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ORIGINAL RESEARCH

Therapeutic Training Game for Children with Diabetes: A Study on Teaching Insulin Self-Injection

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ABSTRACT

Background: Managing diabetes in children requires lifelong insulin therapy and learning how to inject insulin properly to keep blood sugar levels stable and avoid complications. However, many children struggle with fears, anxiety, and low confidence, which can make learning this important skill challenging. Recently, using games as a teaching tool has shown promise in making learning more engaging and supportive.

Objectives: This study aimed to evaluate the effectiveness of a therapeutic training game on improving insulin self-injection performance among children with diabetes and to identify the association of learning outcomes with demographic and clinical factors.

Methodology: An experimental study was conducted with 33 children with diabetes mellitus at Al-Sadr Medical City, Iraq. A validated insulin self-injection performance scale was administered pre- and post-training game. The training game incorporated visual, auditory, and kinesthetic learning methods, including videos, posters, and hands-on practice using dolls. Data were analyzed using SPSS version 20 and $p < 0.05$ was considered statistically significant.

Results: The mean performance score significantly improved from 70.2 ± 7.32 pre-intervention to 86.0 ± 4.74 post- training game ($p < 0.001$). Higher post-training scores were associated with older age (11–13 years), middle school education, urban residence, later age at diagnosis (≥9 years), absence of injection-site pain, and regular glucose monitoring (all $p < 0.05$).

Conclusion: The therapeutic training game significantly enhanced children's insulin self-injection skills and promoted independence in diabetes management. Interactive, child-centered educational approaches that integrate emotional support, family involvement, and multimodal learning are recommended to improve diabetes self-care and long-term outcomes.

Keywords: Diabetes mellitus, insulin self-injection, therapeutic training game, gamification, diabetes self-management.

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INTRODUCTION

Diabetes mellitus is a chronic metabolic condition characterized by the pancreas producing little or no insulin, a hormone essential for regulating blood glucose levels. The daily management of diabetes mellitus relies heavily on insulin therapy to prevent acute complications such as hyperglycemia or hypoglycemia and to reduce the risk of long-term vascular and neurological sequelae. Several insulin types—including rapid-, short-, intermediate-, and long-acting preparations—are administered through various methods, such as syringes, insulin pens, or insulin pumps (Richter et al., 2023).

One of the essential self-care skills for children living with diabetes is insulin self-injection. Mastery of this skill promotes independence, facilitates better glycemic control, and enables children to lead more active and flexible lives. It also reduces the need for hospitalization, equips children to handle sudden hyperglycemic episodes at school or in public settings, and improves long-term health outcomes (Beesley, 2018). However, the acquisition of this skill is often hindered by fear of needles, lack of confidence, and emotional distress—especially among younger patients.

Educational programs or therapeutic training plays a crucial role in supporting children to overcome these barriers and learn insulin self-injection effectively. In developed countries, structured training interventions have shown significant success in teaching children how to prepare appropriate doses, select safe injection sites, and recognize complications such as hypertrophy or infection (Committee, 2024; La Banca et al., 2021). These programs aim to foster self-confidence, improve adherence to insulin therapy, and promote autonomy in disease management. Furthermore, they address the psychological aspects of diabetes by helping children cope with fear and phobia surrounding injections, thereby reinforcing positive attitudes toward their health (La Banca et al., 2021). Therapeutic training also provides a holistic framework for diabetes self-management by offering empowerment, emotional support, and knowledge. It enables children to manage their condition safely while also involving family members to ensure a supportive home environment. Despite these benefits, traditional teaching methods may lack appeal to younger age groups, especially in the digital age where children are more engaged by interactive and visual learning formats (Haleem et al., 2022).

Recently, gamification, process of adding games or gamelike elements to something to encourage participation, has emerged as an innovative educational approach in pediatric healthcare. Therapeutic games integrate medical content with play-based learning, making them highly effective for enhancing engagement, skill acquisition, and emotional resilience. These games have shown promise in chronic disease education by fostering learning through repetition, simulation, and positive reinforcement (DeShazo et al., 2010).

AIMS OF THE STUDY

This study aims to assess the effectiveness of a therapeutic training game designed to teach children insulin self-injection. Using a validated pre- and post-assessment tool, the study evaluates whether the intervention improves procedural performance. Additionally, it explores how demographic variables may influence learning outcomes.

METHODOLOGY

Study Sample:

An experimental study was conducted at Al-Sadr Medical City from January 9 to January 31, 2025. A total of 33 children with diabetes mellitus (both males and females under 18 years old) participated. They were recruited through an open invitation prepared by the researchers and distributed by doctors at the Diabetic Center in Al-Sadr Medical City. This process facilitated the collection of parental

contact information and the scheduling of training game sessions. Ethical approval was obtained from the Faculty of Nursing, University of Kufa, and the Al-Najaf Health Office. Informed consent was obtained from both the children and their families before participation.

Study Instruments:

To assess insulin self-injecting performance, a mixed-methods approach, combining quantitative and qualitative data, including an interview questionnaire (Ortiz La Banca et al., 2022), which involves three parts, including personal information, demographic data, information about diabetes, and insulin self-injecting performance scale by syringe before & after the training game.

Additionally, simulation tools were incorporated to clarify concepts and provide hands-on training for the participants. This multifaceted approach ensured a comprehensive understanding of the participants' progress and the effectiveness of the training game. The training game included a visually engaging and child-friendly presentation, featuring illustrative videos that emphasized the correct steps and proper techniques for using and injecting insulin. Additionally, the training game incorporated educational posters that provided clear guidelines and tips on insulin injection, highlighting the appropriate injection sites. To make the learning process more interactive and effective, we utilized dolls and faux leather pieces to facilitate explanations and deliver the information in a playful and comprehensible manner. Moreover, each child was encouraged to practice these procedures hands-on after the presentation, ensuring that the knowledge was reinforced through practical application.

Reliability and Validity:

For the reliability, the questionnaire demonstrated excellent reliability, with responses from 11 children yielding a Cronbach's alpha of 0.98. For validity, the content validity of the questionnaire was established through review by five experts in pediatric health nursing and maternal and neonatal health nursing from the Faculty of Nursing/ University of Kufa.

Statistical analysis:

All the data in the current study were entered into the SPSS program (version 20). The minimum values, the maximum values, the means, and the standard deviation were calculated. One way ANOVA, paired t test and independent t test, were used for quantitative data according to the fulfillment of the conditions required for each test. P-value <0.05 was considered statistically significant.

RESULTS

Table (1) shows the demographic and clinical data of 33 children with diabetes, revealing that the majority (45.45%) are between 11 and 13 years old, with a mean age of 12 ± 3 years. Females represent a larger percentage (63.64%) than males (36.36%). Most children are in middle school (54.55%) and reside in urban areas (90.91%).

The mean age at diagnosis is 5.7 ± 3.4 years, with nearly one-third diagnosed at or before the age of two. Most children reported no family history (63.64%) or comorbidities (63.64%). Finally, at the insulin injection site, 90.91% of children experienced pain and stiffness, while only 9.09% reported no side effects.

Table (2) shows the diabetic management practices among 33 children with diabetes, revealing that most of the children (90.91%) do not follow a diabetes-specific diet, and 93.94% receive diabetes management support from their parents. Only 30.30% of the children have attempted self-injection, and the majority (69.70%) use needle syringes rather than insulin pens.

While 63.64% of children know how to calculate their insulin dose, 36.36% do not. In terms of emotional response to insulin injection, more than half (54.55%) reported feeling normal, while others experienced fear (27.27%) or anxiety (18.18%).

Moreover, regular monitoring of insulin levels was common, with 72.73% doing so consistently,

18.18% occasionally, and 9.09% rarely. Finally, the vast majority (93.94%) use blood glucose meters with pricking, whereas only 6.06% use non-pricking devices.

Figure (1) shows the effectiveness of the therapeutic training game on insulin self-injection by comparing overall mean score items of children's performance before and after the training game. The overall mean score improved highly significantly from 70.2 ± 7.32 in the pre-test to 86.0 ± 4.74 in the post-test using a paired t test (t-value= 4.49, df=32, and P < 0.0001).

Table (3) presents the relationship between children's post-training performance scores on insulin self-injection and their demographic and clinical data. Statistically significant differences were observed across several variables. Age group was highly significant ($p < 0.0001$), with children aged 11–13 achieving the highest mean scores. Education level and residence also showed significant effects ($p = 0.025$ and $p = 0.019$, respectively), with middle school students and urban residents performing better.

Age at diagnosis demonstrated a highly significant relationship ($p < 0.0001$), where those diagnosed at older ages (≥ 9 years) had superior performance. Injection site pain/stiffness was also highly significant ($p < 0.0001$), with children reporting no pain scoring much higher.

Gender, comorbid conditions, and family history of diabetes showed no significant impact (all p-values > 0.05).

Table (4) shows the relationship between children's post-training performance scores on insulin self-injection and their diabetic management practices, revealing several statistically significant associations. Children who did not follow a diabetes-specific diet had significantly higher scores ($p = 0.019$). Emotional responses to injection also influenced performance ($p = 0.023$), with those experiencing anxiety surprisingly scoring highest, while those reporting fear had the lowest scores. Regular monitoring of insulin levels showed a highly significant association ($p = 0.001$).

Other variables, such as prior self-injection experience, type of insulin delivery method, and glucose meter type, did not show significant differences (all p-values > 0.05).

DISCUSSION:

The initial main finding of this study indicated strong acceptance and active participation among the children, underscoring the critical need for enhanced diabetes health education in pediatric populations. As presented in figure (1), the children's performance on insulin self-injection before and after the therapeutic training game was increased, with mean score 70.2±7.32 in the pre-test to 86.0±4.74 in the post-test. These improvements were statistically significant ($p < 0.001$), confirming the effectiveness of the training intervention. The therapeutic training provided a comprehensive and well-organized curriculum that covered all the essential aspects of self-injection, ensuring that children had a complete understanding of the process.

This finding is consistent with several studies used a variety of interactive and engaging teaching methods, including visual aids, hands-on exercises, and digital resources (e.g., PowerPoint presentations, educational videos, virtual simulations, interactive apps, illustrations, and charts) (Brown et al., 1997; La Banca et al., 2021; Shiferaw et al., 2021; Verdezoto Alvarado et al., 2023). The therapeutic training game and the instructional materials were designed to fit the cognitive and emotional development of young children, making learning effective and enjoyable. The training game involved the presence of practical hands-on training development of competence and skill in self-injection techniques. It provided ongoing support and personalized guidance, ensuring that each child received individual attention and encouragement. The training game included visual, auditory, and kinesthetic (puppet-based) learning techniques, which were aligned with different learning

styles and promoted skill acquisition (Shiferaw et al., 2021). Regular assessments and constructive feedback helped track progress, identify areas for development and improvement, and ensure that skills were properly acquired and mastered (Bakir et al., 2023). The training game fostered a supportive and stimulating environment, empowered children to take responsibility for their health, and promoted independence. It is characterized by its holistic, child-centered approach, and effectively combines practice and emotional support in a playful way to ensure long-term success in self-management of diabetes (Sasha Muhammed et al., 2023).

The second finding of this study revealed that children aged 11–13 years, those attending middle school, residing in urban areas, and those diagnosed at older ages (≥ 9 years) achieved significantly higher mean scores. These characteristics appear to be associated with greater responsiveness to training games, likely due to improved health literacy, access to healthcare resources, cognitive maturity, and longer disease experience, which collectively enhance skill acquisition. These results were with a previous study suggests that older children benefit more from such programs than younger ones, reflecting differences in comprehension and cognitive development (Manganello, 2008). Another study showed that the middle school children demonstrated higher scores compared to primary school children, possibly due to a stronger academic foundation and prior exposure to health-related topics, including diabetes, which facilitated better understanding and practice of insulin self-injection (La Banca et al., 2021). The urban residency was associated with higher performance, likely due to better access to healthcare infrastructure, specialized caregivers, educational resources, and supportive programs designed for children with diabetes. In contrast, children in rural areas may face barriers such as fewer healthcare facilities, limited trained professionals, and challenges in accessing services due to distance or transportation constraints. Furthermore, pain-free children at the injection site performed better score, suggesting that discomfort may hinder engagement and proper injection technique, underscoring the need to address pain management in training game (Omar El Shourbagy, 2015; Shimaa Mohamed Elsayed, 2020). However, the presence of side effects has a negative impact on the child's ability to effectively learn the technique of self-insulin injection. Therefore, addressing these side effects (such as improving injection technique or using less painful needles and replace the injection site) is critical to improve the child's experience and increase his self-insulin injection skills.

The Final Finding of the current study reveal a statistically significant relationship between insulin self-injection training and disease management in children with diabetes. Children with anxiety were more receptive to training, highlighting the importance of psychological support. Additionally, regular glucose monitoring was linked to better training outcomes, emphasizing the need for consistent monitoring and parent-child education to improve diabetes management and prevent complications. These results were in consistent with other studies that emphasized the need to educate children with psychological support to achieve stable blood sugar levels and preventing complications (AlBurno et al., 2022; Ali Dawood Salman, 2021; La Banca et al., 2021).

CONCLUSIONS:

The current study conclude that child-centered, interactive training programs combined with emotional support and family involvement effectively promote independence, skill acquisition, and improved diabetes self-management.

RECOMMENDATIONS:

It is recommended to integrate interactive, child-centered therapeutic training programs into pediatric diabetes education, tailored to

developmental levels and supported by multimodal learning approaches.

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TABLES:

Table (1): The frequency distribution of demographic and clinical data for the studied children with diabetes (n=33).

Demographic and Clinical Data	Category	F. (%)
Age Group (years)	≤ 10	12 (36.36)
	11 - 13	15 (45.45)
	≥ 14	6 (18.18)
	Mean ± SD (min- max)	12 ± 3 (7-17)
Gender	Males	12 (36.36)
	Females	21 (63.64)
Education Level	Primary school	15 (45.45)
	Middle school	18 (54.55)
Residence	Rural	3 (9.09)
	Urban	30 (90.91)
Age at Diagnosis (years)	≤ 2	10 (30.30)
	3 - 5	8 (24.24)
	6 - 8	9 (27.27)
	≥ 9	6 (18.18)
	Mean ± SD (min- max)	5.7 ± 3.4 (1-11)
Family History of Diabetes	No	21 (63.64)
	Yes	12 (36.36)
Comorbid Conditions	No	21 (63.64)
	Yes	12 (36.36)
Injection Site Pain/Stiffness	No	3 (9.09)
	Yes	30 (90.91)
Total		33 (100%)

F. = frequency, %= percentage, min= minimum, max=maximum.

Table (2): The frequency distribution of Diabetic Management practice for the studied children with diabetes (n=33)

Diabetic Management Practice	Category	F. (%)
Diet to control diabetes	No	30 (90.91)
	Yes	3 (9.09)
Who helps the child manage diabetes?	Nobody	2 (6.06)
	Parents	31 (93.94)
Attempted self-injection	No	23 (69.70)
	Yes	10 (30.30)
Type of insulin injection	Needle Syringe	23 (69.70)
	Insulin Pen	10 (30.30)
Knows how to calculate insulin dose	No	12 (36.36)
	Yes	21 (63.64)
Emotional response to injection	No emotional distress	18 (54.55)
	Anxiety	6 (18.18)
	Fear	9 (27.27)
Monitors insulin levels regularly	Always	24 (72.73)
	Sometimes	6 (18.18)

Type of blood glucose meter	Rarely	3 (9.09)
	With pricking	31 (93.94)
	Without pricking	2 (6.06)
Total		**33 (100%)**

F. = frequency, %= percentage.

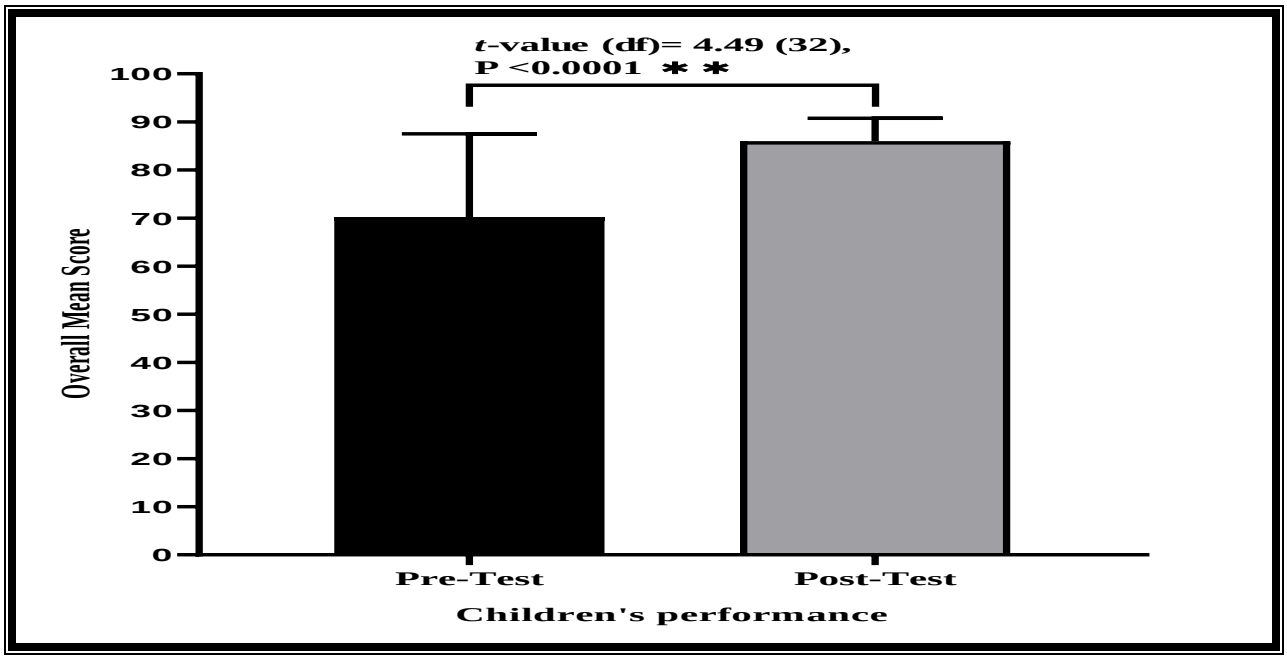

Figure (1): Bar chart of the children's performance scores on insulin self-injection before and after the training game (n=33).

Table (3): Relationship between children's post-training performance scores on insulin self-injection and their demographic and clinical data.

Demographic and clinical data	Category	n	Mean ± SD of Children's performance after the game	Statistical Test	P-Value
Age Group (Years)	≤ 10	12	82.50 ± 2.61	11.125#	<0.0001**
	11 - 13	15	89.20 ± 3.67		
	≥ 14	6	85.00 ± 5.48		
Gender	Male	12	86.50 ± 2.15	0.452ψ	0.654
	Female	21	85.71 ± 5.76		
Education Level	Primary school	15	84.00 ± 3.87	2.364ψ	0.025*
	Middle school	18	87.67 ± 4.85		
Residence	Rural	3	80.00 ± 1.12	2.475ψ	0.019*
	Urban	30	86.60 ± 4.55		
Age at Diagnosis (years)	≤ 2	10	87.50 ± 3.54	13.19#	<0.0001**
	3 - 5	8	80.00 ± 2.43		
	6 - 8	9	87.00 ± 2.29		
	≥ 9	**6**	**90.00 ± 5.48**		
Family History of Diabetes	No	21	87.14 ± 4.63	1.905ψ	0.066
	Yes	12	84.00 ± 4.43		

Comorbid Conditions	No	21	85.71 ± 5.07	0.452ψ	0.654
	Yes	12	86.50 ± 4.27		
Injection Site Pain/Stiffness	No	3	95.00 ± 3.99	4.278ψ	<0.0001**
	Yes	30	85.10 ± 3.95		

#: Statistics was done using One Way ANOVA, ψ: Statistics was done using independent t test, *: significant at (P< 0.05), **: high significant at (P< 0.01).

Table (4): Relationship between children's post-training performance scores on insulin self-injection and their Diabetic Management Practice.

Diabetic Management Data	Category	n	Mean ± SD of Children's performance after the game	Statistical Test	P-Value
Diet to control diabetes	No	30	86.60 ± 4.55	2.457ψ	0.019*
	Yes	3	80.00 ± 3.13		
Who helps the child manage diabetes?	Nobody	2	90.00 ± 3.22	1.241ψ	0.224
	Parents	31	85.74 ± 4.78		
Attempted self-injection	No	23	85.48 ± 4.50	0.957ψ	0.346
	Yes	10	87.20 ± 5.31		
Type of insulin injection	Needle Syringe	23	85.04 ± 5.00	1.819ψ	0.079
	Insulin Pen	10	88.20 ± 3.33		
Knows how to calculate insulin dose	No	12	86.25 ± 4.33	0.225ψ	0.823
	Yes	21	85.86 ± 5.06		
Emotional response to injection	No emotional distress	18	86.00 ± 5.48	4.286#	0.023*
	Anxiety	6	90.00 ± 3.41		
	Fear	9	83.33 ± 2.50		
Monitors insulin levels regularly	Always	24	87.63 ± 4.36	9.679#	0.001**
	Sometimes	6	80.00 ± 3.92		
	Rarely	3	85.00 ± 2.95		
Type of blood glucose meter	With pricking	31	85.74 ± 4.78	1.241ψ	0.224
	Without pricking	2	90.00 ± 3.85		

#: Statistics was done using One Way ANOVA, ψ: Statistics was done using independent t test, *: significant at (P< 0.05), **: high significant at (P< 0.01).