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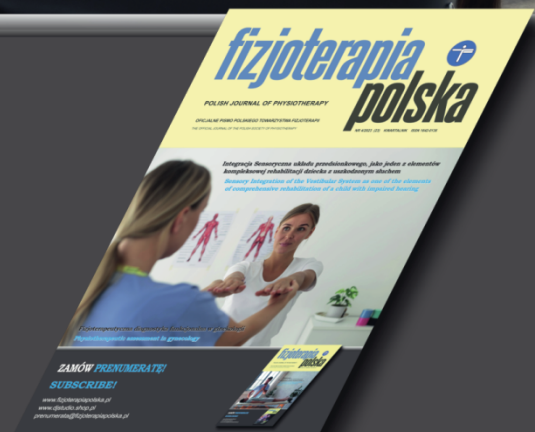
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# Effect of the family-centered program on management of blood glucose levels among children with type 1 diabetes at Tabuk

*Wpływ programu opartego na rodzinie na zarządzanie poziomem glukozy we krwi u dzieci z cukrzycą typu 1 w Tabuk*

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## Abstract

**Background.** Diabetes mellitus (DM) is the second most common chronic disease in childhood. Diabetes care is multidimensional and should focus on preventing acute complications and reducing long-term consequences. A family-centered approach conserves the integrity of families and supports unique care for diabetic children.

**Purpose.** The study aimed to determine the effect of a family-centered program on the management of blood glucose levels in children with type 1 diabetes mellitus at Tabuk. **Methods.** The researcher employed a quasi-experimental design to conduct this study.

A purposive sample of diabetic children and their families was included. Tools included a structured questionnaire (sociodemographic data, anthropometric measurements), Supervisory Behaviors of Caregivers, Management Behaviors of Children with DM questionnaires, a Self-efficacy Scale, and a Blood Glucose Levels Record Sheet. The study was conducted in three phases: preparatory, performance, and evaluation. Pre-test and post-test methods were utilized for data collection.

**Results.** There was a significant decrease in the mean scores of blood glucose levels, significant improvement in children's management behavior for diabetic care, improvement in mothers' supervisory behavior of management behavior for DM, and higher mean scores of mothers' self-efficacy post compared to pre-family centered program.

**Conclusion.** Implementing the family-centered program improved children's diabetic management behavior and hence controlling the blood glucose levels of children with diabetes mellitus and increased mothers' self-efficacy. **Recommendation.** Transformation of diabetic management in children with DM to a fully family-centered system of care should be established.

## Keywords

diabetes mellitus, family-centered program, blood glucose levels

## Streszczenie

**Wprowadzenie.** Cukrzyca (DM) jest drugą najczęstszą przewlekłą chorobą w dzieciństwie. Opieka nad cukrzykami jest wielowymiarowa i powinna koncentrować się na zapobieganiu ostrych powikłań i zmniejszaniu długoterminowych konsekwencji. Podejście skoncentrowane na rodzinie zachowuje integralność rodzin i wspiera unikalną opiekę nad dziećmi z cukrzycą.

**Cel.** Celem badania było określenie wpływu programu opartego na rodzinie na zarządzanie poziomem glukozy we krwi u dzieci z cukrzycą typu 1 w Tabuk. **Metody.** Badacz zastosował quasi-eksperymentalny projekt badania. Do badania włączono celową próbkę dzieci z cukrzycą i ich rodzin. Narzędzia obejmowały sformalizowany kwestionariusz (dane socjodemograficzne, pomiary antropometryczne), Kwestionariusze Zachowań Nadzorczych Opiekunów, Zachowań Zarządzania Dziećmi z DM, Skalę Samooceny oraz Arkusz Rejestracji Poziomu Glukozy we Krwi. Badanie przeprowadzono w trzech fazach: przygotowawczej, wykonawczej i oceny.

Wykorzystano metody przedtestowe i potestowe do zbierania danych.

**Wyniki.** Stwierdzono znaczący spadek średnich wyników poziomu glukozy we krwi, znaczącą poprawę zachowań zarządzania cukrzycą u dzieci, poprawę zachowań nadzorczych matek nad zachowaniami zarządzania DM, oraz wyższe średnie wyniki samooceny matek po w porównaniu do okresu przed programem skoncentrowanym na rodzinie.

**Wnioski.** Wdrożenie programu skoncentrowanego na rodzinie poprawiło zachowania zarządzania cukrzycą u dzieci, a tym samym kontrolę poziomu glukozy we krwi u dzieci z cukrzycą i zwiększyło samoocenę matek. **Rekomendacja.** Transformacja zarządzania cukrzycą u dzieci z DM na system opieki w pełni skoncentrowany na rodzinie powinna zostać ustanowiona.

## Słowa kluczowe

cukrzyca, program skoncentrowany na rodzinie, poziom glukozy we krwi



## Introduction

Worldwide, diabetes mellitus (DM) is currently a major health problem. Type 1 DM or insulin-dependent diabetes mellitus (IDDM) is the most prevalent and common chronic childhood disease [1]. The incidence rate of IDDM is also growing in Saudi Arabia. Recent reports indicated that the incidence rate is 27.5/100,000 [2] and 29/100,000, which are high rates. The prevalence of IDDM in Saudi children and adolescents is 109.5 per 100,000 [3].

Diabetes in children and adolescents is characterized by hyperglycemia, a tendency towards hypoglycemia, and difficulties in insulin adjustment. High blood glucose levels can result in acute diabetic ketoacidosis and long-term complications such as blindness, kidney failure, and microvascular and macrovascular complications, and may have adverse effects on cognitive function [4]. These complications increase the rates of morbidity, mortality, and healthcare costs [5].

Therefore, these children need to protect themselves against the long-term consequences of hyperglycemia, as well as hypoglycemia. This justifies the importance of improving glycemic control, which is simply to keep blood glucose within appropriate levels [6]. This targeted glycemic control requires multidimensional care such as diet control, regular activity, monitoring blood glucose levels, and daily insulin injection. However, children are often incapable of handling their self-monitoring and treatment responsibly [7].

Hence, optimal management of diabetic children to maintain blood glucose levels in the near-normal range cannot be performed unless the families - as a whole - are designated the client. In Saudi Arabia, "families with insufficient knowledge about diabetes, especially in pediatric age groups, fail to identify the symptoms of diabetic ketoacidosis" [1]. Therefore, diabetic children and their families require lifelong education and training [8].

Family-centered care philosophy recognizes the family as the constant in a child's life. Its emphasis is on supporting, respecting, encouraging, and enhancing the strengths and competencies of the families [9]. Pediatric nurses committed to family-centered care will carefully plan instruction and practices and then allow families to demonstrate their ability to provide care for their children [10]. Family-centered care is "an approach to the planning, delivery, and evaluation of health care that is governed by mutually beneficial partnerships between health care professionals, patients, and families". Nursing care for children and adolescents is therefore embedded in two basic concepts of family-centered care: enabling and empowerment [11].

Furthermore, the scope of family-centered care includes caring for the child within the family frame, easing the participation of parents in care, recognizing and promoting the strengths of the family; looking after the child according to his/her age, communicating information with the children and their families, appreciating the individuality of each family, and designing flexible and effective health care plans for each family [12].

Family-centered care improves the quality and safety of

a child's care by helping to foster communication between families and healthcare professionals. Furthermore, it leads to a wiser allocation of healthcare resources, as well as greater patient and family satisfaction [13]. Nurses have an important role in providing standardized diabetic care. The primary focus of nursing care for diabetic children is to enable them and their families to manage blood glucose levels to prevent and/or minimize the occurrence of diabetes complications [8]. They can help to maximize children's potential by advocating, health teaching, and promoting and coordinating a supportive family environment [14].

## Significance of the study

In an international, population-based cross-sectional study conducted by Al-Rubeaan et al., [15] the investigators articulated that abnormal glucose metabolism has become epidemic in Saudi Arabia. Approximately, one-third of the Saudi population is affected. They clarified that among KSA regions, Tabuk has the highest rates (1.3%) of type 1 diabetes. Recently, about seven million Saudi people are challenged with diabetes, and three million are prediabetic [16]. Despite this high prevalence, poor glycemic control among diabetic children is reported by various studies.

On the other hand, there is a scarcity in implementing family-centered care by healthcare professionals. Additionally, the cost of preventive measures is significantly lower than handling the anticipated complications; consequently, cost-effectiveness favors preventive efforts [17]. Therefore, the purposes of the study were to design a family-centered program for children with diabetes, establish sustainable management of blood glucose levels among diabetic children, evaluate self-efficacy among mothers caring for children with diabetes, and determine the effect of a family-centered program on the management of blood glucose levels in children with diabetes mellitus.

## Hypotheses

Children with diabetes mellitus who receive a Family-Centered Care program will have improved blood glucose levels. A Family-Centered Care program will increase mothers' self-efficacy.

## Setting and samples

This study was conducted at governmental hospitals and primary health care centers in Saudi Arabia. A purposive sample of 50 children and their mothers was recruited according to the following inclusion criteria: (a) children had a diagnosis of type 1 diabetes, (b) age ranges from 1 to 18 years, (c) did not have any other chronic illness, and (d) did not participate in any training program for the last 3 months to ensure the quality of the collected data. The sample size was determined based on the study by Cheraghi et al. (2015). They used the formula  $n = p - (1 - p) \times (z1 - \alpha / 2 + z1 - \beta)^2 \div (p1 - p2)^2$ , considering the confidence level of 0.95 and test power of 80%. The calculated sample size was 75 children; however, only 50 children who met the selection criteria were available.

## Measurement and Data Collection

Three instruments were utilized to collect the required data.

### *Instrument one*

Structured Questionnaire. It was developed by the researcher to assess the behavior of the caregiver. It was divided into three parts:

#### *Part one*

Socio-demographic characteristics of children, to obtain data such as children's age, sex, and body weight.

#### *Part two*

Supervisory Behaviors of Caregiver. It was adapted from Cheraghi et al. (2015), which are observational checklists covering four main areas of management behaviors for DM. It included supervision of blood glucose testing, insulin therapy, meal planning, and physical activity. Scores of each checklist ranged as two for "done" and one for "not done", then the sum of all items of each checklist was calculated. Adequate performance is indicated when the total score is  $\geq 60\%$  and inadequate performance for  $< 60\%$ .

#### *Part three*

Management Behaviors of Children with DM questionnaires, adapted from Cheraghi et al. [12]. It is a five-point Likert scale that included 29 statements to assess children's management behavior regarding meal control (8 statements), exercise (2 statements), insulin therapy (9 statements), and hypo/hyperglycemia (6 statements), mother's perception (4 statements). Responses rank between strongly agree and strongly disagree. The total score ranged from 0 to 145 points. The higher the score, the better the management behavior of children. The reliability of the tool was tested by Cronbach's Alpha test ( $r = 0.83$ ).

### *Instrument two*

Self-efficacy Scale, adapted from Sherer & Maddux [18]. It is a five-point Likert scale ranging from strongly agrees to strongly disagrees. It included 17 statements that assessed the general self-efficacy of mothers. The total score ranged from 0 to 85 points. The higher the score, the better the self-efficacy of mothers. The high self-efficacy level ranged from  $> 42$  to 85, and the low level was 0-42. Its reliability of the Cronbach's Alpha test was  $r = 0.86$ .

### *Instrument three*

Blood Glucose Levels Record Sheet. It included two readings of blood glucose at the first session and the last session.

## Validity and Reliability

Tools were adapted by the researcher for data collection after reviewing past and current literature, local and international related literature using books and articles. Furthermore, the tools were submitted to a panel of three pediatric nursing experts for validity purposes. The tool's reliability was tested by Cronbach's coefficient alpha.

## Procedure

The researcher conducted the study in three phases: preparatory, performance, and evaluation.

### *Preparatory phase*

An extensive review of relevant literature was performed to be acquainted with various aspects of the research problem and to develop the tools for data collection and a family-centered program for diabetic children and their families.

The researcher designed the family-centered program. It included standardized diabetic care (glucose monitoring, insulin injection, nutrition, activity, and hypo/hyperglycemia).

Before data collection, written permission to carry out the study was obtained from the director of the setting.

### *Performance phase*

Before implementing the family-centered program, the researcher primarily assessed the study group to collect the pre-intervention data, which was utilized to be compared to post-intervention data. Each data collection interview lasted between 20 and 30 minutes.

The family-centered program is conducted in 5 sessions; each session lasts from 30 to 45 minutes. It was held guided by the family-centered care elements, which include acknowledging the family as the constant in a child's life, building on family strengths, supporting the child in learning about and participating in his/her care and decision-making, honoring cultural diversity and family traditions, recognizing the importance of community-based services, promoting an individual and developmental approach, encouraging family-to-family and peer support, and celebrating successes.

### *Evaluation Phase*

At the end of the family-centered sessions, the researcher reassessed children and their families using the tools of study.

Blood glucose monitoring was conducted during the preparatory phase and evaluation phase.

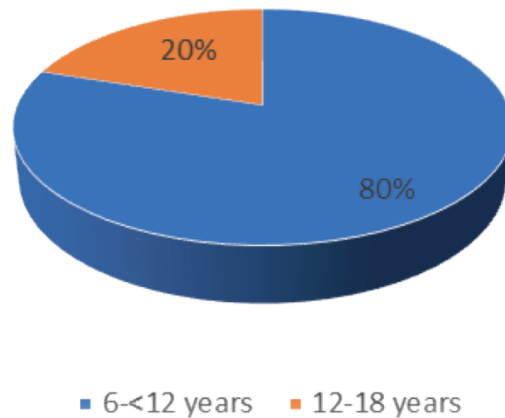
## Data Analysis

Data were categorized, tabulated, and summarized then they were computerized and analyzed by SPSS version 20 (SPSS Inc., Chicago, IL, USA). Two types of statistics were done, descriptive and analytical, to examine the research hypothesis. Descriptive statistics were done using percentage, mean, and standard deviation (SD). Analytical statistics used in the study were Chi-Squared ( $\chi^2$ ), independent t-test, and paired t-test. Statistically, a significant difference was found in  $P < 0.05$ .

## Ethical Considerations

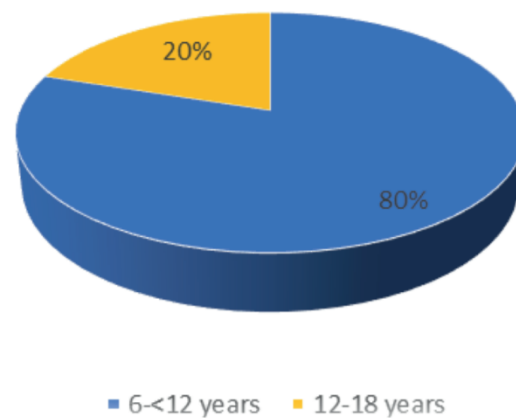
The researcher obtained ethical approval from the Research Ethics Committee at Tabuk University. Furthermore, clear explanations regarding the objectives, importance, safety, and confidentiality of the research were provided to the children and their parents before obtaining their agreement to participate in the study.





**Figure 1. Distribution of Children According to Their Gender**

Figure 1 showed the distribution of children according to their gender. It clarified that more than half of the children (52%) were female.



**Figure 2. Distribution of Children According to Their Age**

Figure 2 showed the distribution of children according to their age. It clarified that most children (80%) were between 6–12 years old with a mean score of  $6.75 \pm 3.23$ .

**Table 1. Mean Scores of Children's Blood Glucose Levels at Pre- and Post-Family-Centered Program**

	Post-intervention (n=50) Mean $\pm$ SD	Pre-intervention (n=50) Mean $\pm$ SD	t-test	P
Blood glucose levels	196.9 $\pm$ 25.4	186.0 $\pm$ 19.9	8.9	0.000***

Table 1 shows the mean scores of children's blood glucose levels at pre- and post-family-centered program. It illustrated that children had decreased mean scores of blood glucose levels in the post-family-centered program compared to the pre-

family-centered program ( $186.0 \pm 19.9$ ,  $196.9 \pm 25.4$  respectively). Hence, there was a highly statistically significant difference between children's blood glucose levels at a 1% level of statistical significance.

**Table 2. Mean Scores of Children's Management Behavior for DM on Pre- and Post-Family-Centered Program**

Children's management behavior for DM	Pre-intervention (n = 50) Mean ± SD	Post-intervention (n = 50) Mean ± SD	Parried t-test	P – value
Meal control	32.5 ± 2.7	36.3 ± 1.5	12.7	0.00***
Exercise	6.12 ± 1.3	8.1 ± 1.01	11.4	0.00***
Insulin therapy	33.4 ± 2.3	39.6 ± 3.3	12.7	0.00***
Hypo-hyperglycemia	21.7 ± 1.5	25.4 ± 1.6	14.5	0.00***
Mother's perception	13.9 ± 2.7	17.2 ± 0.84	9.1	0.00***
Total	107.8 ± 7.8	127.2 ± 6.6	16.5	0.00***

\*\*\* Highly statistically significant at  $P < 0.001$

Table 2 showed the mean scores of children's management behavior for DM on pre- and post-family-centered program. It asserted that children had higher means of management behaviors for DM in the post-family-centered program compared to the pre-family-centered program in areas of meal control, exercise, insulin therapy, hypo-hyperglycemia, mother's per-

ception, and total diabetic management behavior ( $36.3 \pm 1.5$ ,  $8.1 \pm 1.01$ ,  $39.6 \pm 3.3$ ,  $25.4 \pm 1.6$ ,  $17.2 \pm 0.84$ , and  $127.2 \pm 6.6$  respectively). Therefore, there were highly statistically significant differences between children's management behavior for DM on pre- and post-family-centered program at a 1% level of statistical significance.

**Table 3. Mean Scores of Children's Management Behavior for DM and Blood Glucose Levels in Relation to Their Age on Pre- and Post-Family-Centered Program**

Management behavior for DM	6-12 Years (n = 40) Mean ± SD	12-18 Years (n = 10) Mean ± SD	t-test	P – value
<b>Meal control</b>	32.5 ± 2.9	32.7 ± 1.06	0.4	0.7 ns
Pre	36.1 ± 1.6	36.9 ± 0.9	2.13	0.042*
Post				
<b>Exercise</b>	6.2 ± 1.4	5.8 ± 0.4	1.5	0.13 ns
Pre	8.1 ± 1.1	8.2 ± 0.6	0.56	0.6 ns
Post				
<b>Insulin</b>	33.6 ± 2.4	32.6 ± 1.07	1.99	0.05*
Pre	38.9 ± 3.3	42.5 ± 0.9	6.01	0.00***
Post				
<b>Hypo-hyperglycemia</b>	21.7 ± 1.7	21.6 ± 0.6	0.31	0.75 ns
Pre	25.23 ± 1.6	26.5 ± 1.9	2.63	0.01*
Post				
<b>Mother's perception</b>	14.4 ± 2.6	11.8 ± 1.7	3.9	0.001***
Pre	17.3 ± 0.8	16.8 ± 1.03	1.3	0.22 ns
Post				
<b>Total management behavior for DM</b>				
Pre	108.6 ± 8.4	104.9 ± 3.7	2.07	0.046*
Post	125.8 ± 6.6	132.5 ± 3.03	4.73	0.00***
<b>Blood glucose level</b>				
Pre	189.6 ± 10.9	226.5 ± 42.7	4.9	0.00***
Post	179.9 ± 8.3	210.6 ± 32.04	5.52	0.00***

ns = not significant ( $p > 0.05$ ) (\*) = ( $p < 0.05$ ), \*\*\* highly statistically significant at  $P < 0.001$



Table 3 illustrated mean scores of children's management behavior for DM and blood glucose levels in relation to their age on pre- and post-family-centered program. It clarified that on the post-family-centered program, older children (12–18 years) had higher mean scores of management behaviors for DM compared to younger children (6–12 years) in areas of meal control, insulin therapy, hypo-hyperglycemia, and total diabetic management behavior ( $36.9 \pm 0.9$ ,  $42.5 \pm 0.9$ ,

$26.5 \pm 1.9$ , and  $132.5 \pm 3.03$  respectively). In relation to blood glucose levels, younger children demonstrated lower blood glucose levels ( $189.6 \pm 10.9$ ,  $179.9 \pm 8.3$ ) in both pre- and post-family-centered program compared to older children ( $226.5 \pm 42.7$ ,  $210.6 \pm 32.04$ ). Therefore, there were highly statistically significant differences between children's management behavior for DM on the post-family-centered program based on their age.

**Table 4. Mean Scores of Children's Management Behavior for DM and Blood Glucose Levels in Relation to Their Gender on Pre- and Post-Family-Centered Program**

Management behavior for DM	Male (n = 24) Mean $\pm$ SD	Female (n = 26) Mean $\pm$ SD	Independent t-test	P – value
<b>Meal control</b>				
Pre	$33.4 \pm 2.1$	$31.7 \pm 2.9$	2.5	0.03*
Post	$36.5 \pm 1.4$	$36.0 \pm 1.6$	1.3	0.21 ns
<b>Exercise</b>				
Pre	$6.3 \pm 1.3$	$5.9 \pm 1.2$	0.9	0.4 ns
Post	$8.1 \pm 1.2$	$8.1 \pm 0.8$	0.02	0.9 ns
<b>Insulin</b>				
Pre	$33.6 \pm 2.2$	$33.3 \pm 2.3$	0.49	0.63 ns
Post	$40.5 \pm 3.1$	$38.7 \pm 3.4$	1.93	0.06 ns
<b>Hypo-hyperglycemia</b>				
Pre	$22.1 \pm 1.5$	$21.3 \pm 1.5$	1.8	0.08 ns
Post	$25.8 \pm 1.7$	$25.04 \pm 1.3$	1.7	0.09 ns
<b>Mother's perception</b>				
Pre	$13.9 \pm 2.9$	$13.9 \pm 2.5$	0.01	0.99 ns
Post	$17.1 \pm 0.9$	$17.2 \pm 0.7$	0.30	0.78 ns
<b>Management behavior</b>				
Pre	$109.5 \pm 8.3$	$106.3 \pm 7.1$	1.6	0.16 ns
Post	$129.0 \pm 6.7$	$125.5 \pm 6.1$	1.9	0.06 ns
<b>Blood glucose level</b>				
Pre	$201.08 \pm 34.8$	$193.1 \pm 11.4$	1.1	0.3 ns
Post	$189.04 \pm 27.5$	$183.2 \pm 8.2$	1.01	0.3 ns

\* Statistically significant at  $P < 0.05$ , ns None statistically significant

Table 4 showed mean scores of children's management behavior for DM and blood glucose levels in relation to their gender on pre- and post-family-centered program. It clarified that girls had lower mean scores of management behaviors for DM compared to boys in areas of meal control, exercise, insulin therapy, hypo-hyperglycemia, mother's perception, total diabetic management behavior, and blood glucose levels ( $36.0 \pm 1.6$ ,  $8.1 \pm 0.8$ ,

$38.7 \pm 3.4$ ,  $25.04 \pm 1.3$ ,  $125.5 \pm 6.1$ , and  $183.2 \pm 8.2$  respectively) in both pre- and post-family-centered program. However, there were no statistically significant differences between children's management behavior for DM on pre- and post-family-centered program based on gender, except for meal control.

**Table 5. Mothers' Supervisory Behavior of Management Behavior for DM on Pre- and Post-Family-Centered Program**

Supervision behavior	Pre-intervention (n = 50)		Post-intervention (n = 50)		X <sup>2</sup>	P
	N	%	N	%		
Blood glucose testing						
Adequate performance	17	34	48	96	59.2	0.00***
Inadequate performance	33	66	2	4		
Insulin therapy						
Adequate performance	17	34	38	76	27.6	0.00***
Inadequate performance	33	66	12	24		
Physical activity						
Adequate performance	19	38	44	88	47.1	0.00***
Inadequate performance	31	62	6	12		
Meal planning						
Adequate performance	12	24	40	80	28.5	0.00***
Inadequate performance	38	76	10	20		

\*\*\* Highly statistically significant at  $P < 0.001$

**Table 5. Mothers' Supervisory Behavior of Management Behavior for DM on Pre- and Post-Family-Centered Program**

Table 5 showed mothers' supervisory behavior of management behavior for DM on pre- and post-family-centered program. It clarified that most of the parents had improved their supervision skills of management behavior for DM on the

post-family-centered program in areas of blood glucose monitoring, insulin therapy, physical activity, and meal planning (96%, 76%, 88%, 80% respectively). Therefore, there were highly statistically significant differences between parental supervision skills of management behavior for DM on the post-family-centered program.

**Table 6. Mothers' Self-Efficacy on Pre- and Post-Family-Centered Program**

Self-efficacy level	Pre-intervention (n = 50)		Post-intervention (n = 50)		t-test	P
	N	%	N	%		
High self-efficacy	19	38%	47	94%	14.7	0.00***
Low self-efficacy	31	62%	3	6%		
Mean ± SD	42.32 ± 3.1		49.7 ± 4.3			

\*\*\* Highly statistically significant at  $P < 0.001$

Table 6 illustrated mothers' self-efficacy on pre- and post-family-centered program. It asserted that most of the mothers had high self-efficacy on the post-family-centered program compared to the pre-family-centered program (94%, 38%), as well as a higher mean score of mothers' self-efficacy on the

post than on the pre-family-centered program (49.7  $\pm$  4.3, 42.32  $\pm$  3.1 respectively). Therefore, there was a highly statistically significant difference between mothers' self-efficacy on pre- and post-family-centered program at a 1% level of statistical significance.



## Discussion

Diabetes Mellitus is a concerning health problem in Saudi Arabia, which ranks seventh among the top 10 countries in terms of a high prevalence of diabetes and is expected to be the sixth by 2035 [19]. Diabetes is strikingly high among Saudi children and adolescents; its prevalence was 0.4% and 5.2% for type 1 diabetes and type 2 diabetes among young children (0-6 years) and older children (7-18 years) respectively. Furthermore, those children had impaired fasting blood glucose levels ranging from 2.8% to 6.4% respectively [15].

The primary focus of nursing care for diabetic children is to enable them and their families to manage blood glucose levels to prevent and/or minimize the occurrence of diabetes complications [20]. It can help to maximize children's potential by advocating, health teaching, promoting, and coordinating a supportive family environment [14]. Targeted glycemic control requires multidimensional care such as diet control, regular activity, monitoring blood glucose levels, and daily insulin injection [21]. However, children are often incapable of handling their self-monitoring and treatment responsibly.

Therefore, the current study aimed at determining the effect of a family-centered program on the management of blood glucose levels in children with type 1 diabetes mellitus at Tabuk. It hypothesized that children with diabetes mellitus who received a family-centered program would have improved blood glucose levels. In addition, the family-centered program would increase mothers' self-efficacy.

The findings of the existing study support the first hypothesis. It revealed a significant improvement in blood glucose levels among children with diabetes mellitus who received a family-centered program. Regarding blood glucose levels among children with diabetes, children showed lower mean blood glucose levels ( $186.0 \pm 19.9$ ) on the post-test compared to ( $196.9 \pm 25.4$ ) on the pre-test, which reflects the effectiveness of the family-centered program in controlling blood glucose levels. This finding was in accord with the findings of prior studies, which indicated the pivotal part of parents' support and guidance in blood glucose monitoring and control [22, 23, 24, 25].

In addition, this finding agreed with McBroom & Enriquez [26], and Katz et al., [27] who confirmed that family-centered care promoted children's level of health. They illustrated that parents' active involvement and shared responsibility facilitated and improved blood glucose control and management of diabetes among their children. Besides, this finding was supported by the relationship between family support and a child's commitment to diabetes management, which was reported by Graça Pereira et al. [28].

Furthermore, blood glucose levels based on children's age showed that school-aged children (6-12 years old) had significant improvement in their blood glucose level ( $179.9 \pm 8.3$ ) compared to adolescents (12-18 years old) ( $210.6 \pm 32.04$ ) after conducting the family-centered program. This finding reflects the positive effects of family-centered programs on the control of blood glucose levels among school-age children more than adolescents.

This significant improvement in blood glucose levels among school-aged children may be related to the different develop-

mental attributes between school-age children and adolescents, which made school-age children more adherent to the diabetic management behaviors instructed by the researcher and followed up by parents than adolescents who tend to oppose adult authority. Levine et al. [29] and Schmidt's [30] studies show that the metabolic outcome of school-age children with DM is related to how well the family is guided and controlled. They said that mothers should be involved in diabetes care for their school-age children, even though children can show the motor skills and technical aspects needed for diabetes care. Those children have immature cognitive functioning.

On the other hand, parents' authority is easier when children are 8 or 9 years old than when they are teenagers. He clarified that adolescents tend to become more independent and protest impositions of limits [31]. In addition, during adolescence, there are low adherence levels and poor glycemic control; only 17% of adolescents accomplish the targeted levels of blood glucose levels [32].

Regarding management behavior among diabetic children pre- and post-test, children exhibited increased means of meal control (36.3), exercise (8.1), insulin (39.6), hypo- and hyperglycemia (25.4), mothers' perception (17.2), and total management behavior (127.2) at post-test compared to pre-test with a statistically significant improvement ( $P$  value  $< 0.00$ ) in management behavior. These findings reflected the positive effects of the family-centered program on children's management behavior for diabetic care, which in turn translated into more commitment to treatment regimens that aimed at controlling blood glucose levels and reducing diabetic consequences and complications.

These findings are in consistence with Mendez and Belendez [33], who found in their study about behavioral intervention for diabetic adolescents that the behavioral intervention program had no effects on either blood glucose levels or exercise and diet. Nevertheless, they indicated that the program had improved the skills of insulin therapy and increased the frequency of glycemic analyses. Also, Marigliano et al. [34] reported that children with T1DM were unable to understand their disease or diabetic management.

On the other hand, in agreement with Silverstein et al. [35], they concluded that patients with type 1 DM who received self-care teaching showed reduced insulin injection complications. In addition, other researchers documented the effectiveness of educational intervention for diabetic children regarding the effect of physical exercise on the control of blood glucose levels [36]. Furthermore, Aklima, Kritpracha, and Thaniwattananon [14] stated that family-centered care improved diet and meal plan skills among diabetic patients by empowering them. Hence, improved meal planning skills among children could prevent hypoglycemia and hyperglycemia as indicated by Silverstein et al. [35], who mentioned that three meals in addition to three snacks per day control the blood glucose levels and prevent undesired consequences. Even more, Cheraghi et al. [12] reported decreased mean levels of blood glucose among adolescents with T1DM during the 1st week after conducting a family-centered intervention for adolescents and their families. In sum, they illustrated that adolescents' skills in blood glucose testing, insulin administra-

tion, insulin dosage adjustment, and meal planning had been improved after the implementation of an empowering, family-centered intervention for those adolescents and their families. In congruence with the American Diabetes Association [37] recommendations, those children and adolescents require continuous health education regarding diabetes self-management based on their developmental issues.

Concerning the family supervision behavior on children's diabetic management behavior, findings of the current study revealed significant improvement in family supervision behavior on children's diabetic management behavior. Families demonstrated a satisfactory level of supervision behavior at the post-test compared to the pre-test in blood glucose monitoring (96%), insulin therapy (76%), physical exercise (88%), and meal plans (80%). This finding indicates the effectiveness of the family-centered program on children's diabetic management behavior that is reflected in their ability to monitor and control blood glucose levels.

This finding was consistent with Fisher et al. [38] who related the improvement in adolescents' behavior regarding daily meal and exercise planning to family supervision.

It's worth mentioning that eating three meals in addition to three snacks per day helps prevent hypoglycemia and hyperglycemia [35]. Furthermore, many studies reported that families as well as children recognized the positive effects of physical exercise in controlling blood glucose levels after receiving sufficient educational interventions [36, 39].

Besides, these findings agreed with Ingerski et al. [40] who clarified that parental supervision for their children's diabetes management resulted in frequent measuring of blood glucose levels by their children. Also, the adolescent's performance in insulin therapy is improved through parental supervision, which yielded more adherence to treatment. In conclusion, enhancing parents' supervision behavior would promote diabetic management behaviors and enhance adherence among adolescents with T1DM [35, 12].

Concerning the second hypothesis: a family-centered program would increase the mother's self-efficacy. The results of the current study revealed that 94% of mothers showed high self-efficacy with a mean score of 49.7 during post-intervention compared to 38% pre-intervention and a mean score of 42.3. In this regard, the researcher didn't find any direct studies assessing the mother's self-efficacy before and after a family-centered program for diabetic children. However, there is evidence that parents of children with diabetes reported low

self-efficacy regarding their parenting role when compared to parents of healthy children. Also, the researchers highlighted the benefits of implementing family-centered care to promote parents' self-efficacy and, thereby, their psychological well-being [41]. Another study found that family-centered tailoring of type 1 diabetes self-management interventions improved parental self-efficacy and diabetes-related quality of life [42].

### Implication and limitations

The current study enables pediatric nurses to enhance the management of DM among children and empower families to control the blood glucose levels of their children. Additionally, this is a preliminary study for establishing a sustainable monitoring system implicit in the concept of family-centered care to decline the unfavorable consequences of DM. The study had to be discontinued many times due to COVID-19 and difficulties in data collection. Therefore, establishing an electronic follow-up system (mHealth, telehealth) to facilitate the implementation of family-centered care for children with DM is another implication of the study.

### Conclusion

Based on the findings of the present study and research hypothesis, it was concluded that implementing the family-centered program improved children's diabetic management behavior and hence controlling the blood glucose levels of children with diabetes mellitus and increased mothers' self-efficacy.

### Recommendation

Transformation of diabetic management in children with DM to a fully family-centered system of care should be established. Establishing an electronic follow-up system (mHealth, Telehealth) to facilitate the implementation of family-centered care for children with DM.

Further research is required to gain more knowledge about barriers to implementing the family-centered care approach for managing DM in pediatric patients.

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