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Determinants of Diabetic Knowledge and Self-Efficacy and Their Associations with Diabetic Management in Patients with Type 2 Diabetes

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Abstract
BACKGROUND: Diabetic management and education are inadequate in Saudi Arabia. Diabetic knowledge and self-efficacy are believed to mediate the impact of diabetic education. The objective was to examine the association of diabetic knowledge and self-efficacy and their associations with diabetic self-management behaviors and control outcomes. **METHOD:** A cross-sectional study among patients with type 2 diabetes (T2D) receiving care at King Abdulaziz Medical City, Riyadh. Patients were interviewed using a detailed questionnaire covering sociodemographics, knowledge (29 questions), self-efficacy (16 questions), and diabetic self-management behaviors and outcomes. Scores corrected to 100-point scale for both knowledge and self-efficacy were calculated. Glycemic control has been abstracted from the patient chart. **RESULTS:** A total 160 patients gave consent and completed the study. Patients were 56.2% females with an average age of 49.9±14.7 years. The overall average (±SD) knowledge and self-efficacy scores were 65.4%±16.4% and 57.9±17.1%. There was a significant moderate positive correlation between overall knowledge and self-efficacy scores ($r=0.486$, $p<0.001$). Both knowledge and self-efficacy scores were associated with better self-monitoring of blood glucose, frequent checkup, controlled 2-hour blood glucose level, adherence to diabetic medications, appropriate diabetic diet, and doing regular exercise. **CONCLUSION:** The levels of knowledge and self-efficacy scores were moderate among a sample of Saudi patients with T2D. The current findings show the positive impact of and the need to better improve knowledge and self-efficacy among Saudi patients with T2D. Diabetic education offered to patients with T2D should focus more on self-efficacy.
Keywords: Type 2 diabetes, self-efficacy, knowledge, management, Saudi Arabia

1. Introduction

Type 2 diabetes (T2D) is a major global public health problem with several comorbid conditions and high mortality profile. The worldwide prevalence rates of T2D have been doubled in the last three decades [1]. In Saudi Arabia, the rate has been estimated at approximately 24% [2] which is approximately three-fold higher than the estimated global prevalence (8.5% in 2014) [3]. Recent prevalence estimates done by the International Diabetes Federation (IDF) has placed Saudi Arabia in the seventh position among the countries with highest diabetes prevalence worldwide [4]. Additionally, the IDF prevalence estimates listed Saudi Arabia on the top of all Middle Eastern and North African countries [4]. Moreover, a recent projection study estimated the prevalence of T2D in Saudi Arabia at 44% by the year 2022.

Patient self-management is critical for the prevention of acute complications and reducing the risk of long-term complications [5]. A number of studies in Saudi Arabia showed that diabetic management among patients with T2D is inadequate [6-8] and adherence to American Diabetes Association (ADA) standards of care including self-management is suboptimal [9]. According to the ADA, effective diabetes management requires behavioral changes to meet the patient-centered chronic care model of diabetic care [5]. The social cognitive theory postulates that behavioral changes and consequently self-management are based on constant interactions between behavioral, personal, and environmental factors that are expressed as daily adherence to recommended care [10].

Knowledge and self-efficacy of diabetic care are believed to be intermediary outcomes for diabetic education and potential personal predictors for behavioral changes [10, 11]. Knowledge refers to the awareness of diabetes risk and management while diabetes self-efficacy can be defined as the patient's confidence in his/her ability to perform behavioral changes required for diabetic care [12, 13]. The concept of self-efficacy has been introduced long time ago as a core element of social cognitive theory that can serve as a strategy to enhance diabetes self-care [14, 15]. Although self-efficacy has been shown in several studies to positively impact the diabetic care, the level of self-efficacy among diabetic patients in several populations was found to be unsatisfactory [12]. In Saudi Arabia, diabetic knowledge has been examined among patients with T2D in a number of studies with generally insufficient knowledge profile [16-19]. However, diabetic self-efficacy has been poorly examined and only in relation to medication adherence [20]. Additionally, the association between diabetic knowledge and self-efficacy and their impact on diabetic care have never been comprehensively examined in Saudi Arabia. This is particularly important among Saudi patients, who traditionally have

inadequate knowledge and suboptimal disease management. The objective of the current study was to examine the association of diabetic knowledge and self-efficacy and their associations with diabetic self-management behaviors and control outcomes among Saudi patient with T2D.

2. Methods

Setting: The current study was conducted at King Abdulaziz Medical City (KAMC) in Riyadh, Saudi Arabia. KAMC (Riyadh) is an approximately 900-bed tertiary care facility that includes 13 intensive care units, 36 inpatient wards, 150-bed emergency department, and a large outpatient complex. KAMC provides healthcare services to over 600,000 Saudi National Guard soldiers, employees and their families. The care provided ranges from primary and preventive care to tertiary care. The outpatient complex serves approximately 2000 visits per day and the inpatient wards and ICUs serve 710 patients per day.

Study design: A cross-sectional research design was utilized in this study between June and September 2014. The study obtained all required ethical approvals from the institutional review board at Faculty of Nursing at King Saud Bin Abdul Aziz University for Health Science (KSAU).

Population: A total 160 patient with type 2 diabetes were recruited from the medical outpatient clinics at the KAMC, Riyadh. The patients were recruited conveniently after taking their consent. Inclusion criteria included adult male and female patients with type 2 diabetes receiving diabetic care at the KAMC, Riyadh for the last year, irrespective of type of treatment. Exclusion criteria included age less than 18 years or above 80 years and having diabetes for less than a year.

Data collection: Data was collected during face to face interview using a detailed study questionnaire covering the following sections; sociodemographics, clinical history, diabetic knowledge, diabetic self-efficacy, and diabetic self-management behaviors and control outcomes. Knowledge tool included 29 questions which were designed to cover the following topics; general management and coping (8 questions), regular checkup visits (2 questions), checking glucose level and self-monitoring (3 questions), adherence to diabetic medications (1 question), diet control (5 questions), exercise (3 questions), and foot care (7 questions), as shown in Table 2. Responses to knowledge questions yes, no, and don't know. Questions were stated in a way that the correct answer could be yes or no. Self-efficacy tool included 16 questions which were designed to cover the following topics; general management and coping (3 questions), regular checkup visits (2 questions), checking glucose level and self-monitoring (3 questions), adherence to diabetic medications (1 question), diet control (4 questions), exercise (2 questions), and foot care (1 question), as shown in Table 3. Responses to self-efficacy questions included a range between 0 and 10. Diabetic self-management behaviors and control outcomes included; regular checkup, blood glucose level, achieving controlled blood glucose, daily self-monitoring of blood glucose, intake and regular adherence to diabetic medications, sporting, number of meals, eating habits and type of diet, and foot care, as shown in table 5. The face and content validity of the questionnaire and study tools have been conducted by two experts in diabetes research. Additionally, the questionnaire was piloted on 5 patients to assess the clarity of questions and the time needed to fill the questionnaire. Blood glucose levels, weight, and height have been abstracted from the patient chart. Controlled blood glucose was defined as fasting <126 mg/dl and two-hour <200 mg/dl). Body mass index (BMI) was calculated using the standard formula; weight in kilograms by squared height in meters.

Statistical Analysis: Data were presented as frequencies and percentages for categorical data and mean and standard deviation (SD) for continuous data. Responses to individual knowledge questions (N=29) were given scores of 3 when correct, 0 when wrong, and 1 when "don't know". Responses to individual questions of diabetes self-efficacy (N=16) were given scores from 0 to 10. Overall and specific knowledge and diabetes self-efficacy scores were calculated by summing up the score of individual questions and were transformed to percentages of maximum attainable scores. To detect the determinant of knowledge and diabetes self-efficacy, overall knowledge and diabetes self-efficacy scores were compared between the groups defined by demographic and clinical characteristics using t-test (in case of two-category characteristics) or analysis of variance (ANOVA, in case of more than two-category characteristics) to detect any significant differences. The correlations between knowledge and diabetes self-efficacy were tested using Spearman correlation coefficient. To detect the associations of both knowledge and diabetes self-efficacy with diabetic self-management behaviors and control outcomes, overall knowledge and diabetes self-efficacy scores were compared between the groups defined by diabetic self-management behaviors and control outcomes using t-test or ANOVA to detect any significant differences. All P-values were two-tailed. P-value <0.05 was considered as significant. SPSS software (release 20.3, Armonk, NY: IBM Corp) was used for all statistical analyses.

3. Results

A total 160 patients gave consent and completed the study. Table 1 showed the demographic and clinical characteristics of the examined patients. Approximately 56.2% of the patients were females. The average age was 49.9±14.7 years, with the majority (54.4%) having age between 40 and 60 years. The average body mass

index (BMI) was 31.6±6.8, with the majority (59.4%) of patients were obese (BMI ≥30.0). The majority of patients had less than college education (43.8%) or non-educated (38.1%). The average duration of diabetes was 11.9±9.0 years, with approximately half (48.1%) of patients had diabetes from 6 and 15 years. The majority (85.0%) of patients has one or more comorbidity. The most common comorbidities were hypercholesterolemia (73.1%), hypertension (63.1%), joint diseases (19.4%), heart diseases (18.8%), asthma (13.2%), and renal diseases (5.1%). The majority (71.9%) of patients had a family member with diabetes. Table 1 also compared the levels of both knowledge and self-efficacy scores by the patients' demographic and clinical characteristics. Better diabetes knowledge was positively associated with education and having hypertension and negatively associated with BMI. While there were no significant positive associations, better self-efficacy was negatively associated with BMI.

Table 2 showed the responses to 29 knowledge questions arranged into specific topics; general information, regular checkup, glucose level, diabetic medications, diet control, exercise, and foot care. Knowledge questions that were correctly known by more than 80% of the patients included; the benefits of regular follow up visits, the importance of practicing sports, the importance of practicing foot care, the ability to control blood sugar level by diet, and the possibility of losing the feeling in hands, fingers and feet in diabetes. Knowledge questions that were correctly known by less than 50% of the patients included; Insulin reaction is caused by too much food, diabetes often causes poor circulation, diabetes can damage the kidneys, and eating too much sugar is a cause of diabetes. As shown in Figure 1, the average (±SD) overall knowledge score was 65.4%±16.4%. The average specific knowledge scores (in descending order) were 72.8% for exercise, 70.9% for foot care, 66.4% for glucose level, 66.1% for diet control, 66.0% for regular checkup, 58.4% for general information, and 52.7% for diabetic medications.

Table 3 showed the responses to 16 questions of diabetes self-efficacy arranged into specific topics; general management and coping with disease, regular checkup visits, glucose level and self-monitoring, adherence to diabetic medications, diet control, exercise, and foot care. Responses to self-efficacy questions were categorized into three groups in Table 3 for easy reporting of the results; low (response 0 to 4), medium (response 5 to 7), and high (response 8 to 10). Responses that showed relatively high self-efficacy included responses to questions related to controlling low blood glucose levels (76%), adhere to diabetic medications (65%), when to visit the doctor (54%), and adhere to self-care of foot (50%). On the other hand, responses that showed relatively low self-efficacy included responses to questions related to diet control (22.5% to 29.4%), exercise (20.6% to 27.5%), control of stress and worry (29.4%), and self-monitoring of blood glucose (12.5%). As shown in Figure 1, the average (±SD) overall diabetes self-efficacy score was 92.7±27.3 points which is equivalent to 57.9±17.1%. The average specific diabetes self-efficacy scores (in descending order) were 76.7% for adherence to medications, 67.5% for regular checkup visits, 66.9% for foot care, 62.4% for glucose level and self-monitoring, 59.2% for general management and coping with diabetes, 50.8% for diet control, and 39.9% for exercise.

Table 4 showed a significant moderate positive correlation between the overall knowledge score and the overall self-efficacy score ($r=0.486$, $p<0.001$). Significant positive associations were also seen but at smaller degree when correlating all knowledge sub-scores with the overall self-efficacy score. Similarly, significant positive associations were also seen but at smaller degree when correlating self-efficacy sub-scores with the overall knowledge score with the exception of adherence to diabetic medications. Generally, the strongest correlations were observed in diet control ($r=0.343$ and 0.460, respectively) while the weakest correlations were observed in adherence to diabetic medications ($r=0.177$ and 0.153, respectively).

Table 5 showed that several diabetic self-management behaviors and control outcomes were significantly associated with higher knowledge. The followings were significantly associated with higher (better) knowledge score; doing and frequent checkup, lower fasting and 2-hour blood glucose levels, controlled 2-hour blood glucose level (<200 mg/dl), adherence to diabetic medications, sporting, eating fruits/vegetables rich diet, self-monitoring of blood glucose, and using documentation for self-monitoring of blood glucose. On the other hand, controlled fasting blood glucose (<126 mg/dl), frequency of taking diabetic medications, frequency of meals, frequency, taking snacks between meals, and using the diary for self-monitoring of blood glucose were not significantly associated with higher knowledge score.

Table 5 showed also that several diabetic self-management behaviors and control outcomes were significantly associated with higher self-efficacy score. The followings were significantly associated with higher (better) self-efficacy score; frequent checkup, lower fasting and 2-hour blood glucose levels, controlled 2-hour blood glucose level (<200 mg/dl), adherence to diabetic medications, sporting, prolonged exercise (≥150 minutes per week), eating low carbohydrate/fat diet, eating fruits/vegetables rich diet, self-monitoring of blood glucose, using documentation for self-monitoring of blood glucose, and doing foot care. On the other hand, controlled fasting blood glucose (<126 mg/dl), frequency of taking diabetic medications, frequency of meals, frequency, taking snacks between meals, and using the diary for self-monitoring of blood glucose were not significantly associated with higher self-efficacy scores

4. Discussion

A sample of patients with T2D seeking care at outpatient clinics of a tertiary care hospital in Riyadh, Saudi Arabia has been examined in the current study with the aim to determine the levels of diabetic knowledge and self-efficacy and their associations with recommended diabetic management behaviors and outcomes. The study findings showed a moderate level of knowledge and self-efficacy scores, with both knowledge and self-efficacy scores were positively correlated. The study findings also showed that both knowledge and self-efficacy scores were associated with better diabetic self-management behaviors and control outcomes such as self-monitoring of blood glucose, frequent checkup, glycemic control, adherence to diabetic medications, appropriate diabetic diet, and doing regular exercise.

The current finding showed a moderate level of knowledge regarding diabetes and its management, with an overall 65% knowledge level. Comparing knowledge levels in different studies done in Saudi Arabia is limited by the variability of the tool used, the diabetic aspects covered by that tool, the population examined, and the design and recruitment process [16-19]. Nevertheless, the current finding was generally consistent with previous studies that have been repeatedly showing low to moderate knowledge levels, irrespective of the aspect covered [16-19]. For example, in a recent cross-sectional study among 75 patients with T2D attending a diabetic center in Riyadh, the patients showed approximately 65% (score of 7 out of 14) knowledge level regarding diabetic diet and blood glucose level [16]. Additionally, in a case-control study done at diabetes exhibition held in a major city center in the Eastern Province of Saudi Arabia, 62% of the patients were aware of the presence of diabetic complications and only 48% were aware of diabetic foot [19]. Similarly, in another cross-sectional study among 91 female teachers with diabetes in the Eastern Province of Saudi Arabia, almost three-fourth of the patients were aware of the symptoms of hypoglycemia and only a third were aware of different antidiabetic medications [17]. The insufficient knowledge of diabetes among patients with diabetes in Saudi Arabia is even better than diabetes knowledge among other non-diabetic patients [21] or the general population [22]. This generally insufficient knowledge has been attributed to inefficient educational programs targeting patients with T2D [16, 21], which can otherwise improve the knowledge level in all aspects of diabetic care [23]. Additionally, the inadequate knowledge of treating physician and limited time allocated for education of patients may be additional contributing factors [24, 25].

The current study is unique in comprehensively examining the different aspects of diabetes self-efficacy among patients with T2D. Unlike diabetic knowledge, data on self-efficacy among patients with T2D in Saudi Arabia have been very limited. It was examined only in relation to medication adherence as one of the six components of the health belief model used frequently to predict medication adherence among patients with T2D and similar chronic diseases [20]. In a recent cross-sectional study among 220 patients with T2D using a hospital pharmacy at Northwest Region of Saudi Arabia, self-efficacy was a significant predictor of medication adherence [20]. However, multi-domain self-efficacy has never been the focus of any study among patients with T2D in Saudi Arabia. Internationally, a relatively recent narrative review of 26 studies that examined self-efficacy among patients with diabetes concluded that the level of self-efficacy is generally suboptimal [12]. For example, a cross-sectional study in rural India among 126 women showed an average self-efficacy score of 70% [26]. Another cross-sectional study done among 223 patients with T2D in Jordan showed that the majority of the items of the self-efficacy scale used were between 6 and 7 out of 10 points [27]. The current self-efficacy level (58%) is even lower than the above two studies [26, 27]. However, in both the current and previous study [27] self-efficacy was higher for medication adherence and regular checkup but lower for diet control and doing regular exercise.

The current finding showed a positive correlation between the overall knowledge and self-efficacy scores. The finding was similar to findings from previous studies in India and Philippines that showed a significant association between diabetic knowledge and self-efficacy [26, 28]. Additionally, educational interventions aimed to increase the levels of diabetic knowledge were associated with improved levels of self-efficacy for glucose monitoring, medication adherence, foot care, and diabetic management in general [5, 29-31]. The improved self-efficacy by improving the patient's knowledge appeared to be a natural process in the context of social cognitive theory principles [31]. However, the fact that both were found to be independent promotors of diabetic self-care activities may also indicate they are not identical [32]. Self-efficacy is a behavior-oriented belief which can be considered more advanced stage of knowledge [14, 15].

Both diabetic knowledge and self-efficacy in the current study were associated with better diabetic self-management behaviors and control outcomes. While there is almost lack of local data examining the association of either diabetic knowledge or self-efficacy with diabetic care, such associations have been confirmed in several studies around the world. For example, in a survey study among 670 US patients with diabetes, one-point increase in knowledge (measured using eight-item knowledge scale) was associated with 23% higher adherence with diabetes diet, 23% higher adherence with blood glucose self-measurement, and 15% higher adherence with regular exercise [33]. Additionally, diabetes self-management education which works by facilitating knowledge and skills of self-management were reported to improve glycemic control, weight control, quality of life, and

healthy coping [5]. Actually, insufficient knowledge among patients with T2D was identified as one of the factors contributing to inadequate diabetic management inside [7] and outside [34] Saudi Arabia.

Similar to knowledge, the associations of self-efficacy with improved targets of diabetic self-management behaviors and care outcomes have been confirmed in several studies around the world [12, 27, 35-37]. For example, in a secondary analysis of data derived from 463 US patients with T2D and BMI>25, there were independent associations between component-specific self-efficacy and self-management for diet, exercise, and medications [37]. Similarly, in a survey study among >400 US patients with T2D, 10% higher self-efficacy (measured using eight-item self-efficacy scale) was associated with approximately 10-20% better diabetic diet, exercise, self-monitoring of blood glucose and foot care [36]. Such positive association was maintained irrespective of race, the level of health literacy, and knowledge [32, 36]. It is believed that the beneficial impact of patient education on diabetic management is actually mediated by improved knowledge and self-efficacy [38]. Therefore health education offered to patients with T2D should focus more on self-efficacy [27, 35, 37]. The outcome of self-efficacy can be further improved by better communication between the patient and treating physician [39].

To our knowledge, the current study is considered the first study to examine associations of diabetic knowledge, self-efficacy, and diabetic management among Saudi patient with T2D. It should bridge the local knowledge gap in this interesting and interrelated area. Nevertheless, a number of limitations are acknowledged. The cross-sectional design of the current study can prove associations but not causations. The lack of standard tool to measure self-efficacy and self-management is well-recognized [40, 41] and impede fair comparison of findings from different studies including the current study. Being a single center experience, the current findings should be projected to Saudi patients with T2D with caution.

In conclusion, the levels of knowledge and self-efficacy scores were moderate among a sample of Saudi patients with T2D. Both knowledge and self-efficacy scores were positively correlated. Both knowledge and self-efficacy scores were associated with better diabetic self-management behaviors and control outcomes including self-monitoring of blood glucose, frequent checkup, glycemic control, adherence to diabetic medications, appropriate diabetic diet, and doing regular exercise. The current findings show the positive impact of and the need to better improve knowledge and self-efficacy among Saudi patients with T2D, who traditionally have inadequate knowledge and suboptimal disease management. Diabetic education offered to patients with T2D should focus more on self-efficacy.

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Table 1: Demographic and clinical characteristics of patients and their associations with overall knowledge and diabetes self-efficacy scores

	Overall	Knowledge		Self-efficacy	
		Mean±SD	p-value (1)	Mean±SD	p-value (1)
Age (years) (2)					
Mean±SD	49.9±14.7				
<40	34 (21.2%)	68.3%±14.2%	0.369	60.7%±18.8%	0.344
40-60	87 (54.4%)	63.8%±18.0%		56.2%±17.3%	
>60	39 (24.4%)	66.3%±14.1%		59.4%±14.7%	
Gender					
Male	70 (43.8%)	67.3%±17.5%	0.194	57.6%±17.6%	0.835
Female	90 (56.2%)	63.9%±15.4%		58.2%±16.7%	
BMI (2)					
Mean±SD	31.6±6.8				
Normal (<25.0)	22 (13.8%)	73.7%±11.9%	<0.001	66.2%±16.0%	<0.001
Overweight (25.0-29.9)	43 (26.9%)	70.6%±11.7%		63.3%±17.2%	
Obese (≥30.0)	95 (59.4%)	61.1%±17.7%		53.6%±16.0%	
Educational level (2)					
Non-educated	61 (38.1%)	63.3%±15.1%	0.002	57.0%±16.4%	0.450
Up to high school education	70 (43.8%)	63.3%±16.8%		57.2%±16.8%	
College education	29 (18.1%)	74.8%±15.1%		61.6%±19.1%	
Years of diabetes (2)					
Mean±SD	11.9±9.0				
<=5 years	42 (26.2%)	64.7%±14.0%	0.408	58.7%±17.8%	0.707
6-15 years	77 (48.1%)	64.2%±16.2%		56.8%±17.7%	
>15 years	41 (25.6%)	68.3%±18.9%		59.3%±15.2%	
Any comorbidity	136 (85.0%)	64.6%±16.5%	0.150	57.0%±16.2%	0.122
Hypertension	101 (63.1%)	63.1%±16.8%	0.018	56.5%±16.4%	0.156
Heart diseases	30 (18.8%)	65.3%±16.1%	0.984	54.8%±14.5%	0.270
Asthma	21 (13.2%)	65.9%±13.2%	0.865	56.2%±18.6%	0.627
Hypercholesterolemia	117 (73.1%)	64.5%±16.5%	0.261	56.4%±16.0%	0.061
Joint diseases	31 (19.4%)	65.7%±18.5%	0.915	54.6%±14.6%	0.223
Renal diseases	8 (5.1%)	71.3%±13.5%	0.304	57.9%±14.2%	0.968
Family member with diabetes	115 (71.9%)	66.5%±15.6%	0.177	59.2%±16.7%	0.126

Mean±SD: mean and standard deviation; *p-value was calculated using t-test unless mentioned otherwise (2) p-value was calculated using ANOVA F test

Table 2: Response of patients with diabetes to knowledge questions (N=160)

	Correct	Wrong	Don't know
General information of diabetes			
The usual cause of diabetes is lack of effective insulin in the body	85 (53.1%)	29 (18.1%)	46 (28.8%)
Diabetes is caused by failure of the kidneys to keep sugar out of the urine*	35 (21.9%)	49 (30.6%)	76 (47.5%)
Kidneys produce insulin*	64 (40.0%)	26 (16.2%)	70 (43.8%)
In untreated diabetes, the amount of sugar in the blood usually increases	102 (63.8%)	28 (17.5%)	30 (18.8%)
If I am diabetic, my children have a higher chance of being diabetic	98 (61.6%)	36 (22.6%)	25 (15.7%)
Diabetes can be cured*	78 (48.8%)	49 (30.6%)	33 (20.6%)
The best way to check my diabetes is by testing my urine*	75 (46.9%)	34 (21.2%)	51 (31.9%)
Diabetes can damage my kidneys	74 (46.5%)	14 (8.8%)	71 (44.7%)
Regular checkup			
Provide correct reasons for going to follow up visits	118 (73.7%)	41 (25.6%)	1 (0.6%)
Know benefits of regular follow up visits	135 (84.4%)	7 (4.4%)	18 (11.2%)
Glucose level			
A fasting blood sugar level of 210 is too high	97 (60.6%)	45 (28.1%)	18 (11.2%)
Shaking and sweating are signs of high blood sugar*	97 (60.6%)	55 (34.4%)	8 (5.0%)
Frequent urination and thirst are signs of low blood sugar*	113 (70.6%)	38 (23.8%)	9 (5.6%)
Medication			
Medication is more important than diet and exercise to control diabetes*	81 (50.6%)	69 (43.1%)	10 (6.2%)
Diet control			
There is a relation between obesity and developing diabetes	108 (67.5%)	26 (16.2%)	26 (16.2%)
Following diet could control blood sugar level	134 (83.8%)	21 (13.1%)	5 (3.1%)
Eating too much sugar is a cause of diabetes	79 (49.4%)	68 (42.5%)	13 (8.1%)
Insulin reaction is caused by too much food	54 (33.8%)	29 (18.1%)	77 (48.1%)
The way I prepare my food is as important as the food I eat	107 (66.9%)	34 (21.2%)	19 (11.9%)
Exercise			
Regular exercise will increase the need for insulin or other diabetic medication*	72 (45.0%)	50 (31.2%)	38 (23.8%)
It is important to the diabetic patients to practicing sports	136 (85.0%)	18 (11.2%)	6 (3.8%)
Is there a relation between practicing sports and blood sugar control	120 (75.0%)	20 (12.5%)	20 (12.5%)
Foot care			
It is important for the diabetic patient to practice foot care	130 (81.2%)	19 (11.9%)	11 (6.9%)
There is a relation between sugar level and developing foot pain	96 (60.0%)	36 (22.5%)	28 (17.5%)
Cuts and abrasions on diabetes heal more slowly	103 (64.4%)	14 (8.8%)	43 (26.9%)
Diabetics should take extra care when cutting their toenails	99 (62.3%)	21 (13.2%)	39 (24.5%)
Tight elastic hose or socks are not bad for diabetics*	74 (46.2%)	22 (13.8%)	64 (40.0%)
Diabetes often causes poor circulation	65 (40.6%)	12 (7.5%)	83 (51.9%)
Diabetes can cause loss of feeling in my hands, fingers and feet	132 (83.5%)	8 (5.1%)	18 (11.4%)

* Correct answer has the answer no

Table 3: Responses* (%) to diabetes self-efficacy questions among patients with diabetes (N=160)

	Low (0-4)	Medium (5-7)	High (8-10)
General management and coping with disease			
Control diabetes	49 (30.6%)	58 (36.3%)	53 (33.1%)
Control stress and worry	56 (35.0%)	57 (35.6%)	47 (29.4%)
Do all needed to manage diabetes on a regular basis	34 (21.3%)	72 (45.0%)	54 (33.8%)
Regular checkup visits			
Adhere to periodic follow up appointments	40 (25.0%)	53 (33.1%)	67 (41.9%)
Judge when should visit the doctor	23 (14.4%)	50 (31.3%)	87 (54.4%)
Glucose level and self-monitoring			
Adhere to self-monitoring of blood glucose	93 (58.1%)	47 (29.4%)	20 (12.5%)
Know / can manage when blood sugar level goes up	24 (15.0%)	67 (41.9%)	69 (43.1%)
Know/can manage when blood sugar level goes down	19 (11.9%)	19 (11.9%)	122 (76.3%)
Adherence to diabetic medications			
Adhere to diabetic medications	19 (11.9%)	37 (23.1%)	104 (65.0%)
Diet control			
Follow meal plan	65 (40.6%)	58 (36.3%)	37 (23.1%)
Choose the appropriate foods to eat when hungry	60 (37.5%)	53 (33.1%)	47 (29.4%)
Eat meals every 4 to 5 hours every day	64 (40.0%)	52 (32.5%)	44 (27.5%)
Adhere to diabetic diet	68 (42.5%)	56 (35.0%)	36 (22.5%)
Exercise			
Exercise at least 15 to 30 minutes a day, most days of the week	92 (57.5%)	35 (21.9%)	33 (20.6%)
Do something to keep blood sugar controlled during exercise	91 (56.9%)	25 (15.6%)	44 (27.5%)
Foot care			
Adhere to self-care of foot	38 (23.8%)	42 (26.3%)	80 (50.0%)

***Responses between 0 and 10 have been categorized into three groups for easy understanding; low (0-4), medium (5-7), and high (8-10)**

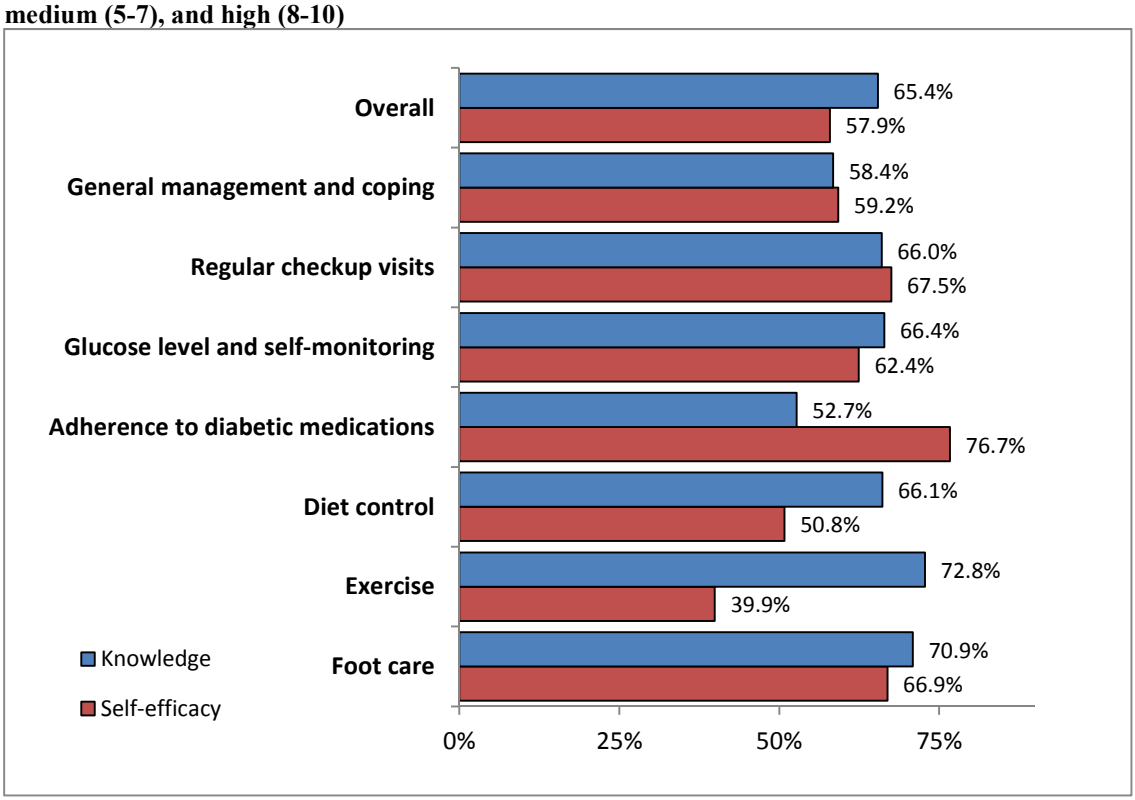

Figure 1: Average scores of diabetes knowledge and self-efficacy among patient with diabetes mellitus (N=160)

Table 4: Correlations of scores of diabetes knowledge and self-efficacy among patient with diabetes mellitus (N=160)

Items	Spearman correlation coefficient *	P-value
Overall	0.486	<0.001
General management and coping	0.372	<0.001
Regular checkup visits	0.225	0.004
Glucose level and self-monitoring	0.230	0.003
Adherence to diabetic medications	0.177	0.025
Diet control	0.343	<0.001
Exercise	0.326	<0.001
Foot care	0.325	<0.001

* For the correlations between overall and individual knowledge scores with overall self-efficacy score

Table 5: The associations of knowledge and self-efficacy scores with diabetic self-management behaviors and control outcomes among patients with diabetes

	Knowledge score		Self-efficacy score	
	Mean±SD (1)	p-value (2)	Mean±SD (1)	p-value (2)
Regular checkup (at least once a year)				
No	56.0%±12.9%	0.006	51.5%±17.1%	0.073
Yes	66.7%±16.4%		58.8%±16.9%	
At least 4 times per year (3)	69.8%±15.9%	0.001	63.5%±16.1%	<0.001
At least twice per year	66.9%±15.9%		57.1%±16.5%	
Once/year	54.5%±14.5%		44.6%±12.4%	
Blood glucose level (4)				
Fasting	-0.241	0.002	-0.374	<0.001
Two-hour	-0.283	<0.001	-0.340	<0.001
Controlled blood glucose				
Fasting (<126 mg/dl)	67.2%±14.9%	0.558	62.5%±14.1%	0.154
Two-hour (<200 mg/dl)	70.6%±18.6%	0.050	63.4%±18.6%	0.047
Intake diabetic medications (3)				
Once a day	66.7%±19.3%	0.889	59.3%±17.6%	0.893
Twice daily	64.9%±16.5%		57.5%±17.0%	
≥3 times per day	65.6%±14.0%		58.0%±17.5%	
Regular adherence to diabetic medications				
No	60.2%±15.5%	0.004	47.2%±16.7%	<0.001
Yes	68.0%±16.2%		63.4%±14.5%	
Sporting (≥15 minutes per week)				
No	61.2%±15.4%	0.001	51.5%±15.0%	<0.001
Yes	70.0%±16.3%		65.0%±16.4%	
≥150 minutes per week	74.8%±16.7%	0.169	76.7%±12.3%	0.001
Number of meals				
1-2 meals per day	65.4%±14.1%	0.989	56.1%±15.9%	0.375
≥3 meals per day	65.4%±17.4%		58.7%±17.6%	
Eating habits				
High carbohydrates or fat diet	63.2%±16.8%	0.087	54.1%±17.0%	0.003
High fruits or vegetables diet	69.7%±16.7%	0.008	62.9%±16.6%	0.004
Taking snacks between meals	65.9%±16.4%	0.499	59.0%±17.0%	0.152
Daily self-monitoring of blood glucose				
No	57.7%±19.9%	0.002	51.5%±19.8%	0.015
Yes	67.4%±14.8%		59.6%±16.0%	
Documenting in a diary	70.3%±15.2%	0.019	63.3%±16.0%	0.005
Using the diary in follow-up visits	69.1%±16.2%	0.333	64.5%±16.3%	0.338
Foot care				
No	53.7%±13.3%	0.236	44.2%±15.6%	0.017
Yes	59.2%±16.4%		55.3%±15.7%	

(1) Mean and standard deviation unless mentioned otherwise (2) P-value was calculated using t-test unless mentioned otherwise (3) Using ANOVA F test (4) Using Spearman correlation coefficient

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