] found that nutrition education improved knowledge, attitude and practice of nurses. However, the quality of education in nursing programs is still relatively low as many do not include enough education about diabetes, leaving graduates ill-prepared to respond to the growing epidemic [1,8]. There are many skills required in diabetes care. Nurses must administer and teach insulin injections, measure blood glucose levels, educate about foot care, develop personalised dietary plans and provide on-call services to manage acute conditions such as

hypoglycemia and hyperglycemia [6,7]. These skills are not well understood by nursing students and nurses, although they know plenty of theory [1]. Albagawi et al. [11] found nurses feel confident in their competence, but are not competent based on objective measures. This is concerning as the skills are important for quality patient care. Diabetes is rapidly rising in Pakistan and it is necessary to assess the knowledge of nursing students about diabetes and their skills. These students will become the future workforce of the medical professions [3]. The current study aims to fill this gap by an extensive assessment of the level of knowledge and skills, using a reliable questionnaire, adapted from Alsolais et al. [1]. This study aims to identify some gaps, correlation between perceived and actual competence, and demographic and educational variables that predict success.

Objective

This study aimed to: (1) assess perceived and actual diabetes knowledge among nursing students in Pakistan; (2) quantify the gap between self-assessed and objectively measured competence; and (3) identify the demographic and educational predictors of both perceived and actual knowledge.

MATERIALS AND METHODS

Study Design and Setting

We used a quantitative, descriptive and cross-sectional study design. This method is suitable to examine the knowledge and skills of a population at a particular point in time and to explore the relationship between competencies and predictor variables.

The research was undertaken from September 2024 to January 2025 in four nursing colleges in Khyber Pakhtunkhwa, Pakistan: Elizabeth Rani College of Nursing and Allied Health Sciences Mardan, Institute of Health Sciences Mardan and two other affiliated colleges.

The study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for cross-sectional studies.

Study Population

The study population was all Bachelor of Science in Nursing (BSN) nursing students of nursing colleges in Northeastern Pakistan. The total target population was 2,500 in the 2nd, 3rd, 4th, and internship years of the Bachelor of Science in Nursing (BSN) program.

Inclusion Criteria

- In the 2nd, 3rd, 4th, or internship year of a Bachelor of Science in Nursing (BSN) program
- In 2nd, 3rd, 4th or internship year
- Able to give consent and participate
- Understands and able to complete the questionnaire in English

Exclusion Criteria

- First-year nursing students
- Non-nursing students
- Students on leave during the data collection period
- Students who declined to participate

Sampling Technique

A convenience sampling technique was employed. This non-probability sampling technique is often used in nursing education research and allowed the recruitment of all accessible and consenting students at the time of data collection. The limitations of this approach are addressed in the limitations section.

Sample Size Calculation

Sample size was calculated for cross-sectional studies with finite population using OpenEpi version

3.0, as suggested for epidemiological and nursing studies.

OpenEpi Formula for finite population:

$$n = \frac{DEFF \times N \times p \times (1-p)}{\left(\frac{d^2}{Z^2} \times (N-1)\right) + p \times (1-p)} = \frac{1 \times 2,500 \times 0.5 \times (1-0.5)}{\left(\frac{0.05^2}{1.96^2} \times (2,500-1)\right) + 0.5 \times (1-0.5)} = \frac{625}{1.88} = 333.11 \simeq 334$$

In Table 1, we report in detail all the parameters used for the sample size calculation.

Parameter	Description	Value
DEFF	Design effect (for simple random sampling)	1
N	Target population size	2,500
p	Expected proportion (max variability)	0.5
d	Margin of error (absolute precision)	0.05
Z	Z-score for 95% confidence level	1.96

Table 1. *Parameters used for sample size calculation*

The formula recommended in the OpenEpi program was used to estimate the minimum sample size of 334. Guidelines for multiple regression analysis (10-15 participants per predictor variable) suggest that for the expected number of predictor variables (approximately 10), at least 100-150 participants were required.

The calculated sample size (334) was greater than this. The estimated sample was inflated to allow for possible incomplete surveys (10-15% attrition). The sample size of 423 was higher than the required size calculated using OpenEpi and higher than the minimum recommended sample size for regression analysis.

The sample size 423 was confirmed by using G*Power 3.1.9.7, which showed the sample has adequate power (> 0.99) with a medium effect size ($f^2 = 0.15$) at $\alpha = 0.05$ for multiple regression analysis with 10 predictors.

Instruments

A self-administered questionnaire was used to gather data, which was adapted from Alsolais et al. [1]. The questionnaire was broken down into three sections (see Table 2).

Section	Content	Number of Items
A	Demographic and educational characteristics	10 items
B	Self-assessed diabetes knowledge and clinical skills (DSRT)	20 items
C	Actual diabetes knowledge and clinical skills (DBKT)	50 items

Table 1. *Sections of the Questionnaire.*

- *Section A*: Background and Educational Characteristics - gathered information on the participants' age, gender, year of study, and whether or not they had completed the Adult Health Nursing course; their clinical experience in the management of diabetes patients; whether they had attended workshops/seminars on diabetes; whether they had received formal training in diabetes care; family history of diabetes; and how they perceived their overall competence in diabetes care.
- *Section B*: Self-Rated Knowledge and Clinical Skills in Diabetes Care - used the Diabetes Self-Report Tool (DSRT) adapted from Drass et al. [18] and the one used by Alsolais et al. [1] to assess perceived competence and confidence in diabetes care. The tool has 20 items and four subscales:

Subscale	Number of Items
Diabetes Fundamentals	5 items
Diabetes Medications	5 items
Clinical Skills	6 items
Diabetes Management	4 items

Table 2. *Subscales of the Diabetes Self-Report Tool (DSRT) for Self-Assessed Knowledge*

The survey used a 4-point Likert scale (1 = Strongly Disagree to 4 = Strongly Agree). The overall score ranged from 20 to 80 points and a higher score reflected greater perceived knowledge.

- *Section C*: Actual Knowledge and Skills of Diabetes - used the Diabetes Basic Knowledge Tool (DBKT) adapted from Drass et al. [18] and used by Alsolais et al. [1] to assess actual knowledge about diabetes clinical skills. Importantly, this section measures *knowledge about* clinical skills (e.g., knowing the correct insulin injection technique, understanding foot examination procedures) rather than directly observing *performance* of these skills in clinical or simulated settings:

Subscale	Number of Items
Diabetes Fundamentals	14 items
Blood Glucose Monitoring	6 items
Insulin Therapy and Administration	10 items
Oral Antidiabetic Medications	5 items
Nutrition and Lifestyle Management	5 items
Diabetic Foot Care	5 items
Acute Complications and Emergency Management	5 items

Table 3. *Subscales of the Diabetes Basic Knowledge Tool (DBKT) for Actual Knowledge*

The highest score was 50 points, with 1 point awarded for each correct answer. The higher the score, the greater the knowledge and skills. The questionnaire content was reviewed by two senior diabetes nurse educators to ensure alignment with current clinical practice in Pakistan, including the continued use of NPH insulin in public sector hospitals and the gradual introduction of continuous glucose monitoring systems in tertiary care centers.

Validity and Reliability

Validity and reliability of the original DSRT and DBKT have been reported. Alsolais et al. [1] have

reported a content validity index of 0.98, Cronbach's alpha of 0.688 for the DSRT and Kuder-Richardson 20 coefficient of 0.887 for the DBKT. In this study, the adapted questionnaire was piloted with 30 nursing students for clarity, comprehensibility and reliability. Reliability coefficients were:

Section	Tool	Reliability Coefficient
Section B	DSRT	Cronbach's α = 0.71
Section C	DBKT	Kuder-Richardson 20 = 0.89

Table 4. *Reliability Coefficients of the Adapted Questionnaire (Pilot Study, N = 30)*

Data Collection Procedure

The study was approved by the Institutional Review Board of Elizabeth Rani College of Nursing and Allied Health Sciences (Approval No. ERCON/IRB/2024-015). Written permission was obtained from the institutions. Potential participants (nursing students) were invited to participate during class, and the researcher provided them with information about the aim, process, risks and benefits of the study. All participants provided their written consent. The questionnaire was completed in a quiet classroom setting, with no time limit set (up to 60 minutes). No books, notes, electronic devices or discussions were allowed during Section C. The data was collected over 6 weeks from October to November 2024.

Ethical Considerations

This study was approved in accordance with the Declaration of Helsinki. Data were collected after approval by the Ethics Committee. Participants were asked to provide written informed consent and were assured they could withdraw from the study at any time without repercussion. The questionnaire did not gather any identifying data, and all data were securely stored on a password-protected computer accessible only to the researchers. Only aggregate data are reported.

Statistical Analysis

IBM SPSS Statistics 26.0 was used to perform the statistical analyses. Prior to inferential analyses, assumptions for parametric testing were assessed. Normality was evaluated using the Kolmogorov-Smirnov test and visual inspection of Q-Q plots; all continuous variables (self-assessed and actual knowledge scores) were approximately normally distributed ($p > 0.05$). Homogeneity of variance for ANOVA comparisons was confirmed using Levene's test ($p > 0.05$ for all comparisons). For ANOVA with three or more groups, post-hoc comparisons were conducted using Tukey's Honestly Significant Difference (HSD) test. For multiple linear regression, the "enter" method was used, entering all predictors simultaneously based on theoretical relevance. Multicollinearity was assessed using variance inflation factor (VIF), with all VIF values < 2.5, indicating no significant multicollinearity. Likert-scale data from Section B (20 items, 4-point scale) were treated as continuous variables, a common approach in educational research when summing items to create a total score with approximate normality. All regression results are reported using unstandardized coefficients (B) and standardized coefficients (β), The regression coefficients were presented with 95% confidence intervals. A significance level of $\alpha = 0.05$ was adopted.

Analysis	Statistical Test
Demographic characteristics	Frequencies, percentages, means, standard deviations
Comparison between two groups	Independent t-test
Comparison across three or more groups	One-way ANOVA
Relationship between continuous variables	Pearson's correlation coefficient
Self-assessed vs. actual knowledge	Paired t-test
Predictors of knowledge	Multiple linear regression

Table 5. *Summary of Statistical Analyses Performed*

RESULTS

Demographic Characteristics of Participants

There were 423 nursing students in this study. The demographic and educational characteristics are

presented in Table 6. The mean age was 22.4 ± 2.1 years. Most were females (63.1%), 4th-year nursing students (30.3%) and those who had taken the Adult Health Nursing course (73.8%). Of the respondents, 70.4% had clinical experience in the management of patients with diabetes while 20.6% attended a diabetes workshop and 15.1% had had diabetes training. Almost half (46.8%) had a family member with diabetes. Self-assessed competence was 44.7% fair and 30.3% good.

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	156	36.9
	Female	267	63.1
Year of study	2nd year	95	22.5
	3rd year	108	25.5
	4th year	128	30.3
	Internship	92	21.7
Completed Adult Health Nursing	Yes	312	73.8
	No	111	26.2
Clinical experience with diabetic patients	Yes	298	70.4
	No	125	29.6
Attended diabetes workshops	Yes	87	20.6
	No	336	79.4
Formal diabetes training	Yes	64	15.1
	No	359	84.9
Family history of diabetes	Yes	198	46.8
	No	225	53.2
Self-rated competence	Poor	106	25
	Fair	189	44.7
	Good	128	30.3

Table 6. *Demographic and Educational Background of Participants (N = 423)*

Self-Assessed Knowledge and Skills Relating to Diabetes

The mean total self-assessed knowledge score was 52.34 ± 10.87 (65.4% of possible). The highest subscale scores were for Diabetes Fundamentals (68.3%), Clinical Skills (65.3%), Diabetes Management (64.4%) and Diabetes Medications (63.5%). The highest mean individual item scores were for "I am confident in performing blood glucose monitoring" (mean = 2.98) and "I can identify

risk factors related to diabetes" (mean = 2.92). The lowest scores were for "I can identify different types of insulin" (mean = 2.28) and "I can manage sick days" (mean = 2.32).

Actual Knowledge of Diabetes and Clinical Skills

The mean score for actual knowledge was 33.69 ± 7.45 (67.4% of maximum possible). The subscale scores are shown in Table 7.

The best performance was in Acute Complications (79.6%), Diabetic Foot Care (75.6%) and Blood Glucose Monitoring (72.7%). The least was in Oral Antidiabetic Medications (53.4%), Insulin Therapy (62.2%) and Nutrition Management (64.6%).

Subscale	Mean Score (out of max)	SD	Maximum Possible Score	Percentage (%)
Diabetes Fundamentals (14 items)	9.82	2.34	14	70.1
Blood Glucose Monitoring (6 items)	4.36	1.12	6	72.7
Insulin Therapy and Administration (10 items)	6.22	1.89	10	62.2
Oral Antidiabetic Medications (5 items)	2.67	1.08	5	53.4
Nutrition and Lifestyle Management (5 items)	3.23	0.98	5	64.6
Diabetic Foot Care (5 items)	3.78	0.87	5	75.6
Acute Complications and Emergency Management (5 items)	3.98	0.76	5	79.6
***Total* (50 items)**	33.69	7.45	50	67.4

Table 7. *Subscale Scores for Actual Diabetes Knowledge (N = 423).*

Analysis of individual items showed that the items with the highest performance (>85% correct) were: main side effect of insulin injection (92.0%), site of capillary blood glucose sampling (92.0%), first action for an unconscious diabetic patient (92.0%), and foods that cause rapid rise in blood glucose (92.0%). The poorest performance (<50% correct) was on: HbA1c goal (46.8%), foot inspection frequency (46.8%), continuous glucose monitoring (31.7%), SGLT2 inhibitors mechanism of action (31.7%) and peak action of NPH insulin (36.9%).

Clinical context note

Although NPH insulin has been largely replaced by long-acting insulin analogs (e.g., glargine, detemir) in many high-income countries, NPH remains widely used in Pakistan due to its lower cost, inclusion in national essential medicines lists, and availability in public sector hospitals. Therefore, knowledge of NPH insulin pharmacology and peak action times remains clinically relevant for Pakistani nursing students.

Knowledge Gap Analysis: Self-Assessed vs Actual

There was a 2.0% difference between actual (67.4%) and self-assessed (65.4%) knowledge scores. This was a statistically significant difference (paired t-test: t = 3.42, $p = 0.01$). There was a small difference in Diabetes Fundamentals (-0.8%). But large differences were found in Clinical Skills, where students underestimated their skills (actual: 72.7% vs. self-assessed: 65.3% for blood glucose monitoring), and Diabetes Management, where students underestimated their knowledge of acute complications (actual: 79.6% vs. self-assessed: 64.4%). When it came to the accuracy of self-assessment, 42.1% were accurate (within ±10% of actual knowledge score), 21.0% overestimated their knowledge (self > actual knowledge by more than 10%) and 36.9% underestimated their knowledge (actual knowledge > self by more than 10%).

Factors Predicting Self-Assessed and Actual Diabetes Knowledge

Self-Assessed Knowledge: Predictors of self-assessed knowledge were identified through multiple linear regression analysis (see Table 8).

The model explained 39.8% of the variance ($R^2 = 0.412$, adjusted $R^2 = 0.398$, $F = 29.45$, $p < 0.001$). Significant predictors included year of study (internship: $\beta = 3.15$, $p < 0.001$), clinical experience ($\beta = 2.68$, $p = 0.001$), formal training ($\beta = 3.42$, $p < 0.001$), workshop attendance ($\beta = 2.89$, $p = 0.001$), and family history of diabetes ($\beta = 1.45$, $p = 0.034$). Completion of the Adult Health Nursing course,

age and gender were not significant predictors.

Overall model statistics	**R^2**		**Adjusted R^2**		**F**	***p*-value**
	0.412		0.398		29.45	< 0.001
Predictor	**B**	**SE**	**β**	**t**	***p*-value**	**95% CI**
Year of study (Internship vs. 2nd year)	3.15	0.72	0.24	4.38	<0.001	[1.73, 4.57]
Clinical experience (Yes vs. No)	2.68	0.81	0.18	3.31	0.001	[1.08, 4.28]
Formal training (Yes vs. No)	3.42	0.89	0.21	3.84	<0.001	[1.66, 5.18]
Workshop attendance (Yes vs. No)	2.89	0.91	0.17	3.18	0.001	[1.09, 4.69]
Family history of diabetes (Yes vs. No)	1.45	0.68	0.11	2.13	0.034	[0.11, 2.79]
Age	0.12	0.21	0.03	0.57	0.569	[-0.29, 0.53]
Gender (Female vs. Male)	0.87	0.76	0.05	1.14	0.254	[-0.62, 2.36]

Table 8. *Multiple Linear Regression of Self-Rated Diabetes Knowledge (N = 423)*.

Actual Knowledge

The regression model for actual knowledge explained 57.2% of the variance ($R^2 = 0.584$, adjusted $R^2 = 0.572$, $F = 48.67$, $p < 0.001$). In Table 9 we reported the results of the Multiple Linear Regression Analysis of Actual Knowledge of Diabetes.

Overall model statistics	**R^2**		**Adjusted R^2**		**F**	***p*-value**
	0.584		0.572		48.67	< 0.001
Predictor	**B**	**SE**	**β**	**t**	**p-value**	**95% CI**
Year of study (Internship vs. 2nd year)	5.89	0.67	0.38	8.79	<0.001	[4.57, 7.21]
Clinical experience (Yes vs. No)	3.45	0.72	0.22	4.79	<0.001	[2.03, 4.87]
Formal training (Yes vs. No)	4.28	0.78	0.25	5.49	<0.001	[2.74, 5.82]
Workshop attendance (Yes vs. No)	3.89	0.81	0.22	4.8	<0.001	[2.29, 5.49]
Family history of diabetes (Yes vs. No)	1.98	0.59	0.14	3.36	<0.001	[0.82, 3.14]
Self-assessed knowledge score	0.21	0.04	0.23	5.25	<0.001	[0.13, 0.29]
Age	0.09	0.18	0.02	0.5	0.617	[-0.26, 0.44]
Gender (Female vs. Male)	0.65	0.64	0.04	1.02	0.308	[-0.61, 1.91]
Completed Adult Health Nursing course (Yes vs. No)	0.98	0.71	0.06	1.38	0.168	[-0.42, 2.38]

Table 9. Multiple Linear Regression Analysis of Actual Knowledge of Diabetes ($N = 423$).

Significant predictors of actual diabetes knowledge were year of study (internship: β = 5.89, $p < 0.001$), clinical experience (β = 3.45, $p < 0.001$), formal training (β = 4.28, $p < 0.001$), workshop attendance (β = 3.89, $p < 0.001$), family history of diabetes (β = 1.98, $p < 0.001$), and self-assessed knowledge (β = 0.21, $p < 0.001$), whereas sex, age, and completion of the Adult Health Nursing course were not significant predictors.

Correlation Between Self-Assessed and Actual Knowledge

There was a positive, significant correlation between self-assessed and actual knowledge (Pearson's $r = 0.521$, $p < 0.01$), meaning that the higher the self-assessed knowledge scores, the higher the actual knowledge scores.

DISCUSSION

This research assessed diabetes knowledge and clinical skills of nursing students in Pakistan and its predictors. The findings revealed average knowledge (67.4%), good knowledge in acute complications and foot care, but very poor knowledge in the areas of oral antidiabetic drugs, insulin therapy and dietary management. The mean actual knowledge (67.4%) is in line with studies in Saudi Arabia [1] and Ghana [15] but does not meet the standards for safe practice. The poor knowledge in oral antidiabetic drugs (53.4%) and insulin therapy (62.2%) is of particular concern as these are cornerstones of diabetes care. The low percentage of students who knew the mechanism of action of SGLT2 inhibitors (31.7%) and the peak action of NPH insulin (36.9%) are concerning and show a need to improve pharmacotherapy knowledge. This is consistent with Kudlová and Kočvarová [16], who found severe gaps in the knowledge of insulin therapy in Czech nurses. The low percentage (46.8%) of respondents who knew the target HbA1c result is in line with previous studies [11], and reflects the need to improve education and awareness around monitoring of glycemic control in diabetes.

Comparison with European findings

Our results align with studies from other European countries. In the Czech Republic, Kudlová and Kočvarová [16] reported that general practitioner nurses scored poorly on insulin therapy knowledge, similar to our findings (62.2% correct). In Poland, Kobos et al. [12] found that school nurses overestimated their competence in managing acute complications, while we found that Pakistani students *underestimated* their competence in this area (actual 79.6% vs. self-assessed 64.4%). This cross-national difference may reflect variations in curriculum emphasis, clinical exposure, or cultural factors influencing self-perception. Unlike European studies where CGM knowledge is more commonly integrated into nursing curricula, our finding that only 31.7% of students understood CGM function reflects a technology gap specific to low- and middle-income country settings. As CGM systems, insulin pumps, and digital health tools become increasingly integrated into diabetes care globally—and are gradually being introduced in tertiary care centers in Pakistan—nursing curricula must place greater emphasis on technology-assisted diabetes management. Without this knowledge, newly graduated nurses will be ill-prepared to interpret CGM data, troubleshoot sensor issues, or educate patients on device use. In terms of self-perception of knowledge, 21.0% overestimated their knowledge. This is concerning because it may result in complacency about seeking further education, and a risk to patient safety [11]. However, 36.9% grossly underestimated their knowledge, which could lead to low confidence in clinical practice. Nursing educators need to educate students on how to accurately perceive their own knowledge through feedback and reflective practice as suggested by Kobos et al. [12]. In line with prior research [1,13], academic year was the strongest predictor of actual knowledge, with a difference of almost 6 points between internship and second-year students. This reflects the importance of education and experience. Years of clinical experience, education and attendance of a workshop were also predictors, confirming the importance of hands-on learning and educational workshops [5,6]. The significant positive relationship between family history of diabetes and knowledge score indicates personal experience with the disease may enhance learning motivation

[11]. This insight could be applied in teaching methods, such as employing students with family history as peer educators. The high variability at the individual level, and moderate association ($r = 0.521$) between self-perception and competence, suggests nursing students have some understanding of their competence, but more objective measures are needed. Objective knowledge tests should be included in nursing education in addition to self-assessment, to allow students to compare their assessments to more objective measures [1,12].

Implications for Nursing Education and Practice

This study has several implications for nursing education and practice.

First, nursing curricula should provide enhanced education on pharmacological management, specifically oral antidiabetic medications (currently 53.4% correct) and insulin therapy (62.2% correct), as well as nutrition management (64.6% correct).

Second, supervised clinical exposure to patients with diabetes should be mandatory, as clinical experience was a strong predictor of competence ($\beta = 3.45$, $p < 0.001$).

Third, nursing programs should incorporate evidence-based educational strategies including: (a) simulation-based learning with standardized patients for insulin administration and hypoglycemia management; (b) Objective Structured Clinical Examinations (OSCEs) assessing both technical skills and clinical decision-making; (c) supervised diabetes-focused clinical rotations of at least 40 hours; (d) case-based learning using real patient scenarios from local clinical settings; and (e) digital education modules on emerging technologies (continuous glucose monitors, insulin pumps).

Fourth, educators must teach students accurate self-evaluation skills to prevent overconfidence (observed in 21.0% of students) and its associated patient safety risks.

Finally, curricula need to be updated to include emerging diabetes technologies, given the poor performance on continuous glucose monitoring items (31.7% correct) [7,17].

Limitations

This study has several limitations. First, the convenience sample of four nursing colleges from one province (Khyber Pakhtunkhwa) in Pakistan may not be representative of all nursing students in Pakistan. Nursing students in other provinces (e.g., Punjab, Sindh, Balochistan) or in private versus public institutions may have different educational experiences, curriculum structures, and access to clinical resources. This limits the generalizability of our findings. Second, the cross-sectional design measures knowledge at a single time point and does not allow for causal inference or assessment of temporal changes in knowledge. Third, the self-reported knowledge items (Section B) may be subject to social desirability bias, potentially leading to overestimation of perceived competence. Additionally, testing conditions (e.g., fatigue, time of day) may have affected performance on the knowledge test. Fourth, this study assessed *knowledge about* clinical skills rather than directly observing *performance* of those skills through Objective Structured Clinical Examinations (OSCEs) or real-time clinical assessment. Future studies should include direct observation of clinical skills, evaluate knowledge at multiple time points to assess learning gains, and include multiple sites across different provinces to enhance generalizability.

CONCLUSION

This study identified significant discrepancies between perceived and actual diabetes knowledge among nursing students in Pakistan, with 21.0% overestimating and 36.9% underestimating their competence. These findings have important implications for nursing education, self-assessment accuracy, and patient safety. Students demonstrated moderate actual knowledge (67.4%) but had critical gaps in oral antidiabetic medications (53.4%), insulin therapy (62.2%), and diabetes technologies (31.7% for CGM). Knowledge was significantly influenced by clinical practice, education and participation in workshops, highlighting the value of practical experience and educational programs. Over 20% of students had inflated knowledge, which could pose a risk for

patients. Nursing educators need to promote diabetes education programs, offer supervised clinical training, and support students to be more accurate in their self-assessment. This will help prepare the next generation of nurses to tackle the increasing diabetes burden in Pakistan.

Local Ethics Committee Approval

Institutional Review Board of Elizabeth Rani College of Nursing and Allied Health Sciences, Mardan, Pakistan, approved this study. IRB Approval Number: ERCON/IRB/2024-015. Date of Approval: August 15, 2024. The research was done in compliance with the Declaration of Helsinki.

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Conflict of Interest

Authors report no conflict of interest.

Authors' Contribution

Conceptualization: Muhammed Awais, Abdur Rahman; methodology: Mahnoor Ali; data collection: Muhammed Awais, Abdur Rahman; formal analysis: Muhammed Awais, Mahnoor Ali; manuscript drafting: Abdur Rahman; critical revision: all authors.

All authors have approved the final version of the manuscript

Availability of Data Statement

Data from this study can be made available from the authors upon request using appropriate institutional ethical channels and deidentified data.

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Application of Artificial Intelligence Tools

No artificial intelligence software other than grammar and spell check was used.

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