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Impact of Interactive Computer-Based Diabetes Education on Self-Care Management of University Students Having Type 1 Diabetes

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Abstract: *Self-management is a fundamental aspect of overall diabetes care. It is the basis for achieving optimum glucose control necessary to avoid the complications of diabetes through increasing knowledge, awareness and learning effective behavioral techniques to manage diabetes. Technology can assist with the provision of tailored and personalized education, feedback, and goal setting, thereby facilitating patient-centered care and communication and educate people with diabetes in managing their own health.*

Aim*: is to assess the impact of interactive computer-based diabetes education on self-care management of university students having type 1 diabetes.* ***Materials and Method****: Quasi-experimental pre/post–test research design. The study was carried out in diabetes clinic at different specialty clinics affiliated to Alexandria University; the total sample was 110 university students. Data was collected through using the diabetes knowledge test questionnaire, structured interview on the diabetes self-management profile, and satisfaction with interactive computer-based diabetes self-care management education scale.*

Results*: more than half of the study and control groups were males and more than two thirds of the study group (67.3 %) with a mean age of 21.36 ± 2.577 years, and more than three quarters of the control group (81.8 %) with a mean age of 21.24 ± 2.194 years. An obvious improvement in the students' level of knowledge was noticed at post program, as less than two third of them (60.0%) and 68.0% in follow up, had good level of knowledge. Interactive computer educational program showed a significant impact on the study group's practices in different areas of diabetes self-management. It is evident that, statistical significant correlation was found between study group's satisfaction with the program and total score of self-management practices in post program and follow up.*

Conclusion and Recommendations*: The interactive computer-based diabetes educational program had positive impacts on diabetes outcomes including improvements in diabetes knowledge, self-management practices. In addition, it plays a significant role in improving glycemic control, and motivates the students to adopt healthy lifestyle. The overall results revealed that, university students' satisfaction with computer-based diabetes educational program was high. Therefore, applying standardized technology-based diabetes education in primary health care facilities is necessary. Also, young people having type 1 diabetes need to receive age-appropriate, quality-assured structured diabetes education through adopting the novel and innovative technology.*

Key words: *Computer-based diabetes education, Diabetes education technology, Self-care behaviors, Self-management, Type 1 diabetes.*

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I. Introduction

Type 1diabetes is a chronic disorder and the most common endocrine-metabolic disorder of childhood and adolescence, which is not linked to modifiable lifestyle factors. There is no cure and it cannot be prevented, however, it must be managed over time [1]. The emerging epidemic of type 1 diabetes in pediatric and youth population presents a serious public health challenge [2]. The global annual incidence of diabetes mellitus is about 3% a year since 1968 especially among pediatrics with strong indications of geographic differences. In total, 1,106,200 of children and adolescents below 20 years are estimated to have type 1 diabetes worldwide in

2017 [3]. This rise in type 1 diabetes is part of a larger global trend and researchers have no easy explanations for what might be causing this trend [4].

Little data is available on the prevalence and characteristics of diabetes in Egypt [5]. Recent study conducted to screen for common NCDs in Egypt, 2017 reported that prevalence of diabetes was 18.2% in Upper Egypt [6]. However, it is estimated that by the year 2030, Egypt will have at least 8.6 million adults with diabetes. Moreover, it is the eleventh most important cause of premature mortality in Egypt, and is responsible for 2.4% of all years of life lost (YLL). Similarly, diabetes is the sixth most important cause of disability burden in Egypt [7]. Besides, epidemiological studies for type 1 diabetes in Egypt are scarce. This has been attributed to many reasons including lack of diabetes registries, scattered medical facilities and suboptimal capturing of new cases [8].

The consequences of diabetes in youth include short-term and long-term complications. Although the long-term complications are unlikely during the years that youths are under the care, they are at risk for the short-term complications every day [9, 10]. Self-management is a fundamental aspect of overall diabetes care. It is the basis for achieving optimal glycemic control necessary to avoid the complications of diabetes through expanding knowledge, awareness and learning effective behavioral techniques to manage diabetes [11]. Likewise, there is increasing recognition that type 1 diabetes requires a sophisticated approach that facilitates better self-management through adherence to standard principles in managing chronic disease in this age group, allied to the complicated clinical needs of managing type 1 diabetes and related conditions, establishing relationships with health care providers, managing emotions, sustaining a positive self-image, relating to family members and friends and preparing for an indefinite future. Balancing between the normal developmental needs of these life stage with the adaptive tasks presented by their chronic condition is multifaceted, because a chronic illness and its treatment can have manifold effects on diverse areas of daily life and development, while developmental changes during the transition to adulthood mutually affect both illness and treatment [12, 13].

Type 1 diabetes is a demanding condition to manage throughout young adulthood that as much as 95% of the self-care is typically provided by the ill persons or their families. Additionally, diabetes is a challenging disease to manage successfully. It can be controlled with lifestyle adjustments and medical treatments. It is, as far as possible, arranged around the preferred lifestyle rather than lifestyle around the diabetes. Though, life style management is apparently the cornerstone of management of diabetes mellitus. Furthermore, the treatment of type 1 diabetes aims to restore the glucose equilibrium of the body to a state of near-normality, and to enable the person concerned to live the life he or she wishes to live. These aims require a reasonably stable balance between food, insulin and physical activity while management of diabetes [14, 15].

Learning self-care behaviors is an important way to enhance self-esteem and autonomy, and to empower the young people with diabetes to become a responsible individual. Self-care behaviors as identified by the American association of diabetes educators (AADE) are the sum of seven core behaviors including; physical activity, healthy eating, medication taking, monitoring blood glucose, problem solving (high and low, and sick day), reducing risk of diabetes complications and psychosocial adaptation [16]. The American Association of Clinical Endocrinologists (AACE) emphasizes the importance of patients becoming active and knowledgeable participants in their care and that diabetes education could lead to improved self-management and psychological wellbeing [17, 18].

Information and communication technologies (ICT) have evolved to be typical elements in all aspects of life. The utility of advanced communication technology in health care is in increasing access to health care services, and broadening availability of resources, even among underserved populations [19]. The use of technology has revolutionized the way patients are educated about health. It has been gaining strong support as evidence builds of its effectiveness for diabetes management and education. Technology can assist with the provision of tailored and personalized education, feedback, and goal setting, thereby facilitating patient-centered care and communication and educate people with diabetes in managing their own condition [20].

The diabetes nurse plays an integral role within the prevention, diagnosis and management of diabetes. Nurses can increase skills, knowledge and confidence, as well as support and empower the person with diabetes to self-manage their condition and lessen the chances of developing further health complications [21]. With that evolution, new roles emerge and provide fertile ground for nurses to apply their skills in different ways. Moreover, emerging and new technologies, such as smart phones, social media and data management systems, could provide solutions to complex health-care issues [22, 23].

Currently, nurses use tele-nursing for all practices of nursing including assessment, planning, intervention, and evaluation of the results of their nursing cares. Tele-nursing includes all kinds of nursing care and services that can be provided from distance and includes a wide range of communication technologies such as phone, email, internet, and video clips to overcome the time and distance obstacles to provide better nursing care. Among these devices, computers are frequently used in tele-nursing as it is accessible for majority of young people. Patients receive emails from health care personnel in a periodical basis and get counsels on their treatment and educational information and it is especially useful for people with diabetes who have problems of far distance to the health care clinics or need a long time waiting for visiting a doctor [24 – 27]. Studies conducted on tele-nursing, concluded that this method has positive effectiveness on the treatment of people with diabetes and the outcomes shows that this technology has associated less hospitalization and has reduced nursing visits to houses' of people with diabetes [28,29]. In light of that, **the aim of the study** is to assess the impact of interactive computer-based diabetes education on self-care management of university students having type 1 diabetes.

Research hypothesis:

University students having type 1diabetes who engage in an interactive computer-based diabetes self-care management education program demonstrate high level knowledge and self-care practices than those who are not.

II. Material And Methods

Material:

Research design: Quasi-experimental pre/post – test study was adopted to conduct this study.

Study setting: The study was carried out in diabetes clinic at different specialty clinics affiliated to Alexandria University.

Subjects: Purposive sample of students who were fulfilling the inclusion criteria at diabetes clinic were selected.

Sampling technique:

A sample of 110 university students was required to estimate an average change at HbA1c level after applying intervention program = 3.4 (mmol/mol) compared to 1.7 (mmol/mol) at control group with effect size of 0.48 and 95% confidence level which provide a study power of 80% keeping 10% for dropout effect.

The study sample was randomly assigned to one of two groups, 55 students was control group and the other 55 students was intervention group. The study group received an interactive computer -based diabetes self-care management education program, while the control group received routine care.

Inclusion criteria:

The students were selected according to the following criteria: who diagnosed as type 1diabetes at least since 6 months, did not attend any diabetic educational program prior to the study, free from other chronic diseases and /or mental disorders, and possessed a personal computer with at least Microsoft office 2007 at home.

Tools for data collection:

Four tools were used to collect the required data for the study;

Tool (I): The Diabetes Knowledge Test (DKT) Questionnaire:

The researcher adopted the Diabetes Knowledge Test (DKT) of the University of Michigan Diabetes Research and Training Centre [30]. The DKT has been proven to be reliable and valid. The questionnaire comprising 23 items to test patients, knowledge of diabetes, it has two parts: part one includes 14-items about general diabetes related knowledge, and part two includes 9-items on insulin-use. The knowledge score was calculated as follows; Correct answer = 1 & Incorrect answer or no response = zero. The range of the DKT was 0 to 23 and was categorized as:

- ≤ 50% (less than 11) = Poor level of knowledge.
- 51% < 75% (11 to 17) = Fair level of knowledge.
- 75% < 100% (greater than 17) = Good level of knowledge.

- The Cronbach's alpha coefficient for the Diabetes Knowledge Test was found α = > 0.70.
- Socio demo- graphic characteristics and health status was added: age, gender, educational level, parents' education, occupation, and monthly income.
- Students' medical history: onset of diabetes, duration, last result of fasting blood glucose level, postprandial blood glucose level, last HbA1c result and eye exam for the last 3 months.
- Anthropometric measurements: weight and height were measured, and body mass index was calculated according to WHO standards [31].

Tool (II): The Diabetes Self-Management Profile (DSMP):

The Diabetes Self-Management Profile (DSMP) [32], originally validated by Harris et al., is a structured interview developed to assess self-management practices among young patients ages ≥ 11 years with type 1diabetes. It consists of 25 items measuring 5 domains: exercise, hypoglycemia, diet, blood glucose test, and insulin dose. This instrument has revealed adequate internal consistency, inter-rater agreement and test-retest reliability, in addition to a correlation with glucose control measured by HbA1C. Responses are coded on rating scale ranging from (0 to 4), which is differing for each item. Exercise scores ranging from (0-12), hypoglycemia (0 -7), diet (0-29), blood glucose test (0-15), and insulin (0-16). The combined scores are summed to create a total adherence score, which can range from 0 – 79. Higher scores on the DSMP indicate better adherence. The DSMP score will be calculated as follows;

- ≤ 50% (less than 40) = Poor level of practice.
- 51% < 75% (41 to 60) = Fair level of practice.
- 75% - 100% (60 - 79) = Good level of practice.

- The Cronbach's alpha coefficient for the Diabetes Self-Management Profile scale was 0.76.

Tool (III): Satisfaction with interactive computer-based diabetes self-care management education scale:

This evaluation tool was developed by the researcher to evaluate the satisfaction with the educational program. It was used to assess the program along multiple dimensions: ease of use; content clarity and comprehensiveness; organization; applicability; usefulness; effectiveness; attractiveness; motivation for self – management; and long-term adherence. This tool was composed of 15 items on a 5-point Likert scale ranging from strongly disagree to strongly agree. For each statement, a score of 1-5 was assigned to responses. Summing the score of the scale items and dividing by the number of items in the scale was computed the score. Thus, the total scale scores range from 1 to 75. The scale score was calculated as follows;

- ≤ 50% (less than 38) = dissatisfied.
- 51% < 75% (38 to 56) = neutral.
- 75% - 100% (56 - 75) = Satisfied.

- The Cronbach's alpha coefficient for this tool was found α = > 0.76.

Method:

The study was executed according to the following steps:

- **Permission** to conduct the study in the selected setting was obtained after explanation of the aim of study.
- **Pilot study**: was carried out on a sample of (11) diabetic students not included in the study sample to ascertain the clarity and applicability of the tools, according to their response the tools were modified.
- **The fieldwork** was accomplished in ten months during the period from 1/12/2016 to 30/9/2017.
- **Program**: Interactive computer-based self-care management diabetes education program was applied according to the following phases:

A. Assessment phase:

The questionnaire distributed to be completed by all selected students control and study groups as pre-test. The objectives and the content of questionnaire were explained to them and the students' HbA1C levels were recorded before intervention. Researcher obtained telephone number from each student in order to follow them up by telephone calls during 6 months of intervention; and also to encounter any problems during application of the program.

B. Planning phase:

Interactive computer self-care management diabetes education program was developed according to the following steps:

1. **Setting General objective.**
2. **Determination of specific objectives**: at the end of the program, students will be able to: identify the concept of healthy eating, implement effective insulin therapy regimen, recognize the components of diabetes monitoring, and identify the preventive measures of acute and chronic complications.
3. **Determining the content of the health education program**: defining the content based on Global IDF/ISPAD Guideline for Diabetes in Childhood and Adolescence [33], current literature and the results of the assessment phase, the researcher divided the subjects of the health education program into 9 subjects:

1. Diabetes basics.
2. Healthy eating.
3. Being active.
4. Insulin therapy.
5. Monitoring.
6. Complications of diabetes.
7. Diabetes problem solving.
8. Management of sick day.
9. Personal hygiene and foot care.

4. Designing the interactive computer program: this step includes the following actions:

4.1. Designing of content presentation methods: Several windows pages were created. Content is displayed through written information accompanied by images, fixed and animated graphics as well as video clips. The windows pages consist of the following: **(Fig. 1, 2, 3)**

•**Main Page**

Figure (1): Screen shot for main page of the educational program.

•**Topics page**

Figure (2): Screen shot for topics page of the educational program.

•**Software help page**

Figure (3): Screen shot for help page of the educational program.

4.2. Design of educational interaction patterns: in designing the program environment, the educational interaction opportunities are diversified, so that students can take advantage of the program's data, which includes: interaction between learner and content, interaction between learner and researcher, and interaction between the learner and graphical interface (GUI).

4.3. Storyboard Scenarios Design: a scenario is a procedural map that includes operational steps to produce a specific learning resource, which is the basic structure of the software, aimed at view the instructional content in a sequential logical way in a written form that shows the details and sequence of events that appear on computer screen. It includes all the terms, specifications and details of this learning resource and its elements: images, text, graphics, video clips, audio and musical effects, this stage was made by the educational designer of the e-learning center at Alexandria University.

4.4. Multimedia production: after the finalization of the scenario, the stage of converting this scenario into computer learning resource, the E-Learning center team at Alexandria University has converted the script, according to the following actions:

- The health education program included a variety of media to enrich the different learning aspects.
- Clustering and programmatic composition.

5. Validity of the program:

This phase aims to ascertain the validity of the health education program produced for the application and to conduct the experiment, which includes the following actions:

1. The researcher carried out the sequential review of the production processes, made the necessary adjustments and reviewed it, to ensure the quality of the production.
2. The Health education program was also presented to members of the community health nursing department at faculty of nursing, with an aim to:

- Check links to the content of the health education program.
- Discovering technical problems in the design or production of the health education program. Accordingly, all appropriate solutions were taken into consideration.
- Ensure the suitability of the multimedia used with the research subjects.
- Evaluate the final form of the design of the health education program as a whole.
- Confirm that the health education program for the diabetic students has thus become a valid application.

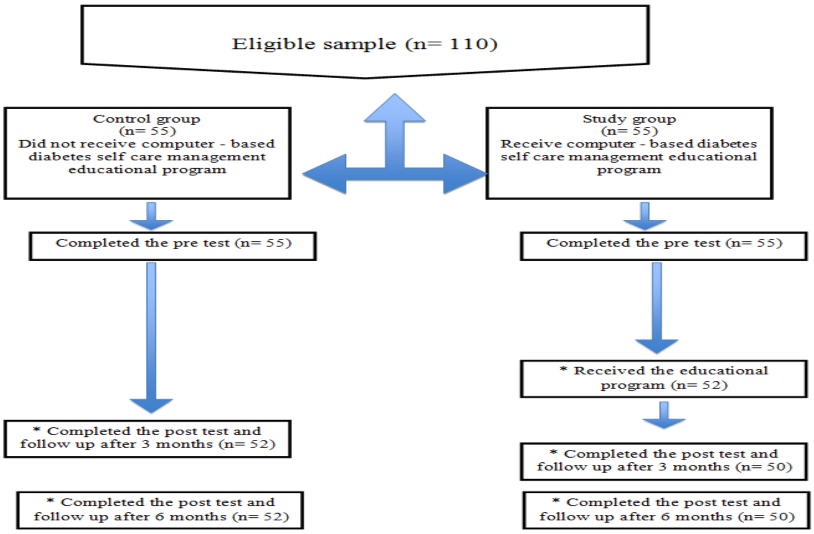
C. Implementation phase:

After completion of program development, researcher started to distribute it through the following steps:

- Phone Calls to all students of the study group to determine the way for receiving the program. Students who prefer to receive through email, program compressed file and program usage manual were sent. On the other hand, a paper manual; self-learning diabetes education CD-ROM; and a universal serial bus (USB) memory stick to store the required data were provided to students who prefer to receive the program during interview. Also, training on how to use the CD-ROM was carried out.
- Any problems related to program setup were encountered in order to make sure that system is running at its peak by adjusting backup and recovery options, and students were guided for what to do to solve these problems encountered them.
- All students were instructed to measure their blood glucose level and record the measurement to the diary and the system will provide feedback through color-coding. Also, they entered data about daily food intake, physical activity, and personal goals.
- Daily Short health messages were sent to all students of the intervention group through WhatsApp application. These messages included important diabetes self-management skills, and Ramadan fasting instructions for diabetics. The researcher replied to any questions from the students.

D. Evaluation phase:

- After the implementation of an interactive computer -based diabetes self-care management education program, the evaluation phase was performed.
- Evaluation for the study group was conducted by posttest after implementation of the program to determine effect of the program on improving self-care management of the diabetic students (using tools: I, II, and III).
- Program clinical outcomes (which include HbA1C level, number of hypoglycemia and hyperglycemia episodes) were assessed at baseline, three and six months of intervention after starting to use the education program.
- Satisfaction with computer-based diabetes self-care management educational program was evaluated using tool (IV).
- Posttest was done for the control group at the same time for the study group through interviewing them at the clinic during regular follow up using the same tools.



* Students drop out after assessment phase.

Figure (4): Workflow of the study.

Statistical analysis:

Data were analyzed using the statistical package for social sciences (SPSS version 20) software. The level of significance selected for this study was ≤0.05
The following statistical measures were used:

- Descriptive statistics: frequencies, percentages, arithmetic means, and standard deviation (SD) were used to describe the characteristics of the studied sample and main variables.
- Analytical statistics: ANOVA with Friedman's test, ANOVA with Cochran's Q, Pearson's R, and Paired t-test were carried out in calculating the difference of knowledge scores, and diabetes self-management profile scores among the study sample. ANOVA with repeated measures was carried out to compare means of glycated hemoglobin (HbA1c), numbers of hypoglycemic episodes, and numbers of hyperglycemic episodes for study groups across the three stages of study. Percent of change was calculated using the following equation:

$$\text{Percent of change} = \frac{\text{Mean value in post test stage} - \text{Mean value in pre test stage}}{\text{Mean value in pre stage}} \times 100$$

- Graphical presentation: Microsoft office Excel software was used to construct the needed graphs.

Ethical considerations: written informed consent was obtained from students to participate in the study. The assurance of anonymity was addressed prior to a request for participation. Privacy and confidentiality were maintained during process of data collection.

III. Results

Table (1) displays that more than two thirds of the study group (67.3 %) ranged from 20 – 28 years with a mean age of 21.36 ± 2.577 years, and more than three quarters of the control group (81.8 %) with a mean age of 21.24 ± 2.194 years. Concerning their sex, more than half of the study and control groups, (50.9 %, and 54.5% respectively) were males. As regards to birth order, 38.2 % of the study, and 32.7 % of the control group were the second child in the family.

Concerning the students' anthropometric measurement, the mean weight for the study group was 67.53 ± 10.037 kg, while the mean weight for the control group was 71.13 ± 25.918 kg. As regards to students' height, the mean height for the study group was 166.42 ± 9.175 cm, however the mean height for the control group was 166.00 ± 9.807 cm. While, the mean of the study group's BMI was 24.44 + 3.61 kg/m2, and control group was 25.62 + 7.18 kg/m2.

Regarding type of faculty, more than three quarters of the study group (76.4 %), and less than three quarters of the control group (70.9 %) were enrolled in theoretical faculties. Moreover, regarding students' academic year, the present table illustrates that more than one third of both the study and control groups (38.2 %, and 34.5 % respectively) were enrolled in the second academic year.

In respect to family history of diabetes, more than two thirds of the study and control groups (70.9 %, and 67.3 %) had family history of diabetes respectively. Moreover, 48.7 %, and 43.2% of them were first-degree relatives.

Table (1): Distribution of the studied sample according to their personal characteristics.

Personal Characteristics	Study (n =55)		Control (n =55)	
	No.	%	No.	%
Age				
- < 20	18	32.7	10	18.2
- 20 – 281	37	67.3	45	81.8
Mean + SD	21.36 ± 2.577		21.24 ± 2.194	
Sex				
Male	28	50.9	30	54.5
Female	27	49.1	25	45.5
Weight/Kg				
- Min. – Max.	45 - 93		40 - 90	
- Mean ± SD	67.53 ± 10.037		71.13 ± 25.918	
Height/cm				
- Min. – Max.	150 - 191		145 - 191	
- Mean ± SD	166.42 ± 9.175		166.00 ± 9.807	
BMI/ Kg/m2				
Underweight (≤ 18.5 kg/m2)	2	3.6	2	3.6
Normal (18.5-24.9 kg/m2)	29	52.7	27	49.1
Overweight (25-29.9 kg/m2)	21	38.2	22	40.0
Obese (Obese: ≥30 kg/m2)	3	5.5	4	7.3
Mean ± SD	24.44 ± 3.61		25.62 ± 7.18	
Type of Faculty				
Scientific	13	23.6	16	29.1
Theoretical	42	76.4	39	70.9
Academic year				
First Year	15	27.3	11	20.0
Second Year	21	38.2	19	34.5
Third Year	10	18.1	9	16.4
Fourth Year	9	16.4	16	29.1
Family history of diabetes:				
Yes	39	70.9	37	67.3
No	16	29.1	18	32.7
If yes, degree of relatives				
First degree	19	48.7	16	43.2
Second degree	10	25.7	11	29.7
Third degree	7	17.9	9	24.4
Fourth degree	3	7.7	1	2.7

Table (2) presents that more than one third of the study group (34.5%) had diabetes since more than 5 years, with mean duration of (8.65 ± 5.680). However, more than two thirds of the study group (67.3%) discovered their disease after appearance of signs and symptoms, and diabetic ketoacidosis (DKA) at initial presentation was diagnosed in 18.2% of them. While, for the control group, more than one quarter of them (27.3%) had diabetes since more than 5 years. On the other hand, less than three quarters of the control group (70.9%) were diagnosed after appearance of the signs and symptoms, and diabetic ketoacidosis (DKA) at initial presentation was diagnosed in 20% of them.

Hypoglycemic episodes were reported to be more than 5 times during the last 3 months among more than half of the study group (58.2%), while 40.0 % of them had less than 5 times, with a mean of 6.42 ± 3.947 episodes. Also, less than two thirds of the control group (63.7%) who experienced more than 5 events of hypoglycemia, followed by 34.5% of them reported less than 5 episodes, with a mean of 7.36 + 5.730 hypoglycemic episodes.

Regarding hyperglycemic episodes, 56.4% of the study group, and 34.5% of the control group reported more than 5 episodes of hyperglycemia during the last 3 months. Whereas, more than one thirds of the study group (41.8%), and less than two thirds of the control group (60.0%) experienced less than 5 episodes of hyperglycemia. Mean of episodes were 6.42 ± 5.294, and 4.69 ± 4.050 for the study and control groups respectively.

Table (2): Distribution of the studied sample according to their diabetic health profile.

Diabetic health profile	Study (n =55)		Control (n =55)	
	No.	%	No.	%
Duration of diabetes (year):				
- < 5	14	25.5	10	18.2
- 5 -	19	34.5	15	27.3
- 10 -	12	21.8	19	34.5
- 15 -	10	18.2	11	20.0
Mean ± SD	8.65	± 5.680	9.66	± 5.299
Clinical presentation at initial diagnosis:				
- Manifestations of diabetes.	37	67.3	39	70.9
- During check-up.	8	14.5	5	9.1
- Diabetic ketoacidosis (DKA).	10	18.2	11	20
No. of hypoglycemic episodes/ last 3 months:				
- Non	1	1.8	1	1.8
- < 5 times	22	40.0	19	34.5
- ≥ 5 times	32	58.2	35	63.7
Mean ± SD	6.42 ± 3.947		7.36 ± 5.730	
No. of hyperglycemic episodes/ last 3 months				
- Non	1	1.8	3	5.5
- < 5 times	23	41.8	33	60.0
- ≥ 5 times	31	56.4	19	34.5
Mean + SD	6.42	± 5.294	4.69	± 4.050

Table (3) exhibits that more than three quarters of the study group (78.2%), and less than three quarters of the control group (70.9%) did not attend any diabetes health education session. However, Hospital physician on admission, were reported as the main source of information about diabetes by more than two thirds of the study group (70.9%), and more than three quarter of the control group (80.0%), followed by 47.3% of the study group, and 65.5% of the control group stated that their family members were one of their source of information. However, browsing social networks and websites were mentioned by 54.5% in study group, and 38.2% in control group. Whereas, only 3.6% of the study group, and 9.1% of control group indicated that the nurses either in hospital or diabetic clinic were their source of information about diabetes.

Table (3): Distribution of the studied sample according to their Diabetic health information.

Diabetes health information.	Study (n =55)		Control (n =55)	
	No.	%	No.	%
Attendance of diabetes health education session				
Yes	12	21.8	15	27.3
No	43	78.2	40	72.7
Source of information *				
Health sessions	12	21.8	15	27.3
Family members	26	47.3	36	65.5
Friends or neighbors	10	18.2	4	7.3
Media	13	23.6	12	21.8
Hospital physician	39	70.9	44	80.0
Nurse	2	3.6	5	9.1
Social networks/Websites	30	54.5	21	38.2

*** Multiple answers.**

Table (4) shows the mean score of the students regarding their knowledge about insulin 2.58 ± 1.23 in the pre program, while this mean scores were increased in post program and during follow up 3.64 ± 1.14, 3.82 ± 1.10 respectively. While, regarding the students' knowledge about diabetic diet, significant increase in mean scores was observed through the three phases pre program (mean 2.98 ± 1.15), post program (mean 3.68 ± 0.79) then follow up (mean 3.74 ± 0.78) respectively. Moreover, in relation to knowledge about exercise, there was little difference between the mean score in pre and post program (0.85 ± 0.36, and 0.98 ± 0.14 respectively). While, the mean score of the follow up (0.98 ± 0.14) remained the same like post program. Concerning glucose monitoring knowledge, the mean score across the different stages of the study were (pre program: 0.78 ± 0.69, post program: 1.0 ± 0.54, and follow up: 0.98 ± 0.52) respectively. While, the mean scores regarding foot care knowledge were (0.82 ± 0.39, 0.92 ± 0.27, and 0.94 ± 0.24 respectively) in the pre, post, and follow up program. Relating to short and long term complications subscales, the mean knowledge scores were (3.69 ± 1.12, 4.56 ± 1.11, and 4.72 ± 0.99) respectively about short-term complications. While, the mean score of long term complications were (2.38 ± 0.78, 2.54 ± 0.68, and 2.60 ± 0.64 respectively) through the three phases.

Overall, the results revealed significant difference of the computer education program on students' knowledge regarding different topics about diabetes at various study phases (Friedman x^2 = 50.935, 29.360, 14.000, 12.167, 9.556, 43.221, 8.667, $p \leq 0.05$ respectively).

Table (4): Distribution of the study group according to their mean scores of diabetic knowledge subscale.

Mean scores of Diabetes Knowledge subscale.	Study			Friedman $^{Fr}x^2$(p)
	Pre program (n=55)	Post program (n=50)	Follow up (n=50)	
Insulin	2.58 ± 1.23	3.64 ± 1.14	3.82 ± 1.10	50.935 (<0.001*)
Diet	2.98 ± 1.15	3.68 ± 0.79	3.74 ± 0.78	29.360 (<0.001*)
Exercise	0.85 ± 0.36	0.98 ± 0.14	0.98 ± 0.14	14.000 (0.001*)
Glucose Monitoring	0.78 ± 0.69	1.0 ± 0.54	0.98 ± 0.52	12.167 (0.002*)
Foot care	0.82 ± 0.39	0.92 ± 0.27	0.94 ± 0.24	9.556 (0.008*)
Short term complication	3.69 ± 1.12	4.56 ± 1.11	4.72 ± 0.99	43.221 (<0.001*)
Long term complication	2.38 ± 0.78	2.54 ± 0.68	2.60 ± 0.64	8.667 (0.013*)

$^{Fr}\chi^2$: Chi square for Friedman test ***: Statistically significant at $p \leq 0.05$**

Table (5) portrays that nearly three quarters of study group (74.5%) in the pre program had fair level of knowledge, followed by 16.4% of them had poor level. While, only 9.1 % of them had good knowledge level, with mean score of 14.09 ± 2.764. On the other hand, more than half of the control group (56.4%) had fair level of knowledge, whereas less than one quarter of them (23.6%) had poor level, and one fifth of them (20.0%) had good knowledge level, with mean score of 14.11 ± 3.430.

An obvious improvement in the students' level of knowledge was noticed, as less than two third of them (60.0%) in post program with mean score of 17.32 ± 2.839, and 68.0% in follow up with mean score of 17.78 ± 2.698, had good level of knowledge. Remarkable decrease in percent of the students who had poor knowledge in both post program and follow up (8.0 %, and 6.0% respectively). However, less than one third of the study group (32.0%) in post program, and more than one quarter of them (26.0%) in follow up had fair knowledge level. Significant differences were observed between three phases (t1 = 6.937, and t2 = 7.468 p=.000 respectively).

In relation to control group, it was noticed that slight decline occurred through post program and follow up (17.3%, and 19.2% respectively) with mean score of 14.21 ± 3.164 in post program and 14.33 ± 3.264 in follow up, among students had good knowledge level. While, nearly two thirds of them (65.4%) and 63.5% had fair knowledge level at the same previous mentioned study stages. No significant difference was observed between three phases (t1 =.000 p= 1.000, and t2 =-.181 p=.857 respectively).

Concerning the effect of the education, a highly significant impact of education on study group's knowledge as ANOVA Friedman's test across the three stages was highly significant for all items as p<0.000.

Table (5): Distribution of the studied groups according to their level of total knowledge scores.

Total knowledge scores	Study						Control					
	Pre program (n=55)		Post program (n=50)		Follow up (n=50)		Pre (n=55)		Post (n=52)		Follow up (n=52)	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Poor(less than 11)	9	16.4	4	8.0	3	6.0	13	23.6%	9	17.3%	9	17.3%
Fair (11 to 17)	41	74.5	16	32.0	13	26.0	31	56.4%	34	65.4%	33	63.5%
Good (greater than 17)	5	9.1	30	60.0	34	68.0	11	20.0%	9	17.3%	10	19.2%
Mean + SD	14.09 ± 2.764		17.32 ± 2.839		17.78±2.698		14.11± 3.430		14.21 ± 3.164		14.33 ± 3.264	
Paired t test	t1 = 6.937 p=.000*		t2 = 7.468 p=.000*				t1 =.000 p= 1.000				t2 =-.181 p=.857	
ANOVA with Friedman's Test	48.951 .000*						.067 .967					

*** Significant at p < 0.05 t1: Between total scores before program and post program after 3 months.**
t2: Between total scores before program and post program after six months follow up.

It is obvious from **table (6)** that, in pre program mean subscale scores were as follows: exercise (5.11 ± 2.69), diet (16.64 ± 6.39), hypoglycemia (3.05 ±1.46), blood glucose test (6.96 ± 3.29), insulin administration, and dose adjustment (10.15 ± 2.48). Those mean subscale scores continued to increase through post program and follow up. For post program: exercise was 8.00 ±1.59, diet (19.82 ± 3.53), hypoglycemia (3.80 ± 1.11), blood glucose test (8.14 ± 2.83), and insulin administration and dose adjustment (11.32 ± 2.06). Whereas the mean subscale scores for follow up were: exercise (8.58+1.74), diet (21.04 ± 3.21), hypoglycemia (3.78 ±1.27), blood glucose testing (9.52 ± 2.27), and insulin administration and dose adjustment (11.60 ±1.98).

Generally, interactive computer educational program showed a significant impact on the study group's practices in different areas of diabetes self-management through the three stages ANOVA Friedman's test (65.024, 26.923, 27.369, 37.389, 37.255) as ($p < 0.001$) in all items.

Table (6): Distribution of the study group according to their mean scores of diabetes self-management profile (DSMP) subscales.

Mean scores diabetes self-management profile subscales.	Study			
	Pre program (n=55)	Post program (n=50)	Follow up (n=50)	Friedman $^{Fr}\chi^2$(p)
Exercise (0-12)	5.11 ± 2.69	8.0 ± 1.59	8.58 ± 1.74	65.024*(<0.001*)
Diet (0-29)	16.64 ± 6.39	19.82 ± 3.53	21.04 ± 3.21	26.923*(<0.001*)
Hypoglycemia(0-7)	3.05 ± 1.46	3.80 ± 1.11	3.78 ± 1.27	27.369*(<0.001*)
Blood glucose testing (0-15)	6.96 ± 3.29	8.14 ± 2.83	9.52 ± 2.27	37.389*(<0.001*)
Insulin(0-16)	10.15 ± 2.48	11.32 ± 2.06	11.60 ± 1.98	37.255*(<0.001*)

$^{Fr}\chi^2$: Chi square for Friedman test ***: Statistically significant at $p \le 0.05$**

In respect to students' total scores of diabetes self-management profile scale, a remarkable improvement was noticed among the study group through the stages of the study **table (7)**. Less than half (45.5%) of the students with diabetes had poor level of self-management in the pre program. Remarkably the majority of the students (94.0%) had fair level in post program, and 78.0% of them in follow up stage. On the other hand, students who had good level self-management were increased from pre program to post program and follow up (3.6%, 6.0%, and 20.0% respectively). It was obvious that significant differences was observed among the study group between the three phases of the intervention (t1 = 8.766, and t2 = 9.600 p=.000) respectively. Furthermore, the results of ANOVA Friedman's test indicated that there were statistical significant differences in responses in study group across the three stages (p= < 0.000).

Table (7): Distribution of the studied groups according to their total scores of diabetes self-management profile scale (DSMP).

Total scores of diabetes self-management profile scale.	Study						Control					
	Pre program (n=55)		Post program (n=50)		Follow up (n=50)		Pre (n=55)		Post (n=52)		Follow up (n=52)	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Poor (less than 40)	25	45.5	0	0.0	1	2.0	21	38.2	18	34.6	25	48.1
Fair (40 – 60)	28	50.9	47	94.0	39	78.0	30	54.5	34	65.4	26	50.0
Good (more than 6o – 79)	2	3.6	3	6.0	10	20.0	4	7.3	0	0.0	1	1.9
Mean + SD	41.07± 9.963		51.08 ± 5.982		54.52 ± 6.038		42.36± 9.999		40.94± 7.742		39.63+ 7.616	
Paired t test	t1 = 8.766 p=.000*				t2 = 9.600 p=.000*		t1= 1.160 p=.252				t2=2.474 p=.117	
ANOVA with Friedman's Test	61.347 .000*						3.879 .224					

*** Significant at $p < 0.05$ t1: Between total scores before program and post program after 3 months.**
t2: Between total scores before program and post program after six months follow up.

Table (8) reveals that more than three quarter (80.0%) of the students in post program phase, and 82.0% of them in follow up phase, had moderate glycemic control, in which glycated hemoglobin level ranged from 7- 9%, as compared to less than half of them (41.8%) in pre intervention phase who had poor glycemic control (HbA1c > 9 %). However, steady increase in the percentage of students who achieved good glycemic control (HbA1c < 7) was noticed (pre test: 5.5%, post test: 6.0%, then follow up stage: 10.0%). It is evident from the table that mean HbA1c % changed across the three study stages (pre test: 9.14 ± 1.73) post: (8.17 ± 1.06), follow up :(7.78 ± 0.97), and percent of change was post test: 10.6%, follow up: 14.9%. Moreover, concerning the effect of the education a highly significant impact of education on HbA1c level as F test (ANOVA) with repeated measures for comparing between the three periods was highly significant as (F=18.972 p <0.001).

Table (8): Distribution of the study group according to their glycated hemoglobin (HbA1c) values.

HbA1c values	Study group					
	Pre (n=55)		Posttest (n=50)		Follow up (n=50)	
	No.	%	No.	%	No.	%
Good glycemic control (< 7%)	3	5.5	3	6.0	5	10.0
Moderate glycemic control (7 – 9 %)	29	52.7	40	80.0	41	82.0
Poor glycemic control (> 9 %)	23	41.8	7	14.0	4	8.0
Min. – Max. Mean ± SD.	6.1 – 13.5 9.14 ± 1.73		6.10 – 11.50 8.17 ± 1.06		6.10 – 10.80 7.78 ± 0.97	
% Change of HbA1c from pre intervention phase.			10.6%		14.9%	
F(p)	18.972*(<0.001*)					

F: F test (ANOVA) with repeated measures for comparing between the three periods
***: Statistically significant at p ≤ 0.05**

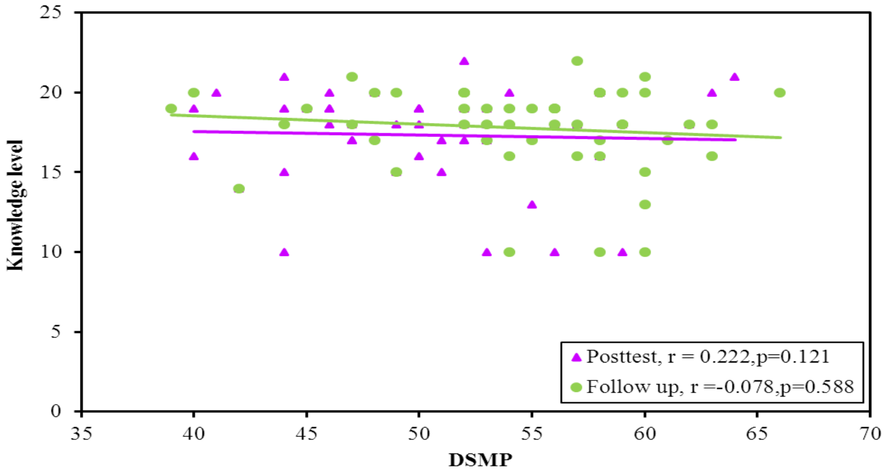
Table (9) shows that, more than three quarters (82.0%) of the study group strongly agreed that the objectives were clear, whereas, 68.0 of them stated that the program objectives meet their needs and expectations. Less than three quarters (74.0%) of the study group mentioned that, the program contents were described and strongly agreed that, it was simple and easily understandable. Completeness and comprehensiveness of program were mentioned by 72.0%, Up to date knowledge by 60.0%, and it contained suitable videos and images by 74.0%. While, more than three quarters (82.0%) of the study group strongly agreed that the language was clear and understandable.

Regarding the program design, less than three quarters of the students (72.0%) strongly agreed that it was interesting and attractive, whereas, more than half (56.0%) of them stated that it was easy to use, the majority (84.0%) of them reported that it was organized, and more than three quarters (76.0%) described it as interactive. Moreover, more than three quarters of students (80.0%) strongly agreed about the usefulness of the program, and it was motivating them to practice self-management. Though, the majority of them (86.6%) decided that, they would adhere to use it for long period. Furthermore, the majority (90%) of them recommended for using the program by any diabetic patient. Overall, the result revealed that, all students of the study group (100.0%) were satisfied with the program with mean satisfaction score of 70.76 ± 2.344.

Table (9): Distribution of the studied sample according to their satisfaction of the educational program

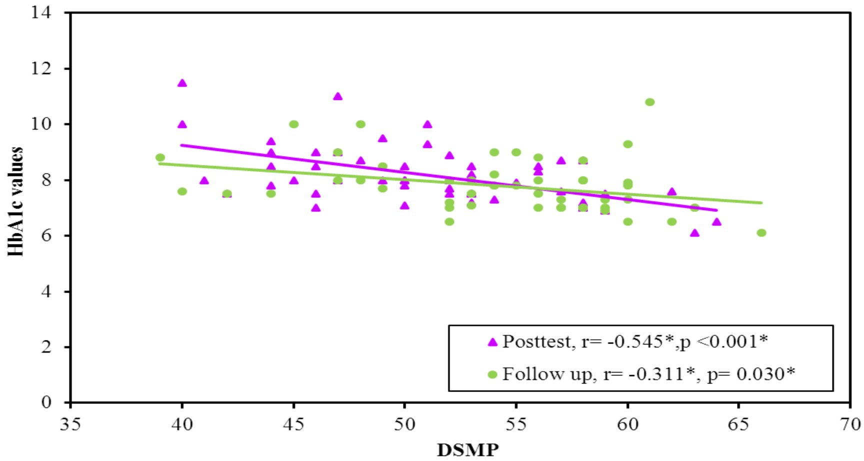
Satisfaction of the educational program.	Study group (n. 50)					
	Neutral		Agree		Strongly Agree	
	No.	%	No.	%	No	%
Program Objectives:						
Clear	0	0.0	9	18.0	41	82.0
Meet needs and expectations	4	8.0	12	24.0	34	68.0
Program Contents:						
Simple and easily understandable	3	6.0	10	20.0	37	74.0
Complete and comprehensive	1	2.0	13	26.0	36	72.0
Up to date	0	0.0	20	40.0	30	60.0
Suitable videos and images.	7	14.0	6	12.0	37	74.0
Language:						
Clear and understandable	4	8.0	5	10.0	41	82.0
Program Design:						
Interesting and attractive.	0	0.0	14	28.0	36	72.0
Easy to use.	4	8.0	18	36.0	28	56.0
Organized.	0	0.0	8	16.0	42	84.0
Interactive	3	6.0	9	18.0	38	76.0
Program Usefulness:						
Useful.	0	0.0	10	20.0	40	80.0
Motivating.	4	8.0	6	12.0	40	80.0
Adherence to use for long period.	0	0.0	7	14.0	43	86.0
Recommend for Using the Program: Recommend for using the program by any diabetic patient.	0	0.0	5	10.0	45	90.0
Total Satisfaction scores	No.			%		
Satisfied (56 – 75)	50			100.0		
Mean ± S D	70.76 ± 2.344					

Graph (1) reveals that no statistical significant differences were observed between diabetes self-management profile of the study group, and their knowledge level across the post intervention and follow up phases.

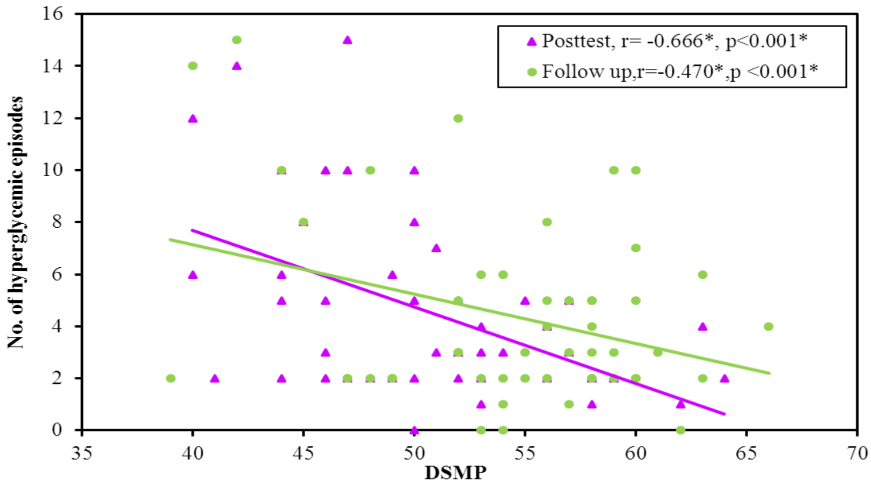


Graph (1): Comparison between the study's group diabetes self-management profile and their knowledge level.

It is evident from this graph that in post program, diabetes self-management was significantly and negatively associated with glycated hemoglobin (HbA1c) values (r = -0.545 p= <0.001) **(graph 2)**. Also, regarding number of hyperglycemic episodes (r = -0.666 p= <0.001) **(graph 3)**. Furthermore, similar results were observed during follow up, significant correlation was found regarding glycated hemoglobin (HbA1c) values (r = –0.311 p= 0.030), and the number of hyperglycemic episodes (r = -0.470 p= 0.001).



Graph (2): Comparison between diabetes self-management profile (DSMP) and glycated hemoglobin (HbA1c) values.



Graph (3): Comparison between diabetes self-management profile (DSMP) and hyperglycemic episodes.

It is evident from **table (10)** that, statistical significant correlation was found between study group's satisfaction with the program and total score of self-management practices (r = 0.424, p = 0.006) in post program. Also, during follow up: self-management practices (r = 0.399 p = 0.011). However, there was no statistical significant correlation between satisfaction with educational program and their knowledge either in post program or follow up.

Table (10): The correlation between the study group's satisfaction with computer educational program and their diabetes self-management profile, knowledge and empowerment score.

	Program Satisfaction			
	Post program		Follow up	
	r	p	R	p
DSMP	0.424*	0.006*	0.399*	0.011*
Knowledge	-0.062	0.705	0.004	0.978

r: Pearson coefficient ***: Statistically significant at $p \leq 0.05$**

IV. Discussion

Good self-management is imperative for achieving glycemic control, and maintaining a healthy life for people with type 1 diabetes. Furthermore, self-management education and support (DSME/S) provides the foundation to help people with diabetes to take decisions with respect to their disease by encouraging the self-care behaviors [34, 35]. However, young adulthood is a critical time for the development and integration of lifelong diabetes management skills. It is important to focus education on core topics and tailor it to the individual needs and learning styles of the young people with type 1 diabetes [12, 13, 36]. Furthermore, finding novel ways to enhance diabetes education is crucial for achieving optimal glycemic control, which can decrease the morbidity and mortality associated with diabetes [27].

The use of new technology, which is becoming increasingly widespread, may help in delivering age-appropriate, quality-assured diabetes education for young people. Moreover, technology can extend the reach of diabetes education and support when primary care resources are insufficient or patient resources and access to care are limited [37]. There are multiple types of technology utilized including: Short Message Service (SMS) text messaging, smart phone applications, computer based interventions, and telemedicine programs (Pal et al., 2013)[38]. Fortunately, young people are considered as a computer-native generation. They are more familiar with new technology in comparison with the previous generations and can adopt this technology more easily [39]. Furthermore, Egypt's official statistics agency (CAPMAS) [40] reported in 2017 that 23.6% of the country's population is between the ages of 18 and 29 years. Among those youth, 62 % use computers, 96.7 % use mobile phones, and 61.9 % use the internet. Therefore, this study was carried out in order to examine the impact of interactive computer-based diabetes education on self-care management of university students having type 1 diabetes.

The current study revealed that nearly three quarters of the studied sample, their age ranged from 20-28 years. This means that their age exceeds the expected age to graduate. Meanwhile, less than two thirds of them were enrolled either in the first or second faculty academic year. Moreover, the majority of them had either moderate or poor glycemic control before the intervention. This result agreed with Knight (2017) [41] who found that overall academic performance is significantly lower in students with type 1 diabetes compared with their non-diabetic classmates. Therefore, this finding draws the attention to an association between diabetes and cognitive function that may explain this decline in academic performance.

Recent studies provide evidence on the connection between excess body weight and glycemic control, which may contribute to poor glycemic control, increase the amount of insulin used in patients with type 1 diabetes, and a risk factor for dyslipidemia and cardiovascular diseases. Though, body mass index should be measured regularly for patients, more dietary energy restriction, and sustained weight control has been shown to improve glycemic control [42]. The present study revealed that, the mean of the study group's BMI was 24.44 + 3.61 kg/m^2, and control group was 25.62 + 7.18 kg/m^2. These results were in consistence with results of studies conducted in Romania by Mut-Vitcu et al., (2017) [43] who reported that 83 % of patients had a BMI >25 kg/m2. This might be as most of young people have unhealthy eating habits, which they were not used to have breakfast every day, but consume unhealthy foods (sweets, chips, pretzels, soft drinks) as a mid-day snack, and don't have three main meals due their college schedule.

Diabetes is a disease in which information has an impact on patients' self-management and accordingly patients' health care outcomes. "Health information behavior" is the currently preferred term used to describe the many ways in which young people with diabetes interact with information; in particular, the ways in which people seek and utilize information, and the diabetes-related sources of information [44]. Findings of the present study revealed that, hospital physicians on admission, were reported as the main source of information about diabetes by more than three quarters of the total sample, followed by more than half of them stated that their family members, and less than half of them browsing social networks and websites. Whereas, only 6.4% indicated that the nurses either in hospital or diabetic clinic were their source of information about diabetes. These data are in agreement with the findings of the Qusaier et al., (2017) [45] in Saudi Arabia, who reported that participants' treating physician and the ophthalmologist, respectively, as an extremely important source of diabetes-related information, followed by the broadcast media such as television and radio. On the other hand, sources such as seminars for diabetics; followed by internet and the nurses were quite low for patient as source of information. These results come in contrast with Longo et al., (2010) [46] who reported that, nurse practitioners, diabetes educators, and dietitians were recognized as the most useful and informative sources. The less important status of nurses as a perceived diabetes information resource in the present study could reflect a doctor-centered approach, which limit their ability to provide patient-centered care. Moreover, nurses' knowledge deficits and educational gaps, may potentially have an impact on their ability to provide effective DSME.

Despite the established benefits of structured self-management diabetes education, attendance of diabetes health education session was very poor [47]. Hence, the present study revealed that about only one quarter of the total sample participated in diabetes education outside the clinic. This finding is in congruent with the results of recent National diabetes Audit in the UK (2016) [48] which reported that, of those diagnosed with Type 1 diabetes, education was recorded as being offered to only 2.4%, while, only 1.1% were recorded as attending. Although the reasons for non-attendance might be different between countries, several studies from different countries have used a standardized quantitative assessment to identify barriers for diabetes patient education. Barriers identified include time constraints, stress, transportation problems, functional limitations, no interest, feeling sufficiently informed, and anxious temperament [49, 50].

Over the course of a lifetime, young people with diabetes will need a variety of skills and knowledge to enable them to control their condition on a day-to-day basis, and modify their approach when circumstances change. Though, the success of diabetes care relies mainly on patients' daily self-care activities and providers' continuous support [51]. The results of the present study revealed that more than half of the control group and less than three quarters of the study group had fair knowledge before conducting the program. In spite, they did not get any structured education on diabetes from their healthcare providers; educated participants and high rate of positive family history could explain the relatively higher rate of knowledgeable diabetics in the present study. This result was in line with a study conducted in Egypt by El-Khawaga et al., (2015) [52] who found that the overall rate of adequate knowledge regarding diabetes was only 52.3% among participants, and insulin-treated patients had lowest knowledge, attitude, and practice toward diabetes.

While after intervention, the results of the study revealed that, the study group expressed higher total knowledge scores compared to the control group, less than two thirds of the study group in post-test, and more than two thirds of them in follow up stage had good level of knowledge. Moreover, significant difference of the computer education program on students' knowledge regarding different topics about diabetes at various study phases was noticed. There was highly significant impact of education on study group's knowledge across the three stages. This finding correspond with the results of Walker et al. (2010) [53] who mentioned that, there was significant differences between pre and post IT based intervention regarding the knowledge about diabetes mellitus. In addition, Huang (2009) [54] who found positive effect of using an interactive multimedia computer education to intervene in diabetes self-care in raising the subjects' knowledge about the disease, whereas, the subjects may need more time to implement more effective blood glucose control and self-care activities after receiving instruction. The results had proved that multimedia could be a useful method to provide the basic diabetes knowledge.

Self-care in diabetes is a critical factor to keep the disease under control and about 95% of care of the diseases usually carried out by the affected individual or their families [17, 18, 26]. Concerning comparison of total score of different aspects of diabetes self-care management profile before and after intervention, the finding of the present study revealed statistical significant improvement in practices and skills regarding most areas of diabetes self-management (diet, hypoglycemia, glucose monitoring, and insulin). Whereas, there was no change noticed between post and follow up of practicing exercise mean score. This may be due to that, students had busy faculty schedule and there is no time for practicing exercise or due reluctance about doing physical activity. However, the majority of the study group had fair level of total score diabetes self-management profile in post intervention stage, and more than three quarter of them in follow up stage in contrast to the control group, which showed a significant decline in level of self-management profile score at each post test and the follow- up stage. This finding is similar to what was reported by Huang et al., (2014) [55] who found that, the intervention group who received a 2-month intensive intervention delivered via the internet and text messaging which provided disease management and a skill-based intervention followed by a 6-month review period, demonstrated significant improvements in all targeted outcomes including disease self-management and health related self-efficacy. On the contrary, Glasgow et al., (2012) [56] conducted behavior therapy for the management of type 1 diabetes in adolescents through tele-health. Both the treatment and control groups demonstrated improvements in adherence to the regimen as measured by the DSMP. Accordingly, participants engaged in more diabetes-related tasks (e.g., blood glucose monitoring and administering insulin). However, results were not statistically significant between groups.

Glycemic control is a cornerstone for reducing short and long term complications of diabetes, and HbA1c is the benchmark for defining glucose control over long durations. The diabetic patient is tasked with maintaining euglycemic blood glucose levels, a goal requiring education, decision strategies, willing control, and the wisdom to avoid hyper- and hypoglycemia [57, 58]. It is evident from the present study that the mean of glycated hemoglobin (HbA1c %) levels of the study group changed across the three study stages. It decreased by - 0.97% at 3 months and further by - 0.39% over the following 3 months, showing a significant (-1.36%) decrease (p = <0.001). These findings are consistent with results of Fearnley et al., (2012) [59] who found that structured education on type 1 diabetes delivered online with supplemental tutorial time increases the accessibility for young people and has a significant positive impact on HbA1c % (- 1.53% vs. - 0.49% in control; P = 0.031). Also, the findings of the present study is in an accordance with the study of Kwon et al. (2014) [60], who study the impact of information technology (IT) on glycemic control, that reported decreased glycated hemoglobin (HBA1c) levels and improvement of glycemic control in diabetic children with type 1 diabetes. However, it was noted in the present study, that students with higher baseline HbA1c % at start of study seemed to benefit most from these interventions, whereas those with good glycemic control at pre intervention stage had less notable (although significant) glycemic improvements.

Young people with diabetes play a major role in their treatment process and are able to change their life style and quality. In spite of various methods for training of young diabetics, the present study showed that a computer-based self-management program is effective for upgrading the students' level of knowledge, and practices. However, it was observed from the current study that there was no statistically and positively significant correlation between students' levels of self-management practices and knowledge across the different stages of the study (post intervention: r= 0.222, p=0.121, and follow up stage: r= –0.078, p= 0.588). Similarly, a study executed by El-Khawaga et al., (2015) [52] who revealed a negative weak significant correlation between patients' knowledge and practice (r= -0.45 and p<0.001). This could be explained on basis of knowledge practice gap, as adequate knowledge didn't necessarily determine good practice especially in developing communities where many cultural factors play a role.

Self-care management involves a series of behaviors' among young people with type 1 diabetes who has to be critical decision makers and understand how to balance insulin, diet and exercise to achieve glycemic control. Hence, better self-care behaviors lead to better glycemic control and quality of life [61]. However, analysis of the current results found that there was an association between level of students' self-management profile and their clinical outcomes. As students' self-management practices was significantly and negatively associated with glycated hemoglobin (HbA1c) values, and number of hyperglycemic episodes. These results are supported by results of other studies carried out in Egypt by Eljerjawy (2015) [62] they reflected that, those participants who had higher adherence with self-care behaviors had lower HbA1c. The reason for this may be due to that computer- based diabetes education appeared to be a motivating factor in young people's self-management of their condition, which adversely affect their clinical outcomes.

Close relationship with technology involves everyone: adults, adolescents and even children. Young people are often the main users of digital media, because they have always been synonymous with novelty and modernity [63]. The present results indicating the greater interest of students with diabetes to learn through computer technology and their satisfaction from self-management educational programs. The study group's evaluation showed high satisfaction with the program's objectives, contents, design, and usefulness. Similarly, studies executed by Eljerjawy (2015) [62]. These may be attributed to that they found the program a good way to communicate with the health care providers at any time they need through e-mails, WhatsApp messages, or phone calls, in contrast to what actually happened during usual clinic visit, that lack of time is a major barrier to patient-physician self-care communication, which hinder patient from discussing self-care challenges during medical visits.

The quality of diabetes care and education depend on active involvement and participation of patients. Thus, insuring students' satisfaction with computer-based educational program may be an important way of improving care or education for this major public health problem. Measurement of program satisfaction is important, as greater satisfaction has been found to be associated with higher rates of adherence and compliance with self-management [64]. This was evident in the present findings, as positive significant association was found between study group' s satisfaction with the program, total score of self-management practices, and their attitude toward diabetes. This results were in lines with Johnson (2012) [65] who found that participants who expressed more satisfaction with the care provided by their health care provider reported feeling more empowered to participate in diabetes self-care and had better glycemic control.

To sum up, the present study was grounded on the hypothesis that university students having type 1diabetes who engage in an interactive computer-based diabetes self-care management education program will demonstrate high-level knowledge and self-care practices than those who are not. Hence, this hypothesis was verified after implementation of computer-based software program that providing comprehensive information about diabetes, and aim to generate tailored content to improve different self-management domains through feedback, tailored advice, patient decision support, goal setting or reminders.

V. Conclusion and Recommendations

Based upon the results of the present study, it could be concluded that the interactive computer-based diabetes educational program had positive impacts on diabetes outcomes including improvements in diabetes knowledge, and self-management practices. In addition, it plays a significant role in improving glycemic control, and motivates the students to adopt healthy lifestyle.

The overall results revealed that, university students' satisfaction with computer-based diabetes educational program was high. All the students were satisfied with the program. Also, they had an advantage versus using traditional methods, through exploiting the benefits of computer-based learning, which it was flexible so that learners accessed the education regardless of time and geographical barriers, and enable wider access to the same content.

Based on the current study findings the following recommendations are suggested:

1. Young people having type 1 diabetes need to receive age-appropriate, quality-assured structured diabetes education through adopting the novel and innovative technology (e.g.; computer-based education, short messages services (SMS), mobile, and web-based education), tailored to their preferences in learning, and sustained for longer time.
2. Training and empowering of health care providers to be confident with technology-based diabetes education and patient care.
3. Apply standardized technology-based diabetes education in primary health care out-patients' clinics, centers and hospitals caring for young people with diabetes and their caregivers.
4. Create a faculty diabetes network, that ensuring continuous link between faculty administrators, health care providers, and students, which will empower them to fulfill their potential and spread awareness and education of diabetes in faculty.

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