# Effect of Simulation-Based Education on Nurses' Performance regarding Insulin Self-Injection for Diabetic Patients

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# Abstract

Background: Diabetes Mellitus is an endocrine disorder, characterized by hyperglycemia that is, highblood sugar levels. Insulin is one of the oldest valuable anti-diabetic medications available and also the most effective agent in dropping hyperglycemia when used in appropriate doses. Simulation-based education serves as a link between classroom learning and clinical practice. This study aimed to investigate the effect of simulation-based education on nurses' performance regarding insulin self-injection for diabetic patients. Method: A quasi-experimental design was used to conduct this study (pre/post-test one group). Setting: The study was conducted in the Diabetic Inpatient and Outpatient Clinic at Specialized Medical Hospital, Mansoura University. Subjects: The study subjects were included a convenient sample of all available staff nurses (50) working in previous selected setting. Tools for data collection: Tool (I) Insulin self-injection questionnaire and Tool (II): Insulin self-injection observational checklist (pre/posttest). **Results**: Between the knowledge and practice of the nurses under study, there was a very statistically significant difference (P<0.001). Before implementing the simulation-based education, the study found that (66%) of the nurses had poor knowledge and 74% had unsatisfactory practice with insulin self-injection for patients with diabetes. Following the implementation of simulation-based education, (94%) of the nurses in the study demonstrated a satisfactory level of practice and a good level of knowledge (92%). After the simulation-based intervention, nurses' performance improved and changed in a highly statistically significant way compared to before (P<0.001). Conclusion: According to the current study's findings, simulation-based education has a positive effect on improving nurses' performance regarding insulin self-injection for diabetic patients post simulation-based education. Recommendations: According to the study, the gaps in knowledge about self-administration of insulin injections should be addressed with appropriate instruction and an insulin injection demonstration. Comprehensive insulin usage education programs that emphasize empowering insulin use among patients with diabetes mellitus and related information should be widely accessible as essential elements of diabetes mellitus management programs.

Keywords: Diabetic Patients, Insulin self-Injection, Nurses' Performance, Simulation-Based Education.

# Introduction

Diabetes is a long-term condition that is widespread, progressive, and debilitating. In the last two decades, there has been a significant rise in the global incidence of diabetes; the International Diabetes Federation estimates that 463 million individuals worldwide have the condition. This number is projected to grow to 578 million by 2030, and to 700 million by 2045. According to the International Diabetes Federation, the Middle East and North Africa region was expected to have 55 million individuals aged 20 to 79 with diabetes in 2019. This number is anticipated to surge to 108 million by 2024, marking a 96% increase (International Diabetes Federation, 2022).

Diabetes mellitus, a group of metabolic disorders, is characterized by high blood sugar levels resulting from inadequate insulin production or action, or both. This condition is prevalent in both developed and developing countries, presenting a significant public health issue. It is recognized globally as a leading cause of premature illness, death, and disability. Projections suggest that the number of affected individuals will rise from 171 million in 2000 to 366 million by 2030, with forecasts for all age groups worldwide indicating prevalence rates of 2.8% in 2000 and 4.4% in 2030. In the sub-Saharan Africa (SSA) region, diabetes affects 2.1-6.7% of the population, with around 14.2 million individuals aged 20-79 estimated to be suffering from the condition (Antar et al., 2023).

When given in the suggested dosages, insulin is the most effective medication for reducing hyperglycemia and stands as one of the oldest and antidiabetic treatments available. most crucial insulin administration, whether Subcutaneous continuously or in multiple doses, is the preferred treatment for individuals with type 1 diabetes mellitus. Patients are required to adhere to their doctor's instructions and engage in insulin therapy to manage their condition effectively. A frequently neglected aspect where errors can occur is in the delivery of insulin. For patients to play an active role in their own care, it is essential that they possess a thorough understanding of self-administration of insulin and maintain a positive outlook (Almheiri, et al., 2024).

Enhanced self-administration of insulin is associated with a patient's optimistic outlook and their comprehension of the procedure. Regarding attitudes towards insulin self-administration, research found that 68.0% of Ethiopians, 50.3% of Turks, 98%

of Ethiopians, and 60.1% of Egyptians held favorable views. A thorough understanding of diabetes emerged as a significant predictor of attitudes toward self-management. Numerous factors, including age, gender, marital status, level of education, occupation, place of residence, duration of illness, length of insulin usage, and family history of diabetes mellitus, can influence an individual's knowledge and attitude concerning insulin self-administration (Endale & Teni, 2020). Individuals with type 2 diabetes may receive insulin treatment exclusively or, based on their current hemoglobin A1C (HbA1c) levels; insulin may be combined with other anti-diabetic medications. Insulin assists individuals in achieving their glycemic targets and reducing their HbA1c levels. Nevertheless, various factors could hinder a patient's acceptance of and adherence to insulin therapy, including lack of information, busy schedules, travel, missed meals, stress or anxiety, or feelings of embarrassment (Xie et al., 2023).

Recent statistics indicate that individuals with type 1 or type 2 diabetes who are on insulin miss their doses an average of 3.3 days each month for similar reasons. Consequently, it is essential for patients with type 2 diabetes undergoing insulin therapy to receive education regarding the indications for this treatment, potential side effects, and techniques for self-administration. The prevalence of diabetes is rising globally, contributing to a greater medical burden, worsening long-term complications, and making it less likely for patients with type 2 diabetes to adhere to their prescribed medication (American Association of Diabetes, 2022).

Simulation-based clinical education in nursing goes beyond simply managing mannequins and includes technologies, skilled personnel, realistic virtual settings, and role-playing. Clinical simulation, defined by the National Council of State Boards of Nursing (NCSBN) as "an activity or event that replicates clinical practice using scenarios, highfidelity manikins, medium-fidelity manikins, standardized patients, role-playing, skills stations, and computer-based critical thinking simulations," is a vital aspect of nursing education (Koukourikos et al., 2021).

advantages The simulation-based of educational techniques include opportunities for repetitive practice, adjusting difficulty levels, customizing learning experiences, and providing immediate feedback. Research suggests that undergraduate programs often do not offer sufficient chances for aspiring nurses to practice clinical skills on real patients. This situation could potentially affect the competence of newly trained healthcare professionals, increasing the likelihood of errors and jeopardizing patient safety (Shin & Kim, 2019; Elendu, et al., 2024).

Nurses play a crucial role in diabetes management. They are responsible for educating patients and their family members or significant others on how to self-inject insulin, starting this instruction as soon as insulin therapy is deemed necessary, using both written and verbal materials along with demonstration techniques (Alshammari et al., 2021).

Providing optimal care for individuals with diabetes mellitus includes teaching them selfmanagement skills, such as the correct methods for injecting insulin and monitoring blood sugar levels at home. Additionally, it involves instructing them on how to properly mix insulin and administer it using a syringe. Various strategies exist for managing diabetes mellitus, which may include advancements in medication development, implementing dietary and lifestyle changes, preventing obesity, and regulating blood pressure (UnitedHealth Group, Diabetes in the United Arab Emirates, 2020).

# Significance of the study:

Diabetes is recognized as one of the leading causes of death and disability worldwide. The global health community now faces a significant threat from diabetes. It has become crucial to assess the knowledge, attitudes, and practices of patients with type 2 diabetes regarding insulin therapy in order to promote behavioral changes and adherence to diabetes management. In Egypt, numerous studies have investigated the prevalence of type 2 diabetes and the knowledge, attitudes, and behaviors of affected individuals. However, to our knowledge, no research has specifically assessed the practices, attitudes, or knowledge concerning insulin therapy. Several international studies have indicated that in India, 52.5% of individuals had a good understanding of insulin self-administration, while this figure was 50.3% in Turkey, 46% in Nepal, 98.7% in Ethiopia, and 33.3% in Egypt (Global Burden of Disease Collaborative Network, 2021).

According to the "Fear of Injecting and Self-Testing Questionnaire," a severe fear of selfadministering insulin, known as injection phobia, can potentially compromise both glycemic control and emotional well-being. Cramer and Pugh's research, "The Influence of Insulin Use on Glycemic Control," highlights various barriers to insulin use, which include anxiety regarding self-injection and situations of hypoglycemia, the hassle of injections, timing injections in relation to meals, and other related challenges (**American Diabetes Association, 2022**). So, the researchers did this to investigate the effect of Simulation-based education on Nurses' Performance regarding Insulin Self-injection for diabetic patients.

#### **Operational definition:**

#### Nurses' performance:

It means the act of successfully carrying out a task while utilizing knowledge, as opposed to merely processing it. In this study, "performance" refers to assessing the practice and knowledge of the participating nurses in the care of Insulin Selfinjection for diabetic patients.

#### Aim of the study:

The study aimed to investigate the effect of simulation-based education on nurses' performance regarding insulin self-injection for diabetic patients through:

- Assessing nurses' knowledge pre and postsimulation-based education.
- Assessing nurses' practices pre and post- simulationbased education.
- Designing and implementing simulation-based education based on nurses' needs.
- Evaluating the effect of simulation-based education on nurses' performance regarding insulin selfinjection for diabetic patients.

#### **Research hypothesis:**

- H1: Nurses' knowledge would be improved postreceiving Simulation-based education regarding Insulin Self-injection for diabetic patients post intervention than pre intervention.
- H2: Nurses' practices would be improved postreceiving Simulation-based education regarding Insulin Self-injection for diabetic patients post intervention than pre intervention.

#### Subjects and Method:

#### **Research design:**

A quasi-experimental design was used to conduct this study (pre/post-test one group)

#### Setting:

The study was conducted in the Diabetic Inpatient and Outpatient Clinic at Specialized Medical Hospital, Mansoura University.

#### Subjects:

The study subjects included a convenient sample of all available staff nurses (50) working in previous selected settings and who agreed to participate in the study

#### Data collection tools:

Two tools were usedfor 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 (**Giugliano et al., 2021; International Diabetes Federation, 2022).** 

This tool comprised two components as follows:

**Part 1:** This component included information regarding nurses, such as their age, gender, educational background, and years of experience.

Part 2: A structured multiple-choice questionnaire (administered pre-test, immediately post-test, and one month later) aimed at evaluating nurses' understanding of insulin self-injection for diabetic patients. It was developed by Giugliano et al., 2021; International Diabetes Federation, 2022, and encompassed the following topics: Recognizing the essentials of insulin administration (5 questions), sites and techniques for insulin self-administration (7 questions), challenges related to insulin administration (6 questions), and safety precautions for insulin administration (5 questions).

#### Scoring system:

Each correct answer earned one point, while incorrect answers received zero points. Nurses' knowledge was classified into three categories: poor (less than 50%), fair (between 50 and 75%), and good (greater than 75%).

**Tool II: Observational checklist for insulin selfinjection (pre/post-test)**. This checklist was adapted from the **American Diabetes Association, (2022)** to evaluate reported practices concerning insulin injection. It consists of 23 steps essential for performing self-insulin administration and focuses on insulin preparation and injection.

Scoring system: A fully completed checklist received a score of (2), an incomplete checklist earned a score of (1), and an unfinished checklist got a score of (0). According to **Alfar et al.**, (2020), there are two categories of nursing practices: good and unsatisfactory. Unsatisfactory practice was characterized by a nurse's score of below 80%, while satisfactory practice was identified as a score above 80%.

#### Method

### Validity and reliability:

Five medical surgical 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 Mansoura University Faculty of Nursing's Ethical Research Committee (Ref. No. 0685). A letter from the dean of Mansoura University's faculty of nursing was used to formally grant authorization. The 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.

**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 patients 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 and knowledge gaps of the nurses about insulin self-injection for patients with diabetes. The researchers organized five sessions for the nurses under study, two of which were theoretical and three were practical.

#### **III. Implementation phase:**

- Five sessions (two theoretical and three practical, lasting around 35 to 45 minutes each) were used to administer a simulation-based education with the goal of improving nurses' performance regarding insulin self-injection for patients 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.
- The study starts at the end of December 2024 till the end of February 2025. Three days a week at morning and afternoon shifts, 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 four to six 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 selfinjection for patients 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, were used in the simulated education program. Handouts, PowerPoint, figures, flipcharts, and animated films regarding insulin self-injection for patients with diabetes were among the teaching resources used.

#### **IV-Evaluation phase:**

The performance of nurses was reassessed using the previously mentioned tools both immediately following the simulation-based education (posttest) and one month later (follow-up) in order to investigate the effect of simulation-based education on nurses' performance regarding insulin selfinjection for diabetic patients.

### Statistical analysis:

Data were organized, coded, and converted into a specially designed format suitable for computer entry. SPSS version 22 was utilized to input and analyze the data. Graphs were generated using the Excel application. When comparing the same group on the pretest and posttest, quantitative data were expressed as mean and standard deviation, and analyzed using a t-test. Quantitative data was represented through numbers and percentages. The relationship among normally distributed quantitative variables was described using Pearson correlation. Statistical significance was determined with a P-value threshold of 0.05 as follows:

• A P-value below 0.05 was regarded as statistically significant.

• A P-value of 0.001 or lower was deemed highly statistically significant.

# **Results:**

Table (1) indicates that 70% of the nurses surveyed were under the age of 25, with an average age of 24.9  $\pm$  3.8 years, and 76% were female. In terms of their educational background, 66% of the nurses were from a Technical Institute of Nursing. Regarding their experience, 52% of the nurses had between 5 and less than 10 years of experience, while 20% had more than 5 years of experience.

Table (2) reveals a significant improvement in nurses' knowledge about insulin self-injection for diabetic patients, showing a highly statistically significant difference before, immediately after, and one month after implementing the simulation-based education (P < 0.001).

Figure (1) shows that 66% of the nurses had a poor understanding of insulin self-injection for diabetic patients prior to the simulation-based education. However, after the training, their knowledge level rose to a good level at 92%, and one month later, it improved further to 94%.

A notable statistically significant change in nurses' practical skills related to insulin self-injection for diabetic patients was observed before, immediately after, and one month after the simulation-based education, as shown in Table (3).

Figure (2) indicates that 26% of the nurses exhibited a satisfactory level of practice concerning insulin self-injection before the simulation-based education implementation. After the education, the satisfaction level of practice increased to 94%, and one month later, it reached 96%. Table (4) illustrated a positive correlation between nurses' knowledge and practice following the simulation-based education on insulin self-injection for diabetic patients, with a statistically significant pvalue of p < 0.001 across pre-, immediate post-, and one-month post-education implementation.

Table (1): Percentage distribution of the studied nurses regarding their demographic characteristics (n. =50)Demographic characteristicsNo.%

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Age (Years)				
< 25 years	35	70		
$25 - \ge 36$ years	15	30		
Mean ± SD	$24.9\pm3.8$			
Gender:				
Male	12	24		
Female	38	76		
Qualifications:				
Technical Institute of nursing	33	66		
Baccalaureate degree in nursing	17	34		
Years of experience:				
< 5 years	10	20		
5 – <10 years	26	52		
$10 - \ge 15$ years	14	28		

immediately post, and one month post- simulation based education implementation (n. =50)								
Nurses' knowledge regarding insulin self-injection for diabetic	Pre- simulation Immediately Post- simulation		one month post- simulation		F	P-value		
patients	No	%	No	%	No	%		
Diabetes mellitus <b>Definition</b>								
Correct	30	60.0	50	100.0	50	100.0	112.5	<0.001**
Incorrect	20	40.0	0	0.0	0	0.0		
Diabetes mellitus Causes								
Correct	24	48.0	49	98.0	46	92.0	132.6	<0.001**
Incorrect	26	52.0	1	2.0	4	8.0		
Diabetes mellitus Risk factors								
Correct	26	52.0	47	94.0	45	90.0	122.8	<0.001**
Incorrect	24	48.0	3	6.0	5	10.0		
Diabetes mellitus Symptoms								
Correct	22	44.0	46	96.0	47	94.0	107.4	<0.001**
Incorrect	28	56.0	4	4.0	3	6.0		
Diabetes mellitus Complications								
Correct	19	38.0	46	96.0	46	92.0	97.9	<0.001**
Incorrect	31	62.0	4	4.0	4	8.0		
The role in caring for patients with diabetes mellitus								
Correct	28	56.0	49	98.0	47	94.0	87.6	<0.001**
Incorrect	22	44.0	1	2.0	3	6.0		
Know about insulin (types, correct mixing method)								
Correct	30	60.0	50	100.0	50	100.0	112.5	<0.001**
Incorrect	20	40.0	0	0.0	0	0.0		
<b>Correct storage</b> temperature (Insulin vials are kept cool or in the refrigerator)								
Correct	24	48.0	49	98.0	46	92.0	132.6	<0.001**
Incorrect	26	52.0	1	2.0	4	8.0		
Appropriate insulin injections site, time (administered either before or after meals)							122.8	
Correct	26	52.0	47	94.0	45	90.0		
Incorrect	24	48.0	3	6.0	5	10.0		<0.001**
Insulin injection-associated complications include low blood sugar, insulin allergy, weight gain, and wasting of subcutaneous tissue								
Correct	22	44.0	46	96.0	47	94.0	105 1	0.00111
Incorrect	28	56.0	4	4.0	3	6.0	107.4	<0.001**
Proper insulin <b>disposal method</b> after injection								
Correct	19	38.0	46	96.0	46	92.0	97.9	<0.001**
Incorrect	31	62.0	4	4.0	4	8.0		

 Table (2): Nurses' knowledge distribution regarding insulin self-injection for diabetic patients pre, immediately post, and one month post- simulation based education implementation (n. =50)

#### (\*\*) highly statistical significance at p < 0.001



Figure (1): Nurses' total knowledge level distribution regarding insulin self-injection for diabetic patients pre, immediately post, and one month post- simulation based education implementation (n. =50) Table (3): Mean score differences of the nurses' practice mean scores regarding insulin self-injection for diabetic patients pre-, post, and one-month post simulation-based education (n=50)

unabelie patients pre-, post, and one-month post simulation-based education (n 50)					
Items	Pre- simulation-	Immediately Post- simulation	One-month Post- simulation	t-test	Р
Mean score Nurses' practice	$17.6 \pm 2.5$	$39.3\pm2.7$	$41.7\pm2.5$	156.3	<0.001**



(\*\*) Highly significant at P<0.001

Figure (2): Nurses' total practice level distribution regarding insulin self-injection for diabetic patients pre, immediately post, and one month post- simulation based education implementation (n. =50)

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

<b>Total Practice scores</b>	Total knowledge scores		
	Pre- simulation	Post- simulation	
R	-0.100	0.976	
P – value	0.453	0.001**	

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

#### **Discussion:**

Diabetes significantly adversely affects a patient's health and overall quality of life, potentially leading to chronic organ failure. Cardiovascular disease remains the primary cause of mortality and can shorten life expectancy by as much as 15 years. Additionally, it imposes a considerable financial burden on communities, healthcare systems, and individuals (Venkataraman, et al., 2020). Patients with type 1 diabetes (T1DM) are absolutely deficient in insulin and must rely on exogenous insulin supplementation. Insulin treatment is also required for patients with type 2 diabetes (T2DM) with progressive  $\beta$ -cell insufficiency or who are contraindicated for oral antidiabetic medications (Wu, et al., 2021). Therefore, this study aimed to explore the impact of simulation-based education on nurses' performance concerning insulin self-injection for patients with diabetes.

The study revealed that greater than three-quarters of the nurses surveyed were under than 25 years, with a mean age of  $24.9 \pm 3.8$  years, and less than threequarters were female. This finding may be attributed to the predominance of women in the nursing profession in Egypt, a trend historically linked to the perception of nursing as a female-dominated field. Moreover, the high percentage of female students can be explained by the fact that nursing programs in Egyptian institutions have typically been available only to girls until recently.

The results indicated a notable enhancement in nurses' knowledge regarding insulin self-injection for diabetic patients, with a statistically significant difference observed before, immediately after, and one month following the implementation of simulation-based education. From the researchers' viewpoint, this underscores the positive effect of simulation-based education in improving knowledge. This finding aligns with previous research that indicated nurses achieved a higher overall score, suggesting that training on insulin injection knowledge should particularly emphasize diabetes clinic nurses. Studies have demonstrated that nurses exhibit proficiency in diabetes management and care knowledge (Alotaibi et al., 2016). We believe that the low knowledge scores reflect insufficient training and a lack of awareness regarding current diabetes guidelines. Dai et al. found that only nearly half of nurses at tertiary care facilities were familiar with the most recent recommendations for insulin injection in diabetic patients, highlighting the necessity for workplacebased training and learning grounded in the latest guidelines to further improve knowledge and practice related to insulin injections (**Dai et al., 2019**).

The findings of the study revealed that approximately two-thirds of nurses exhibited a poor level of knowledge prior to the implementation of simulationbased education regarding insulin self-injection for diabetic patients. However, following the introduction of simulation-based education, their knowledge level significantly improved to a satisfactory standard, and one month after the education, most of them maintained this improvement. From the researchers' perspective, this confirms the beneficial impact of simulation-based education in equipping the studied nurses with adequate information, thereby enhancing their knowledge. Furthermore, this suggests, in the view of the researchers, the overall success of the simulationbased education initiative.

This outcome aligns with the findings of **Wu et al.** (2021), who reported that less than two-thirds of the surveyed nurses reached a satisfactory knowledge score, although the majority attained a good or satisfactory practice score. This underscores the necessity to understand the objective of simulation-based education in order to improve knowledge. The conclusions drawn by La Cerra et al. (2019) support this assertion, indicating that participants' knowledge and performance outcomes were positively influenced by simulation training.

These results may be attributed to inadequate theoretical training; however, they correspond with conclusions from other studies (**Robb et al., 2017**; **Adhikari et al., 2018; Wu et al., 2021**). There is a pressing need to reinforce theoretical training for diabetes specialist nurses, and ongoing evaluations of both theoretical and practical knowledge are essential, yet no singular organization or standard currently addresses this training need. To address personalityrelated barriers, educational materials should be customized to fit local contexts. This approach has the potential to enhance the overall knowledge level of clinical nurses (Adhikari et al., 2018). In contrast to the data reported, Wu et al. (2021) found that a majority of nurses were performing at a satisfactory level.

The mean score of nurses' practices concerning insulin self-injection for diabetic patients demonstrated a statistically significant improvement before, immediately after, and one month following the simulation-based education. From the researchers' standpoint, this validates the efficacy of simulationbased education for patients with diabetes who selfinject insulin. Furthermore, newly hired nurses should undergo pre-employment training to elevate their professional education.

Since proficiency in insulin injection knowledge and techniques is crucial for nurses to administer insulin correctly and to effectively educate patients, our findings emphasize the necessity of enhancing nurses' understanding and practice related to insulin injection as well as the importance of patient education. Moreover, patient education concerning proper and safe insulin injection practices could benefit from improved knowledge by nurses, as there exists a deficiency in their injection technique (**Gentile et al., 2016**).

According to **Robb et al. (2019)**, department managers should also disseminate knowledge regarding standardized insulin administration and undertake comprehensive research on injection techniques, methods, and potential complications associated with insulin therapy, along with other relevant information specified in the injection recommendations. They can participate in training programs for diabetes specialist nurses to gain further education or attend academic conferences and lectures conducted by diabetes specialists to enhance their practice and broaden their understanding of insulin injection.

The study's findings indicated that just over onequarter of nurses achieved a satisfactory level of practice prior to the implementation of simulationbased education concerning insulin self-injection for diabetic patients. However, following the implementation of this education, their practice level rose to satisfactory, and one month subsequent to the education, almost all of them maintained this satisfactory level.

The findings indicated that nurses exhibited a low compliance rate with insulin injection practices. This conclusion was corroborated by Adhikari et al. (2018), who reported that the overall insulin injection

technique among clinical nurses was satisfactory. Comparable results were noted in numerous studies (Zhao et al., 2019; Yunihastuti et al., 2020; Friel et al., 2022 & Li et al., 2022), which also indicated that insulin injection practices among nurses were inferior to those of other clinical nurses, irrespective of their educational background or knowledge. This research suggests that the practical skills of highly trained nurses need enhancement. To facilitate postgraduate students in grasping insulin injection techniques and improving their practices, organizing specific clinical competitions on the topic could encourage active participation and skill refinement (Wu et al., 2021).

The study emphasized the need to strengthen nurses' abilities to address the specific needs of diabetic patients in insulin self-injection. This was evidenced by the success of simulation-based education implemented before, immediately after, and one month later, highlighting its positive impact on the nursing practices studied and its effectiveness in elevating clinical practice ratings. The outcomes were in line with previous research conducted by Silva et al. (2020) and Koukourikos et al. (2021), which explored the influence of simulation-based education on the practical achievements of nursing students, revealing performance improvements. Furthermore, Beal et al. (2017) found that clinical simulation was a successful method for enhancing student performance compared to other teaching strategies.

Post the simulation-based education, a larger percentage of nurses reported achieving a satisfactory proficiency level, supporting similar findings by Zapko et al. (2018), who noted that participants felt confident in their practice, were pleased with their simulated learning experience, and believed these simulations were crucial for effective learning based on solid educational principles. Additionally, Togan et al., (2023) reported that students were satisfied with their simulation experiences and experienced an increase in self-confidence scores following the simulation sessions. Moreover, Hall (2013), who assessed the effects of high-fidelity simulation on knowledge gain, self-confidence, and satisfaction among Baccalaureate Nursing Students using the Solomon-Four research design, concluded that students were highly satisfied with the simulation learning activities.

This research found that nurses' knowledge and practice of insulin self-injection for diabetic patients improved after they participated in simulation-based education. The p-value recorded was p<0.001 before, immediately after, and one month after the education. The significance of both areas underscores the notion that knowledge can influence insulin injection practices. Collectively, the findings suggest potential advantages of enhancing knowledge about insulin injection to increase the effectiveness and safety of

insulin treatment. Establishing collaborative nurse groups across departments could be beneficial for providing specialized diabetes nursing and guidance, as well as monitoring the nursing quality of other staff. These groups could also facilitate knowledge exchange among various departments and diabetes specialist nursing (**Torres & Donlo, 2021**) to standardize insulin injection training and improve overall nursing practices.

The study's results indicated that after the simulationbased intervention on insulin self-injection for diabetes patients, there was a noticeable positive relationship between nurses' knowledge and their practices before, immediately after, and one month following simulation-based education. From a scientific perspective, this correlation can be attributed to the strong link between acquiring accurate information and its reflection in the proper execution of tasks. This suggests that knowledge affects practice, highlighting the significance of thoroughly understanding the correct technique for insulin injection. Enhancing the knowledge levels that influence nurses' practices could have a more significant impact.

### Conclusion:

According to the current study's findings, it was concluded that simulation-based education has a positive effect on improving nurses' performance regarding insulin self-injection for diabetic patients post simulation-based education.

# **Recommendations**:

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

- The study indicates that gaps in knowledge regarding the self-administration of insulin injections must be filled with suitable guidance and a demonstration of the injection technique.

- Education programs on insulin usage should be comprehensive and focus on empowering patients with diabetes mellitus to manage their condition effectively.
- Relevant information should be readily available as a fundamental aspect of diabetes mellitus management initiatives.
- Our research underscores the necessity for workplace-based training and education to improve knowledge and practices related to insulin injections.

- Nurses ought to utilize simulation-based education as an effective method for instructing diabetic patients on how to administer insulin injections.

- Conduct the current study again with a larger sample drawn from various geographical regions.

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