Determinants of Juvenile Diabetic Patients' Health Literacy

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Abstract

Background: Childhood and adolescence are crucial developmental phases characterized by important physical, emotional, cognitive, and behavioral changes. Chronic disease represents an additional challenge. Diabetes mellitus (DM) in children and adolescents is becoming an increasingly important public health concern throughout the world. Diabetic children have to cope with the disease and participate in self-care activities, they must be health literate. Therefore, the present study **aimed** to assess the determinants of juvenile diabetic patients' health literacy. **Subjects and methods:** A cross-sectional analytical design was used, where 20 juvenile diabetic patients were enrolled using convenience and snowball sampling technique from social media groups (Facebook). Four tools were used to collect data they were: An Interview Questionnaire composed of two parts (Socio-Demographic Data & Diabetes Knowledge Test), Diabetes Self-Care Behaviors Questionnaire, Diabetes Numeracy Test [DNT 15], and Health Literacy Questionnaire included (Health Literacy Measure for Adolescents [HELMA] & Literacy Assessment Test for Diabetes [LAD]). **Results:** Juvenile diabetic children mainly had insufficient HELMA, inadequate LAD and inadequate self-care behaviors. In addition to, unsatisfactory DM knowledge and numerical skills. **Recommendations:** Structured nursing intervention should be tailored to fulfill the special needs of juvenile diabetic children from the time of diagnosis and incorporating numeracy skills as a core component of diabetes education. Moreover, it is very important to spotlight on telenursing as a mean of improving health outcomes especially among patients with chronic diseases.

Key words: Health literacy, juvenile diabetic patients, knowledge, numerical skills, and self-care behaviors.

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1. Introduction

The number of people with diabetes worldwide is rapidly increasing. DM is a chronic disease and a global health problem, affecting about 422 million people worldwide. The epidemic of DM has grown at an alarming rate, resulting in severe socioeconomic and health impacts, especially in developing countries, where about 80% of affected people live **(World Health Organization [WHO], 2018)**. Diabetes in children and adolescents (T1DM) is becoming an increasingly important public health concern throughout the world, it is one of the most common chronic diseases of childhood after asthma and mental retardation, and it is a major disease that is becoming more prevalent **(Madian & Ismail, 2020)**. Also, T1DM is especially relevant because the disease interferes with the quality of life of the patients and their families, increasing the risk of secondary complications in the long term **(International Diabetes Federation, 2019)**. The patients with DM have to cope with the disease and participate in self-care activities, they must be health literate, since patients with limited training and insufficient health literacy tend to have more difficulties during therapy, presenting low adherence to the therapeutic regimen, poor understanding of health problems, lack of self-care knowledge, low use of preventive services, poor general health and morbidity **(Moura et al., 2019)**. Currently, health literacy plays a very important role in developing countries, and some programs and plans have been implemented in this direction **(Kazerani et al., 2018)**. Consequently the aim of the present study is to assess the determinants of juvenile diabetic patients' health literacy.

2. Subjects & Methods

2.1. Design:

A cross-sectional analytical design was used to conduct the present study.

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 20 juvenile diabetic patients aged 10 to less than 18 years from both sexes.

2.4. Tools of data collection:

Four tools were used to carry out the present study, they were:

Tool I: An Interview questionnaire developed by the researchers in the light of the current related literature and composed of two parts: Socio- demographic data and diabetes knowledge test.

Part 1: Socio- Demographic Data: It involved two parts;

- **Child's data:** such as; child's age, grade, sex, siblings, birth order.
- **Family's data:** such as; parents' age, educational level, occupation, parents' marital status, family income, residence, family size, and crowding index.

Part 2: Diabetes Knowledge Test [DKT]:

This test was developed by **Fitzgerald et al. (2016)**, it composed of 20 items regarding nutrition, comorbidities, blood glucose control, exercise, foot care, diabetes complications, infection, insulin dose, and regular checkups.

Scoring system:

A correct response was scored one and the incorrect zero, for the knowledge items. For each area of knowledge and for the total questionnaire the scores of the items were summed-up and the total divided by the number of the items, giving mean scores. These scores were converted into percent scores. Knowledge was considered:

- Satisfactory: If the percent score was 60% or more.
- Unsatisfactory: If less than 60%.

Tool II: Diabetes Self-Care Behaviors Questionnaire:

This questionnaire is an online questionnaire developed by **American Nativadid Medical Center (2018)**. It composed of 57 questions, involved mainly seven domains (healthy eating, being active, monitoring, taking medications, problem solving, 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. The sum score of each behavior was divided by the corresponding number of items and the score converted into a percent score. The behavior was considered:

- **Adequate:** If the percent score was 60% or higher.
- **Inadequate:** If less than 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 shortened version of the Diabetes Numeracy Test (DNT) by **Huizinga et al. (2008)**. It was designed to investigate numeracy skills in diabetic patients as the ability to understand and use numbers and math skills in daily life such as, glucose monitoring, carbohydrate counting, and adjustment of insulin. Arriving at the answers will require not only the ability to perform a variety of math skills, such as addition, subtraction, and multiplication, but also the application of those skills in the daily setting.

Scoring system:

Child performance on the DNT-15 was calculated as a percentage of questions answered correctly (score range: 0–100%). Missing values were considered incorrect responses. Child numeracy test was considered:

- Satisfactory: If the percent score was 60% or more.
- Unsatisfactory: If less than 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. (2016)**, and can be used to evaluate different levels of functional, interactive, and critical health literacy in adolescents. It deals with the patient's perceived abilities and competences on obtaining and using health information. It composed of 44 questions divided on eight domains, self-efficacy, access, reading, understanding, appraisal, use, communication and numeracy.

Scoring system:

To calculate each subscale or total score, raw scores were summed and converted into percent scores. The total score for each subscale and for the total scale was categorized into:

- **Insufficient:** (<66%).
- **Sufficient:** (66%+).

Part 2: Literacy Assessment Test for Diabetes (LAD):

It assesses the patient's ability to read ordinary nutritional and medical terms as well as those terms specific to diabetes. It was developed by **Nath et al. (2001)**. Subjects were to pronounce 60 words, arranged in three columns in order of increasing complexity. Half of the words were at the fourth grade level (10 years), the rest range from sixth through sixteenth grade level (12 to 22 years). This educational tool tested the subject's ability to recognize words – not the subject's speech or diction.

Scoring system:

For each of the three lists, correct answer was scored one and the incorrect zero. The scores of each list and for the total of the three lists were computed by summing-up. The test was considered:

- **Adequate:** If the raw score was 40 or higher.
- **Inadequate:** If less than 40.

2.5. Pilot study:

The pilot study was carried out on a sample of two juvenile diabetics representing 10% of the calculated total sample size. The aim was to test clarity of the questions, the format of the tools, comprehensiveness of the items and to estimate the exact time required for filling out the tools sheet. Children involved in the pilot study were excluded from the main study sample.

2.6. Field work:

The fieldwork was carried out within the period of three months, starting from the mid of April 2021 to the mid of July 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. 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. Where, the researchers communicated by phone with each child, during the phone call the researcher introduced herself and explained the aim of the study briefly. Then, the researcher assured that the obtained information will be treated confidentially and used for the purpose of

the study only. After that during the phone call, the researcher sent the tools online via WhatsApp to each participant. The researcher read and explained the items and instructions of the tools, then the child began to answer the questions and during that time the researcher was recording his/her answers in the printed tools. The time consumed for answering the tools ranged from 90-105 minutes (1½ - 1¾ hours).

2.7. Validity

It was ascertained by a panel of three experts in the field of community health nursing, medical and surgical nursing, and community medicine who reviewed the content of the tools for clarity, relevance, comprehensiveness and understandability.

2.8. Ethical consideration:

Firstly, the research protocol was approved by the Research Ethics Committee (REC) in Zagazig University. The agreement of participants and their parents was taken by their acceptance to join our WhatsApp group (Future Generation Health) after full explanation of the aim of the study in our own post on Facebook groups that include juvenile diabetics. Participants were given the opportunity to refuse participation and they were notified that they could withdraw at any time of the data collection online interviews, also they were assured that the information would be confidential and used for the research purpose only. The researchers assured maintaining anonymity and confidentiality of the patients' data.

2.9. Statistical design:

Data entry and statistical analysis were done using SPSS 20.0 statistical software package. Quality control was done at the stages of coding and data entry. Data were presented using descriptive statistics in the form of frequencies and percentages for qualitative variables, and means and standard deviations, and medians for quantitative variables. Cronbach alpha coefficient was calculated to assess the reliability of the HELMA scale through its internal consistency. Quantitative continuous data were compared using Student t-test in case of comparisons between two independent groups. When normal distribution of the data could not be assumed, the non-parametric Mann-Whitney test was used instead. Qualitative categorical variables were compared using chi-square test. Whenever the expected values in one or more of the cells in a 2x2 tables was less than 5, Fisher exact test was used instead. In larger than 2x2 cross-tables, no test could be applied whenever the expected value in 10% or more of the cells was less than 5. Spearman rank correlation was used for assessment of the inter-relationships among quantitative variables and ranked ones. In order to identify the independent predictors of the scores of knowledge, DNT, HELMA, and LAD tests, multiple linear regression analysis was used and analysis of variance for the full regression models was done. Statistical significance was considered at p-value <0.05.

3. Results

As to the demographic characteristics of diabetic children, 65% of them 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. Regarding mothers' characteristics, 50% of them aged <40. Considering their education and jobs, (65% & 60%) of them had university education and were housewives respectively. As for fathers, 55% of them aged 45 years or more, 75% of them had university education, and 55% of them were employees. Also, 65% of their families had sufficient income. Concerning residence, higher percentage of them belonged to urban areas (80%) and their homes were mainly not crowded (<2 /room) as reported by 50% of children.

Table 1 illustrates DM knowledge among children in the study sample. From this table, it is evident that only 40% of children had satisfactory DM knowledge.

Regarding DM self-care behaviors among children in the study sample, **table 2** indicates higher percentage of children ate main meals, snacks, fruits/vegetables, cereals, and meat/legumes and drank water as recommended (85%, 80%, 70%, 90%, 90%, & 70%). However, small number of them ate balanced diet (35%). Moreover, only (25% & 38.9%) exercised regularly and complied to treatment respectively.

Table 3 demonstrates attitudes towards ability and importance of DM self-care behaviors among children in the study sample. According to this table, it is obvious that the highest mean±SD of children attitudes was toward the importance of the medication (10.0±0.0).

As to DM numeracy, literacy (HELMA), and Literacy assessment (LAD) among children in the study sample, **table 4** reveals that only 40% of children had satisfactory DM numerical skills. In addition to 55% of them had insufficient HELMA especially in appraisal and numeracy domains. The same table also points to only 35% of children had adequate LAD.

Table 5 demonstrates correlation matrix of children's scores of knowledge, DNT, HELMA, and LAD in the study sample. This table points to a statistically significant positive correlation between knowledge and DNT (r= 0.362). Where the increasing in DNT score led to increase in knowledge score. Also, there were statistically significant positive correlations between DNT and HELMA (r= 0.437) and LAD (r= 0.541). This means that when HELMA and LAD scores increased, DNT score accordingly increased. In addition, there was a statistically significant positive correlation between HELMA and LAD (r= 0.394). Where the higher the LAD score, the higher was the HELMA score.

Table 6 illustrates correlation between children's scores of knowledge, DNT, HELMA, and LAD and their characteristics in the study sample. 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). 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.

Table 1: DM knowledge among children in the study sample (n=20)

Satisfactory knowledge (60%+) of DM	Frequency	Percent
Complications	16	80.0
Diet	16	80.0
Follow-up	18	90.0
Insulin	19	95.0
Lab testing	16	80.0
Self-care	11	55.0
Total:		
Satisfactory	8	40.00
Unsatisfactory	12	60.00

Table 2: DM self-care behaviors among children in the study sample (n=20)

Adequate DM self-care behaviors (60%+)	Frequency	Percent
Diet as recommended:		
Main meals	17	85.0
Snacks	16	80.0
Water	14	70.0
Fruits/vegetables	14	70.0
Cereals	18	90.0
Meat/legumes	18	90.0
Dairies	11	55.0
Eat balanced diet	7	35.0
Effective exercise	5	25.0
Adequate follow-up	10	50.0
Comply to treatment	7	38.9
Adequate dealing with problems	13	65.0
Dealing with stress	8	40.0
Adequate coping	12	60.0

Table 3: Attitudes towards ability and importance of DM self-care behaviors among children in the study sample (n=20)

Items	Mean±SD	Median
Exercise:		
Importance	9.2±1.8	10.00
Ability	9.5±1.3	10.00
Monitoring:		
Importance	9.6±0.7	10.00
Ability	9.0±1.7	10.00
Medication:		
Importance	10.0±0.0	10.00
Ability	9.7±1.1	10.00
Problem solving:		
Importance	7.2±1.8	7.00
Ability	7.2±1.8	7.00
Not dealt with	3.1±1.7	3.00

Table 4: DM numeracy, literacy (HELMA), and Literacy assessment (LAD) among children in the study sample (n=20)

Items	Frequency	Percent
DM numeracy test:		
Satisfactory	8	40.0
Unsatisfactory	12	60.0
Sufficient literacy (HELMA):		
Self-efficacy	15	75.0
Access	12	60.0
Reading	12	60.0
Understanding	14	70.0
Appraisal	8	40.0
Use	12	60.0
Communication	12	60.0
Numeracy	4	20.0
Total HELMA:		
Sufficient	9	45.0
Insufficient	11	55.0

Adequate Literacy Assessment Test (LAD):		
List 1	17	85.0
List 2	14	70.0
List 3	10	50.0
Total LAD:		
Adequate	7	35.0
Inadequate	13	65.0

Table 5: Correlation matrix of children's scores of knowledge, DNT, HELMA, and LAD in the study sample (n=20)

Scores of:	Spearman's rank correlation coefficient			
	Knowledge	DNT	HELMA	LAD
Knowledge	1.000			
DNT	.362*	1.000		
HELMA	.169	.437**	1.000	
LAD	.151	.541**	.394*	1.000

(*) Statistically significant at p<0.05 *(**) Statistically significant at p<0.01*

Table 6: Correlation between children's scores of knowledge, DNT, HELMA, and LAD and their characteristics in the study sample (n=20)

Characteristics	Spearman's rank correlation coefficient			
	Knowledge	DNT	HELMA	LAD
Child Age	.142	.453*	.467*	.240
Siblings	-.158	-.012	.225	-.202
Mother age	.080	.530*	-.120	.040
Mother education	.046	.142	-.169	.201
Father age	.216	.120	.047	.086
Father education	-.015	.037	.395	.349
Income	.103	.530*	.100	-.028
Crowding index	.009	-.441	.136	-.207

(*) Statistically significant at p<0.05 *(**) Statistically significant at p<0.01*

4. Discussion

Diabetes is a chronic disease with a prevalence that varies widely throughout the world and is continuously increasing **(Gomes et al., 2020)**. Research has demonstrated that health literacy and knowledge of insulin therapeutic regimens, diet, exercise, glucose monitoring, and treatment modification are necessary to effectively self-manage diabetes **(Yeh et al., 2018)**. In contrast, studies proved that low health literacy lead to poor self-management knowledge and abilities and poorer level of glycemic control and this may lead to high healthcare costs and poor health outcomes **(Rachmawati et al., 2019)**. Finally, health literacy is known to determine the successful achievement of health outcomes as well as improve juvenile patients' diabetes self-management **(Gomes et al., 2020)**.

Regarding DM knowledge among children in the study sample, the existing study results clarified that most of children had satisfactory DM knowledge in terms of diet, insulin intake, lab testing, follow up and DM complications, but nearly half of them had obvious defect regarding self-care domain. However totally, more than half of children had unsatisfactory DM knowledge.

Possible explanation of such result, higher percentage of children belonged to families with high financial income, and they had their own mobile phones and tablets which might help them to brows internet and social media platforms from which they derive information. In the same vein, a study conducted in Malawi by **Phiri et al. (2017)** found limited knowledge among adolescents on diabetes self-care practices, but contrary to the current study results, this study also identified inadequate knowledge on diabetes complications and monitoring of blood glucose among diabetic adolescents. As well, **Chingatichifwe et al. (2014)** in Malawi displayed less knowledge regarding the healthy lifestyle (including diet, compliance with treatment, lab testing, follow up & self-care) and complications of diabetes among diabetic patients.

Moreover, in the same line with the study group results, a study carried out by **Alruhaim et al. (2021)** in Saudi Arabia to describe the association between diabetes knowledge, DM numeracy and diabetes self-management among patients with insulin-treated diabetes revealed that more than two third of diabetic patients with either type 1 or type 2 had low diabetes knowledge level.

Considering DM self-care behaviors among children in the study sample, the present study results clarified that children ate main meals (breakfast, lunch and dinner) at regular times with nearly 2 hours apart between the main meals and snacks. They took adequate portions of cereals and meat/legumes, but nearly half of them did not properly consume dairies. Based on this, higher percentage of children did not eat a balanced diet.

This finding is in the same line with, **Nansel et al. (2012)** in Unites states of America (U.S.A) revealed that the diabetic patients who aged 8 to18 years demonstrated low adherence to dietary guidelines. As well, **Phiri et al. (2017)** in Malawi who emphasized that it was difficult for diabetic adolescents to prepare balanced diet considering the amount, frequency and type of food

which they are allowed to eat to control the blood glucose levels. Similarly, a study conducted in Saudi Arabia revealed that the domain 'balanced diet' had the lowest mean score among diabetic patients' self-care behaviors **(Alruhaim et al., 2021)**.

Also, only quarter of children practiced exercise on regular bases with a median of three or five times/week for 60 minutes. In addition, all the sample monitored their blood sugar, where higher percentage of them checked their blood sugar after meals and checked urine sugar/ketone. However, half of children did not adequately apply ideal follow up. As well, the majority of children injected insulin by pen in different body places, but small number of them injected themselves. Also, more than one third of children missed their doses more than twice per month, so that totally, more than half did not comply with treatment.

Likewise, **Borus and Laffel (2012)** in U.S.A indicated that adolescents with type 1 diabetes demonstrated poorer adherence to treatment regimens compared with other age groups. Also, a concordant result reported by **RobatSarpooshi et al. (2020)** in Iran revealed that diabetic patients received an average score for self-care behaviors, where the mean self-care scores for the various dimensions indicated that the lowest averages were those of the physical activity and the proper treatment dimensions. As well, **Mukanoheli et al. (2020)** in Rwanda indicated poor adherence to self-care activities among diabetic patients, where the lowest mean in performing self-care activities was of practicing exercise (M±SD=1.04±1.68). In addition, **Ukpabi (2021)** conducted a study in Nigeria and found that more than half of diabetic patients had poor self-care behaviors adoption.

This result is in agreement with **Phiri et al. (2017)** in Malawi who demonstrated that the most of diabetic adolescents monitored their blood glucose at home. Also, this study revealed that about two third of diabetic adolescents were injecting themselves by the insulin but only a few (26%) were rotating the injection site and this result is contrary to the present study results. As well in contrast with the existing study results, **Madian and Ismail (2020)** in Egypt revealed that the majority of diabetic children applied regular follow-up.

Moreover, all children suffered from occurrence of hyper/hypoglycemia and higher percentage of them (two third) could deal adequately with these problems. Finally, more than half of children could not properly deal with stress. Whereas, more than half of them could adequately cope with diabetes. In the same stream, a study conducted in U.S.A by **Jaser et al. (2017)** revealed that the diabetic adolescents perceived fairly high control and coping with their disease. In addition, a congruent study in Egypt indicated that the majority of diabetic children had good self-care practices during hyper/hypoglycemia **(Madian & Ismail, 2020)**.

Concerning DM numerical skills among children in the study sample, the existing study results clarified that more than half of children had unsatisfactory DM numerical skills. In the same line with this results, a study carried out by **Alruhaim et al. (2021)** in Saudi Arabia revealed that more than half of diabetic patients had low DNT score especially those with type 1

diabetes. Likewise, **Moosa and Segal (2011)** in South Africa revealed that more than half of diabetic children applied the mathematical skills.

Regarding health literacy measure (HELMA), and literacy assessment for Diabetes (LAD) among children in the study sample, the current study results illustrated that higher percentage of children had self-efficacy and could understand the health information and more than half of them could access, read and use the information related to their health and had adequate communication skills with health care providers and others. Whereas, only 40% and 20% of them could appraisal the obtained information and had adequate numerical skills respectively. Totally, more than half of children had insufficient HELMA and two third of them had insufficient LAD.

In the same vein, a study conducted in Iran by **Ziapour et al. (2020)** indicated that more than half of diabetic patients has a limited or inappropriate health literacy level. As well, **Mukanoheli et al. (2020) carried** out a study in Rwanda and clarified that more than half of diabetic patients had inadequate health literacy. Moreover, similar finding was found in a study carried out in U.S.A by **Murray (2021)** who demonstrated that half of diabetic patients (type 1 or type 2) had limited health literacy.

Also, **Ukpabi (2021)** conducted a study in Nigeria and found that more than half of diabetic patients had inadequate health literacy. In addition, **Olesen et al. (2017)** in Denmark indicated that relatively low score of type 1 diabetic patients' health literacy was observed in the domain "Appraisal of health information". As well, **Nacanabo et al. (2021)** in Burkina Faso found that the lowest mean score of diabetic patients health literacy was observed in "Appraisal of health information" domain (mean = 2.57 [2.48 - 2.66]) and the mean score was quite low for "Ability to actively engage with healthcare providers" domain (mean = 3.08 [2.96 -3.20]).

Considering correlates of children knowledge, diabetes numeracy (DNT), health literacy measure (HELMA), and literacy assessment for Diabetes (LAD) scores in the study sample, the present study results demonstrated statistically significant positive correlations between knowledge, DNT, HELMA and LAD scores. Possible explanation of such result is that the higher the knowledge and health literacy of children, the higher were 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 (2019)** conducted a study in U.S.A and indicated statistically significant positive correlations between DNT, diabetes knowledge and health literacy scores among adolescents with type 1 diabetes. As well, a study conducted in Rwanda by **Mukanoheli et al. (2020)** revealed a strong relationship between health literacy and self-care behaviors including the numerical skills among diabetic patients. Also, **Chollou et al. (2020)** in Iran indicated that health literacy dimensions positively associated with diabetes self-care behaviors such as DM numerical abilities.

Also, the current study results indicated statistically significant positive correlations between children age, DNT and HELMA scores. This result might be attributed to the increase of children age which in turn promote their knowledge, awareness, abilities and experiences in how to deal with their DM, and thus their health literacy would improve which positively would affect their DM numerical skills.

Likely, a study conducted in Iran revealed a significant relationship between the diabetic patients' age and their health literacy level **(Tahery, 2018)**. As well, **Yeh et al. (2018)** carried out a study in Taiwan revealed a significant positive correlation between the age of diabetic patients and their health literacy. Moreover, a study conducted in Iran by **Noroozi et al. (2019)** indicated a significant positive correlation between the diabetic patients' age and their health literacy level.

According to the present study results, a statistically significant positive correlation between children DNT score and their 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 children DNT score and their families' 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.

In the same vein, a study conducted in Iran by **RobatSarpooshi et al. (2020)** 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. (2021)** 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).

Finally, Juvenile diabetes is an increasingly prevalent chronic disease in children and adolescence and associated with several complications, particularly increased mortality and high risk of micro and macro vascular complications. Where, it is a predisposing factor for retinopathy, neuropathy and nephropathy, cardiovascular diseases and diabetic foot. Also, as a chronic disease, it is responsible for a significant health burden. So that, the diabetic children must be health literate and have to cope with the disease and participate in self-care activities. Nowadays, health literacy is an important issue in diabetes management, as health literacy and knowledge of insulin therapeutic regimens, diet, exercise, glucose monitoring, and treatment

modification are necessary to effectively self-manage diabetes. Therefore, the current study had been implemented in this direction to assess the determinants of juvenile diabetic patients' 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 large number of participants. But unfortunately, majority 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 mainly had insufficient HELMA, inadequate LAD and inadequate self-care behaviors especially in terms of effective exercise, adequate follow up and complying with treatment. In addition to, unsatisfactory DM knowledge and numerical skills. Moreover, diabetic children age played prominent role in their DNT and HELMA scores.

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Declaration of Conflicting Interests

The author(s) declare(s) that there is no conflict of interest.

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