Design and effectiveness of app-based clinical simulation scenarios to Enhance Nursing Students' Clinical Decision-Making Skills

Abstract:

Aims: This study aimed to design and evaluate the effectiveness of application-based clinical simulation scenarios on improving the clinical decision-making skills of nursing students.

Methods: This quasi-experimental pretest–posttest study with a two-group design included 42 third-semester undergraduate nursing students from Dezful University of Medical Sciences. Participants were recruited using a census sampling method and allocated into an intervention group (n = 21) and a control group (n = 21). Data were collected using a demographic questionnaire and Lauri's Clinical Decision-Making Questionnaire. The intervention group participated in six application-based clinical simulation scenarios developed by the researchers. The scenarios were implemented through small-group discussions during six 30-minute sessions throughout the clinical internship period. Data were analyzed using descriptive and inferential statistics in SPSS software

Findings: The mean clinical decision-making score in the intervention group increased from 80.33 at pretest to 87.23 at posttest, whereas the mean score in the control group decreased from 85.28 at pretest to 81.56 at posttest. However, the results of the analysis of covariance (ANCOVA), after controlling for pretest scores, showed no statistically significant difference in clinical decision-making scores between the intervention and control groups.

Conclusion: Although simulation-based education is known to enhance nursing competencies, the definitive effectiveness of mobile application-based clinical simulation scenarios in improving clinical decision-making requires further evidence from well-designed studies.

Keywords: Clinical Decision-Making[1], Simulation Training[2], Mobile Applications[3], Students, Nursing[4]

1. https://www.ncbi.nlm.nih.gov/mesh/?term=Clinical+decision+making
2. https://www.ncbi.nlm.nih.gov/mesh/?term=Simulation
3. https://www.ncbi.nlm.nih.gov/mesh/?term=Mobile+Application
4. https://www.ncbi.nlm.nih.gov/mesh/?term=nursing+student

Introduction:

Clinical education is an effective approach to developing nursing students' competencies, providing them with an appropriate opportunity to expand their theoretical knowledge, translate knowledge into psychomotor skills, and develop their attitudes (1). However, in recent years, nursing education has become increasingly focused on theoretical instruction, which has contributed to the persistent theory–practice gap in nursing. It has frequently been observed that nursing students, despite having an adequate theoretical foundation, lack the necessary skills to function effectively in clinical settings (2). Moreover, nursing clinical education programs are generally of moderate quality and do not fully promote the development of students' cognitive, affective, and psychomotor competencies (3).

With advances in technology, traditional educational tools alone are no longer sufficient to meet the evolving educational needs of nursing students. This need is particularly evident in the nursing profession, where timely and accurate decision-making can have significant implications for patient outcomes, underscoring the importance of adopting innovative educational approaches(4). To achieve this goal, universities have sought to shift from traditional and passive teaching approaches toward innovative, active, and interactive methods, including problem-based learning, case-based learning, team-based learning, e-learning, flipped learning, concept mapping, evidence-based education, and simulation-based education in the clinical education of nursing students (5,6).

Simulation is an interactive teaching and learning method in nursing education (7). It is also defined as a process designed to achieve outcomes that closely resemble those of real-world situations. In this approach, real-life experiences are replaced or supplemented by guided learning experiences (4). This approach provides nursing educators and healthcare providers with an important

educational strategy that can address the needs of contemporary learners through experiential and interactive learning approaches (8). Simulation enables students to work in a hospital-like environment and helps them gain healthcare and nursing care experiences even before entering professional practice. Students can apply what they have learned in practice, encounter problems and challenges, and even make mistakes without causing harm to patients. All of these experiences take place in a safe environment without exposing patients to any risk (9,10). In fact, simulation is designed around clinical scenarios to enable nursing students to gain experience in the authentic aspects of their professional roles and to facilitate their integration into various healthcare settings and teams (11).

Clinical simulations, particularly those delivered through mobile technologies, have been introduced as effective tools for enhancing clinical decision-making skills and facilitating students' engagement with complex clinical situations (12). Clinical decision-making involves the collection and interpretation of clinical data to achieve judgments and make decisions regarding an appropriate course of action. This concept is considered one of the fundamental skills in nursing practice (13). The foundation of clinical decision-making begins during the early stages of nursing education, when students learn how to formulate and document nursing diagnoses and interventions (14).

Due to the changes and developments in the healthcare system compared with the past, greater expectations are now placed on nursing graduates to demonstrate problem-solving and decision-making abilities when entering professional practice. In fact, society needs nursing students who possess the ability to collaborate, solve problems, and make appropriate professional decisions (15,16). The World Health Organization identifies clinical decision-making and critical thinking as gold standards for professional nursing practice within nursing education programs (17).

According to the Human Caring Model, nursing education should be structured in a way that enables students to acquire the necessary preparation to provide holistic and comprehensive care. An appropriate nursing education program should facilitate the development of human caring behaviors in the nurse–patient relationship (18). However, nursing graduates often report limitations after entering hospitals and clinical settings, which are attributable not only to a lack of work experience but also to insufficient confidence in making clinical decisions within highly dynamic environments characterized by more informed patients and increased workloads (17). The complexity of decision-making among nurses increases with growing patient awareness and expectations, as well as with advances in technology (14). Clinical simulation scenarios, as an effective educational tool, provide a safe environment for nursing students to learn and develop clinical decision-making skills by engaging learners and practitioners in simulated settings where they can practice and enhance this essential competency (19). Applying knowledge and engaging in sufficient practice within this safe environment, using realistic scenarios, can effectively improve clinical knowledge and skills while simultaneously enhancing learners' confidence (20). Previous studies have reported improvements in critical thinking, self-efficacy, and confidence among nursing students who participated in simulation-based learning experiences (21,22). Furthermore, review studies have demonstrated that educational simulations have positive effects on learning and clinical performance (23,24).

Nowadays, personal smartphones have become widely used as educational and learning tools among health sciences students (25). The use of mobile phones and their applications plays an important role in facilitating evidence-based care, enhancing patient safety, and reducing learners' anxiety while providing care to patients with diverse needs (26,27). Given that the use of electronic methods and educational content delivered through simulation applications is not restricted by time or location and is simple to use and can be repeatedly accessed, these features may have a positive impact on the education and training of nursing students (28).

Fluid and electrolyte disorders are among the most common clinical problems encountered by hospitalized patients and constitute an integral part of their daily care (29). As vital members of the healthcare team, nurses are responsible for assessing and identifying any changes in patients' fluid and electrolyte status (30).Therefore, understanding the fundamental principles of fluid and electrolyte imbalance is essential for assessing patients' signs and symptoms, making nursing diagnoses, planning and implementing interventions, and evaluating patient outcomes. Consequently, the nursing process is considered a fundamental principle in identifying and improving the condition of patients with fluid and electrolyte disorders (31). The nursing process also plays a significant role in enhancing clinical assessment, clinical reasoning, and clinical decision-making (29).

Significance of the Study:

Given the importance of simulated clinical scenarios in improving clinical decision-making and the application of the nursing process, particularly in the care of patients with fluid and electrolyte disorders, and considering the limited evidence on mobile application–based simulation in this context, especially in universities in Khuzestan Province, this study aimed to design and evaluate mobile application–based simulated clinical scenarios to improve nursing students' clinical decision-making skills related to the nursing process for patients with fluid and electrolyte disorders at Dezful University of Medical Sciences during the 2025–2026 academic year.

Methods:

This quasi-experimental study employed a pretest–posttest design and was conducted among undergraduate nursing students during the 2025–2026 academic year. The study was carried out in the internal medicine and surgical wards of a teaching hospital affiliated with Dezful University of Medical Sciences, Iran. The study population consisted of all third-semester undergraduate nursing students during the 2025–2026 academic year. Following the application of the predefined inclusion and exclusion criteria, eligible students were selected from the study population using census sampling, resulting in a final sample of 42 students.

The inclusion criteria were willingness to participate in the study, enrollment in the third semester of the undergraduate nursing program, completion of the Adult and Older Adult Nursing I course, and no history of employment in hospitals or other healthcare settings. The exclusion criteria included participation in similar research projects, failure to pass the Adult and Older Adult Nursing I course, absence from more than one clinical practicum session, withdrawal from the nursing program or transfer to another university, incomplete completion of the study questionnaires, or withdrawal of consent to participate.

Because group allocation was based on two consecutive admission cohorts rather than randomization, students admitted in September 2025 were assigned to the control group (n = 21), whereas those admitted in February 2026 were assigned to the intervention group (n = 21). The Adult and Older Adult Nursing I clinical practicum was conducted over eight days in both the internal medicine and surgical wards for each group.

Data were collected using a demographic questionnaire and the Persian version of the Clinical Decision-Making Questionnaire originally developed by Lauri and colleagues (32). The demographic questionnaire included age, sex, marital status, grade point average (GPA), place of residence (dormitory or private residence), theoretical course grade for the fluid and electrolyte balance component of the Adult and Older Adult Nursing I course, history of psychological disorders, previous clinical work experience, and level of interest in the nursing profession.

The Clinical Decision-Making Questionnaire consists of 24 items assessing clinical decision-making and is scored on a five-point Likert scale ranging from 1 (never) to 5 (always), with response options of never, rarely, sometimes, often, and always. The total score ranges from 24 to 120, with higher scores indicating greater clinical decision-making ability. Scores below 67 indicate an analytic decision-making style, scores between 68 and 78 indicate an analytic–intuitive decision-making style, and scores above 78 represent an intuitive decision-making style. Tawer et al. (2012) reported a Cronbach's alpha coefficient of 0.81 for the questionnaire (33). In Iran, Noohi et al. (2014) confirmed its content validity and reported a Cronbach's alpha coefficient of 0.85, indicating satisfactory reliability (34).

To reassess content validity for the present study, the questionnaire was reviewed by a panel of 10 nursing faculty members. The clinical scenarios used in the intervention were developed based on evidence from published studies, standard nursing textbooks, and reputable nursing websites. Five clinical scenarios were developed, each consisting of a patient history, assessment findings, and clinical data related to patients with fluid and electrolyte imbalances. The content and face validity of the scenarios were evaluated and approved by a panel of 10 faculty members from the Department of Nursing.

After obtaining written informed consent from all participants, the demographic questionnaire and the Clinical Decision-Making Questionnaire were completed by both the control and intervention groups on the first day of the clinical practicum. On the same day, students in the intervention group received an orientation to the study procedures and instructions on using the mobile application. The clinical scenarios, together with the corresponding learner assessment domains, were integrated into a custom-developed mobile application that was accessible via smartphones, tablets, and laptop

computers.The intervention was implemented during the final 30 minutes of the second through sixth clinical practicum sessions.

Students worked in groups of two or three under the supervision of the same clinical instructor, who had received training on the use of the application. All sessions were conducted in the educational classrooms of the respective clinical wards. Each clinical scenario was assigned a maximum score of 25 points, resulting in a maximum total score of 125 points across all five scenarios. At the end of each session, a small incentive was awarded to the group that achieved the highest score. Access to the clinical scenarios through the mobile application was restricted to the predetermined dates and times scheduled for each session. In addition, a new set of clinical scenarios with an equivalent level of difficulty was developed for each intervention cohort.

On the eighth (final) day of the clinical practicum, the Clinical Decision-Making Questionnaire was re-administered to both groups as the post-test assessment.

Students in the control group received routine clinical education as part of the Adult and Older Adult Nursing I clinical practicum under the supervision of the same instructor but did not have access to the mobile application. During the final 30 minutes of each practicum session, they participated in group question-and-answer discussions based on their assigned presentations related to fluid and electrolyte balance.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 27. Statistical significance was set at $P < 0.05$. Continuous variables were summarized as mean ± standard deviation (SD), whereas categorical variables were presented as frequencies and percentages.

Baseline comparisons between the intervention and control groups were performed using the Mann–Whitney U test for continuous variables because the assumption of normality was violated in one group. Categorical variables were compared using the chi-square test or Fisher's exact test when expected cell frequencies were less than five.

To evaluate the effect of the educational intervention on post-test clinical decision-making scores while controlling for baseline (pre-test) scores, analysis of covariance (ANCOVA) was performed. Before conducting ANCOVA, its assumptions were examined. Homogeneity of variances was assessed using Levene's test, and homogeneity of regression slopes was evaluated by testing the interaction between group and the covariate. Both assumptions were satisfied.

Because the normality assumption for residuals was violated in one group, Quade's nonparametric ANCOVA was additionally performed as a sensitivity analysis to confirm the robustness of the findings.

Result

A total of 42 nursing students participated in the study, with 21 students in the control group and 21 in the intervention group. As presented in Table 1, significant baseline differences were observed between the two groups in age (control: 21.48 ± 1.69 years vs. intervention: 23.67 ± 3.39 years; $P = 0.005$), grade point average (GPA) (control: 16.47 ± 0.92 vs. intervention: 17.32 ± 1.39; $P = 0.005$), and marital status (control: 100% single vs. intervention: 47.6% single and 52.4% married; $P < 0.001$). No statistically significant differences were found between the groups regarding sex ($P = 0.537$), previous clinical work experience ($P = 0.484$), interest in the nursing profession ($P = 0.367$), or history of psychological disorders ($P = 0.488$).

Table ١ : Baseline characteristics of study participants in control and intervention group

Table 2 presents the results of the analysis of covariance (ANCOVA) comparing post-test clinical decision-making scores between the intervention and control groups after adjustment for baseline (pre-test) scores. In the intervention group, the mean clinical decision-making score increased from 80.33 ± 13.67 at pre-test to 87.23 ± 13.31 at post-test. In contrast, the mean score in the control group decreased from 85.28 ± 14.35 at pre-test to 81.56 ± 10.05 at post-test. However, after adjustment for baseline scores, ANCOVA showed that the difference in post-test clinical decision-making scores between the two groups was not statistically significant (P = 0.110). Because the assumption of normality was violated in one group, Quade's nonparametric ANCOVA was performed as a sensitivity analysis, yielding results consistent with those of the primary analysis.

Variable		**Group**		**P-value**
		Intervention (n=21)	**Control (n=21)**	
Age (year)		23.67 ± 3.39	21.48 ± 1.69	**0.005**[a]
Average grade		17.32 ± 1.39	16.47 ± 0.92	**0.005**[a]
Sex	Female	11(52.4)	9(42.9)	**0.537**[b]
	Male	10(47.6)	12(57.1)	
Marital status	Single	10(47.6)	21(100.0)	**<0.001**[b]
	Married	11(52.4)	0(0.0)	
Clinical experience	Yes	4(19.0)	7(33.3)	**0.484**[b]
	No	17(81.0)	14(66.7)	
Interest in nursing	Low	2(9.5)	1(4.8)	**0.367**[c]
	Moderate	15(71.4)	11(52.4)	
	High	4(19.0)	9(42.9)	
History of mental illness	Yes	2(9.5)	0(0.0)	**0.488**[c]
	No	19(90.5)	21(100.0)	

Data are presented as mean ± SD for continuous variables and n (%) for categorical variables. a: Mann–Whitney U test; b: Chi-square test; c: Fisher's exact test

Table 2.
Comparison of clinical decision-making skills scores between control and intervention groups adjusted for pre-test scores using ANCOVA

Group	**Pre-test (Mean ± SD)**	**Post-test (Mean ± SD)**	**P-value**
Intervention	80.33 ± 13.67	87.23 ± 13.31	0.110
Control	85.28 ± 14.35	81.56 ± 10.05	

Conclusion:

The present study aimed to investigate the effect of mobile application–based simulated clinical scenarios on the clinical decision-making skills of nursing students in the context of fluid and electrolyte imbalance disorders. The findings demonstrated that the mean clinical decision-making score increased in the intervention group following implementation of the simulated scenarios, whereas a decline was observed in the control group. However, after adjusting for baseline scores and other potential confounding variables, the difference between the two groups was not statistically significant.

Although the intervention did not result in a statistically significant difference between the two groups, the observed trend in clinical decision-making scores is noteworthy. The intervention group demonstrated an increase of approximately seven points in the mean clinical decision-making score, whereas the control group showed a decline of nearly four points. These findings suggest a potential beneficial effect of mobile application–based simulated clinical scenarios on clinical decision-making. However, because the between-group difference was not statistically significant, this interpretation should be considered with caution. Nevertheless, this improvement did not reach statistical significance in the present study.

In educational research, particularly in the context of complex cognitive skills such as clinical decision-making, the observation of favorable trends even in the absence of statistical significance may indicate a potential effect that could become more evident in studies with larger sample sizes or longer intervention periods (35).

The findings of the present study are consistent with those of several previous studies on simulation-based education. Studies conducted by Mohebi et al. (2015), Abdulmohdi and McVicar (2023), and Malathi et al. (2023) have demonstrated that clinical simulation can enhance nursing students' clinical decision-making, clinical reasoning, and self-confidence (36–38).Furthermore, recent systematic reviews have confirmed the positive impact of simulation-based learning on nursing students' knowledge, clinical performance, and critical thinking (22, 39–40). The direction of the changes observed in the present study was consistent with these findings; however, The relatively small sample size may have limited the statistical power to detect a true effect.

One possible explanation for the absence of a statistically significant difference is the relatively small sample size. Methodological studies have shown that small sample sizes may reduce statistical power and increase the risk of a Type II error, meaning that a true difference between groups may exist but remain undetected by the study (41).In addition, baseline differences between the two groups in terms of age, grade point average (GPA), and marital status may have influenced the study outcomes. These variables are associated with factors such as knowledge level, cognitive maturity, personal experiences, and social support, all of which may affect the clinical decision-making process.

On the other hand, clinical decision-making is a complex, multidimensional skill influenced by a variety of factors, including professional knowledge, critical thinking, clinical reasoning, practical experience, self-efficacy, and problem-solving ability (42–44).Therefore, expecting substantial changes in this skill through a relatively short-term six-session intervention may not be realistic. It is possible that implementing simulated clinical scenarios over a longer period and on a continuous basis throughout an academic semester could have a greater impact on the development of nursing students' clinical decision-making skills.

One of the key innovations of the present study was the use of digital technology and a mobile application to deliver simulated clinical scenarios. Mobile learning facilitates rapid access to educational content, promotes greater interaction, and encourages active student engagement (45).However, some studies have suggested that the use of mobile devices may also be associated with distractions, increased cognitive load, and reduced concentration (46).Therefore, It is also possible that factors related to the use of mobile devices, such as distractions or increased cognitive load, may have influenced learning outcomes, as suggested in previous studies. Accordingly, optimizing the user interface, enhancing educational interactivity, and minimizing potential distractions should be considered in the design of future studies.

Another noteworthy finding was the decline in the mean clinical decision-making scores observed in the control group. This finding may be attributed to several factors, including the gradual forgetting of previously learned material, the absence of supplementary educational interventions, fatigue associated with clinical practicum activities, or a decline in students' motivation over the course of the practicum (47–49).In contrast, the active participation of students in the intervention group in

scenario-based discussions may have facilitated better knowledge retention and sustained the cognitive processes involved in clinical decision-making (38).

Overall, although the present intervention did not result in a statistically significant difference between the groups, the improvement observed in the intervention group suggests that the use of technology-enhanced simulated clinical scenarios may represent a promising approach to improving nursing students' clinical decision-making skills. Further research using more rigorous study designs and larger sample sizes is warranted to better evaluate the effectiveness of this educational approach.

Conclusion:

The findings of the present study indicated that the implementation of mobile application–based simulated clinical scenarios was associated with an increase in nursing students' clinical decision-making scores. However, after controlling for baseline differences between the groups, this improvement was not statistically significant. Nevertheless, the favorable trend observed in the intervention group suggests the potential of this educational approach to enhance nursing students' clinical decision-making skills.

Given the critical role of clinical decision-making in the quality of nursing care and the growing integration of innovative educational technologies into nursing education, the use of digitally delivered simulated clinical scenarios may represent a promising complementary educational strategy that warrants further investigation(20, 22). Future randomized controlled studies with larger sample sizes, longer intervention periods, and objective measures of clinical performance are recommended to establish the effectiveness of this educational approach more conclusively.

Limitations:

The present study has several limitations that should be considered when interpreting the findings. First, the relatively small sample size may have limited the statistical power to detect true differences between the study groups, thereby increasing the risk of a Type II error. Second, although baseline clinical decision-making scores were statistically controlled, initial differences between the groups in terms of age, grade point average (GPA), and marital status may have acted as potential confounding factors and influenced the study outcomes.

Furthermore, the duration of the intervention and the number of educational sessions may not have been sufficient to produce a significant improvement in a complex skill such as clinical decision-making, which is developed through continuous practice, clinical experience, and repeated feedback. In addition, study outcomes were assessed only immediately after completion of the intervention; therefore, the long-term sustainability of the educational effects was not evaluated.

Finally, as the study was conducted at a single university and included students from only one academic semester, the generalizability of the findings to other nursing student populations and educational settings should be interpreted with caution.

In addition, because participants were allocated to the study groups based on admission cohort rather than randomization, selection bias cannot be completely ruled out.