ABSTRACT

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±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.

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Diabetes is a worldwide problem. Approximately 350–415 million people worldwide have diabetes. 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. Four out of 10 adults with diabetes in the Middle East and North Africa are undiagnosed. 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. Diabetes self-management education (DSME) “is the process of facilitating the knowledge, skills, and abilities necessary for diabetes self-care”. Also, diabetes education minimizes the risk of short- and long-term complications and improves health outcomes and quality of care. 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. 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-administered Diabetes Knowledge Test 2 (DKT2), was used in this study, which is an updated version of DKT (we called it DKT1). 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. Diabetes Knowledge Test is significantly associated with general diet and foot care according to one previous study. 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 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 (%) |
| Gender | | |
| Male | 350 (47.0) | 109 (14.6) |
| Female | 285 (38.4) | |
| Age | | |
| <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) | |
| Marital status | | |
| Single | 102 (13.7) | 161 (21.6) |
| Married | 481 (64.7) | |
| Educational level | | |
| 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) | |
| Smoking | | |
| Yes | 104 (14.0) | 172 (23.1) |
| No | 468 (62.9) | |
| Physical activity | | |
| Yes | 253 (34.0) | 153 (20.6) |
| No | 338 (45.4) | |
| Duration of diabetes | | |
| 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) | |
| Diabetes related complications | | |
| Yes | 341 (45.8) | 169 (22.7) |
| No | 234 (31.5) | |
| Family history of DM | | |
| Yes | 425 (57.1) | 159 (21.4) |
| No | 160 (21.5) | |
| Compliance with medication | | |
| Yes | 545 (73.3) | 152 (20.4) |
| No | 47 (6.3) | |
| Glucometer use | | |
| Yes | 541 (72.7) | 151 (20.3) |
| No | 52 (7.0) | |
| Wearing medical shoes | | |
| Yes | 298 (40.1) | 157 (21.1) |
| No | 289 (38.8) | |
| Regular in follow ups | | |
| Yes | 514 (69.1) | 160 (21.5) |
| No | 70 (9.4) | |
| Use of herbal | | |
| 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                      | Global DKT Score | Diabetes Knowledge Test | Insulin use part |
|--------------------------------|------------------|-------------------------|------------------|
|                                | Mean±S.D         | General Knowledge Part  | Mean±SD          | P-value | Mean±SD          | P-value |
|                                |                  | Mean±SD                 |                  |         |                  |         |
|                                | **P-value**      | **P-value**             | **P-value**      |         | **P-value**      |         |
| **Gender**                     |                  |                         |                  |         |                  |         |
| Male                           | 13.4±3.3         | 8.1±2.0                 | 5.3±1.9          | 0.522   | 0.903            | 0.245   |
| Female                         | 13.2±3.2         | 8.0±2.0                 | 5.2±2.0          |         |                  |         |
| **Age**                        |                  |                         |                  |         |                  |         |
| <36                            | 14.1±3.7         | 8.3±2.1                 | 5.8±2.2          | 0.039*  | 8.0±2.0          | 0.816   | 5.3±1.8          | 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          |         |                  |         |
| **Marital status**             |                  |                         |                  |         |                  |         |
| Single                         | 13.7±3.7         | 8.2±2.1                 | 5.5±2.2          | 0.264   | 8.1±2.0          | 0.755   | 5.2±1.9          | 0.231   |
| Married                        | 13.3±3.1         | 8.1±2.0                 |                  |         |                  |         |
| **Educational level**          |                  |                         |                  |         |                  |         |
| Primary School                 | 12.3±2.7         | 7.8±1.8                 | 4.7±1.9          | 0.001*  | 8.2±1.6          | 0.001*  | 5.3±1.8          | 0.001*  |
| Elementary School              | 13.4±2.5         | 8.2±1.6                 | 5.0±2.0          |         |                  |         |
| High School                    | 12.5±3.3         | 7.5±2.0                 | 6.0±1.9          |         |                  |         |
| University                     | 14.8±3.3         | 8.8±2.0                 | 4.6±1.8          |         |                  |         |
| Not Educated                   | 12.3±2.9         | 7.7±2.0                 |                  |         |                  |         |
| **Smoking**                    |                  |                         |                  |         |                  |         |
| Yes                            | 13.1±3.3         | 7.8±2.1                 | 5.3±2.0          | 0.407   | 8.1±2.0          | 0.199   | 5.3±2.0          | 0.934   |
| No                             | 13.4±3.2         | 8.1±2.0                 | 5.3±2.0          |         |                  |         |
| **Physical activity**          |                  |                         |                  |         |                  |         |
| Yes                            | 13.3±3.4         | 8.0±2.0                 | 5.3±2.0          | 0.489   | 8.0±2.0          | 0.835   | 5.2±1.9          | 0.252   |
| No                             | 13.2±3.1         | 8.0±2.0                 |                  |         |                  |         |
| **Duration of diabetes**       |                  |                         |                  |         |                  |         |
| 5 years or less                | 13.0±3.3         | 7.8±2.1                 | 5.2±1.9          | 0.023*  | 8.0±1.9          | 0.09    | 5.0±1.9          | 0.032*  |
| 6-10 years                     | 13.0±3.1         | 8.4±2.0                 | 5.5±2.0          |         |                  |         |
| 11-15 years                    | 14.2±3.3         | 8.5±1.9                 | 6.1±1.9          |         |                  |         |
| 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          |         |                  |         |
| **Diabetes related complications** |               |                         |                  |         |                  |         |
| Yes                            | 13.2±3.3         | 8.0±2.1                 | 5.2±1.9          | 0.237   | 8.1±1.9          | 0.814   | 5.4±2.1          | 0.143   |
| No                             | 13.5±3.2         | 8.1±1.9                 |                  |         |                  |         |
| **Family history of diabetes mellitus** |            |                         |                  |         |                  |         |
| Yes                            | 13.5±3.2         | 8.0±2.0                 | 5.5±2.0          | 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          |         |                  |         |
| **Compliance with medication** |                  |                         |                  |         |                  |         |
| Yes                            | 13.4±3.3         | 8.1±2.0                 | 5.3±2.0          | 0.313   | 7.6±1.8          | 0.095   | 5.2±1.9          | 0.796   |
| No                             | 12.8±2.9         | 7.6±1.8                 |                  |         |                  |         |
| **Glucometer use**             |                  |                         |                  |         |                  |         |
| Yes                            | 13.5±3.3         | 8.1±2.0                 | 5.4±2.0          | 0.002*  | 8.1±2.0          | 0.04*   | 4.5±1.9          | 0.006*  |
| No                             | 12.0±3.0         | 7.5±2.1                 |                  |         |                  |         |
| **Wearing medical shoes**      |                  |                         |                  |         |                  |         |
| Yes                            | 13.6±3.3         | 8.2±2.0                 | 5.4±2.0          | 0.023*  | 8.2±2.0          | 0.032*  | 5.1±2.0          | 0.043*  |
| No                             | 13.0±3.1         | 7.9±2.0                 |                  |         |                  |         |
| **Regular in follow ups**      |                  |                         |                  |         |                  |         |
| Yes                            | 13.4±3.3         | 8.1±2.0                 | 5.3±2.0          | 0.203   | 7.7±2.0          | 0.137   | 5.2±1.9          | 0.651   |
| No                             | 12.9±2.8         | 7.7±2.0                 |                  |         |                  |         |
| **Use of Herbal**              |                  |                         |                  |         |                  |         |
| Yes                            | 13.4±3.1         | 8.1±1.9                 | 5.3±1.9          | 0.59    | 8.0±2.1          | 0.669   | 5.3±2.0          | 0.839   |
| No                             | 13.3±3.3         | 8.0±2.1                 |                  |         |                  |         |

*Statistical significant value (P-values were obtained by Kruskal-Wallis Test or Mann-Whitney Test depending on the variable)
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.\(^{15-19,20}\) Indian studies had a knowledge score of 45.0%±12.1% and Turkish studies had a knowledge score of 68.3%±16.1%, but they used different instruments to measure the knowledge.\(^{22,23}\)

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.\(^{15-18,21-25}\) 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.\(^{15,16,21,23}\)

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.\(^{26}\)

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

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

| Country | Version of DKT | GDKT $\pm$SD | GKP $\pm$SD | IUP $\pm$SD |
|---------|----------------|--------------|--------------|--------------|
| Present Study | DKT2 | 57.8%±13.3% | 57.8%±13.6% | 57.8%±21.1% |
| Kuwait\(^{15}\) | DKT1 | 58.9%±22.1% | 61.6%±22.1% | 54.7%±22.7% |
| Zimbabwe\(^{26}\) | DKT1 | 63.1%±14.2% | 63.8%±15.2% | 62.1%±19.7% |
| Australia\(^{27}\) | DKT1 | 61.7%±17.2% | - | - |
| Greek\(^{28}\) | DKT1 | - | 59.6%±15.8% | - |
| USA\(^{19}\) | DKT1 | - | 63.5%±0.2% | - |
| Nigeria\(^{21}\) | DKT1 | - | 39.5%±16.7% | - |
| Nigeria\(^{20}\) | DKT1 | - | 44.3%±15.7% | - |

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

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

| Diabetes Knowledge Test Questions | Answers n (%) | No answer n (%) |
|-----------------------------------|--------------|----------------|
| 1. The diabetes diet is:          |              |                |
| a. The way most Saudi people eat  | 232 (31.2)   | 449 (60.3)     |
| b. A healthy diet for most people | 32 (4.3)     | 32 (4.3)       |
| c. Too high in carbohydrate for most people | 27 (3.6) | 398 (52.9)     |
| 2. Which of the following is highest in carbohydrate? |          |                |
| a. Baked chicken                  | 102 (13.7)   | 88 (11.8)      |
| b. Swiss cheese                   | 294 (39.5)   | 250 (33.6)     |
| c. Baked potato*                  | 376 (50.5)   | 250 (33.6)     |
| d. Peanut butter                  |              |                |
| 3. Which of the following is highest in fat? |         |                |
| a. Low fat (2%) milk*             | 223 (30.0)   | 29 (3.9)       |
| b. Orange juice                   | 376 (50.5)   | 250 (33.6)     |
| c. Corn                           | 99 (13.3)    | 250 (33.6)     |
| d. Honey                          |              |                |
| 4. Which of the following is a “free food”? |       |                |
| a. Any unsweetened food           | 206 (27.7)   | 118 (15.9)     |
| b. Any food that has “fat free” on the label | 233 (31.3) | 118 (15.9)     |
| c. Any food that has “sugar free” on the label | 376 (50.5) | 250 (33.6)     |
| d. Any food that has less than 20 calories per serving* | 182 (24.3) | 118 (15.9)     |
| 5. A1C is a measure of your average blood glucose level for the past: | |                |
| a. Day                            | 61 (8.2)     | 662 (89.0)     |
| b. Week                           | 102 (13.7)   | 176 (23.7)     |
| c. 6-12 weeks*                    | 384 (51.6)   | 176 (23.7)     |
| d. 6 months                       |              |                |
| 6. Which is the best method for home glucose testing? | |                |
| a. Urine testing                  | 8 (1.1)      | 74 (9.9)       |
| b. Blood testing*                 | 662 (89.0)   | 0 (0.0)        |
| c. Both are equally good          |              |                |
| 7. What effect does unsweetened fruit juice have on blood glucose? | |                |
| a. Lowers it                      | 92 (12.4)    | 283 (38.0)     |
| b. Raises it*                     | 364 (48.9)   | 176 (23.7)     |
| c. Has no effect                  |              |                |
| 8. Which should not be used to treat a low blood glucose? | |                |
| a. 5 hard candies                 | 201 (27.0)   | 113 (15.2)     |
| b. 1/2 cup orange juice           | 262 (35.2)   | 162 (21.8)     |
| c. 1 cup diet soft drink*         | 262 (35.2)   | 162 (21.8)     |
| d. 1 cup skim milk                |              |                |
| 9. For a person in good control, what effect does exercise have on blood glucose? | |                |
| a. Lowers it*                     | 617 (82.9)   | 34 (4.6)       |
| b. Raises it                      | 83 (11.2)    | 34 (4.6)       |
| c. Has no effect                  |              |                |
| 10. What effect will an infection most likely have on blood glucose? | |                |
| a. Lowers it                      | 62 (8.3)     | 477 (64.1)     |
| b. Raises it*                     | 188 (25.3)   | 17 (2.3)       |
| c. Has no effect                  |              |                |
| 11. The best way to take care of your feet is to: | |                |
| a. Look at and wash them each day* | 491 (66.0)   | 90 (12.1)      |
| b. Massage them with alcohol each day | 46 (6.2)    | 46 (6.2)       |
| c. Soak them for 1 hour each day  | 110 (14.8)   | 46 (6.2)       |
| d. Buy shoes a size larger than usual | 110 (14.8) | 46 (6.2)       |
| 12. Eating foods lower in fat decreases your risk for: | |                |
| a. Nerve disease                  | 45 (6.0)     | 100 (13.4)     |
| b. Kidney disease                 | 554 (74.5)   | 100 (13.4)     |
| c. Heart disease*                 | 40 (5.4)     | 100 (13.4)     |
### Patients' knowledge of diabetes … Zowgar et al

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

| Diabetes Knowledge Test Questions | Answers | No answers |
|----------------------------------|---------|------------|
|                                  | n (%)   | n (%)      |
| 13. Numbness and tingling may be symptoms of: |
| 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)  |            |
| 14. Which of the following is usually not associated with diabetes: |
| 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) |            |
| 15. Signs of ketoacidosis (DKA) include: |
| 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) |            |
| 16. If you are sick with the flu, you should: |
| 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) |            |
| 17. If you have taken rapid-acting insulin, you are most likely to have a low blood glucose reaction in: |
| 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)    |            |
| 18. You realize just before lunch that you forgot to take your insulin at breakfast. What should you do now? |
| a. Skip lunch to lower your blood glucose | 303 (40.7) |            |
| b. Take the insulin that you usually take at breakfast | 40 (5.4) | 15 (2.0) |
| c. Take twice as much insulin as you usually take at breakfast | 312 (41.9) |            |
| d. Check your blood glucose level to decide how much insulin to take* | 74 (9.9) |            |
| 19. If you are beginning to have a low blood glucose reaction, you should: |
| 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)  |            |
| 20. A low blood glucose reaction may be caused by: |
| a. too much insulin*             | 440 (59.1) |            |
| b. too little insulin            | 80 (10.8)  | 40 (5.5)   |
| c. too much food                 | 135 (18.1) |            |
| d. too little exercise           | 85 (11.4)  |            |
| 21. If you take your morning insulin but skip breakfast, your blood glucose level will usually: |
| a. increase                      | 90 (12.1)  | 25 (3.4)   |
| b. decrease*                     | 579 (77.8) |            |
| c. remain the same               | 50 (6.7)   |            |
| 22. High blood glucose may be caused by: |
| 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) |            |
| 23. A low blood glucose reaction may be caused by: |
| 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