

Impact of Simulation-Based Intervention on Nurses' Performance Regarding Insulin Self-Injection for Diabetic Children

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Abstract

Background: Type 1 diabetes demands extensive self-care including multiple daily insulin injections, several finger-pricks daily for blood glucose testing, and venipuncture when attending the outpatient clinic. Simulation-based education serves as a link between classroom learning and clinical practice. It aids nursing competency before working with neonates in a real-life environment, hence improving the quality of care and ensuring neonates' safety. **This study aimed to** evaluate the impact of simulation-based intervention on nurses' performance regarding insulin self-injection for diabetic children. **Method:** A quasi-experimental research design was used. **Setting:** The study was conducted at Pediatric Diabetes inpatient and outpatient Clinics at Sohag University Hospital. **Subjects:** A convenient sample of all nurses (50) who are working in the previously mentioned setting. **Tools for data collection:** (1) an insulin self-injection questionnaire sheet and (2) an observational checklist were used to collect data. **Results:** Between the knowledge and practice of the nurses under study, there was a very statistically significant difference. Before implementing the simulation-based intervention, the study found that three-quarters of the nurses had inadequate knowledge and three-fifths had inadequate practice with insulin self-injection for children with diabetes. Following the implementation of simulation-based intervention, the majority of the nurses in the study demonstrated a satisfactory level of practice and a good level of knowledge. After the simulation-based intervention, nurses' performance improved and changed in a highly statistically significant way compared to before. **Conclusion:** According to the current study's findings, nurses' performance in administering insulin to children with diabetes improved when they participated in a simulation-based intervention. **Recommendations:** The study recommended that nurses be trained in insulin self-injection for children with diabetes using a simulation-based intervention.

Keywords: Diabetic children, Insulin self-injection, Nurses' Performance, Simulation-based intervention.

Introduction

Type 1 diabetes (T1D) is a chronic autoimmune illness that is defined by hyperglycemia due to insulin insufficiency caused by pancreatic β -cell dysfunction. The cause of Type 1 diabetes mellitus is unknown although genetic, immunologic, and environmental factors are recognized to increase the risk of its occurrence (Saeedi et al., 2020). It demands extensive self-care including multiple daily insulin injections, several finger-pricks daily for blood glucose testing, and venipuncture when attending the outpatient clinic. If the child is treated with an insulin pump, a change of needle is required at least every third day, and a change of a sensor is required once a week or fortnight for continuous glucose monitoring. Additionally, the international guidelines recommend venipuncture once a year to test, for example, blood lipids, thyroid function, and kidney function (Giugliano et al., 2021).

The primary goal of diabetes management is to achieve the blood sugar level within the target range. To meet this target, an appropriate delivery of insulin is essential. Insulin is an effective drug for the control of blood sugar levels. Diabetes type 1 is a chronic condition that necessitates frequent insulin

replacement and a strong patient regimen. The goal of treatment is to reduce hyperglycemia while lowering the chance of hypoglycemia. Exercise, insulin dosages, food, physical stress, and a host of other variables all impact the intricate glucose balance (ADA, 2021).

Type 1 diabetic children and teenagers can expect to live long, happy lives if they receive the right support and care. This exercise goes over how type 1 diabetes mellitus is diagnosed and treated in kids and emphasizes the need of interprofessional team members to work together to deliver coordinated care and improve patient outcomes (ADA, 2021). When choosing an educational approach to teach insulin injection techniques to children, health professionals must consider engaging strategies for the pediatric population, such as the use of therapeutic play (Li et al., 2020).

Using pediatric patient simulators, simulation-based clinical education in nursing encompasses more than just handling mannequins; it also includes technologies, skilled personnel, realistic virtual environments, and role-playing. A crucial component of nursing education is clinical simulation, which the National Council of State Boards of

Nursing (NCSBN) defines as "an activity or event replicating clinical practice using scenarios, high-fidelity manikins, medium-fidelity manikins, standardized patients, role-playing, skills stations, and computer-based critical thinking simulations" (Alexander et al., 2019).

The benefits of simulation-based educational treatments include repetitive practice learning, the ability to modify the level of difficulty, the ability to personalize learning, and the ability to give quick feedback. According to the research, undergraduate degrees usually do not provide many opportunities to practice nursing practices on real patients (Cant & Cooper, 2019). According to Shin & Kim (2019), this fact could affect the competency of upcoming freshly trained healthcare workers, raising the possibility of mistakes and endangering patient safety.

Nurses have an important role in the management of diabetes. The nurse has the responsibility of teaching the self-injection of insulin to the patient and the family members or significant others and she has to begin this as soon as the need for the insulin has been established and use written or verbal instructions and demonstration techniques for teaching the patient (Conwell et al., 2020).

Significance of the study

Type 1 diabetes (T1D) According to the American Diabetes Association, (2021) increases by about 3% per year among children of preschool age. It is added this index the improper and late diagnostics, causing major consequences to the child. In Egypt 8 out of 100,000 children under the age of 14 have type 1 diabetes. Type 1 diabetes mellitus can occur at any age but it is the most common metabolic disease in children and youth (Yanachkova, & Staynova, 2020)

There is still room for improvement in the insulin injection knowledge of nurses and the deficiencies highlight the need for workplace-based learning and development programs combined with real-time guidelines and research, which can enhance the insulin knowledge and practice of district nurses (Wu et al., 2021). So, this study focused on evaluating the impact of simulation-based intervention on nurses' performance regarding insulin self-injection for diabetic children.

Aim of the study

To evaluate the impact of simulation-based intervention on nurses' performance regarding insulin self-injection for diabetic children

Research Hypotheses

Simulation-based intervention is expected to have a positive effect on improving nurses' knowledge and practice regarding insulin self-injection for diabetic children.

Subject and methods

Research design

A quasi-experimental design (one group pre/ post-test design) was used.

Settings

The study was conducted at Pediatric Diabetes inpatient and outpatient Clinics at Sohag University Hospital.

Subjects

A convenient sample of all nurses (50) who are working in the previously mentioned setting.

Tools for data collection

Three tools were used for collecting data in this study.

Tool (I): Insulin self-injection questionnaire: It was developed by the researchers after reviewing the national and international related literature (Vimmerstedt, 2006). This tool consisted of two parts as the following:

Part 1: This part included data about nurses' data such as nurses' age, gender, education, and years of experience.

Part (2): Structured multiple-choice questionnaire (pre-, immediate post, and after one month) to assess the nurses' knowledge about insulin self-injection for diabetic children. It was made by (Vimmerstedt, 2006) and covered the following subjects: Recognizing the fundamentals of insulin administration (5 questions), insulin self-administration sites and techniques (7 questions), insulin administration challenges (6 questions), and insulin administration safety measures (5 questions).

Scorings system

Every right response earned a score of one, while the wrong response earned a score of zero. Three categories were used to classify the nurses' knowledge: poor (less than 50%), fair (between 50 and 75%), and good (greater than 75%).

Tool II: Insulin self-injection observational checklist (pre/posttest). It was adopted from the American Association of Diabetes Educators, (2020) to assess the studied children's reported practice regarding their insulin injection. The procedure consists of 23 steps that are required to perform the self-insulin administration by children; this checklist is concerned with insulin preparation and injection.

Scoring system

A correctly completed checklist received a score of (2), an incomplete checklist received a score of (1), and an unfinished checklist received a score of (0). According to Alfar, El-sheik, Hassan, and Selim, there are two types of nursing practices: good and unsatisfactory. Unsatisfactory practice was defined as a nurse's score of less than 80%, and satisfactory practice was defined as a score of more than 80%.

Method

Validity and reliability:

Five pediatric nursing specialists reviewed the instruments for comprehensiveness, application, clarity, and relevance before evaluating the content validity. According to Cronbach's alpha coefficient test, tool I's reliability of internal consistency was 0.862, whereas tool II's was 0.945.

Ethical considerations

The research proposal was accepted by the Sohag University Faculty of Nursing's Ethical Research Committee. A letter from the dean of Sohag University's faculty of nursing was used to formally grant authorization. The NICU administrators were met by the researchers to explain the study's goal and obtain their cooperation in carrying it out.

Nurses were informed of the purpose and advantages of the current trial before giving their informed consent to participate. Researchers told the nurses they were studying that they could leave the study at any time. They also received assurances that the information they provided would be kept private.

Pilot study

The pilot study was conducted. Five nurses, or ten percent of the sample, participated in the test to evaluate the generated tools' usability, simplicity, clarity, and applicability. The required adjustments were made. The study's overall sample includes the pilot study.

Field of work

The Sohag University Hospital's director gave his approval. The study took place between the first of September 2023 and the last day of February 2024. The interview started with the researchers welcoming each nurse, introducing themselves, and outlining the purpose and design of the study.

Phases of the study: The study was conducted through the following four phases:

I-Assessment Phase

To gather information about the nurses' characteristics, instrument (I) part (1) was used to interview each nurse before the program.

Using tool (I) part (2) and tool II, nurses' knowledge and practice of insulin self-injection for children with diabetes were evaluated.

II. Planning phase:

Based on the results of the previous phase, the goals, priorities, and expected results were formulated to address the practical requirements, knowledge gaps, and satisfaction of the nurses about insulin self-injection for children with diabetes. The researchers organized five sessions for the nurses under study,

two of which were theoretical and three were practical.

The educational program

An educational program was created and updated. Sessions on insulin self-injection for children with diabetes were both theoretical and practical.

The general objective of simulation-based intervention sessions:

Following the sessions, the nurses were supposed to gain knowledge and practices that improve their performance of insulin self-injection for diabetic children.

Specific objectives of the program:

- Know the fundamentals of insulin administration.
- List the insulin self-administration sites and techniques.
- Know the insulin administration challenges.
- Discuss the insulin administration safety measures.
- Demonstrate the care of the insulin administration.
- Perform the appropriate documentation.

III. Implementation phase:

- Five sessions (two theoretical and three practical, lasting around 35 to 45 minutes each) were used to administer a simulation-based intervention with the goal of improving nurses' performance regarding insulin self-injection for children with diabetes.

- "The researchers began by gathering input regarding the previous session at the start of each one, and they provided a summary at the conclusion.

- "Three days a week, from nine in the morning until one in the afternoon, the researchers were on hand in the study locations. The study techniques stated above were used to conduct individual interviews with each nurse.

- "There were six to eight nurses in each of the categories into which the nurses under study were divided.

- After reviewing the relevant literature and assessing the actual needs of the nurses under study, the simplified booklet was distributed to nurses in Arabic as supportive material. It covered every topic about knowledge and practice regarding insulin self-injection for children with diabetes.

- "Various teaching techniques, including lectures, brainstorming sessions, small group discussions, photographs, demonstrations, re-demonstrations, and the use of simulation manikins available in a hospital teaching

class faculty clinical lab, were used in the simulated education program. Handouts, PowerPoint, figures, flipcharts, and animated films regarding insulin self-injection for children with diabetes were among the teaching resources used.

The theoretical and practical sessions were carried out as the following.

The first session (Theoretical): This session started with the researchers introducing themselves, welcoming the nurses, thanking them for participating in the study, and outlining the goals of these training sessions. The first session's topics included: identifying the basics of insulin administration (5 questions), insulin self-administration locations and methods (7 questions), insulin administration difficulties (6 questions), and insulin administration safety precautions (5).

Second session (Theoretical): The topics discussed in these sessions included the nurse's role in helping children with diabetes who self-inject insulin.

Third session (Practical): The study nurses were instructed in these sessions on how to prepare children with diabetes for insulin self-injection.

Fourth session (Practical): Clinical demonstration and re-demonstration of the insulin self-injection process for children with diabetes were part of these sessions, which took place in the faculty clinical lab. The simulated manikin was utilized to conduct these sessions. Following faculty lab sessions, trainees were moved to the designated Sohag University Hospital environment for a real-time re-demonstration under the researchers' supervision to reassure them of their ability to carry out the operations.

Fifth session (Practical): Before thanking each participant's nurse for participating in the trial, the researcher delivered the post-test and began by gathering input regarding the previous sessions and responding to any queries regarding insulin self-injection for children with diabetes.

IV-Evaluation phase:

The performance of nurses was reassessed using the previously mentioned tools both immediately following the simulation-based intervention (posttest) and one month later (follow-up) in order to determine the impact of the intervention.

Statistical analysis:

- Information was coded, tabulated, and converted into a template that could be input into a computer. Version 22 of SPSS was utilized to enter and analyze the data. Utilizing the Excel program, the graphics

were produced. To compare the same group on the pretest and posttest, a t-test was used to analyze the quantitative data, which were provided as mean and SD. We represented quantitative data with numbers and percentages. Using Pearson correlation, the link between quantitative variables that are regularly distributed was described. A P-value of 0.05 was used to calculate the significance in the following manner:

For statistical significance, a P-value of less than 0.05 was observed.

- P-values less or equal to 0.001 were regarded as highly significant in terms of statistics.

Results

According to **Table 1**, 78% of the nurses in the study were female, and 64% of them were older than 25 years old, with a mean age of 26.7 ± 5.6 years. Seventy-two percent of the nurses in the study had degrees from a technical institute of nursing. Fifty percent of them have five to less than ten years of experience.

Table (2) shows that nurses' knowledge before and immediately after the simulation-based intervention improved by a highly statistically significant ($P < 0.001$).

Before receiving the simulation-based intervention, 75% of nurses had inadequate knowledge of the procedures, as shown in **Table (3)**. However, following simulation-based instruction, their knowledge level increased to an excellent level (94.0%) and one month later (96.0%). A substantial difference ($P < 0.001$) was seen between the nurses' knowledge level before and immediately after the simulation-based intervention and one month later.

According to the mean score of nurses' practice related to insulin self-injection for diabetic children, a highly statistically significant change was observed before, immediately following, and one month following the simulation-based intervention (**Table 4**).

Before, right after, and one month following the simulation-based intervention, **Figure 1** displays the distribution of the nurses' practice level in relation to insulin self-injection for children with diabetes. It revealed that, following a month of the simulation-based intervention, 90% of the nurses had a satisfactory level of practice, whereas, before the intervention, 94% of the nurses had an unsatisfactory level, compared to 8% following education.

Table (6): demonstrated that, following the simulation-based intervention on insulin self-injection for children with diabetes, there was a good association between nurses' knowledge and practice at a p-value $p < 0.001$ pre-, immediately post, and one-month post- simulation-based intervention.

Table (1): Nurses distribution regarding their data (n. =50)

Personal data	No.	%
Age (Years)		
< 25 years	32	64
25 - ≥ 36 years	18	36
Mean ± SD	26.7 ± 5.6	
Gender:		
Male	11	22
Female	39	78
Qualifications:		
Technical Institute of Nursing	36	72
Baccalaureate degree in nursing	14	28
Years of experience:		
< 5 years	14	28
5 – <10 years	25	50
10 - ≥15 years	11	22

Table (2): Percentage distribution of the studied nurses' knowledge regarding insulin self-injection for diabetic children pre-, immediately post, and one-month post- simulation based intervention (n. =50)

Nurses' knowledge regarding insulin self-injection for diabetic children	Pre- simulation-based intervention		Immediately Post-simulation-based intervention		one month Post-simulation-based intervention		F	P-value
	No	%	No	%	No	%		
Recognizing the fundamentals of insulin administration							122.5	<0.001**
Correct	30	60.0	50	100	50	100		
Incorrect	20	40.0	0	0.0	0	0.0		
insulin self-administration sites and techniques							135.6	<0.001**
Correct	24	48.0	50	100	50	100		
Incorrect	26	52.0	0	0.0	0	0.0		
Insulin administration challenges							127.8	<0.001**
Correct	26	52.0	49	98.0	46	92.0		
Incorrect	24	48.0	1	2.0	4	8.0		
Insulin administration safety measures							127.4	<0.001**
Correct	22	44.0	46	96.0	47.0	94		
Incorrect	28	56.0	4	4.0	3.0	6.0		

(**) highly statistical significance at $p < 0.001$ 

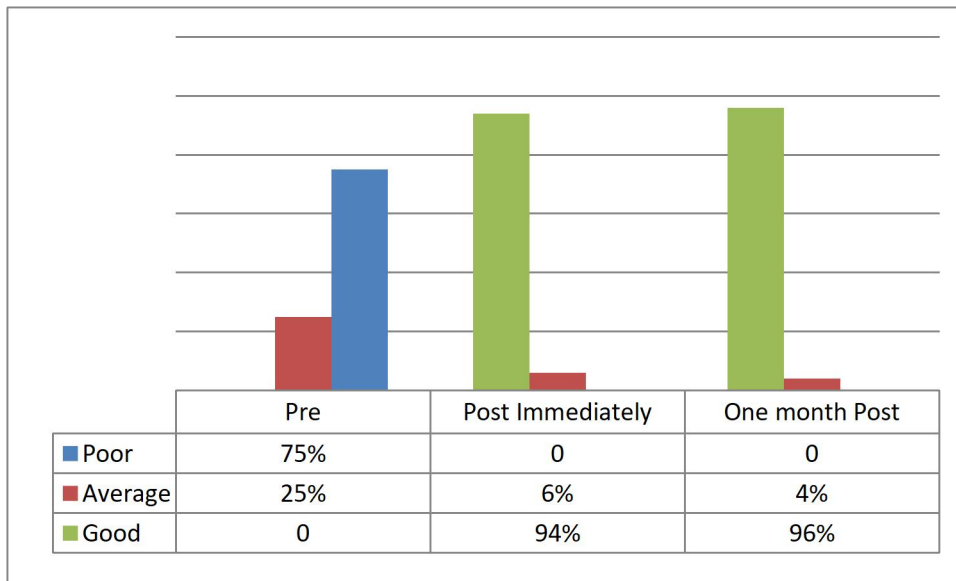


Figure (1): Total knowledge level among the studied nurses regarding insulin self-injection for diabetic children pre-, immediately post, and one month post simulation-based intervention (n=50)

Table (4): Mean score differences of the nurses' practice regarding insulin self-injection for diabetic children pre-, post, and one-month post simulation-based intervention (n=50)

Items	Pre- simulation-based intervention	Immediately Post-simulation-based intervention	One-month Post-simulation-based intervention	t-test	P
Mean score Nurses' practice	8.5 ± 2.6	18.4 ± 3.5	21.6 ± 2.3	137.3	<0.001**

(**) Highly significant at P<0.001

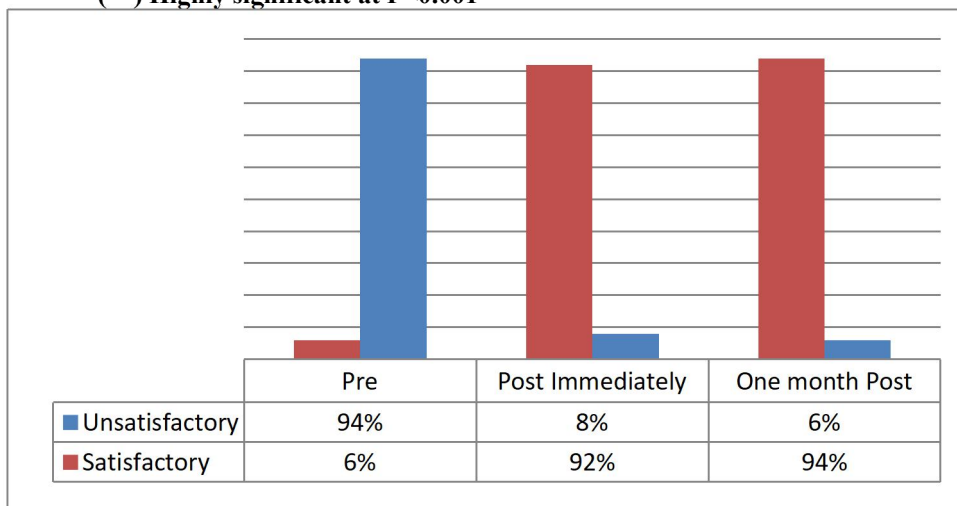


Figure (2): Total practice level among the studied nurses regarding insulin self-injection for diabetic children pre-, immediately post, and one month post simulation-based intervention (n=50)

Table (4): Correlation coefficient between total knowledge and practice of the nurses' practice regarding insulin self-injection for diabetic children pre-, post, and one-month post simulation-based intervention (n=50)

Total Practice scores	Total knowledge scores	
	Pre-Gamification Strategy	Post-Gamification Strategy
R	-0.100	0.933
P – value	0.486	0.001**

(**) Correlation is highly significant at the <0.001

Discussion

Improving self-belief in one's ability to engage in health-promoting activities in line with managing type 1 diabetes is a serious goal (**Whittemore et al., 2019**). Type 1 diabetes is a challenging condition to manage for both individuals and families, requiring a great deal of knowledge and expertise (**Allen et al., 2018**).

One method that nursing educators might employ to assist aspiring nurses in getting ready for practical practice is simulation. Performance is defined as doing a certain task in accordance with established criteria for accuracy, completeness, cost, and speed. There is growing evidence that poor outcomes are associated with inadequate nurse knowledge preparation and skill (**McGaghie et al., 2019**). Hence, this study aims to evaluate the impact of simulation-based intervention on nurses' performance regarding insulin self-injection for diabetic children.

Approximately two-thirds of the nurses in this study were under 25, and the majority of nurses were female. This conclusion may be explained by the fact that women make up the majority of nurses in Egypt. Naturally, the reason for this is that nursing has always been associated with women in Egypt. According to the results of the current study, the high proportion of female students may be explained by the fact that, until recently, nursing was only offered to girls in Egyptian institutions.

According to the study's findings, nurses' understanding of insulin self-injection for children with diabetes improved before, immediately after, and one month after the simulation-based intervention. The difference was highly statistically significant. From the perspective of the researchers, it demonstrated the beneficial impact of simulation-based interventions that aid in knowledge enhancement.

According to the current findings, before receiving the simulation-based intervention, three quarters of the nurses in the study lacked sufficient knowledge of the processes. However, following simulation-based instruction, the vast majority of nurses' knowledge levels improved to a good level, and a highly significant difference was found between nurses' knowledge levels before and immediately after the simulation-based intervention and one month later. This indicates, in the opinion of the researchers, how successful the simulation-based intervention was. The necessity to comprehend the goal of the simulation-based intervention to enhance knowledge was expressed in this. The study "Effects of high-fidelity simulation-based on life-threatening clinical condition scenarios" by **Cerra et al. (2018)** supports this conclusion on learning outcomes of

undergraduate and postgraduate Nursing students' knowledge and performance were found to be positively impacted by simulation training.

This outcome may have been caused by insufficient or inefficient theoretical instruction, but it was in line with the findings of other studies (**Adhikari et al., 2018; Robb et al., 2017; Wu et al., 2021**). Diabetes specialist nurses' theoretical training needs to be reinforced, and regular theoretical and operational evaluations should be conducted, however, there is currently no one organization or standard for this type of training. To overcome personality-related obstacles, training materials should be tailored to the local environment. This could raise clinical nurses' general level of knowledge (**Adhikari et al., 2018**). Compared to the reported value, **Wu et al. (2021)** observed that most nurses were at a good and satisfactory level.

The present study's results showed that nurses' practice related to insulin self-injection for diabetic children had a significant difference in mean scores before, immediately after post, and one month after the simulation-based intervention to this topic. From the perspective of the researchers, it validated the effectiveness of the simulation-based intervention concerning children with diabetes who self-inject insulin. Additionally, the recently hired nurses ought to complete pre-employment training and improve their professional education. According to **Robb et al. (2019)**, department managers should additionally publicize specialist knowledge of insulin standardized administration and conduct thorough research on injection techniques, methodologies, complications associated with insulin therapy, and other information indicated in the injection recommendations.

They can also take part in diabetes specialist nurse training programs for additional education, or they can go to academic conferences and lectures given by diabetes specialists to increase their level of insulin injection practice and expand their knowledge.

Additionally, clinical nurses' overall insulin injection technique was good (**Adhikari et al., 2018**). Similar findings were obtained in several studies (**Friel et al., 2022; Yuniastuti et al., 2020; Zhao et al., 2019**) (**Li et al., 2022**), which also revealed that nurses' insulin injection behavior was worse than that of other clinical nurses, regardless of their degree of education or knowledge. This research implies that highly trained nurses' practical abilities ought to be improved. To help postgraduate students better understand insulin injection technology and enhance their behavior, certain clinical competitions on the subject might be organized to motivate them to actively engage and hone their practical skills (**Theofanidis, 2019**).

When it came to the nurses' practice of insulin self-injection for children with diabetes before, right after, and one month after the simulation-based intervention, it was found that the majority of the nurses in the study had inadequate practice levels before the intervention, but that most of them had satisfactory practice levels after a month of the scenario.

According to the study, nurses' abilities to meet the unique needs of children with diabetes in insulin self-injection must be strengthened. This is demonstrated by the success of the simulation-based intervention before, just after, and one month after it was implemented. This demonstrated the beneficial impact of the simulation-based intervention on the practice of the nurses under study and was successful in raising their clinical practice level ratings.

The findings were consistent with earlier research by **Gomes et al. (2020)** and **Nuraini et al. (2019)**, who examined the effect of simulation-based education on nursing students' practical accomplishments and discovered that it enhanced their performance. Additionally, in contrast to alternative teaching methods, **Beal et al. (2019)** discovered that clinical simulation was an effective tactic for raising the performance of the students under study.

Following the simulation-based intervention, a greater proportion of nurses reported a satisfactory level, according to the study's findings. Similar findings were made by **Zapko et al. (2018)** who found that participants were confident in their practice, were happy with the simulated education experience, and believed the simulations were essential for learning and based on sound educational practices. Additionally, **Saied (2019)** who found that students were happy with the simulation experience and after the simulation session, their self-confidence scores increased. Additionally, **Mattson (2023)**, who investigated the impact of high-fidelity simulation on knowledge acquisition, self-confidence, and satisfaction with Baccalaureate Nursing Students using the Solomon-Four research design; stated that the students were very satisfied with the simulation learning activity.

This study discovered that nurses' knowledge and practice of insulin self-injection for children with diabetes improved after completing the simulation-based intervention. The p-value was $p < 0.001$ before, right after, and one month after the simulation-based intervention. The significance of the two aspects is shown by the suggestion that knowledge may affect insulin injection practice. Overall, the results point to the potential benefits of increasing insulin injection knowledge for boosting the efficacy and safety of insulin therapy. It is possible to establish contact nurse groups across departments to provide diabetes-

specialized nursing and guidance, as well as to oversee the nursing quality of other nurses. The groups, however, can actively engage in the exchange of information between other departments and diabetes specialist nursing (**Cabre et al., 2021**), to standardize insulin injection training so that the overall practices of nurses may be improved.

Conclusion

The present study's results indicate that nurses' performance in administering insulin self-injection to children with diabetes improved as a result of the simulation-based intervention.

Recommendations

It is suggested that in light of the results of the current study:

- Nurses should use simulation-based intervention as an efficient technique for teaching diabetic children how to inject themselves with insulin.
- It is advised that nurses receive ongoing instruction on how to administer insulin to children with diabetes.
- Replicate the current study on a larger sample selected from different geographical areas.

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