Effect of Nursing Intervention on Juvenile Diabetic Patients' Health Literacy

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Abstract

Background: Children and adolescents are the most vital human resource a country possesses. Children are a primary target cohort for health literacy research and interventions from the perspective of public health. Therefore, the current research sought to evaluate the effect of nursing intervention on the health literacy of juvenile diabetic patients. Subjects and methods: Pre-post tests were employed in a quasi-experimental design, where 40 juvenile diabetic patients (20 cases & 20 controls) were enrolled using convenience and a snowball sampling technique from social media groups (Facebook). Data was collected using four tools, including: an Interview Questionnaire composed of two parts (Socio-Demographic Data & Diabetes Knowledge Test), a Diabetes Self-Care Behaviors Questionnaire, a Diabetes Numeracy Test [DNT 15], and a Health Literacy Questionnaire included (Health Literacy Measure for Adolescents [HELMA] & Literacy Assessment Test for Diabetes [LAD]). Results: Juvenile diabetic children either study or control group mainly had insufficient HELMA, inadequate LAD and inadequate self-care behaviors before intervention. In addition to, unsatisfactory DM knowledge and numerical skills especially among the study group. Whereas the nursing intervention was an independently positive indicator of knowledge and HELMA ratings for diabetic children, that was statistically significant. Conclusion: After intervention, the study group had compelling and significant improvements regarding their DM knowledge, numerical skills, self-care behaviors, HELMA and LAD.

Keywords: Health literacy, juvenile diabetic patients, numerical skills, nursing intervention, and self-care behaviors.

1. Introduction

Children and adolescents hold the potential and set the limit of future development of any country. Basic cognitive, physical, and emotional development processes occur, just as they do in childhood and adolescence, and skills and behaviors associated with health are developed. These life stages are therefore seen as essential for healthy development, personal health, and well-being throughout adulthood. Hence, targeting children with health literacy interventions may aid in the promotion of healthy behaviors and the mitigation of future health risks. [1]

One of the most prevalent metabolic and endocrine disorders in children is diabetes mellitus. Till today, type 1 diabetes, sometimes referred to either juvenile diabetes or insulin-dependent diabetes, was almost exclusively found in children and adolescents. It is a chronic disorder where the pancreas generates little or no insulin. The hormone insulin is necessary for glucose (sugar) to enter cells and be used as an energy source. [2] In this context, World Health Organization [WHO] [3] pointed out that the number of children with type 1 diabetes in Egypt is about one million. Moreover, the International Diabetes Federation [4] clarified that about 80,000 children under the age of 18 are predicted to have T1DM each year around the world.

Furthermore, Marciano et al. [5] clarified that diabetes could cause long-term harm, malfunction, and failure of various organs, particularly the eye, kidney, nerves, heart, and blood vessels. Patients with diabetes need to actively self-manage the condition in their daily lives. For this reason, the capacity to use healthcare services and health information efficiently is crucial. Health literacy is closely related to effective self-management that includes engaging in regular exercise, following a healthy diet, taking care of one's feet every day, adhering to a therapy regimen (Insulin), and treating complications like hypoglycemia episodes.

Health literacy is usually characterized as a comprehensive set of knowledge and competences that can help adolescents and children find, interact with, and use health information in order to facilitate and get access to activities that promote health. [6] On the other hand, diabetes self-management is significantly influenced by health literacy. For people with diabetes, a significant barrier to care or education is a lack of health literacy. Patients with low health literacy have trouble understanding health-related information

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and find it difficult to communicate their condition to healthcare providers, which leads to poor self-management. [7]

In general, there is growing evidence that patient education for people experiencing chronic illnesses like diabetes is a vital element of disease treatment. Thus, there is a unique role for community nurses in self-management of diabetic children, whereas community health nurses are at the forefront of educating diabetic children. To the best of their abilities, community health nurses must help the children understand their disease so that they are capable of managing it and taking care of themselves, which will enable them to alter their lifestyle, enhance their quality of life, and avoid complications. [8]

2. Subjects and Methods

2.1. Design

The present study has been carried out using a pre-posttest quasi-experimental design.

2.2. Setting

The researchers collected the sample online from social media groups (Facebook) then communicated with them via WhatsApp and the phone calls.

2.3. Subjects

The existing study enrolled 40 juvenile diabetic patients (20 cases & 20 controls) aged 10 to less than 18 years from both sexes.

Sample size

A total sample of 40 juvenile diabetic patients (20 cases & 20 controls) was required to assess a minimum change in participants' health literacy score of 25% with effect size of 0.72 (good) at 95% confidence level, study power of 80% and dropout rate of 10%. The sample size was calculated using PASS software including the reference parameters. [9]

2.4. Data collection tools

Four tools were employed to conduct the current study; they were

Tool I: The researchers created a two-part interview questionnaire that includes socio-demographic data and a diabetes knowledge test in light of the most recent literature in the field.

Part 1: Socio- Demographic Data: It consists of two components.

Data about children, including their age, grade, sex, siblings, and birth order.

Data about the family, including the age, level of education, occupation, parents' marital status, family income, place of residence, family size, and crowding index.

Part 2: Diabetes Knowledge Test [DKT]:

Fitzgerald et al. [10] developed this test, which includes 20 questions about nutrition, comorbidity, blood sugar control, exercise, foot care, diabetes complications, infection, insulin dose, and regular checkups.

Scoring system

For the knowledge items, a correct response received a score of 1, and an incorrect one, a score of 0.

The mean scores were calculated for every area of knowledge and the entire questionnaire by adding the item scores and dividing the total by the number of items. These ratings were transformed into percent ratings. Knowledge was taken into account.

Satisfactory: If the percentage score was 60% or higher.

Unsatisfactory: If the percentage falls below 60%.

Tool II: Diabetes Self-Care Behaviors Questionnaire

This questionnaire is an online questionnaire developed by American Nativadid Medical Center. [11] It is composed of 57 questions and involves mainly seven domains (healthy eating, exercise, medication monitoring, medication use, solving problems, stress, & healthy coping).

Scoring system

The scoring of diabetes self-care behaviors questionnaire was divided as follows:

Diet: The food frequency of each food item was calculated with computation of means, standard deviations, and medians. Then, child intake in each food group was considered

Adequate: If recommended servings were reported.

The diet was considered

Balanced: If the intake of all essential food groups was adequate.

Other self-care behaviors: The correct behaviors were scored one and the incorrect scored zero. Each behavior's total score was divided by the corresponding number of elements, and the result was transformed into a percent score. The behavior has been deemed

Adequate: If the percentage score was 60% or higher.

Inadequate: If the percentage falls below 60%.

Attitude: The attitudes related to exercise, monitoring, medication, and problem solving were scored on a 10-point numeric scale. The scores of each of their sub-items of importance, ability, and not dealing with problems were presented in means and standard deviations and medians so that a higher score indicates more positive attitude.

Tool III: Diabetes Numeracy Test [DNT 15]

The DNT15 is a briefer version of Huizinga et al.'s [12] Diabetes Numeracy Test (DNT). It was designed to investigate diabetic patients' numeracy skills, which are defined as the capacity to comprehend and apply numbers and mathematical skills in everyday life like glucose monitoring, carbohydrate counting, and insulin adjustment. Obtaining the answers will necessitate not only the ability to carry out a range of mathematical skills, like addition, subtraction, and multiplication, but

also the implementation of these skills in everyday circumstances.

Scoring system

The percentage of questions properly answered was used to determine how well children performed on the DNT-15 (score range: 0–100 percent). Missing values have been regarded as incorrect answers. The child numeracy test has been deemed
Satisfactory: If the percentage score was 60% or more.
Unsatisfactory: If the percentage falls below 60%.
Tool IV: Health Literacy Questionnaire
This questionnaire consisted of two parts they are

Part 1: Health Literacy Measure for Adolescents (HELMA)
It was developed by Ghanbari et al. [13] and may be employed to assess adolescents' functional, interaction, and critical health literacy levels. It deals with the patient's perceived abilities and competences in obtaining and using health information. It is composed of 44 questions divided into eight domains: self-efficacy, accessibility, reading, comprehension, assessment, usage, communication, and numeracy.

Scoring system

To calculate each subscale or total score, raw scores were summed and transformed into percent scores.The total score for every subscale and for the total scale has been categorized into:
Insufficient: (<66%).
Sufficient: (66 %+).
Part 2: Literacy Assessment Test for Diabetes (LAD)
It assesses the patient's capability to read common medical and nutritional terms and also diabetes-specific terms. It was developed by Nath et al. [14] in three columns of increasing complexity, the subjects had to pronounce 60 words. Half of the words were in the fourth grade (10 years), with the remainder ranging from sixth to sixteenth grade (12 to 22 years). This educational tool did not assess the patient's speech or diction; rather, it tested the patient's ability to recognise words.

Scoring system

Each of the three lists' correct answers received a score of 1, while the incorrect ones received a score of 0. The scores for each list, as well as the total of the three lists, were computed by summing-up. The test has been deemed
Adequate: If the raw score was 40 or higher.
Inadequate: If it is below 40.

2.5. Pilot study

A sample of four juvenile diabetics, or 10% of the estimated overall sample size, participated in the pilot study. The purpose was to evaluate the questions' clarity, the tools' format, and the items' thoroughness, and to calculate the precise amount of time needed to complete the tools sheet. The main study sample did not include any of the pilot study's participants' children.

2.6. Field work

Fieldwork has been conducted over a five-month period, beginning in mid-April 2021 and ending in mid-September 2021. Children diabetes, our children and diabetes, I am a diabetic child, everything related to type 1 diabetes for diabetics and their parents and friends with diabetes were the results of researchers search on social media.
Then, the researchers sent a request to join and communicated with the admin of each group, where the researchers introduced themselves and explained everything related to the study and the intervention. Additionally, the researchers sent everything that proved this, such as their personal identity and the official letter obtained from faculty of nursing. After that, the researchers obtained the permission from the admin of each group to publish their own post containing all the information related to the researchers and the study, and then the researchers set on WhatsApp group the participants who accepted to participate and called it Future Generation Health and communicated with them via private WhatsApp and phone calls individually.

Nursing intervention

The intervention was executed through successive phases of assessment, planning, implementation, and evaluation.

Assessment phase

During this phase, the researchers communicated by phone with each child individually. During the phone call, the researchers introduced themselves and briefly explained the goals of the research. The researchers then gave the assurance that the data would be utilized only for the research's purposes and would be treated with confidentiality. After that during the phone call, the researchers sent the tools online via WhatsApp to each participant. The researchers read and explained the items and instructions of the tools, then the child began to answer the questions and during that time the researchers were recording child's answers in the printed tools. The time consumed for answering the tools ranged from 90-105 minutes (1½ - 1¾ hours). This phase lasted for six weeks.

Planning phase

The researchers designed the content of the intervention sessions in accordance with the requirements of the children and the purpose of the research, depending on baseline data collected during the assessment phase and in light of the pertinent research. Identified requirements, needs, and shortcomings were converted into the intervention's objectives and goals, which were presented in the form of a booklet that was viewed by the scientific committee and then sent online via WhatsApp to the children to be used as a guide for self-learning to upgrade their health literacy regarding juvenile diabetes. The researchers assigned the participants to both groups randomly. The intervention content was divided into 14

interactive sessions. This phase lasted for five weeks.

Teaching methods: The program was implemented by the researchers using a variety of learning methods, including an interactive lecture and brain storming sessions where the researcher and the children exchanged ideas.

Teaching media: Various media were utilized, such as videos (Downloaded videos from internet & videos recorded by researchers), educational flyers, the researchers' audio records, and pictures. All these materials were sent online on WhatsApp.

Implementation phase

The intervention was executed as preplanned "twice per week" for each child individually via WhatsApp through sending the audio or video records and other educational materials. This phase lasted for seven weeks. The session duration was variable (Ranging from 15-30 minutes) according to the content of each session, the time available, and the child's response and participation, except pre-test session and the termination session (post-test) was 90-105 minutes (1½ - 1¾ hours) and 60-75 minutes (1 - 1¼ hours) respectively. Also, the researchers were keen to expose all children to the same learning experience.

Every session began with a revision of the information presented in the previous session and an explanation of the goals of the new one. Each session ended with a summary. Simple language was used. Finally, during the intervention, reinforcement and motivation in the form of encouragement and praise were employed to foster active engagement and application of all learned information and skills.

Evaluation phase

In this phase, the researchers evaluated the effect of nursing intervention on juvenile diabetic patients' health literacy after its implementation by asking the children to apply post-test in the last session of the program with the same tools of the pre-test, and then comparing the change in juvenile diabetic patients' health literacy before and after the application of the intervention sessions.

After that, the researchers recommunicated with the children in the control group and asked them to apply the same tools of the pre-test (This lasted for 2 weeks) to compare the change in their health literacy with that of the children in the case group.

Note: At the end of this phase, the researchers sent the booklet to the children in the control group and also communicated with them and gave them all the sessions of the intervention, as was done with the children in the case group.

2.7. Validity

It was ascertained by a panel of three specialists in the fields of community health nursing, surgical and medical nursing, and community medicine who reviewed the tools' content for clarity, relevancy, thoroughness, and understandability.

2.8. Ethical consideration

First of all, Faculty of Nursing, Zagazig University's Research Ethics Committee (REC) gave its approval to the research protocol. Participants' and their parents' consent was obtained by their acceptance to join our WhatsApp group (Future Generation Health) after a full explanation of the aim of the study in our own post on Facebook groups that include juvenile diabetics. Participants had been given the choice to decline engagement in the data collection online interviews and were informed that they might leave at any time. They have also been given the assurance that the information will be kept private and used exclusively for study purposes. The researchers assured the parents that the patient data would remain anonymous and confidential.

2.9. Statistical design

The statistical software package SPSS 20.0 has been employed for data entry and statistical analysis. Coding and data entry stages both underwent quality control. Descriptive statistics have been employed to present the data. For qualitative variables, frequencies and percentages have been employed. For quantitative variables, means, standard deviations, and medians have been employed. The Cronbach alpha coefficient has been computed to evaluate the HELMA scale's reliability based on its internal consistency. When comparing two independent groups, the Student t-test has been employed to compare quantitative continuous data. If a normal distribution of the data might not be assumed, the non-parametric Mann-Whitney test has been performed instead. Employing the chi-square test, qualitative categorical variables have been compared. Instead, the Fisher exact test has been performed when the anticipated values in one or more cells of a 2x2 table were fewer than 5. When the predicted value was less than 5 in 10% or more of the cells in cross-tables greater than 2x2, no test might be performed. A Spearman rank correlation has been performed to evaluate the inter-relationships between ranked and quantitative variables. Multiple linear regression analysis and analysis of variance for the full regression models were performed to determine the independent predictors of the knowledge scores, DNT, HELMA, and LAD test. Statistical significance was deemed to have a p-value less than 0.05.

3. Results

As to the demographic characteristics of children in the study and control groups, 65% of study group children were females and aged 12 years or more, 60% of them were at preparatory/secondary school, 90% of them had siblings, and 55% of them were not the first child. Meanwhile, 65% of control group children were not the first child and aged <12 years, 60% of them were at primary school, 50% of them

were males, and all of them had siblings. Regarding mothers' characteristics, 50% of study group mothers compared to 80% of control group mothers aged <40. Considering their education and jobs, (65% & 60%) of study group mothers compared to (80% & 65%) of control group mothers had university education and were housewives respectively. As for fathers, 55% of study group fathers compared to 70% of control group fathers aged 45 years or more, 75% of them had university education in both groups, and higher percentage of them were employees (55% & 80%) in the study and control groups respectively. Also, 65% of study group families compared to all control group families had sufficient income and this result was found statistically significant (p= 0.008). Concerning residence, higher percentage of them belonged to urban areas (80% & 75%) in the study and control groups respectively and their homes were mainly not crowded (<2 /room) as reported by 50% of study group children compared to 80% of control group children.

Table 1 illustrates the correlation between children's scores of knowledge, DNT, HELMA, and LAD and their characteristics in the research and control groups. From this table, it is evident that there were statistically significant positive correlations between DNT and age (r= 0.453), mother age and income (r= 0.530), as well, there was a statistically significant positive correlation between HELMA and age (r= 0.467) in the study group. Where, the older the children and their mothers' age and the higher their families' income, the higher was their DNT score. Also, the older the children age, the higher was their HELMA score. As regard the control group, the same table points to a statistically significant positive correlation between DNT and age (r= 0.571), also there were statistically significant positive correlations between HELMA and age (r= 0.471) and father education (r= 0.511). Moreover, there was a statistically significant positive correlation between LAD and age (r= 0.668). This means that when the children age became older, DNT, HELMA and LAD scores accordingly increased. Also the higher the father education, the higher was the children HELMA score.

Concerning the best-fitting multiple linear regression model for children's knowledge scores, table 2 reveals that time and intervention were statistically significant independent positive predictors of knowledge score. Where, the knowledge score increased with time. Also, the intervention significantly improved the knowledge score. The result of r-square indicates that the model accounts for 28% of the variation in this score.

For the children's DNT score, Table 3 demonstrates the best-fitting multiple linear regression model. Time, age, mother's university degree, mother's status as a widow, and knowledge score all served as statistically significant independent positive indicators of DNT value, as shown in the table. This means that the older the children age, the higher their knowledge score, their mother's education, and being a child of a widowed mother, the higher the DNT score. Also, the DNT score improved with time. The result of r-square indicates that the model accounts for 50% of the variation in this score.

Table 4 shows that age, father's university degree, intervention, and DNT score were statistically significant independent good indicators of HELMA score in the best fitting multiple linear regression model for the children's HELMA score. Where the older the children age and the higher their DNT score and their father education, the higher was the HELMA score. As well, the intervention significantly improved HELMA score. The result of r-square shows that the model accounts for 63% of the variation in this score.

Table 1: Correlation between children's scores of knowledge, DNT, HELMA, and LAD and their characteristics in the study and control groups (n=40)

Characteristics	Spearman's rank correlation coefficient							
	Study group (n=20)				Control group (n=20)			
	Knowledge	DNT	HELMA	LAD	Knowledge	DNT	HELMA	LAD
Child Age	.142	.453*	.467*	.240	.247	.571**	.471*	.668**
Siblings	-.158	-.012	.225	-.202	-.264	-.063	.031	.012
Mother age	.080	.530*	-.120	.040	.219	.209	.341	.188
Mother education	.046	.142	-.169	.201	.022	.344	.412	.055
Father age	.216	.120	.047	.086	-.031	.080	.102	.056
Father education	-.015	.037	.395	.349	.113	.277	.511*	.092
Income	.103	.530*	.100	-.028				
Crowding index	.009	-.441	.136	-.207	-.331	-.115	-.417	-.110
(*) Statistically significant at p<0.05 (**) statistically significant at p<0.01								

Table 2: The knowledge score for the children's best-fitting multiple linear regression model

Items	Unstandardized Coefficients		Standardized Coefficients	t-test	p-value	95% Confidence Interval for B	
	B	Std. Error				Lower	Upper
Constant	9.83	1.13		8.680	<0.001	7.57	12.08
Time (pre & post intervention)	3.10	0.68	0.44	4.541	<0.001	1.74	4.46
Intervention	2.10	0.68	0.30	3.076	0.003	0.74	3.46
R-square=0.28 Model ANOVA: F=15.05, p<0.001							

Table 5 shows that time and age were statistically significant independent strong indicators of LAD score in the multiple linear regression model that best fit the children's LAD score. This means that

the LAD score increased with time and increasing the children age. Living in a rural area, on the other hand, was a statistically significant independent negative predictor of LAD score. Where a child belonged to a rural residence, this decreased his/her LAD score. The result of r-square shows that the model accounts for 28% of the variation in this score.

Age, gender, parents' age, education, marital status, place of residence, and income were among the variables entered and excluded.

Table 3: The children's DNT score's best-fitting multiple linear regression model

Items	Unstandardized Coefficients		Standardized Coefficients	t-test	p-value	95% Confidence Interval for B	
	B	Std. Error				Lower	Upper
Constant	-3.31	11.18		-0.296	0.768	-25.59	18.97
Time (pre & post intervention)	8.17	3.21	0.24	2.542	0.013	1.77	14.57
Child Age	1.76	0.57	0.26	3.066	0.003	0.62	2.90
Mother university degree	11.18	3.34	0.29	3.347	0.001	4.52	17.84
Widow mother	11.27	4.77	0.20	2.362	0.021	1.76	20.77
Knowledge score	2.06	0.47	0.42	4.410	<0.001	1.13	2.99
R-square=0.50 Model ANOVA: F=14.55, p<0.001							

Gender, parent age and father's education, residence, income, and intervention are among the variables that were entered and excluded.

Table 4: The children's HELMA score's best-fitting multiple linear regression model

Items	Unstandardized Coefficients		Standardized Coefficients	t-test	p-value	95% Confidence Interval for B	
	B	Std. Error				Lower	Upper
Constant	-19.64	9.37		-2.096	0.039	-38.30	-0.97
Child Age	1.32	0.67	0.16	1.979	0.051	-0.01	2.64
Father university degree	12.55	3.59	0.25	3.495	0.001	5.40	19.71
Intervention	13.88	3.25	0.32	4.271	<0.001	7.41	20.35
DNT score	0.64	0.09	0.52	6.823	<0.001	0.46	0.83
R-square=0.63 Model ANOVA: F=31.26, p<0.001							

Gender, parent age, mother's education, marital status, place of residence, income, and time were among the variables entered and excluded.

Table 5: The children's LAD score's best-fitting multiple linear regression model

Items	Unstandardized Coefficients		Standardized Coefficients	t-test	p-value	95% Confidence Interval for B	
	B	Std. Error				Lower	Upper
Constant	45.42	3.78		12.023	<0.001	37.89	52.94
Time (pre & post intervention)	3.13	1.08	0.28	2.890	0.005	0.97	5.28
Child Age	0.75	0.21	0.35	3.545	0.001	0.33	1.18
Rural residence	-2.95	1.31	-0.22	-2.244	0.028	-5.56	-0.33
R-square=0.28 Model ANOVA: F=9.75, p<0.001							

Gender, parents' age, education, marital status, income, and intervention were among the variables entered and excluded.

4. Discussion

Children and adolescents are a primary target cohort for health literacy research as well as intervention from a public health standpoint because during childhood and adolescence, essential processes of cognitive, physical, and emotional development occur, as well as the development of health-related behaviours and skills. As a result, engaging children and adolescents with health literacy interventions may aid in the promotion of healthy behaviors and the alleviation of future health risks.[6] Moreover, health literacy is a crucial factor in determining a person's capacity to manage their health optimally because it is an indication of high care for chronic illnesses such as diabetes. [15] Therefore, the present research sought to evaluate the effect of nursing intervention on the health literacy of juvenile diabetic patients.

As to the characteristics of children in the study and control groups, the current research findings indicated that two thirds of the study group children were females, aged 12 years or more and more than half of them were at preparatory/secondary school. Meanwhile, two third of control group children aged <12 years, more than half of them were at primary school and half of them were males. Concerning residence, higher percentage of children in both groups belonged to urban areas and their homes were mainly not crowded (<2 /room).

This result is in contrast with Azizi et al. [16] in Iran who clarified that around two third of intervention group children were males and majority of them were at preparatory/secondary school. Whereas, more than two third of control group children were females and more than three quarter of them were at preparatory/secondary school. This discrepancy between results might be attributed to the random

assignment of the participants into the two groups of study and control.

Considering correlates and predictors of children's knowledge, diabetes numeracy (DNT), health literacy measure (HELMA), and literacy assessment for Diabetes (LAD) scores in the research and control groups, the present study results indicated that children's knowledge score was a statistically significant independent positive predictor of DNT score. In addition, the DNT score of the children was a statistically significant independent strong indicator of the HELMA score. The potential causes for this outcome are that the higher the knowledge and health literacy of children, the higher their literacy and awareness related to diabetes, consequently, their DM numerical skills improved (such as calculating the amount of carbohydrates in their diets and the required doses of insulin and so on), and vice versa.

In the same context, Manegold [17] conducted a study in the U.S.A and indicated statistically significant positive correlations between DNT, diabetes knowledge, and health literacy scores among adolescents with T1D. As well, research performed in Rwanda by Mukanoheli et al. [18] revealed a strong relationship between health literacy and self-care behaviors, including numerical skills among diabetic patients. Also, Chollou et al. [19] in Iran indicated that health literacy dimensions positively associated with diabetes self-care behaviors such as DM numerical abilities.

Additionally, congruent findings were found in a study carried out in Iran by RobatSarpooshi et al. [20] who demonstrated a significant correlation between the diabetic patients' knowledge and health literacy and the domains of their self-care behaviors, which involved their numerical skills. Moreover, a study carried out by Klinovszky et al. [21] in Hungary revealed that health literacy of the diabetic patients had an impact on their self-care behaviors including their DM numerical skills.

Also, the present study findings indicated that children's age was a statistically significant independent positive predictor of DNT, LAD, and HELMA scores. This result might be attributed to the increase in children's ages, which in turn promotes their knowledge, awareness, abilities, and experiences in how to deal with their DM, and thus their health literacy would improve, which positively affects their DM numerical skills.

Likely, a study conducted in Iran revealed a significant relationship between the diabetic patients' age and their health literacy level. [22] As well, Yeh et al. [23] carried out research in Taiwan that revealed a significant positive correlation between the diabetes patients' age and their health literacy. Moreover, a study conducted in Iran by Noroozi et al. [24] indicated a significant positive correlation between the diabetic patients' age and their health literacy level.

As well, the existing study demonstrated that children's mothers' university degrees and being a child of a widowed mother were statistically significant independent positive predictors of DNT score. Meanwhile, children's fathers' university degrees were a statistically significant independent positive indicator of HELMA score. This outcome may be attributed to the fact that the higher the children's parents' educational level, the higher their levels of awareness and knowledge, and consequently this can be reflected on their children 's health literacy level and abilities to deal with their DM. As regards being a child of a widow mother, mothers' increased fears and attachment to child can increase their care for their children. Therefore, mothers are very careful to preserve their children health by teaching them how to take care of their disease, including the importance of DM numerical skills.

This result is in agreement with Manegold [17] in U.S.A who demonstrated a statistically significant positive correlation between diabetic adolescents' DNT score and their caregivers' educational level. As well, Sanjari et al. [25] conducted a study in Iran and revealed that the diabetes management process in juvenile diabetic children was affected by a number of demographic and social-cultural factors such as their parents' education and occupation.

According to the present study results, a statistically significant positive correlation between DNT score and study group children mothers' age was found. This result might be attributed to that when the children mothers' age increase, their experience and knowledge also increase and this accordingly promote the knowledge level of their children including their numerical skills of DM.

Also, a statistically significant positive correlation between DNT score and study group children family income was confirmed. This result might be due to that the higher the income of families, the more children chances of owning mobiles and tablets, which enable them to view and obtain information on DM from the internet and social media groups, and also increase their chances to go to doctors' clinics or private treatment centers through which they obtain information and DM educational materials, and this consequently improve their knowledge as well as their numerical skills related to DM as reported by children and their caregivers during data collection.

Similarly, research carried out in Iran by RobatSarpooshi et al. [20] showed a significant relation between the mean score of diabetic patients' self-care behaviors, including their numerical skills, and their economic status. Where, the mean score of self-care behaviors was significantly higher in patients with excellent economic status. Also, Alruhaim et al. [26] in Saudi Arabia found that the higher the income of diabetic patients, the higher was the score of their diabetes self-management (including DM numerical skills).

As well, the current research showed that rural residence was a statistically significant independent negative indicator of LAD score. A potential cause

for this outcome is that children residing in the rural areas are marginalized to some extent in terms of receiving adequate health education about diabetes, and their chances of accessing diabetic care centers are limited as these centers are distant for them. It is also possible that these rural areas suffer from poor quality of the Internet, consequently this reduces their chances of retrieving and benefiting from the information related to diabetes. All these factors might negatively affect their literacy of diabetes.

A contrary result reported by Ziapour et al. [27] in Iran indicated no significant association between diabetic patients' residence and health literacy. Also, a study conducted in Ethiopia by Tefera et al. [28] revealed no significant relationship between the diabetic patients' health literacy and their residence. Such variation might be due to differences in cultural and social systems among the countries.

Ultimately, the existing study results showed that the nursing intervention was a statistically significant independent positive indicator of children's knowledge and health literacy scores. This result might be attributed to that the intervention equipped the children with the sound knowledge and practice related to DM which in turn enhanced their favorable attitude towards managing and accepting DM. This finding is in line with that of Indi [29] in India, who emphasized that the structured learning intervention was significantly efficient in enhancing diabetic patients' knowledge of self-care activities. Likewise, Chigozie and Ali [30] in Finland indicated that the post-intervention results presented a compelling increase in diabetic patients' knowledge and health literacy. Moreover, a study carried out by Chen et al. [31] in China revealed that every patient who got the intervention displayed a significant enhancement in their level of health literacy.

Limitation of the Study

The current study was supposed to be conducted at the universal diabetic clinic in Zagazig city because it is the only place where juvenile diabetic children attending. But unfortunately, recently the director of Health Insurance branch in Sharkia Governorate has given instructions to prevent the collection of any data for scientific research from juvenile diabetic children attending the clinic, because the General Authority of Health Insurance is a service institution and not an educational one, and also due to the fact that the scarcity of non-governmental places of attendance of juvenile diabetics (The private clinics), the decision was taken to conduct this study by using telenursing techniques. Also, the response rate was high on the researcher's WhatsApp group (Future Generation Health) that already included 90 participants. But unfortunately, more than half of them did not match the inclusion criteria of the study because they were underage (less than 10 years).

5. Conclusion

The current study results bring about the conclusion that

Juvenile diabetic children either study or control group mainly had insufficient HELMA, inadequate LAD and inadequate self-care behaviors especially in terms of effective exercise, adequate follow up and complying with treatment before intervention. In addition to, unsatisfactory DM knowledge and numerical skills especially among the study group. Meanwhile after intervention, the study group had compelling and significant improvements regarding their DM knowledge, numerical skills, self-care behaviors, HELMA and LAD. Moreover, diabetic children age played prominent role in their DNT, HELMA and LAD scores. Ultimately, it was proved that the nursing intervention positively affected the juvenile diabetic patients' health literacy.

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Declaration of Conflicting Interests

There is no conflict of interest declared by the author (s).

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