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Nurses' Knowledge, Practices, and Educational Roles in Pediatric Type 1 Diabetes Management: A Cross-Sectional Study in Atbara, Sudan

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Abstract
Background: Type 1 Diabetes Mellitus (T1DM) is a chronic endocrine disorder requiring continuous care, education, and psychosocial support, especially in children. Nurses play an essential role in pediatric diabetes management.

Objective: To assess nurses' knowledge, practices, and educational/supportive roles in managing children with T1DM at Atbara Teaching Hospital, Sudan.

Methods: A descriptive cross-sectional study was conducted among 92 pediatric nurses at Atbara Teaching Hospital between January and March 2025. Data were collected using a structured self-administered questionnaire and analyzed using SPSS version 20.

Results: Almost 54.3% of nurses demonstrated good knowledge regarding T1DM, while 63.0% showed adequate clinical practices. No statistically significant associations were found between knowledge and years of experience ($p = 0.068$) or between practice and educational qualification ($p = 0.057$). Gaps were identified in structured education, documentation, and psychosocial support.

Conclusion: Although most nurses demonstrated adequate knowledge and practice, important gaps remain in pediatric diabetes education and psychosocial support. Continuous training and standardized care protocols are recommended to improve pediatric T1DM care.

Keywords: Type 1 Diabetes Mellitus; Pediatric Nursing; Diabetes Care; Nursing Practice.

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1. Introduction

One of the prevalent chronic endocrine diseases among children in the world is Type 1 Diabetes Mellitus (T1DM) (Syed, 2022). It is defined as autoimmune pancreatic beta cells destruction that results in the total lack of insulin and the inability to survive without exogenous insulin (Libman et al., 2022). The disease tends to appear in those childhood or adolescence stage and requires life-long medical management, careful maintenance of glycemic level, and thorough education, so as to avoid acute and chronic complications (Phelan et al., 2022). T1DM in children is a growing health issue in the world, and it represents a major threat to health among children, especially in low- and middle-income nations, where the availability of healthcare services can be constrained (dos Santos, 2025).

Type 1 Diabetes Mellitus is a disease that predisposes children to acute complications, including diabetic ketoacidosis and hypoglycemia, and to chronic complications of the disease, including complications involving the eyes, kidneys, nerves, and the cardiovascular system(Foti Randazzese et al., 2025; Rivetti et al., 2023). The management of T1DM in children requires not only the administration of insulin but also regular blood glucose levels, nutritional, physical exercise control, psychosocial, and lifelong education of the child and their guardians (Małachowska et al., 2023).

In the case of Atbara Teaching Hospital, nurses lead the frontline when attending to children with T1DM, especially in hospitals. They will be involved in clinical management, educating patients and families, emotional support, coordination of care and complications monitoring(Khatri et al., 2023). Children and their families can also face pediatric nurses as the first point of contact, which is why they can play a crucial role in encouraging compliance with treatment plans and developing self-management skills in accordance with the developmental stage of a child (Sińska et al., 2023). Nurses continue to interact with children and their caregivers to educate them about the disease process, insulin therapy, methods of blood glucose monitoring and how hypo- and hyperglycemia can be recognized and managed(McCall et al., 2023).

In resource-constrained environments, including most areas in Sudan, the role of nurses is even more important because of the problem of unspecialized medical professionals and the lack of access to modern technologies in diabetes care (Clapin et al., 2022). Nurses play a key role in filling care gaps at Atbara Teaching Hospital through constant monitoring, individualized education, and culturally relevant counseling. They are also very instrumental in avoiding hospital readmissions as they make sure that the caregivers are well equipped to deal with the conditions of the child at home.

Diabetes management is based on education(Davis et al., 2022). They educate the insulin administration methods, such as dosage calculation, injection site, and insulin storage(Ibrahim Eldesouky Mohamed et al., 2024). Besides, nurses educate the families about meal planning, counting carbohydrates, and the role of physical activity(Abdelrahman et al., 2025). In the case of school-aged children and adolescents, nurses assist in the progressive development of self-care skills that will enable them to volunteer in the management of the condition, keeping them safe and under supervision (Sińska et al., 2023).

Another critical component of nursing interventions with children with T1DM is the psychosocial support(Małachowska et al., 2023). Children and their families may also be scared, anxious, and emotionally distressed when they are diagnosed with a chronic illness(Hilliard et al., 2016). Nurses offer reassurance, counseling, and emotional support and assist families to manage the disease that is lifelong(Afenigus & Sinshaw, 2025). They also determine psychosocial factors, which could influence treatment adherence, including family dynamics, socioeconomic status, and access to healthcare resources.

Despite the increasing burden of Type 1 Diabetes Mellitus (T1DM) among pediatric populations, there is limited evidence in Sudan assessing nurses' knowledge, clinical practices, and educational and supportive roles in the management of children with T1DM (Bhagat et al., 2020). In particular, few studies have explored nurses' levels of knowledge and practice in this context, as well as their associations with socio-demographic characteristics such as years of experience and educational qualification. This gap is more pronounced in sub-Saharan Africa, where nurses' knowledge of diabetes care has been reported to be suboptimal (Beran et al., 2005; Lumu et al., 2024). This gap hinders the development of evidence-based strategies to strengthen pediatric diabetes nursing care in resource-limited settings.

Therefore, this study aims to assess nurses' knowledge, practices, and educational and supportive roles in the management of children with Type 1 Diabetes Mellitus at Atbara Teaching Hospital, Sudan, and to examine their association with socio-demographic characteristics.

2. Methodology

2.1 Study Design and Setting

A descriptive cross-sectional study design was conducted to assess nurses' knowledge, practices, and educational/supportive roles in the management of children with Type 1 Diabetes Mellitus (T1DM) at Atbara Teaching Hospital, River Nile State, Sudan. The study was carried out between January and March 2025. The

hospital is a major referral center providing inpatient and outpatient pediatric services, including care for children with T1DM.

2.2 Study Population

The study population included all nurses working in pediatric wards and pediatric outpatient clinics at Atbara Teaching Hospital who were involved in the care of children with T1DM.

2.3 Sample Size and Sampling technique

A census (total population sampling) approach was adopted to include all eligible pediatric nurses working at Atbara Teaching Hospital (N = 120). Therefore, no sample size calculation formula was required. All eligible nurses were invited to participate during the data collection period.

Out of the total eligible nurses, 92 completed the questionnaire, resulting in a response rate of 76.7%. Non-participation (n = 28) was due to absence during the data collection period (leave or shift unavailability) and voluntary refusal.

1. Inclusion Criteria

- Nurses working in pediatric wards or outpatient pediatric clinics
- Nurses involved in the care of children with T1DM
- Nurses who agreed to participate in the study

2. Exclusion Criteria

- Nurses not working in pediatric units
- Nurses on leave during the data collection period

2.4 Data Collection Tool

The questionnaire was developed based on an extensive review of literature and internationally recognized guidelines, including the American Diabetes Association (Committee, 2025) and the International Society for Pediatric and Adolescent Diabetes standards (Libman et al., 2022).

The tool consisted of 43 items distributed across four domains:

1. Knowledge domain (15 items): included questions on insulin administration, recognition of hypoglycemia and diabetic ketoacidosis, and long-term complications of Type 1 Diabetes Mellitus (e.g., "signs of hypoglycemia" and "principles of insulin dose adjustment").

2. Practice domain (18 items): assessed routine nursing care such as blood glucose monitoring, insulin administration techniques, documentation practices, and patient education at discharge.

3. Education and psychosocial support domain (10 items): included items on family counseling, dietary education (carbohydrate counting), emotional support, and diabetes self-management education for caregivers.

The scoring system was based on predefined cut-off points adopted from previously published studies using similar instruments, where knowledge and practice scores were categorized into standard levels for analysis.

All items were adapted and aligned with evidence-based recommendations from ADA 2025 and ISPAD 2022, ensuring content validity and clinical relevance(Committee, 2025; Libman et al., 2022). These scoring approaches are consistent with methods commonly used in validated nursing assessment studies.

The scoring system was adapted from previously published studies using similar instruments in nursing research. Knowledge and practice levels were categorized based on Bloom's taxonomy cut-off points, where a score ≥75% was considered good, 50–74% fair, and <50% poor (Emire et al., 2022). This classification is widely used in health sciences research to ensure standardized interpretation of competency levels.

2.5 Data Collection Procedure

After obtaining official approval from the hospital administration, eligible nurses were approached and informed about the purpose and objectives of the study. Written informed consent was obtained from all participants prior to data collection.

The questionnaire was distributed in paper format during working hours and completed during designated break periods to minimize disruption of clinical duties. Data collection was conducted in a quiet and separate area within pediatric wards and outpatient clinics to ensure privacy and reduce discussion among participants.

To minimize response bias and ensure independence of responses, participants were instructed not to share or discuss questionnaire items during completion. The researcher was present throughout the data collection process to provide clarification when needed and ensure adherence to study procedures.

2.6 Validity and Reliability of the Instrument

Content validity was ensured through expert evaluation. Reliability was assessed using Cronbach's alpha coefficient, which indicated acceptable internal consistency ($\alpha = 0.88$).

2.7 Data Analysis

Data were analyzed using SPSS version 20. Descriptive statistics (frequencies, percentages, and standard deviations) were used to summarize the data. Inferential analysis was performed using the Chi-square test to examine associations between categorical variables such as knowledge level, practice level, years

of experience, and educational qualification. Statistical significance was set at $p < 0.05$.

Missing data were minimal and handled through listwise deletion. Assumptions for Chi-square test were checked to ensure validity of analysis.

2.8 Ethical Considerations

Ethical approval was obtained from the Institutional Review Board (IRB) of Atbara Teaching Hospital, River Nile State, Sudan (IRBATH-5-109-2024, dated 22 December 2024). The committee operates under the administration of the Ministry of Health, River Nile State, Sudan. Administrative permission was also obtained prior to data collection.

3. Results

3.1 Study Participants Flow

Figure 1 illustrates the flow of study participants. A total of 120 eligible pediatric nurses were approached for participation. Of these, 28 nurses did not participate due to absence during data collection (shift unavailability or leave) or voluntary refusal.

Consequently, 92 nurses completed the questionnaire and were included in the final analysis, yielding a response rate of 76.7%, as shown in figure 1.

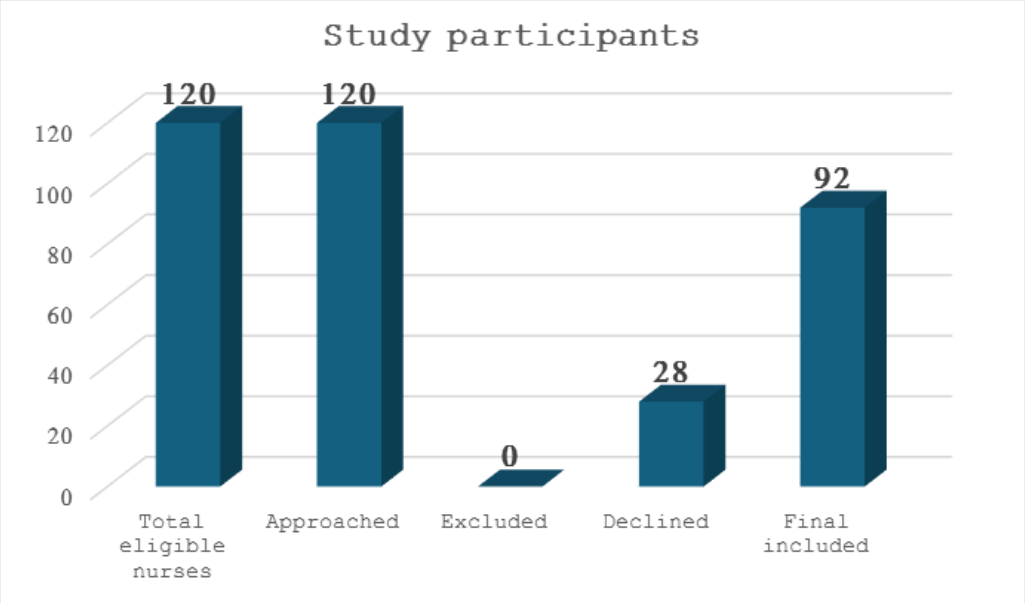


Figure 1. Flow diagram of study participants

3.2 Reliability of the Study Instrument

The internal consistency of the questionnaire was high, with an overall Cronbach's alpha coefficient of 0.88. All domains demonstrated acceptable reliability levels above 0.70, indicating that the instrument was consistent and suitable for assessing nurses' knowledge, practices, and educational/supportive roles in the management of children with Type 1 Diabetes Mellitus (T1DM), as shown in table 1.

Table 1. Reliability Analysis of the Questionnaire

Domain	Number of Items	Cronbach's Alpha
Knowledge items	15	0.82
Practice items	18	0.86
Education & support items	10	0.79
Overall reliability	**43**	**0.88**

3.3 Socio-Demographic Characteristics of Nurses

A total of 92 nurses participated in the study. The majority were female (69.6%). Nearly half of the participants held a bachelor's degree (48.9%), while 7.6% had postgraduate qualifications. Regarding clinical experience, 41.3% had five years or less of experience, indicating a relatively young nursing workforce in pediatric services. This reflects a moderately experienced pediatric nursing workforce, as shown in table 2.

Table 2. Distribution of Nurses According to Socio-Demographic Characteristics (n = 92)

Variable	Frequency	Percentage (%)
Gender		
Male	28	30.4
Female	64	69.6
Educational Level		
Diploma	40	43.5

Variable	Frequency	Percentage (%)
Educational Level		
Bachelor	45	48.9
Postgraduate	7	7.6
Years of Experience		
≤ 5 years	38	41.3
6–10 years	34	37.0
> 10 years	20	21.7

3.4 Nurses' Knowledge Regarding Type 1 Diabetes Mellitus

More than half of the nurses demonstrated good knowledge (54.3%), while 30.4% had fair knowledge and 15.3% had poor knowledge.

Despite this overall moderate level of knowledge, item-level analysis indicated deficiencies in key clinical areas, particularly insulin dose adjustment, recognition of acute complications such as hypoglycemia and diabetic ketoacidosis, and prevention of long-term complications, according to the study cut-off classification.

As shown in figure 2.

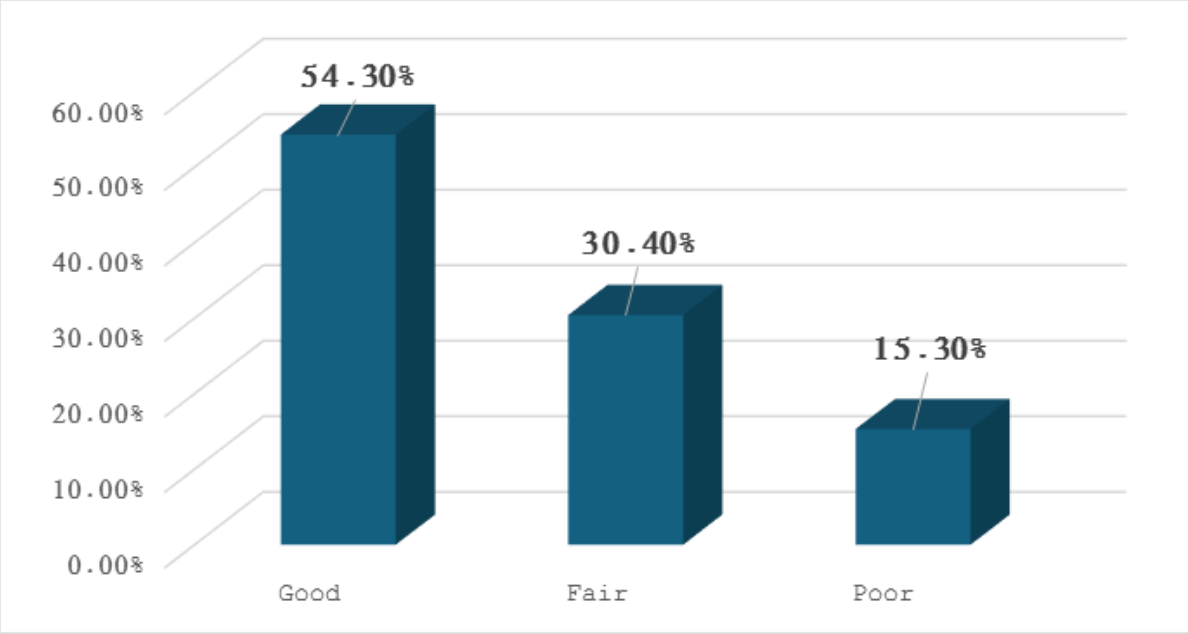


Figure 2. Distribution of nurses according to knowledge level

3.5 Association Between Knowledge Level and Years of Experience

No significant relationship was observed between nurses' knowledge level and years of clinical experience ($\chi^2 = 8.72$, $p = 0.068$, Cramer's $V = 0.22$). However, nurses with more than 10 years of experience demonstrated relatively higher proportions of good knowledge compared to less experienced nurses, indicating a small-to-moderate effect size. although the association was not statistically significant, the effect size suggests a potential practical trend, as shown in table 3.

Table 3. Relationship Between Nurses' Knowledge Level and Years of Experience

Years of Experience	Good	Fair	Poor	Total
≤ 5 years	15	16	7	38
6–10 years	21	10	3	34
> 10 years	14	2	4	20
Total	50	28	14	92

3.6 Nurses' Practice in Managing Children with Type 1 Diabetes Mellitus

Overall, 63.0% of nurses demonstrated adequate practice, while 37.0% had inadequate practice levels.

A domain-based analysis of practice items indicated strengths in routine clinical care, particularly in basic insulin administration and blood glucose monitoring. However, deficiencies were identified in patient education consistency, documentation practices, and psychosocial support, especially among newly diagnosed children and their families, as shown in figure 3.

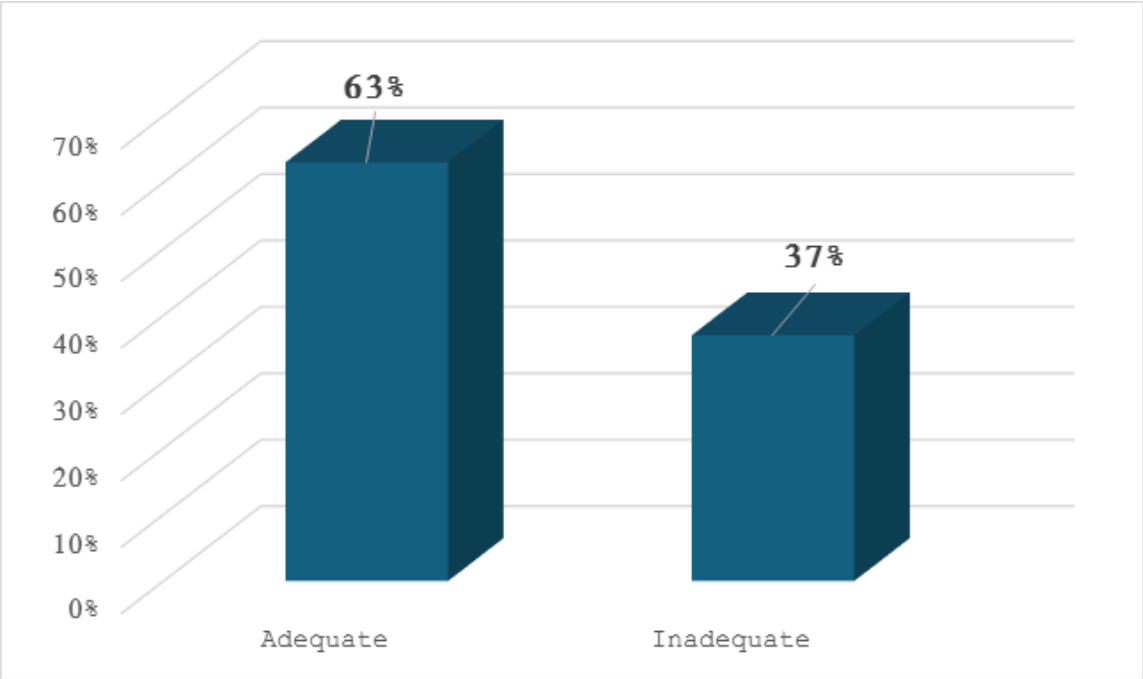


Figure 3. Distribution of nurses according to practice level

3.7 Association Between Practice Level and Educational Qualification

No significant relationship was observed between educational qualification and practice level ($\chi^2 = 5.72$, $p = 0.057$, Cramer's $V = 0.25$). Nevertheless, nurses with higher educational attainment (Bachelor's and postgraduate degrees) showed comparatively better practice scores, suggesting that higher education level may contribute to improved clinical performance despite the lack of statistical significance. Fisher's Exact Test was also applied due to small expected cell counts to confirm the robustness of the findings. The results are presented in Table 4.

Table 4. Relationship Between Practice Level and Educational Qualification

Educational Level	Adequate	Inadequate	Total
Diploma	20	20	40
Bachelor	32	13	45
Postgraduate	6	1	7
Total	58	34	92

4. Discussion

The present study assessed nurses' knowledge, clinical practices, and educational and supportive roles in the management of children with Type 1 Diabetes Mellitus (T1DM) at Atbara Teaching Hospital, Sudan.

The socio-demographic characteristics of the participants revealed a predominantly female nursing workforce, with many nurses holding bachelor's degrees and a considerable proportion having relatively limited clinical experience. This pattern is consistent with international trends in pediatric nursing, where female nurses constitute the majority of the workforce and early-career practitioners are commonly represented (Albagawi et al., 2023; Organization, 2025). While this workforce composition may facilitate family-centered care and communication with children and their caregivers, limited clinical experience may influence confidence and competency in managing complex chronic conditions such as T1DM, which require advanced clinical judgment and specialized patient education skills.

The findings demonstrated that nurses possessed a moderate level of knowledge regarding the management of children with T1DM. Nevertheless, important gaps were identified in critical areas, including insulin dose adjustment, recognition and management of acute diabetic complications, and prevention of long-term complications. These findings are consistent with previous studies conducted in low- and middle-income countries, where insufficient continuing education and limited access to specialized diabetes training programs have been identified as barriers to optimal nursing knowledge and competency (Albagawi et al., 2023; Lumu et al., 2024).

Although no statistically significant association was observed between knowledge level and years of experience, nurses with longer clinical experience tended to demonstrate better knowledge. This finding suggests that clinical exposure may contribute to professional growth and knowledge acquisition over time. However, experience alone may not be sufficient to ensure comprehensive competency in pediatric diabetes care. This observation supports Benner's theory of skill acquisition, which emphasizes that expertise develops through the integration of practical experience and formal learning opportunities(Gregory et al., 2022).

With regard to clinical practice, nurses generally demonstrated satisfactory performance in routine aspects of diabetes management, including insulin administration and blood glucose monitoring. However, weaknesses were identified in documentation practices, patient education, and psychosocial support. These findings suggest variability in the implementation of evidence-based nursing care and may reflect challenges related to workload pressures, limited training opportunities, and the absence of standardized protocols for pediatric diabetes management (Hayek et al., 2025; Sińska et al., 2023).

Similarly, although educational qualification was not significantly associated with practice performance, nurses with higher academic preparation appeared to demonstrate better clinical practice. This finding indicates that academic education may contribute to enhanced clinical reasoning and evidence-based decision-making. Nevertheless, educational attainment alone does not guarantee competency across all domains of diabetes care, highlighting the importance of continuous professional development and structured in-service training programs (Albagawi et al., 2023).

A particularly important finding of this study was the limited provision of psychosocial support and structured diabetes education for children and their families, especially among newly diagnosed cases. This issue is clinically significant because psychosocial support and diabetes self-management education are fundamental components of comprehensive pediatric diabetes care. International guidelines emphasize the integration of medical treatment with structured educational and psychological support interventions to improve treatment adherence and glycemic outcomes (Libman et al., 2022). However, these components remain insufficiently developed in many resource-limited settings due to staffing shortages, heavy workloads, and inadequate educational resources.

4.1 Study Limitations

This study has several limitations that should be considered when interpreting the findings. The use of a self-administered questionnaire may have introduced self-reporting and social desirability biases, potentially leading participants to overestimate their knowledge and practices. In addition, the study was conducted in a single healthcare institution, which limits the generalizability of the findings to other healthcare settings. Non-response bias may also have occurred because some eligible nurses were unavailable or declined participation. Furthermore, the cross-sectional design does not permit causal inferences regarding the relationships between nurses' characteristics and their knowledge or practice levels.

5. Conclusion

This study demonstrated that nurses possessed moderate knowledge and generally adequate clinical practice regarding the management of children with Type 1 Diabetes Mellitus. Despite these encouraging findings, deficiencies remained in several important areas, particularly diabetes-specific knowledge, documentation practices, patient education, and psychosocial support. The findings further suggest that competency in pediatric diabetes care is influenced by multiple factors beyond educational attainment and years of clinical experience alone. Strengthening continuous professional development initiatives, promoting evidence-based practice, and implementing standardized diabetes care protocols may contribute to improving the quality of nursing care and enhancing health outcomes among children with T1DM.

5.1 Implications for Nursing Practice, Education, and Research

The findings highlight the importance of strengthening nurses' competencies in pediatric diabetes management through continuous professional development and the implementation of standardized clinical protocols. Nursing education programs should incorporate comprehensive content related to pediatric diabetes care, with particular emphasis on insulin management, patient education, psychosocial support, and accurate clinical documentation. Healthcare institutions should support ongoing competency development through structured training initiatives and evidence-

based practice updates. Future research should employ longitudinal and interventional designs to evaluate the effectiveness of educational programs and their impact on patient outcomes, including glycemic control, treatment adherence, and diabetes-related complications.

6. Recommendations

Based on the findings of this study, healthcare institutions should prioritize the implementation of continuous and targeted educational programs to strengthen nurses' knowledge and competencies in pediatric diabetes management, particularly in areas related to insulin therapy, hypoglycemia, and diabetic ketoacidosis. Efforts should also focus on enhancing nurses' abilities to provide effective patient education and psychosocial support for children with Type 1 Diabetes Mellitus and their families. The development and consistent implementation of standardized nursing protocols for diabetes management, including monitoring, insulin administration, discharge planning, and follow-up care, are recommended to improve the consistency and quality of care. In addition, healthcare facilities should promote accurate documentation practices through the use of standardized documentation tools and regular clinical audits. Nursing education programs may further benefit from integrating simulation-based and competency-based learning approaches to strengthen practical skills and clinical decision-making abilities. Adequate staffing levels should also be ensured to facilitate comprehensive patient education and psychosocial care. Furthermore, future multicenter and interventional studies are recommended to evaluate the effectiveness of training interventions and their impact on clinical outcomes, including glycemic control and diabetes-related complications among children with T1DM.

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