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ASSESSMENT OF KNOWLEDGE REGARDING MEDICATION ADMINISTRATION AND MEDICATION ERRORS AMONG NURSING STUDENTS

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Abstract

Background: Medication errors remain a major challenge to patient safety worldwide, particularly among nursing students who are still developing clinical competence. Nurses play a critical role in medication administration, and insufficient knowledge or errors during this process can lead to serious patient harm. Therefore, assessing nursing students' knowledge regarding medication administration and medication errors is essential to improve educational strategies and enhance patient safety.

Objectives: This study aimed to assess the level of knowledge regarding medication administration protocols and medication errors among undergraduate nursing students. It also evaluated students' ability to identify error types, recognize contributing factors, and understand error reporting practices.

Method: A quantitative cross-sectional study design was conducted at People's Nursing School, Liaquat University of Medical and Health Sciences (LUMHS), Jamshoro. A total of 132 nursing students from 2nd, 3rd, and 4th year were selected using convenience sampling. Data were collected through a structured and validated Likert-scale questionnaire consisting of 20 items. Reliability testing showed excellent internal consistency (Cronbach's alpha = 0.933). Data were analyzed using SPSS version 27, employing descriptive statistics and non-parametric tests including Mann–Whitney U test, Kruskal–Wallis test, and Wilcoxon signed-rank test.

Results: The findings revealed that nursing students demonstrated a high level of knowledge regarding medication administration (Mean = 42.39 ± 6.61, Median = 43) and medication errors (Mean = 41.76 ± 6.71, Median = 42). A Wilcoxon signed-rank test showed that knowledge of medication administration was significantly higher than knowledge of medication errors ($Z = -2.122$, $p = 0.034$). No statistically significant differences were found in knowledge scores based on gender (Mann-Whitney U test: knowledge $p = 0.215$; error $p = 0.223$) or academic year (Kruskal-Wallis test: knowledge $p = 0.433$). Reliability of the instrument was excellent (Cronbach's alpha = 0.933).

Conclusion: The study concludes that nursing students possess a good theoretical understanding of medication safety. However, the persistent theory–practice gap highlights the need for enhanced practical training, simulation-based learning, and supportive clinical environments. Strengthening these areas will help bridge the gap between knowledge and practice and ultimately improve patient safety outcomes.

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INTRODUCTION

Patient safety is a foundational principle of healthcare, yet medication errors (MEs) represent one of its most significant and persistent global threats, jeopardizing patient well-being and imposing substantial financial costs on health system[3]. A medication error is formally defined as any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the healthcare professional, patient, or consumer[9, 18].

Global patient safety remains a paramount concern for healthcare systems worldwide. To address this, the World Health Organization launched the "Medication Without Harm" global challenge, which seeks to diminish severe avoidable medication-related harm by fifty percent globally (WHO, 2017)[7]. This initiative underscores the gravity of medication errors as a primary cause of preventable injury[6, 10]. Ensuring patient safety through rigorous protocols is vital to maintaining the integrity and public trust of international healthcare institutions[25].

According to the National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP), a medication error is any preventable event that might lead to inappropriate medication use or patient harm. These incidents occur while the medication remains within the control of a healthcare professional, patient, or consumer[22]. Defining these errors clearly is the first step toward developing effective educational frameworks that allow nursing students to recognize and avoid potential pitfalls in clinical practice

Nurses play an indispensable role in the medication cycle, frequently serving as the final checkpoint or the last line of defense before a drug reaches the patient[15]. While errors can occur during prescribing or dispensing, nurses are uniquely positioned to intercept these mistakes during the administration phase[22]. This responsibility requires high levels of clinical vigilance and a deep understanding of pharmacological principles to ensure that every patient receives the correct treatment safely[10]. Undergraduate nursing students are at a significantly higher risk of being involved in medication administration errors compared to seasoned professionals. Research indicates that the prevalence of errors among students can reach approximately 39.68% in various clinical settings (Dehvan et al., 2021). Their limited clinical experience and burgeoning skill sets make them particularly vulnerable to the complexities of modern pharmacology[25]. Preparing these students through focused education is essential to minimize the risk of harm during their formative years[25].

One of the most significant challenges facing nursing education is the theory-practice gap. This phenomenon describes the discrepancies between the idealized protocols taught in formal classrooms and the task-centered realities experienced in clinical environments. Students often feel confused or stressed when they observe practicing nurses deviating from established evidence-based guidelines. Bridging this gap is crucial to ensure that students can effectively apply their theoretical knowledge to real-world patient care scenarios without hesitation and confusion[10, 11].

The administration of high-alert medications (HAMs) presents a heightened risk for nursing students, requiring specialized knowledge and extreme precision[15]. Dealing with complex drugs while managing clinical stress and anxiety often impairs a student's ability to perform accurate dosage calculations[24]. Deficiencies in managing HAMs are common, and students frequently struggle to

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balance technical requirements with high-pressure acute care environments. This reality necessitates a more robust educational focus on medication safety to prevent the occurrence of fatal errors[24].

Common errors committed by nursing students frequently involve deviations from the fundamental "Five Rights" of medication administration. These include administering the wrong dose, giving medication at the incorrect time, or failing to identify the right patient properly[6]. Errors of omission, where a medication is not administered as intended, also represent a significant portion of student-related incidents[25]. Understanding these common error types allows educators to tailor curriculum improvements to address specific practical weaknesses and identify nursing students' learning needs[6, 10].

Medication errors can be systematically classified into several categories to better understand their origins and prevent their recurrence. One approach involves categorizing them based on the medication use process, including errors in prescribing, transcribing, dispensing, administering, or monitoring[18]. Another sophisticated method distinguishes between knowledge-based or rule-based errors (mistakes in planning) and action-based errors, frequently referred to as "slips" or "lapses" (errors in carrying out a plan). Among nursing students, the most frequently reported types of errors include administering doses at the wrong time and at incorrect rates, which can compromise therapeutic serum levels and overall patient safety[9, 13].

The psychological and institutional barriers to error reporting represent a significant hurdle in fostering a safe healthcare environment[18]. Research indicates that a staggering 48.60% of nursing students fail to report errors they have committed or witnessed, largely due to a pervasive "blame culture"[17]. Students often cite the fear of disciplinary action, concern about losing their job or clinical placement, and the fear of negative reactions from nursing directors or peers as primary deterrents. Furthermore, many students remain uncertain about what constitutes a reportable error or believe that "minor" mistakes that do not cause immediate harm do not require formal documentation[13].

Environmental and systemic factors further exacerbate the vulnerability of nursing students to clinical mistakes. High workloads, staff shortages, and frequent distractions during medication rounds are consistently identified as major contributors to avoidable harm[1]. In resource-limited settings, the unavailability of clinical pharmacists or senior staff to provide consultation often leaves students with uncertain answers, further compromising safety during complex drug administration[18].

The transition from the classroom to the clinical ward is often described by novice nurses and students as overwhelming, often resulting in anxiety and diminished cognitive performance[9]. Many feel that their theoretical education does not sufficiently prepare them for the "real-world" demands of managing multiple patients and complex medication regimens simultaneously. This academic-practice gap suggests that traditional teaching methods must be supplemented with active learning strategies[3]. Implementing structured educational programs, such as those based on Kern's six-step model, has shown promise in improving knowledge retention and fostering more positive attitudes toward error reporting and patient safety practices[3].

To address these systemic challenges, there is an urgent need to integrate advanced teaching technologies and simulation-based training into nursing curricula[23]. High-fidelity simulation allows

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students to encounter critical clinical scenarios and learn from mistakes in a non-punitive, controlled environment, which significantly builds their confidence and decision-making skills[17, 23]. Furthermore, the adoption of Electronic Medical Records (EMR) and dispensing technologies has been identified as a vital strategy for reducing errors stemming from manual transcription and communication failures. By assessing the current level of knowledge and the perceived barriers among nursing students, educational institutions can develop targeted interventions to better prepare the future nursing workforce for safe clinical practice[8, 13].

The preservation of patient safety and the promotion of health are the primary mandates of modern health-therapeutic systems[5]. Within this context, medication errors (MEs) have emerged as a significant and persistent global threat, jeopardizing patient well-being and imposing substantial financial costs on healthcare infrastructures[3, 14]. A medication error is formally defined by the National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP) as any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of a healthcare professional, patient, or consumer[9, 21]. Globally, the economic burden associated with these errors is estimated at approximately US$ 42 billion annually, accounting for nearly 5% of all hospital admissions[17]. In the United States alone, MEs are cited as the third leading cause of mortality, resulting in between 7,000 and 9,000 deaths per year[13]. Given the severity of this issue, the World Health Organization (WHO) launched the third Global Patient Safety Challenge, "Medication Without Harm," in 2017 with the objective of reducing severe, avoidable medication-related harm by 50% over a five-year period[19].

Nurses play a pivotal role in the medication management process, often described as the "nucleus" of the healthcare system and the "last link" in the drug therapy chain[21]. It is estimated that nursing staff spend approximately 40% of their clinical working hours on activities related to medication administration[3]. Despite their central role in error detection and prevention, nurses are also the most vulnerable to committing administration errors, which are the most common type of nursing-associated medical mistakes[12]. This vulnerability is significantly amplified among nursing students and novice practitioners who are at a heightened risk during clinical rotations due to underdeveloped skills, limited clinical experience, and critical gaps in theoretical and pharmacological knowledge[18, 23].

Research consistently demonstrates a high prevalence of MEs among nursing students across diverse international settings, although findings occasionally conflict regarding the frequency and tendency to commit such errors. A systematic review and meta-analysis of Iranian nursing students identified a pooled prevalence of 39.68% for MEs, with individual studies reporting rates as high as 80%[5]. In Turkey, reported that 38.3% of students committed at least one error during their clinical education, while a study in Sudan found that approximately two-thirds of nurses and a high proportion of students had committed errors[9]. In the United States, Silvestre and Spector (2023) analyzed data from over 200 prelicensure programs and found that medication errors represented 58.8% of all student-reported practice errors[20].

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Conversely, some contemporary studies report a lower tendency toward errors or higher levels of awareness. Found that intern nursing students in Palestine and Saudi Arabia exhibited a relatively low tendency to commit errors, scoring 161/215 and 188/215 on awareness scales, respectively[14, 17]. These conflicting findings may be attributed to differences in educational curricula, clinical supervision models, or the sensitivity of the reporting tools used, such as the web-based system in Turkey compared to self-report questionnaires in other regions[9]. The typology of errors committed by students is multifaceted. The most frequently reported error type across several studies is "wrong time" administration, with rates of 60% in Sudan and 76.4% in Turkey[17]. Other common errors include "wrong dose," "wrong patient," "wrong medication," "omission of dose," and "incorrect administration rate[20]". Silvestre and Spector (2023) specifically highlighted that errors frequently occurred because students failed to adhere to three major safety procedures: checking patient identification, checking allergy status, and following the "rights" of medication administration[20].

A lack of comprehensive pharmacological knowledge is a primary driver of MEs among nursing students and novice nurses[19, 23] noted that MAEs were often linked to unfamiliarity with drug mechanisms[23], clearance rates, and the "reasonableness" of prescriptions. Of particular concern is the inadequate knowledge regarding high-alert medications (HAMs), such as insulin, anticoagulants, and concentrated electrolytes, which possess a greater potential to cause serious harm or death if misapplied[18]. conducted a multicenter survey in Pakistan and found that 84% of nurses achieved scores below 70% in HAM administration and regulation. Specific deficits included the inability to identify concentrated electrolyte complications, such as 15% potassium chloride causing cardiac arrest, and the safe storage requirements for look-alike drugs[18]. These inadequacies were attributed to a lack of extensive training in pharmacology both during and after basic nursing education. Furthermore, research in Sudan revealed that 50% of students struggled with illegible physician handwriting and 53.8% found it difficult to interpret physician orders[13, 18].

Mathematics and dosage calculation competence represent another significant area of knowledge deficit. While students may perform well in simple arithmetic, many struggle with complex calculations required for pediatric patients, intravenous (IV) flow rates, and liquid medications[4, 8]. found that while students perceived themselves as competent in basic calculations, their actual performance often lagged when faced with real-world clinical complexity[8]. This "academic-practice gap" suggests that theoretical success in examinations does not always translate to safe clinical application[14, 23].

The origins of medication errors are categorized into intrinsic (human) and extrinsic (environmental) factors[13]. Intrinsic factors include a lack of self-confidence, reduced coping skills, and the reluctance of novice nurses to seek assistance when they are uncertain[23]. Stress, anxiety, and persistent fear of making mistakes are commonly cited by students as major contributors to cognitive lapses and "slips" during administration. Sleep deprivation and fatigue were also identified as significant predictors of MEs, with 58.8% of Sudanese students agreeing that these were leading causes of their mistakes[1, 13].

Extrinsic factors are frequently reported as systemic causes of MEs[9]. Heavy workloads, high patient-to-nurse ratios, and frequent interruptions during medication rounds are consistently identified as

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major contributors to avoidable harm[2, 19]. Poor interprofessional communication, characterized by illegible handwriting, unclear verbal orders, and the use of confusing abbreviations, remains a leading systemic cause[13] highlighted that a lack of understanding of interprofessional roles often leads to confusion and missed opportunities for medication reconciliation. Additionally, senior staff behavior and ward culture can influence student performance; Murray et al. (2019) and Sahay et al. (2022) found that graduate nurses often witnessed senior nurses deviating from best practices (e.g., omitting bedside checks) and felt unable to speak up due to their junior status[13].

A major obstacle to improving patient safety is the pervasive "blame culture" that discourages transparency and results in high rates of underreporting[12]. found that nearly half (48.60%) of nursing students fail to report errors they have committed or witnessed. In Sudan, 47.5% of students indicated they had never reported a ME[20].

The primary deterrents to reporting are psychological and professional fears[12]. Students cite the fear of disciplinary action (92.5%), fear of adverse reactions from supervisors (90%), fear of losing grades, and the fear of being labeled incompetent by peers or instructors[12, 13]. Some students do not report errors because they believe the mistake is "minor" or did not cause immediate harm, while others are uncertain about what constitutes a reportable error or the appropriate time to submit an incident report. Identified that administrative barriers and no positive feedback for reporting were the top reasons for non-disclosure, emphasizing that punishment has little effect on future error prevention[13].

To address these systemic vulnerabilities, researchers advocate for the integration of active learning strategies and patient safety education throughout the nursing curriculum[4]. Simulation-based learning (SBL) has emerged as one of the most effective interventions. Authentic simulations that replicate clinical distractions, multiple patient assignments, and high-stress scenarios allow students to learn from mistakes in a safe, non-punitive environment[23]. Studies utilizing pre- and post-testing reported significant improvements following simulation training, with one study documenting a 73% reduction in MAEs[23].

Structured educational models have also shown promise. Implemented a program based on Kern's six-step model and evaluated it using Kirkpatrick's model, finding lasting improvements in knowledge, attitude, and clinical performance[3]. Similarly, demonstrated that while standard curricula provide a baseline foundation, targeted educational interventions provide additive benefits in augmenting students' grasp of medication safety protocols[16].

Furthermore, the adoption of technology, such as Electronic Medical Records (EMR), bar-coding technology, and computerized physician order entry (CPOE), has been identified as a vital strategy for reducing errors stemming from transcription and communication failures[2]. However, novice nurses often feel underprepared to use these technologies in the "real world," indicating a need for EMR training to be integrated into undergraduate programs[23].

The literature reveals that while nursing students and novice practitioners possess basic foundational knowledge, there are critical gaps in pharmacological understanding, calculation skills, and the practical application of safety protocols in high-stress environments[2, 4]. MEs are frequently the result of a complex interplay between intrinsic human factors and extrinsic systemic pressures, exacerbated

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by a culture that prioritizes blame over learning[3, 7]. Moving forward, educational institutions must prioritize patient safety by shifting away from a punitive culture and adopting comprehensive, simulation-based curricula that bridge the theory-practice gap[3, 23]. Assessing students' self-perceptions and actual knowledge through validated tools like the NURSPeM is an essential first step toward developing targeted interventions that will prepare a competent and safety-oriented future nursing workforce[8].

Specific Objectives:

1. To evaluate nursing students' theoretical and practical knowledge of medication administration protocols, including the "rights" of medication administration.
2. To assess the students' ability to correctly identify and categorize medication errors and near-misses in various clinical scenarios.
3. To identify the key contributing factors (intrinsic, extrinsic, and environmental) that nursing students perceive as primary causes of medication errors.
4. To examine students' awareness of and attitudes toward medication error reporting systems.

MATERIALS AND METHODS

This study employed a quantitative cross-sectional research design to assess the knowledge regarding medication administration and medication errors among nursing students. The cross-sectional design was appropriate as it allowed the collection of data at a single point in time to evaluate the current level of knowledge among participants. The study was conducted at People's Nursing School (PNS), Liaquat University of Medical and Health Sciences (LUMHS).

The duration of the study was three months, from January 2026 to March 2026. The target population of this study consisted of 261 undergraduate nursing students enrolled in 2nd, 3rd, and 4th year at People's Nursing School (PNS), Liaquat University of Medical and Health Sciences (LUMHS), Jamshoro.

The sample size was calculated using the Raosoft sample size calculator with a 95% confidence level and 5% margin of error for the actual population of 261 students. This yielded a required sample size of approximately **158** students.

However, due to unforeseen circumstances including the sudden suspension of regular classes and the shift to online or off-campus mode caused by regional geopolitical tensions in early 2026 many students became difficult to access physically. As a result, a total of **132** nursing students were ultimately recruited using convenience sampling. This sample size, though slightly below the ideal calculated number, was considered adequate given the time constraints and practical challenges faced during the data collection period (January to March 2026). The achieved sample still provides reasonable statistical power for descriptive and comparative analysis in this exploratory study. A convenience (non-probability) sampling technique was employed to select participants based on their availability, willingness to participate, and accessibility during the restricted academic schedule. Inclusion criteria, Male and female nursing students Students enrolled in 2nd, 3rd, and 4th year,

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Students willing to participate Exclusion Criteria, 1st year nursing students, Students who were absent during data collection, Evening shift students, Students unwilling to participate Data were collected using a structured, validated Likert scale questionnaire.

The questionnaire consisted of two main sections:

Section I: Demographic Data

Age, Gender, Academic year

Section II: Knowledge Assessment

The questionnaire included 20 items, divided into two domains:

A. Medication Administration Knowledge (Items 1–10)

B. Medication Error Knowledge (Items 11–20)

Scoring System

A 5-point Likert scale was used:

1 = Strongly Disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly Agree

Higher scores indicated better knowledge.

A pilot study was conducted on 20 nursing students to test the clarity and reliability of the instrument.

Reliability was assessed using Cronbach's Alpha, which yielded a value of 0.933, indicating excellent internal consistency.

Permission was obtained from the concerned authorities of People's Nursing School prior to conducting the study. All participants were clearly informed about the purpose of the research, and written consent was obtained from them through a Google Form before data collection began. Questionnaires were then distributed to eligible students, who were given sufficient time to complete them. All completed questionnaires were collected on the same day.

Data were entered and analyzed using Statistical Package for Social Sciences (SPSS) version 27.

Descriptive Statistics Frequencies and percentages were used for demographic variables, Mean and standard deviation were calculated for knowledge scores

3.8 Ethical Considerations

Ethical approval was obtained from the relevant institutional authority prior to the commencement of the study. Participation was entirely voluntary, and the confidentiality of all participants was strictly maintained throughout the research process. No personal identifiers were recorded to ensure anonymity, and participants were informed of their right to withdraw from the study at any time without any consequences.

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RESULTS

4.1 Demographic characteristics of nursing students

This chapter presents the analysis and interpretation of data collected from **132 nursing students** at People's Nursing School, LUMHS. Both descriptive and inferential statistics were used to assess knowledge regarding medication administration and medication errors.

All 132 participants provided complete responses with no missing data. The majority of the nursing students (44.7%) belonged to the age group of 22–25 years, followed by 36.4% in the 18–21 years age group and 18.9% in the above 26 years age group. With respect to academic year, the highest number of participants were from the 2nd year (42.4%), followed by 4th year (34.8%) and 3rd year (22.7%). Regarding gender, male students constituted the majority of the sample (58.3%), while female students represented 41.7% of the total participants.

Table 4.1: Demographic Characteristics of Participants

Variable	Category	Frequency (n)	Percentage (%)
Age of Student	18–21 years	48	36.4
	22-25 years	59	44.7
	Above 26 years	25	18.9
	Total	132	100.0
Academic Year of Student	2nd Year	56	42.4
	3rd Year	30	22.7
	4th Year	46	34.8
	Total	132	100.0
Gender of Student	Male	77	58.3
	Female	55	41.7
	Total	132	100.0

4.1.2 Descriptive Statistics of Demographic Variables and Knowledge Scores Among Nursing Students

This table 4.2 presents the descriptive statistics of demographic variables (age, gender, academic year) and overall knowledge and error scores among nursing students. The results include mean, standard deviation, minimum, and maximum values.

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Table 4.2: *Descriptive Statistics of Knowledge Scores among Nursing Students*

Variable	Mean	Std. Deviation	Minimum	Maximum
Age of Students	1.83	0.72	1	3
Gender of Students	1.42	0.49	1	2
Academic Year	1.92	0.87	1	3
Knowledge Score	42.39	6.61	11	50
Error Score	41.76	6.71	10	50

Table 4.3 : *Descriptive Statistics of Knowledge Scores among Nursing Students*

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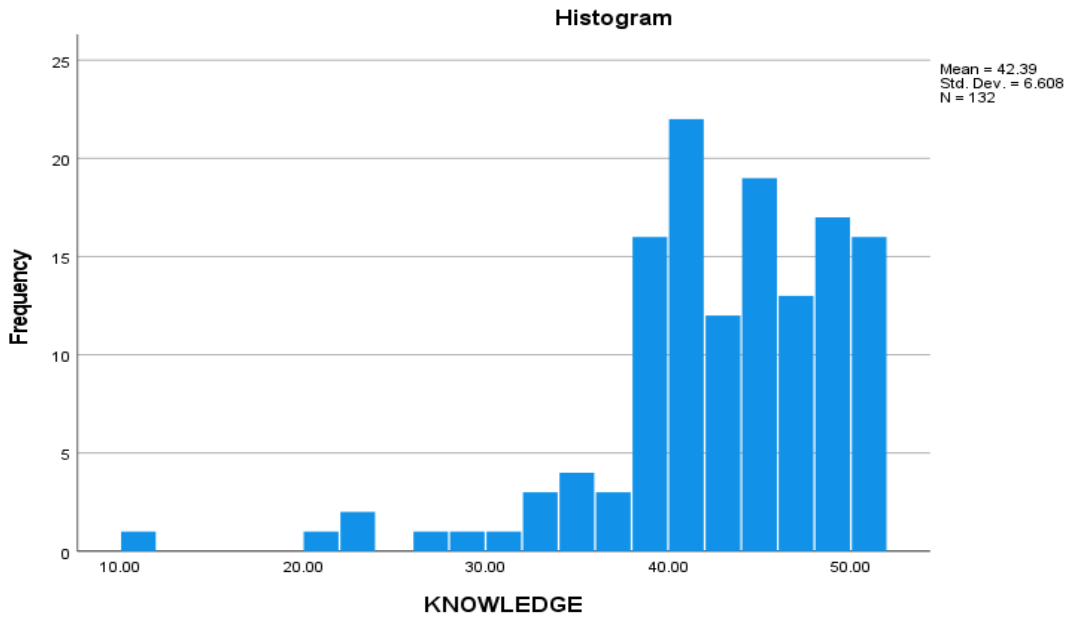

The mean knowledge score among nursing students was **42.39 ± 6.61**, indicating a relatively high level of understanding regarding medication administration. The moderate standard deviation suggests that most students had fairly consistent knowledge levels with only slight variation among participants.

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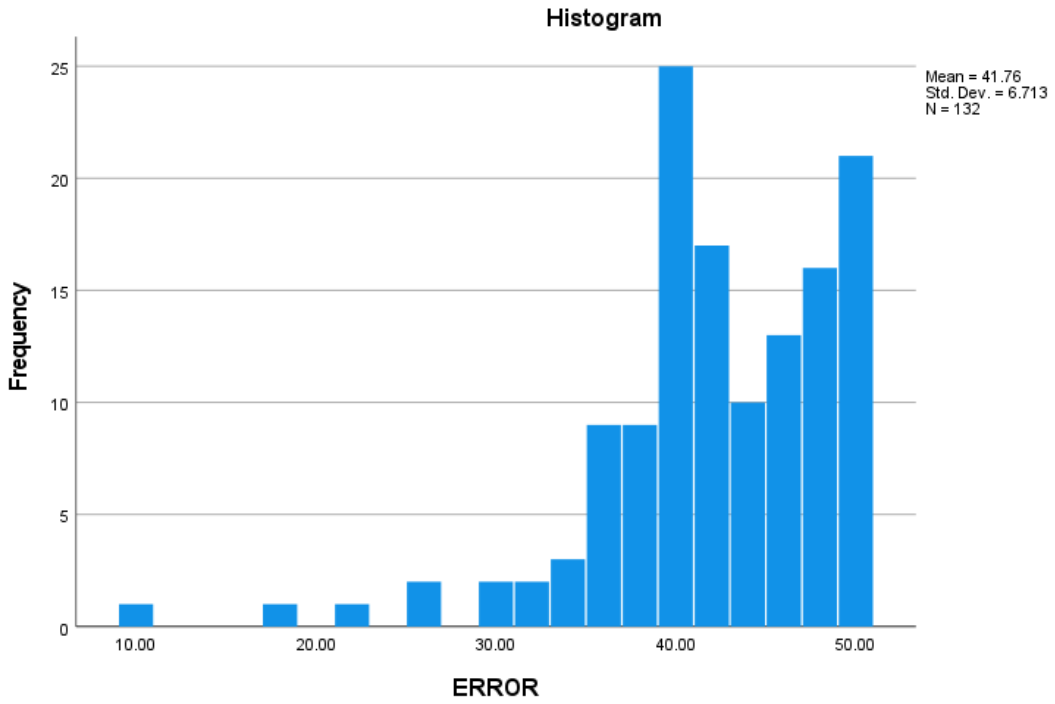
Table 4.4: *Descriptive Statistics of Medication Error Scores among Nursing Students*



The mean medication error score was **41.76 ± 6.71**, which also reflects a high level of awareness about medication errors. The similar standard deviation indicates consistency in responses, showing that students generally shared comparable perceptions or experiences related to medication errors.

4.2 Normality Test of Study Variables

This table presents the results of the normality tests conducted on the study variables, including age, gender, academic year, knowledge, and error scores of students. Both **Kolmogorov-Smirnov** and **Shapiro-Wilk** tests were used to assess whether the data for each variable followed a normal distribution. Normality assessment is essential because it determines the appropriate statistical tests (parametric or non-parametric) for further analysis.

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Table 4.5: Normality Test of Study Variables

Variable	Kolmogorov-Smirnov	Df	Shapiro-Wilk	df	Sig.
Age of Students	0.236	132	0.799	132	0.000
Gender of Students	0.383	132	0.626	132	0.000
Academic Year	0.278	132	0.756	132	0.000
Knowledge Score	0.137	132	0.862	132	0.000
Error Score	0.113	132	0.888	132	0.000

All variables have p-values of 0.000 in both Kolmogorov-Smirnov and Shapiro-Wilk tests, which are less than 0.05, indicating that none of the variables are normally distributed.
Therefore, non-parametric tests are appropriate for analyzing these data in the study.

4.3 Reliability of the Instrument

Table 4.6

Cronbach's Alpha	N of Items
.933	23

The Cronbach's Alpha value of 0.933 indicates excellent internal consistency among the 20 items. This confirms that the instrument is reliable and consistently measures the intended construct.

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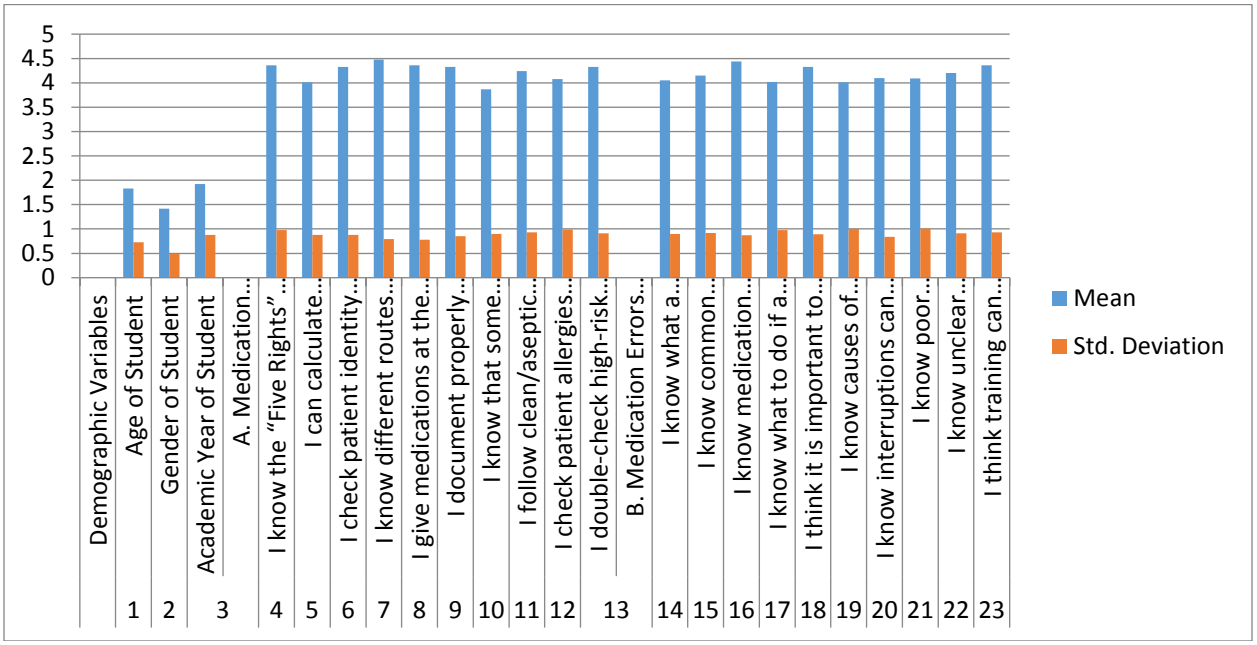
Table 4.7 Item Statistics



4.4 Descriptive Statistics of Study Variables (Median and IQR)

This section presents the central tendency and spread of participants' age, gender, academic year, knowledge, and error scores using median and interquartile range, suitable for non-normal data.

Table4.8: Descriptive Statistics (Median and IQR)

Variable	Median	Interquartile Range (IQR)	Minimum	Maximum
Knowledge	43.00	8.50	11.00	50.00
Error	42.00	8.00	10.00	50.00

The median values indicate that most participants are in the 2nd academic year and are slightly more likely to be male.

Knowledge and error scores are relatively high (median = 43 and 42, respectively) with moderate variability (IQR = 8.5 and 8), suggesting that students generally have good awareness and consistent error-related understanding.

4.5 Wilcoxon Signed Rank Test : Knowledge vs Medication Error scores

Boxplot Showing Comparison of Medication Administration Knowledge and Medication Errors Knowledge Scores among Nursing Students (N=132).

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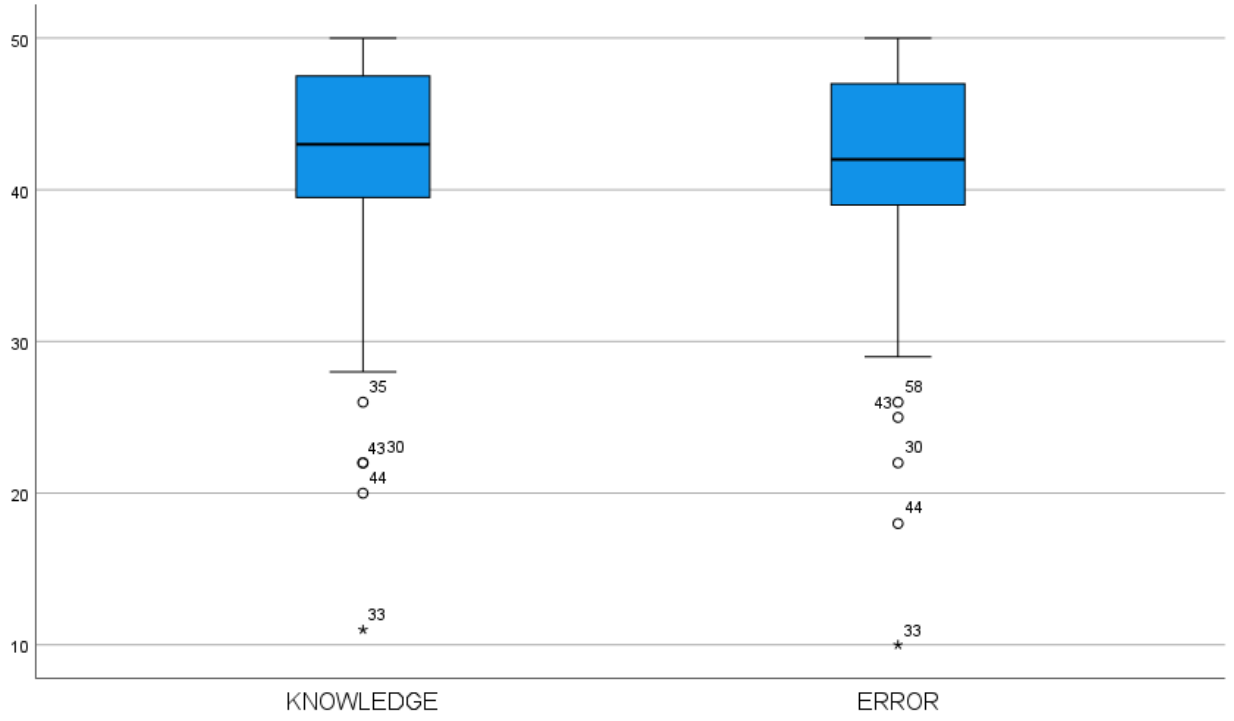
Table 4.9

Variable	Mean	Std. Deviation	Median	Minimum	Maximum
Medication Administration Knowledge	42.39	6.61	43.00	11	50
Medication Errors Knowledge	41.76	6.71	42.00	10	50

Table 4.9.1

Ranks	N	Mean Rank	Sum of Ranks
Negative Ranks (Error < Knowledge)	66	53.13	3506.50
Positive Ranks (Error > Knowledge)	40	54.11	2164.50
Ties	26	-	-
Total	132	-	-



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Test Statistics

Z = -2.122

Asymp. Sig. (2-tailed) = 0.034

The boxplot and descriptive statistics further illustrate this finding. Nursing students exhibited good overall knowledge in both domains. The median score for Medication Administration Knowledge was **43.00** (Mean = 42.39, SD = 6.61), which was higher than the median score for Medication Errors Knowledge (**42.00**, Mean = 41.76, SD = 6.71). Minimum and maximum scores ranged from 11 to 50 for knowledge and 10 to 50 for error scores.

4.6 Mann-Whitney Test: Knowledge By Gender Association

This section compares the knowledge scores between male and female students. As the data was not normally distributed, the **Mann-Whitney U test** was applied to assess the difference between the two groups.

Table 4.10 : Mann-Whitney Test

Gender	N	Mean Rank	Sum of Ranks
Male	77	63.08	4857.00
Female	55	71.29	3921.00
Total	132	-	-

Mann-Whitney U = 1850.000, Z = -1.239, p-value = 0.215

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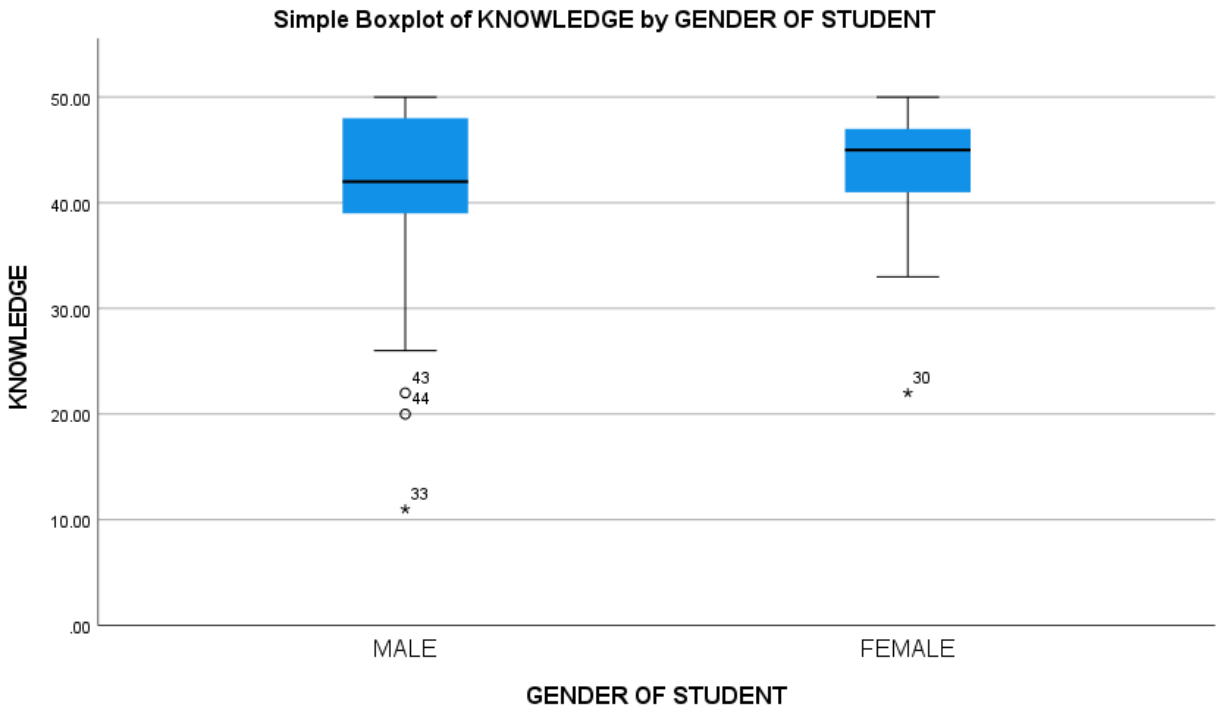

Female students demonstrated a higher mean rank of knowledge scores (71.36) compared to male students (63.03), but the difference was not statistically significant ($p = 0.215 > 0.05$), indicating no significant effect of gender on knowledge scores.

4.6.1 Mann-Whitney Test: Error By Gender Association

Table 4.11

Gender	N	Mean Rank	Sum of Ranks
Male	77	63.08	4857.00
Female	55	71.29	3921.00
Total	132	-	-

Mann-Whitney U = 1854.000, Z = -1.220, p-value = 0.223

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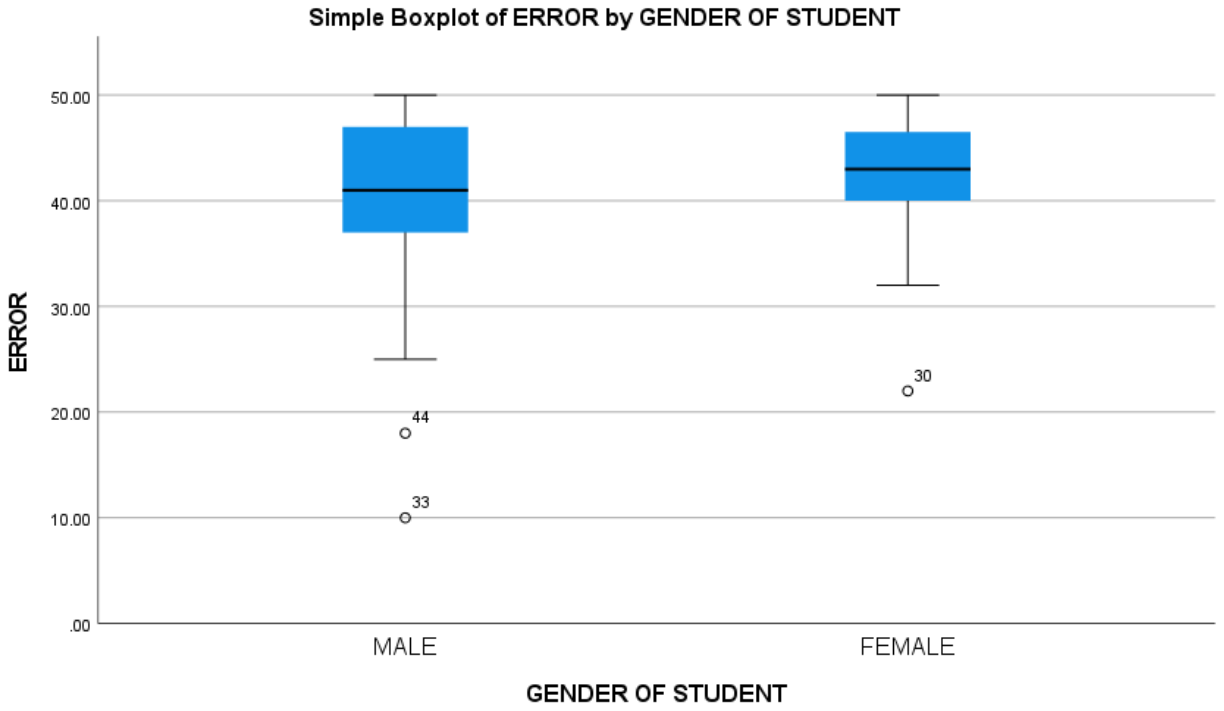

There was no statistically significant difference in error scores between male and female students (U = 1854.000, p = 0.223), indicating gender is not associated with error scores.

4.7 Kruskal-Wallis Test : Knowledge and Academic Year Association

A Kruskal-Wallis test was used to assess differences in knowledge scores across the three academic years.

No statistically significant association was found between academic year and knowledge scores (χ^2 = 1.676, df = 2, p = 0.433).

Mean ranks were: 2nd year (61.71), 3rd year (68.03), and 4th year (71.34). Median scores showed a slight increasing trend (43, 44, and 45 respectively).

Academic Year	N	Mean Rank
2nd Year	56	61.71
3rd Year	30	68.03
4th Year	46	71.34
Total	132	-

Test Statistics Kruskal-Wallis H = 1.676 df = 2

Asymp. Sig. = 0.433

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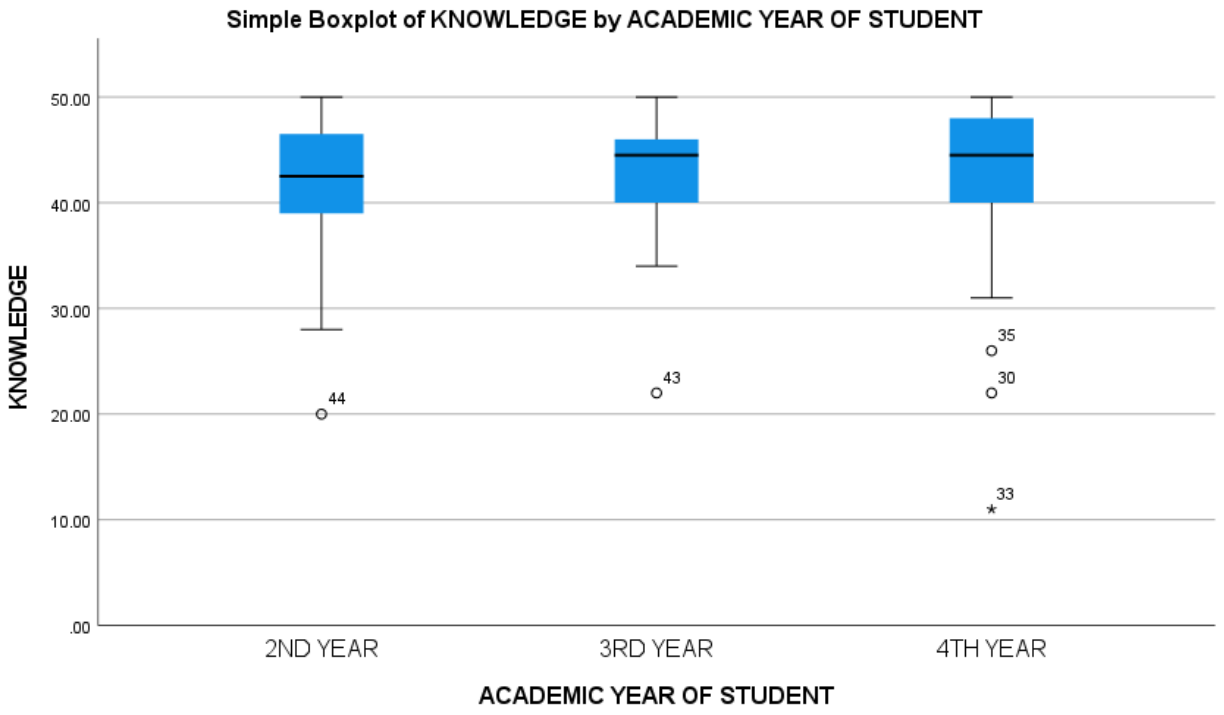

The Kruskal-Wallis test showed no statistically significant difference in medication administration knowledge scores across academic years (χ^2 = 1.676, df = 2, p = 0.433). Although a slight increasing trend was observed in mean ranks and median scores from 2nd year to 4th year, this difference was not statistically meaningful.

4.7.1 Kruskal-Wallis Test: Error and Academic Year Association

A Kruskal-Wallis test was conducted to examine differences in medication error knowledge scores across the three academic years (2nd, 3rd, and 4th year).

The test revealed **no statistically significant difference** in medication error knowledge scores by academic year (**Kruskal-Wallis H = 2.332, df = 2, p = 0.312**).

The mean ranks were: 2nd year (61.93), 3rd year (64.63), and 4th year (73.28).

Table 4.13: Kruskal-Wallis Test – Medication Error Scores by Academic Year

Academic Year	Median	IQR (approx.)	Minimum	Maximum	Notable Outliers
2nd Year	41	9–10	26	50	18, 44
3rd Year	42	7–8	29	50	43, 25
4th Year	44	7–8	31	50	33*, 30, 23

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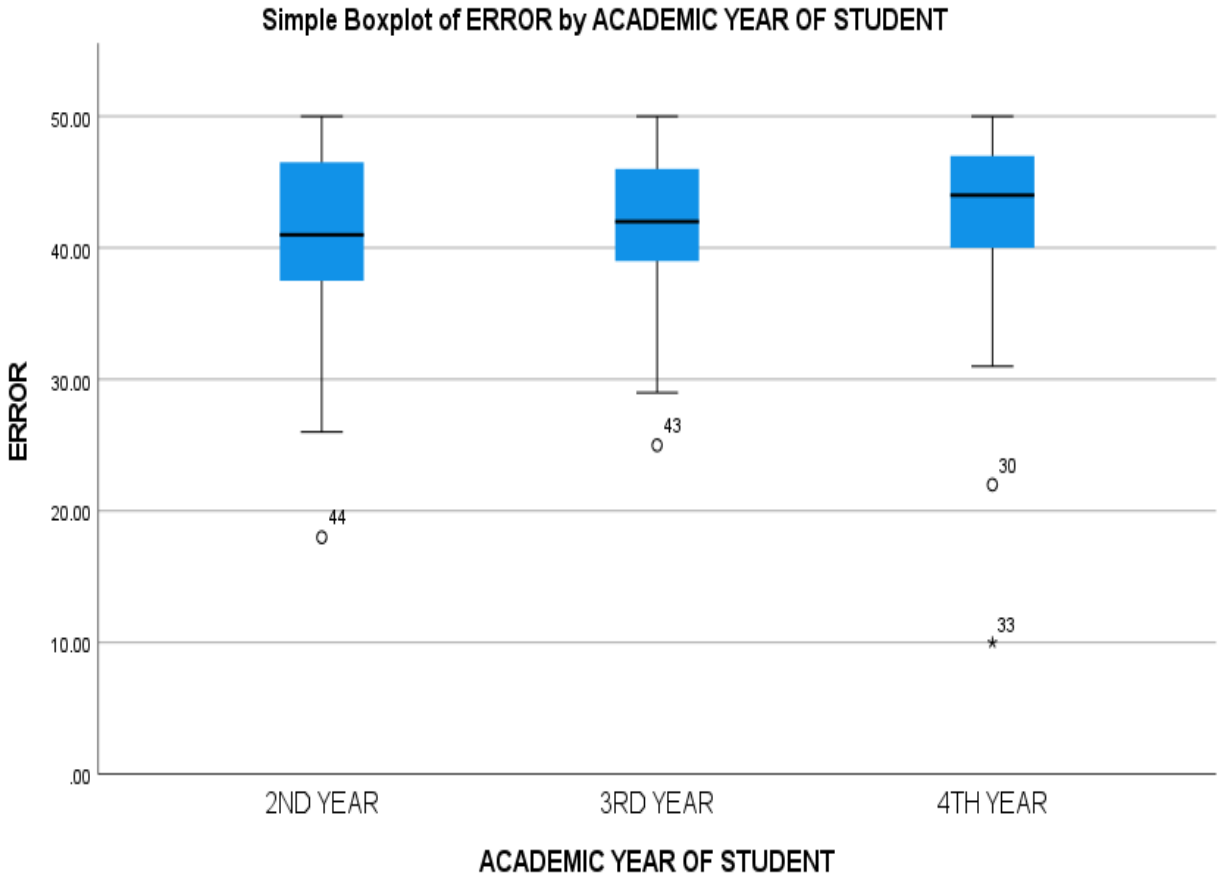
Academic Year	N	Mean Rank
2nd Year	56	61.93
3rd Year	30	64.63
4th Year	46	73.28
Total	132	-

Test Statistics

Kruskal-Wallis H = 2.332 df = 2

Asymp. Sig. (2-tailed) = 0.312



The boxplot displays the distribution of medication error knowledge scores across 2nd, 3rd, and 4th academic years of the students. Median error scores showed a slight increasing trend from 41 (2nd year) to 44 (4th year). Most students scored between 38 and 47, indicating generally good error-related understanding. However, low outliers were observed, particularly in the 2nd year (score = 18)

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and 4th year (scores = 10*, 23, 30, 33). Overall, academic year had only a minor influence on medication error knowledge scores.

DISCUSSION

The present study found that nursing students at People's Nursing School possessed a high level of knowledge regarding medication administration (median = 43/50) and medication errors (median = 42/50). However, a Wilcoxon signed-rank test revealed that knowledge of medication administration protocols was significantly higher than knowledge regarding medication errors ($Z = -2.122$, $p = 0.034$). This suggests that while students have strong theoretical understanding of the "Five Rights," patient identification, and documentation, they have relatively lower awareness or confidence in areas related to medication error identification, causes, prevention, and management.

When comparing these findings to regional literature, my study aligns with research conducted by Ahmad et al. (2024) in Karachi, which reported that 57% of nurses possessed a high level of knowledge regarding medication errors[1]. Similarly, the Nigerian study by Osuchukwu et al. (2024) found that 95% of nursing students demonstrated good knowledge[16]. These similarities suggest that modern nursing curricula in developing nations are increasingly effective at imparting essential medication safety concepts. The high scores across these studies may be attributed to the standardized integration of pharmacology and patient safety modules in current nursing education frameworks.

However, a notable disagreement exists when comparing my results to the multicenter survey by Salman et al. (2020), which found that 84% of Pakistani nurses had poor knowledge of high-alert medications (HAMs), with a median score of only 6 out of 10[18]. While my study showed a high mean score for checking high-risk medications (4.33 out of 5), the contrast is likely due to the specific focus of the literature on HAM regulation and specialized pharmacology versus my broader assessment of general medication administration[18]. This suggests that while general knowledge is high, specialized training for high-risk drugs remains a critical gap in the local nursing workforce.

Furthermore, the study by Alandajani (2022) in Saudi Arabia reported that only 55% of nurses demonstrated good knowledge[2]. The higher knowledge level found in my study (84.7%) could be attributed to the academic setting, where students are frequently tested on theoretical protocols, whereas

practicing nurses in the Saudi study may face more diverse clinical challenges that deviate from classroom theory. Additionally, my study utilized a sample where 58.3% were male, whereas the literature often features female-dominated cohorts, such as the 94.8% female sample in Salman's study, which might influence different educational priorities or reporting styles[18].

Regarding specific protocols, my study found that students have a strong grasp of the "Five Rights" of medication administration, with a mean score of 4.36 out of 5 (87.2%)[16]. This closely matches the findings of Osuchukwu et al. (2024), where 96.6% to 97.5% of participants were aware of these essential safety rights. Both studies demonstrate that the "Five Rights" remain a cornerstone of nursing education. The consistent emphasis on these rights in both the Pakistani and Nigerian

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curricula explains why students in both regions perform exceptionally well in this particular knowledge domain.

Competence in dose calculation is another vital area where my study found a mean score of 4.01 out of 5 (80.2%). In contrast, the literature suggests this is often a significant area of weakness; for example, Gunes (2020) noted that miscalculation was a frequent cause of errors among students in Turkey[9]. Additionally, Myroniak and Elder (2021) reported that none of their simulated groups questioned incorrect doses outside safe ranges[23]. The higher scores in my study may reflect a strong focus on mathematical proficiency within the current local curriculum, or perhaps a higher level of student confidence compared to actual clinical performance

Patient identification protocols were well understood in my study, with a mean score of 4.33 out of 5. This is consistent with the findings of Mousa and Salameh (2024), who reported that 68.7% of Palestinian intern students always verified the patient's ID before administration[14]. While both studies show high awareness, the literature indicates that failure to check ID bands remains a common factor in actual errors, appearing in 5.8% of occurrences in a large U.S. study[20]. This discrepancy highlights that while students know they must identify patients, they may sometimes bypass this step in practice.

Adherence to correct timing and documentation was rated highly in my study, with means of 4.36 and 4.33 respectively. This contrasts sharply with actual error reports in the literature, Identified "treatment delay" (76.4%) as the most common error type among students[9]. Similarly, Sudanese research found that 60% of student errors were related to wrong timing[13]. This suggests a significant gap where students possess the knowledge of proper timing but struggle to maintain it under the pressure of clinical workloads and poor time management skills mentioned in the literature[23]

Knowledge of aseptic technique and allergy checks also yielded positive results in my study, with means of 4.24 and 4.08. Literature findings are more varied reported that 54.6% of students always checked allergy history, while some international studies found that students failed to check allergies in 3.8% of error cases[16]. The high level of awareness in my study is encouraging, yet the literature emphasizes that distractions often lead students to forget these critical verification steps during high-stress clinical rotations[4].

Awareness of high-alert medications (HAMs) was a strong point in my results, with a mean of 4.33 out of 5. This differs from the findings of Salman et al. (2020), where Pakistani nurses showed serious inadequacies in HAM knowledge, particularly regarding the use of spoons for pediatric doses (81% unaware of inappropriateness)[18]. My students' high scores might reflect more recent curriculum updates that specifically address the dangers of drugs like 15% potassium chloride, which sparked national concern in Pakistan following high-profile medical errors mentioned in the literature[18].

When identifying common medication errors, my participants scored a mean of 4.05 out of 5. Literature from Palestine supports this, showing that 63.6% of interns had a good awareness of medical error types[17]. However, some studies, such as the meta-analysis by Dehvan (2021), suggest that while students can identify errors, the actual prevalence of committing them is high at 39.68%[5].

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This suggests that while my study confirms high theoretical awareness, students may still be highly vulnerable to making these same errors when they transition to the clinical environment.

Paragraph 12: My study identified workload and stress as significant perceived causes of errors, with a mean of 4.01 out of 5. This is strongly corroborated by international literature. For instance, the Sudanese study reported that 58.8% of students attributed errors to heavy workloads and sleep deprivation[13]. Furthermore, Webb et al. (2025) identified time pressure and hectic environments as leading extrinsic factors for novice nurses[23]. The agreement between my results and the literature emphasizes that the systemic issue of nursing shortages and high patient acuity is a global threat to medication safety.

Regarding error reporting, my study participants strongly believe it is important, with a mean score of 4.33 out of 5. However, the literature reveals a disheartening reality where knowledge does not lead to action. In Sudan, 47.5% of students admitted to never reporting an error they made[13]. This disagreement highlights a potential social desirability bias in my survey responses, where students may be over-reporting their virtuous intentions while actual practice remains hindered by institutional barriers and fear of consequences.

The barriers to reporting highlighted in my findings align with the "blame culture" described by where fear of reprimand and decreasing evaluation scores were primary individual barriers[12]. My study's students recognized that interruptions and poor communication are issues, which the literature links to a lack of positive feedback (mean 5.12/6) in administrative responses to errors[12]. This indicates that the environment in Pakistani nursing schools, similar to those in Iran, may still prioritize individual punishment over system improvement.

The literature specifically mentions the fear of disciplinary action as a deterrent, with 92.5% of Sudanese students citing this as a reason for underreporting[13]. My study's high awareness scores for reporting importance (4.33) suggest that students want to be ethical, but the "fear of humiliation" and "advice on secrecy from nurses" mentioned in Iranian qualitative research likely create a barrier my quantitative tool could not fully capture. This suggests that the emotional and psychological consequences of errors are universal among nursing students.

An evident theory-practice gap is observed when comparing my study's high knowledge results with the frequent errors reported in clinical settings in the literature. For example, while my students claim to know correct administration routes (mean 4.48), literature shows that "wrong route" errors persist in both clinical and simulation settings. The NURSPeM study in Spain notes that students often find it difficult to transfer theoretical knowledge because they cannot see the internal critical thinking process of senior nurses they observe[8]

An unexpected finding in my study was the gender distribution, with 58.3% males, which is uncharacteristic of most nursing research in the literature. For example, the study by Salman (2020) was comprised of only females, and Ahmad's sample was 45% female[18]. This high male representation in my study could be a specific characteristic of the student body at People's Nursing School. This demographic shift is important to note as it may impact perceptions of workplace culture and communication styles within the nursing profession in Pakistan.

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The present study has several notable strengths. It focused on a highly relevant and timely topic — medication administration and medication errors which directly affects patient safety and aligns with the World Health Organization's "Medication Without Harm" initiative.

The use of a structured, validated Likert-scale questionnaire with excellent internal consistency (Cronbach's alpha = 0.933) ensured reliable data collection.

The sample size of 132 students was appropriately calculated using a 95% confidence level and 5% margin of error, providing reasonable statistical power for the analysis.

The use of 132 students from a single institution limits the generalizability of the findings to all nursing students in Pakistan.

Participants may have provided socially desirable answers (over-reporting safety adherence) rather than reflecting their actual clinical behavior. This study only captures knowledge at one point in time and does not track how that knowledge evolves after entering professional practice.

Although students reported high knowledge scores, the significant difference between administration and error knowledge ($p = 0.034$) may reflect greater emphasis on administration protocols in the current curriculum. Self-reported data may also be influenced by social desirability bias.

Enhance Simulation-Based Learning: It is recommended to integrate regular high-fidelity simulation sessions into the curriculum across all academic years. These practical sessions will provide students with valuable opportunities to apply theoretical knowledge in realistic clinical scenarios, thereby building greater confidence and competence in medication administration.

Strengthen Focus on High-Alert Medications: Incorporating dedicated modules and hands-on workshops on high-alert medications will further enrich students' understanding and help them develop essential skills for safe handling, storage, and administration of these critical drugs.

Promote a Supportive Error-Reporting Culture: Establishing structured sessions and open discussions on error reporting will encourage students to view mistakes as valuable learning opportunities. This positive approach will foster transparency, professional growth, and a strong safety culture among future nurses.

Increase Clinical Supervision and Mentorship: Continuing to provide close guidance and mentorship during clinical placements will support students in smoothly translating their classroom knowledge into safe and confident practice, ultimately contributing to improved patient outcomes.

Conclusion

This study concludes that undergraduate nursing students at People's Nursing School, LUMHS Jamshoro, possess a good level of theoretical knowledge regarding medication administration and medication errors. However, knowledge of medication administration was significantly higher than knowledge of medication errors ($p = 0.034$). Students demonstrated strong understanding of the "Five Rights," patient identification, timing, and the importance of error reporting. No significant differences were found based on gender or academic year. The findings highlight the need to strengthen education specifically on medication error identification, contributing factors, prevention strategies, and high-alert medications through enhanced simulation-based training and practical

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sessions. Bridging this small but significant gap will better prepare students for safe clinical practice and contribute to improved patient safety.

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