The moderating effect of information technology on the relationship between self-efficacy and self-management for patients with type (2) diabetes in Jordan

Fadi Taher Qutaishat

Faculty of Business,
Department of Management Information Systems,
Al-Balqa Applied University,
P.O. Box 19117, Al-Salt, Jordan
Email: fadi_qutaishat@bea.edu.jo

Abstract: The purpose of this study is to investigate the moderating effect of Information Technology on the relationship between self-efficacy and self-management for patients with type (2) diabetes in Jordan. To achieve this, a survey questionnaire was developed and then distributed to participants of this study. Participants were chosen based on their diagnosis with diabetes (type (2) only) and also based on their experience of using Information Technology to access diabetes-related information. Several statistical tests were used to examine the research hypotheses including descriptive analysis, simple regression analysis and moderated hierarchical regression. It was evident according to the results of this study that self-efficacy was a predictor for self-management, and information technology positively moderated the relationship between these variables.

Keywords: self-efficacy; self-management; information technology; type (2) diabetes; Jordan.

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Biographical notes: Fadi Taher Qutaishat is an Associate Professor teaching various subjects in the Department of Management Information Systems, Business School at Al-Balqa Applied University. He received a Bachelor degree in Computer Science from Amman Private University, Jordan, MSc in Information and Knowledge Management and PhD in Information Systems from Loughborough University, UK. His research interests include personalised information delivery for individuals with disabilities, health and technology, adaptive hypermedia, knowledge management, user-centred design, systems analysis and design, database management systems, enterprise systems, human-computer interaction, e-learning, e-business and e-commerce.

1 Introduction

Diabetes is a medical condition where the blood sugar or glucose level rises in the human body, referred to in medical terminology as hyperglycemia, and the most common form being type (2) diabetes. This usually occurs due to the inability of the human body (specifically the pancreas) to produce insulin which is responsible for keeping blood glucose at normal levels. If not treated and kept under careful control, patients with type (2) diabetes could run the risk of severe complications, including heart disease and strokes, high blood pressure, kidney disease, amputation and blindness. Fortunately, however, a person with type (2) diabetes can learn to live a relatively normal and happy life with this disease through making healthy lifestyle choices (ADA, 2016).

In a 2013 paper published in Al Rai, a Jordanian national newspaper, it was stated that 16% of people aged 18 years and above suffered from diabetes (almost half a million individuals), putting Jordan in tenth place globally for the percentage of the population with the disease. Furthermore, the direct and indirect costs of treatment have been estimated at approximately 654 million JD. Clearly, immediate measures need to be taken to curtail the spread of diabetes and improve the health of Jordanian society as a whole (Al Rai Newspaper, 2013).

Patients diagnosed with type (2) diabetes are encouraged to take an active role in controlling their disease. Naturally, this requires patients to learn more about the disease to better manage diabetes-associated symptoms and enhance their own well-being. This can be achieved through a range of interventions, collectively called diabetes self-management activities, which include adopting a healthy diet, monitoring blood glucose, regularly examining skin and feet, exercising, etc. (Hunt, 2015).

Research within this area has emphasised the vital role of self-management for patients with diabetes in decreasing complications of the disease and enhancing the patients' quality of life (Renders et al., 2009; Minet et al., 2010).

A study by Morrison and Weston (2013) focused on self-efficacy as it affects patients' ability to achieve specific educational objectives for their disease. In a later study, self-efficacy was defined as the individual’s belief in their capability to achieve a change which evolves as individuals acquire new skills, experiences and understanding. In fact, researchers discussed self-efficacy as a critical factor that can improve self-management activities and, therefore, enhances the general health and well-being of patients with diabetes (Morrison and Weston, 2013; Hunt et al., 2014; Yu et al., 2012).

1.1 Research problem

Based on the above information, it is obvious that patients with diabetes need to be able to improve their knowledge surrounding the disease so that they can better live with diabetes. Significant antecedents in this context are self-efficacy, self-management and Information Technology (IT). This research investigates the effect of IT on the relationship between self-efficacy and self-management for people with type (2) diabetes.

1.2 Aim and objectives

The overall aim of this research is to investigate how people with diabetes can raise their levels of self-management of the disease to better enhance their health. Therefore, the following objectives were developed:

- identifying the underlying factors that are needed to improve self-management for patients with type (2) diabetes
- Determining the role of IT interventions in the relationship between the aforementioned underlying factors.
- Proposing a research model with practical outcomes that can improve the self-management of people diagnosed with type (2) diabetes.

1.3 Motivation for this study

Jordan has been identified as a country that has a disproportionally high number of people diagnosed with diabetes. This illness affects not only the lives of the patients themselves, but also those of their family members as they strive to better understand and manage the disease-related conditions and the available treatments. However, diabetes can be lived with through careful management of its symptoms and conditions. This can be accomplished by educating patients of diabetes about the nature of the disease and how it can be managed effectively. IT, in this context, can help provide patients with useful and relevant information related to their condition. As noted by the studies discussed in Section 2, IT has been generally used to enhance **either** self-efficacy **or** self-management, without taking into consideration the relationship between these two factors. Therefore, we found it to be of great importance to investigate the mediating role of IT on the relationship between self-efficacy and self-management.

2 Theoretical framework and related studies

Self-efficacy can be defined as the individual's belief in their ability to generate an influence over events in their lives. It is generally a belief that determines how people feel, think, motivate themselves and behave over time. The level of self-efficacy that individuals possess may determine how much effort they want to expend when confronted with challenging situations. Specifically, for people with diabetes, having an adequate sense of self-efficacy positively affects their ability to perform their diabetes-related activities including taking medication correctly, adjusting diet as needed, controlling hypoglycemia, and exercising appropriately. It seems that self-efficacy in the form of having a sense of confidence in ability is predominant for people with diabetes with respect to glycemic control (Beckerle and Lavin, 2013).

A number of research studies have associated self-efficacy with self-management for people with diabetes. For instance, Beckerle and Lavin (2013), King et al. (2010) and Lanting et al. (2008), all indicated in their research that higher self-efficacy levels are related to higher self-management activities which result in the improvement of overall disease control.

Self-management is mainly interpreted as the daily tasks that individuals have to perform in order to control or reduce the impact of a chronic disease. These activities are generally practiced at home after having sought guidance from a physician or healthcare provider (Clark et al., 1991). Successful self-management of a chronic disease such as diabetes requires individuals to master three practices. First, patients need to make informed decisions about how to take care of themselves, helped by having sufficient

knowledge about their illness and available treatments. Second, they need to know how to perform any activities that help manage the illness. Third, patients need to apply skills necessary for maintaining sufficient psychosocial functioning, especially in the event of a relapse of the disease (Clark et al., 1991). However, self-management remains challenging for people with diabetes as it requires many practices to be performed such as taking medications, maintaining a healthy diet, exercising and glucose monitoring (Beckerle and Lavin, 2013). Yet, improvement in self- management through higher levels of self-efficacy enhances the overall well-being of people with diabetes (Hunt et al., 2014).

Information Technology (IT) is being increasingly used to help people with diabetes cope with their chronic illness (Dadgar and Joshi, 2017). IT interventions can support patients with their daily routines and practices related to their illness and provide them with educational and motivational support to better manage their conditions (Hunt et al., 2014). Therefore, using IT as a supporting tool for people with diabetes serves not only to enhance their self-management, but also assists in improving the psychological state (such as motivation) of such patients.

Thus, it has been proven that IT can be used as an intervention to support self-efficacy and self-management for people with diabetes (Hunt, 2015). In addition, patients are becoming more adept at using technology, a variety of devices are becoming more readily available and patients nowadays have access to several methods to reach information. According to Ghazal (2014), 95% of Jordanians have mobile phones and 47% have access to the internet. One significant use of technology is to provide the educational and motivational support in conjunction with medical support provided by healthcare professionals. This is especially crucial when patients have limited access to healthcare programs. For instance, patients may have difficulty attending training and educational courses to learn about self-management activities due to time, distance, or financial constraints (Hunt, 2015).

The following studies discuss how the use of technology can be beneficial for people with diabetes.

One study, carried out in three different countries (Congo, Cambodia and the Philippines), simply used text messages (SMS) sent via mobile phones, in addition to conventional educational programs as means to support diabetes self-management and to further empower patients. Mobile phones were used to seek health advice from local health professionals who also validated the content of the SMS messages that were sent to participants. Generally, participants of the study reported a positive effect of such interventions (Olmen et al., 2013).

Another study, carried out by (Pacaud et al., 2012), employed the three different methods of conventional face-to-face teaching, static website and interactive website to provide educational material about diabetes. Results showed that these three methods all led to an overall improvement in knowledge about diabetes, which promoted greater levels of self-efficacy and self-management. It was concluded that diabetes education that was delivered through technology could be as effective as the face-to-face traditional method.

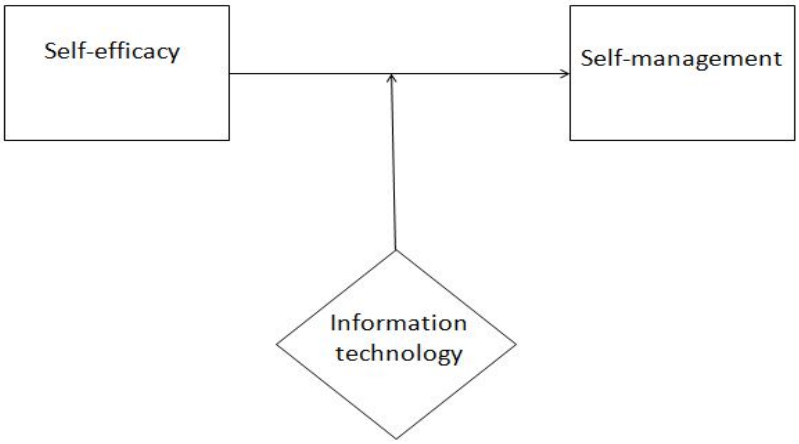
A further study (Avdal et al., 2011) aimed to test the effect of providing diabetes education using web-based technology for people with type (2) diabetes. Two groups participated in that study; one group received diabetes education via the traditional method in a clinic, while the other group received the education program using web technology intervention. After six months, the group who received diabetes education

through technology interventions recorded a decrease in the HA1C (glycated hemoglobin which identifies the average plasma glucose concentration over prolonged periods), whereas the group who used traditional methods (in a clinic) recorded no difference. It was concluded that as far as the maintenance of glycemic control was concerned, web technology could be adopted as a complementary tool for monitoring individuals with diabetes.

Based on the above theoretical framework and related studies, the following research model and hypotheses were devised.

As it can be seen from Figure 1, the study model adopted self-efficacy as an independent variable, with self-management as a second independent variable. Information Technology was adopted as the moderating variable of the relationship between self-efficacy and self-management.

Figure 1 The study model



This subsequently led to the formulation of the following hypotheses:

- *H_1: The self-efficacy of patients with diabetes has a significant effect on their self-management.*
- *H_2: The use of Information Technology has a significant moderating effect on the relationship between self-efficacy and self-management for patients with diabetes.*

3 Research methodology

3.1 The study sample

The population sample for this research consisted of patients who are residents of the city of Amman. Participants of the study sample were selected in two stages. First, the author visited two hospitals and one private diabetes clinic in Amman where the purpose of the study was clearly explained to the managers and physicians. Second, after gaining their permission, questionnaires were printed, distributed to and retrieved from individuals who voluntarily agreed to participate in this study. The researcher used the purposive sampling technique because only patients with type (2) diabetes were the focus of this

research. A total of 300 questionnaires were distributed and 193 valid questionnaires were retrieved, giving a response rate of 64.3%. Table 1 shows the characteristics of the research sample.

Table 1 Sample characteristics

Variable	*Categories*	*Frequency*	*Percent*
Gender	Male	120	62.2
	Female	73	37.8
Age	30 years or less	28	14.5
	31–40 years	15	7.8
	41–50	40	20.7
	51 years or above	110	57.0
Education	Diploma or less	68	35.2
	Bachelor degree	93	48.2
	High Diploma or Masters	14	7.3
	PhD	18	9.3
Job status	Full-Time or Part-Time Job	92	47.6
	Retired	55	28.5
	Do not Work	46	23.8
Years of diagnosis	10 Years or Less	101	52.3
	More than 10 Years	92	47.7
Diabetes follow-up	Private Doctor and Diabetes Centre	18	9.3
	Private Doctor and Military Hospital	23	11.9
	Private or Public Hospital	45	23.3
	Diabetes Centre	58	30.1
	Military Hospital	49	25.4

3.2 Data collection methods

Primary data collection method was used in this study. A survey questionnaire was used as the primary data collection method. This questionnaire was highly structured with specific questions and a number of alternatives for respondents to choose from.

3.3 Measures of the study variables

Items and scales used to measure the study variables were drawn from the available literature and related studies which have been explained in the below subsections.

3.3.1 Self-efficacy

Self-efficacy variable was measured using six items (statements) that were adopted from (Ouyang, 2007). These items used the five-point Likert scale ranging from 1 = Strongly disagree to 5 = Strongly agree. One of the items, for example, was "I believe I can exactly follow the meal plan from the dietitian and control my diet".

3.3.2 Information technology

IT variable was measured using four items that were devised based on related studies concerning using IT tools to aid people with diabetes (Olmen et al., 2013; Pacaud et al., 2012; Avdal et al., 2011). These items involved four different IT tools, namely the internet and web resources, mobile phone applications, text messages and email technology. A five-point Likert scale was assigned to the items that allowed participants to determine the level of usage (in percentage) ranging from 1 = 0% < 20% to 5 = 80–100%.

3.3.3 Self-Management

This variable was measured using nine items which were adopted from (Toobert et al., 2000). These items used the five-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree. One of the items, for example, was "For how many of the past months have you followed a healthful eating plan?".

3.4 Reliability

The reliability of the study variables was identified using Cronbach's alpha coefficient. According to Hair et al. (2010), reliability values of any study variable should score 0.70 and above in order to be considered reliable. The values of Cronbach's alpha coefficient for this study are provided in Table 2.

Table 2 Cronbach alpha value

Study variables	*Cronbach's alpha*
Self-efficacy	0.824
Information technology (IT)	0.763
Self-management	0.877

As can be seen from Table 2, all values were ranged from 0.763 to 0.877 which means that the survey questionnaire is reliable for measuring the study variables.

3.5 Validity

Content validity and construct validity were used to test the validity of study measures. Based on extensive literature review and interviews with health professionals and academic experts in the field, content validity was supported. After collecting data, construct validity was tested via principal component analysis with varimax rotation (Hair et al., 1998). Tables A1 and A2 show that all items loaded strongly (0.5) on their appropriate factors which supported their unidimensionality (Hair et al., 1998).

3.6 Questionnaire development and administration

At the outset of this research, the literature was reviewed in order to develop the data collection instrument to measure the study variables. Consequently, a survey questionnaire was developed and validated. The questionnaire was translated into the

Arabic language and proof edited. A face-to-face approach was used to distribute the questionnaires and to retrieve them from respondents. The respondents' consent to participate in this study was verbally communicated. A total of 193 questionnaires valid for analysis were retrieved.

4 Data analysis and findings

Two types of data analysis were used, including descriptive statistics covering both means and standard deviations. In addition, simple regression and hierarchical interaction regression were used to identify the relationship between the study variables. These statistical tests were conducted using SPSS software package.

4.1 Results

The descriptive statistics represented in Table 3 depict that patients' perceptions towards self-efficacy were moderate, with mean = 3.41 and standard deviation = 0.689. In addition, results showed that patients' perceptions towards self-management were also moderate with mean = 3.05 and standard deviation = 0.567. Despite the extensive spread of IT devices and the low cost of an internet connection in Jordan, the usage of IT to acquire information about diabetes was still low with mean = 1.88 and standard deviation = 0.766.

Table 3 Mean and standard deviation of the study variables

Study variables	*Mean*	*Standard deviation*
Self-efficacy	3.41	0.689
Information technology (IT)	1.88	0.766
Self-management	3.05	0.567

4.2 Hypotheses testing

This section represents hypotheses testing results as in the following.

- *H_1: The self-efficacy of patients with diabetes has a significant effect on their self-management.*

The results of simple regression (in Table 4 and Figure 2) depict that there is a positive effect of self-efficacy on self-management ($\beta = 0.538$, $P < 0.05$), therefore we accept the H_1 which states that:

> The self-efficacy of patients with diabetes has a significant effect on their self-management.

The value of R^2 in Table 4 indicates that self-efficacy explains 29% of the variance in the variable of self-management.

- *H_2: The use of Information Technology has a significant moderating effect on the relationship between self-efficacy and self-management for patients with diabetes.*

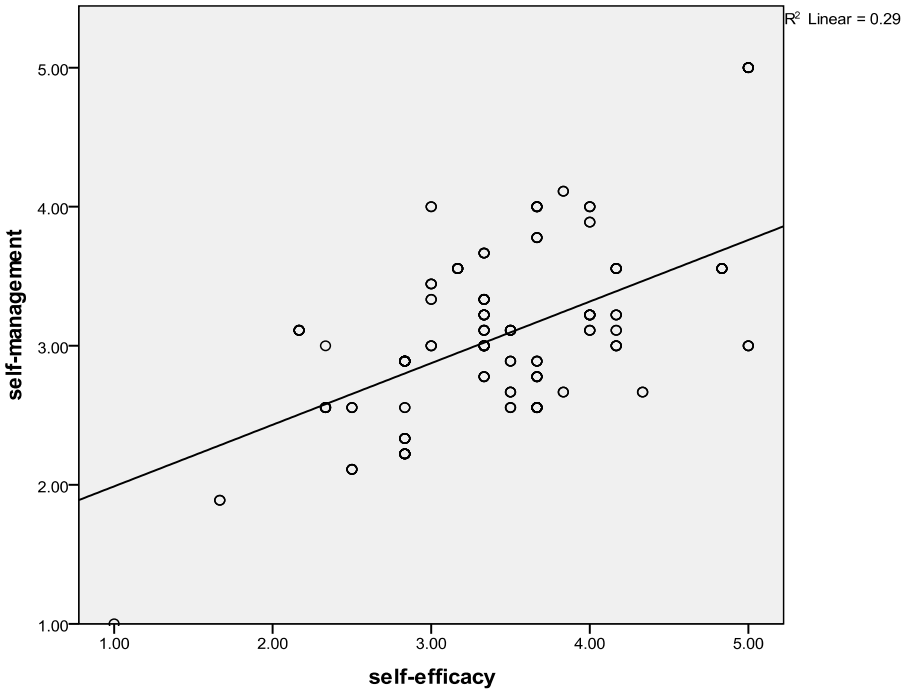
To test the second hypothesis, the hierarchical interaction regression test was used in three steps. In step 1, the independent variable was incorporated into the study model. In step 2, the moderating variable was incorporated into the study model. Finally, in step 3, the interaction between the independent and the moderating variable was incorporated into the study model.

Table 4 Simple regression results

Variable	R^2	β	*t-value*	*Sig*
Self-efficacy	0.29	0.538	8.826*	0.000

*$P < 0.05$.

Figure 2 Observed values against the regression line



Based on step 1 (as shown in Table 5), the results depict a positive direct impact of self-efficacy on self-management ($\beta = 0.538$, $P < 0.05$). The results of step 2 reveal a positive direct impact of IT on self-management ($\beta = 0.380$, $P < 0.05$). The coefficient of determination was increased significantly by adding the moderating variable into the study model ($\Delta R^2 = 0.0.114$, ΔF value = 36.278, $P < 0.05$).

The results of step 3 indicate a significant impact of interaction between self-efficacy × IT on self-management ($\beta = 0.0.120$, $P < 0.05$). The coefficient of determination was increased significantly by adding the interaction variable into the study model ($\Delta R^2 = 0.013$, ΔF value = 4.217, $P < 0.05$). Therefore, we accept H_2 which states:

The use of Information Technology has a significant moderating effect on the relationship between self-efficacy and self-management for patients with diabetes.

Furthermore, the collinearity diagnostics were conducted to check the correlation between independent and moderating variables. The results of the collinearity diagnostics are presented in Table 5 which shows for all study variables variance inflation factor (VIF) is less than 2. According to Howitt and Cramer (2011), a VIF of less than 10 indicates no multicollinearity.

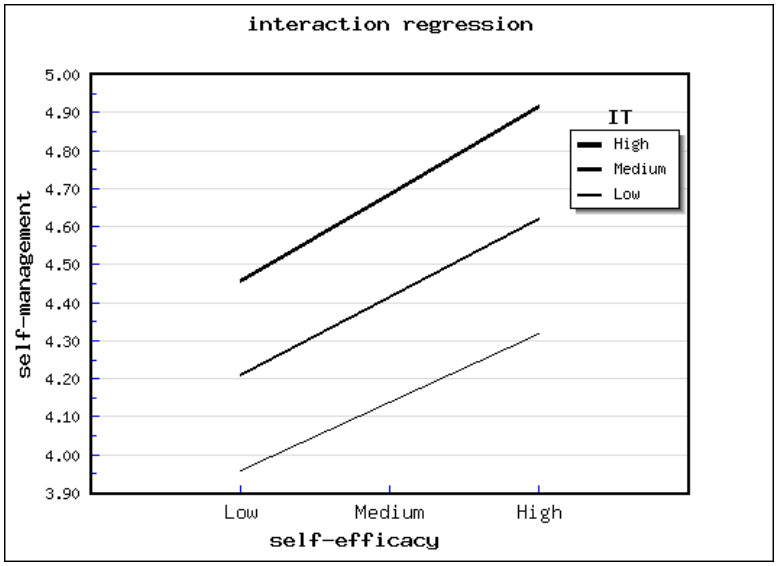
Table 5 Hierarchical interaction regression results

	Step 1		*Step 2*		*VIF*	*Step 3*		
Variables	*β*	*t-value*	*β*	*t-value*		*β*	*t-value*	*VIF*
Self-efficacy	0.538	8.826*	0.363	5.755*	1.269	0.365	5.837*	1.269
IT			0.380	6.023*	1.269	0.342	5.236*	1.381
Self-efficacy × IT						0.120	2.054*	1.107
R^2	0.290		0.404			0.417		
F value	77.897*		64.281*			44.986*		
ΔR^2	0.290		0.114			0.013		
ΔF value	77.897*		36.278*			4.217*		

*$P < 0.05$.

In order to show the level of interaction results, the researcher used ModGraph software. Figure 3 reveals that the impact of self-efficacy on self-management was greater for patients who used IT at a high level compared to those who used IT at medium or low levels.

Figure 3 Interaction regression graph (see online version for colours)



5 Discussion of results

This study investigated the moderating effect of IT on the relationship between self-efficacy and self-management among Jordanian patients of Type (2) diabetes. It was evident from this study that participants rated themselves moderately in respect to self-efficacy (Appendix, Table A1). This result goes hand in hand with the study conducted by Bernal et al. (2000) where the participants recorded weak to moderate scores regarding self-efficacy. The generally poor standards of diabetes management could be attributed to the low levels of participants' self-confidence. Actually, this issue was evident from the items that were concerned with self-efficacy in the survey questionnaire. Based on the results (Appendix, Table A1), it can be seen that the items such as choosing appropriate food when eating out and exercising recorded the lowest scores, whereas taking medications at specific times with the recommended doses recorded the highest score. One possible explanation to this perspective is that people with type (2) diabetes in Jordan are predominantly relying on medicine to control their diabetes, abandoning the importance of other interventions such as changing lifestyle in terms of choosing the right food and exercising. However, this may be due to the high cost of such lifestyle-changing interventions. In fact, Narayan et al. (2006) discussed that lifestyle interventions for people with diabetes require the expertise of certain specialists, such as dieticians and exercise physiologists. These specialists are not available in great enough numbers, and their services demand unavailable financial resources, which may present a barrier to the health care system providing such interventions in populations, especially in developing countries. This may explain the limited number of initiatives in Jordan that highlight and promote the importance of lifestyle-changing interventions to people with diabetes.

In respect to self-management, it was also reported as moderate by the respondents of this study (Appendix, Table A3). This confirms that self-efficacy is the predictor of self-management (the two variables were reported moderate by respondents). This finding is consistent with the literature and previous studies presented in Section 2.

It is evident from this study that the employment of IT effectively moderated the relationship between self-efficacy and self-management for people with type (2) diabetes. Although respondents reported low to moderate use of IT to acquire diabetes-related information (Appendix, Table A2), results (of hierarchical interaction regression) showed that patients who used IT to acquire information about diabetes scored higher self-efficacy and self-management than those who did not. This result goes hand in hand with other studies that showed the positive effect of using IT in controlling diabetes (e.g., Hunt, 2015; Sahu et al., 2014; Olmen et al., 2013; Pacaud et al., 2012).

According to the results reported by the population sample of this study (Appendix, Table A2), the preferred IT method to receive information on diabetes was via internet and web resources. This result is very similar to the results found by Wilson (2013) where participants of that study preferred to access general diabetes information via the internet as it was viewed to be a fast resource. Internet and web resources can provide people suffering from long-term diseases such as diabetes with general information related to the management of their conditions which can effectively enhance their overall self-management.

It should be noted, however, that not all information on the internet is accurate and there might be some instances where the internet contains inaccurate and misleading information, as reported by Wilson (2013).

6 Recommendations

Based on the analysis and discussion of results, the recommendations generated by the study are as follows:

- Self-efficacy and self-management are important factors that need to be taken into consideration by healthcare systems and practitioners. The significance of these factors has been proven through this study, as well as other studies from the literature, to play an important role when trying to effectively enhance the overall well-being of people with long-term diseases such as diabetes.
- IT plays an important role in diabetes management, as was evident from this study. IT can increase patients' knowledge and understanding of diabetes and therefore enhance their overall well-being. Local websites can be developed and supervised by the healthcare system in Jordan to ensure the credibility and accuracy of the contained information.
- It is vital to raise awareness among patients with diabetes in Jordan of the importance of other interventions, such as choosing healthy food and exercising, in addition to taking medicine to control diabetes. This can be effectively achieved through using IT in a form of local websites and mobile phone applications due to the constantly-diminishing cost of such technologies.
- Family members and support groups in Jordan can use IT tools to effectively communicate with each other and with other diabetes sufferers and provide the required level of support. This, in turn, would enhance the level of self-efficacy and self-management and eventually result in an overall improvement in the well-being of patients.

7 Conclusion, limitations and future research

In conclusion, this study revealed the effect of IT on the relationship between self-efficacy and self-management for people with type (2) diabetes. It was evident from this study that self-efficacy played a vital role in managing diabetes as it was a major predictor of self-management. This relationship positively increased when IT was incorporated into this relationship. This demonstrates the positive role of IT in managing long-term diseases, such as diabetes. However, the current paper included a relatively small sample and focused only on people with type (2) diabetes which could limit the generalisation of results.

Future studies may take this study as a common ground on which to base other studies. Further studies can focus on areas such as information needs for people with diabetes to enhance the type and level of information that is needed for ameliorating the levels of patients' self-management. Such information may not solely target patients, but also their family members and support groups. Such a holistic approach in information provision would greatly enhance the ultimate goal of such interventions to better the quality of life and overall well-being of people with diabetes.

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References

Al Rai Newspaper (2013) *16% the Prevalence of Diabetes among Jordanians*, http.//www.alrai.com/article/616950.html (Accessed 10 February, 2015).

American Diabetes Association (ADA) (2016) *Type 2 Diabetes*, http.//www.diabetes.org/diabetes-basics/type-2/ (Accessed 2 January, 2016).

Avdal, E.U., Kizilci, S. and Demirel, N. (2011) 'The effects of web-based diabetes education on diabetes care results: a randomized control study', *Comput. Inform. Nurs.*, Vol. 29, pp.TC29–TC34, PMID: 21372642, doi. 10.1097/NCN.0b013e3182155318.

Beckerle, C.M. and Lavin, M.A. (2013) 'Association of self-efficacy and self-care with glycemic control in diabetes', *Diabetes Spectrum*, Vol. 26, No. 3, pp.172–178.

Bernal, H., Wolley, S., Schensul, J.J. and Dickinson, J.K. (2000) 'Correlates of self-efficacy in diabetes self-care among hispanic adults with diabetes', *The Diabetes Educator*, Vol. 26, No. 4, pp.673–680.

Clark, N.M., Becker, M.H., Janz, N.K., Lorig, K., Rakowski, W. and Anderson, L. (1991) 'Self-management of chronic disease by older adults: a review and questions for research', *J. Aging Health*, Vol. 3, pp.3–27.

Dadgar, M. and Joshi, K.D. (2017) 'Value-sensitive review and analysis of technology-enabled self-management systems: a conceptual investigation', *Int. J. Electronic Healthcare*, Vol. 9, Nos. 2–3, pp.157–185.

Ghazal, M. (2014) *95% of Jordanians Own Mobiles; 47% Use the Internet*, http.//www.Jordantimes.com/news/local/95-jordanians-own-mobiles-47-use-internet (Accessed 15 January, 2015).

Hair, J.F., Anderson, R.E., Tatham, R.L. and Black, W.C. (1998) *Multivariate Data Analysis*, 5th ed., Prentice-Hall, Upper Saddle River, NJ.

Hair, J.F., Black, W.C., Babin, B.J. and Anderson, R.E. (2010) *Multivariate Data Analysis: A Global Perspective*, 7th ed., Person Education, Inc., Saddle River, New Jersey.

Howitt, D. and Cramer, D. (2011) *Introduction to SPSS Statistics in Psychology for Version 19 and Earlier*, 5th ed., Pearson Education Limited, Essex.

Hunt, C.W. (2015) 'Technology and diabetes self-management: an integrative approach', *World Journal of Diabetes*, Vol. 6, No. 2, pp.225–233.

Hunt, C.W., Sanderson, B.K. and Ellison, K.J. (2014) 'Support for diabetes using technology: a pilot study to improve self-management', *Medsurg Nursing*, Vol. 23, No. 4, pp.231–237.

King, D.K., Glasgow, R.E., Toobert, D.J., Strycker, L.A., Estabrooks, P.A., Diego, O. and Faber, A.J. (2010) 'Self-efficacy, problem solving and social-environmental support are associated with diabetes self-management', *Behaviors Diabetes Care*, Vol. 33, No. 4, pp.751–753.

Lanting, L.C., Joung, I.M., Vogel, I., Bootsma, A.H., Lamberts, S.W. and Mackenbach, J.P. (2008) 'Ethnic differences in outcomes of diabetes care and the role of self-management behavior', *Patient Education and Counseling*, Vol. 72, pp.146–154.

Minet, L., Moller, S., Vach, W., Wagner, L. and Henriksen, J.E. (2010) 'Mediating the effect of self-care management intervention in type 2 diabetes: a meta-analysis of 47 randomised controlled trials', *Patient Education and Counseling*, Vol. 80, pp.29–41.

Morrison, G. and Weston, P. (2013) 'Self-efficacy: a tool for people with diabetes managed by continuous subcutaneous insulin infusion', *Journal of Diabetes Nursing*, Vol. 17, No. 1, pp.32–37.

Narayan, K.M., Zhang, P., Kanaya, A.M., Williams, D.E., Engelgau, M.M., Imperatore, G. and Ramachandran, A. (2006) *Disease Control Priorities in Developing Countries: Diabetes the Pandemic and Potential Pollutions*, 2nd ed., Oxford University Press, New York, http.//www.ncbi.nlm.nih.gov/books/NBK11777/ (Accessed 1 June, 2016).

Olmen, J.V., Ku, G.M., Pelt, M.V., Kalobu, J.C. and Hen, H. (2013) 'The effectiveness of text messages support for diabetes self-management: protocol of the TEXT4DSM study in the Democratic Republic of Congo, Cambodia and the Philippines', *BMC Public Health*, Vol. 13, p.423.

Ouyang, C.M. (2007) *Factors Affecting Diabetes Self-Care among Patients with type 2 Diabetes in Taiwan*, PhD Thesis, Tufts University, USA.

Pacaud, D., Kelley, H., Downey, A.M. and Chiasson, M. (2012) 'Successful delivery of diabetes self-care education and follow up through ehealth media', *Canadian Journal of Diabetes*, Vol. 36, pp.257–262.

Renders, C.M., Valk, G.D., Griffin, S.J., Wagner, E., van Eijk, J.T. and Assendelft, W.J.J. (2009) 'Interventions to improve the management of diabetes mellitus in primary care, outpatient and community settings (review)', *Cochrane Library*, p.4.

Sahu, M., Grover, A. and Joshi, A. (2014) 'Role of mobile phone technology in health education in Asian and African countries: a systematic review', *Int. J. Electronic Healthcare*, Vol. 7, No. 4, pp.269–286.

Toobert, D.J., Hampson, S.E. and Glasgow, R.E. (2000) 'The summary of diabetes self-care activities measure: results from 7 studies and a revised scale', *Diabetes Care*, Vol. 23, No. 7, pp.943–950.

Wilson, V. (2013) 'Patient use of the Internet for diabetes information', *Nurs. Times*, Vol. 109, No. 23, pp.18–20.

Yu, C.H., Parsons, J., Mamdani, M., Lebovic, G., Shah, B.R., Bhattacharyya, O., Laupacis, A. and Straus, S.E. (2012) 'Designing and evaluating a web-based self-management site for patients with type 2 diabetes–systematic website development and study protocol', *Medical Informatics and Decision Making*, Vol. 12, p.57.

Appendix

Table A1 Mean and standard deviation of self-efficacy items

Self-efficacy items	*Mean*	*Standard deviation*	*Factor loading*
I believe I can exactly follow the meal plan from the dietitian and control my diet	3.27	1.061	0.839
I believe I can select and prepare appropriate foods and portions for my diabetes at home	3.40	1.027	0.799
I believe I can choose appropriate foods for my diabetes when I am eating out	3.05	1.121	0.545
I believe I can exercise properly and regularly (About 2–3 times weekly and at least 20 min per time)	3.10	1.350	0.555
I believe I can take all my medications at the recommended time and dose	4.15	1.020	0.550
I believe I can check my blood sugar regularly (Once a day or 2 to 3 times weekly)	3.46	1.136	0.598

Table A2 Mean and standard deviation of IT items

IT Items	*Mean*	*Standard deviation*	*Factor loading*
Internet and Web resources	2.66	1.409	0.591
Mobile phone applications	1.94	1.083	0.832
Mobile phone text messages	1.46	0.913	0.785
Email technology	1.47	0.860	0.774

Table A3 Mean and standard deviation of self-management items

Self-management items	*Mean*	*Standard deviation*	*Factor loading*
How many of the past month have you followed a healthful eating plan?	2.96	1.161	0.745
On average, over the past month, how many have you followed your eating plan?	3.11	1.140	0.763
On how many of the past month did you eat five or more servings of fruit and vegetables?	3.44	1.088	0.697
On how many of the past month did you eat high fat foods such as red meat or full-fat dairy products?	3.18	1.026	0.635
On how many of the past month did you participate in at least 30 min of physical activity? (Total minutes of continuous activity, including walking)	2.41	1.196	0.777
On how many of past month did you participate in a specific exercise session (such as walking, biking) other than what you do around the house or as part of your work?	2.53	1.377	0.519
On how many of the past month did you test your blood sugar?	3.66	1.364	0.604
On how many of the past month did you test your blood sugar the number of times recommended by your healthcare provider?	3.46	1.330	0.504
On how many of the past month did you check your feet?	2.74	1.509	0.565