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Effectiveness of Simulation-Based Learning on Intravenous (IV) Cannulation Skills among Nursing Students

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Abstract

Background: Simulation-based learning provides nursing students with a safe and structured environment to develop clinical skills through demonstration, practice, and feedback. Intravenous (IV) cannulation is an essential nursing procedure that requires adequate theoretical knowledge and repeated hands-on practice to achieve competency. Limited clinical exposure and opportunities for supervised practice may contribute to deficiencies in students' IV cannulation skills.

Objective: To assess the effect of simulation-based learning on intravenous cannulation practices among nursing students.

Methods: A quasi-experimental one-group pre-test and post-test design was used among **40 BSN 7th-semester nursing students** at Teaching Hospital Gujranwala. Participants were selected using simple random sampling. Data were collected from January to May 2026. A structured demographic questionnaire and a **15-item Intravenous (IV) Cannulation Skills Checklist** were used to assess students' IV practices before and after the simulation-based learning intervention. Each checklist item was scored from 0 to 2, with a total possible score of 30. Descriptive statistics were used to summarize the data, while a paired-sample t-test was applied to compare pre-intervention and post-intervention IV practice scores. A p-value of <0.05 was considered statistically significant.

Results: Before the intervention, **37 (92.5%)** participants demonstrated incompetent IV practices, while only **3 (7.5%)** demonstrated competent practices. Following the simulation-based learning intervention, the proportion of participants demonstrating competent IV practices increased to **15 (37.5%)**, while **25 (62.5%)** remained incompetent. The mean IV practice score increased from **1.0750 ± 0.26675** at pre-intervention to **1.3750 ± 0.49029** at post-intervention. However, the difference was not statistically significant (**p = 0.171**).

Conclusion: The simulation-based learning intervention demonstrated a **descriptive improvement in IV cannulation practices** among nursing students, with a notable increase in the proportion of students achieving competent practice. However, the improvement in mean scores was not statistically significant. Regular simulation sessions, repeated hands-on practice, clinical supervision, and competency-based assessment are recommended to further strengthen IV cannulation skills among nursing students.

INTRODUCTION

1.1. BACKGROUND OF STUDY

Nursing education is fundamentally based on the integration of theoretical knowledge with clinical practice to ensure safe, competent, and effective patient care. Clinical skill development is a core component of nursing training; however, traditional clinical learning in hospital settings is often challenged by limited patient availability, ethical concerns regarding patient safety, inconsistent clinical exposure, and reduced opportunities for hands-on practice (Alharbi et al., 2024). These challenges have created a need for innovative teaching strategies that can better prepare nursing students for real clinical environments.

In this context, simulation-based learning (SBL) has emerged as an effective and widely accepted educational approach in nursing education. Simulation provides a structured, controlled, and realistic learning environment where students can practice clinical skills repeatedly without risking patient safety (Lin, 2022). It enables learners to develop critical thinking, psychomotor skills, decision-making abilities, and effective communication through active participation in realistic clinical scenarios. Simulation also allows immediate feedback, reflection, and correction of errors, which enhances long-term skill retention and confidence among learners (Lee et al., 2023).

International evidence strongly supports the effectiveness of simulation-based education. A systematic review and meta-analysis indicated that simulation-based learning significantly improves clinical competence, knowledge retention, and confidence among nursing students compared to traditional teaching methods (Alharbi et al., 2024). Similarly, a meta-analysis by (Görücü et al., 2024) reported that simulation training enhances clinical decision-making skills and improves overall nursing performance in both academic and clinical environments. Furthermore, simulation-based training has been shown to improve communication skills and teamwork, which are essential components of safe patient care (Wei et al., 2024).

In addition, research conducted in high-income countries such as the United States, United Kingdom, and Australia has demonstrated that simulation-based education improves readiness for clinical practice and reduces anxiety among nursing students when transitioning from classroom to clinical settings. The National League for Nursing (NLN) has also recognized simulation as a vital component of nursing curricula, emphasizing its role in bridging the gap between theory and practice (Tong et al., 2024).

In developing countries, including Pakistan, nursing education faces additional challenges such as overcrowded clinical settings, shortage of trained clinical instructors, limited clinical resources, and high patient-to-student ratios. These limitations often reduce students' opportunities for supervised clinical practice. As a result, nursing students may graduate with insufficient hands-on experience and lack confidence in performing essential clinical procedures (Hoebes & Ashipala, 2023).

Recent national studies have highlighted the growing importance of simulation-based learning in Pakistan. A study in Pakistan found that simulation-based training significantly improved clinical skills performance among undergraduate nursing students, particularly in areas such as patient assessment and therapeutic communication (Khan et al., 2025). Similarly, a study by (Iqbal & Abbas, 2025) reported that students exposed to simulation-based education demonstrated higher clinical competence and improved preparedness for real clinical environments compared to those taught through traditional methods.

Despite this growing evidence, the implementation of simulation-based learning remains limited in many nursing institutions in Pakistan due to resource constraints, lack of trained faculty, and insufficient simulation facilities. Moreover, there is still a gap in localized research focusing specifically on the effectiveness of simulation in improving individual clinical skills such as physical assessment, communication, and patient interaction techniques among nursing students (Bajwa et al., 2024).

1.2. PROBLEM STATEMENT

Intravenous (IV) cannulation is an essential clinical skill that nursing students must master to provide safe and effective patient care. However, students often have limited opportunities

to practice this procedure due to overcrowded clinical settings, limited patient availability, and patient safety concerns. Consequently, many students graduate with inadequate practical skills and confidence.
Although simulation-based learning is recognized as an effective method for improving psychomotor skills in a safe environment, its use in nursing education in Pakistan remains limited, and local evidence on its effectiveness is scarce. Therefore, this study aims to evaluate the effectiveness of simulation-based learning in improving IV cannulation skills among nursing students at Teaching Hospital Gujranwala.

1.3. SIGNIFICANCE OF THE STUDY

This study is significant because it evaluates the effectiveness of simulation-based learning in improving intravenous (IV) cannulation skills among nursing students. Simulation provides a safe and controlled environment where students can repeatedly practice the procedure, improve their competence, and build confidence without compromising patient safety.
The findings will help nursing educators and curriculum developers integrate simulation-based training into nursing education. The study will also contribute to improving the clinical competence of nursing students, enhance patient safety, and support the delivery of high-quality nursing care.

1.4. RESEARCH QUESTIONS

1. What is the effectiveness of simulation-based learning in improving intravenous (IV) cannulation skills among nursing students?

1.5. OBJECTIVES OF STUDY

1. To determine the effectiveness of simulation-based learning in improving intravenous (IV) cannulation skills among nursing students.

1.6. OPERATIONAL DEFINITION

Simulation-Based Learning

In this study, simulation-based learning refers to a structured educational intervention in which nursing students will practice clinical skills in a simulated clinical environment using standardized scenarios, demonstrations, and guided practice sessions. It will be designed to enhance students' psychomotor, cognitive, and communication skills in a safe and controlled setting without risk to real patients.

Intravenous (IV) Cannulation Skills

In this study, **intravenous (IV) cannulation skills** refer to the nursing students' competency in performing peripheral IV cannulation according to standard clinical guidelines. This includes preparation of equipment, infection prevention and aseptic technique, vein selection, catheter insertion, catheter stabilization, safe disposal of sharps, and post-procedure patient care. IV cannulation skills will be assessed before and after the simulation-based learning intervention using a standardized **IV Cannulation Skills Checklist**, with higher scores indicating better competency.

CHAPTER 2
LITERATURE REVIEW

Simulation-based learning (SBL) has gained significant importance in nursing education as an effective pedagogical approach to enhance clinical skill development among nursing students. It provides a safe and controlled environment where students can practice

clinical procedures, improve decision-making, and develop confidence before interacting with real patients. A growing body of national and international literature supports its effectiveness in bridging the gap between theoretical knowledge and clinical practice.
A quasi-experimental study was conducted to evaluate the effectiveness of simulation-based learning (SBL) in enhancing clinical skill competence among undergraduate nursing students and to bridge the gap between theoretical knowledge and clinical practice. The study employed a single-group pre-test and post-test design. A total of 80 students were selected using a non-probability convenience sampling technique, and written informed consent was obtained from all participants prior to data collection. Baseline clinical skills were assessed using a structured head-to-toe assessment checklist. The intervention consisted of simulation-based learning sessions that included video demonstrations and scenario-based classroom teaching of head-to-toe assessment skills. After completion of the intervention, a post-assessment was conducted using the same checklist to evaluate improvement in clinical performance. Data were analyzed using SPSS version 26. The findings revealed a statistically significant improvement in clinical skills after the intervention. The mean score increased from 6.35 ± 2.41 in the pre-test to 14.43 ± 2.75 in the post-test, with a highly significant p-value (< 0.0001) using paired t-test analysis. The study concluded that simulation-based learning significantly improves clinical skill competence among undergraduate nursing students. It recommended the integration of simulation-based teaching strategies into nursing curricula to enhance clinical performance and effectively bridge the theory-practice gap (Ahmed et al., 2025).
A quantitative descriptive cross-sectional study was conducted to assess the satisfaction levels of undergraduate nursing students with simulation-based learning (SBL) in public nursing colleges of Peshawar. The study included undergraduate nursing students from public colleges, excluding first-semester students, with a total sample of 278 students, of whom 239 participated in the final analysis. Data were collected using an adopted questionnaire consisting of 13 satisfaction items and 6 items related to challenges, and ethical approval was obtained prior to data collection. The data were analyzed using SPSS version 25 through descriptive statistics. The findings revealed that participants (20.9% males and 79.1% females) reported 100% overall satisfaction with simulation-based learning. High satisfaction was noted regarding the usefulness of patient simulators (Mean = 4.28 ± 0.568), desire for more training sessions (Mean = 4.37 ± 0.483), and the perception that simulation made subjects more interesting (Mean = 4.21 ± 0.597). However, some challenges were also identified, including inadequate practice time (Mean = 2.46 ± 0.671) and limited access to high-fidelity simulators (Mean = 2.98 ± 0.534). The study concluded that simulation-based learning is highly effective in nursing education, as it enhances student satisfaction, knowledge retention, and clinical decision-making skills, and recommended improving access to simulation resources and increasing practice opportunities to further strengthen learning outcomes (Iqbal et al., 2024).
A quasi-experimental (pre- and post-test) study was conducted to evaluate simulation-based learning within the Management and Leadership course in nursing, focusing on its effect on students' knowledge, satisfaction, and effectiveness. The study included third-year nursing students (n = 140), and data were collected using a structured questionnaire assessing knowledge acquisition, satisfaction, and effectiveness of simulation-based learning. The findings showed a significant improvement in student satisfaction after the simulation experience, with post-simulation mean scores of 3.76 ± 0.66 (p = 0.001). However, no significant difference was observed in knowledge levels, as the pre-simulation mean score (13.11 ± 4.53) was slightly higher than the post-simulation score (12.79 ± 4.88). The study also revealed that the design and environment of the simulation laboratory significantly influenced students' knowledge and satisfaction, while demographic factors showed some impact, with computer skills significantly associated with simulation effectiveness and satisfaction (p = 0.005). The study concluded that simulation-based learning improves student satisfaction and effectiveness and supports skill development in nursing education,

recommending further enhancement of simulation facilities and integration of realistic scenarios to strengthen learning outcomes (Abd Alqder, 2025).

An exploratory qualitative study was conducted to explore nursing faculty members' perceptions of simulation-based education (SBE), along with its facilitators and barriers in nursing schools offering the BScN program. The study included one public and three private institutions, and data were collected through face-to-face focus group discussions with 33 nurse academics. The transcripts were analyzed using content analysis. The findings revealed four main themes: faculty perceptions of SBE, barriers, facilitators, and the future of simulation. Faculty members viewed simulation as an effective teaching strategy that improves students' confidence and critical thinking skills. However, barriers such as high cost, limited equipment, and lack of trained faculty were identified. Facilitators included student preparation and institutional collaboration, while future improvements focused on faculty development and administrative support. The study concluded that addressing barriers and strengthening facilitators can enhance the effective implementation of simulation-based education in nursing (Lalani, 2023).

A descriptive cross-sectional study was conducted to investigate the effect of simulation-based learning on the clinical performance of nursing interns in a private hospital in Lahore. The study aimed to assess how simulation-based education influences interns' ability to perform clinical tasks effectively in real hospital settings. A total of 76 nursing interns participated in the study, and data were collected using a structured questionnaire. The study was carried out in a private hospital in Lahore. The findings revealed that simulation-based learning had a positive impact on the clinical performance of nursing interns, as participants reported improved ability to manage patients and demonstrated greater confidence in handling clinical situations within a short period of time after training. The study concluded that simulation-based learning significantly enhances the clinical performance of nursing interns and recommended its integration into nursing education and internship programs to strengthen clinical competencies and improve patient care outcomes (Farooq et al., 2023).

A quasi-experimental pre-test and post-test study was conducted to evaluate the effectiveness of simulation-based training in enhancing clinical decision-making skills among final-year nursing students in Swat, Pakistan. The study included 60 final-year nursing students from different colleges, who participated in six structured simulation sessions over a period of two weeks. Clinical decision-making skills were assessed using a validated tool before and after the intervention, and the data were analyzed using paired sample t-test and chi-square test. The findings showed a significant improvement in clinical decision-making skills after simulation-based training, as the mean post-test score (25.75 ± 3.90) was significantly higher than the pre-test score (18.40 ± 4.25), with a mean difference of 7.35 ($p < 0.001$). Additionally, no significant association was found between demographic variables such as age and gender and post-test scores ($p > 0.05$), indicating that simulation-based training is effective across different student groups. The study concluded that simulation-based training significantly improves clinical decision-making skills among nursing students and recommended its integration into nursing curricula to better prepare students for real clinical practice (Malhotra, 2025).

A quantitative descriptive cross-sectional study was conducted to assess the effectiveness of simulation-based learning in enhancing self-efficacy and clinical performance among post-RN BSN nursing students in Pakistan. The study was carried out at Superior College of Nursing, Lahore, and included 110 post-RN BSN students who were assigned to either a simulation-based training group (intervention) or a traditional clinical rotation group (control). Data were collected in July 2024 using a structured, pre-validated questionnaire that included the Self-Efficacy Scale (SES) and an Objective Structured Clinical Examination (OSCE). Statistical analysis was performed using SPSS version 23, and both descriptive and inferential statistics including paired t-tests and ANOVA were applied. The findings revealed that students in the simulation group showed a significant improvement in self-efficacy compared to the control group, with mean scores increasing from 62.5 in the pre-test to

79.3 in the post-test ($p < 0.01$). OSCE results also demonstrated a 28% increase in procedural accuracy (88% vs. 60%) and a 25% reduction in clinical errors (1.5 vs. 4.0 per 10 cases) among the simulation group compared to controls ($p < 0.01$). In addition, qualitative findings from reflective journals identified key themes including increased confidence, enhanced preparedness, and reduced anxiety during clinical practice. The study concluded that simulation-based learning significantly improves self-efficacy, clinical performance, and decision-making skills while reducing errors and anxiety among nursing students. It recommended the integration of simulation-based learning into nursing curricula to develop confident, competent, and practice-ready graduates capable of delivering safe and high-quality patient care (Rateb et al., 2025).

RESEARCH GAP

Although simulation-based learning has been widely recognized internationally as an effective teaching strategy for improving clinical skills, confidence, and decision-making abilities among nursing students, there is still limited context-specific evidence in developing countries like Pakistan regarding its effectiveness in clinical skill development. Most existing studies have focused on outcomes such as satisfaction, knowledge gain, or specific competencies, while fewer studies have comprehensively evaluated overall clinical skill performance using standardized observational checklists in a pre-test and post-test design. Additionally, much of the available national literature is concentrated in major cities and may not fully represent teaching hospital settings where resource constraints and large student populations may influence learning outcomes. Furthermore, variations in teaching methods, simulation facilities, and faculty training also create inconsistencies in findings across studies. Therefore, there is a need for more localized, structured research to evaluate the effectiveness of simulation-based learning on clinical skill development among nursing students in Teaching Hospital Gujranwala, which this study aims to address.

CHAPTER 3
MATERIAL AND METHODS

3.1: Study Design

The present study employed a quasi-experimental one-group pre-test and post-test design. This design is used to evaluate the effect of simulation-based learning on clinical skill development by measuring changes in the same group of nursing students over time.

3.2: STUDY SETTING

The study was carried out at Teaching hospital Gujranwala.

3.3: DURATION OF STUDY

After receiving ethical approval from the college's ethics committee, the study was conducted over five months, from January 2026 to May 2026.

3.4: SAMPLE SIZE

The sample size for this study was calculated using a standard formula for a paired t-test design, considering a 95% confidence level, 80% power, an assumed standard deviation of 10, and an expected mean difference of 5 in clinical skill scores before and after the simulation-based learning intervention. The minimum required sample size was found to be 32 nursing students, which was then increased to 40 participants after adding a 10–20% attrition rate to ensure adequate statistical power and account for possible dropouts.

Formula used for sample size calculation

$$n = \frac{(Z_{\alpha/2} + Z_{\beta})^2 \times \sigma^2}{d^2}$$

Where:

- n= required sample size
- Zα/2 = 1.96 (at 95% confidence level)
- Zβ = 0.80 (at 80% power)
- σ\sigma = standard deviation (assumed 10)
- d= expected mean difference (effect size, assumed 5)
-

3.5: SAMPLING TECHNIQUE

Simple random sampling technique will be used to collect the data.

3.6: SAMPLE SELECTION

3.6.1: Inclusion Criteria

1. Students enrolled in Bachelor of Science in Nursing (BSN) program (7th semester).
2. Both male and female nursing students.
3. Students who are willing to participate and provide informed consent.
4. Students available during the data collection period.
5. Students who have not previously undergone structured simulation-based training for the selected clinical skills.

3.6.2: Exclusion Criteria

1. Students who are not willing to participate or withdraw consent at any stage of the study.
2. Students who are absent during pre-test or post-test assessment.
3. Students who have already received formal advanced simulation-based clinical skills training.
4. Intern nurses or graduates who are no longer in the academic BSN program.
5. Students with incomplete participation in simulation-based learning sessions.

3.7: DATA COLLECTION PROCEDURE

After obtaining ethical approval and permission from Teaching Hospital Gujranwala, data collection was initiated for the study. Eligible participants were selected according to the inclusion criteria. The purpose of the study was explained to all participants, and written informed consent was obtained to ensure voluntary participation and confidentiality.

Pre-Intervention Phase

In the first phase, pre-test data were collected from all participants using a structured demographic questionnaire and Taylor's Clinical Nursing Skills Checklist. The checklist was used to assess the baseline clinical competencies of nursing students in key areas such as communication, patient identification, orientation, therapeutic communication, and physical assessment skills. Each item was observed and scored by the researcher in a standardized clinical or skills laboratory setting.

Intervention Phase

After completion of the pre-test, the simulation-based learning intervention was implemented. The intervention consisted of structured simulation sessions focusing on the development of clinical skills, including patient interaction, therapeutic communication, and systematic physical assessment. The sessions were conducted in a controlled skills laboratory using demonstration, practice, and scenario-based learning.

Post-Intervention Phase

Following completion of the intervention, post-test data were collected using the same Taylor's Clinical Nursing Skills Checklist under similar conditions as the pre-test to ensure consistency and reduce bias.

3.8: DATA COLLECTION TOOLS

Following tools were selected for data collection.

1. Demographic Characteristics Tool

The demographic characteristics tool is a structured questionnaire used to collect baseline information from nursing students in the study. It includes key socio-demographic and academic variables such as age, gender, year of study, residence, GPA, previous clinical training experience, prior exposure to simulation-based learning, and frequency of clinical practice per week.

2.Intravenous (IV) Cannulation Skills Checklist

The **Intravenous (IV) Cannulation Skills Checklist** is a structured observational tool used to assess the competency of nursing students in performing peripheral intravenous (IV) cannulation. The checklist was adapted from **Taylor's Clinical Nursing Skills: A Nursing Process Approach**, the **Infusion Nurses Society (INS) Infusion Therapy Standards of Practice (2024)**, and the **World Health Organization (WHO) Best Practices for Injections and Related Procedures Toolkit**. It evaluates students' performance according to standard evidence-based clinical guidelines.

The checklist consists of **15 items** covering the essential steps of IV cannulation, including hand hygiene, preparation of equipment, patient identification, vein selection, aseptic technique, catheter insertion, securing the cannula, disposal of sharps, post-procedure care, and documentation. Each item is assessed through direct observation by the researcher or a trained evaluator during a simulated IV cannulation procedure.

Each item is scored using a **three-point rating scale**: **2 = Performed correctly**, **1 = Performed partially**, and **0 = Not performed/Performed incorrectly** . The total score ranges from **0 to 30**, with higher scores indicating better competency in IV cannulation.

The competency levels are interpreted as follows:

Incompetent Practices = 0-20

Competent Practices = 21-30

The checklist will be used to assess students' IV cannulation skills **before (pre-test)** and **after (post-test)** the simulation-based learning intervention to determine the effectiveness of the educational program. Prior to implementation, the checklist will be reviewed by experts in nursing education and clinical practice to establish **content validity**, and its reliability will be evaluated through a pilot study using **Cronbach's alpha** or **inter-rater reliability**, as appropriate. This instrument provides an objective and standardized method for measuring practical competency in intravenous cannulation among nursing students.

3.9: DATA ANALYSIS PROCEDURE

The collected data were analyzed using the Statistical Package for Social Sciences (SPSS), version 25. Descriptive statistics, including frequency, percentage, mean, and standard deviation, were used to summarize the demographic characteristics of the nursing students and their clinical skill scores. To assess the effectiveness of the simulation-based learning intervention, a paired-sample t-test was applied to compare the pre-test and post-test clinical skill scores of the same group of students. A p-value of less than 0.05 was considered statistically significant.

3.10: ETHICAL CONSIDERATION

- The study was conducted after obtaining formal approval from the relevant Ethical Review Committee and permission from the concerned hospital/healthcare facility.
- Written informed consent was obtained from all eligible participants before enrollment in the study. The purpose, procedures, potential benefits, and possible risks of the stabilization exercises program were clearly explained to the participants.

- Participation in the study was entirely voluntary. Participants were informed that they had the right to refuse participation or withdraw from the study at any stage without any penalty or effect on their routine antenatal care.
- All information and collected data were kept strictly confidential and were used only for research purposes. Participant anonymity was maintained by assigning identification codes instead of recording names.
- Before participation, pregnant women were assessed for their suitability to perform the stabilization exercises. Participants with any medical or obstetric contraindications to exercise were excluded from the study to minimize potential risks.
- The stabilization exercises were conducted under appropriate supervision, and participants were instructed to report any pain, discomfort, dizziness, bleeding, contractions, or other unusual symptoms during the intervention. The exercise session was discontinued if any concerning symptoms occurred.

CHAPTER 4
RESULTS
4.1 Demographic Characteristics of Participants

Table 1: Frequency distribution according to age groups

Age	Frequency	Percent
18–20 Year	17	42.5
21–30 Year	14	35.0
31–35 Year	9	22.5
Total	40	100.0

Table 1 shows the age distribution of the participants. Among the 40 participants, the majority, 17 (42.5%), were aged 18–20 years, followed by 14 (35.0%) participants aged 21–30 years. The remaining 9 (22.5%) participants were aged 31–35 years.

Figure 1: Frequency distribution according to age groups

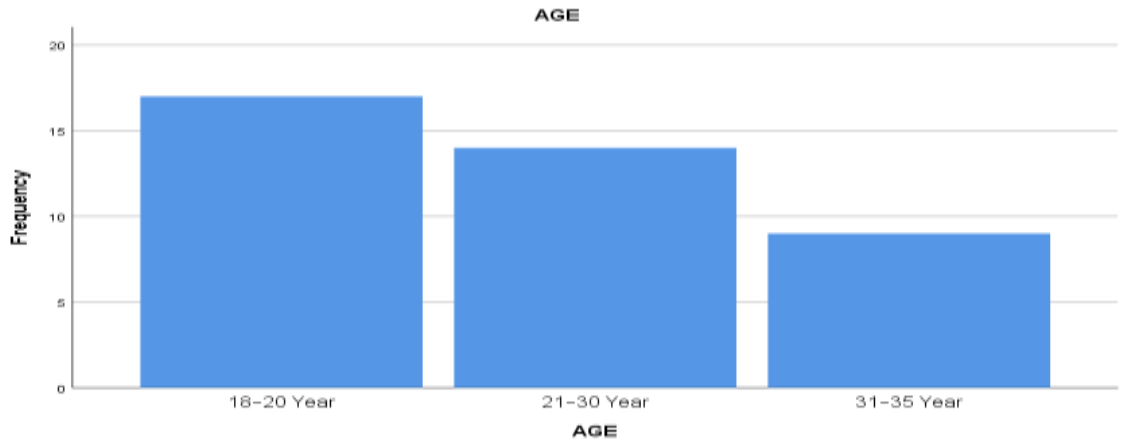

Table 2: Frequency distribution according to gender

Gender	Frequency	Percent
Male	24	60.0
Female	16	40.0
Total	40	100.0

Table 2 shows the gender distribution of the participants. Among the 40 participants, **24 (60.0%) were male**, while **16 (40.0%) were female**. Thus, the majority of the participants were male.

Figure 2: Frequency distribution according to gender

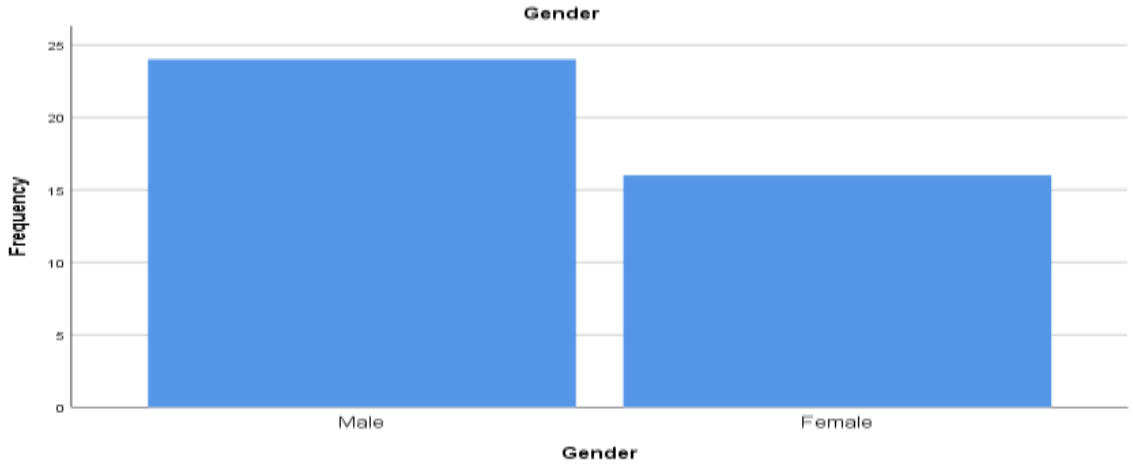

Table 3: Frequency distribution according to Area of Residence

Area of Residence	Frequency	Percent
Urban	22	55.0
Rural	18	45.0
Total	40	100.0

Table 3 shows the distribution of participants according to their area of residence. Among the 40 participants, **22 (55.0%)** were from **urban areas**, while **18 (45.0%)** were from **rural areas**. Thus, the majority of participants belonged to urban areas.

Figure 3: Frequency distribution according to Area of Residence

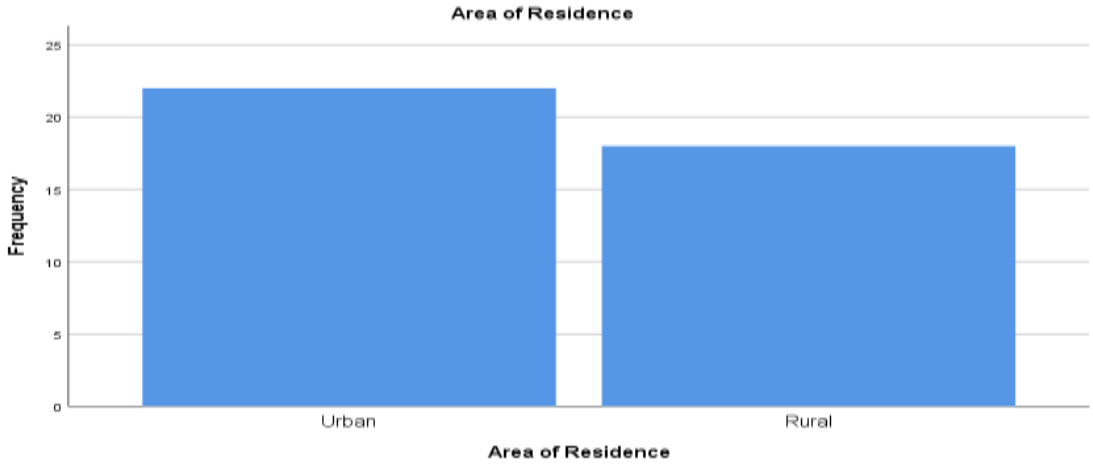

Table 4: Frequency distribution according to Current GPA

Current GPA	Frequency	Percent
< 2.5	3	7.5
2.6-3.0	20	50.0
3.1-3.5	13	32.5
3.6-4.0	4	10.0
Total	40	100.0

Table 4 shows the distribution of participants according to their current GPA. Among the 40 participants, the majority, **20 (50.0%)**, had a GPA of **2.6–3.0**, followed by **13 (32.5%)**

participants with a GPA of **3.1–3.5**. **4 (10.0%)** participants had a GPA of **3.6–4.0**, while **3 (7.5%)** had a GPA of **less than 2.5**.

Figure 4: Frequency distribution according to Current GPA

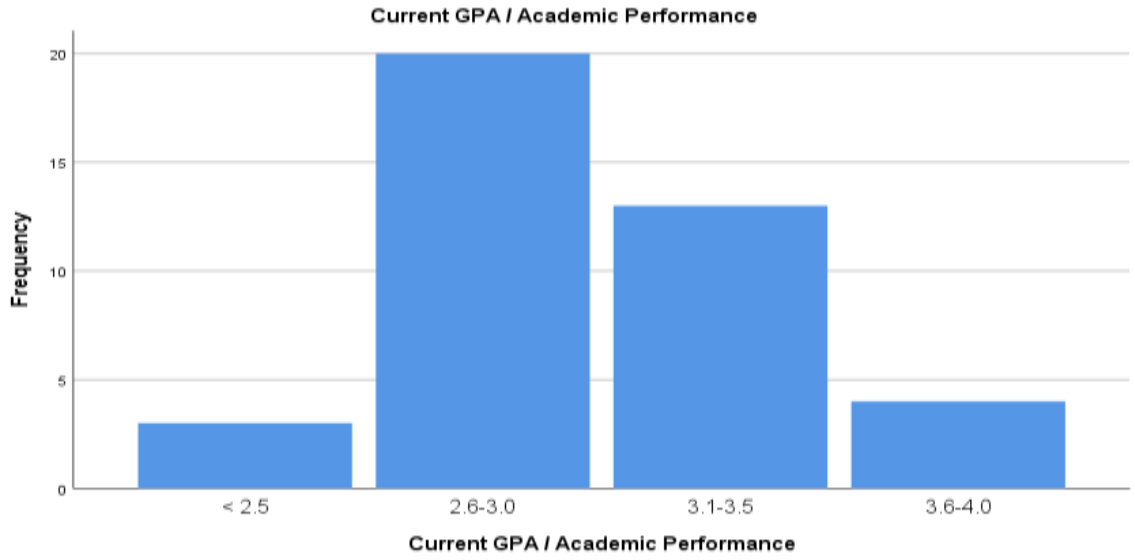

Table 5: Frequency distribution according to Clinical Practice per Week

Clinical Practice per Week	Frequency	Percent
1–2 days	16	40.0
3-5 days	14	35.0
> 5 days	10	25.0
Total	40	100.0

Table 5 shows the distribution of participants according to their clinical practice per week. Among the 40 participants, **16 (40.0%)** had clinical practice for **1–2 days per week**, followed by **14 (35.0%)** who practiced for **3–5 days per week**. The remaining **10 (25.0%)** participants had clinical practice for **more than 5 days per week**.

Figure 5: Frequency distribution according to Clinical Practice per Week

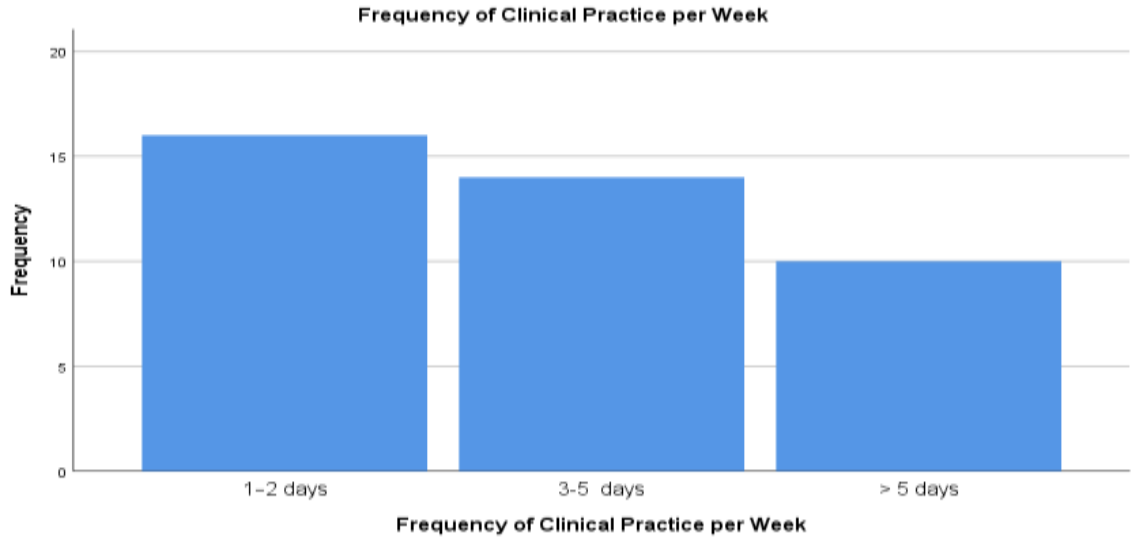

Table 6: Pre-intervention Intravenous practices of student nurses

Level of IV Practices	Frequency	Percent

Incompetent Practices	37	92.5
Competent Practices	3	7.5
Total	40	100.0

Table 6 shows the pre-intervention level of intravenous (IV) practices among student nurses. Among the 40 participants, the majority, **37 (92.5%)**, demonstrated **incompetent IV practices**, while only **3 (7.5%)** demonstrated **competent IV practices**. This indicates that most student nurses had inadequate IV practice skills before the intervention.

Figure 6: Pre-intervention Intravenous practices of student nurses

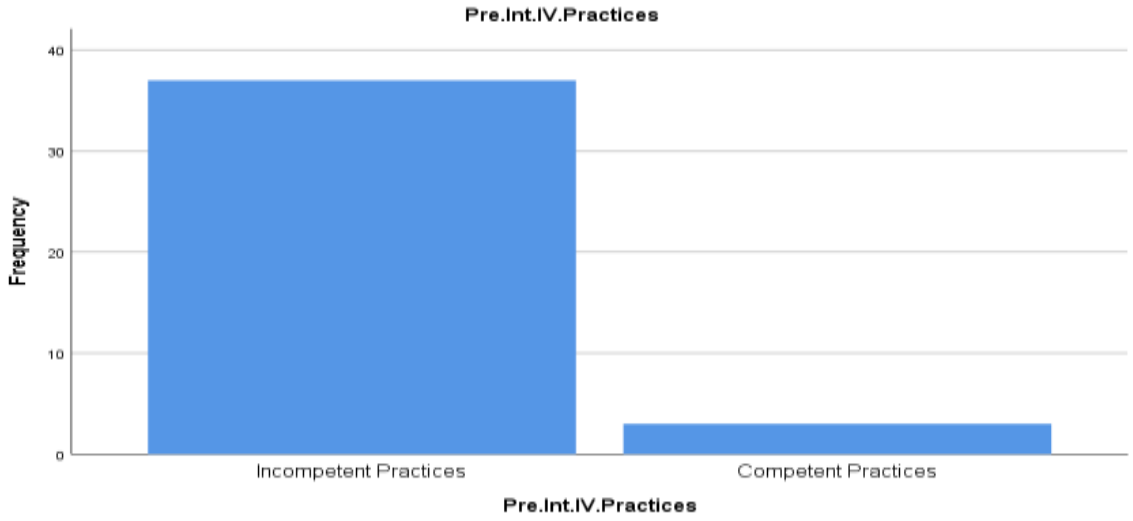

Table 7: Post-intervention Intravenous practices of student nurses

Level of IV Practices	Frequency	Percent
Incompetent Practices	25	62.5
Competent Practices	15	37.5
Total	40	100.0

Table 7 shows the post-intervention level of intravenous (IV) practices among student nurses. Among the 40 participants, **25 (62.5%)** demonstrated **incompetent IV practices**, while **15 (37.5%)** demonstrated **competent IV practices** after the intervention. The findings indicate an improvement in competent IV practices compared with the pre-intervention results.

Figure 7: Post-intervention Intravenous practices of student nurses

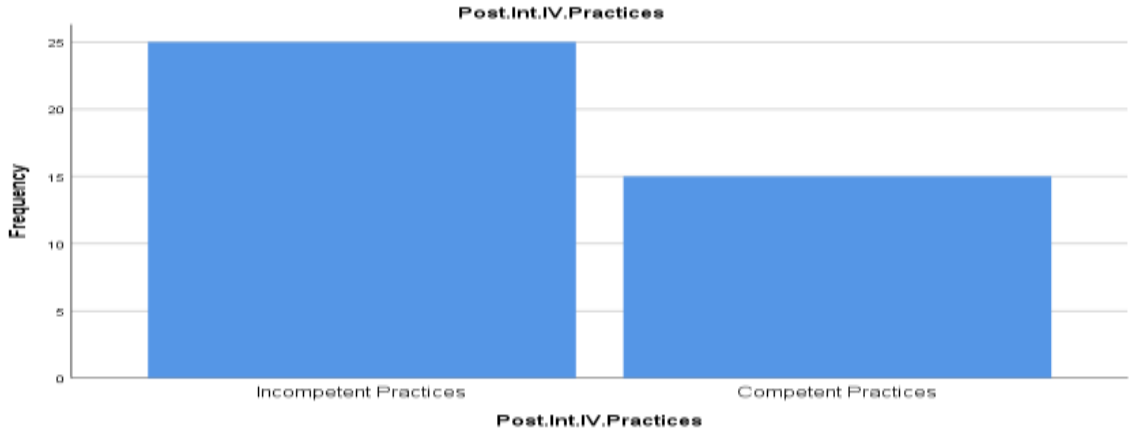

Table 7: Comparison of Pre-Intervention and Post-intervention Intravenous practices of student nurses

Level of IV Practices	Mean	Std. Deviation	P Value
Pre-Intervention IV Practices	1.0750	.26675	0.171
Post- Intervention IV Practices	1.3750	.49029	

Table 7 shows the comparison of pre-intervention and post-intervention intravenous (IV) practices among student nurses. The mean IV practice score increased from 1.0750 ± 0.26675 before the intervention to 1.3750 ± 0.49029 after the intervention. However, the difference was not statistically significant (p = 0.171), as the p-value was greater than 0.05.

CHAPTER 5
DISCUSSION

The present study assessed the intravenous (IV) practices of student nurses before and after the intervention. The demographic findings showed that the majority of participants, **17 (42.5%)**, were aged 18–20 years, followed by **14 (35.0%)** aged 21–30 years and **9 (22.5%)** aged 31–35 years. The relatively young age distribution may be explained by the fact that the participants were nursing students who were still developing their clinical competencies. This finding is comparable with Hernon et al. (2024), who evaluated venipuncture and peripheral intravenous cannulation among nursing and midwifery students and highlighted the importance of adequate education and supervised opportunities for developing these procedural skills.

Regarding gender, the present study showed that **24 (60.0%) participants were male and 16 (40.0%) were female**. In contrast, Hernon et al. (2024) reported a predominantly female student population in their study of venipuncture and peripheral IV cannulation. The difference may reflect variations in nursing student demographics across educational institutions and countries. Therefore, gender composition may not necessarily influence IV practice competency but may simply represent the characteristics of the population available at the study setting.

In relation to residence, **22 (55.0%) participants belonged to urban areas**, while **18 (45.0%) belonged to rural areas**. This relatively balanced distribution suggests that participants had diverse educational and social backgrounds. Although residence was not directly examined as a predictor of IV practice competency in the present study, differences in access to clinical exposure, simulation laboratories, and educational resources may potentially influence students' opportunities to develop practical skills.

Regarding academic performance, **20 (50.0%) participants had a GPA of 2.6–3.0**, followed by **13 (32.5%) with a GPA of 3.1–3.5**. Only 4 (10.0%) participants had a GPA of 3.6–4.0, while 3 (7.5%) had a GPA below 2.5. The distribution indicates that most participants had moderate academic performance. Previous evidence suggests that educational level and clinical experience can be associated with better knowledge of peripheral venous catheter management. For example, a multicenter study of nursing students found that students in later academic years and those with greater professional experience demonstrated higher knowledge scores regarding peripheral venous catheter management (Bahl et al., 2021).

The findings regarding clinical exposure showed that **16 (40.0%) participants practiced clinically for only 1–2 days per week**, while 14 (35.0%) practiced for 3–5 days and 10 (25.0%) for more than 5 days per week. Limited clinical exposure may provide fewer opportunities for students to repeatedly perform invasive procedures such as IV cannulation. This is particularly important because peripheral IV cannulation is a complex psychomotor skill that requires repeated practice and appropriate supervision. Hernon et al. (2024) emphasized that nursing students may have limited opportunities to perform peripheral IV cannulation

in clinical environments, making simulation and structured skills practice important components of nursing education.

Pre-Intervention IV Practices

One of the most important findings of the present study was the very low level of IV practice competency before the intervention. Before the intervention, **37 (92.5%) participants demonstrated incompetent IV practices**, whereas only **3 (7.5%) demonstrated competent practices**. This finding indicates a substantial gap in students' practical IV skills at baseline. The finding is consistent with previous literature demonstrating that nursing students may have inadequate knowledge and practical experience related to peripheral IV procedures. Hernon et al. (2024) found that nursing students required improvements in their preparation and training for venipuncture and peripheral IV cannulation, particularly regarding opportunities to perform the procedure and maintain appropriate aseptic technique. Similarly, Bahl et al. (2021) reported that nursing students demonstrated relatively limited knowledge concerning peripheral venous catheter insertion and care and emphasized the need to strengthen educational approaches by incorporating more active and experiential learning methods. The authors further suggested better alignment between theoretical teaching and clinical practice. These findings support the present study because the high proportion of incompetent students before the intervention suggests that theoretical instruction alone may not be sufficient for achieving practical IV competency.

Post-Intervention IV Practices

After the intervention, the proportion of students demonstrating competent IV practices increased from **3 (7.5%) to 15 (37.5%)**, while incompetent practices decreased from **37 (92.5%) to 25 (62.5%)**. Thus, there was a **30-percentage-point increase in competent practice** following the intervention. Although most students remained in the incompetent category, the descriptive improvement indicates a favorable change in practical performance.

This finding is supported by research demonstrating that structured and simulation-based education can enhance IV-related knowledge and clinical performance. A randomized controlled quasi-experimental study by Koukourikos et al. (2021) examined simulation-based learning for IV therapy administration among nursing students and found that simulation provided a realistic environment in which students could safely develop IV-related knowledge and performance skills.

Similarly, a study examining simulator-based vascular access education found significant improvement in students' performance following practical training using an anatomical arm simulator. The researchers emphasized that simulation laboratories provide a safe environment in which students can practice procedures repeatedly without exposing patients to potential harm (De Sio et al., 2023).

Recent research also supports the use of innovative educational approaches for IV skills. For example, a 2024 study using an immersive virtual reality simulator for intravenous injection education reported that such technology provided students with opportunities to practice procedures safely and at their own pace, while also supporting engagement and learning motivation. This evidence suggests that repeated, experiential practice may be particularly useful when students have limited opportunities to perform invasive procedures during routine clinical placements.

Comparison of Pre- and Post-Intervention Scores

The mean IV practice score increased from **1.0750 ± 0.26675 before the intervention to 1.3750 ± 0.49029 after the intervention**. This numerical increase indicates an improvement in IV practice following the intervention. However, the difference was **not statistically significant (p = 0.171)**. Therefore, the null hypothesis was not rejected at the 0.05 level of significance.

The absence of statistical significance is important because it indicates that, although more students achieved competent practice after the intervention, the magnitude of improvement was insufficient to demonstrate a statistically significant difference in this sample. This finding differs from some studies that have reported significant improvements following structured IV education. For example, Koukourikos et al. (2021) demonstrated improvements in IV therapy-related learning through simulation-based education, while De Sio et al. (2023) reported significant improvement in vascular access performance following simulator-based training.

However, the present finding is also consistent with evidence showing that not every simulation-based IV intervention produces statistically significant differences. Arslan et al. (2022), in a systematic review and meta-analysis of simulation-based peripheral IV catheterization training, reported that the available evidence showed small-to-moderate effects across several outcomes, but the pooled effects were not statistically significant for skills, knowledge, satisfaction, or anxiety. The authors concluded that the superiority of one simulation approach over traditional training remained uncertain.

More recent evidence also demonstrates that additional practice may improve students' performance without necessarily producing significant differences between intervention groups. A 2024 randomized controlled study examining structured self-evaluation of video-recorded peripheral IV catheter insertion found that both groups improved their knowledge, performance, and attitudes from baseline to follow-up, although the difference between the groups was not statistically significant (Hernon et al., 2024). This supports the interpretation that improvement in clinical skills can occur gradually through practice and exposure, while statistical significance may depend on sample size, intervention intensity, and study design.

The non-significant finding in the present study may have several possible explanations. First, the **sample size was relatively small (n = 40)**, which may have limited the statistical power to detect a significant difference. Second, **40.0% of participants had clinical practice for only 1–2 days per week**, potentially limiting their opportunities for repeated IV practice. Third, IV cannulation is a complex psychomotor skill that generally requires repeated practice, feedback, supervision, and reassessment rather than a single educational exposure. Current evidence emphasizes that students benefit from experiential learning, simulation, supervised practice, and opportunities to repeat procedures (Bahl et al., 2021; Hernon et al., 2024).

Overall, the present study demonstrated a **descriptive improvement in IV practices**, with competent practice increasing from 7.5% before the intervention to 37.5% after the intervention. However, the improvement in mean scores did not reach statistical significance (**p = 0.171**). These findings suggest that the intervention may have had a beneficial educational effect, but stronger evidence would require a larger sample size, a longer intervention period, repeated hands-on practice, continuous supervision, and follow-up assessment. The findings are broadly consistent with contemporary nursing education literature emphasizing that IV competency is best developed through structured, experiential, and repeated practice rather than theoretical teaching alone (Arslan et al., 2022; Hernon et al., 2024).

Conclusion

The study concluded that student nurses had a considerably low level of intravenous (IV) practice competency before the intervention, with **92.5% demonstrating incompetent practices** and only **7.5% demonstrating competent practices**. Following the intervention, competent IV practices increased to **37.5%**, while incompetent practices decreased to **62.5%**, indicating a positive improvement in practical performance. The mean IV practice score also increased from **1.0750 ± 0.26675** pre-intervention to **1.3750 ± 0.49029** post-intervention. However, this improvement was not statistically significant (**p = 0.171**). Therefore, although the intervention showed a favorable descriptive improvement in IV practices, it was not sufficient to establish a statistically significant effect in the present sample. Continued

hands-on practice, repeated skills training, clinical supervision, and larger-scale interventions may be required to achieve and maintain competency in IV practices among student nurses.

Limitations of the Study

1. The study was conducted with a **small sample of 40 student nurses**, which may have limited the statistical power to detect significant differences.
2. The study was conducted in a **single teaching institution**, which may limit the generalizability of the findings to nursing students in other institutions.
3. The study used a **pre-test and post-test design without a separate control group**, making it difficult to determine whether the observed improvement was entirely attributable to the intervention.
4. The intervention period was relatively limited, which may not have provided sufficient time for students to develop consistent IV practice competency.
5. The participants had **different levels of clinical exposure**, which may have influenced their baseline and post-intervention IV performance.
6. The study assessed IV practices shortly after the intervention; therefore, **long-term retention of IV skills was not evaluated**.
7. The relatively high proportion of students with limited weekly clinical practice may have restricted their opportunities for repeated IV procedure practice.

Recommendations

1. **Regular hands-on IV training** should be incorporated into nursing education to strengthen students' psychomotor skills.
2. Skills laboratory sessions should provide students with **repeated opportunities to practice IV cannulation and related procedures** under qualified clinical supervision.
3. **Simulation-based and competency-based training** should be incorporated into IV education to provide a safe environment for repeated practice and immediate feedback.
4. Students should be assessed using **standardized IV practice checklists** before and after training to identify specific skill deficiencies.
5. Nursing institutions should provide adequate opportunities for students to perform IV procedures during **supervised clinical practice**.
6. Future studies should include a **larger sample size and a control group** to provide stronger evidence regarding the effectiveness of IV skills interventions.
7. Future researchers should consider conducting **follow-up assessments** to determine the long-term retention of IV practice competency.
8. Similar studies should be conducted in **multiple nursing institutions and clinical settings** to improve the generalizability of findings.

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