Nano-Learning Strategy and its Effect on Knowledge and Practices of Parents having Children with Diabetes Mellitus

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Abstract

Background: Diabetes mellitus is one of the most prevalent chronic childhood diseases, requiring ongoing management to maintain optimal glycemic control and prevent complications. As primary caregivers, parents play a critical role in their children's diabetes management; however, insufficient diabetes-related knowledge and practices may compromise disease control and health outcomes. Nano-learning has emerged as an innovative educational strategy with the potential to improve parental knowledge and practices related to diabetes care. **Aim of the study** was to evaluate the effect of nano-learning strategy on knowledge and practices of parents regarding diabetes mellitus. **Study design:** A quasi-experimental design (pre-posttest) was utilized. **Setting:** Pediatric Diabetic Clinic in the Comprehensive Health Insurance Hospital (Hassan Awad Clinic), in Benha City, Qalyubia Governorate, Egypt. **Study subjects:** A purposive sample of (50) parents of children recently diagnosed with T1DM were gathered. **Tools of data collection:** Two tools were used; **Tool I:** A structured interviewing questionnaire, **Tool II:** Parents-reported practices regarding DM. **Results:** Pre-nano-learning strategy intervention, minority of parents reported satisfactory knowledge and practices. Furthermore, post and after one-month of intervention, vast majority of parents demonstrated a satisfactory level of knowledge and practices. **Conclusion:** The nano-learning strategy significantly improved parents' knowledge and practices regarding diabetes mellitus. It represents an effective and accessible educational approach for supporting parents in managing their children's diabetes. **Recommendations:** Integrating nano-learning sessions into caregiver education programs to enhance parents' knowledge and practices in managing childhood diabetes.

Keywords: Nano-learning strategy, Diabetes mellitus, Knowledge, Practices, Parents

Introduction:

Continuous advancement of professional competence requires systematic skill refinement, ongoing knowledge updating, and the adoption of innovative strategies. Increasing time constraints pose a major challenge to optimizing intellectual productivity and engagement. Effective structuring of learning content by specialized creators plays a pivotal role in supporting educators in designing and delivering organized and impactful instructional experiences. Rapid technological evolution has positioned blended nano-learning as an efficient and adaptive educational approach that meets the demands of modern learners while enhancing the quality and effectiveness of global digital education practices ***(Babu, 2023).***

The emergence of nano-learning can be traced to the evolution of educational paradigms, particularly with the introduction of connectivism and the development of e-learning, leading to the establishment of a distinct educational approach centered on delivering knowledge through concise, segmented learning units, later conceptualized as nano-learning ***(Al Shehhi, 2022).*** Nano-learning, also called bite-sized learning, where the learner attains knowledge by taking learning capsules or modules delivered through a variety of learning methods, such as short e-learning tutorials like text, images, audio, and video ***(Madan, 2021).***

Nano learning is a contemporary educational approach that delivers highly focused instructional content designed to address specific learning objectives according to the learners' needs, typically lasting between two to ten minutes. So, it is characterized by its brevity, precision, and alignment with digital habits of modern learners ***(Sukmojati et al., 2025).*** The key principle of nano-learning rests on the idea that short-term and frequent training intervals can contribute to more effective retention of information in memory ***(Radzitskaya & Islamov, 2024).***

Nano-learning is characterized by a high degree of learner autonomy, enabling learners to determine what to study, when to engage, and the extent of content consumption. Immediate feedback mechanisms constitute a key feature, facilitating prompt error correction and effectively bridging knowledge gaps. Nano-learning is often grounded in the Pareto principle, whereby a focused 20% of content delivers approximately 80% of the intended learning outcomes. Flexibility and adaptability make nano-learning suitable for diverse learner groups across different age ranges and educational backgrounds. ***(Sanam, 2023).***

Type 1 Diabetes Mellitus (T1DM) is a chronic autoimmune disorder characterized by the destruction of insulin-producing pancreatic β-cells, resulting in lifelong exogenous insulin therapy for survival and metabolic control. T1DM accounts for approximately 10% of all diabetes cases worldwide ***(American Diabetes Association Professional Practice Committee, 2025).*** According to the 11th edition of the ***International Diabetes Federation (IDF) Diabetes Atlas, 2025***, approximately 589 million individuals were living with diabetes worldwide in 2024, with projections rising to 853 million by 2050. Among these cases, more than 9.5 million individuals are affected by T1DM, including approximately 1.9 million children and adolescents under the age of 20 years.

Type 1 diabetes mellitus (T1DM) evolves through well-defined stages. Stage 1 is characterized by the presence of two or more islet autoantibodies in the setting of normoglycemia and absence of clinical symptoms. Stage 2 involves the development of dysglycemia while remaining asymptomatic, whereas Stage 3 is marked by the onset of overt clinical manifestations. As hyperglycemia worsens (typically exceeding 160–180 mg/dL), glycosuria ensues, leading to osmotic diuresis and consequent symptoms such as polyuria, polydipsia, dehydration, and fatigue. Additional manifestations may include unintentional weight loss, nausea, visual disturbances, and increased susceptibility to infections ***(Tatovic et al., 2023).***

Complications of T1DM are broadly categorized into acute and chronic forms, each driven by distinct pathophysiological mechanisms. Acute complications arise from sudden insulin deficiency or rapid fluctuations in blood glucose levels, often manifesting as life-threatening conditions such as diabetic ketoacidosis and severe hypoglycemia, both of which require immediate recognition and intervention. In contrast, chronic complications develop insidiously as a consequence of sustained hyperglycemia, leading to progressive vascular and neural damage. These long-term effects include microvascular complications, namely neuropathy, retinopathy, and nephropathy, as well as macrovascular complications ***(Longendyke et al., 2024).***

Optimal management of T1DM requires a comprehensive and integrated approach that includes continuous insulin therapy, regular blood glucose monitoring, appropriate dietary regulation, and adequate physical activity. ***(Olinder et al., 2022& ElSayed et al., 2024).*** So, the treatment of T1DM is complex and often exhausting ***(Quattrin et al., 2023).***

Parental involvement is a fundamental component of optimal diabetes management in children, as highlighted by the American Diabetes Association's 2023 Standards of Care ***(ElSayed et al., 2023).*** Accordingly, parents or caregivers bear primary responsibility for daily disease monitoring and the implementation of treatment regimens. Consequently, their knowledge and practices are critical determinants of effective disease management and long-term health outcomes in children with T1DM ***(Costa et al., 2025).***

Nurses play a vital role in managing children with T1DM through clinical care, education, and family support. Nurses contribute to early detection, enabling prompt diagnosis and timely initiation of treatment. Effective management extends beyond glycemic control to include coping strategies, motivation, and psychosocial support. Integration of these approaches improves understanding of the condition and promotes positive treatment behaviors. Continuous support and guidance using innovative 4ducational strategies helps address daily challenges and ensures better disease management. ***(Dai BD et al., 2022).***

Significance of the study:

Lifelong learning requires continuous professional and personal development by staying up to date on new research and developments in this field, and because several new jobs necessitate the willingness to expand an individual's knowledge and abilities through continuous learning, in which the majority of learners face some problems that can be easily solved through nano-learning that can increase learners' productivity beside maintaining their interest throughout the lesson and also can save learners time as sessions usually last between one and fifteen minutes ***(Drakidou &Longworth, 2018; Gramming et al., 2019; Pham et al., 2023).***

Globally, type 1 diabetes mellitus (T1DM) affects about 500,000 kids with an annual increase of about 3% ***(British Medical Association, 2020)***. Egypt has the largest contribution among Eastern Mediterranean& Middle East countries, accounting for a quarter of the region's total, and incidence is about 8/100000 per year in children <15years ***(International Diabetic Federation, 2020)***. ***According to the Comprehensive Health Insurance Hospital Statistics Office, Hassan Awed Clinic, (2025)*** it was about 18,000 T1DM children admitted to pediatric diabetic clinic.

As parents are considered the primary caregivers, putting them at the first line of controlling and managing DM along with healthcare providers through daily care, and supervision of their diabetic

children. ***(Cho et al., 2023)***. So, a lack of DM awareness and education can contribute to poor care and control of the disease ***(Bl Dhada, 2019)***. Furthermore, parents don't find enough time for education because parents obliged by other responsibilities like occupations or domestic chore duties, which make them quit the learning. Nano-learning helps them overcome this issue that assists in incorporating appealing new information into parents' busy lives ***(Lee et al., 2020)***. So, this study is conducted to increase the knowledge of parents and promote their practices regarding managing their children having diabetes mellitus.

Aim of the Study:

This study aims to evaluate the effect of nano-learning strategy on knowledge and practices of parents regarding diabetes mellitus.

Research Hypotheses:

- Parents who attend nano-learning strategy will have a satisfactory knowledge level regarding diabetes mellitus.
- Parents who attend nano-learning strategy will perform a satisfactory practices level regarding diabetes mellitus.

Subjects & Method:

Research Design:

A quasi-experimental design (pretest-posttest) with a one-month follow-up was used. Data gathering took place throughout five months and two weeks, from the beginning of June to the first 2 weeks of November, 2025.

Study Setting:

This study was carried out at at the Pediatric Diabetic Clinic in the Comprehensive Health Insurance Hospital (Hassan Awad Clinic), affiliated with the General Insurance Authority, in Benha City, Qalyubia Governorate, Egypt. It provides specialized medical services to children with diabetes under 18 years of age and their parents, allowing for consistent implementation of the intervention and assessment of outcomes.

Study Subjects:

Sample size calculation:

The sample size was calculated based on the study conducted by ***Zayed et al. (2024)***, which investigated nano-teaching strategies and their effect on feeding difficulties among children with cerebral palsy. For a single-group pre-post design, the calculation was performed using the formula developed by ***Hulley et al. (2013)*** for detecting a mean difference within the same group:

$$n = \frac{(Z_{\alpha/2} + Z_{\beta})^2 \cdot SD^2}{\Delta^2}$$

Where:

- $Z_{\alpha/2} = 1.96$(5% significance level, two-tailed)
- $Z_{\beta} = 0.84$(80% power)
- $\sigma_d = 1.52$(standard deviation of differences)
- $\Delta = 0.60$ (expected mean difference)

Based on these parameters, the minimum required sample size was calculated to be **50 participants**.

Sample type: A purposive sampling method of 50 eligible parents with their children having T1DM. were taken from the previously mentioned setting after fulfilling **the inclusion criteria**:

- parents of children recently diagnosed with T1DM.
- parents responsible for the child's daily diabetes care.
- parents who owned and could use a smartphone.
- parents ready to be included in the study.

Exclusion criteria:

- parents who had previously received health education about T1DM.
- parents of children with diabetes insipidus, secondary diabetes, or atypical forms of diabetes such as Maturity-Onset Diabetes of the Young (MODY) or Neonatal Diabetes Mellitus (NDM), because these conditions have different pathophysiological mechanisms, treatment regimens, and management needs, which could confound the assessment of the effectiveness of the nano-learning intervention specifically tailored for T1DM management.

Tools of data collection:

Two tools were used to gather data pertained to the study as the following:

Tool (1): A structured interviewing questionnaire: it was developed by the researcher after investigating relevant research for gathering the essential data. It was written in Arabic language and composed of two parts:

part 1: (a) Characteristics of the studied parents:

It concerned with characteristics of the studied parents such as parents' age, gender, residence, level of education, occupation, marital status, consanguinity, attendance of previous diabetes training programs.

(b) Characteristics of the studied children:

It concerned with characteristics of the studied children such as children's age, gender, educational level, birth order.

Part II: Knowledge assessment questionnaire:

It was developed by the researcher based on recent literature ***Pham et al. (2023), Kayalar (2021), Radzitskaya and Islamov (2024), Egyptian Drug Authority (2024), Kyle and Carman (2021), Pal (2021)***. It consisted of multiple-choice questions

designed to assess parents' knowledge. The questionnaire included two main sections:

Section 1: parents' knowledge regarding the nano-learning strategy (six questions), covering its definition, principles, tools, advantages, disadvantages, and barriers.

Section 2: parents' knowledge regarding diabetes mellitus (52 questions), covering blood glucose, insulin hormone (general knowledge and precautions), diabetes mellitus (definition, risk factors, types, investigations, and parental role), treatment, and complications. Participants' responses were examined using a model answer sheet.

The scoring system for parents' knowledge:

A scoring system was estimated in which each correct answer was given "1", while incorrect answers were scored zero. The total knowledge score was expressed as percentages and defined as unsatisfactory (<60%) and satisfactory (≥60%).

Tool (II): Parents-reported practices checklist:

It was developed by the researcher following an extensive review of the multiple literature sources such as ***Rojina and Lumina (2018), Kyle and Carman (2021), Kliegman et al. (2025), Adolfsson, et al. (2022), Egyptian Drug Authority (2024), David et al. (2023), Mabdavlya et al. (2022)*** to assess parents' practices regarding DM. It involved (123) steps categorized under eleven domains named dietary practices (14), exercises (11), insulin administration via syringe and pen (41), blood glucose monitoring (18), foot care (12), personal hygiene (6), skin care (4), eye care (3), dental and gum care (5), and wound care (8).

The scoring system for parents' reported practices:

Parents' responses were scored 1 for "done" and 0 for "not done," and the total score of practice was categorized into percentages and interpreted as unsatisfactory (<60%) and satisfactory (≥60%).

Pilot study:

A pilot study was carried out on 10% (5 parents) of the total study sample size to investigate the visibility, applicability, and feasibility of the study instruments, as well as to determine the time required for completion. Based on the pilot study findings, minor modifications were made to improve the wording and organization of some items. The study sample did not include parents who took part in the pilot study. The pilot study lasted about one month, from the beginning to the end of May 2025.

Administrative design:

Prior to beginning the practical work, an official letter clarifying the aim of and nature the study was taken from the Dean of Nursing Faculty, Benha University, the director of the Comprehensive Health Insurance Hospital (Hassan Awad Clinic) to perform the study. A clear explanation was provided about importance and the expected outcomes of the study.

Content validity:

Tools of data collection were designed and submitted to a jury of three experts (one professor and two assistant professors in pediatric nursing specialty from the faculty of nursing, Benha University) to test the content validity of tools for clarity, relevance, comprehensiveness, understanding, and applicability. The necessary modifications were obtained regarding the arrangement, rephrasing, and adding some questions to the study tools, and all of their observations were taken into consideration. The tools were considered to be valid from the experts' point of view.

Reliability of the tools:

The reliability of study tools was estimated by using Cronbach's Alpha coefficient test in the SPSS program, version 25, to examine the produced tools for reliability. The results were as the following: Internal consistency reliability Cronbach's alpha for parents' knowledge regarding diabetes mellitus and nano-learning strategy was excellent, reliable, and emerged as (0.936) and parents' reported practices regarding diabetes mellitus (0.975). these results confirm the expectational stability and perception of the tools, establishing them as highly dependable instruments for academic data collection.

Ethical considerations:

A written approval was obtained from the Scientific Research Ethical Committee at the Faculty of Nursing/ Benha University (Ethics code: REC-PN-P86). Written consent was taken from the parents to participate in the study. The parents were informed that participation in the study is completely voluntary and also had the right to withdraw from the study at any time without an explanation of their rationale and without incurring any consequences. Privacy and confidentiality were secured through coding the data. Moreover, parents were informed that the data was secured and would not be reused for any research purposes without their permission. All research techniques were conducted in compliance with the Declaration of **Helsinki's ethical criteria**, which govern research involving human subjects.

Field work:

The study took place throughout seven months, from the beginning of June to the end of December 2025. The implementation of the nano-learning strategy was conducted in four phases:

1. Assessment phase:

The researcher introduced herself and explained the aim of the study to the parents. The researcher attended the study setting three days per week (Saturday, Tuesday, and Thursday) from 9:00 AM to 12 A.M in accordance with the operating hours of Pediatric Diabetic Clinic at the Comprehensive Health Insurance Hospital (Hassan Awad Clinic). Initial screening was conducted for all parents and their children who met the inclusion criteria. Each parent was interviewed to assess the characteristics of parents and their children using the first part of the pretest tool of data collection (**1**). The average time needed to fill it was between 10-15 minutes. Parents' knowledge regarding diabetes mellitus was assessed using the second part of the pretest tool of data collection (**1**). The average time needed to fill it was between 25-50 minutes. Parents' practices regarding diabetes mellitus were assessed using a tool of data collection (**2**). The average time needed to fill it was between 20-60 minutes. This took about one month (from the beginning of June to the end of June 2025).

2. Planning phase:

Based on extensive analysis of relevant scholarly literature from journals, textbooks, bulletins, and electronic media, the researcher created instructional videos to improve parents' knowledge and practices regarding diabetes mellitus. Limitations in knowledge and practices related to diabetes mellitus of parents having children with diabetes were recognized and considered when creating nano-learning videos. With the aid of motion graphics and video editing experts, videos were designed using animation techniques in order to make videos more attractive to the parents watching them. Nano-learning videos were carried out using an AI-assisted multimedia production workflow. Advanced generative video models (VEO-2 and VEO-3) and AI-based image generation tools were utilized for visual content creation, while speech synthesis was performed using Google AI Studio. Professional post-production, compositing, and final editing were completed using Adobe Premiere Pro 2025 and Adobe Photoshop 2025. All produced nano-learning videos are protected by intellectual property and copyright rights and are the exclusive property of the researcher and supervising staff. Unauthorized reproduction, distribution, or use of these materials is strictly prohibited. This phase took one month (from the beginning of July to the end of July 2025).

3. Implementation phase:

The nano-learning strategy was implemented through eleven sessions (five theoretical and six reported practices), with 1-2 videos delivered per session while 2 sessions were conducted per day as follows; (one or two theoretical videos) session which started from 9 to 10 A.M. followed by (two reported practice videos) session which initiated from 11-12 P.M. Each video ranged in duration from one to a maximum of four minutes. The duration of the session ranged from 30 to 45 minutes, allowing sufficient time for clarification, discussion, and addressing parents' questions related to the presented content. Parents and their children were divided into small groups of (4–5) based on their physical and mental readiness. In total, 10 small groups were formed. All sessions were conducted in the area in front of the Pediatric Diabetic Clinic and repeated for all groups. Each group required approximately three days (one week) to complete all nano-learning sessions. The nano-learning videos were delivered using the researcher's personal laptop, supported by a sound amplifier. To enhance learning outcomes, the videos were also provided to all recruited parents and made readily accessible on their mobile phones (through WhatsApp group) for further review and understanding.

This phase took about ten weeks from the beginning of August to the first two weeks of October, and each session addressed a single learning outcome as follows:

- **The first session (theoretical session):**

This session aimed to provide the knowledge required for understanding the concept of the nano-learning strategy. It covered the definition, key principles, teaching tools used to deliver nano-learning content, as well as the advantages and disadvantages of the strategy. Additionally, factors hindering the implementation of the nano-learning strategy were discussed.

- **The second session (theoretical session):**

This session aimed to provide the basic knowledge necessary to understand blood glucose and insulin. It covered the definition, benefits, and normal levels of blood glucose, as well as the definition of insulin, its functions, and indications. In addition, the session addressed insulin administration, including appropriate injection sites, the correct administration technique, and the necessary precautions to be followed before and after insulin administration, as well as proper insulin storage.

- **The third session (theoretical session):**

This session aimed to provide the basic knowledge necessary to understand diabetes mellitus. It covered the definition, predisposing factors, and types of diabetes mellitus. In addition, the session addressed type 1 diabetes mellitus,

including its definition, causes, signs and symptoms, diagnostic investigations, and related treatment.

- **The fourth session (theoretical session):**

This session aimed to explain the modern methods used in the treatment of diabetes mellitus. It covered advanced insulin delivery methods, including insulin pumps (definition, types, and advantages), smart insulin pens (definition, benefits), injection ports with emphasis on definition, advantages, and site change recommendations, as well as inhaled insulin, including its definition and advantages.

- **The fifth session (theoretical session):**

This session aimed to illustrate the complications of diabetes mellitus and how to manage them, as well as the parents' role. It covered types of DM complications, including hypoglycemic and hyperglycemic coma (definition, causes, signs and symptoms, and first aid). The duration of this session was 10minutes.

- **The sixth session (reported practices session):**

This session aimed to enhance parents' dietary practices regarding their children having diabetes mellitus. It covered healthy daily nutritional practices, including appropriate meal frequency and regular meal timing, adequate daily water intake, and estimation of daily caloric requirements. The session addressed proper macronutrient distribution, highlighting the recommended proportions of carbohydrates, proteins, and fats. In addition, a practical example of a balanced daily meal plan was provided to support parents in applying these dietary guidelines in real-life settings.

- **The seventh session (reported practices session):**

This session aimed to enhance parents' practices regarding exercises performed by their children having DM. It covered the importance of regular exercise, appropriate types and duration of exercises suitable for children, and general safety precautions. The session also addressed essential preparatory measures and blood glucose monitoring and basic ketone testing (in both blood and urine).

- **The eighth session (reported practices session):**
  - This session aimed to enhance parents' practices regarding insulin administration. It covered safe and correct insulin injection techniques using both the syringe method and the insulin pen. The session also addressed essential steps before, during, and after insulin administration, including hand hygiene, insulin preparation and storage, dose preparation, appropriate selection and rotation of injection sites, correct injection angles, safe disposal of needles, and post-injection monitoring for glycemic changes and possible adverse reactions.

- **The ninth session (reported practices session):**

This session aimed to enhance parents' practices regarding blood glucose level monitoring for their children having DM. It covered proper preparation before measurement. This session also explained the correct blood sampling technique and post-measurement procedures were emphasized. Recommended monitoring times were also highlighted to ensure effective diabetes management.

- **The tenth session (reported practices session):**

This session aimed to enhance parents' practices regarding proper foot care for their children having diabetes mellitus. It covered daily foot inspection for abnormalities, including symptoms of inflammation or infection, hygiene practices, nail care, precautions regarding socks and footwear, and early detection with timely medical consultation to prevent complications.

- **The eleventh session (reported practices session):**

This session aimed to enhance parents' practices regarding personal hygiene and health care for their children having DM. It covered key areas including personal hygiene (hand washing, bathing, clothing, and hair care), skin care (proper moisturizing and daily inspection for abnormalities), eye care (annual eye exams, sun protection, and prompt consultation for visual changes), dental and gum care (brushing, flossing, monitoring for signs of dental problems, and routine dental visits), and wound care (cleaning, dressing, monitoring healing, and timely medical consultation).

- Each session is supported with a clear presentation of its educational objectives, providing parents with a roadmap of the intended learning outcomes. At the conclusion of each video, a clear learning moment was highlighted, reinforcing the key practical points and ensuring that the intended knowledge and skills were effectively consolidated for the parents

4. Evaluation phase:

At this phase, Parents' knowledge and practices were evaluated using post-test tools of data collection (**1,2**) as follows: immediately after nano-learning strategy (immediate post-test), and after one month (follow-up test). This period extended over

one month, from the last 2 weeks of October to the first 2 weeks of November, 2025.

Statistical analysis:

The Statistical Package for Social Sciences (SPSS) for Windows version 25 was used to arrange, tabulate, and statistically analyze the gathered data. Using descriptive statistical techniques, categorical variables were represented as numbers and percentages, while continuous variables were summarized together and displayed as mean and standard deviation (SD). The chi-square test was used for inferential statistics to compare qualitative variables. The study variables were correlated using Pearson's correlation coefficient (r). In order to confirm the resilience and consistency of the instruments used for data collection, the study tools' internal consistency and reliability were also evaluated using Cronbach's alpha coefficient. The level of statistical significance was set at a p-value of < 0.05, while a highly significant level was considered at $p < 0.001$. A p-value of ≥ 0.05 was regarded as statistically nonsignificant.

Results:

Table (1): It shows that, age of less than half (47.1%) and more than one third (37.5%) of studied mothers and studied fathers ranged from 30–<35 years, with mean age of 34.17± 5.88 and 36.18± 4.90 years respectively. As regards place of residence, less than three quarters (70.6%) and more than two-thirds (68.8%) of studied mothers and studied fathers were from rural areas respectively. Regarding educational level, more than half (52.9%) and less than two-thirds (62.5%) of studied mothers and studied fathers had secondary education respectively. In relation to occupation, most (91.1%) of studied mothers were housewives, while, less than two-thirds (62.5%) of studied fathers were government employee. Moreover, this table reveals that, majority (88.2%) and (81.3%) of studied mothers and studied fathers were married respectively. Furthermore, 73.5% and 68.8% of studied mothers and studied fathers didn't have consanguinity between spouse respectively and among those reporting consanguinity, more than two-thirds (66.7%) and less than two-thirds (60.0%) of studied mothers and studied fathers indicated a second-degree relationship. Notably, all (100%) of the studied mothers and studied fathers didn't attend training programs regarding diabetes using nano learning strategy.

Table (2): It shows that, the children had a mean age of 7.18 ± 2.74 years, with more than half falling within the 6–<9 years age group (60.0%). Males represented a substantially higher proportion (72.0%) compared to females (28%). Regarding educational level, more than half of the children (56.0%) were enrolled in the elementary stage. Moreover, this table shows that, nearly two-thirds (66.0%) of studied children were the first child in the family.

Table (3): displays that, there was a highly statistically significant difference in parents' knowledge regarding Nano-learning strategy, blood sugar, insulin and diabetes mellitus after implementation of nano-learning strategy compared to pre- implementation with a highly statistically significant difference at ($P < 0.001$). Also, this table reflects that, there was a significant improvement in parents' total knowledge after implementation of nano-learning strategy compared to pre- implementation with a highly statistically significant difference at ($P < 0.001$). As evidence, 22.0% of the studied parents had satisfactory total knowledge pre implementation, which improved to 80.0% at immediate post implementation and 76.0% follow-up after one month of the implementation.

Figure (2): portrays that, 22.0% of the studied parents had satisfactory level of total knowledge at pre implementation, which increased to 80.0% at immediate post implementation and 76.0% follow-up after one month of the implementation. While, 78.0% of the studied parents had unsatisfactory level of total knowledge at pre implementation, which decreased to 20.0% at post implementation and 24.0% after one month of the implementation**.**

Table (4): shows that, there was a significant difference in parents' reported practices subscales after implementation of nano-learning strategy compared to pre-intervention with a highly statistically significant difference at ($P< 0.001$). Also, this table reflects that, there was a significant improvement in parents' total reported practices after implementation of nano-learning strategy compared to pre- implementation with a highly statistically significant difference at ($P < 0.001$). As evidence, 28.0% of the studied parents had satisfactory total reported practices pre-implementation, which improved to 78.0% at immediate post implementation and 74.0% follow-up after one month of the implementation.

Figure (3): shows that, 28.0% of the studied parents had satisfactory level of total reported practices at pre implementation phase, which increased to 78.0% at post implementation phase and 74.0% after one month of the implementation. Meanwhile, 72.0% of the studied parents had unsatisfactory level of total reported practices at pre

implementation phase, which decreased to 22.0% at immediate post implementation phase and 26.0% follow-up after one month of the implementation.

Table (5): explains that, there was highly statistically significant positive correlation between total knowledge score, total reported practices score at pre, immediate post and follow-up after one month of nano-learning strategy implementation ($P < 0.001$).

Table (1): Distribution of the studied parents according to their characteristics (n=50).

Characteristics	Studied mothers (n=34)		Studied fathers (n=16)	
	No.	%	No.	%
Age (Years)				
< 30	5	14.7	4	25.0
30-< 35	**16**	**47.1**	**6**	**37.5**
35-<40	6	17.6	2	12.5
≥40	7	20.6	4	25.0
Mean ± SD	**34.17± 5.88**		**36.18± 4.90**	
Place of residence				
Urban	10	29.4	5	31.3
Rural	**24**	**70.6**	**11**	**68.8**
Level of education				
Read and write	2	5.9	1	6.3
Primary education	5	14.7	2	12.5
Preparatory education	6	17.6	1	6.3
Secondary education	**18**	**52.9**	**10**	**62.5**
University education	2	5.9	2	12.5
Postgraduate studies	1	2.9	0	0.0
Occupation				
Housewife	**31**	**91.1**	0	0.0
Government Employee	3	8.8	**10**	**62.5**
Private Employee	0	0.0	4	25.0
Unemployed	0	0.0	2	12.5
Marital Status				
Married	**30**	**88.2**	**13**	**81.3**
Widowed	2	5.9	1	6.3
Divorced	2	5.9	2	12.5
Consanguinity between spouse				
Yes	9	26.5	5	31.3
No	**25**	**73.5**	**11**	**68.8**
If yes, degree of kinship	**(n=9)**		**(n=5)**	
Second degree	**6**	**66.7**	**3**	**60.0**
Third degree	2	22.2	1	20.0
Fourth degree	1	11.1	1	20.0

Attending training programs regarding diabetes using nano learning strategy				
No	**34**	**100.0**	**16**	**100.0**

Table (2): Distribution of the studied children according to their characteristics (n=50).

Characteristics of the studied children	No.	%
Age (Years)		
< 3	3	6.0
3-< 6	11	22.0
6-<9	**30**	**60.0**
≥9	6	12.0
Mean ± SD	**7.18±2.74**	
Gender		
Male	**36**	**72.0**
Female	14	28.0
Level of education		
Pre-nursery	5	10.0
Nursery	13	26.0
Elementary stage	**28**	**56.0**
Middle stage	3	6.0
Secondary stage	1	2.0
Child's order in the family		
First	**33**	**66.0**
Second	10	20.0

Third	7	14.0

Table (3): Subtotal and total level of parents' knowledge scores at pre, immediate post and follow-up after one month of nano-learning strategy intervention (n=50).

Knowledge subscales	Pre- nano-learning strategy intervention				Immediate post-nano-learning strategy intervention				Follow-up after one month of nano-learning strategy intervention				χ^2 /FET (P_1)	χ^2 /FET (P_2)	χ^2 /FET (P_3)
	Satisfactory		Unsatisfactory		Satisfactory		Unsatisfactory		Satisfactory		Unsatisfactory				
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%			
Nano-learning strategy	7	14.0	43	86.0	39	78.0	11	22.0	37	74.0	13	26.0	**X^2=41.22 P=0.000****	**X^2=52.00 P=0.000****	**X^2=0.219 P=0.640**
Blood sugar	12	24.0	38	76.0	41	82.0	9	18.0	38	76.0	12	24.0	**X^2= 33.76 P=0.000****	**X^2=42.63 P=0.000****	**X^2=0.542 P=0.461**
Insulin	10	20.0	40	80.0	39	78.0	11	22.0	37	74.0	13	26.0	**X^2=33.65 P=0.000****	**X^2=42.89 P=0.000****	**X^2=0.219 P=0.640**
Diabetes Mellitus	8	16.0	42	84.0	42	84.0	8	16.0	39	78.0	11	22.0	**X^2=46.24 P=0.000****	**X^2=58.74 P=0.000****	**X^2=0.585 P=0.444**
Total knowledge score	**11**	**22.0**	**39**	**78.0**	**40**	**80.0**	**10**	**20.0**	**38**	**76.0**	**12**	**24.0**	**X^2= 33.65 P=0.000****	**X^2=43.48 P=0.000****	**X^2=0.233 P=0.629**

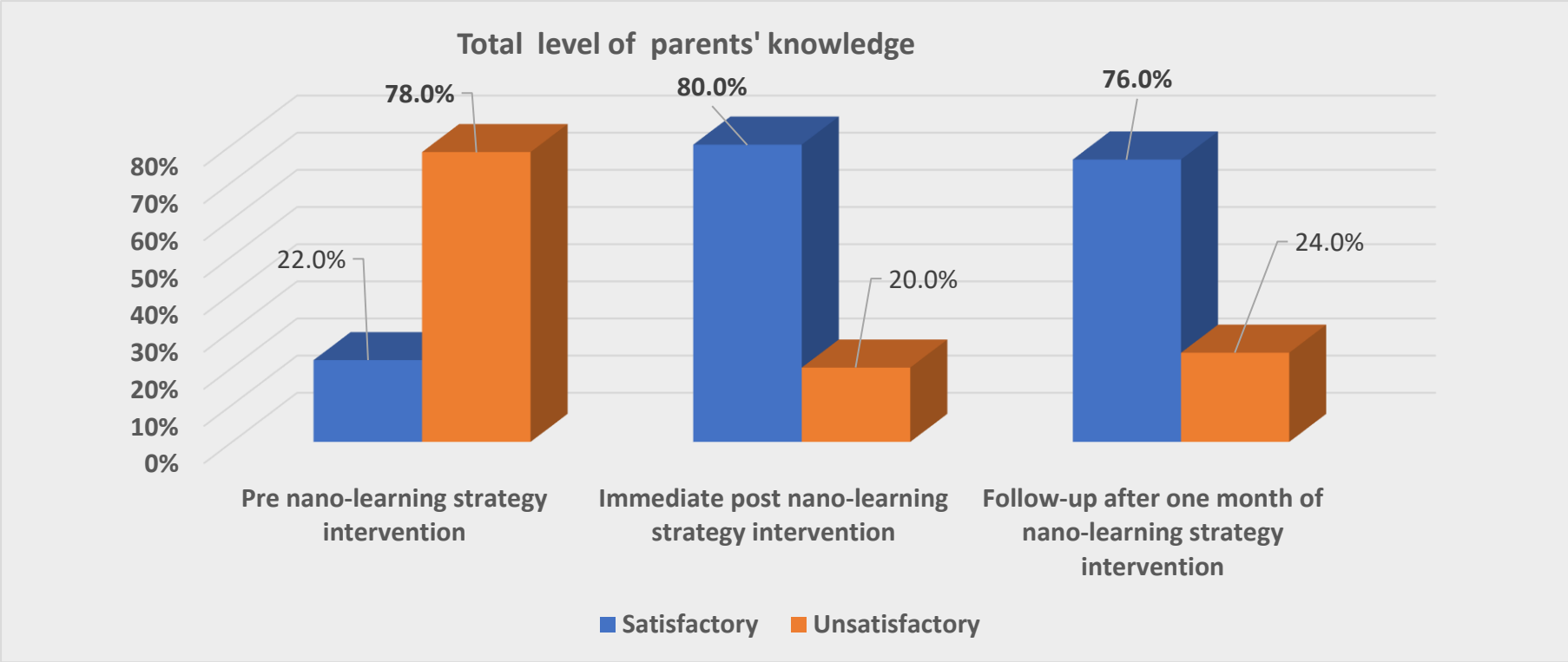

Figure (2): Percentage distribution of total level of parents' knowledge at pre, immediate post and after one month of nano-learning strategy implementation (n=50).

Table (4): Subtotal and total level of parents' reported practices scores at pre, immediate post and follow-up after one month of nano-learning strategy intervention (n=50).

Reported practices subscales	Pre- implementation of nano-learning strategy				Immediate post-implementation of nano-learning strategy				Follow-up after one month of nano-learning strategy intervention				χ^2 /FET (P_1)	χ^2 /FET (P_2)	χ^2 /FET (P_3)
	Satisfactory		Unsatisfactory		Satisfactory		Unsatisfactory		Satisfactory		Unsatisfactory				
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%			
Dietary Practices	17	34.0	33	66.0	44	88.0	6	12.0	41	82.0	9	18.0	**X^2=30.64 P=0.000****	**X^2= 40.025 P=0.000****	**X^2=0.706 P=0.401**

Exercise Practices	7	14.0	43	86.0	38	76.0	12	24.0	35	70.0	15	30.0	**X^2=38.82 P=0.000****	**X^2=46.98 P=0.000****	**X^2=0.457 P=0.499**
Insulin injection using syringes	8	16.0	42	84.0	41	82.0	9	18.0	40	81.6	9	18.4	**X^2=43.57 P=0.000****	**X^2=59.83 P=0.000****	**X^2=0.002 P=0.461**
Insulin injection using an insulin pen	10	20.0	40	80.0	41	82.0	9	18.0	38	76.0	12	24.0	**X^2=38.45 P=0.000****	**X^2=48.46 P=0.000****	**X^2=0.542 P=0.461**
Blood glucose level monitoring	15	30.0	35	70.0	46	92.0	4	8.0	42	84.0	8	16.0	**X^2=40.39 P=0.000****	**X^2= 52.86 P=0.000****	**X^2=1.515 P=0.218**
Foot care	13	26.0	37	74.0	40	80.0	10	20.0	36	72.0	14	28.0	**X^2=29.26 P=0.000****	**X^2=35.20 P=0.000****	**X^2=0.877 P=0.349**
Personal hygiene	20	40.0	30	60.0	44	88.0	6	12.0	39	78.0	11	22.0	**X^2=25.00 P=0.000****	**X^2=29.80 P=0.000****	**X^2=1.772 P=0.183**
Skin care	14	28.0	36	72.0	38	76.0	12	24.0	36	72.0	14	28.0	**X^2=23.07 P=0.000****	**X^2=29.25 P=0.000****	**X^2=0.208 P=0.648**
Eye care	7	14.0	43	86.0	35	70.0	15	30.0	33	66.0	17	34.0	**X^2=32.18 P=0.000****	**X^2=39.04 P=0.000****	**X^2=0.713 P=0.398**
Dental and gum care	12	24.0	38	76.0	41	82.0	9	18.0	38	76.0	12	24.0	**X^2=33.76 P=0.000****	**X^2=42.63 P=0.000****	**X^2=0.542 P=0.461**
Wound care	12	24.0	38	76.0	40	80.0	10	20.0	37	74.0	13	26.0	**X^2=31.41 P=0.000****	**X^2=39.17 P=0.000****	**X^2=0.508 P=0.476**
Total reported practices score	**14**	**28.0**	**36**	**72.0**	**39**	**78.0**	**11**	**22.0**	**37**	**74.0**	**13**	**26.0**	**X^2=25.09 P=0.000****	**X^2=32.16 P=0.000****	**X^2=0.219 P=0.640**

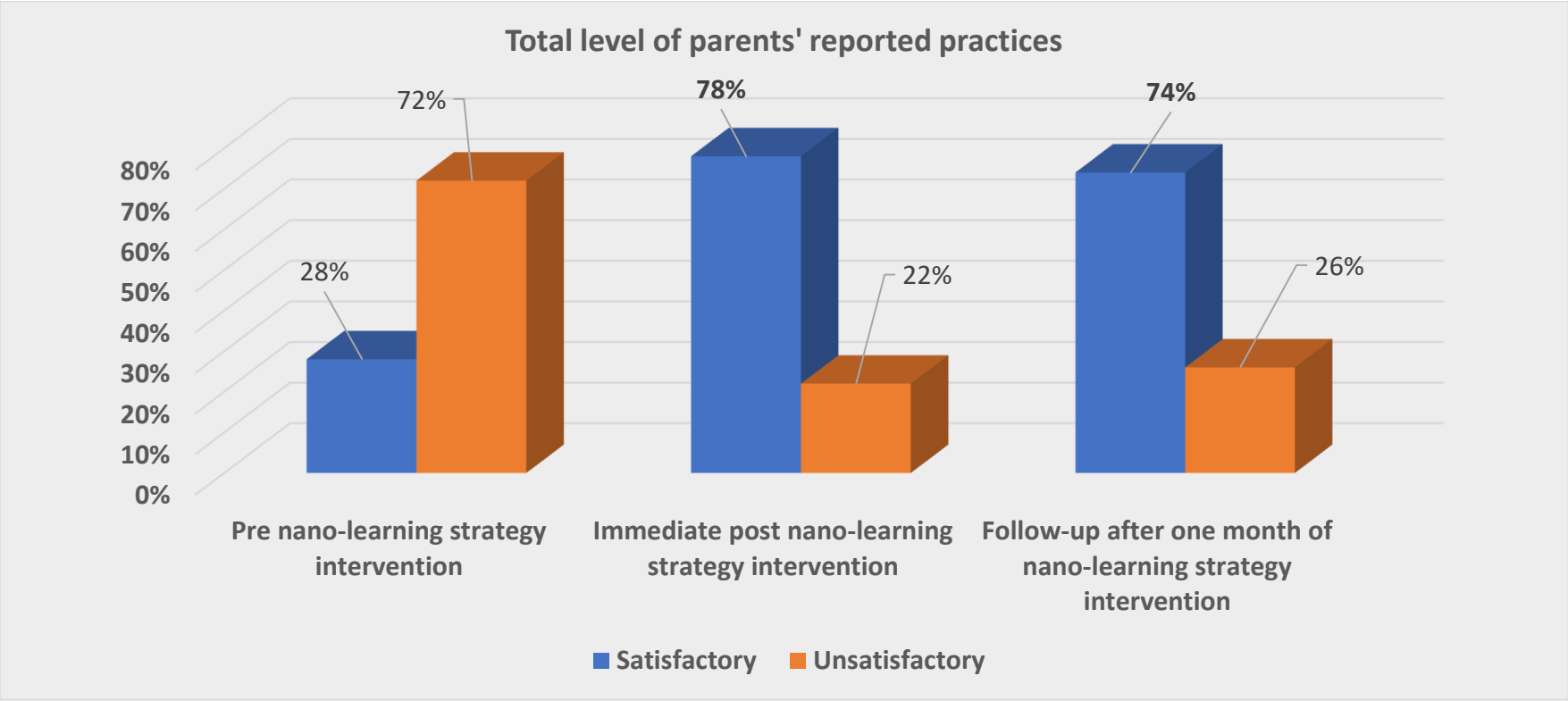

Figure (3): Percentage distribution of total level of parents' knowledge at pre, immediate post and after one month of nano-learning strategy implementation (n=50).

Table (5): Correlation between total knowledge score and total reported practice score at pre, immediate post and follow-up after one month of nano-learning strategy intervention (n=50).

Variables			Total Knowledge	Total practices
Pre-nano-learning strategy intervention	Total Knowledge	r	1	0.852
		P-value		**0.000****
	Total practices	r	0.852	1
		P-value	**0.000****	

Immediate post-nano-learning strategy intervention	**Total Knowledge**	r	**1**	0.941
		P-value		**0.000****
	Total practices	r	0.941	1
		P-value	**0.000****	
Follow-up after one month nano-learning strategy intervention	**Total Knowledge**	r	**1**	0.948
		P-value		**0.000****
	Total practices	r	0.948	**1**
		P-value	**0.000****	

Discussion:

Type 1 Diabetes Mellitus (T1DM) is the most common endocrine disorder in the pediatric population. Globally, approximately 8.4 million individuals are affected by T1DM, including nearly 1.5 million children ***(Gregory et al., 2022).*** Children with T1DM require lifelong and meticulous management, including continuous blood glucose monitoring, regular insulin administration, and careful dietary regulation. These complex responsibilities are further intensified by the child's ongoing physical, emotional, and psychological development ***(Commissariat et al., 2020; Xu, 2021).***

Parents serve as the primary caregivers and decision-makers in daily disease management. Parents are responsible for adjusting insulin doses based on blood glucose readings, regulating dietary intake and physical activity, preventing acute and long-term complications, and providing continuous emotional and psychological support to their children ***(Lu et al., 2020; Zhang et al., 2024).*** The implementation of effective and accessible educational strategies is vital to enhance parents' knowledge and practical skills in managing childhood T1DM ***(Juhi et al., 2024).***

Nano-learning has emerged as an innovative educational strategy characterized by the delivery of concise, focused, and time-efficient learning units. This approach is designed to enhance knowledge retention, promote practical application, and facilitate flexible learning. Nano-learning enables learners to acquire essential information and skills through short, targeted educational content that can be seamlessly integrated into daily life routines ***(Madan, 2021; Sanam, 2023).***

Therefore, the present study was conceptualized to investigate the effect of the nano-learning strategy on the knowledge and practices of parents having children with diabetes mellitus, addressing a critical gap in contemporary educational and healthcare research.

The findings of the current study show that more than half of the studied parents were female. From the researcher's point of view, mothers are usually the main individuals responsible for seeking healthcare services, communicating with healthcare providers, and adhering to treatment plans. This may have contributed to their higher participation rate compared to fathers.

These results agree with ***Glocker et al., (2022)*** who studied " Fear of hypoglycemia and quality of life in young people with type 1 diabetes and their parents in the era of sensor glucose monitoring " and found that, around half of the studied participants were females. Moreover, these findings agree with **Saßmann et al., (2022)** who studied "Understanding daily, emotional, and physical burdens and needs of parents caring for children with type 1 diabetes" and found that, more than half of the participants were females.

Regarding the age distribution, less than half (47.1%) and more than one third (37.5%) of studied mothers and studied fathers ranged from 30–<35 years, with mean age of 34.17± 5.88 and 36.18± 4.90 years, respectively. This finding may be attributed to delays in marriage in recent years, which are often followed by postponed childbearing, causing a greater proportion of parents in their early thirties. This trend may explain the predominance of the 30–<35-year age group among the participants in the present study.

These results agree with ***Abolwafa et al., (2023)*** who studied "Effect of educational program on mothers' knowledge, stress and fear of hypoglycemia and their children glycemic control" and revealed that, the ages of participants' mothers were under 30 years old with mean was 33.5 ± 0.921. Additionally, these results agree with ***Alhomood et al., (2020)*** who carried out a study entitled "Knowledge about diabetic ketoacidosis among parents of type 1 diabetic children " and reported that more than half of parents (56.4%) were aged 30-40 years.

As regards residence, this study revealed that the vast majority of studied parents were from rural areas. From the researcher's point of view, this result may be due to the geographical location of the selected health insurance clinic, which serves a large number of surrounding villages. Therefore, reflecting a higher attendance rate and subsequent representation in the study sample**.** This finding is in harmony with ***Mohammad et al., (2020)*** who studied "Knowledge and self-efficacy among children with type 1 diabetes and their caregivers" and found that the majority of the studied fathers and mothers were from rural areas.

On the other hand, this result disagrees with ***Farooq et al., (2025)*** who conducted a study to evaluate "Parents' Quality of Life Caring for Child with Type 1 Diabetes Mellitus: A Cross-Sectional Study from Eastern Pakistan" and illustrated that, most of the studied parents were from urban areas.

Regarding educational level, the vast majority of the studied mothers and fathers had secondary education. This finding may be related to the characteristics of the study setting. Since the sample was recruited from a governmental health insurance hospital (Hassan Awad Clinic), which primarily serves middle socioeconomic groups, where secondary education represents the most common level of educational attainment in Egypt.

This finding is in agreement with ***Akter eta al., (2022)*** who assessed "Knowledge, attitude and

practice of diabetes among secondary school-going children in Bangladesh" reported that, the vast majority of the studied mothers and fathers had secondary school education.

On the other hand, this result disagrees with ***Ayub et al., (2025)*** who conducted a study about "Affective Response of Parents of Newly Diagnosed Type-1 Diabetes Patients: An Experience from a Developing Country" and illustrated that, more than half of the studied parents (54%) weren't not educated or still had primary education.

In relation to occupation, most (91.1%) of studied mothers were housewives, while, less than two-thirds (62.5%) of studied fathers were government employees. This finding may reflect prevailing gender-role patterns in the Egyptian society, where mothers typically assume primary responsibility for childcare, particularly when caring for a child with a chronic condition such as diabetes mellitus that requires continuous monitoring and daily management.

This result harmony with ***Aldubayee et al., (2020)*** who conducted a study entitled "Parental levels of stress managing a child diagnosed with type 1 diabetes in Riyadh: a cross-sectional study" illustrated that most (85.2%) of studied mothers were not employed (housewives), while less than two-thirds (63.3%) of studied fathers were government employees.

Regarding marital status, the majority (88.2%) and (81.3%) of studied mothers and studied fathers were married, respectively. This is likely because married couples are more likely to have and raise children together, making them the predominant group in pediatric populations, compared to divorced or single parents. This matches with ***Ibrahim et al., (2025)*** who conducted study about "Parents Empowerment regarding Care of their Children with Diabetes Mellitus" and found that the majority (90%) of studied parents were married.

Regarding consanguinity between spouses, most of parents reported no consanguinity between spouse. From the researcher's point of view, the occurrence of T1DM does not depend strongly on close genetic relatedness between parents; it is a multifactorial autoimmune disease and is influenced by a combination of genetic susceptibility and environmental triggers (e.g., viral infections). which explains the low rate of consanguinity observed in the sample.

This finding was paralleled with ***Abou El Ella et al., (2021)*** who conducted study about "PTPN22 gene and IL2RA rs11594656, rs2104286 gene variants: additional insights of polygenic single-nucleotide polymorphisms' pattern among Egyptian children with type 1diabetes" and found that vast majority of the studied parents showed no consanguinity between spouse.

The result of the current study showed that none of the studied parents had previously attended training programs regarding diabetes management using a nano-learning strategy. From the researcher's point of view, this result highlights the lack of exposure to innovative educational approaches and underscores the necessity of structured educational interventions.

As regard studied children age, the current study revealed that the studied children had a mean age of 7.18 ± 2.74 years. This age pattern likely reflects the typical onset of type 1 diabetes in early childhood, when progressive autoimmune destruction of pancreatic β-cells reaches a clinically detectable stage, driven by the interaction between genetic susceptibility and environmental triggers. This finding was congruent with ***Betemariem et al., (2025)*** who conducted a study about "Parental role in paediatric cancer treatment decision making at Tikur Anbessa Specialized Hospital, Ethiopia: A mixed method study" and found that participants' children's mean age was 6.3 ± 3.89 years.

Concerning the gender of the studied children, the vast majority of them are males. this result is related to the reported higher incidence of type 1 diabetes among males in certain populations, also sociocultural factors, where male children are more likely to receive medical attention and be diagnosed earlier leading to their higher representation in the studied sample. This finding agrees with ***Nafee et al., (2022)*** who conducted study about "Effectiveness of an Evidence-Based Insulin Injection Guidelines Application on Diabetic Children Mothers' Awareness about insulin injection: A quasi experimental study" and revealed that most of the studied children were males.

Regarding educational level, most of the children studied were enrolled in the elementary stage. This result is linked to most of the studied children, with a mean age of 7.18 ± 2.74 years. This result is in harmony with ***Ghaljaei et al., (2022)*** who conducted study about "The effect of the family-centered empowerment model on family functioning in type 1 diabetic children: a quasi-experimental study" and found that most of the studied children were enrolled in the elementary or primary stage of education. Also, ***Zalzala et al., (2020)*** who assessed "Epidemiological profile of type 1 diabetes among primary school children in Baghdad, Iraq" revealed that majority of the studied children were enrolled in the elementary stage.

Concerning the child order, most of the studied children were the first child in the family. From the

researcher's point of view, this result may be attributed to greater parental attention and increased healthcare-seeking behavior for first-born children, leading to earlier recognition and diagnosis of symptoms compared to later-born siblings. This result agrees with ***Adege et al., (2025)*** who studied "Predictors of glycemic control among type 1 pediatric diabetes patients—Northeast Ethiopia" and found that the majority of the studied children were firstborn children.

Concerning knowledge level of the studied parents regarding diabetes mellitus and nano-learning strategy pre-nano-learning strategy implementation, the results of the present study illustrated that, the majority of the studied parents revealed unsatisfactory level of knowledge. This result may be linked to the fact that all studied parents didn't attend any DM education using nano-learning due to unavailability of its' resources.

This result of the present study is supported by ***Razzaq & Handi (2025)*** who studied "Education Program to Enhance Parents' Knowledge of Caring for Children with Type One Diabetes Mellitus" found that the studied parents had a knowledge gap regarding T1DM pre-educational program implementation, additionally these results supported with ***Abd El Aal et al., (2024***) who conducted a study about "Assessment of Family Centered Care Provided for their Children Suffering from Diabetes Mellitus" and demonstrated that studied parents had poor knowledge regarding diabetes mellitus in their children. these findings underscore the importance of innovative educational strategies, such as nano-learning, in enhancing parents' knowledge and improving their preparedness to manage their children's diabetes mellitus effectively.

While, post-nano-learning implementation, the vast majority of the studied parents had satisfactory knowledge level. This is proved by ***Zayed et al., (2024)*** who conducted a study about "Nano Teaching Strategies: Effect on Feeding Difficulties among Children Having Cerebral Palsy" and found that the studied mothers' knowledge improved after nano-learning sessions.

Moreover, utilizing video as an educational medium engages participants through a combination of audio, text, and animation, which can enhance cognitive, affective, and psychomotor domains, as well as support the development of interpersonal skills. This result is supported by ***Ratri et al., (2020)*** who evaluated "Video-based health education to support insulin therapy in diabetes mellitus patients" and demonstrated that the educational video was effective in enhancing participants' knowledge, emphasizing that visually engaging and easily understandable videos provide an efficient medium for delivering critical information on insulin management. In agreement with these results, recent evidence shows that video-based diabetes self-management education significantly enhances participants' level of knowledge regarding diabetes care ***Harahap et al., (2025)***.

This observed improvement from the previously mentioned studies is likely attributable to the effectiveness of the nano-learning strategy in delivering concise and focused educational content related to diabetes mellitus.

concerning parents' reported practice level about diabetes mellitus pre-nano-learning strategy implementation, the results of the present study illustrated that, the majority of the studied parents revealed unsatisfactory level of practice. This result may be linked to the fact that all studied parents had children recently diagnosed with T1DM in addition to didn't attend any DM education using nano-learning.

In line with this finding, ***Fantahun et al., (2024)*** who studied "Caregivers' knowledge and practice regarding hypoglycemia prevention in children with type one diabetes mellitus at Saint Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia" found that caregivers' practice regarding hypoglycemia prevention was poor, emphasizing that education about hypoglycemia and its prevention practice was critical. Similar with ***Al-Malki (2025)*** who conducted a study about "Sick day management rules: Knowledge, attitudes, and practices among children with type 1 diabetes and their caregivers in Taif City, Saudi Arabia" reported that many caregivers, including parents, exhibit suboptimal practices. These findings indicate gaps in their practice, highlighting the need for targeted educational interventions to improve caregivers' or parents' practice related to their children suffering from diabetes mellitus.

On the other hand, post-nano-learning strategy implementation, the vast majority of the studied parents had satisfactory practice level. This finding aligns with previous research demonstrating the effectiveness of nano-learning strategies in enhancing participants' practices. ***Ibrahim et al., (2024)*** conducted a study to evaluate "Effect of Monkeypox nano-teaching sessions versus self-learning on nurses' knowledge, attitude, and confidence in disease diagnosis and management" reported that nano-teaching significantly improved participants' practical performance. Similarly, ***Abdelaziz et al., (2025)*** "Nano Teaching Sessions for University Students regarding Prevention of Helicobacter Pylori Infection" found statistically significant improvements in the

participants' reported practices following the implementation of nano-learning sessions.

Additionally, ***Gomaa et al., (2024)*** who assessed "Effect of Nano-Teaching on Knowledge and Practices of Multipara Women Regarding Stress Urinary Incontinence" indicated that participants achieved significant improvement in their total practice levels after the implementation of the nano-learning strategy.

Collectively, this finding highlights the value of nano-learning in equipping parents with the appropriate practices to effectively control their children's diabetes and, thus, improve health outcomes.

In relation to correlation between total knowledge and total practice scores, the current study revealed that, significant positive correlations between parents' total knowledge scores and reported practice levels across pre, immediate post, and follow-up after one-month of nano-learning strategy intervention. This finding reflects that improving knowledge and understanding were closely linked to enhanced practical performance and stronger engagement in daily diabetes management activities.

This result is consistent with ***Elmetwaaly et al., (2025)*** who conducted a study about "Mothers' Performance Regarding Type 1 Diabetes Mellitus and Their Children's Adherence to Self-Care Practices" and reported that there was a statistically significant positive correlation between total mother' reported practice and knowledge related care of their children with T1DM. Additionally, this result is in agreement with a study by ***Hussien (2019)*** who studied "Mothers' Knowledge and Practices toward Their Children Suffering from Juvenile Diabetes: an Assessment Study" found that there was a positive correlation between total knowledge of the studied mothers about juvenile diabetes and their total reported practices.

Also, ***Chen et al., (2025)*** who evaluated "The Relationship Between Diabetes Knowledge and Diabetes Self-Care Behaviors in Relation to Diabetes Distress in Type 2 Diabetes Mellitus" and reported that the eastern Taiwan DM patients showed a positive correlation between diabetes knowledge and self-care behaviors, indicating that better knowledge is associated with better self-care behaviors and practices.

Conclusion:

Nano-learning strategy as an educational intervention was effective in improving parents' knowledge and enhancing their reported practices regarding DM management in their children.

Recommendations:

In light of the findings of the present study, the following recommendations are suggested:

For clinical nursing practice:

- Integrating nano-learning strategies into routine parent education programs at pediatric diabetic clinics to improve parents' knowledge and caregiving practices.
- Encouraging the use of digital tools such as mobile applications and AI-assisted videos to facilitate continuous access to educational content at home.

For healthcare professionals:

- Conducting periodic workshops and refresher sessions to maintain high levels of parents' competence and confidence
- Promoting awareness regarding dietary control, physical activity, and regular glucose monitoring to enhance self-management and prevent complications.

For community and family support:

- Encouraging collaboration between healthcare providers, parents, and support networks to ensure a comprehensive, family-centered approach to pediatric diabetes care.

For future nursing research:

- Conducting longitudinal and prospective studies to assess the long-term sustainability of nano-learning strategy effects.
- Investigating additional factors such as parental attitudes, self-efficacy, social beliefs, and psychological support for better understanding the broader impact of nano-learning interventions in pediatric diabetes management situations.

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استراتيجية تعليم النانو وأثرها على معلومات وممارسات الوالدين الذين لديهم أطفال مصابين بمرض السكر

يُعدّ مرض السكر من أكثر الأمراض المزمنة شيوعًا بين الأطفال، ويتطلب إدارة مستمرة للحفاظ على مستوى السكر في الدم ضمن المعدل الأمثل والوقاية من المضاعفات. وبصفتهم مقدمي الرعاية الأساسيين، يلعب الآباء دورًا محوريًا في إدارة مرض السكر لدى أطفالهم؛ إلا أن نقص المعرفة والممارسات المتعلقة بالسكر قد يُؤثر سلبًا على التحكم بالمرض والنتائج الصحية المتعلقة به. وقد برز التعلّم المصغر كاستراتيجية تعليمية مبتكرة قادرة على تحسين معرفة الآباء وممارساتهم المتعلقة برعاية مرضى السكر. لذا هدفت هذه الدراسة الى تقييم تأثير استراتيجية تعليم النانو على معلومات وممارسات الوالدين تجاه مرض السكر حيث تم استخدام تصميم شبه تجريبي من نوع القياس القبلي-البعدي وأجريت الدراسة بعيادة السكر للأطفال بمستشفى التأمين الصحي الشامل (عيادة حسن عوض) بمدينة بنها بمحافظة القليوبية بمصر واشتملت الدراسة على عينة قصدية مكونة من (٥٠) من والدي الأطفال الذين تم تشخيصهم حديثا بمرض السكر من النوع الأول. وتم جمع البيانات باستخدام مجموعة من الأدوات شملت استبيان مقابلة منظم الى جانب استبيان لقياس الممارسات التي يبلغ عنها الوالدان ذاتيا فيما يتعلق برعاية طفلهم المصاب بمرض السكر. واظهرت النتائج ان نسبة محدودة من الوالدين لديهم مستوى مرضيا من المعلومات والممارسات قبل تطبيق استراتيجية تعليم النانو في حين تحسن مستوى المعلومات والممارسات بصورة ملحوظة بعد تطبيق التدخل وبعد مرور شهر من المتابعة حيث حققت الغالبية العظمى من الوالدين مستوى مرضيا من المعلومات والممارسات المتعلقة بمرض السكر. كما كشفت النتائج عن وجود علاقة ارتباط إيجابية وفروق ذات دلالة إحصائية عالية بين مستوى المعلومات والممارسات لدى الوالدين الذين لديهم أطفال مصابين بمرض السكر. وخلصت الدراسة الى ان استراتيجية تعليم النانو تعد أسلوبا فعالا في تحسين معلومات وممارسات الوالدين المتعلقة بمرض السكر ويعد هذا الأسلوب نهجا تعليميا سهل الوصول وموفرا للوقت ومعتمدا على التكنولوجيا لدعم الوالدين في رعاية أطفالهم المصابين بمرض السكر كما يمكن للممرضات المتخصصات في تمريض الأطفال توظيف هذه الاستراتيجية لتثقيف الوالدين ودعمهم في الرعاية اليومية لمرض السكر. كما توصي الدراسة بدمج جلسات تعليم النانو ضمن برامج تثقيف مقدمي الرعاية بهدف تعزيز معلومات وممارسات الوالدين في إدارة مرض السكر لدى الأطفال.