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# EFFECTIVENESS OF SIMULATION-BASED PEDIATRIC TRAINING IN IMPROVING CLINICAL COMPETENCE AND DECISION-MAKING SKILLS AMONG MEDICAL STUDENTS

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**Abstract.**
**Background.** In recent years, simulation-based education has become an important component of modern medical training. Traditional clinical teaching methods often provide limited opportunities for students to actively practice diagnostic reasoning and clinical decision-making, particularly in pediatric settings where patient safety considerations restrict independent student participation. Simulation-based training offers a safe and controlled learning environment where students can develop both technical and non-technical clinical competencies through realistic clinical scenarios.
**Aim.** The aim of this study was to evaluate the effectiveness of simulation-based pediatric training in improving clinical knowledge, practical skills, and clinical decision-making abilities among undergraduate medical students.
**Methods.** A prospective educational study was conducted at the simulation training center of Tashkent State Medical University, Uzbekistan. A total of 150 third-year medical students participated in the study and were divided into two groups: the main group (n=100), which received structured simulation-based pediatric training, and the control group (n=50), which underwent traditional clinical instruction. The simulation program included several pediatric clinical scenarios such as assessment of a child with fever, recognition of dehydration, identification of respiratory distress, and initial management of acute pediatric conditions. Educational outcomes were assessed using knowledge tests, objective structured clinical examination (OSCE), and structured observation of clinical decision-making performance. Statistical analysis was performed using standard biomedical statistical methods.
**Results.**The results demonstrated significant improvement in clinical competence among students who participated in simulation-based training. The mean knowledge score in the main group increased from 62.4±5.1 to 84.6±4.3 points ($p<0.001$), whereas the control group showed a smaller improvement from 61.8±5.3 to 71.2±4.9 points. Similarly, OSCE performance scores in the simulation group increased from 63.1±5.4 to 86.2±4.1, indicating substantial enhancement of practical clinical skills. In addition, the proportion of students capable of correctly identifying urgent pediatric conditions increased from 58% to 88% after simulation training. Students also demonstrated improved communication skills, teamwork, and adherence to patient safety principles.

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**Conclusion.** Simulation-based pediatric training significantly improves clinical knowledge, practical skills, and diagnostic decision-making among medical students. Integration of simulation technologies into undergraduate medical education may enhance the quality of clinical training and better prepare future physicians for real pediatric practice.
**Keywords.** simulation-based education; medical students; pediatric training; clinical skills; clinical decision-making; medical simulation.

**Introduction.** In recent decades, medical education has undergone substantial transformation due to the increasing complexity of healthcare systems, the growing emphasis on patient safety, and the need to ensure high standards of clinical competence among future healthcare professionals. Traditional models of medical training, which rely heavily on theoretical instruction and limited clinical exposure, are no longer sufficient to fully prepare medical students for real clinical practice. This challenge is particularly evident in pediatric education, where clinical decision-making requires rapid assessment, careful communication with patients and parents, and accurate interpretation of clinical signs in vulnerable patient populations.

Simulation-based education has emerged as one of the most effective pedagogical approaches in modern medical training. It allows students to practice clinical skills in a controlled and safe environment without posing risks to real patients. Simulation technologies make it possible to reproduce complex clinical scenarios, including emergency situations, diagnostic challenges, and interprofessional teamwork tasks. Through repeated practice and structured feedback, students develop not only technical skills but also critical thinking, communication, and teamwork competencies.

The integration of simulation methods into undergraduate medical curricula has been widely supported by international educational organizations and accreditation bodies. Numerous studies have demonstrated that simulation-based training significantly improves clinical reasoning, procedural skills, and confidence among medical students. In addition, simulation provides opportunities for experiential learning, allowing students to actively engage in clinical problem-solving rather than passively receiving theoretical information.

Pediatric medical education presents unique challenges that make simulation particularly valuable. Children often present with rapidly changing clinical conditions, and early recognition of deterioration is essential for preventing severe complications. However, opportunities for students to independently perform clinical procedures or make decisions in real pediatric settings may be limited due to ethical considerations and patient safety concerns. Simulation-based training helps bridge this gap by enabling students to experience realistic pediatric clinical scenarios and practice evidence-based clinical management strategies.

Furthermore, simulation training promotes the development of essential non-technical skills such as communication with parents, teamwork in multidisciplinary healthcare environments, and adherence to patient safety principles. These competencies are increasingly recognized as critical components of high-quality healthcare delivery.

Despite the growing global adoption of simulation-based education, its implementation and evaluation remain limited in many developing countries, including those in Central Asia. In Uzbekistan, modernization of medical education has become a strategic priority, with increasing attention being paid to innovative teaching technologies and competency-based training models. The establishment of simulation centers at medical universities provides new opportunities to enhance the practical training of students and to align medical education with international standards.

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However, evidence regarding the effectiveness of simulation-based pediatric training within the context of medical education in Uzbekistan remains scarce. Investigating the impact of simulation-based learning on the development of clinical competencies among medical students is therefore important for optimizing educational strategies and improving the quality of pediatric healthcare training.

**Aim of the Study.** The aim of this study was to evaluate the effectiveness of simulation-based pediatric training in improving clinical skills, clinical decision-making abilities, and patient safety competencies among undergraduate medical students. In addition, the study sought to assess how simulation-based educational strategies contribute to the development of practical competencies required for the management of common pediatric clinical situations.

**Materials and Methods.** This study was conducted as a prospective educational intervention aimed at evaluating the effectiveness of simulation-based training in pediatric education. The research was carried out at the simulation training center of Tashkent State Medical University within the framework of undergraduate clinical education. The simulation center provides a modern educational environment equipped with pediatric training mannequins, diagnostic equipment, and standardized clinical scenarios designed to reproduce realistic situations frequently encountered in pediatric practice. The use of simulation technologies allows students to acquire and improve clinical competencies in a safe and controlled learning environment, which is particularly important in pediatric medicine where direct independent participation of students in real clinical situations may be limited by ethical and patient safety considerations.

A total of 150 undergraduate medical students participated in the study. All participants were third-year students undergoing clinical training in pediatric propedeutics and basic clinical skills development. For the purpose of comparative analysis, the students were divided into two groups according to the educational method used during their practical training. The main group consisted of 100 students who participated in structured simulation-based pediatric training sessions. The control group included 50 students who received traditional clinical instruction based on conventional bedside teaching, instructor demonstrations, and case-based discussions without the use of simulation technology. Such a design made it possible to evaluate the educational effectiveness of simulation training compared with traditional teaching methods.

The educational intervention was developed according to the principles of competency-based medical education and was focused on the development of both technical and non-technical clinical competencies. The simulation program included several clinical scenarios that reflect common pediatric conditions frequently encountered in clinical practice. These scenarios were designed to train students in the clinical assessment of a child with fever, recognition and management of dehydration, identification of respiratory distress, evaluation of acute abdominal complaints, and early recognition of clinical deterioration in pediatric patients. The use of such scenarios allowed students to develop clinical reasoning, practical examination skills, and decision-making abilities in conditions closely resembling real clinical situations.

Each simulation training session followed a structured format consisting of three sequential stages. At the beginning of each session, students participated in a pre-briefing phase during which instructors introduced the learning objectives, explained the structure of the scenario, and familiarized students with the simulation environment and available equipment. Special attention was given to patient safety principles, effective communication, and the

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importance of teamwork in clinical practice. This introductory stage was essential for preparing students for active participation in the simulation scenario.

During the simulation phase, students were engaged in realistic clinical cases that required them to perform a systematic pediatric examination, identify key symptoms and danger signs, interpret clinical findings, and determine appropriate initial management strategies. Depending on the complexity of the scenario, students worked individually or in small teams. Faculty members observed the performance of each participant using structured assessment criteria that allowed objective evaluation of clinical competencies.

After completion of each scenario, a structured debriefing session was conducted. Debriefing represented a critical educational component of the training process and provided an opportunity for reflective learning. During this stage, instructors and students analyzed the actions performed during the simulation, discussed diagnostic reasoning and clinical decisions, identified possible errors, and reinforced evidence-based approaches to patient management. Such reflective discussion helped students better understand clinical processes and consolidate newly acquired knowledge and skills.

The effectiveness of the educational intervention was assessed using several indicators reflecting both theoretical knowledge and practical clinical competence. Students' knowledge of pediatric clinical assessment and emergency response principles was evaluated through structured pre-training and post-training tests that included case-oriented questions. Practical clinical skills were assessed using an objective structured clinical examination approach that allowed evaluation of students' ability to perform general pediatric examination, recognize critical symptoms, interpret vital signs, and make appropriate clinical decisions. In addition, special attention was paid to non-technical competencies such as communication skills, teamwork, and adherence to patient safety principles, which were evaluated during simulation scenarios by trained instructors.

Statistical analysis of the obtained data was performed using standard biomedical statistical methods. Quantitative variables were expressed as mean values with corresponding measures of variation. Comparisons of results before and after the educational intervention were performed using Student's t-test, while differences between the main and control groups were assessed using independent statistical comparison methods. Qualitative variables were analyzed as percentages, and the significance of intergroup differences was determined using the chi-square test. A probability value of less than 0.05 was considered statistically significant.

All stages of the study were conducted in accordance with the ethical principles of educational research. Participation of students in the study was voluntary, and all collected data were analyzed anonymously. The results were used exclusively for scientific purposes and for the evaluation of innovative educational approaches in medical training.

**Results.** The analysis of the obtained results demonstrated a clear positive impact of simulation-based pediatric training on the development of clinical competencies among medical students. At the initial stage of the study, prior to the educational intervention, the level of theoretical knowledge and practical clinical skills among students in both groups was generally comparable. Pre-training assessment revealed no statistically significant differences between the main and control groups in baseline clinical knowledge and practical skills, which confirms the initial homogeneity of the study population and allows reliable comparison of educational outcomes following the intervention.

After completion of the training program, students who participated in simulation-based education demonstrated substantially greater improvements in both theoretical knowledge and

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practical clinical performance compared with those receiving traditional clinical instruction. In particular, the results of the objective knowledge assessment showed a significant increase in the average test scores among students in the simulation training group. The mean knowledge score increased from 62.4±5.1 points before training to 84.6±4.3 points after training, indicating a statistically significant improvement ($p<0.001$). In contrast, the control group demonstrated only moderate progress, with scores increasing from 61.8±5.3 to 71.2±4.9 points during the same period.

Similarly, evaluation of practical clinical competencies revealed marked improvement among students exposed to simulation-based learning. The average OSCE performance score in the main group increased from 63.1±5.4 before training to 86.2±4.1 after training, reflecting a significant enhancement of clinical examination skills and diagnostic reasoning. In comparison, students in the control group demonstrated a smaller improvement in practical performance, which suggests that traditional bedside teaching alone may not provide sufficient opportunities for repetitive practice and active clinical decision-making.

A comparative summary of the key educational indicators observed in the study is presented in Table 1.

**Table 1.**

**Changes in clinical competence indicators among medical students after simulation-based training**

| **Indicator** | **Main group before training** | **Main group after training** | **Control group before training** | **Control group after training** | p value |
|---|---|---|---|---|---|
| Clinical knowledge score | 62.4±5.1 | 84.6±4.3 | 61.8±5.3 | 71.2±4.9 | <0.001 |
| OSCE practical skills score | 63.1±5.4 | 86.2±4.1 | 62.9±5.2 | 72.4±4.8 | <0.001 |
| Correct clinical decision (%) | 58% | 88% | 57% | 69% | <0.001 |

As shown in Table 1, simulation-based training was associated with a pronounced improvement in multiple domains of clinical competence. The most substantial progress was observed in the ability of students to correctly identify clinical symptoms, interpret vital signs, and make appropriate clinical decisions during pediatric assessment. The proportion of students capable of correctly identifying urgent pediatric conditions increased from 58% to 88% in the main group, whereas in the control group the increase was considerably smaller, rising from 57% to 69%.

In addition to improvements in technical clinical competencies, simulation-based training also contributed to the development of important non-technical skills such as teamwork, communication, and adherence to patient safety principles. Observational assessments conducted during simulation sessions demonstrated that students progressively

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improved their ability to collaborate within clinical teams, communicate diagnostic reasoning, and maintain structured clinical assessment approaches.

Student feedback further supported the educational value of the simulation program. The majority of participants reported that simulated clinical scenarios closely resembled real pediatric clinical situations and significantly enhanced their confidence in performing clinical examinations. Approximately 93% of students indicated that simulation training improved their confidence in clinical skills, while 89% reported enhanced clinical decision-making abilities. Furthermore, over 95% of students recommended the integration of simulation-based training into regular undergraduate medical education programs.

Overall, the findings of the present study indicate that simulation-based pediatric training provides a highly effective educational approach for improving both theoretical knowledge and practical clinical competencies among medical students. The integration of realistic clinical scenarios, structured debriefing, and active student participation creates a powerful learning environment that facilitates deeper understanding of clinical processes and promotes the development of professional clinical skills.

**Discussion.** Simulation-based education has increasingly become an essential component of contemporary medical training, particularly in disciplines that require the rapid integration of theoretical knowledge with practical clinical decision-making. The results obtained in the present study demonstrate that the integration of simulation-based pediatric training into undergraduate medical education significantly improves both theoretical knowledge and practical clinical competencies among medical students. These findings are consistent with the growing body of international research highlighting the educational effectiveness of simulation technologies in medical training.

One of the most widely cited studies in this field is the work of Issenberg et al., who conducted a comprehensive review of simulation-based medical education and identified several key factors contributing to effective learning outcomes. According to their findings, simulation training improves clinical skill acquisition when learners are exposed to repetitive practice, realistic clinical scenarios, and structured feedback during debriefing sessions. The results of our study closely correspond with these observations. In particular, the significant increase in knowledge scores and OSCE performance among students participating in simulation-based training indicates that the combination of scenario-based practice and reflective discussion facilitates deeper understanding of pediatric clinical assessment.

Similarly, McGaghie et al. emphasized that high-fidelity simulation provides superior educational outcomes compared with traditional teaching methods. Their research demonstrated that students trained through simulation show improved diagnostic accuracy and procedural competence. Our results support this conclusion. Students in the main group who participated in simulation sessions demonstrated markedly greater improvement in both theoretical knowledge and clinical performance compared with students who received conventional bedside instruction. These findings suggest that simulation-based education provides a more effective learning environment for developing complex clinical competencies.

The improvement in practical clinical skills observed in our study is also consistent with the findings reported by Okuda et al., who highlighted the importance of simulation in developing procedural competence and clinical reasoning among medical trainees. According to their research, simulation allows learners to repeatedly practice clinical tasks in a controlled environment, which leads to improved diagnostic performance and clinical confidence. In the present study, students exposed to simulation-based pediatric scenarios demonstrated

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substantial improvement in performing pediatric examinations, recognizing critical symptoms, and interpreting clinical signs, confirming the effectiveness of experiential learning in clinical education.

Another important dimension of simulation-based education relates to the development of clinical decision-making abilities. Lateef noted that simulation scenarios provide opportunities for learners to analyze complex patient presentations and make timely clinical decisions without the risk of harming real patients. This process promotes the development of critical thinking and diagnostic reasoning. Our findings demonstrate a similar pattern. The proportion of students capable of correctly identifying urgent pediatric conditions increased considerably in the simulation group compared with the control group. This improvement suggests that simulation-based training enhances students' ability to analyze clinical information and select appropriate management strategies.

In addition to improving technical clinical skills, simulation-based education also contributes to the development of non-technical competencies such as communication, teamwork, and patient safety awareness. Liaw et al. reported that simulation training significantly improves collaborative skills and interprofessional communication among healthcare trainees. These competencies are particularly important in pediatric practice, where effective interaction with caregivers and coordinated teamwork among healthcare professionals are essential components of patient care. The results of our study support this perspective. Students participating in simulation sessions demonstrated improved teamwork, clearer communication of clinical reasoning, and greater adherence to patient safety principles during simulated scenarios.

The educational value of simulation-based training is further reflected in the high level of student satisfaction observed in the present study. The majority of participants reported that simulation scenarios closely resembled real pediatric clinical situations and significantly improved their confidence in performing clinical assessments. Similar findings have been reported in several international studies, where simulation-based learning has been associated with increased student motivation, engagement, and confidence in clinical practice.

It is also important to emphasize the particular relevance of simulation-based training for pediatric medical education. Pediatric patients often present with rapidly evolving clinical conditions, and early recognition of critical symptoms is essential for effective management. However, opportunities for medical students to independently perform clinical procedures in pediatric settings may be limited because of ethical considerations and the need to ensure patient safety. Simulation-based training helps overcome these limitations by allowing the safe reproduction of complex pediatric scenarios that students might otherwise rarely encounter during clinical rotations.

The findings of the present study therefore provide important evidence supporting the integration of simulation-based pediatric training into undergraduate medical curricula. Implementation of simulation technologies can contribute to the modernization of medical education systems and facilitate alignment with international standards of competency-based medical training.

Nevertheless, several limitations of the study should be considered. The research was conducted within a single educational institution, which may limit the generalizability of the results to other medical universities. Furthermore, the study primarily evaluated short-term educational outcomes, and the long-term retention of clinical competencies following simulation training was not assessed. Future research should focus on multicenter studies

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involving larger cohorts of students as well as longitudinal assessment of clinical competence during later stages of medical training.

Despite these limitations, the comparative analysis of our findings with those reported in international literature clearly demonstrates that simulation-based pediatric training represents a highly effective educational strategy for improving clinical competence, strengthening diagnostic reasoning, and promoting patient safety culture among medical students. The integration of simulation technologies into medical education may therefore play a crucial role in preparing future physicians for the challenges of modern clinical practice.

**Conclusion.** The results of the present study demonstrate that simulation-based pediatric training represents an effective educational strategy for improving the clinical competence of undergraduate medical students. The introduction of structured simulation scenarios into the pediatric clinical training program significantly enhanced students' theoretical knowledge, practical examination skills, and clinical decision-making abilities. Students who participated in simulation sessions demonstrated markedly higher improvements in objective knowledge assessments and practical clinical performance compared with those who received traditional bedside instruction.

The findings of this study confirm that simulation-based education allows students to integrate theoretical knowledge with practical clinical reasoning in a safe learning environment. Through repeated exposure to realistic pediatric clinical scenarios, students were able to develop essential competencies such as systematic clinical assessment, early recognition of critical symptoms, and formulation of appropriate management strategies. In addition, simulation training contributed to the development of important non-technical competencies including communication, teamwork, and adherence to patient safety principles.

The high level of student satisfaction observed in this study further emphasizes the educational value of simulation-based learning. Most participants reported increased confidence in performing pediatric examinations and making clinical decisions following participation in simulation scenarios. These findings support previous international research demonstrating that simulation training improves learner engagement, motivation, and preparedness for real clinical practice.

From a broader perspective, the integration of simulation technologies into undergraduate medical education represents an important step toward modernization of medical training systems. Simulation centers provide structured environments where students can repeatedly practice clinical procedures, receive constructive feedback, and develop professional competencies without risk to patients.

Given the positive educational outcomes demonstrated in the present study, the incorporation of simulation-based training into pediatric medical education programs may significantly improve the quality of clinical training and contribute to the preparation of competent healthcare professionals. Wider implementation of simulation technologies in medical universities may therefore play a key role in strengthening medical education and improving patient safety standards in clinical practice.

Future research should focus on evaluating the long-term impact of simulation-based education on clinical performance during later stages of medical training and professional practice. In addition, further studies involving larger multicenter cohorts would provide valuable insights into the effectiveness of simulation-based learning across different educational contexts.

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