

ASSESSMENT OF KNOWLEDGE AND CAUSES OF MEDICATION ERRORS AMONG NURSING STUDENTS DURING CLINICAL ROTATIONS IN PUBLIC SECTOR HOSPITALS IN KOHAT

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Keywords

Medication errors, medication safety, nursing students, clinical rotations, knowledge, patient safety, public sector hospitals, cross-sectional study.

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Abstract

Introduction: The problem of medication errors is one of the most important patient safety problems in the world today and also the most common preventable adverse events in the field of medicine. It is well known that the nursing students are very prone to making medication errors due to their limited clinical experience, lack of supervision, burdened work load, and lack of knowledge of medication safety. It is necessary to know the level of the knowledge about medication errors in order to be able to solve the problem.

Objectives: The purpose of the study is to assess the knowledge regarding medication errors among the nursing students during clinical practice in the public sector hospitals of Kohat.

Method: A descriptive cross-sectional study included 152 BS Nursing and Post-RN students using stratified random sampling. Structured questionnaires were analyzed in IBM SPSS 26 using descriptive statistics, t-tests, and ANOVA.

Results: Of the 152 subjects, 40.8% showed good knowledge, 47.4% had moderate knowledge, and 11.8% had poor knowledge about medication errors, with an average knowledge score of 8.1 ± 2.1 (of 12). The top items with the highest percentage of correct answers were patient identification prior to medication administration (96.7%), medication administration rights (95.4%), definition of medication errors (92.1%), and prevention of medication errors (90.8%). The least items included look alike / sound alike (LASA) medications (66.4%) and high alert medications (68.4%). The average perceived causes score was 39.8 ± 5.7 (of 50), reflecting high level of agreement with the listed contributing factors. The leading organizational factors were heavy workload (mean score of 4.48 ± 0.63) and understaffing (4.40 ± 0.68). Among individual factors, fatigue (4.42 ± 0.69), stress (4.31 ± 0.73), interruptions during administration of medications (4.36 ± 0.70), similarity of drug names (4.28 ± 0.72), and lack of supervision (4.19 ± 0.77). Scores for knowledge were found to have significant association with age ($F = 3.92$, $p = 0.022$) and clinical rotation ($F = 6.11$, $p = 0.003$), but not with gender ($p = 0.240$). Likewise, cause

perception scores had significant association with age ($F = 3.41$, $p = 0.036$) and clinical rotation ($F = 5.02$, $p = 0.008$), but not with gender ($p = 0.189$).

Conclusion: Nursing students possessed moderate-good knowledge of medication safety issues, although there were deficiencies regarding high-alert and LASA medications. Workload, poor supervision, and clinical experience were significant factors in the area of medication errors.

INTRODUCTION

Medication administration is among the most common and risky tasks that nurses and nursing students carry out in practice. This task demands exact calculation, proper techniques, solid knowledge of pharmacology, and constant alertness because any oversight in the medication process might be hazardous to the wellbeing of the patients and even cause an irreparable damage. Medication mistakes are known all over the world to be one of the main preventable reasons of patient harm in the healthcare environment, which causes extended stays in hospitals, higher treatment expenses, and, in some instances, patient death(1).

This is because the nursing students have a special place in this whole procedure. In their clinical training program, they need to make sure that they

can put into practice the theoretical knowledge that they have acquired in class, in an environment where there is limited clinical experience, little supervision, many tasks, and an unfamiliar setting in the hospital(2). This period from classroom learning to practicing on their own is considered a crucial period where medication errors take place. Some of the common causes associated with medication errors among nursing students found in the literature are lack of pharmacology knowledge, poor supervision by clinical instructors or staff nurses, high ratio of patients to students, tiredness, distractions, poor communication, and poor prescriptions(3). Figure 1.1 illustrates the approximate distribution of medication errors across different stages of the medication process

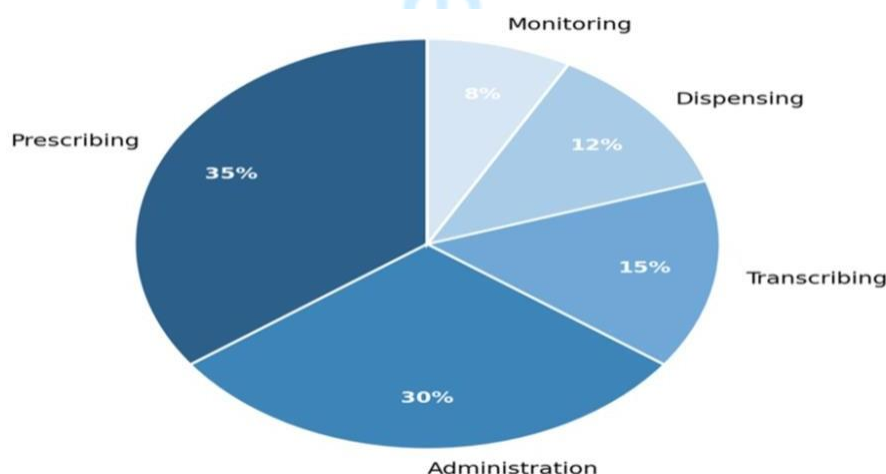


Figure 1.1: Global Distribution of Medication Errors Across Different Stages of the Medication Process

However, in the case of public hospitals in Pakistan and especially in a constrained situation like that in Kohat, there could be many other problems for students, such as crowded wards, insufficient access to the latest medical information, irregular mentoring, and an

overwhelming workload that leaves no time for verification of medications used. In this way, it may become possible to experience many more mistakes but, at the same time, it becomes harder for them to recognize, report, and analyze those(4). As illustrated in Figure 1.2, factors such as

inadequate knowledge, poor supervision, lack of clinical experience, heavy workload, communication problems, fatigue, and similar drug names are among the most commonly reported causes of medication errors during

clinical rotations. Thus, it becomes important to understand how much nursing students know about safe use of medicines, their attitudes towards errors, and factors contributing to those mistakes.

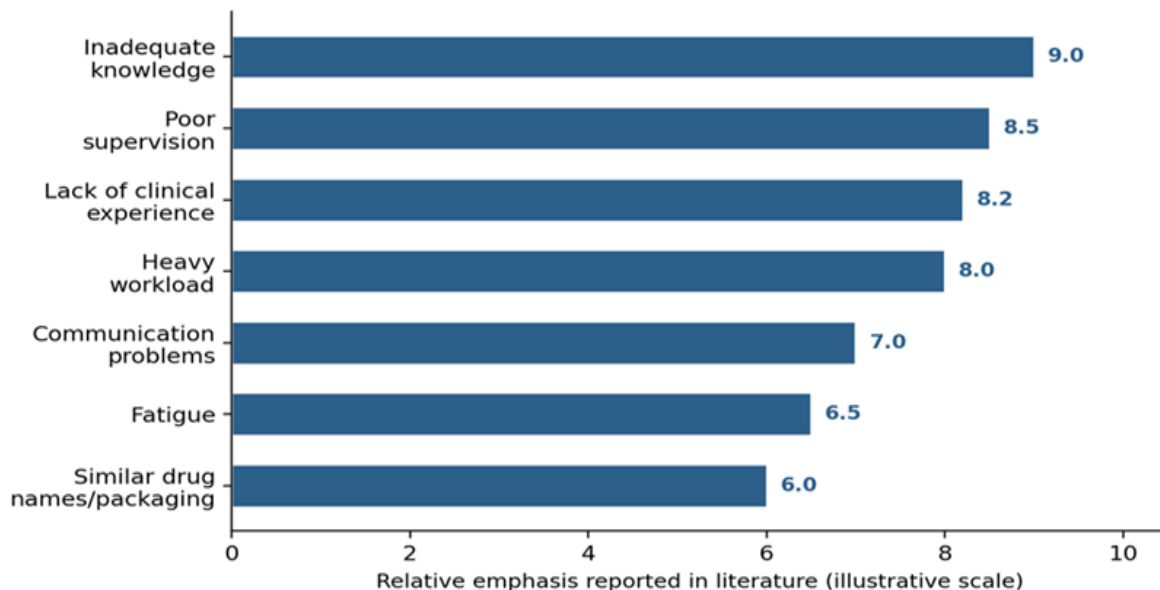


Figure 1.2: Common Causes of Medication Errors Among Nursing Students During Clinical Rotations

This research intends to evaluate the level of knowledge that nursing students have about drug safety issues, identify their attitude towards the error, and determine the type of medication errors and their causes in the clinical placement in the government sector hospitals in Kohat. The objective is to develop locally relevant information that can be used to improve nursing curriculum, clinical supervisory practice, and hospital policies related to the reduction of medication errors.

Problem Statement

The problem of medication errors made by nursing students when on their clinical rotation periods continues to be an issue of significant patient safety concern in public hospitals of developing countries, given that these institutions are typically associated with very high numbers of patients, low supervision ratios between the faculty members and nursing students, and few resources. In the case of Kohat, for instance, nursing students are frequently assigned to the busy ward of the hospitals to give medications under different levels

of supervision; however, there is very little evidence available locally to determine what these students know concerning medication safety, how they react to medication errors, and the causes of such errors.

In the absence of this type of evidence, nursing education programs and hospitals will have to make use of general assumptions or evidence collected from other health care settings and different educational setups which may not necessarily reflect the reality of nursing students enrolled at Kohat. Therefore, it is important to systematically analyze the medication knowledge of nursing students and the underlying reasons for medication errors so that effective strategies may be designed to reduce the occurrence of these errors. The development of effective strategies for the reduction of medication errors will ultimately help to preserve the well-being of patients.

Significance of the Study

The study is practically valuable to many parties involved in both nursing education and healthcare

delivery in clinical settings(5). In particular, nursing education facilities could use the results to pinpoint the exact areas where there are shortcomings in the knowledge base of students regarding drug safety issues, which could be used as the foundation for improving pharmacology education(6).

In regards to training and administrative work at the hospitals, knowing the underlying reasons for errors in medication administration by the nursing students could help improve the ratio of supervisions, mentorship relationships and wards safety policies which will consequently lead to minimizing risks for patients and improving the quality of the training process(4, 7). From the policy makers' point of view, the research could be used as one of the bases for developing or improving the national and provincial policies about supervision of nursing students(8). In general, the study is helpful for the issue of patient safety since it draws attention to the potential source of injury that can be easily prevented and generates the evidence in a local context and does not rely on the results obtained from different settings or countries. Lastly, the study provides the scarce literature on nursing education research in the context of Kohat as well as Khyber Pakhtunkhwa region.

Objectives

1. To assess nursing students' knowledge regarding medication safety.
2. To explore attitudes of nursing students toward medication errors.
3. To identify types of medication errors during clinical rotations.
4. To determine causes of medication errors among nursing students.
5. To explore the role of supervision and role models in medication safety.

Operational Definitions

Medication Error

For the purpose of this study, a medication error is defined as any preventable event, occurring at any stage of the medication process (prescribing, transcribing, dispensing, administering, or monitoring), that may lead to inappropriate medication use or patient harm while the medication is under the control of the nursing student or healthcare provider. This includes, but is not limited to, wrong dose, wrong route, wrong time, wrong patient, wrong drug, and omission or duplication of a prescribed medication, regardless of whether the error reaches the patient or causes actual harm. **Figure 1.3** presents the conceptual framework of the study, illustrating the factors that may influence medication errors among nursing students during clinical rotations.



Figure 1.3: Conceptual Framework of Factors Influencing Medication Errors Among Nursing Students

Knowledge

In this study, knowledge refers to the nursing students' cognitive understanding and awareness of medication safety principles, including but not limited to drug dosage calculation, routes and techniques of administration, drug interactions and contraindications, the "rights" of medication administration, and institutional protocols for safe medication practice, as measured through a structured knowledge assessment tool.

Causes of Medication Error

Causes of medication error, for the purpose of this

study, refer to the identifiable factors reported by or observed among nursing students that contribute to the occurrence of medication errors during clinical rotations. These may be categorized broadly as student-related factors (e.g., inadequate knowledge, fatigue, inexperience, distraction), supervisory and educational factors (e.g., insufficient supervision, lack of mentorship or role modeling), and system-related or organizational factors (e.g., heavy workload, high patient-to-student ratios, illegible prescriptions, interruptions, and inadequate institutional safety protocols).

Table 1.1: Operational Definitions of Study Variables

Variable	Operational Definition	Measurement Method
Medication Error	Any preventable event that may lead to inappropriate medication use or patient harm	Questionnaire
Knowledge	Students' understanding of medication safety principles	Knowledge score
Attitude	Students' beliefs and perceptions regarding medication safety	Likert-scale questionnaire
Causes of Medication Errors	Factors contributing to medication errors during clinical rotations	Multiple-response questionnaire
Clinical Rotation	Supervised practical training in hospital settings	Student placement record

LITERATURE REVIEW

However, medication errors are still one of the most commonly reported hazards to the safety of patients all over the world(9). As defined by the World Health Organization (2016), medication errors include any avoidable event that can result in the incorrect use of the medication by the patient or harm of the latter caused during its use and controlled by the health professional, patient, or consumer(10). Nurses play an essential role in the medication process since they are often the last barrier before medication enters the patient's body(11). Medication errors can happen at any stage in the medication administration process, such as prescribing, transcription, distribution, and administration. According to Stolic et al. (2022), the most prevalent medication errors committed by nursing students include calculation error, wrong patient identification,

wrong medication, and omission of the prescription. Administration errors are the most reported errors due to the involvement of nursing students in this last phase of the process(12).

The medication administration process entails some series of steps such as verification of the prescription, dosage preparation, verification of patients' identity, administration of the drug, and documentation of the same. According to Hijji et al. (2026), medication administration is a complex process that demands precise mathematical abilities and appropriate supervision, especially for learners who are developing their competence. Administration rights (patient rights, drug rights, dose rights, route rights, timing rights, and documentation rights) can be considered a basic checklist of safety rules for nurses and nursing students(13). According to Raxon Jo et al. (2026), the adherence to all of these rights, when

accompanied by proper supervision and up-to-date technologies, is unlikely to result in any administration errors at clinical placements(14).

Various studies have highlighted knowledge deficits in terms of medication safety amongst nursing students. In this regard, Elonin et al. (2022) found that poor dosing calculations and lack of pharmacology knowledge amongst graduating nursing students increased their likelihood of making errors when they started practicing clinically(15). Musharyanti et al. (2019) have also noted that Indonesian nursing students made mistakes mainly due to the deficiency of knowledge and skills acquired academically.

Lack of pharmacological understanding and inadequate calculation ability were the major factors contributing to medication mistakes made by students(16).

Distractions in the environment, such as noise and interruptions, and lack of communication between health care practitioners were noted by Hijji et al. (2026) as one of the main factors increasing the risk of making an error. Additionally, Musharyanti et al. (2019) listed poor supervision and lack of good examples as major clinical issues.

Organizational shortcomings, including staff shortages and insufficient orientation programs, place additional strain on students and reduce opportunities for close mentorship, a pattern documented across multiple clinical settings(13).

International studies indicate that nursing students from various healthcare systems face the same difficulties. According to Yilmaz et al. (2024), Turkish nursing students often blamed their mistakes on work overload and inexperience, which is confirmed by the study of Musharyanti et al. (2019), who found the same results in Indonesian students(17).

Data collected in Pakistan has shown consistent deficiencies in knowledge regarding medication safety practices amongst nurses and even students. According to Mustafa et al. (2020), there was an inadequate level of high-alert medication knowledge amongst nurses in Pakistan, which was attributed to their deficient training and lack of access to accurate clinical guidelines. It can be inferred that nursing students in Pakistan may be

at an equal or even higher risk(18).

Even though international literature is abundant regarding medication errors made by nursing students, there have been only a few number of studies related to the medication errors and reasons for the same committed by the nursing students during their clinical postings in Pakistan. The majority of existing Pakistani literature revolves around the medication errors committed by registered nurses and not nursing students.

METHODOLOGY

Study Design

The current study adopted a descriptive cross-sectional research design to investigate the level of knowledge and reasons for medication errors amongst nursing students on clinical practice. The cross-sectional research design was deemed most suitable since it offered an opportunity to get a snap-shot of the information desired from the students within a short period of time.

Study Setting and Duration

This research study was conducted in the public-sector teaching hospitals of the Kohat District, Khyber Pakhtunkhwa, Pakistan, specifically at the clinical training units, where the nurses' trainees perform their practical internships. The data was collected during the span of four months, from March 2026 to June 2026, after obtaining all the requisite institutional and ethical clearances.

Study Population

Population of interest included undergraduate nursing students pursuing Bachelor of Science Nursing and Post-RN courses, currently going through clinical placement in the public sector hospitals in Kohat. They were chosen as a population of interest for this research due to their active involvement in the clinical setting, thus being at the frontline in terms of administering drugs to patients.

Sample Size

The required number of samples to be taken was determined using the sample size calculator in OpenEpi, with a 95% confidence level and 5% margin of error. According to these criteria, 156

nursing students took part in the research.

Sampling Technique

Stratified random sampling method was employed to ensure proportional representation in all academic levels. The subjects were stratified by their level of studies, that is, year two, year three, year four, and Post-RN, and then randomly selected based on the proportionate size of each stratum. This was meant to reduce any form of selection bias and ensure representation of the views of the subjects from different levels of clinical education.

Inclusion Criteria. Those who were enrolled in the BS Nursing course or the Post-RN program and had already undergone at least one clinical rotation were included in the study provided that they agreed to take part voluntarily.

Exclusion Criteria. First year nursing students were not included in the study due to their lack of clinical exposure, together with those students who were absent during the data gathering period or refused to participate.

Data Collection Tool

Data collection was done through a self-administered structured questionnaire which was developed by the researcher following a review of literature about medication safety. The instrument was divided into three sections as follows.

Section A of the questionnaire contained questions about demographics of the respondents and included six questions which were age group (18-20, 21-23 and 24-26 years), gender, academic

program (BS Nursing or Post-RN), year of study, type of clinical rotation (medical, surgical, ICU, pediatric, emergency or gynecology) and whether or not the respondents were trained about medication administration.

Section B of the questionnaire included questions about the knowledge level of the respondents concerning medication errors. It included twelve multiple choice statements which evaluated knowledge about definition and types of medication errors, high alert medications, medication administration rights, error reporting procedures, patient identification procedures, dosing calculations, documentation, prevention, storage of medications, look alike and sound alike drugs and supervision during medication administration.

Section C identified the causes of medication errors within clinical placements and comprised ten statements that were rated using a five-point Likert scale ranging from strongly disagree to strongly agree. The statements included possible contributing factors like heavy workload, tiredness, lack of supervision, poor training, reluctance to ask questions, similarity of names of medications, medication administration interruptions, low staffing numbers, stress while practicing clinically, and poor communication with the healthcare professionals.

Scoring Procedure

As for the knowledge section, one mark was allocated for each correct answer while zero mark was assigned for each wrong answer, and therefore, the possible maximum mark scored ranged from 0 to 12. The total score determined the level of knowledge of the respondents into three levels as shown in Table 3.1 below.

Score Range	Knowledge Category
0-4	Poor Knowledge
5-8	Moderate Knowledge
9-12	Good Knowledge

For the causes part, the responses received were evaluated based on a scale of 5, with 'strongly disagree' given a score of 1, 'disagree' a score of 2, 'neutral' a score of 3, 'agree' a score of 4, and 'strongly agree' a score of 5. In this case, the

cumulative score fell between 10 and 50, where a higher score meant stronger belief in the causes of the errors.

Data Collection Procedure

After obtaining formal approval from the hospital management and the associated nursing institutions, the researcher toured the clinical training sites when the students were on their scheduled rotations. The nature of the research and its objectives were communicated to the potential participants before securing informed consent. In order to reduce the probability of non-response, the questionnaires were administered to the participants on the same day.

Data Analysis

The data was entered into and analyzed with IBM SPSS version 26. Descriptive analysis in the form of frequencies and percentages was used for the demographic variables, whereas means and standard deviations were used for calculating the knowledge and cause score. An independent samples t-test and one way ANOVA test were used for testing mean differences between demographic subgroups. The value of significance was set at a p-value of less than 0.05.

Data Cleaning

All questionnaires completed were checked for completeness before being entered into the database. Out of a total of 156 questionnaires that had been obtained, 4 (2.6%) were found to have incomplete information and were later excluded from the analysis process. The remaining data were then checked for duplicates, invalid ranges, and coding problems.

Ethical Considerations

The ethical clearance was granted by the Institutional Ethical Review Committee, and approval was sought individually from the administrations of all the involved hospitals and nursing institutes. Participants were recruited on purely voluntary grounds, and informed written consent was gained from all the participants before conducting the study. The anonymity of all the participants was strictly ensured during the entire process of research, and the participants were made aware of the fact that they were not under any pressure and could opt out of the study at any point of time.

RESULTS

4.1 Demographic Characteristics of Participants

The total number of questionnaires distributed was 156. Four questionnaires were not considered for analysis since they had incomplete answers. Thus, a total of 152 nursing students comprised the final sample of the research. In terms of age, the majority of the participants (46.7%) were within the age bracket of 21-23 years, which is the highest among the four categories. The second highest age category among the participants was 18-20 years (38.2%), while the least was the age bracket of 24-26 years (15.1%). This implies that the research was conducted mostly on young nursing students at the beginning of their education. The detailed demographic information is shown in Table 4.1 along with the valid sample sizes (n) for each variable.

Table 4.1: Demographic characteristics of respondents

<i>Variable</i>	<i>Category</i>	<i>n</i>	<i>%</i>
<i>Age Group</i>	18–20 years	58	38.2
	21–23 years	71	46.7
	24–26 years	23	15.1
<i>Gender</i>	Male	62	40.8
	Female	90	59.2
<i>Academic Year</i>	2nd Year	38	25.0
	3rd Year	42	27.6
	4th Year	40	26.3

<i>Clinical Experience</i>	<i>Rotation</i>	Post-RN	32	21.1
		1 Rotation	34	22.4
		2-3 Rotations	67	44.1
		>3 Rotations	51	33.6
<i>Clinical Area</i>		Medical	36	23.7
		Surgical	31	20.4
		ICU	22	14.5
		Pediatrics	21	13.8
		Emergency	20	13.2
		Gynecology	22	14.5

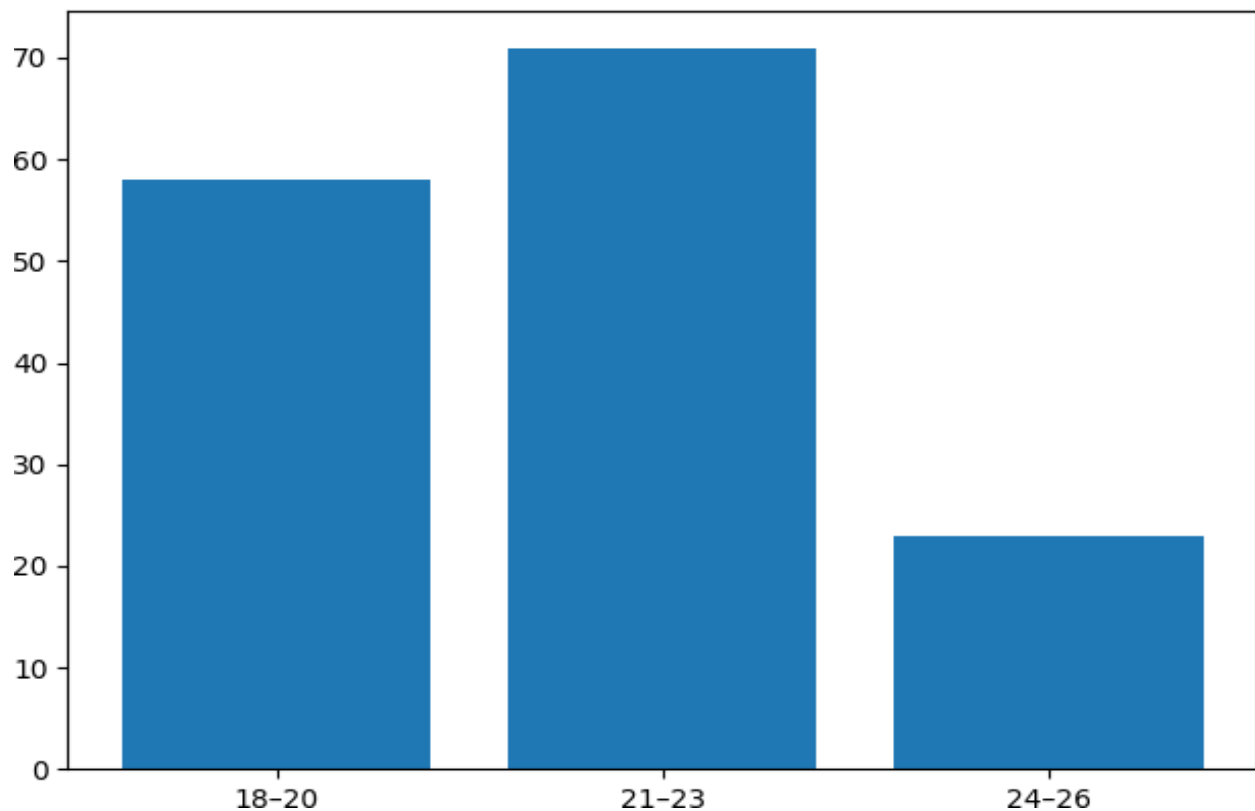


Figure 4.1: Age distribution of respondents (N=152)

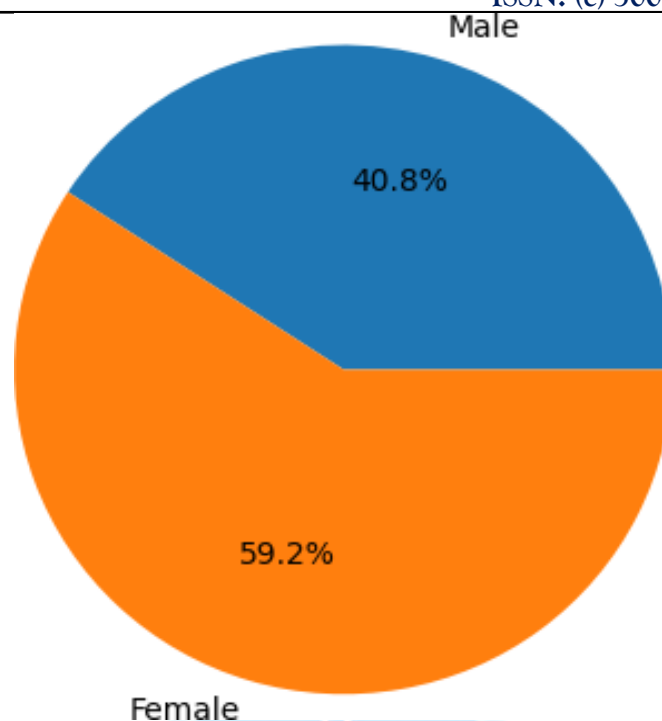


Fig. 4.3 Academic Year Distribution of respondents Gender (n=152)

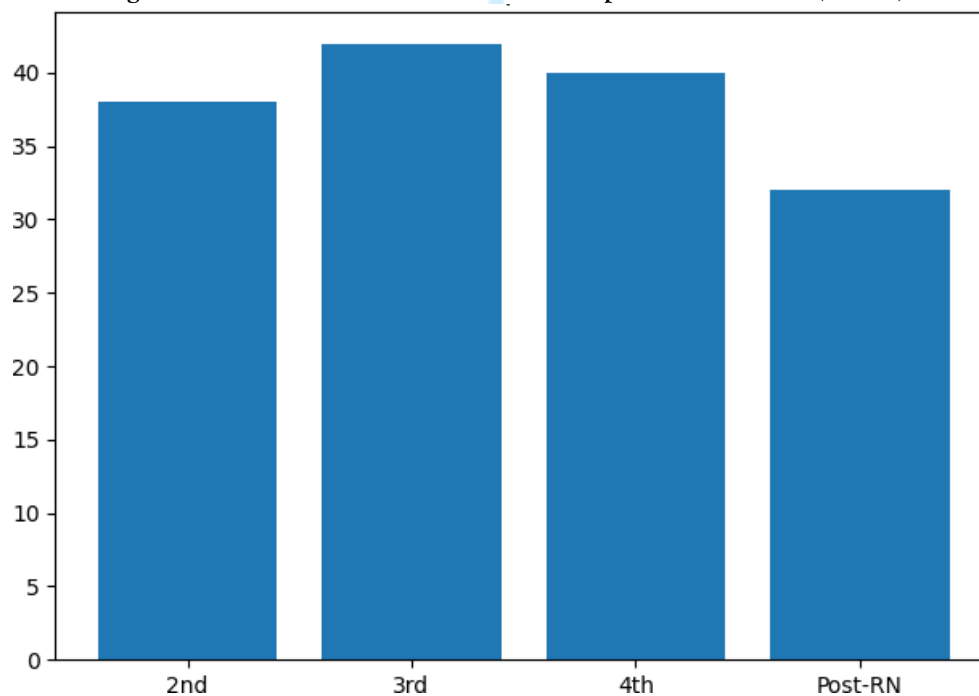


Fig.4.4 Experience of respondents

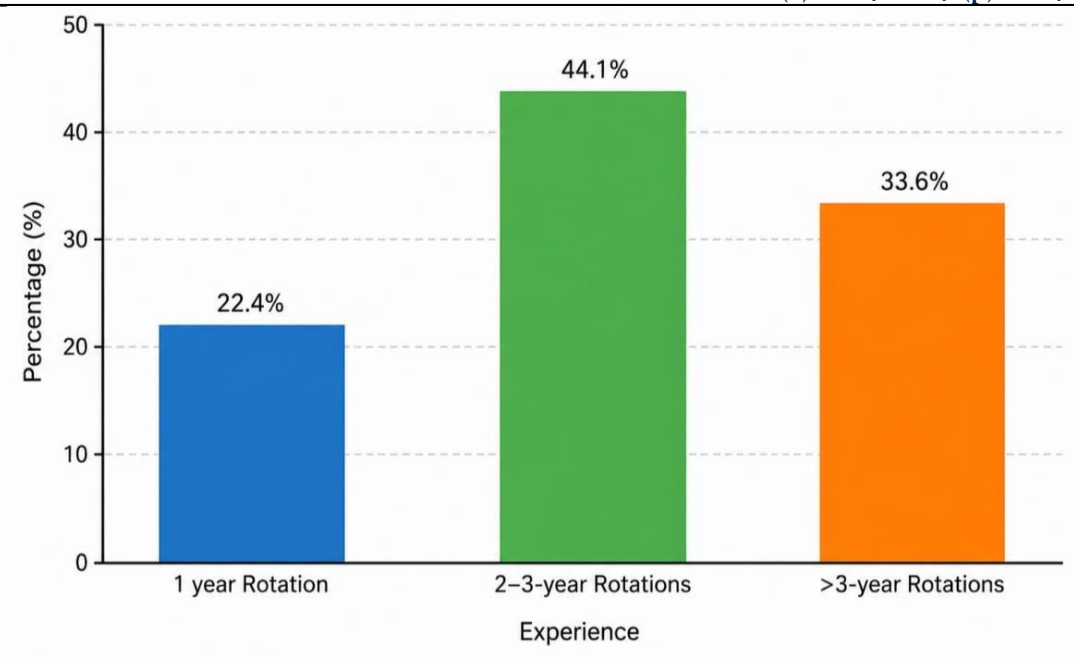
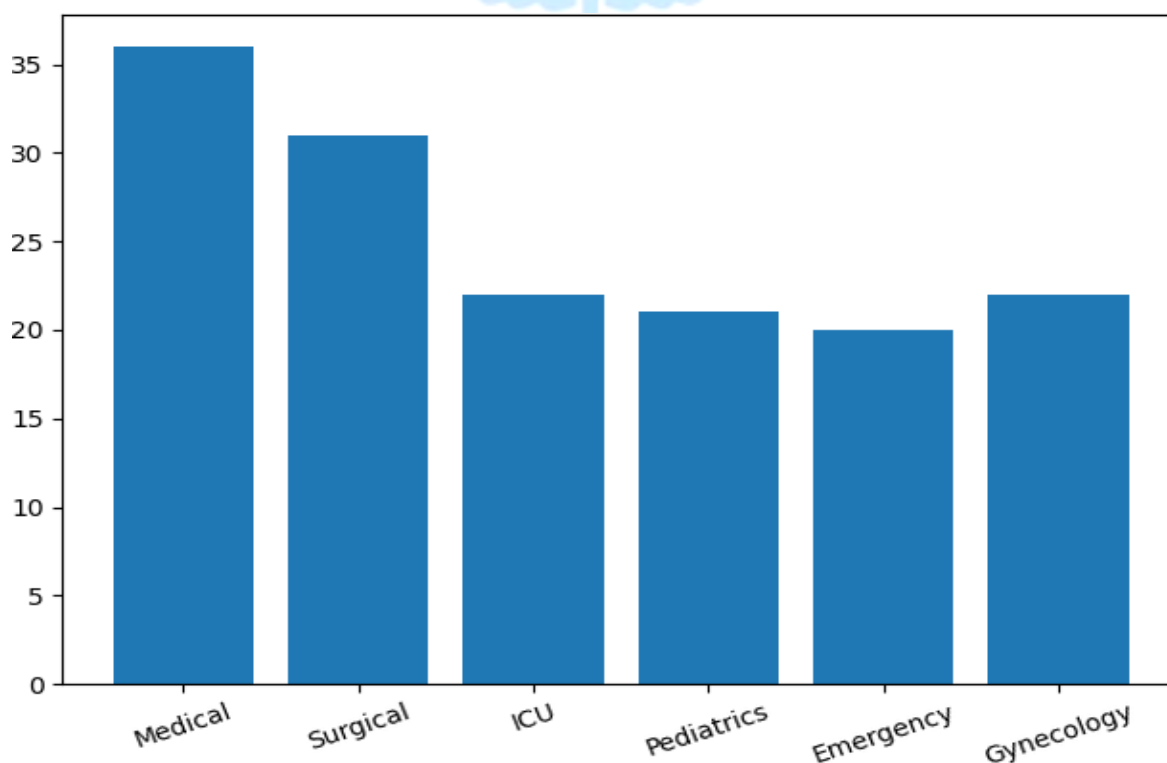


Fig 4.5 Distribution of respondents by clinical ward/unit

**Knowledge Regarding Medication Errors**

Overall knowledge score about medication errors was found to be low to high, with an average score of 8.1 ± 2.1 . According to the pre-determined scoring system, out of the total respondents, 62 (40.8%) had good knowledge, 72 (47.4%) had

moderate knowledge, while 18 (11.8%) had poor knowledge of medication errors, implying that most of the nursing students had either moderate or good knowledge about medication errors. As seen from the item wise analysis (Table 4.2 and Figure 4.6), the highest level of knowledge was

found about patient identification (96.7%) and right of medication administration (95.4%), followed by the definition of medication errors (92.1%) and prevention methods (90.8%). Lower

knowledge was found about look alike/sound alike (LASA) drugs (66.4%) and high alert medications (68.4%).

Table 4.2: Nurses' knowledge regarding the medication error (item-wise, % correct response, N=152)

Table 4.2

Knowledge statements	Correct	Incorrect	Correct %
Medication errors are preventable events that may cause patient harm.	140	12	92.1
Medication errors can occur at different stages of medication use.	132	20	86.8
High-alert medications require extra caution during administration.	104	48	68.4
Safe medication administration follows the medication rights.	145	7	95.4
Medication errors should be reported promptly through the proper system.	112	40	73.7
Patient identity must be verified before administering medication.	147	5	96.7
Accurate dose calculation helps prevent medication errors.	108	44	71.1
Medication administration should be documented accurately and completely.	126	26	82.9
Medication errors can be reduced by following safety protocols.	138	14	90.8
Proper medication storage maintains drug safety and effectiveness.	118	34	77.6
Look-alike and sound-alike (LASA) drugs require careful verification.	101	51	66.4
Clinical supervision helps reduce medication errors among students.	130	22	85.5

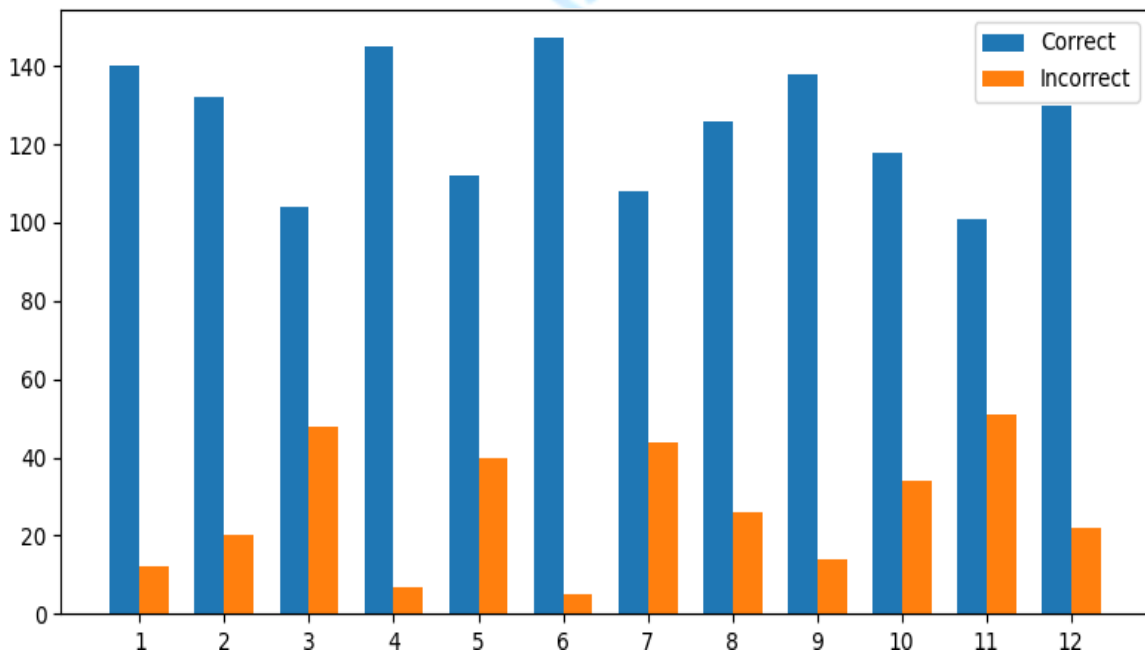


Figure 4.6. Item-wise Distribution of Correct and Incorrect Responses Regarding Knowledge of Medication Errors Among Nursing Students

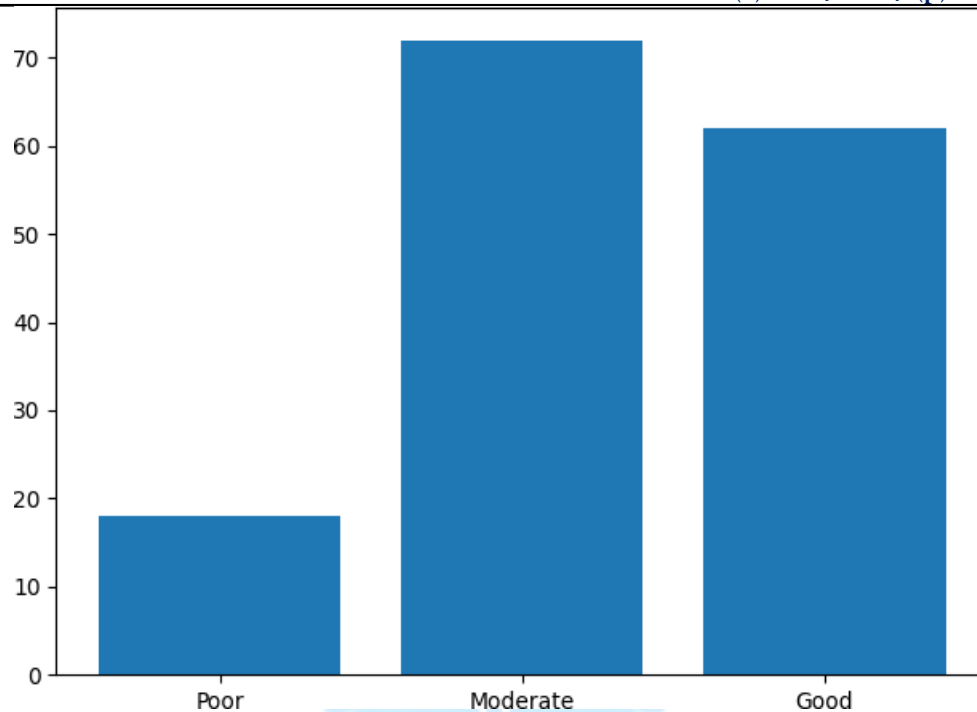


Fig 4.7 overall knowledge of respondents

4.2 Causes of Medication Errors During Clinical Rotations

Perceived causative factors score between 22 and 50 of 50 possible was recorded (mean 39.8, SD 5.7), which reflected the fact that the listed factors had a great deal to do with the occurrence of

medication errors among clinical students. The three groups of factors are deemed very significant in the occurrence of medication errors, as illustrated in figure 4.8.

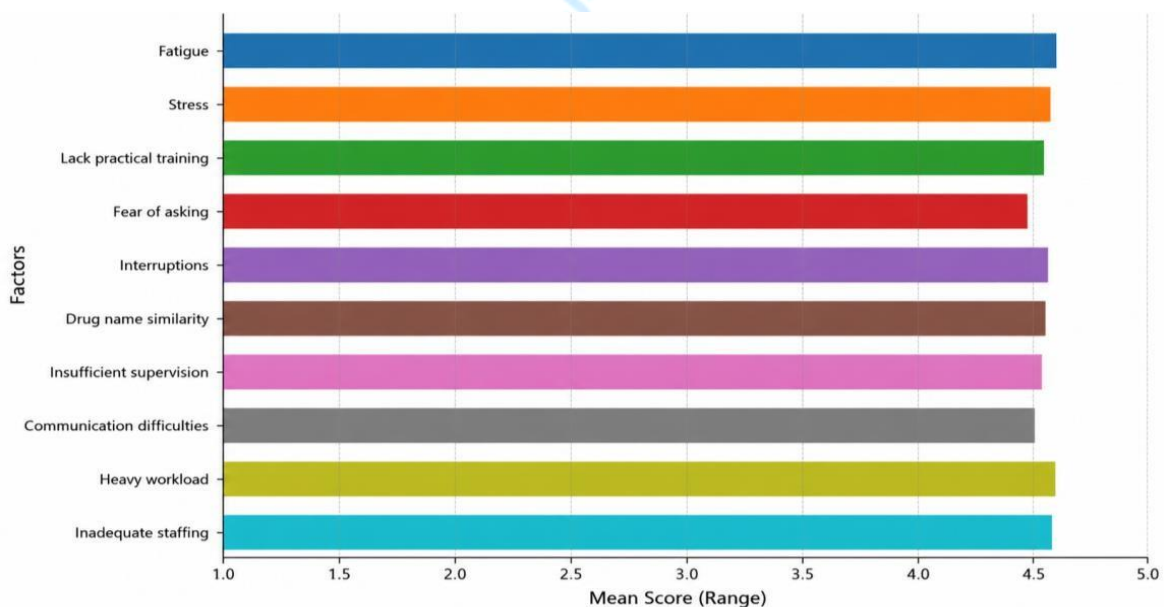


Fig.4.8 Mean Scores of Factors Contributing to Medication Errors

Of the three, the highest scores were attributed to the organizational causes, namely heavy workload and understaffing. Individual factors which stood out as being the most important included fatigue, stress, and lack of training. The clinical factors

which stood out as leading causes of medication errors include medication administration interruption, similar drug names, poor supervision, and communication problems (Tables 4.3).

Category	Factor	Mean	SD	Rank
Individual Factors	Fatigue	4.42	0.69	1
	Stress	4.31	0.73	2
	Lack of practical training	4.21	0.75	3
	Fear of asking	4.05	0.81	4
Clinical Factors	Interruptions	4.36	0.70	1
	Drug name similarity	4.28	0.72	2
	Insufficient supervision	4.19	0.77	3
	Communication difficulties	4.11	0.80	4
Organizational Factors	Heavy workload	4.48	0.63	1
	Inadequate staffing	4.40	0.68	2

4.3 Association Between Demographic Variables and Knowledge

Statistical analysis of the relationship between demographic factors and knowledge about medication errors (Table 4.4) showed that there were statistically significant differences according

to age group and clinical experience ($p < 0.05$). Students whose ages ranged between 24-26 years old and students who had more than three clinical experiences showed higher levels of knowledge. There was no statistically significant correlation between gender and knowledge ($p > 0.05$).

Table 4.4

Demographic Variable	Test	Statistic	p-value	Interpretation
Age group	One-way ANOVA	F = 3.92	0.022	Significant
Gender	Independent t-test	t = 1.18	0.240	Not significant
Clinical rotation experience	One-way ANOVA	F = 6.11	0.003	Significant

This is shown through Figure 4.9, which depicts the comparison between mean knowledge scores about medication errors among various age groups based on their gender. From this figure, one can see that the mean knowledge scores varied with age such that individuals within the 24-26 years age bracket obtained the highest mean knowledge score followed by the 21-23 years age group and the lowest in the 18-20 years age group. It is clear that the females obtained slightly higher mean knowledge scores than males among all the age groups.

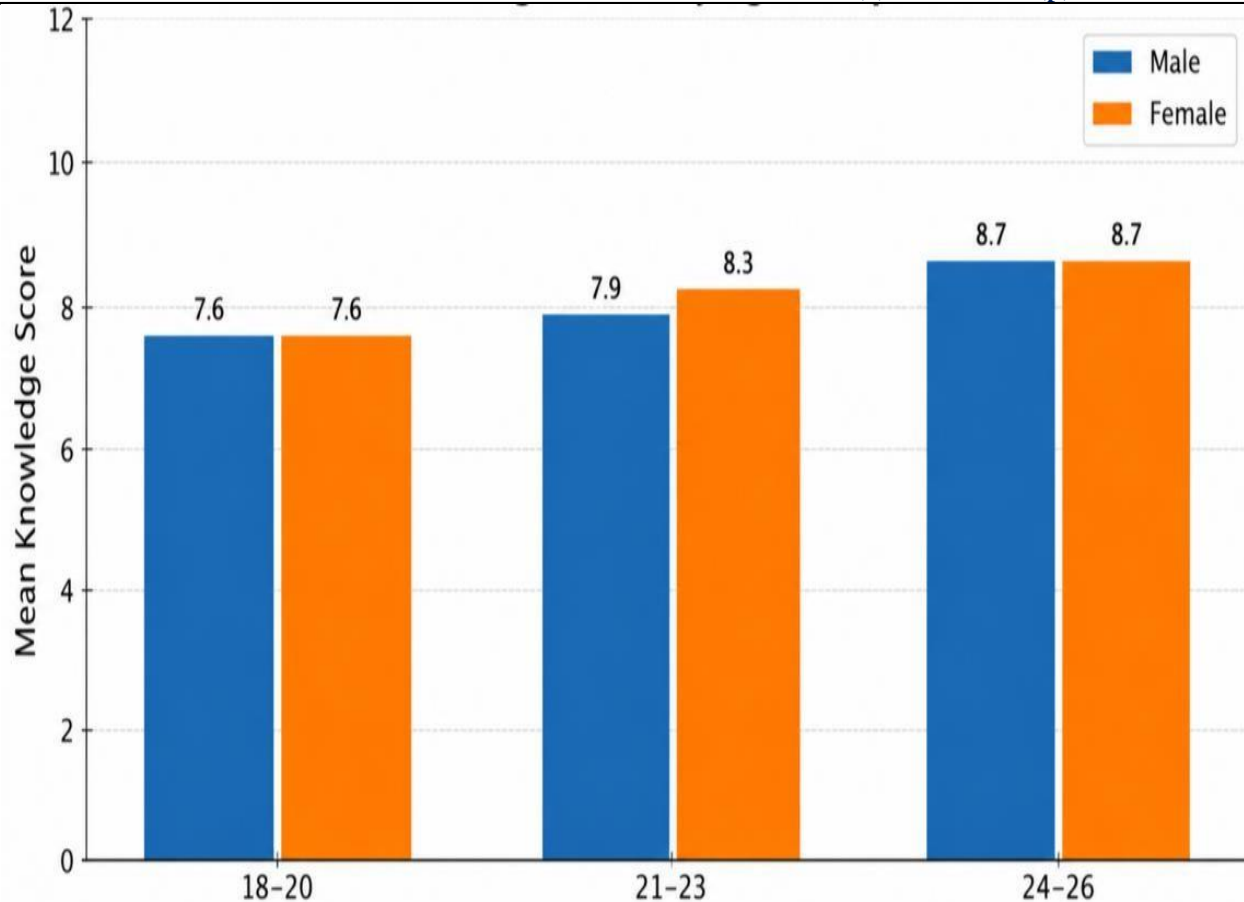


Fig.4.9 Comparison of Knowledge Scores Among Male and Female Nursing Students Across Age Groups

4.4 Association Between Demographic Variables and Causes of Medication Errors

Table 4.10 reveals the relationship between the demographics of the respondents and their perceptions on the causes of medication errors. Based on the results, there is a statistically significant difference in the mean cause score for age groups ($F = 3.41$, $p = 0.036$) and clinical

rotation experience ($F = 5.02$, $p = 0.008$). Those belonging to the age group 24-26 years (41.0 ± 5.2) and more than three clinical rotations (41.3 ± 5.1) had the highest mean cause scores. On the other hand, there was no statistically significant difference in the mean cause scores between the males (39.2 ± 5.8) and females (40.2 ± 5.6) respondents ($t = -1.32$, $p = 0.189$).

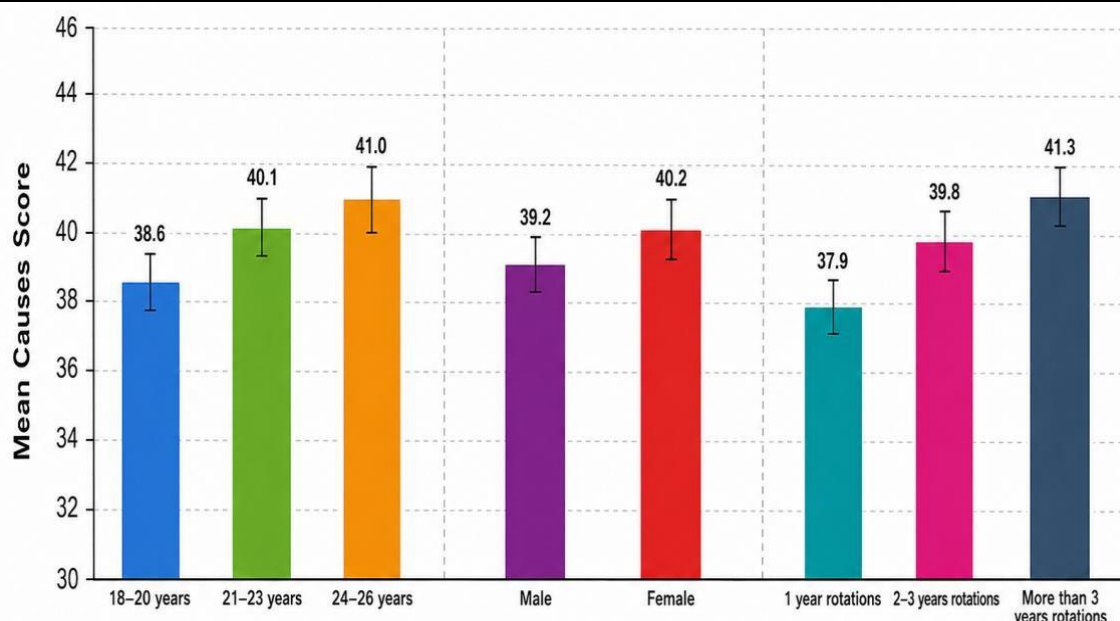


Fig. 4.10 Mean Causes of Medication Error Scores Across Age, Gender, and Clinical Rotation Duration

Discussion

Knowledge scores obtained overall (Mean: 8.1 ± 2.1) suggest that nursing students posted in clinical placement at Kohat public sector hospitals have a fair to good level of knowledge about basic medication safety concepts, and only 11.8% of the students were classified as having poor knowledge. The best performance by the students was observed in patient identification (96.7%), rights of medication administration (95.4%), medication error definition (92.1%) and medication error prevention (90.8%). These four items are the most basic and fundamental concepts repeated many times during training and education. However, students showed less knowledge of LASA medications (66.4%) and high alert medications (68.4%), two topics which require much more specialized knowledge at the ward-level than general classroom knowledge.

As for causes of medication errors, the mean score of 39.8 (SD 5.7) in relation to 50 indicates that students have strongly agreed with the causes listed above. In terms of organizational causes, the highest-rated factors included heavy workload (4.48) and lack of sufficient personnel (4.40), which can be related to the overwhelming situation at public teaching hospitals. As for personal factors, the leading causes are fatigue

(4.42) and stress (4.31), followed by lack of practical training (4.21) and unwillingness to ask questions (4.05), which may be associated with hierarchical clinical practice and unwillingness of students to seek help. As for clinical causes, interruptions in the process of administering (4.36) and similarity of drugs' names (4.28) were considered the most significant factors, followed by lack of supervision (4.19) and poor communication (4.11). It is important to note that the high score given to similarity of drugs' names as a cause of error is consistent with weak LASA knowledge indicated before and, therefore, indicates its validity.

The results of the demographic analysis showed that age and experience correlated significantly with knowledge and cause scores. The mean knowledge score was significantly different based on age groups ($F = 3.92$, $p = 0.022$) and experience ($F = 6.11$, $p = 0.003$), with students aged 24-26 years and those who had more than three clinical rotations having the highest scores. As expected, the mean cause scores were also significantly influenced by age ($F = 3.41$, $p = 0.036$) and experience ($F = 5.02$, $p = 0.008$). Gender had no significant effect on knowledge ($t = 1.18$, $p = 0.240$) and cause scores ($t = -1.32$, $p = 0.189$). These trends indicate that age and clinical exposure

operate as proxies for learning and training over time, with learning and risk perception being consolidated through time. Importantly, far from having less concern for causes of errors as a result of their growing experience, more experienced participants found them more important to be considered, which could be attributed to the fact that repeated exposure on the ward provides an experiential understanding of the consequences of workload, fatigue, and supervision in terms of potential error opportunities. Given the stability of these trends, with the positive relationship with experience and neutral relationship with gender, clinical exposure should be targeted via education. These results are in line with what has been found before in studies on the same subject matter. As was the case for Vaismoradi et al. (2022) and Musharyanti et al. (2019), this study too reveals that students lack knowledge about dosages and about HAMs, indicating that the same areas have been identified as needing improvement for quite some time now. The factors that caused medical errors were also very much in accordance with what has been said by Hijji et al. (2022) concerning interruptions, poor communication, and staff shortages. Moreover, as was mentioned by Musharyanti et al. (2019), lack of supervision and lack of role models are major factors. According to Cebeci et al. (2015), Turkish nursing students cited high workload and inexperience as the cause for errors, which indicates that these issues have become widespread within the sphere of clinical education of nursing students. On the other hand, this study adds to the literature that is focused on the nurses in Pakistan (e.g., Mustafa et al., 2022).

CONCLUSION

The nursing students on clinical placement at public-sector hospitals in Kohat exhibited a moderate to good level of knowledge about medication safety; however, very few nursing students were rated poorly knowledgeable about medication safety. The essential elements of patient identification, medication rights, and error prevention were thoroughly known by the nursing students, but there was a lack of understanding concerning look alike/sound alike and high alert medications. Organizational, individual, and

clinical elements were strongly favored by the nursing students as the causes of medication errors. Age and clinical placement were significantly related to knowledge and causes, but gender was not significantly related to both.

Limitations

- Single-district, cross-sectional design limits causal inference and generalizability beyond public-sector hospitals in Kohat.
- Stratified random sampling was confined to one district, so findings may not reflect private-sector or other regional settings.
- Self-reported knowledge and Likert-scale responses are subject to social desirability and recall bias.
- The knowledge and causes questionnaires were study-specific rather than previously validated standardized instruments.
- A small proportion of questionnaires (2.6%) were excluded due to incomplete responses, marginally reducing the effective sample size.
- Cross-tabulations across smaller demographic subgroups (e.g., 24–26 years, >3 rotations) may have limited statistical power for some comparisons.

Recommendations

- Introduce targeted, case-based teaching on LASA and high-alert medications during clinical orientation to address the specific knowledge gaps identified.
- Strengthen organizational support through improved staffing ratios and workload management to reduce the leading causes of medication errors reported by students.
- Establish structured supervision and mentorship programs, particularly for less experienced students, to reduce interruptions and improve communication during medication administration.
- Extend this assessment to other districts of Khyber Pakhtunkhwa and to private-sector hospitals, using validated instruments and larger samples to improve generalizability.
- Conduct follow-up qualitative or mixed-

methods research to explore why knowledge and risk perception improve with clinical experience, to inform earlier and more effective curriculum interventions.

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