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Study Relation between Information Technology and Glycemic Control of Children with Type $_1$ Diabetes

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ABSTRACT:

Introduction: *Diabetes mellitus (DM) is a chronic disorder of metabolism characterized by a partial or complete deficiency of the insulin hormone that result in elevation of the blood glucose level****Aim:*** *The study aimed to study the relation between information technology and glycemic control of children suffering from Type $_1$ diabetes in Gaza Strip.* ***Subjects & Methods****: A quasi-experimental study design was utilized in this study (pre-test/post-test). This intervention study was carried out on 80 children suffering from Type $_1$ diabetes. Attending diabetes clinic in Palestinian Medical Relief Society, Gaza city from March 2012 to August 2012.A structured questionnaire was used to collect data about socio-demographic characteristics of the children (pretest posttest questioner) about information technology and glycemic control knowledge and practice, also, blood glucose result was taken from those children. According to the deficit needs of the children the information technology program was designed.* ***Results:*** *Study results revealed that there was a statistical significant difference between pre and post test program intervention in most items related to diabetic children knowledge and practice about information technology and diabetes mellitus. After information technology intervention a significant improvement was revealed in children's' knowledge and practice with lowering of their mean levels of blood glucose.* ***Conclusion:*** *The study concluded that educational information technology based intervention was effective as well as their knowledge, and practice towards diabetes and blood sugar levels.* ***Recommendation:*** *The study recommended apply such educational intervention using information technology program in other diabetic clinics for teaching diabetic children hygienic care, diet, and compliance to medical staff instructions regarding diabetes management.*

Keywords: *information technology, type $_1$diabetes mellitus, knowledge, practice, glycemic control, health education, pediatric nursing.*

INTRODUCTION

The existing and emerging technologies such as wireless devices (cell phones) with email and text messaging (SMS) functionality, pagers, and the Internet can help facilitate patient self-management of diabetes. These types of devices are practical and cost-effective methods for monitoring clinical outcomes and increasing patient adherence to treatment **(Krishna and Boren, 2008).** Wireless technologies can be used as intermediary tools to facilitate the information between patient and care provider and treatment advice between clinic visits. Results from studies incorporating the use of remote patient monitoring devices (cell phones and other wireless tools) have indicated significant decreases in HbA1c levels and improved health-related outcomes in diabetes**(Faridi, 2008 and Krishna, 2008)**

Type $_1$ diabetes incidence varies greatly between different countries, within countries, and between different ethnic populations. Mean annual incidence rates for childhood type $_1$ diabetes (0-14 years age group) is (0.1 to 57.6 per 100,000) comparing different countries of the world **(Cage et al., 2012).**

Approximately one in three children born in the United States will develop diabetes. The odds are higher for African-American and Hispanic children: nearly 50% of them will develop diabetes **(Urrutia-Rojas and Menchaca, 2009).**

It is generally accepted that in order to effectively manage diabetes, education about components of management such as blood glucose monitoring, insulin replacement, diet, exercise, and problem solving strategies must be delivered to the diabetic children and their families. Education seems necessary both at diagnosis, where there is usually no knowledge base and diabetic children and their families are given the basic skills for controlling the disease and throughout the patient's lifetime, with ongoing attention to self-management skills, screening and prevention of complications, and new developments in these areas. Since management of diabetes requires lifestyle changes, most clinicians feel it is important for education to be delivered to the whole family **(Gage et al., 2012).**

Significance of the study

According to the annual report of the department of health in 2010, there are 986 children were diagnosed as Type $_1$ diabetes and 4.8% of them complaining from diabetes related complications, they faced some difficulties in accessibility to Palestinian Medical Relief Society (PMRS) which care given for 1,440,332 populations at 364 km (Ministry of Health, **(MOH) 2009).** Thus this study would be of great value for nursing practice by testing the relation between information technology and glycemic control of children suffering from Type $_1$ diabetes. And it will help diabetic children and their care givers to maintain

glucose concentration as near to normal as possible by near glycemic control which is essential to delay and/or prevent the diabetic related complications, as well as for improving the length and quality of life of diabetic children.

Aims of the study

This study aimed to study the relation between information technology and glycemic control of children suffering from Type $_1$diabetes.

Research hypotheses:

There are positively/negativelyrelation between information technology and glycemic control of the diabetic children.

Subjects and Methods:

The subjects and methods of the current study will be discussed under the following designs :

I- Technical design

II- Operational design

III- Administrative design

IV- Statistical design

Research design:

A quasi – experimental study design was utilized in carrying out this study (pre / post program intervention).

Study setting

This study was conducted at Palestinian Medical Relief Society (PMRS) which care given for 1,440,332 inhabitant, it has the largest numbers of diabetic children in Gaza strip. The services provided at this society include laboratory services for blood samples with especial room for diabetic children , giving injections and pharmaceutical service.

Sample size

The sample size was calculated through EPI info (Epidemiological information system) soft ware version 6 according to the following collected data, the confidence level 95% and a power of study 80%. The estimated sample size was calculated to be 80 diabetic children.

Study subjects

Purposive sample that was involved children suffering from diabetes mellitus who are attending the (PMRS) in Gaza Strip, their number was 80.

Inclusion criteria

The following inclusion criteria was considered.

1- Children with confirmed diagnosis of diabetes (regardless to their gender, residence, glycemic control and presence or absence of diabetes related complications) .

2- Children in the age group of 10-18 years.

3- Able to read and write.

4- Availability and accessibility of IT devices such as (Internet, Mobile, CD, memory flash, SMS, E-mail).

5- Having the willingness and skills of information technology

Excluded criteria

Exclude diabetic children suffering from other chronic physical or mental illness.

Ethical approval

An agreement for participation of the subjects was taken verbally before inclusion and after the aim of the study explained to them. They were given the free will to refuse to participate and they were notified that they could withdraw at any stage of the research. They also were assured that any information taken from them would be confidential and used for the research

Data collection tool

Study tools developed by the researcher after reviewing the relevant literature, it includes:

I- Structured Questionnaire (by interview) which includes data about Socio-demographic characteristic of the diabetic children (Age, gender, educational level…….etc), knowledge of the diabetic children related to the use of information technology and its relation on glycemic control. (such as internet, mobile, SMS, diet, exercise etc…). Pre-post test sheet were used to assess the diabetic children knowledge and practice regarding glycemic control in diabetes.

2- Observation checklist: This tool was adopted from (John & William, 1997) to assess the actual practices of the diabetic children such as urine and blood testing, insulin preparation and injection,……etc,

3-Information technology based intervention was designed according to the actual needs assessment of the diabetic children, accordingly different IT tools was used for the intervention such as internet, short message services (SMS), telephone calls, E-mails, CD and memory flash.

Scoring System

According to answer. Each correct answer had score 1 degree and wrong answer (do not know) had 0 degree. Then the total scoring was calculated as level of knowledge and practice satisfactory > 70% and unsatisfactory level of knowledge and practice < 70% .

Validity and reliability

Tools validity was checked through distribution of the tools to ten experts in the field of the study, content validity was conducted to determine whether the tool

covers the appropriate and necessary content, as well as its relevance to the aim of the study, clarity, and its simplicity.

Pilot study

A pilot study was carried out on 8 children suffering from Type $_1$ diabetes mellitus to test the applicability and clarity of tools and to determine the needed time for fulfilling of the study tools. The necessary modifications were done on the tools based on the pilot study. The diabetic children who participated in the pilot study were excluded from the study sample.

Field work

Data collection was carried out in the period from January 2013 to June 2013. The researcher was available at study setting three days weekly: Sunday, Monday and Tuesday thought the period of data collection at Palestinian Medical Relief Society (PMRS).

The researcher described the nature and the aim of the study to the diabetic children and care givers, children were assessed for their knowledge and practice regarding information technology and glycemic control using the study tools

The intervention was prepared according to the actual needs assessment using multiple methods of information technology such as [Compact Disk (CD), internet, short message services (SMS), telephone calls, E-mails and memory flash]. CD's were distributed to all diabetic children which includes ninth sessions. The first session focused on knowledge about diabetes mellitus (causes, clinical manifestation, complications and management). The second session focused on knowledge about information technology (definition and importance of IT. in control glycemia, methods and uses) The third session focused on information about importance of glycemic control (parameters and patterns of glycemic control). The fourth session focused on knowledge about hyper and hypoglycaemia (signs and symptoms, causes and management). The fifth session focused on knowledge and practices related to insulin therapy (importance, types, routs, sites and storage). The sixth session focused on diet management for diabetic children (recommended and unrecommended diet and the relationship between diet and glycemic control). The seventh session focused on physical exercise (importance, types and technique of suitable exercise). The eighth session focused on the personal hygiene care(importance, oral care, feet, skin care and technique). The ninth session focused on glucose monitoring, importance to control glucose and measuring glucose in blood and urine.

Multiple videos in CDs and flash memory were used to demonstrate the management of Glycemic control in children with diabetes mellitus, it include video for physical exercise, diet, insulin injections in addition to how measure blood glucose. Multiple SMS were send weekly to the children to refresh their knowledge about glycemic control. E-mails and internet through chatting were used every three days as well as daily. Telephone calls when needed to discuss any issue about diabetes mellitus and glycemic control. Additionally, memory flash was utilized for supporting with any information related to diabetes mellitus.

The researcher met with the children during the research period for blood glucose monitoring and follow up of their progress and to discuss any difficulties which may face them during the intervention period.

Administrative design

Approval was obtained from the dean of Faculty of Nursing (AinShams University) and directors of Palestinian Medical Relief Society (PMRS) to conduct the study at the previously mentioned settings.

Statistical design

Data entry were analyzed using statistical package for the social science (SPSS) version 20. Data were examined for coding and entry error. Numerical data were expressed as means, medians and standard deviation. Qualitative data were expressed as frequency and percentage. Paired–t-test and the pearson correlation coefficient test was used to examine the relationship between two variables either numerical and qualitative. Probability of error (p-value) <0.05 was considered significant. Kolmogorov-Smirnov test was used to test the Normality of data. Paired sample T- test was used to test the difference between mean for pre and post intervention. Chi-square test was used to test the difference between proportions for pre and post intervention. One way analysis of variance (ANOVA)test was used to examine if the three or more means are significantly different from each other.

Results:

Socio-Demographic Characteristics:

Figure (1): Distribution of the studied subject according to their gender

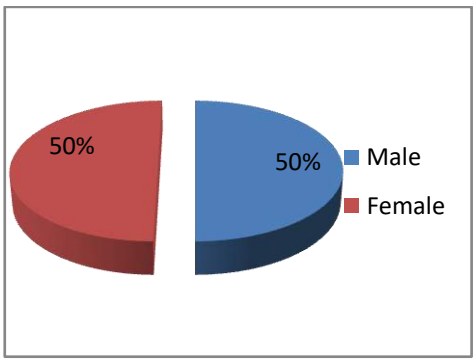

Figure (1) *reveals that 50% were males and the rest of them were females*

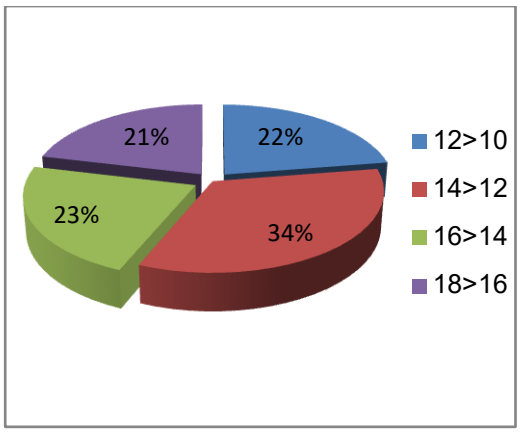

Figure (2) showed that, more than half of the studied children (56%) aged from 12 year to less than 14, while 21% of them aged from 16 < 18 years.

Figure(2): *Distribution of the studied subject according to their age*

Figure (3): Distribution of the studied subject according to their educational leve

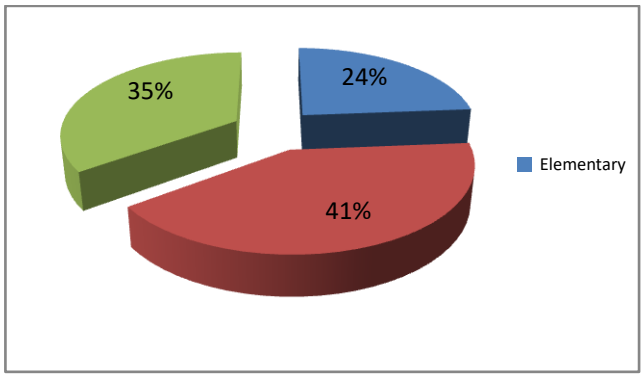

Figure (3) illustrates that, 41%, 35%, and 24% of the studied children enrolled in phase of preparatory, secondary, and elementary education respectively.

Table (1): *Number and percentage distribution of the studied subject according to their characteristics (n=80)*

Item	N=80	100%
Ranking		
First	13	16.2
Second	18	22.5
Third	18	22.5
Fourth	31	38.8
Family size		
6-4	21	26.2
9-7	36	45.0
+10	23	28.8
Residence		
Urban	48	60
Rural	32	40

As regards characteristics of the studied children, table, (1) showed that 38.8% of them were ranked as the fourth child in the family, Nearly, half of them (45%) were having a family size of 7 < 9 members and 60% of them were from urban residence.

Table (2): *Mean value for blood glucose level among the studied subject pre and post IT based intervention (n=80)*

Items	Pre test	Post test	T-test	p-value
	Mean SD	Mean SD		
Blood glucose level	312.27 ± 119.73	118.16 ± 42.36	7.52	0.000*

*p-value is significant at level of ≤ 0.05

Table, (2) showed that, there was statistical significant difference between the studied subject regarding to their mean value for blood glucose level pre and post IT basedintervention (t = 7.52, p =0.000)

Table (3) *Relation between the studied subject according to their Knowledge and practice level pre and post IT based intervention (n=80)*

Items	Mean	SD	T-test	P-value
Knowledge Knowledge Pre test	29.35	17.23	7.608	0.000*
Knowledge Post test	56.34	7.02		
Practice Practice Pre test	11.99	5.25	7.512	0.000*
Practice Post test	20.49	3.83		

* The mean difference is significant at 0.05 level

Table, (3) showed that, there was highly statistically significant differencebetween the studied subject regarding to their Knowledge and practice level pre and post IT based intervention

Table (4) *Relation between the studied subject according to their Knowledge and practice level pre and post IT based intervention (n=80)*

Items	Correlation coefficient value	P-value
Knowledge	.286	0.005*
Practice	.312	0.002*

* The Correlation coefficient is significant at 0.05 level

Table, (4) showed that, there was statistically significant difference (Spearman correlation

coefficient) between the studied subject regarding to their Knowledge and practice level pre and post IT program intervention.

Table (5): *Comparison between the mean of scores pre and post test of the IT based intervention and blood glucose level pre and post intervention(n=80)*

Items	Mean	SD	T-test	P-value
IT Pre test	6.85	3.40	6.869	0.000*
IT Post test	12.33	3.18		
Blood glucose level (pre test)	312.27	119.73	7.52	0.000*
Blood glucose level (post test)	118.16	42.36		

* The mean difference is significant at 0.05 level

Table, (5) showed that, there was highly statistically significant difference between the studied subject regarding to their IT based intervention and blood glucose levelpre and post IT program intervention.

Discussion

This study aimed to study the relation between information technology and glycemic control of diabetic children in Gaza Strip. In this chapter, the findings of the study will be discussed in terms of diabetic children's knowledge and practice regarding information technology, diabetes mellitus Type $_1$ as well as their blood glucose level.

In this study, the results revealed that more than half of the studied children aged from 10 to less than 16 years old. This result supported by **Hockenberry and Wilson, (2009),** who study that diabetes mellitus most common among children with the peak age between 10 and 15 years, also, supported by**Sebatian et al, (2005*)***, who mentioned that the prevalence of type $_1$ diabetes is about (5% of the total suspected diabetic population or about (10% of the known diabetic population in the US total diabetic population in USA were 16 million. The Peak onset occurs in the second decade of life (ages 10-14) with another peak in the sixth decade, although the actual onset may occur at any age. Prevalence is 1.7 cases/1000 among children < 20 years of age in the USA. Primarily Caucasian, less in Hispanics and lowest in blacks or Asians. The incidence is 18 new cases/year/100,000<20 years of age

Regarding the educational level of studied children, the current study illustrated that three fourths of them were preparatory and secondary levels. The researcher expected that the level of education could affect the performance of the children in managing their diabetes through information technology intervention. Also, it was noted that the effect of education level have a significant relation regarding their knowledge and practices. This study congruent with a study undertaken in Sultanate of Oman by **Alshafaee et al., (2008),** who found that about forty-six percent had studied up to high school level

The current study showed that more than half of studied children had a positive family history of diabetes. This study was in agreement with **Ahmed et al., (2011)** who mentioned that family history of diabetes was detected among children.

The findings of the study revealed that the knowledge of studied children about information technology was satisfactory, because the majority of studied children have previous knowledge and experience about information technology from schools age (10 years) according to Palestinian curriculum. In addition to availability and facilities of IT methods in their homes and schools (internet, mobile, computer, memory flash, e-mail, SMS, and CD). These findings were highly supported with the studies of **d'annunzioet al., (2013)and Gammon et al., (2005)** who studied the impact of IT on children (ages 9–15) with cellular phone glucometers that sent text message glucose readings to them, while it was found that an improvement in diabetic self care**.** However, another study to test the telecommunication system connecting between diabetic children unitand a medical uniton six intensively treatedType $_1$ diabetic children, aged 10–16 y. The researcher found that the diabetic children were used the different methods of information technology effectively, since age 10 years help them from difficult transportation and save their times and money.

In the same point of view the current study revealed that the mean differences of blood glucose values among children were highly statistically significant after the information technology intervention. Also, the findings illustrated that there was correlation coefficient between IT and blood glucose after the intervention, These findings were highly supported with the studies of **Kwon et al., (2014),d' annunzio et al., (2013), Kim, (2007), Rami et al., (2007), Tasker, (2007); and Franklin et al., (2006**), whom study the impact of IT on glycemic control, they reported decreased glycated hemoglobin (HbA1c) levels and improvement of glycemic control in diabetic children with type one diabetes mellitus when compared with two groups of diabetic children. In which one group was requested to input their blood glucose levels weekly for 3 months to a Web site using their cell phoneafter receiving weekly optimal recommendations for 3 months using SMS. While the other group received usual care. The intervention group of diabetic children had a significant mean change in the 2 hour post meal glucose level while those in the control group had no difference.

Another study at Canada,itexamined whether modem technology allows foreffective management of diabetes among diabetic children. While, the Control groupof diabetic children continued the usual program

of quarterly clinic visits, whereas the modem group of diabetic children were instructed to transmit blood glucose data every 2 week for 6 months instead of the clinic visit. The health care providers analyzed the data received by the modem and contacted diabetic children to discuss treatment changes. This study demonstrated that electronic transmission of data resulted in a similar level of decrease in HbA_1c values and similar incidence of acute complications to that recorded with current standard care. Intensive telephone-based behavioral health interventions may lower barriers to treatment access, providing lower-cost treatment that is easier to access for youth.Moreover, according **Adkins et al., (2009)**to delivery via telephone permits the interventions to take place at home. Implementation of telehealth interventions incorporating intensive video and phone conferencing with psychology services to children with poor diabetes control and to family members in an open trial has shown that intensive telehealth interventions can improve metabolic control, the mechanism of change is intervention in adherence behaviors and diabetes specific family processes related to adherence. It is hoped that continuous telemonitoring of the diabetic child data during normal daily activities will result in faster achievement of normoglycemia without the necessity of frequent ambulatory visits Cellular Telecommunication and Internet Association **(CTIA, 2008)**. According to the Cellular Telecommunications and Internet Association, there are over 255 million cell phone subscribers in the United States**.** Although income may seem to be a major barrier in cell phone ownership, every two out of three households in the United States have a cell phone In, 35% said that they use it for text messaging **(Pew Internet & American life project, 2008).**

These findings illustrated that were a large numbers of diabetic children used different methods of information technology. This study was in accordance with the study of **Idriss et al., (2009), Morak et al., (2008) and Wilkinson et al., (2008),** who mentioned that as technology becomes increasingly accessible and affordable, this may due to the number of people in the United States adopting new technologies continues to grow. Over 250 million Americans own mobile phones and more than 70% use the Internet. In addition, technology was playing a growing role in the management of chronic diseases. Many clinicians in USA are now investigating the role of the Internet, cellular phones, and other wireless technologies in monitoring their diabetic children and improving access to medical care and information**.** In addition to study of **Grover et al., (2012)** who mentioned that there was an increasing number of diabetic children are expressing interest in integrating such technologies into their health care management.

The current findings support the researcher opinion that there was a relationship between using different methods of information technology and glycemic control such as internet, chatting, E-mail….etc. which support the hypothesis of research.

As regards to the relation between information technology, knowledge and practice of studied children, a statistically significant difference was observed. This result is in an accordance with **Alshafee et al., (2008),** who found that, appositive correlation between information technology, knowledge and practice among children.

As regards to the relation between information technology and gender of studied children, no statistically significant difference was observed. This result is in an accordance with **Chromas and Slany, (2011),** who mentioned that no difference between boys and girls regarding information technology.

As regards to the relation between information technology and age of studied children, a statistically significant difference was observed. This result is in an accordance with **Gammon et al., (2005),** who mentioned that children ages (9-15) years can using information technology.

As regards to the relation between information technology and child level of education of the studied children, a statistically significant difference was observed. This result is in an accordance with **Shi et al., (2009)**, who found that, a positive relation between information technology and child level of education of the studied children especially among preparatory and secondary school.

As regards to the relation between information technology and family numbers of the studied children, a statistically significant difference was observed. This result is in an accordance with **Ahmad et al., (2011)**, who found that, a positive relation between information technology and family numbers.

As regards to the relation between information technology and mean blood glucose level of the studied children, a statistically significant difference was observed. This result is in an accordance with **Faridi et al., and Krishna et al., (2008)**, who found that, a positive relation between information technology and significant decrease in HbA_1c levels and improved health related outcomes in diabetes.

CONCLUSION

It was concluded that the IT intervention program facilitate access of information for diabetic children by using IT methods (CD, SMS, Email, internet, flash memory, cell phone). Therefore, IT program was successful in improving the knowledge and practices of the children which affects positively on their blood glucose level.

RECOMMENDATIONS

According to the result of the current study, the following recommendations are suggested:

1. It is recommended to apply such IT educational program in primary health care centers and hospitals for diabetic children.
2. Periodic and constant follow up is very important to discuss and facilitate any difficulties may face the children with diabetes.
3. Educate the diabetic children how to care for themselves by using available means of technology.
4. Availability of illustrated CD and videos to be distributed for each diabetic children and their families.
5. More studies are needed to investigate the long-term effect of such IT educational interventions in relation to the prevalence of diabetes in Gaza strip and its complications.

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