

# Level of diabetes knowledge among adult patients with diabetes using diabetes knowledge test

Asim M. Zowgar, MBBS, Muhammad I. Siddiqui, FCPS, MPhil, Khalid M. Alattas, Medical student.

## ABSTRACT

**الأهداف:** لتحديد مستوى الثقافة عن مرض السكري وللتعرف على الثغرات الثقافية بين مرضى السكري (النوعين الأول والثاني) وذلك لوجود نسبة انتشار عالية لهذا المرض في السعودية

**الطريقة:** أجريت هذه الدراسة المقطعية في مدينة مكة خلال الفترة من نوفمبر 2016م إلى فبراير 2017م وتضمنت جميع مراكز الرعاية الصحية الأولية والمستشفيات الحكومية. تم استخدام اختبار مستوى الثقافة بمرض السكري النسخة 2 لتحديد مستوى الثقافة بين المرضى. ويتضمن هذا الاستبيان جزئيين: الأول الثقافة العامة والثاني استخدام الأنسولين بمجموع كلي من 23 نقطة.

**النتائج:** مجموع المرضى المشاركين 942 مريض في هذه الدراسة. نسبة الذكور إلى الإناث 55.1:44.9 وبلغ متوسط الدرجة الكلية للاستبيان  $13.3 \pm 3.2$  (57.8%±13.3%) والغالبية العظمى من المرضى (66.1%) لديهم مستوى ثقافة متوسط و (29.2%) لديهم ثقافة ضعيفة و (4.7%) لديهم ثقافة عالية. ولقد وجدنا ثقافة أفضل وارتباط وثيق بين مرضى السكر الأصغر سناً وذو التعليم العالي ومدّة أطول مع المرض، ووجود تاريخ عائلي لمرض السكري.

**الخلاصة:** ثقافة المرضى عن مرض السكري ضعيفة لذلك مقدمي الرعاية الصحية يجب عليهم أن يولوا اهتماماً بالثقافة بمرض السكري وخصوصاً تلك المرتبطة بمبادئ التغذية. ننصح بشدة الباحثين والأطباء في السعودية بإجراء دراسات مشابهة لهذا البحث لتحديد مستوى الثقافة عن مرض السكري والحصول على صورة أشمل في هذا الحقل.

**Objectives:** To determine the level of diabetes knowledge and to identify the main knowledge gaps among patients with diabetes (both types 1 and 2) as there is a high prevalence of diabetes in Saudi Arabia.

**Methods:** A cross-sectional study was conducted in Makkah city, Kingdom of Saudi Arabia and included governmental primary healthcare centers and hospitals from November 2016 until February 2017. A self-administrated Diabetes Knowledge

Test 2 (DKT2) was used to determine the level of diabetes knowledge. It consisted of two parts: general knowledge and insulin use with a global score out of 23.

**Results:** A total of 942 patients with diabetes were enrolled in this study. Male to female ratio was 55.1:44.9, with mean global DKT2 score of  $13.3 \pm 3.2$  (57.8%±13.3%). The majority of patients (66.1%) had average diabetes knowledge while 29.2% had low knowledge, and 4.7% had high knowledge. Better knowledge and significant associations were found with younger ages, high educational levels, longer duration of diabetes, and positive family history of diabetes.

**Conclusion:** Patients' knowledge regarding diabetes was found poor in this study. Hence healthcare providers should pay more attention to diabetes education, especially with respect to dietary concepts. We are strongly advising researchers and physicians in Saudi Arabia to do similar research to determine the level of diabetes knowledge in their fields to get a more comprehensive picture of their patients' knowledge of diabetes.

*Saudi Med J 2018; Vol. 39 (2):161-168  
doi: 10.15537/smj.2017.2.21343*

*From the Department of Community Medicine (Zowgar, Siddiqui, Alattas), Faculty of Medicine, Umm Al-Qura University, Makkah, Kingdom of Saudi Arabia.*

*Received 12th October 2017. Accepted 19th December 2017.*

*Address correspondence and reprint request to: Dr. Asim M. Zowgar, Department of Community Medicine, Faculty of Medicine, Umm Al-Qura University, Makkah, Kingdom of Saudi Arabia.  
E-mail: amz-md@outlook.com  
ORCID ID: orcid.org/0000-0002-8416-0989*

**Disclosure.** Authors have no conflict of interests, and the work was not supported or funded by any drug company.

Diabetes is a worldwide problem. Approximately 350–415 million people worldwide have diabetes.<sup>1,2</sup> In 2012, diabetes was the direct cause of 1.5 million deaths with more than 80% of them occurring in low- and middle-income countries.<sup>1</sup> Four out of 10 adults with diabetes in the Middle East and North Africa are undiagnosed.<sup>2</sup> It is well known that diabetes is associated with many complications including eye, kidney, neurological, and heart diseases. In Saudi Arabia, the prevalence of diabetes in 2015 was 17.6% in adults with a total number of cases about 3,487,000. The total number of cases among children was 16,100 who have type 1 diabetes with incidence rate of 31.4 per 100,000 population per year, which is considered the highest annual incidence rate of type 1 among children in the world.<sup>2</sup> Diabetes self-management education (DSME) “is the process of facilitating the knowledge, skills, and abilities necessary for diabetes self-care”.<sup>3</sup> Also, diabetes education minimizes the risk of short- and long-term complications and improves health outcomes and quality of care.<sup>3-11</sup> For these reasons, the level of diabetes education should be high in all diabetic patients because high-quality DSME has been shown to improve patient self-management, satisfaction, and glucose outcomes.<sup>3</sup> The research question examined in this study is: “Do patients with diabetes in Saudi Arabia have adequate knowledge about their disease that can help them avoid complications and possible fatal outcomes?” Unfortunately, this question has been poorly studied in Saudi Arabia. This study will address this question and determine the level of diabetes knowledge and to identify the main knowledge gaps among diabetic patients in Makkah City, Kingdom of Saudi Arabia.

**Methods. Study design and Setting.** A cross-sectional design was used to answer our research question. This study was conducted in all governmental primary healthcare centers and hospitals in Makkah City, Saudi Arabia between November 2016 and February 2017.

**Instrument.** A self-administrated Diabetes Knowledge Test 2 (DKT2), was used in this study, which is an updated version of DKT (we called it DKT1).<sup>12,13</sup> Diabetes Knowledge Test 2 is a quick and low-cost method of assessing general diabetes and diabetes self-care knowledge. The DKT2 contains 2 parts with a total of 23 questions. The first part is a general knowledge part (GKP) and consists of 14 questions, and the second part is insulin use part (IUP) with 9 questions. Both are appropriate for adults with types 1 and 2 diabetes. Each section of the DKT2 can be used independently, but we used both parts with

a global DKT (GDKT) score out of 23.<sup>13</sup> Diabetes Knowledge Test is significantly associated with general diet and foot care according to one previous study.<sup>14</sup>

We obtained permission from the DKT2 authors (Prof. James T. Fitzgerald) to use the questionnaire in our study. We added several items that related to gender, age, marital status, educational level, smoking, physical activity, duration of diabetes, compliance with medication regimens, glucometer use, wearing medical shoes, regular follow-ups, diabetes-related complications, family history of diabetes, and use of herbal diabetic treatments.

**Sample size and sampling technique.** The estimated sample size was 744, which was calculated based on a DKT2 score of 59% with 95% confidence interval and power of the study as 80%. The design effect was estimated as 2.0. The total sample size was increased to 893 to accommodate an expected non-response rate of 20%.

We selected our subject using non-probability purposive sampling technique. We went to all hospitals and primary healthcare centers and asked the patients about their diabetic status. All those who said that they are diabetic and confirmed from diabetic register in respective hospitals and primary healthcare centers, were included in this study.

**Inclusion and exclusion criteria.** All diabetic patients (both types 1 and 2) who were 18 years of age or older and have lived for 5 years or more in Makkah were included in this study. Patients who refused to sign the consent form were excluded from the study.

**Ethical consideration and data collection.** The study followed the principles of the Helsinki Declaration and was approved by the ethical committees of Faculty of Medicine, Umm Al-Qura University and the Directorate of Health Affairs, Makkah City, Kingdom of Saudi Arabia. The study aims and objectives were explained to the patients and data were collected from patients who agreed to participate in this study. All patients signed the consent form. The questionnaire was anonymous without any reference or responsibility to participating patients. The data were collected between November 2016 and February 2017.

**Statistical Analysis.** The Statistical Package for the Social Sciences (SPSS) version 23.0 (IBM Corp., Armonk, NY, USA) was used to enter, edit and analyze the data. We calculated the percentage of each category of the social and demographics variables. We also calculated mean and standard deviation of DKT2. We applied Mann-Whitney Test on gender, marital status, smoking, physical activity, compliance with medication

regimens, glucometer use, wearing medical shoes, regular follow-ups, diabetes-related complications, family history of diabetes, and use of herbal diabetic treatments and Kruskal-Wallis Test on age, educational level and duration of diabetes. A *p*-value less than 0.05 was considered significant.

The DKT2 gives only a numerical score, but it does not have standardized categories of low, average and high levels of knowledge. Because of this, we developed our own definition of categories range as follows: 1) Global DKT (GDKT): 1–11 (Low), 12–18 (Average), 19–23 (High), 2) General Knowledge Part (GKP): 1–6 (Low), 7–11 (Average), 12–14 (High), 3) Insulin Use Part (IUP): 1–4 (Low), 5–7 (Average), 8–9 (High).

**Results. Social and demographic characteristics.**

In the present study, 942 patients with diabetes were enrolled. All the questionnaires, where the answers given was 21 or more of DKT2 (out of 23), were included in the study. Finally, only 744 were valid with a response rate of 79%. The male to female ratio was 55.1:44.9, and most of the patients were married (64.7%). About 58.3% of the patient ages were more than 45 years, 34.0% performed physical activity, and 14.0% of the patients were smokers. The educational level most frequently selected was university education (28.1%) with only 12.9% of patients having no education (Table 1).

About 39.5% of the patients were diagnosed with diabetes 10 years ago or less. Most patients (73.3%) adhered to their medication regimens, 72.7% had a glucometer at home, and 69.1% regularly went to their follow-up appointments. We found that 40.1% of patients wore medical shoes, and 28.1% of patients tried to use herbs to treat their diabetes. As expected, 57.1% of the patients had a family history of diabetes, and 45.8% had diabetes-related complications (Table 1).

**Level of diabetes knowledge.** The majority of patients (66.1%) had average diabetes knowledge while 29.2% had low knowledge, and only 4.7% had high knowledge according to the global DKT2 scores with a mean 13.3±3.2 (57.8%±13.3%). As for the GKP of the DKT2, the mean score was 8.1±1.9 (57.8%±13.6%) while the IUP of the DKT2 mean score was 5.2±1.9 (57.8%±21.1%). Figure 1 shows more details.

**Factors affecting level of diabetes knowledge.** The level of education showed a very significant association with DKT2 (*p*<0.001) with university levels receiving the best scores. Also, patients who used a glucometer

(*p*=0.002) or wore medical shoes (*p*=0.023) got significantly higher DKT2 scores than those who did not (Table 2).

Younger patients scored better than older patients with a significant association between age and only GDKT (*p*=0.039) and IUP (*p*=0.009). Also, diabetes

**Table 1 -** Social and demographic characteristics.

Variables	n (%)	No Answer n (%)
<b>Gender</b>		
Male	350 (47.0)	109 (14.6)
Female	285 (38.4)	
<b>Age</b>		
<36	98 (13.2)	
36-45	90 (12.1)	122 (16.4)
46-55	186 (25.0)	
56-65	159 (21.4)	
>65	89 (11.9)	
<b>Marital status</b>		
Single	102 (13.7)	161 (21.6)
Married	481 (64.7)	
<b>Educational level</b>		
Primary School	91 (12.2)	
Elementary School	88 (11.8)	136 (18.3)
High School	124 (16.7)	
University	209 (28.1)	
Not Educated	96 (12.9)	
<b>Smoking</b>		
Yes	104 (14.0)	172 (23.1)
No	468 (62.9)	
<b>Physical activity</b>		
Yes	253 (34.0)	153 (20.6)
No	338 (45.4)	
<b>Duration of diabetes</b>		
5 years or less	160 (21.5)	
6-10 years	134 (18.0)	161 (21.6)
11-15 years	108 (14.5)	
16-20 years	89 (12.0)	
>20 years	92 (12.4)	
<b>Diabetes related complications</b>		
Yes	341 (45.8)	169 (22.7)
No	234 (31.5)	
<b>Family history of DM</b>		
Yes	425 (57.1)	159 (21.4)
No	160 (21.5)	
<b>Compliance with medication</b>		
Yes	545 (73.3)	152 (20.4)
No	47 (6.3)	
<b>Glucometer use</b>		
Yes	541 (72.7)	151 (20.3)
No	52 (7.0)	
<b>Wearing medical shoes</b>		
Yes	298 (40.1)	157 (21.1)
No	289 (38.8)	
<b>Regular in follow ups</b>		
Yes	514 (69.1)	160 (21.5)
No	70 (9.4)	
<b>Use of herbal</b>		
Yes	209 (28.1)	158 (21.2)
No	377 (50.7)	

**Table 2 -** Comparison of different variables and its significant with Diabetes Knowledge Tests2 parts.

Variables	Diabetes Knowledge Test					
	Global DKT Score		General Knowledge Part		Insulin use part	
	Mean±S.D	P-value	Mean±SD	P-value	Mean±SD	P-value
<i>Gender</i>						
Male	13.4±3.3	0.522	8.1±2.0	0.903	5.3±1.9	0.245
Female	13.2±3.2		8.0±2.0		5.2±2.0	
<i>Age</i>						
<36	14.1±3.7	0.039*	8.3±2.1	0.816	5.8±2.2	0.009*
36-45	13.4±3.2		8.0±2.0		5.3±1.8	
46-55	13.2±3.1		8.0±2.0		5.3±1.9	
56-65	13.1±3.1		8.0±2.0		5.1±1.9	
>65	12.7±3.1		7.8±2.1		4.8±1.9	
<i>Marital status</i>						
Single	13.7±3.7	0.264	8.2±2.1	0.755	5.5±2.2	0.231
Married	13.3±3.1		8.1±2.0		5.2±1.9	
<i>Educational level</i>						
Primary School	12.3±2.7	<0.001*	7.8±1.8	<0.001*	4.7±1.9	<0.001*
Elementary School	13.4±2.5		8.2±1.6		5.3±1.8	
High School	12.5±3.3		7.5±2.0		5.0±2.0	
University	14.8±3.3		8.8±2.0		6.0±1.9	
Not Educated	12.3±2.9		7.7±2.0		4.6±1.8	
<i>Smoking</i>						
Yes	13.1±3.3	0.407	7.8±2.1	0.199	5.3±2.0	0.934
No	13.4±3.2		8.1±2.0		5.3±2.0	
<i>Physical activity</i>						
Yes	13.3±3.4	0.489	8.0±2.0	0.835	5.3±2.0	0.252
No	13.2±3.1		8.0±2.0		5.2±1.9	
<i>Duration of diabetes</i>						
5 years or less	13.0±3.3	0.023*	7.8±2.1	0.09	5.2±1.9	0.032*
6-10 years	13.0±3.1		8.0±1.9		5.0±1.9	
11-15 years	14.2±3.3		8.5±1.9		5.9±2.1	
16-20 years	13.2±3.1		7.9±2.1		5.2±1.9	
>20 years	13.4±3.5		8.1±2.1		5.3±2.0	
<i>Diabetes related complications</i>						
Yes	13.2±3.3	0.237	8.0±2.1	0.814	5.2±1.9	0.143
No	13.5±3.2		8.1±1.9		5.4±2.1	
<i>Family history of diabetes mellitus</i>						
Yes	13.5±3.2	0.038*	8.0±2.0	0.778	5.5±2.0	0.002*
No	12.8±3.4		8.0±2.1		4.8±2.1	
<i>Compliance with medication</i>						
Yes	13.4±3.3	0.313	8.1±2.0	0.095	5.3±2.0	0.796
No	12.8±2.9		7.6±1.8		5.2±1.9	
<i>Glucometer use</i>						
Yes	13.5±3.3	0.002*	8.1±2.0	0.04*	5.4±2.0	0.006*
No	12.0±3.0		7.5±2.1		4.5±1.9	
<i>Wearing medical shoes</i>						
Yes	13.6±3.3	0.023*	8.2±2.0	0.032*	5.4±2.0	0.043*
No	13.0±3.1		7.9±2.0		5.1±2.0	
<i>Regular in follow ups</i>						
Yes	13.4±3.3	0.203	8.1±2.0	0.137	5.3±2.0	0.651
No	12.9±2.8		7.7±2.0		5.2±1.9	
<i>Use of Herbal</i>						
Yes	13.4±3.1	0.59	8.1±1.9	0.669	5.3±1.9	0.839
No	13.3±3.3		8.0±2.1		5.3±2.0	

\*Statistical significant value (p-values were obtained by Kruskal-Wallis Test or Mann-Whitney Test depending on the variable)



**Figure 1** - Level of knowledge according to each part of Diabetes Knowledge Test 2.

duration and family history were significantly associated with GDKT ( $p=0.023$  for the diabetes duration and  $p=0.038$  for the family history) and IUP ( $p=0.032$  for the diabetes duration and  $p=0.002$  for the family history) (Table 2).

There was not a significant difference in the knowledge scores between men and women ( $p=0.522$ ). No significant difference was found for rest of the variables (Table 2).

**Dietary conceptions.** This study found that patients had dietary misconceptions as noted from questions 1-4, 7, and 8 with average correct answers of 37.9%. Questions 3 and 4 were the most incorrectly answered (70.0% for question 3 and 75.5% for question 4) while questions 6 and 9 were the most correctly answered (89.0% for question 6 and 82.9% for question 9) (Appendix 1).

**Discussion.** The result of the study presented impressive results with 70.8% of diabetic patients having average (66.1%) and high (4.7%) levels of diabetes knowledge. In Table 3 we have presented a comparison of the present study with previous studies that used DKT and found almost similar results in Kuwait, Zimbabwe, Australia, Greece and USA studies, however our results were different than Nigerian studies.<sup>15-19,20,21</sup> Indian studies had a knowledge score of  $45.0\% \pm 12.1\%$  and Turkish studies had a knowledge score of  $68.3\% \pm 16.1\%$ , but they used different instruments to measure the knowledge.<sup>22,23</sup>

Similar to our study, other researchers have reported better knowledge and significant association with younger age, high educational level, longer duration of diabetes, and positive family history of diabetes, but not with gender or marital status.<sup>15-18,21,23-25</sup> Unlike our study, other researcher reported significant association with smoking and diabetes related complications but not with age, educational level, or family history of diabetes.<sup>15,16,21,23</sup>

**Table 3** - Comparison of present study with previous studies that used DKT.

Country	Version of DKT	GDKT	GKP	IUP
		Mean±SD		
Present Study	DKT2	57.8%±13.3%	57.8%±13.6%	57.8%±21.1%
Kuwait <sup>15</sup>	DKT1	58.9%±22.1%	61.6%±22.1%	54.7%±22.7%
Zimbabwe <sup>16</sup>	DKT1	63.1%±14.2%	63.8%±15.2%	62.1%±19.7%
Australia <sup>17</sup>	DKT1	61.7%±17.2%	-	-
Greek <sup>18</sup>	DKT1	-	59.6%±15.8%	-
USA <sup>19</sup>	DKT1	-	63.5%±0.2%	-
Nigeria <sup>21</sup>	DKT1	-	39.5%±16.7%	-
Nigeria <sup>20</sup>	DKT1	-	44.3%±15.7%	-

GDKT - global DKT, GKP - general knowledge part, IUP - insulin use part

One study conducted in Makkah more than 15 years ago, with a sample size of 1,039 diabetic subjects, found that 68.7% had dietary misconceptions. Our study's dietary items showed a decrease in dietary misconception (62.1%), but most items were still incorrectly answered.<sup>26</sup>

It is important to mention 2 key points: 1) all Saudi citizens are treated for free in government healthcare institutions, including primary healthcare centers and hospitals (some of them have specific diabetic centers). 2) Saudi citizens get free education from primary school until university in governmental institutions in Saudi Arabia; this is an important point since we found that education is the most significant factor ( $p<0.001$ ) in this study. From all of these facilities, only 4.7% had a high level and about one-third of the patients had a low level of diabetes knowledge.

Some of the limitations of this study is that it excluded private clinics and hospitals, their results may be different. Also, the study cannot be generalized to Saudi Arabia because it is limited to one city and based on non-probability technique.

In conclusion, patients' knowledge regarding diabetes was found poor in this study. Hence it is recommended that health care providers should pay more attention to diabetes education, especially with respect to dietary concepts. We are strongly advising researchers and physicians in Saudi Arabia to do similar research to determine the level of diabetes knowledge in their fields, to get a more comprehensive picture of their patients' knowledge of diabetes. The next study should examine the reasons associated with the low frequency of high knowledge; is it due to physician's activity, the healthcare system, the patients, or a combination of



all? Researchers who are planning to do similar studies should explore this question. Finally, we suggest setting the DKT2 score range for low, average, and high levels of diabetes knowledge so it is easier when speaking to non-medical people; for researchers, it would be more reliable when comparing different studies that use DKT2 rather than developing their own individual scales.

**Acknowledgment.** *The authors thank all patients, primary healthcare centers and hospitals for their effective contribution to the success of this study. Special thanks to Diabetes center at Al-Noor Hospital and their staff.*

## References

- World Health Organization. World Diabetes Day 2015 2015.
- International Diabetes Federation. IDF Diabetes Atlas. 7th ed. Brussels (Belgium): International Diabetes Federation; 2015.
- Powers MA, Bardsley J, Cypress M, Duker P, Funnell MM, Hess Fischl A, et al. Diabetes Self-management Education and Support in Type 2 Diabetes: A Joint Position Statement of the American Diabetes Association, the American Association of Diabetes Educators, and the Academy of Nutrition and Dietetics. *Diabetes Care* 2015; 38: 1372-1382.
- American Diabetes A. 1. Promoting Health and Reducing Disparities in Populations. *Diabetes Care* 2017; 40: S6-S10.
- Weaver RG, Hemmelgarn BR, Rabi DM, Sargious PM, Edwards AL, Manns BJ, et al. Association between participation in a brief diabetes education programme and glycaemic control in adults with newly diagnosed diabetes. *Diabet Med* 2014; 31: 1610-1614.
- Brunisholz KD, Briot P, Hamilton S, Joy EA, Lomax M, Barton N, et al. Diabetes self-management education improves quality of care and clinical outcomes determined by a diabetes bundle measure. *J Multidiscip Healthc* 2014; 7: 533-542.
- Steinsbekk A, Rygg LO, Lisulo M, Rise MB, Fretheim A. Group based diabetes self-management education compared to routine treatment for people with type 2 diabetes mellitus. A systematic review with meta-analysis. *BMC Health Serv Res* 2012; 12: 213.
- Duncan I, Birkmeyer C, Coughlin S, Li QE, Sherr D, Boren S. Assessing the value of diabetes education. *Diabetes Educ* 2009; 35: 752-760.
- Ellis SE, Speroff T, Dittus RS, Brown A, Pichert JW, Elasy TA. Diabetes patient education: a meta-analysis and meta-regression. *Patient Educ Couns* 2004; 52: 97-105.
- Norris SL, Lau J, Smith SJ, Schmid CH, Engelgau MM. Self-management education for adults with type 2 diabetes: a meta-analysis of the effect on glycemic control. *Diabetes Care* 2002; 25: 1159-1171.
- Fan L, Sidani S. Effectiveness of Diabetes Self-management Education Intervention Elements: A Meta-analysis. *Canadian Journal of Diabetes* 2009; 33: 18-26.
- Fitzgerald JT, Funnell MM, Hess GE, Barr PA, Anderson RM, Hiss RG, et al. The reliability and validity of a brief diabetes knowledge test. *Diabetes Care* 1998; 21: 706-710.
- Fitzgerald JT, Funnell MM, Anderson RM, Nwankwo R, Stansfield RB, Piatt GA. Validation of the Revised Brief Diabetes Knowledge Test (DKT2). *Diabetes Educ* 2016; 42: 178-187.
- Dawson AZ, Walker RJ, Egede LE. Differential Relationships Between Diabetes Knowledge Scales and Diabetes Outcomes. *Diabetes Educ* 2017; 43: 360-366.
- Al-Adsani AM, Moussa MA, Al-Jasem LI, Abdella NA, Al-Hamad NM. The level and determinants of diabetes knowledge in Kuwaiti adults with type 2 diabetes. *Diabetes Metab* 2009; 35: 121-128.
- Mufunda E, Wikby K, Bjorn A, Hjelm K. Level and determinants of diabetes knowledge in patients with diabetes in Zimbabwe: a cross-sectional study. *Pan Afr Med J* 2012; 13: 78.
- Fenwick EK, Xie J, Rees G, Finger RP, Lamoureux EL. Factors associated with knowledge of diabetes in patients with type 2 diabetes using the Diabetes Knowledge Test validated with Rasch analysis. *PLoS One* 2013; 8: e80593.
- Poulimeneas D, Grammatikopoulou MG, Bougioukli V, Iosifidou P, Vasiloglou MF, Gerama MA, et al. Diabetes knowledge among Greek Type 2 Diabetes Mellitus patients. *Endocrinol Nutr* 2016; 63: 320-326.
- Vivian EM, Ejebe IH. Identifying knowledge deficits of food insecure patients with diabetes. *Curr Diabetes Rev* 2014; 10: 402-406.
- Jasper US, Ogundunmade BG, Opara MC, Akinrolie O, Pyiki EB, Umar A. Determinants of diabetes knowledge in a cohort of Nigerian diabetics. *J Diabetes Metab Disord* 2014; 13: 39.
- Odili VU, Isiboge PD, Eregie A. Patients' Knowledge of Diabetes Mellitus in a Nigerian City. *Tropical Journal of Pharmaceutical Research* 2011; 10: 637-642.
- Mehta NV, Trivedi M, Maldonado LE, Saxena D, Humphries DL. Diabetes knowledge and self-efficacy among rural women in Gujarat, India. *Rural and Remote Health* 2016; 16: 3629.
- Gunay T, Ulusel B, Velipasaoglu S, Unal B, Ucku R, Ozgener N. Factors affecting adult knowledge of diabetes in Narlidere Health District, Turkey. *Acta Diabetol* 2006; 43: 142-147.
- Murata GH, Shah JH, Adam KD, Wendel CS, Bokhari SU, Solvas PA, et al. Factors affecting diabetes knowledge in Type 2 diabetic veterans. *Diabetologia* 2003; 46: 1170-1178.
- Bruce DG, Davis WA, Cull CA, Davis TM. Diabetes education and knowledge in patients with type 2 diabetes from the community: the Fremantle Diabetes Study. *J Diabetes Complications* 2003; 17: 82-89.
- Al-Saeedi M, Elzubier AG, Al-Dawood KM, Bahnasi AA. Dietary misconceptions among diabetic patients in makka city, saudi arabia. *J Family Community Med* 2002; 9: 41-47.

**Appendix 1** - Questions of Diabetes Knowledge Test 2 and answers according to patients.

Diabetes Knowledge Test Questions	Answers n (%)	No answer n (%)
<b>1. The diabetes diet is:</b>		
a. The way most Saudi people eat	232 (31.2)	
b. A healthy diet for most people*	449 (60.3)	4 (0.5)
c. Too high in carbohydrate for most people	32 (4.3)	
d. Too high in protein for most people	27 (3.6)	
<b>2. Which of the following is highest in carbohydrate?</b>		
a. Baked chicken	102 (13.7)	
b. Swiss cheese	88 (11.8)	10 (1.3)
c. Baked potato*	294 (39.5)	
d. Peanut butter	250 (33.6)	
<b>3. Which of the following is highest in fat?</b>		
a. Low fat (2%) milk*	223 (30.0)	
b. Orange juice	29 (3.9)	17 (2.3)
c. Corn	376 (50.5)	
d. Honey	99 (13.3)	
<b>4. Which of the following is a "free food"?</b>		
a. Any unsweetened food	206 (27.7)	
b. Any food that has "fat free" on the label	118 (15.9)	5 (0.7)
c. Any food that has "sugar free" on the label	233 (31.3)	
d. Any food that has less than 20 calories per serving*	182 (24.5)	
<b>5. A1C is a measure of your average blood glucose level for the past:</b>		
a. Day	61 (8.2)	
b. Week	102 (13.7)	21 (2.8)
c. 6-12 weeks*	384 (51.6)	
d. 6 months	176 (23.7)	
<b>6. Which is the best method for home glucose testing?</b>		
a. Urine testing	8 (1.1)	0 (0.0)
b. Blood testing*	662 (89.0)	
c. Both are equally good	74 (9.9)	
<b>7. What effect does unsweetened fruit juice have on blood glucose?</b>		
a. Lowers it	92 (12.4)	5 (0.7)
b. Raises it*	283 (38.0)	
c. Has no effect	364 (48.9)	
<b>8. Which should not be used to treat a low blood glucose?</b>		
a. 3 hard candies	201 (27.0)	
b. 1/2 cup orange juice	113 (15.2)	6 (0.8)
c. 1 cup diet soft drink*	262 (35.2)	
d. 1 cup skim milk	162 (21.8)	
<b>9. For a person in good control, what effect does exercise have on blood glucose?</b>		
a. Lowers it*	617 (82.9)	10 (1.3)
b. Raises it	34 (4.6)	
c. Has no effect	83 (11.2)	
<b>10. What effect will an infection most likely have on blood glucose?</b>		
a. Lowers it	62 (8.3)	17 (2.3)
b. Raises it*	477 (64.1)	
c. Has no effect	188 (25.3)	
<b>11. The best way to take care of your feet is to:</b>		
a. Look at and wash them each day*	491 (66.0)	
b. Massage them with alcohol each day	90 (12.1)	7 (0.9)
c. Soak them for 1 hour each day	46 (6.2)	
d. Buy shoes a size larger than usual	110 (14.8)	
<b>12. Eating foods lower in fat decreases your risk for:</b>		
a. Nerve disease	45 (6.0)	
b. Kidney disease	100 (13.4)	5 (0.7)
c. Heart disease*	554 (74.5)	
d. Eye disease	40 (5.4)	

**Appendix 1** - Questions of Diabetes Knowledge Test 2 and answers according to patients (continued).

Diabetes Knowledge Test Questions	Answers n (%)	No answers n (%)
<b>13. Numbness and tingling may be symptoms of:</b>		
a. kidney disease	80 (10.8)	
b. nerve disease*	591 (79.4)	14 (1.9)
c. eye disease	27 (3.6)	
d. liver disease	32 (4.3)	
<b>14. Which of the following is usually not associated with diabetes:</b>		
a. vision problems	47 (6.3)	
b. kidney problems	77 (10.3)	9 (1.2)
c. nerve problems	103 (13.8)	
d. lung problems*	508 (68.3)	
<b>15. Signs of ketoacidosis (DKA) include:</b>		
a. shakiness	127 (17.1)	
b. sweating	185 (24.9)	38 (5.1)
c. vomiting*	274 (36.8)	
d. low blood glucose	120 (16.0)	
<b>16. If you are sick with the flu, you should:</b>		
a. Take less insulin	93 (12.5)	
b. Drink less liquids	145 (19.5)	9 (1.2)
c. Eat more proteins	53 (7.1)	
d. Test blood glucose more often*	444 (59.7)	
<b>17. If you have taken rapid-acting insulin, you are most likely to have a low blood glucose reaction in:</b>		
a. Less than 2 hours*	538 (72.3)	
b. 3-5 hours	133 (17.9)	24 (3.2)
c. 6-12 hours	41 (5.5)	
d. More than 13 hours	8 (1.1)	
<b>18. You realize just before lunch that you forgot to take your insulin at breakfast. What should you do now?</b>		
a. Skip lunch to lower your blood glucose	74 (9.9)	
b. Take the insulin that you usually take at breakfast	303 (40.7)	15 (2.0)
c. Take twice as much insulin as you usually take at breakfast	40 (5.4)	
d. Check your blood glucose level to decide how much insulin to take*	312 (41.9)	
<b>19. If you are beginning to have a low blood glucose reaction, you should:</b>		
a. exercise	31 (4.2)	
b. lie down and rest	109 (14.7)	2 (0.3)
c. drink some juice*	547 (73.5)	
d. take rapid-acting insulin	55 (7.4)	
<b>20. A low blood glucose reaction may be caused by:</b>		
a. too much insulin*	440 (59.1)	
b. too little insulin	80 (10.8)	4 (0.5)
c. too much food	135 (18.1)	
d. too little exercise	85 (11.4)	
<b>21. If you take your morning insulin but skip breakfast, your blood glucose level will usually:</b>		
a. increase	90 (12.1)	
b. decrease*	579 (77.8)	25 (3.4)
c. remain the same	50 (6.7)	
<b>22. High blood glucose may be caused by:</b>		
a. not enough insulin*	382 (51.3)	
b. skipping meals	129 (17.3)	9 (1.2)
c. delaying your snack	62 (8.3)	
d. skipping your exercise	162 (21.8)	
<b>23. A low blood glucose reaction may be caused by:</b>		
a. heavy exercise*	387 (52.0)	
b. infection	208 (28.0)	19 (2.6)
c. overeating	99 (13.3)	
d. not taking your insulin	31 (4.2)	

\*The correct answer