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Original Article

Simulation versus supervised clinical training for endotracheal intubation skills in acute care nurses: a convergent mixed-methods study

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Abstract

Background & Objective: Endotracheal intubation is a high-risk, lifesaving procedure. Evidence directly comparing simulation-only and participation-based clinical training for nurses remains limited. This study compared simulation-based and participation-based clinical training for improving endotracheal intubation competency among acute care nurses.

Materials & Methods: A convergent mixed-methods, quasi-experimental pre-test/post-test study was conducted across the Emergency Department (ED), Intensive Care Unit (ICU), Coronary Care Unit (CCU), and Neonatal Intensive Care Unit (NICU) over six months. Eighty nurses were randomly assigned to simulation-based or participation-based training. Outcomes included knowledge (0–40), attitude (10–40), and Direct Observation of Procedural Skills (DOPS) scores.

Results: The two groups were comparable at baseline (knowledge: 26.68 ± 5.91vs. 26.20 ± 7.61, p = 0.756; attitude: 26.78 ± 7.11vs. 26.90 ± 6.79, p = 0.936; DOPS: 11.55 ± 2.31vs. 11.98 ± 2.64, p = 0.445). After adjustment, post-test scores favored participation-based training: knowledge mean difference = 2.47, Cohen's d = 0.51 (p = 0.025); attitude mean difference = 2.81, Cohen's d = 0.61 (p = 0.008); DOPS mean difference = 1.48, Cohen's d = 0.78 (p < 0.001); and satisfaction mean difference = 0.77, Cohen's d = 0.51 (p = 0.025). Qualitative themes highlighted realism, safety, feedback, and transfer to practice.

Conclusion: Participation-based training produced greater gains in knowledge, attitudes, and performance than simulation. Future research should examine whether hybrid models combining simulation and real-patient training can balance safety with realism.

Keywords: intubation, intratracheal; simulation training; clinical competence; education, nursing; critical care nursing; inservice training

Introduction

Endotracheal intubation is a critical lifesaving procedure in acute care settings, requiring advanced technical proficiency, clinical judgment, and confidence to ensure optimal patient outcomes [1]. The importance of this skill is underscored by the fact that unsuccessful or delayed intubation can lead to severe complications, including hypoxia, cardiac arrest, brain injury, and death [2]. Studies have shown that failed first-pass intubation attempts are associated with a two- to three-fold increase in adverse events, and up to 20% of intubation attempts in emergency and critical care settings result in complications such as esophageal intubation, aspiration, or airway trauma [3]. For nurses working in intensive care units and emergency departments, competency in airway management has become increasingly essential as healthcare systems evolve to meet complex patient needs [4]. Simulation-based endotracheal intubation training provides a controlled environment in which nurses can repeatedly practice technical skills, decision-making, and teamwork without risk to patients [5]. Traditional participation-based training, in contrast, relies on supervised clinical exposure to real cases, supporting the development of clinical intuition and adaptability [6]. However, first-pass success rates for nurse-performed intubations vary widely—from 39% to 90%—reflecting inconsistencies in training quality and opportunities for skill acquisition [7, 8]. Given the potentially life-threatening consequences of unsuccessful intubation and the variability in training outcomes, identifying the most effective educational strategies for preparing nurses to perform this procedure safely and competently is essential.

High-fidelity simulation has been shown to enhance knowledge retention, self-efficacy, and procedural performance more effectively than didactic methods alone [9]. Nurses trained through simulation achieve higher scores on competency assessments and demonstrate stronger adherence to algorithmic steps during intubation, while also improving nontechnical skills such as communication and crisis management [10]. Participation-based training, though invaluable for contextual learning, is limited by patient safety concerns and variable case volumes, which may hinder consistent skill development among acute care nurses [11].

For example, Mankute et al. reported that 88% of nurses trained via an algorithm-driven hybrid simulation correctly completed endotracheal intubation on patients, compared with 52% among those receiving traditional clinical instruction; all simulation participants adhered to the procedural sequence, versus only 32% of the control group [6]. Similarly, Nadkarni et al. observed pediatric first-attempt success rates rise from 39% to 78% after implementation of a mastery-based simulation curriculum, underscoring simulation's ability to improve real-world outcomes [12]. Despite the critical nature of endotracheal intubation and the high stakes associated with unsuccessful attempts, few studies have directly compared simulation-only and participation-based training for nurses in acute care settings. This study was therefore undertaken to address this gap and to determine which training method most effectively improves nurses' knowledge, attitudes, and clinical performance in endotracheal intubation, with the ultimate aim of enhancing patient safety and outcomes.

Materials & Methods

Design and setting(s)

This research employed a mixed-methods design using a quasi-experimental pre-test/post-test approach to compare the effectiveness of simulation-based training versus participation-based training on endotracheal intubation competency among nurses working in acute care settings.

The study was conducted from April 1, 2022, to September 30, 2022, at Imam Reza Hospital, Maragheh, East Azerbaijan Province, Iran. A convergent parallel mixed-methods design was used, in which quantitative and qualitative data were collected simultaneously during the intervention phase; qualitative semi-structured interviews were conducted sequentially following completion of the post-test quantitative assessments, allowing participants to reflect on their full training experience.

Participants and sampling

The study population comprised nurses employed in acute care units with varying levels of clinical experience. Participants were recruited through convenience sampling from four distinct ward types—ED, ICU, CCU, and NICU—to ensure representation across different acute care settings. The allocation resulted in 33 nurses from the ICU and 15 nurses from the ED being assigned to the participation-based training group, while the simulation-based training group included 18 nurses from the CCU and 14 nurses from the NICU. Inclusion criteria required registered nurses aged > 24 years who were actively working in acute care environments and had provided informed consent to participate. Eighty nurses who met the inclusion criteria were randomly assigned to either the simulation-based training group (n = 40) or the participation-based training group (n = 40) using a computer-generated random number sequence. **Figure 1** shows the flow diagram of participant recruitment and study phases.

Intervention

Participants were randomly assigned to one of two groups: a simulation-based training group (Group 1) or a participation-based training group (Group 2). Both groups received a total of 16 hours of training, delivered over four sessions of four hours each across a two-week period. The content covered in both groups was identical, including airway anatomy, indications and contraindications for intubation, equipment selection, procedural steps, and complication management.

The simulation-based training group received detailed instruction using high-fidelity manikins and simulation equipment in a controlled laboratory environment, allowing participants to practice endotracheal intubation skills in a standardized setting without direct patient contact. The goal of this model was to provide opportunities for multiple practice sessions, immediate feedback, and practice-based learning in a risk-free, non-patient environment. Each nurse in the simulation-based training group performed a minimum of 10 supervised intubation attempts on the manikin during the training period. Participants in the participation-based training group learned through supervised clinical practice. This involved performing intubation procedures on real patients under the direct supervision of an experienced clinician in an actual clinical environment. Each nurse was allowed to perform up to three intubation attempts on live patients during the training period; patients included those requiring intubation due to respiratory failure or airway obstruction. Both groups utilized the same training duration and standardized content coverage, ensuring that all participants had equal exposure to theoretical knowledge and practical skill development. Training programs incorporated evidence-based guidelines related to endotracheal intubation, and both training sessions were delivered by a certified instructor with specialized training in airway management. Near the completion of each session, training included pre-briefing to summarize course content, hands-on practice, and debriefing to allow time for reflection and integration of learning—designed to encourage skill consolidation.

The supervision ratio during participation-based training was maintained at 1:2, meaning one experienced clinician supervised two nurses during their intubation attempts. Safety stopping rules were established: if a nurse encountered difficulty during an intubation attempt beyond a predetermined time limit of 30 seconds, the procedure was halted and the supervising clinician intervened to ensure patient safety.

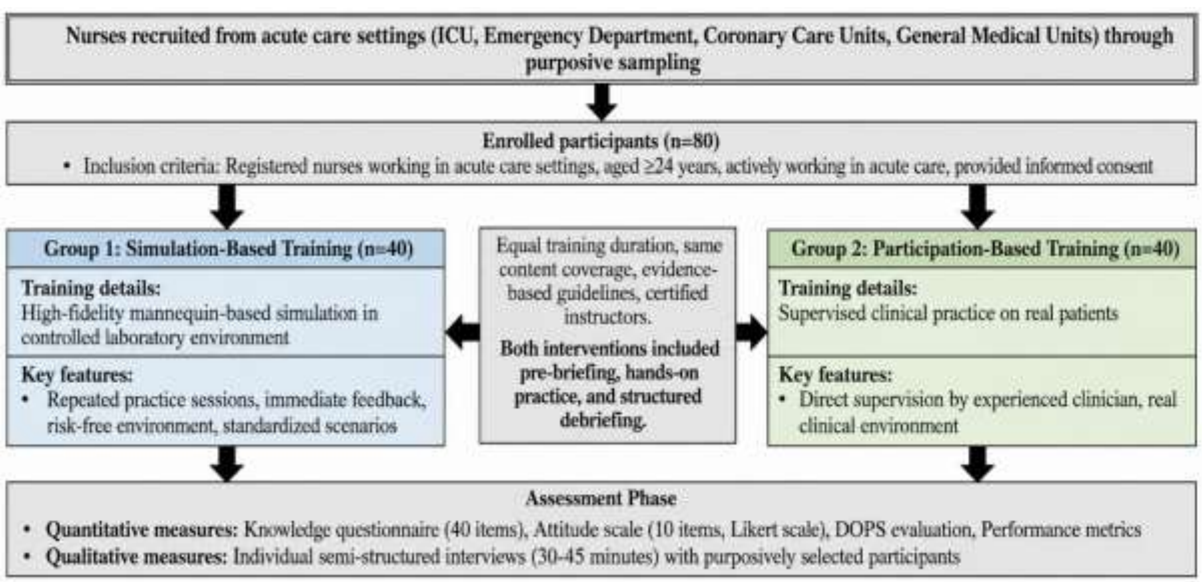

Figure 1. Flow diagram of participant recruitment and study phase.

Quantitative part

The quantitative component of the study utilized a structured data collection instrument to assess multiple dimensions of participants' competency and performance. Before the main data collection, a pilot test was conducted to evaluate the clarity, feasibility, validity, and reliability of the study instruments. The pilot was performed with 10 nurses from acute care units who met the inclusion criteria but were not included in the final analysis. Based on pilot feedback, minor wording and formatting revisions were made to improve item clarity. Knowledge was measured using a validated questionnaire consisting of multiple-choice and short-answer questions covering theoretical aspects of endotracheal intubation, including anatomy, indications, contraindications, equipment selection, procedural steps, and complication management. The knowledge assessment instrument comprised 40 items, with scores ranging from 0 to 40 points, where higher scores indicated superior theoretical understanding. Content validity was assessed by an expert panel ($n = 5$) consisting of nursing education faculty and airway-management clinicians, who reviewed the items for relevance and construct coverage. Reliability (internal consistency) was assessed in the pilot sample, yielding a Cronbach's alpha of $0.87$for the knowledge questionnaire. Attitude toward endotracheal intubation was evaluated using a standardized Likert-scale questionnaire that assessed participants' confidence, perceived importance, willingness to perform the procedure, and anxiety levels associated with intubation. The attitude scale contained 10 items rated on a 4-point scale, yielding total scores ranging from 10 to 40 points, with higher scores reflecting more positive attitudes and greater confidence in performing the procedure. The same expert panel evaluated the attitude instrument for content validity.

Pilot testing demonstrated acceptable internal consistency for the attitude scale (Cronbach's alpha = 0.81). Clinical performance was assessed using the Direct Observation of Procedural Skills (DOPS) evaluation tool, a validated instrument for assessing technical competence in clinical procedures. DOPS was administered by two independent trained raters for each participant, who observed participants performing endotracheal intubation and rated their performance across multiple domains, including preparation, technical skill execution, communication, professionalism, and overall procedural competency. For the performance checklist ratings, internal consistency in the pilot sample was acceptable (Cronbach's alpha = 0.84).

Inter-rater reliability was assessed prior to the study using a pilot sample, resulting in an intraclass correlation coefficient (ICC) of 0.92, indicating excellent agreement between raters.

Two separate DOPS scores were recorded (DOPSSCORE1 and DOPSSCORE2) to capture different aspects of performance across multiple evaluation points. Additional quantitative variables collected included the time required to complete the procedure (DOPSusetime), the number of procedures performed (proceduredone), perceived difficulty of the procedure (proceduredifficulty), and satisfaction ratings from both examinees and examiners on a 10-point scale. The educational utility of DOPS as a learning tool was also assessed (dopsuseeducation) using a categorical scale ranging from 1 to 4, where higher values indicated greater perceived educational benefit.

Qualitative part

The qualitative component employed semi-structured interviews and open-ended questionnaire items to explore participants' subjective experiences, perceptions, and insights regarding the training interventions. Following completion of the training programs and all quantitative post-test assessments, purposively selected participants from both groups ($n = 10$ from each group, selected to represent a range of experience levels and ward types) were invited to participate in individual interviews lasting approximately 30 to 45 minutes. The interview guide was developed based on the study objectives and included questions exploring participants' learning experiences, perceived strengths and limitations of their respective training methods, confidence in performing endotracheal intubation, factors influencing skill acquisition, and suggestions for improving training programs. Interviews were audio-recorded with participants' permission and subsequently transcribed verbatim for analysis. Thematic analysis was employed to identify, analyze, and report patterns within the qualitative data, following Braun and Clarke's six-phase framework: familiarization with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the final report.

Two independent researchers conducted the coding process to enhance credibility and reduce potential bias, and discrepancies in coding were resolved through discussion and consensus. The qualitative findings were integrated with the quantitative results during the interpretation phase to provide a holistic understanding of the training interventions' effectiveness and to explain or expand upon the statistical findings.

Data analysis

Data were analyzed using IBM SPSS Statistics version 27. Descriptive statistics (mean ± standard deviation, frequency, percentage) were used to summarize participant characteristics and all outcome measures at pre- and post-test.

Within-group pre–post changes in knowledge, attitude, and DOPS scores were examined using paired-samples t-tests, and between-group differences at post-test were assessed using independent-samples t-tests and Analysis of Covariance (ANCOVA) with corresponding pre-test scores as covariates. Effect sizes were calculated as Cohen's d, and 95% confidence intervals were reported for between-group mean differences; a two-tailed p-value $<0.05$was considered statistically significant.

Results

Table 1 presents the demographic and professional characteristics of the 80 nurses who participated in the study. Among them, 31 (38.8%) were male and 49 (61.3%) were female, with a mean age of 33.31 ± 5.20 years. Regarding workplace distribution, 15 (18.8%) worked in the Emergency ward, 33 (41.3%) in the ICU, 18 (22.5%) in the CCU, and 14 (17.5%) in the NICU. In terms of education, 71 (88.8%) held a Bachelor's degree in Nursing (BSN) and 9 (11.3%) held a Master's Degree (MSN). Participants had an average of 9.03 ± 5.54 years of professional experience. Regarding prior training in the use of the assessment tool, 52 (65.0%) had no prior training, 11 (13.8%) received face-to-face training, 6 (7.4%) learned through self-instruction, and 11 (13.8%) through other methods. Concerning the self-rated degree of difficulty of the procedure, 24 (30.0%) considered it low, 28 (35.0%) medium, and 28 (35.0%) high. The mean age of participants was 33.55 ± 5.90years in the simulation-based training group and 33.08±4.46years in the participation-based training group (p = 0.686). Mean years of professional experience were similarly comparable: 8.98 ± 6.04in the simulation-based training group and 9.08 ± 5.07in the participation-based training group (p = 0.936). Pre-test scores for knowledge about intubation showed no significant difference between groups, with means of 26.68 ± 5.91and 26.20 ± 7.61, respectively (p = 0.756). Likewise, attitudes toward intubation did not differ significantly, with scores of 26.78 ± 7.11and 26.90 ± 6.79 (p = 0.936). There was also no significant difference in DOPS pre-test scores, at 11.55 ± 2.31for the simulation-based training group and 11.98 ± 2.64for the participation-based training group (p = 0.445). Examinees' satisfaction with the DOPS evaluation was similar in both groups, at 5.68 ± 1.79and 5.88 ± 1.65 (p = 0.605) (**Table 2**).

Table 1. Demographic and professional characteristics of the study participants (n = 80)

Variable	n (%)
Sex	
Female	49 (61.3)
Male	31 (38.8)
Age (years)	**33.31 ± 5.20**
Clinical ward	
ICU	33 (41.3)
CCU	18 (22.5)
Emergency	15 (18.8)
NICU	14 (17.5)
Educational level	
BSN	71 (88.8)
MSN	9 (11.3)
Previous intubation training	
None	52 (65.0)
Face-to-face training	11 (13.8)
Self-directed instruction	6 (7.5)
Other methods	11 (13.8)
Self-rated procedural difficulty	
Low	24 (30.0)
Moderate	28 (35.0)
High	28 (35.0)
Clinical experience (years)	**9.03 ± 5.54**

Note: Continuous variables are presented as mean ± standard deviation (SD), and categorical variables are presented as frequency (percentage).
Abbreviations: BSN, Bachelor of Science in Nursing; MSN, Master of Science in Nursing; ICU, intensive care unit; CCU, coronary care unit; NICU, neonatal intensive care unit; SD, standard deviation.

Table 3 presents within-group pre–post changes in knowledge, attitude, DOPS, and satisfaction scores for nurses in the simulation-based and participation-based training groups. In both groups, mean scores for all four outcomes increased significantly from pre-test to post-test (all p < 0.001). In the simulation-based training group, knowledge increased from 26.68 ± 5.91to 32.38 ± 5.13, attitude from 26.78 ± 7.12to 32.18 ± 5.28, DOPS from 11.55 ± 2.31to 15.50 ± 1.79, and satisfaction from 5.68±1.79to 7.68±1.58. In the participation-based training group, larger improvements were observed, with knowledge rising from 26.20±7.61to 34.85±4.56, attitude from 26.90 ± 6.79to 34.98 ± 3.87, DOPS from 11.98 ± 2.64to 16.98 ± 2.00, and satisfaction from 5.88 ± 1.65to 8.45 ± 1.45.

Table 2. Baseline comparison of demographic characteristics and pre-intervention outcome measures between the simulation-based and participation-based training groups

Variable	Simulation-based training (n = 40)	Participation-based training (n = 40)	Sig.
Age (years)	33.55 ± 5.90	33.08 ± 4.46	t = 0.40, p = 0.686
Clinical experience (years)	8.98 ± 6.04	9.08 ± 5.07	t = -0.08, p = 0.936
Knowledge score	26.68 ± 5.91	26.20 ± 7.61	t = 0.32, p = 0.756
Attitude score	26.78 ± 7.11	26.90 ± 6.79	t = -0.08, p = 0.936
DOPS score	11.55 ± 2.31	11.98 ± 2.64	t = -0.78, p = 0.445
Satisfaction with DOPS	5.68 ± 1.79	5.88 ± 1.65	t = -0.52, p = 0.605

Note: Independent t-test was used to compare continuous variables between the two groups.
Abbreviations: DOPS, Direct Observation of Procedural Skills; SD, standard deviation; t, independent t-test; Sig., statistical significance.

Table 3. Within-group changes in knowledge, attitude, procedural performance, and satisfaction following the educational intervention

Outcome	Group	Pre-test Mean ± SD	Post-test Mean ± SD	Mean Difference (Pre − Post), Mean ± SD	t	95% CI	Sig.
Knowledge	Simulation-based training	26.68 ± 5.91	32.38 ± 5.13	− 5.70 ± 2.84	− 12.69	− 6.61 to − 4.79	0 < 0.001
	Participation-based training	26.20 ± 7.61	34.85 ± 4.56	− 8.65 ± 4.70	− 11.63	− 10.16 to − 7.15	0 < 0.001
Attitude	Simulation-based training	26.78 ± 7.12	32.18 ± 5.28	− 5.40 ± 2.98	− 11.47	− 6.35 to − 4.45	0 < 0.001
	Participation-based training	26.90 ± 6.79	34.98 ± 3.87	− 8.08 ± 4.32	− 11.81	− 9.46 to − 6.69	0 < 0.001
DOPS score	Simulation-based training	11.55 ± 2.31	15.50 ± 1.79	− 3.95 ± 1.65	− 15.16	− 4.48 to − 3.42	0 < 0.001
	Participation-based training	11.98 ± 2.64	16.98 ± 2.00	− 5.00 ± 2.53	− 12.49	− 5.81 to − 4.19	0 < 0.001
Satisfaction	Simulation-based training	5.68 ± 1.79	7.68 ± 1.58	− 2.00 ± 1.13	− 11.17	− 2.36 to − 1.64	0 < 0.001
	Participation-based training	5.88 ± 1.65	8.45 ± 1.45	− 2.58 ± 1.39	− 11.68	− 3.02 to − 2.13	0 < 0.001

Note: Paired t-test was used to compare pre-test and post-test scores within each study group. Mean differences were calculated as pre-test minus post-test scores.
Abbreviations: CI, confidence interval; DOPS, Direct Observation of Procedural Skills; SD, standard deviation; t, paired t-test; Sig., statistical significance.

Table 4 compares post-test outcomes between the simulation-based and participation-based training groups and shows that the participation-based group achieved significantly higher scores across all measures. Knowledge scores were 34.85 ± 4.56in the participation-based training group versus 32.38 ± 5.13in the simulation-based training group (p = 0.025, d = 0.51), and attitude scores were 34.98 ± 3.87versus 32.17 ± 5.28, respectively (p = 0.008, d = 0.61). Clinical performance measured by DOPS was also superior in the participation-based training group (16.98 ± 2.00 vs. 15.50 ± 1.79; p < 0.001, d = 0.78), as were satisfaction scores (8.45 ± 1.45 vs. 7.68 ± 1.58; p = 0.025, d = 0.51). Systematic analysis of the interview transcripts identified four themes capturing participants' experiences and perceptions regarding the effectiveness of the two training approaches. These themes illustrated how each type of training related to skill acquisition, confidence building, and clinical competence in endotracheal intubation. **Table 5** shows the themes, their associated initial codes, and representative participant quotes. The emotional engagement experienced in real clinical settings was identified as a significant factor that heightened attention, increased motivation, and fostered a deeper sense of professional responsibility. As one nurse explained:

> *"When you are working with a real patient, it carries an emotional weight. It feels more impactful, which elicits more focus and carefulness with each step you take."* (P7-Part)

This emotional dimension of learning appeared to create a more profound connection to the procedure and its consequences. Furthermore, participants noted that the contextual complexity of authentic clinical environments provided learning opportunities that extended beyond the technical aspects of endotracheal intubation. One experienced nurse elaborated on this complexity:

> *"In a real clinical environment, you are not performing the procedure alone. You are dealing with multiple aspects at the same time—observing vitals, conversing with team members, reacting to unanticipated changes. Simulation cannot represent that complexity."* (P4-Part)

This multifaceted nature of clinical practice required nurses to develop not only technical proficiency but also the ability to coordinate with multidisciplinary teams, manage competing priorities, and respond to dynamic patient conditions. Conversely, nurses who received simulation-based training acknowledged the educational value of the controlled environment but also recognized its limitations in replicating the full spectrum of clinical reality. Several participants described the simulated scenarios as somewhat artificial, with one nurse candidly observing:

> *"The manikin was useful for learning the initial steps, but everything felt artificial. The airway was always the same, the response was predictable, and you didn't feel a sense of urgency or consequence."* (P10-Sim)

The predictability of manikin responses and the absence of genuine clinical consequences diminished the sense of urgency and authenticity that characterized real patient encounters. Despite these limitations, simulation participants appreciated the opportunity to develop foundational technical skills in a standardized manner before transitioning to patient care. The contrast between these perspectives highlighted the tension between the safety and standardization offered by simulation and the authenticity and complexity inherent in real clinical practice.

Table 4. Between-group comparison of post-intervention outcomes in the simulation-based and participation-based training groups

Outcome	Simulation-based training Mean ± SD	Participation-based training Mean ± SD	Mean Difference (Simulation − Participation)	95% CI	t	Cohen's d	Sig.
Knowledge	32.38 ± 5.13	34.85 ± 4.56	2.47 ± 1.09	− 4.64 to − 0.32	− 2.28	0.51	0.025
Attitude	32.17 ± 5.28	34.98 ± 3.87	2.81 ± 1.04	− 4.86 to − 0.74	− 2.70	0.61	0.008
DOPS score	15.50 ± 1.79	16.98 ± 2.00	1.48 ± 0.43	− 2.32 to − 0.63	− 3.46	0.78	0 < .001
Satisfaction	7.68 ± 1.58	8.45 ± 1.45	0.77 ± 0.34	− 1.45 to − 0.10	− 2.29	0.51	0.025

Note: Independent t-test was used to compare post-intervention outcome measures between the simulation-based and participation-based training groups. Cohen's *d* was calculated to estimate effect size.
Abbreviations: CI, confidence interval; DOPS, direct observation of procedural skills; SD, standard deviation; t, independent t-test; Sig., statistical significance.

Table 5. Themes, representative initial codes, and illustrative quotations from the qualitative content analysis

Theme	Representative Initial Codes	Illustrative Quotations
Authenticity and clinical realism	Real patient variability enhances learning	"Engaging with real patients taught me that no two intubations are identical. Each patient has unique anatomy that cannot be fully replicated in a simulation laboratory." (P2)
	Emotional engagement in real settings	"Working with a real patient carries emotional weight. It makes the experience more meaningful and encourages greater focus and attention throughout the procedure." (P7)
	Contextual complexity of the clinical environment	"In the clinical environment, you are simultaneously monitoring vital signs, communicating with the healthcare team, and responding to unexpected situations. Simulation could not fully reproduce that level of complexity." (P4)
	Limitations of simulated scenarios	"The manikin was helpful for learning the initial steps, but everything felt artificial. The airway was always the same, responses were predictable, and there was no real sense of urgency." (P10)
Safety and risk management in learning	Psychological safety during simulation	"Simulation allowed me to make mistakes without worrying about harming a patient. I could try different approaches and learn from my errors in a completely safe environment." (P1)
	Reduced anxiety through repeated practice	"I felt much less anxious when I later performed the procedure in the clinical setting because simulation had prepared me well." (P3)
	Ethical concerns regarding patient-based learning	"Sometimes I felt uncomfortable practicing on real patients before I was fully confident. It raised ethical concerns because I felt that patients were becoming part of my learning process." (P9)
	Confidence gained through gradual exposure	"Simulation gave me a solid foundation before approaching real patients. Although I was still nervous, I felt considerably more prepared." (P6)
Feedback quality and learning optimization	Immediate corrective feedback	"During simulation, the instructor could immediately stop me and explain how to improve my technique. That immediate feedback accelerated my learning." (P1)
	Reflective debriefing	"The debriefing sessions were extremely valuable because we could discuss mistakes, understand why they occurred, and identify better approaches without the pressure of a real clinical situation." (P8)
	Real-time clinical mentorship	"Having an experienced clinician guide me while working with a real patient was invaluable because they could anticipate complications and teach appropriate responses." (P2)
	Delayed feedback in busy clinical settings	"Clinical wards were often too busy for detailed feedback. Supervisors observed my performance, but explanations frequently came later." (P5)
Transfer of learning and development of clinical competence	Gap between simulation and clinical reality	"There was a clear difference between simulation and caring for real patients, so I had to adapt my skills beyond what I had previously learned." (P10)
	Confidence through repeated practice	"Repeated simulation practice strengthened my procedural memory and confidence much faster than clinical exposure alone." (P3)
	Holistic development of clinical competence	"Working with real patients improved not only my technical skills but also my communication, decision-making, and ability to work under pressure." (P7)
	Integration of theoretical and practical knowledge	"Participation-based training required me to integrate anatomy, physiology, pharmacology, and procedural skills simultaneously in a real clinical situation." (P4)

Note: Representative quotations were selected to illustrate each initial code while preserving participants' original meanings. Participant identifiers (P1–P10) are pseudonyms used to ensure confidentiality.
Abbreviations: DOPS, direct observation of procedural skills.

Theme 1: Authenticity and clinical realism

The first theme that emerged from the qualitative analysis centered on the authenticity and clinical realism inherent in the two training approaches. Participants who underwent participation-based training consistently emphasized the value of encountering real patient variability, which they perceived as essential for developing adaptive clinical skills. One participant articulated this perspective by stating:

> *"Engaging with real patients taught me that there are no two identical intubations. Each patient has unique anatomy that you cannot replicate in a simulation lab."* (P2-Part)

This sentiment was echoed by multiple nurses who described how working with actual patients exposed them to anatomical variations, unexpected complications, and the unpredictable nature of clinical practice—elements that could not be adequately replicated in simulated environments.

Theme 2: Safety and risk management in learning

The second major theme addressed the critical issue of safety and risk management in the learning process. Participants from the simulation-based training group consistently emphasized the psychological safety afforded by practicing on manikins rather than real patients. This safe learning environment enabled nurses to experiment with different techniques, make mistakes, and learn from errors without the fear of causing patient harm. One participant captured this advantage succinctly:

> *"The simulated environment gave me the ability to make mistakes without the worry of harming anyone. I could use alternative strategies and learn from mistakes while being completely safe to do so." (P1-Sim)*

The ability to practice repeatedly in a risk-free setting was identified as particularly valuable for building initial confidence and reducing performance anxiety. Another nurse elaborated on how this approach facilitated confidence development:

> *"I had much less anxiety about doing it clinically; I felt much more prepared to do it. I wasn't as nervous to finally perform it in a clinical setting."* (P3-Sim)

Several participants described how this graduated exposure to the procedure, beginning with simulation and potentially progressing to supervised clinical practice, helped them develop competence more comfortably and systematically. One nurse from the simulation-based training group reflected:

> *"The simulation gave me a base level of confidence. I had rehearsed the steps thoroughly before I ever approached a patient. I felt somewhat ready for the patient, even though I was still intimidated."* (P6-Sim)

However, nurses who trained directly with patients under supervision expressed mixed feelings about the safety aspects of their learning experience. While they valued the authenticity and immediate applicability of their training, some participants acknowledged experiencing ethical discomfort regarding the use of real patients as learning subjects, particularly during their initial attempts when their skill level was still developing. One nurse articulated this ethical tension:

> *"Sometimes I was uncomfortable practicing on real patients; I was uncomfortable being there without some sense of confidence. I felt as if we were using the patients as tools for our learning. That raised some ethical issues for me—I wasn't sure how I felt about the clinical experience using patients for learning."* (P9-Part)

These nurses described feelings of heightened responsibility and occasional anxiety about potentially causing harm or discomfort to patients. Despite these concerns, many participation-based training learners felt that the presence of experienced supervisors and the gradual increase in procedural independence provided adequate safety measures.

The tension between maximizing learning effectiveness and ensuring patient safety emerged as a central consideration in evaluating the appropriateness of each training approach.

Theme 3: Feedback quality and learning optimization

The third theme focused on the quality, timing, and nature of feedback received during the training process, which participants identified as crucial for optimizing learning outcomes. Nurses who underwent simulation-based training particularly valued the immediate and detailed corrective feedback they received during practice sessions. One participant emphasized this benefit:

> *"In the simulation lab, the instructor could stop me at any moment and correct my technique immediately.*

That instant feedback helped me adjust my approach right away, which accelerated my learning." (P1-Sim)

The ability of instructors to pause simulations, provide real-time corrections, and allow immediate repetition of techniques was described as highly beneficial for rapid skill acquisition and error correction.

The structured debriefing sessions that followed simulation exercises were consistently praised as opportunities for reflective learning. As one nurse explained:

"The debriefing after simulation sessions was incredibly valuable. We could discuss what went wrong, why it happened, and how to improve without the pressure of a real clinical situation." (P8-Sim)

These sessions allowed participants to analyze their performance, understand their mistakes, and develop strategies for improvement in a supportive and non-judgmental environment. The psychological safety of these debriefing sessions appeared to facilitate deeper reflection and more honest self-assessment than might occur in high-pressure clinical settings.

Participants who trained in clinical settings with real patients described a different feedback experience characterized by real-time mentorship and contextual guidance. These nurses valued the opportunity to receive coaching from experienced clinicians who could anticipate complications and provide situational advice. One participant articulated this advantage:

"Having an experienced clinician guide me through the procedure with a real patient was invaluable. They could anticipate complications and teach me how to respond in the moment, which is something you can't fully learn from simulation." (P2-Part)

This type of mentorship allowed learners to observe expert decision-making in authentic clinical contexts and receive guidance tailored to specific patient situations.

However, several participation-based training learners noted that the quality and consistency of feedback in busy clinical environments could vary, depending on the supervisor's availability, the urgency of patient care demands, and the complexity of the clinical situation. One nurse described this limitation:

"Sometimes in the clinical setting, we were so busy that there wasn't time for proper feedback. The supervisor would observe but couldn't always stop to explain things in detail, so I had to figure some things out on my own later." (P5-Part)

Some participants described instances where immediate feedback was limited due to time constraints or competing clinical priorities, requiring them to engage in self-directed reflection and learning after the procedure. This variability in feedback quality and timing was identified as a potential limitation of participation-based training compared to the more structured and consistent feedback mechanisms inherent in simulation-based approaches.

Theme 4: Skill transfer and clinical competence development

The fourth and final theme addressed the broader issue of skill transfer from training environments to independent clinical practice and the development of comprehensive clinical competence. Participants from the simulation-based training group acknowledged experiencing a noticeable gap between their simulated practice and subsequent real patient encounters. One nurse candidly described this challenge:

"There was undoubtedly a difference between simulation learning and real patients; this meant I had to adapt and learn again beyond what I had comprehended." (P10-Sim)

Several nurses described the need for additional adaptation and learning when transitioning from manikins to actual patients, noting differences in anatomical feel, patient responses, and the overall complexity of real clinical situations.

Despite this transfer gap, simulation participants emphasized that their training provided a solid technical foundation and procedural confidence that facilitated their eventual transition to clinical practice. As one nurse reflected:

"The simulation allowed me to go through the same procedure multiple times in a short period of time, building my muscle memory and procedural confidence much faster than I would have done in clinical practice." (P3-Sim)

The opportunity for repetitive practice in a controlled environment appeared to accelerate the development of technical proficiency and procedural automaticity, even if subsequent adaptation to real patients was necessary.

In contrast, nurses who underwent participation-based training described a more seamless integration of learning and practice, as their training occurred directly in the context where they would ultimately apply their skills. These participants emphasized that working with real patients from the outset promoted holistic skill development that encompassed not only technical proficiency but also clinical judgment, communication skills, teamwork, and the ability to manage unexpected situations. One nurse articulated this comprehensive development:

"Working with real patients not only developed my technical skills, but also my communication, decision-making, and the ability to work under pressure—skills that I could not learn in simulation." (P7-Part)

The necessity of integrating theoretical knowledge with practical application in real time was identified as a distinctive advantage of participation-based training. Another participant elaborated on this integration:

"The participation-based training forced me to integrate everything I knew at once—anatomy, physiology, pharmacology, and technique—all in a real situation; that integration happened more smoothly than in simulation." (P4-Part)

Nonetheless, some participation-based learners recognized that real clinical encounters could sometimes render initial learning more challenging and stressful due to the unpredictability and variability inherent in the clinical context. Although learning in more complex situations could ultimately be advantageous for supporting all aspects of competence, initially encountering real clinical complexity could create a degree of disorientation for learners, who might have benefited from a more incremental exposure to procedural demands.

Discussion

Nursing education continually evolves to address the demands of clinical competence and patient safety. Simulation-based and participation-based (i.e., supervised clinical practice with real patients) training have garnered attention for their impact on skill acquisition and confidence building [13]. The current study aimed to compare the effectiveness of simulation-based training and participation-based training on nurses' success in endotracheal intubation within acute care units. The results demonstrated that participation-based training was associated with superior outcomes in knowledge, attitude, procedural performance, and satisfaction compared to simulation-based training. This finding highlights the importance of experiential learning in authentic clinical environments for developing adaptive skills and professional readiness.

Comparing these findings with previous literature reveals both consistency and discrepancy. For instance, Zhu et al. found that simulation training effectively improved satisfaction and self-confidence among Chinese nurses, echoing the benefits of psychological safety and repeated practice highlighted in this study [14]. However, the present study's participants emphasized a distinct gap between simulation and reality, supporting Mamaghani et al., who noted that supervised clinical practice and patient-based learning fostered holistic competencies, including communication and decision-making [10]. The emotional engagement and contextual complexity of real patient care, as described by nurses in the qualitative analysis, align with findings from recent virtual simulation research, which identified enhanced immersion and engagement but also acknowledged technological limitations in replicating clinical unpredictability [15, 16].

The most notable finding was in procedural performance: the participation-based group achieved a higher mean DOPS score (16.98) than the simulation group (15.50). This difference indicates that real patient training enhances not only technical proficiency but also clinical judgment, communication, and adaptability—skills that extend beyond procedural mechanics. Prior research has highlighted a "transfer gap" between simulation and real clinical practice, with simulation improving knowledge and lab performance but offering limited evidence of transfer to authentic patient care [17, 18]. The present results suggest that training in real clinical environments reduces this gap, allowing smoother integration of learning with practice. Qualitative feedback supported this, as participants reported that real patient training demanded immediate synthesis of theory and technique, fostering more effective skill application than simulation alone.

The ethical implications of the superiority of participation-based training deserve careful consideration. As Theme 2 revealed, some participants expressed ethical discomfort about practicing high-risk procedures on real patients, particularly during early skill development. This tension between educational efficacy and patient safety has been documented by Ziv et al., who argued that simulation should be considered an ethical imperative to minimize patient risk during training [19]. The present findings suggest that educators must carefully weigh the greater learning gains of real-patient training against the potential for patient harm and learner distress. Strategies to address this ethical tension may include establishing rigorous competency thresholds on simulators before permitting any patient contact, implementing strict supervision protocols with low trainee-to-supervisor ratios, and ensuring comprehensive informed consent processes for patients involved in training. The 1:2 supervision ratio and 30-second safety stopping rules used in this study provide a practical framework, but institutions should consider further safeguards such as mandatory simulation-based pre-qualification before clinical attempts.

Past research has shown that consistency in training outcomes often stems from methods that blend technical instruction with lived clinical experience. Some studies have reported that simulation can efficiently cultivate foundational technical skills and reduce anxiety through controlled practice, yet may lack the richness of situational learning that direct patient care provides [20–22]. This partly explains why the performance and attitude scores in the current participation-based group exceeded those of simulation-trained nurses, suggesting that real patient exposure accelerates the integration of theory, practical expertise, and interprofessional collaboration.

The current study noted immediate feedback advantages in simulation but stressed that authentic mentorship and situational guidance in clinical settings often led to deeper learning [22]. However, ethical discomfort about learning on real patients has been documented elsewhere, indicating a dual need for safety and realism in training environments [23].

Supervised clinical practice in nursing education remains a pivotal strategy for experiential learning. It facilitates active participation, self-reflection, and confidence, allowing students to embody both nurse and patient perspectives. Recent studies underscore that this approach enhances communication skills, critical thinking, self-efficacy, and teamwork, thereby bridging gaps between classroom learning and clinical practice. Its integration into curricula is especially valued for preparing nurses to manage complex patient interactions and adapt to unpredictable scenarios [10, 13].

This study has several limitations that should be acknowledged. First, although participants were randomly assigned to groups, the study employed a quasi-experimental design at a single center (Imam Reza Hospital, Maragheh, Iran), which may limit the generalizability of findings to other settings, institutions, or countries with different clinical training cultures. Second, the DOPS evaluators were not blinded to participants' group allocation, which introduces potential detection bias; future studies should employ blinded assessors to strengthen internal validity. Third, the difference in the nature of practice attempts between groups (minimum 10 manikin attempts versus up to 3 live patient attempts) means that the number and type of practice opportunities were not equivalent, which may have influenced outcomes independently of the training modality itself. Fourth, the study did not include long-term follow-up assessments to evaluate retention of knowledge, skills, and confidence over time or to assess actual patient outcomes in independent clinical practice. Fifth, the sample size of 80 participants, while adequate for detecting medium-to-large effects, may have been insufficient to detect smaller but clinically meaningful differences. Finally, the self-report nature of the attitude and satisfaction measures may introduce social desirability bias. Future multi-center randomized controlled trials with blinded assessors, larger samples, and longitudinal follow-up are needed to confirm and extend these findings.

Conclusion

Overall, participation-based training appears to be more effective than simulation-based training for building comprehensive endotracheal intubation competence in nurses. Although simulation-based training provides a psychologically safe, feedback-rich setting for developing technical skills, its limited ability to reproduce clinical complexity restricts skill transfer. Exposure to real patients, involving genuine emotional engagement and adaptation to context, promotes deeper learning and better prepares nurses for independent clinical practice. Nonetheless, given the ethical concerns participants raised about learning through patient-based training, future studies should explore hybrid approaches combining simulation-based and participation-based strategies to assess whether such models can address both ethical and feedback-related limitations while maintaining safety and realism in nursing education. Further investigation of these hybrid models is needed to optimize nursing education and improve patient care outcomes going forward.

Ethical considerations

The study protocol was approved by the institutional review board and ethics committee of the participating healthcare facilities before data collection began (Ethics approval code: IR.MARAGHEHPHC.REC.1398.010). All participants received detailed written and verbal information about the study's purpose, procedures, potential risks and benefits, the voluntary nature of their participation, and their right to withdraw at any time without penalty. Written informed consent was obtained from all participants prior to enrollment.

Artificial intelligence utilization for article writing

We recognize the utilization of artificial intelligence techniques for language editing and grammatical verification in article preparation; nonetheless, all scientific content, data interpretation, and final findings remain the exclusive responsibility of the authors.

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Conflict of interest statement

The authors declare no conflict of interest.

Author contributions

EM contributed to conceptualization, methodology, drafting the original manuscript, and reviewing and editing it. HA was responsible for data curation, formal analysis, validation, and reviewing and editing the manuscript. SGR participated in methodology, software, resources, validation, and reviewing and editing the manuscript. AA conducted the investigation and contributed to validation, data curation, and reviewing and editing the manuscript. EH managed project administration, funding acquisition, supervision, drafted the original manuscript, and reviewed and edited it. All authors read and approved the final manuscript.

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Data availability statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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