

Peer-Supported Education for Pediatric Medication Administration: Effects on Nursing Students' Knowledge and Self-Efficacy

Abstract

Background: Limited opportunities for clinical practice leave nursing students feeling unprepared to administer pediatric medications safely. Peer education may enhance learning by promoting active participation and engagement.

Aim: This study aimed to examine the effects of a Peer Education Program on Pediatric Medication Administration on nursing students' knowledge and self-efficacy.

Methods: This randomized controlled trial included 62 third-year nursing students (experimental group=30; control group=32). The experimental group received peer education, whereas the control group received traditional classroom instruction. Data were collected using a Sociodemographic Information Form, the Medication Administration Self-Efficacy Scale in Children, and the Pediatric Medication Administration Knowledge Test. Pretest-posttest data were analyzed using independent- and dependent-samples t tests.

Results: Most participants had not previously received training in pediatric medication administration (93.5%), and the majority reported limited experience with pediatric medication administration (93.5%). The experimental group's mean posttest knowledge score [87.33±12.29] was significantly higher than that of the control group [68.75±19.30; $p<0.001$]. The increase in knowledge from pretest to posttest was also greater in the experimental group. Similarly, posttest self-efficacy scores were higher in the experimental group [71.26±6.94] than in the control group [54.71±12.16; $p<0.001$].

Conclusion: Peer education effectively improves nursing students' knowledge of pediatric medication administration and their self-efficacy. Integrating peer education into nursing curricula may enhance clinical competence and contribute to safer medication administration practices.

Keywords: Medication administration, nursing students, pediatric nursing, peer education, self-efficacy

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Introduction

Medication errors are a major threat to patient safety and may result in serious morbidity and mortality, particularly among pediatric patients.¹ Children are more vulnerable to medication errors than adults because of differences in pharmacokinetic and pharmacodynamic characteristics, the complexity of weight-based dose calculations, and communication limitations.² According to a recent prospective observational study conducted among pediatric nurses, the most frequently observed medication administration errors included incorrect intravenous rate or duration [44.8%], incorrect solvent or diluent volume [35.5%], use of an incorrect solvent or diluent [16.2%], wrong-time administration [12.2%], wrong-dose administration [3.9%], and wrong-route administration [3.9%.³ These errors can prolong treatment, increase healthcare costs, and negatively affect patient outcomes and satisfaction.¹⁻³

Nurses play a central role in ensuring the accurate, safe, and timely administration of medications.³ Therefore, it is essential that nursing students acquire adequate knowledge and skills in medication administration before graduation. Previous studies have reported high rates of medication errors among nurses, highlighting the need for educational programs on medication administration to be continuously developed and updated.²⁻⁵ Furthermore, nursing students often report low self-efficacy in performing invasive procedures and considerable anxiety about making errors during clinical practice.⁶ Structured and repetitive simulation-based training has been recommended to bridge the gap between theoretical knowledge and clinical practice, reduce students' anxiety, and improve medication administration skills. Nursing students who lack simulation-based learning opportunities frequently report feeling professionally unprepared and experience difficulty translating theoretical knowledge into clinical practice.⁷ In a study conducted by Bowling⁸ in 2015, simulation training was found to improve clinical skills; however, a substantial proportion of students still failed to verify patient identity or administer medications safely following the training. This finding highlights the need for repeated, practice-based educational strategies.

Peer education has emerged as an effective, evidence-based teaching approach in nursing education.⁹ It is an educational process in which individuals of similar educational or professional levels exchange knowledge, skills, and experiences. Because peers do not occupy hierarchical roles and typically communicate using similar language and shared experiences, peer education fosters a collaborative learning environment.¹⁰ Previous studies have demonstrated that peer education improves nursing students' clinical competence, communica-

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tion skills, self-efficacy, and professional confidence.¹¹ In pediatric clinical settings, peer mentoring has also been shown to facilitate students' adaptation to the clinical environment, reduce practice-related anxiety, and enhance competence in safe medication administration.

Although previous studies have examined the contribution of peer education to nursing education, randomized controlled trials evaluating its effects on both knowledge and self-efficacy related to pediatric medication administration remain limited.^{10,11} Given the high risk of medication errors in pediatric care and the substantial anxiety experienced by nursing students during medication administration, further research is needed.^{2,6} Therefore, this randomized controlled trial was conducted to examine the effects of a peer education program on pediatric medication administration on nursing students' knowledge and self-efficacy.

Research Hypotheses

H1: Nursing students who participate in the Peer Education Program on Pediatric Medication Administration will have significantly higher Medication Administration Self-Efficacy Scale in Children for Nursing Students scores after the intervention than before the intervention.

H2: Nursing students who participate in the Peer Education Program on Pediatric Medication Administration will have significantly higher Medication Administration Self-Efficacy Scale in Children for Nursing Students scores than those who receive traditional classroom instruction.

H3: Nursing students who participate in the Peer Education Program on Pediatric Medication Administration will demonstrate a significantly greater increase in Pediatric Medication Administration Knowledge Test scores from pretest to posttest than those who receive traditional classroom instruction.

Materials and Methods

Design

This randomized controlled trial was conducted between February and July 2024.

Sample

The study population comprised third-year nursing students enrolled in the pediatric nursing course at a university during the 2023–2024 academic year. The study sample consisted of students who met the inclusion criteria. Because the study included all eligible students enrolled in the course during the study period, an a priori sample size calculation was not performed. A total of 68 students were enrolled in the pediatric nursing course during the study period. After applying the inclusion and exclusion criteria, 64 eligible students were randomly assigned to the experimental or control group using stratified randomization. Following the withdrawal of two participants, the study was completed with 62 students. A post hoc power analysis was conducted based on the between-group difference in posttest knowledge scores. With 30 students in the experimental group and 32 in the control group, the study achieved a statistical power of 99.3% at a significance level of $\alpha=0.05$.

The inclusion criteria were enrollment in the pediatric nursing course during the study period and willingness to participate. Students repeating the pediatric nursing course because of previous academic failure were excluded.

Randomization

Stratified randomization was performed using participants' baseline scores on the Medication Administration Self-Efficacy Scale in Children for Nursing Students and gender to ensure balanced group allocation. Participants were stratified according to self-efficacy scores (0–39 and 40–80) and gender. Within each stratum, participants were randomly assigned to the experimental or control group using a computer-generated random allocation sequence. The randomization process was conducted by an independent individual who was not involved in the study, and allocation was concealed from the researchers until group assignment had been completed.

Blinding of participants and researchers was not feasible because of the nature of the educational intervention. However, participants were not informed of their group assignment before the theoretical training and were unaware of whether they would subsequently participate in the skills training and simulation sessions.

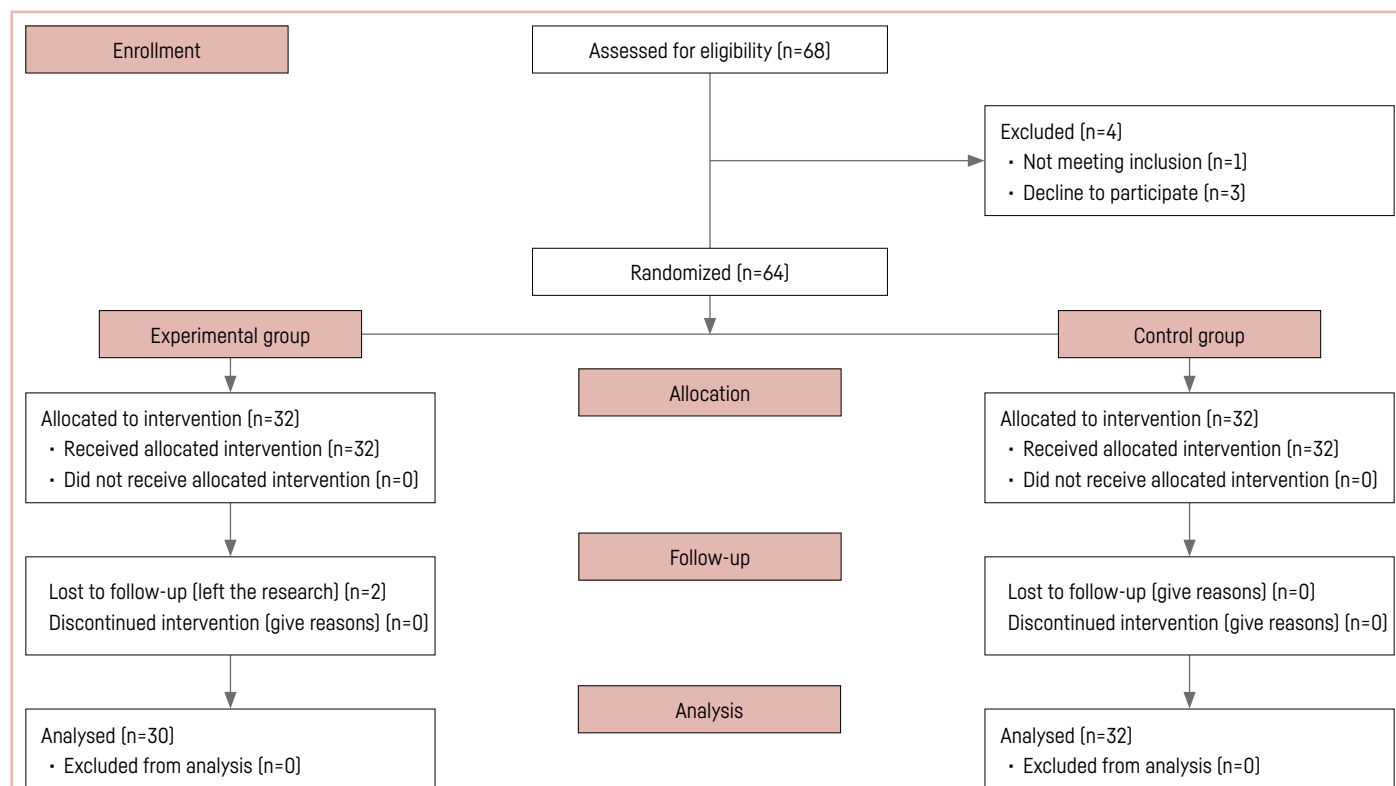


Figure 1. CONSORT 2010 flow diagram of the study.

Initially, 32 students were allocated to each group. Following the withdrawal of two participants from the experimental group, the final sample included 30 students in the experimental group and 32 students in the control group [Fig. 1].

Data Collection Instruments

Data were collected using the Sociodemographic Information Form, the Medication Administration Self-Efficacy Scale in Children for Nursing Students, the Pediatric Medication Administration Knowledge Test, the Peer Educator Training Presentation, the Pediatric Medication Administration Training Presentation, and the Pediatric Medication Administration Checklist.

Sociodemographic Information Form

The Sociodemographic Information Form was developed by the researchers based on the literature.^{12,13} It consisted of 10 items assessing participants' demographic characteristics (e.g., age and gender), previous experience with peer education, and employment status in a healthcare setting.

Medication Administration Self-Efficacy Scale in Children for Nursing Students

The Medication Administration Self-Efficacy Scale in Children for Nursing Students, developed to assess nursing students' self-efficacy in pediatric medication administration, was used with written permission from its developers.¹⁴ The scale consists of 16 items and two subscales and uses a five-point Likert scale with the following response options: 1=definitely not competent, 2=somewhat competent, 3=partially competent, 4=competent, and 5=definitely competent. Total scores range from 16 to 80, with higher scores indicating greater self-efficacy in pediatric medication administration. The scale assesses students' confidence in preparing medications for different pediatric age groups, calculating appropriate dosages, diluting medications correctly, measuring powdered medications accurately, administering medications safely, and preparing children and their families for medication administration. In the original study, Cronbach's alpha coefficients were 0.94 for the total scale, 0.91 for the medication preparation subscale, and 0.87 for the medication administration subscale. In the present study, Cronbach's alpha for the total scale was 0.944.

Pediatric Medication Administration Knowledge Test

The Pediatric Medication Administration Knowledge Test was developed by the researchers according to the literature and the learning objectives of the pediatric nursing course.^{13,15,16} The test consists of 10 multiple-choice questions assessing knowledge of pediatric medication pharmacology, dosage calculations, and safe medication administration. Scores were converted to a 100-point scale, with higher scores indicating greater knowledge. Content validity was established through expert review by specialists in pediatric nursing and nursing education, and revisions were made based on their recommendations. The instrument was also pilot-tested to evaluate clarity and comprehensibility. Internal consistency was assessed using the Kuder-Richardson Formula 20 (KR-20), yielding a coefficient of 0.62, indicating moderate reliability.

Pediatric Medication Administration Checklist

A three-point Likert-type checklist was developed based on the literature and expert opinion to standardize practical training delivered by peer educators.¹³ The checklist was used to guide skills training and structured debriefing but was not included in the outcome evaluation. Participants' performance was rated as inadequate (1) if the step was not performed, partially adequate (2) if the step was performed incompletely or with deficiencies, and adequate (3) if the step was performed correctly and completely. Debriefing sessions were conducted using the checklist as a structured feedback guide.

Educational Intervention

The educational intervention consisted of two components: peer educator training and pediatric medication administration training.

Peer Educator Training: The peer educator training program was developed by the principal investigator based on the literature. The training covered the principles and objectives of peer education, the roles and responsibilities of peer educators, educational materials and teaching strategies, essential competencies,

approaches to managing potential challenges, and implementation of the training program.^{7,9,10,11} Four fourth-year nursing students were selected and trained as peer educators by a faculty member certified in simulation-based nursing education. At the end of the training, peer educators completed a 10-item competency test. One student who scored below the predetermined competency threshold (70%) received additional training and was reassessed. All four peer educators ultimately achieved scores above 70% and participated in the intervention.

Pediatric Medication Administration Training: The pediatric medication administration training was developed by the researchers according to current literature. The 80-minute session included pediatric dosage calculations based on body weight, principles of safe medication administration, pediatric pharmacological characteristics, and medication administration routes.¹⁶ The same peer educator delivered the standardized theoretical training to both the experimental and control groups.

Data Collection Procedure

Data collection was conducted in three phases. In the first phase, all participants completed the Sociodemographic Information Form, the Medication Administration Self-Efficacy Scale in Children for Nursing Students, and the Pediatric Medication Administration Knowledge Test as pretest measures. Subsequently, both groups received the same standardized theoretical training in pediatric medication administration. Following the pretest assessments, participants were randomly assigned to the experimental or control group before the theoretical training.

In the second phase, students in the experimental group participated in supervised skills practice led by trained peer educators. In the third phase, the experimental group completed simulation-based practice followed by a structured debriefing session. After completion of the intervention, all participants completed the knowledge test and self-efficacy scale as posttest measures. The study flow is presented in Table 1.

Bias Control

Several strategies were implemented to minimize bias. Selection bias was reduced through stratified randomization based on baseline self-efficacy scores and gender. The randomization sequence was generated by an independent individual who was not involved in the study, and allocation was concealed until all participants had been assigned to their respective groups. Performance bias was minimized by providing identical theoretical instruction to both groups using standardized educational materials delivered by the same peer educator. Measurement bias was minimized by using standardized data collection instruments and administering the same pretest and posttest assessments to both groups under identical conditions. Attrition bias was minimal because only two participants withdrew, and all remaining participants completed the intervention and outcome assessments.

Data Analysis

Data were analyzed using SPSS Statistics for Windows, Version 22.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics are presented as frequencies, percentages, means, and standard deviations. Differences between categorical variables were analyzed using the chi-square test. Continuous variables were compared between groups using the independent-samples t test and within groups using the dependent-samples t test. Statistical significance was set at $p < 0.05$. Exact p values are reported whenever possible, whereas values less than 0.001 are reported as $p < 0.001$.

Ethical Considerations

This study was conducted in accordance with the principles of the Declaration of Helsinki. Ethical approval was obtained from Fenerbahçe University Non-interventional Clinical Research Ethics Committee [Approval Number: 25.2022fbu, Date: 14.09.2022]. Institutional permission was obtained from the university where the study was conducted, and written informed consent was obtained from all participants before data collection. Permission to use the Medication Administration Self-Efficacy Scale in Children for Nursing Students was obtained from the scale developers. The study was conducted as an educational intervention involving nursing students in a university setting. As it did not involve clinical patients or therapeutic interventions, it was not registered in a clinical trial registry.

Table 1. Study flow

Four fourth-year nursing students completed a 4-hour Peer Educator Training Program delivered by a faculty member with expertise in pediatric nursing. Peer educators scoring <70% on the competency test received additional training and were reassessed until competency was achieved. Written informed consent was obtained from all participants. The Sociodemographic Information Form was completed by all participants. Participants completed the Medication Administration Self-Efficacy Scale in Children for Nursing Students at baseline (pretest). Participants were assigned to the experimental or control group using stratified randomization based on baseline self-efficacy scores and gender. Participants were not informed of their group allocation before the theoretical training and were unaware of whether they would proceed to the skills and simulation sessions.

Experimental Group: Peer Education	Control Group: Traditional Classroom Instruction
STAGE I (Theoretical Training)	STAGE I (Theoretical Training)
The Pediatric Medication Administration Knowledge Test was administered as a pretest.	The Pediatric Medication Administration Knowledge Test was administered before the theoretical training (pretest).
Participants received an 80-minute standardized theoretical training session on pediatric medication administration.	Participants received an 80-minute standardized theoretical training session on pediatric medication administration.
Participants took a 15-minute break.	Following the training, the Pediatric Medication Administration Knowledge Test was administered (posttest).
Four trained peer educators were assigned to small groups of approximately eight students each.	Participants completed the Medication Administration Self-Efficacy Scale in Children for Nursing Students (posttest).
STAGE II (Skills Practice)	
Each peer educator supervised a one-hour skills practice session in pediatric medication administration using task trainer models and the Pediatric Medication Administration Checklist.	
Lunch break	
STAGE III (Simulation Practice)	
Each peer educator paired the students within their group and supervised a 15-minute simulation of pediatric medication administration using a structured scenario. The simulation session lasted approximately two hours.	
Orientation (15 minutes)	
Simulation practice (2 students, 15 minutes per pair; total for 8 students: 60 minutes)	
Debriefing (all 8 students together, 30 minutes)	
During the simulation practice, the Pediatric Medication Administration Checklist was completed by the peer educator, and the simulation performance was evaluated using this checklist during the debriefing session.	
After the debriefing session, the Pediatric Medication Administration Knowledge Test was administered as the posttest.	
After the debriefing session, participants completed the Medication Administration Self-Efficacy Scale in Children for Nursing Students (posttest).	
Students provided feedback on the peer education program.	

Results

Seventy percent of students in the experimental group and 65.6% of those in the control group were female. There were no significant differences between the groups in terms of age, gender, or high school graduation ($p>0.05$). In the experimental group, 56.7% of students had previously received training in general medication administration, compared with 71.9% in the control group. The majority of participants in both groups had not received training in pediatric medication administration (90% in the experimental group and 96.9% in the control group). Similarly, no statistically significant between-group differences were found regarding previous peer education, general medication administration training, or pediatric medication administration training ($p>0.05$). Only a small proportion of students in either group reported part-time employment in pediatric settings or previous experience with pediatric medication administration. Previous medication administration errors were reported by 3.3% of students in the experimental group and 3.1% of those in the control group. Overall, the two groups were comparable across all baseline characteristics (Table 2).

In the peer education group, among the 15 students who received simulation training, 11 failed to document the procedure, six failed to verify the patient, five administered medication to the wrong patient, five used medications with previously

opened labels, three administered an incorrect drug dose, four administered the injection at the wrong site, four failed to manage waste appropriately, and three performed intramuscular injections without replacing the needle tip.

Students' knowledge of pediatric medication administration improved significantly following the intervention in both groups. In the experimental group, the mean knowledge score increased from 30.667 at pretest to 87.333 at posttest ($t=-13.527$, $p<0.001$, $d=2.470$, 95% confidence interval [CI]: -65.234 to -48.099). In the control group, the mean score increased from 35.625 to 68.750 ($t=-9.262$, $p<0.001$, $d=1.637$, 95% CI: -40.419 to -25.831). Additionally, posttest total scores differed significantly between the groups ($t(60)=4.487$, $p<0.001$), with the experimental group achieving higher mean scores ($\bar{x}=87.333$) than the control group ($\bar{x}=68.750$) (Table 3). An analysis of covariance (ANCOVA) was conducted to compare posttest knowledge scores between the groups while controlling for pretest scores. The results indicated a significant effect of the group on posttest knowledge scores ($F(1,59)=23.549$, $p<0.001$, $\eta^2=0.285$), with the experimental group demonstrating higher scores than the control group.

Self-efficacy regarding pediatric medication administration also improved significantly following the intervention ($t(60)=6.520$, $p<0.001$). The experimental group had higher posttest self-efficacy scores ($\bar{x}=71.267$) than the control group ($\bar{x}=54.719$).

Table 2. Baseline characteristics of participants by study group

Characteristic	Experimental: Peer education		Control: Traditional instruction		Total		p
	n	%	n	%	n	%	
Age							
20–21	20	66.7	13	40.6	33	53.2	$\chi^2=4.347$ $p=0.114$
22–23	8	26.7	14	43.8	22	35.5	
24–26	2	6.7	5	15.6	7	11.3	
Gender							
Female	21	70.0	21	65.6	42	67.7	$\chi^2=0.136$ $p=0.462$
Male	9	30.0	11	34.4	20	32.3	
High school graduated							
Anatolian/science high school	20	66.7	25	78.1	45	72.6	$\chi^2=1.311$ $p=0.519$
Regular high school	3	10.0	3	9.4	6	9.7	
Health vocational high school	7	23.3	4	12.5	11	17.7	
Previous peer education							
Yes	0	0.0	2	6.2	2	3.2	$\chi^2=1.938$ $p=0.262$
No	30	100.0	30	93.8	60	96.8	
Previous training in general medication administration							
Yes	17	56.7	23	71.9	40	64.5	$\chi^2=1.564$ $p=0.162$
No	13	43.3	9	28.1	22	35.5	
Previous training in pediatric medication administration							
Yes	3	10.0	1	3.1	4	6.5	$\chi^2=1.213$ $p=0.282$
No	27	90.0	31	96.9	58	93.5	
Part-time work experience in pediatrics							
Yes	1	3.3	3	9.4	4	6.5	$\chi^2=0.936$ $p=0.331$
No	29	96.7	29	90.6	58	93.5	
Previous experience with pediatric medication administration							
Yes	1	3.3	3	9.4	4	6.5	$\chi^2=0.936$ $p=0.331$
No	29	96.7	29	90.6	58	93.5	
Previous medication administration error							
Yes	1	3.3	1	3.1	2	3.2	$\chi^2=0.002$ $p=0.738$
No	29	96.7	31	96.9	60	96.8	

Chi-square test.

Table 3. Comparison of Pediatric Medication Administration Knowledge Test scores between and within groups

Assessment	Experimental: Peer education (n=30)		Control: Traditional instruction (n=32)		t ^a	p
	Mean	SD	Mean	SD		
Pretest	30.667	20.500	35.625	17.769	-1.020	0.312
Posttest	87.333	12.299	68.750	19.302	4.487	<0.001
t ^b	-13.527		-9.262			
p	<0.001		<0.001			

^a: Independent-samples t test, ^b: Dependent-samples t test. SD: Standard deviation.

Within the experimental group, Medication Administration Self-Efficacy Scale in Children for Nursing Students scores increased significantly from pretest ($\bar{x}=36.333$) to posttest ($\bar{x}=71.267$) [$t=-19.349$, $p<0.001$, $d=3.533$, 95% CI: -38.626 to -31.241]. Similarly, the control group showed a significant increase from pretest ($\bar{x}=34.469$) to

posttest ($\bar{x}=54.719$) [$t=-13.691$, $p<0.001$; $d=2.420$, 95% CI: -23.266 to -17.234] (Table 4). After controlling for pretest scores, ANCOVA revealed a significant effect of the group on posttest self-efficacy scores [$F(1,59)=58.043$, $p<0.001$, $\eta^2=0.496$], with the experimental group demonstrating higher self-efficacy than the control group.

Table 4. Comparison of Medication Administration Self-Efficacy Scores between and within groups

Assessment	Experimental: Peer Education (n=30)		Control: Traditional Instruction (n=32)		t ^a	p
	Mean	SD	Mean	SD		
Pretest	36.333	11.081	34.469	10.327	0.686	0.495
Posttest	71.267	6.943	54.719	12.163	6.520	<0.001
t ^b	-19.349		-13.691			
p	<0.001		<0.001			

Bold values indicate statistical significance ($p < 0.05$). ^a: Independent-samples t test, ^b: Dependent-samples t test. SD: Standard deviation.

Discussion

Guidance and instruction from peers with similar experiences can help alleviate students' anxiety when learning new skills while providing a supportive learning environment.^{11,17} Peer education may also foster a less stressful atmosphere in small-group settings and enhance the learning process.^{11,17} Öztürk and Göçmen Baykara¹¹ reported that nursing students who learned complex skills through peer education greater skill improvement, better reinforcement of learning, and superior knowledge retention than those taught using conventional methods. Similarly, a systematic review examining the effects of peer education in pediatric nursing education found that peer education improved both cognitive knowledge level and communication skills.¹⁷ More recently, Ramadan Ghareb et al.¹⁸ reported that peer education combined with role-playing was more effective than traditional teaching methods in developing pediatric nursing students' competence in intramuscular injection and gavage feeding. They also found that students trained using these methods reported higher levels of self-confidence and satisfaction. Consistent with these findings, nursing students in the present study, who were trained in peer groups of eight, reported feeling more comfortable, enjoying the learning process more, communicating more easily, and feeling better understood and closer to their peers. They also described experiencing positive excitement, greater stress when the course instructor was present, less fear of making mistakes during skills practice, and a greater sense of interacting with friends rather than being formally evaluated.

In a 2020 study, Powell et al.¹⁹ found that pharmacy students who provided peer education to nursing students significantly improved the nursing students' pharmacotherapy knowledge while enhancing their self-awareness and professional self-confidence. Likewise, another study reported that nursing student peer educators who provided stoma care training using a low-fidelity simulator increased learners' knowledge levels.¹² The findings of the present study are consistent with this evidence. Although both peer education and conventional instruction resulted in significant improvements in nursing students' knowledge of pediatric medication administration, the greater improvement observed in the peer education group suggests that the peer education program was more effective in facilitating learning.

The large effect size observed in the experimental group, according to Cohen's classification, indicates a substantial educational impact. This finding suggests that peer-supported simulation training produced not only statistically significant but also educationally meaningful improvements in pediatric medication administration knowledge. The magnitude of this effect may be attributed to the active participation, repeated practice opportunities, immediate feedback, and collaborative learning environment inherent in peer education and simulation-based training.

Previous studies have shown that nursing students' self-efficacy in pediatric medication administration influences their likelihood of committing medication errors.²⁰ In a 2023 study, Akça and Berşe²¹ reported that students who did not experience anxiety during pediatric medication administration had significantly higher self-efficacy than those who reported feeling anxious. Consistent with these findings, the present study demonstrated a significant increase in students' self-efficacy for medication administration in children following the training program. The greater improvement observed in the peer education group suggests that this educational approach was particularly effective in enhancing students' confidence in administering medications safely. Furthermore, the significantly higher posttest knowledge and self-efficacy scores in the peer education group, compared with the conventional education group, underscore the value of structured and repetitive educational strategies in promoting safe pediatric medication administration.

Medication errors remain a major concern in pediatric nursing practice, where they occur at relatively high rates and can have serious consequences because of the vulnerability of pediatric patients. The persistence of these errors suggests that professional experience alone is insufficient to eliminate them.^{3,4,15,22,23} In a phenomenological study exploring pediatric nurses' experiences with implementing the "ten rights" of medication administration, nurses generally reported adhering to these principles but identified particular challenges with ensuring the correct dose and correct time.²⁴ Similarly, a study conducted in a pediatric intensive care unit demonstrated that increasing staff awareness and implementing technology-based strategies significantly improved medication safety.²⁵ A study conducted in a simulated hospital setting to examine medication administration errors among nursing students found that such errors were common and that students frequently failed to account for the displacement volume of dry-powder medications during reconstitution.¹³ These findings underscore the importance of providing effective, structured training in safe medication administration during undergraduate nursing education. Sears et al.²⁶ reported that although experienced nurses made more medication errors, the severity of these errors was lower, suggesting that experience and repeated practice may enhance awareness of medication safety. Based on the serious errors observed among students in the present study, it appears that this level of awareness has not yet fully developed.

The debriefing session conducted after the simulation training yielded valuable insights into students' experiences. Most students reported feeling anxious, fearful, and stressed during the simulation, particularly while administering medications, as the responsibility associated with the task intensified their anxiety. Similarly, Türkmen et al.⁶ found that nursing students enrolled in pediatric nursing courses experienced mild state and trait anxiety, with anxiety levels increasing during invasive procedures. In the present study, however, students reported that they gradually learned to manage their stress as the training progressed and that the simulation experience enhanced their sense of professional competence. Several students commented that they "*felt like a real nurse*" during the simulation, indicating that the experience strengthened their self-confidence. Students also reported that the simulation increased their awareness of the importance of being adequately prepared for medication administration and enhanced the retention of the knowledge they had acquired. They perceived theoretical instruction alone as insufficient for long-term retention, whereas simulation reinforced their learning and provided valuable experience for future clinical practice. Some students suggested that the use of simulated patients, rather than manikins, could further enhance the realism of the learning experience and increase motivation. These perceptions are consistent with previous studies demonstrating that simulation enhances students' knowledge and clinical skills by increasing the realism and authenticity of the learning experience.^{7,27,28}

Jarvill²⁹ reported in 2021 that nursing students were not adequately prepared for safe medication administration before graduation. Özgüven Öztornaci et al.³⁰ reported that the mean pediatric medication error rate among nursing students decreased from 55.37% before the intervention to 13.52% following simulation training supported by a web-based Double-Eye Control Program. Bowling⁸ also highlighted the positive effects of simulation training on clinical skills but reported that more than half of the students failed to verify patient identity or administer medications safely. Consistent with these findings, more than half of the students in the experimental group in the present study omitted critical medication safety steps during the simulation despite having previously received instruction in general medication administration. Common errors included failing to verify patient identity, administering medication to the wrong patient, calculating an incorrect dose, and administering medication at the wrong

site. These findings suggest that theoretical instruction or a single skills practice session is insufficient to ensure safe medication administration and that students require repeated, structured opportunities to practice medication administration skills.

The findings of this study suggest that peer education is an effective educational strategy for improving nursing students' knowledge and self-efficacy related to pediatric medication administration. Learning in small peer groups within a supportive and less stressful environment appears to facilitate knowledge acquisition and skill development. Combining peer education with simulation-based learning may further promote the translation of theoretical knowledge into clinical practice, reduce students' anxiety about making errors, and strengthen safe medication administration practices. Incorporating peer education and simulation-based learning into nursing curricula may therefore improve educational outcomes while ultimately contributing to patient safety. Providing peer support during preparation for clinical practice may also strengthen students' self-efficacy, and repeated peer-assisted learning experiences may promote long-term knowledge retention. Moreover, the benefits of peer-supported simulation training may extend beyond undergraduate education. Enhancing pediatric medication administration knowledge and self-efficacy before graduation may contribute to safer medication practices, greater professional confidence, and improved patient safety during professional practice. Integrating peer education into nursing curricula may therefore help prepare competent and confident novice nurses for pediatric clinical settings.

Limitations

This study was conducted with a relatively small sample of third-year nursing students from a single university; therefore, the findings may not be generalizable to the broader population of nursing students. In addition, data were collected over a single academic term, precluding the evaluation of long-term knowledge and skill retention. Furthermore, the simulation and peer education activities were conducted in a laboratory setting, which may not fully reflect students' behavior and performance in actual clinical practice.

Because the assessments were based on self-report scales and a knowledge test, the findings may be subject to response bias. In addition, the knowledge test was developed by the researchers, and its properties were not formally evaluated through validity and reliability testing. Future studies with larger sample sizes, multicenter designs, and longer follow-up periods are needed.

Conclusion

The findings of this study demonstrate that a three-stage peer education program improved nursing students' knowledge and self-efficacy regarding pediatric medication administration. The improvements observed among students who participated in peer education were greater than those achieved through conventional theoretical instruction alone. In the short term, peer-supported simulation training enhanced students' knowledge, self-efficacy, and confidence in pediatric medication administration. In the long term, strengthening these competencies during undergraduate nursing education may promote safer medication administration practices and facilitate a smoother transition to clinical practice after graduation. These findings suggest that peer education may be an effective educational strategy in pediatric nursing education. Therefore, incorporating structured peer education and simulation-based learning into nursing curricula may contribute to the development of competent, confident, and practice-ready nurses.

Ethics Committee Approval: The study was approved by the Fenerbahçe University Non-interventional Clinical Research Ethics Committee (Approval Number: 25.2022fbu, Date: 14.09.2022).

Informed Consent: Written informed consent was obtained from all the participants.

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