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# Necessity and impact of patient education driven by pharmacist on the knowledge level of diabetic patients

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**ABSTRACT**: Turkey had the highest prevalence of diabetes in Europe and approximately 60,000 people pass away because of diabetes mellitus (DM) in Turkey each year. It is essential to provide education to increase knowledge and awareness regarding DM and to motivate patients for the disease management. The aim of this study was to assess the diabetes knowledge levels of diabetes patients using insulin and to evaluate the impact of education provided by pharmacist on their diabetes knowledge level. 64.8% of the participants were having diabetes for more than 5 years and about half of the participants (51.4%) even did not know what type of diabetes they had. 64.86% of the 37 patients have never had education regarding DM or medicines used for the treatment before. The participants' total mean score from Revised Diabetes Knowledge Test (DKT2) was significantly increased from 13.57±5.57 to 19.08±5.05 after patient education (p=0.000). Even though the number of diabetic patients is continually increasing, there is still a dearth of knowledge regarding DM in Turkey. On the other hand, the significant increase on the DKT2 score after education clearly demonstrates the effectiveness of pharmacist-driven education. Pharmacists have an impact to make important contributions on increasing patients' awareness and knowledge regarding DM. This was a cross-sectional, pilot study conducted among diabetes mellitus patients who came to a community pharmacy in Istanbul. A structured, validated questionnaire was used to assess diabetes knowledge level and impact of patient education by pharmacist.
**KEYWORDS**: Diabetes mellitus; patient education; knowledge; DKT2.

## 1. INTRODUCTION

American Diabetes Association (ADA) guideline describes diabetes mellitus (DM) as a complex, chronic disease that may require permanent medical care that includes versatile risk reduction methods other than glycemic control [1]. Poorly controlled diabetes causes various disorders in carbonhydrate, protein and fat metabolism [2]. This long-term metabolic disorder causes dysfunction and damage to the eye, kidney, cardiovascular function and nerve systems which are vital parts of our body [3].

Turkey had the highest prevalence of diabetes in Europe, at 11.1%, according to the 2019 Diabetes Atlas [4]. Amongst the 6.6 million diabetic patients in Europe, Turkey has the third highest diabetic population after Germany and the Russian Federation [4]. Approximately 60,000 people pass away because of diabetes in Turkey each year [5]. In addition, it is specified that about one-third of diabetics in Turkey have retinopathy, and more than half are diagnosed with at least two diabetes-related complications [4-6].

Self-care skills of patients are of great importance in the management of DM. Therefore, patient education is generally considered one of the essential components of DM management. Insufficient knowledge about diabetes affects self-care behavior negatively [4, 6, 7, 8]. Studies have shown that improvement in glycemic control reduces the complication rate, and evidence suggests that patients who are aware of their DM self-care have better long-term glycemic control. Considering that nearly half of individuals with diabetes are not even aware of their condition, it is critical to ensure that patients' knowledge, attitudes and practices are sufficient [1, 5, 8, 9]. The review of various studies indicate that patients need patient education by healthcare professionals to understand disease management better, regulate their diet, reduce symptoms and prevent complications [10, 11, 12]. As diabetes is a disease which continues for the lifetime, it is essential to provide education to the patients at the beginning of the disease and on a regular basis to increase knowledge and awareness regarding DM and to motivate for the management of DM [13].

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Pharmacists have a potential role to make a significant contribution to diabetes care. They can contribute significantly by assessing patients' overall health status, providing education to encourage patient self-care, assessing patients' adherence to treatment, monitoring outcomes and referring patients to other healthcare providers as necessary [14, 15]. Community pharmacists are often more accessible to patients with diabetes due to the extended hours of operation of many pharmacies. This frequent accessibility can lead to more frequent interactions between pharmacists and patients than other healthcare professionals.

The aim of this study is to assess the diabetes knowledge levels of diabetes patients using insulin, whether they got education regarding DM before and to evaluate the impact of education provided by pharmacist on their diabetes knowledge levels.

## 2. RESULTS

A total of 37 patients were enrolled, with a mean age of 58.43±6.61 years. 56.76% ( n=21) of them were male. 32.4% (n=12) of the patients were graduated from high school and 18.9% (n=7) of the patients were graduated from university. 64.8% (n=24) of the patients were diabetes mellitus patients for more than 5 years and more than half of the patients (64.9%) were using both insulin and oral medication for the treatment of DM (Table 1).

**Table 1.** Sociodemographic characteristics of patients

| **Variables** | | **Mean** | **SD** |
|---|---|---|---|
| | **Age (year)** | 58.43 | 6.61 |
| | | **Number (n)** | **Percentage (%)** |
| **Gender** | **Female** | 16 | 43.2 |
| | **Male** | 21 | 56.8 |
| **Educational Status** | **≤8 years of education** | 18 | 48.6 |
| | **>8 years of education** | 19 | 51.3 |
| **Occupation** | **Retired** | 16 | 43.2 |
| | **Housewife** | 6 | 16.2 |
| | **Artisan** | 5 | 13.5 |
| | **Worker** | 3 | 8.1 |
| | **Other** | 7 | 19 |
| **Cigarette usage** | **Smoker** | 19 | 51.4 |
| | **Non-smoker** | 18 | 48.7 |
| **Alcohol usage** | **Alcohol user** | 9 | 24.3 |
| | **Non- alcohol user** | 28 | 75.7 |
| **Types of diabetes mellitus** | **Type 1** | 2 | 5.4 |

| | | | |
|---|---|---|---|
| | **Type 2** | 16 | 43.2 |
| | **Not known** | 19 | 51.4 |
| **Duration of DM** | **5 years or less** | 13 | 35.1 |
| | **6 – 10 years** | 14 | 37.8 |
| | **11 years or more** | 10 | 27.0 |
| **Types of medicines used for DM treatment** | **Insulin** | 13 | 35.1 |
| | **Insulin + Tablet** | 24 | 64.9 |
| **Comorbid diseases** | **Hyperlipidemia** | 24 | 64.9 |
| | **Hypertension** | 23 | 62.2 |
| | **Cardiac diseases** | 16 | 43.2 |
| | **Cancer** | 4 | 10.1 |
| | **COPD** | 3 | 8.1 |
| | **Asthma** | 3 | 8.1 |
| | **Other** | 13 | 35.1 |

SD: Standart deviation

Majority of patients (89.19%) had comorbid disease and 70.27% (n=26) of the patients had a family history of DM. 64.86% (n=24) of the patients have never had education regarding DM or medicines used for the treatment before (Figure 1).

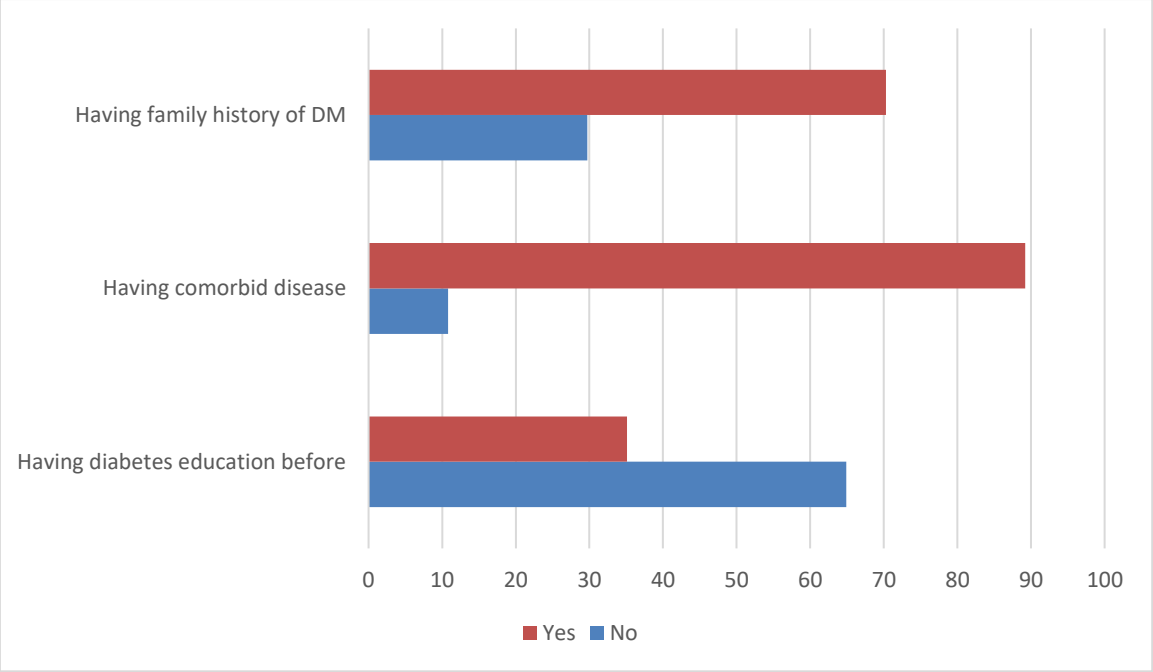


**Figure 1.** Diabetes health status of study participants

For evaluating the effect of the education, the answers given by the patients to the Revised Diabetes Knowledge Test (DKT2) before and after the education were compared and it was determined that there was an increase in the correct answers to all the questions in the DKT2 after the patient education (Table 2).

**Table 2.** Comparison of patients' answers to DKT2 before and after education

| Questions (right answers are highlighted)[a] | | Pre-Education n (%)[b] | Post-Education n (%) |
|---|---|---|---|
| 1) The diabetes diet is: | a. The way most Turkish people eat | 9 (24.32) | 5 (13.5) |
| | **b. A healthy diet for most people** | **24 (64.9)** | **30 (81.1)** |
| | c. Too high in carbonhydrate for most people | 2 (5.4) | 2 (5.4) |
| | d. Too high in protein for most people | 2 (5.4) | 0 (0) |
| 2) Which of the following is highest in carbonhydrate? | a. Baked chicken | 4 (10,81) | 1 (2.7) |
| | b. Swiss cheese | 3 (8.1) | 2 (5.4) |
| | **c. Baked potato** | **21 (56.8)** | **27 (73)** |
| | d. Peanut butter | 9 (24.3) | 7 (18.9) |
| 3) Which of the following is highest in fat? | **a. Low fat (2%) milk** | **26 (70.3)** | **28 (75.7)** |
| | b. Orange juice | 1 (2.7) | 2 (5.4) |
| | c. Corn | 6 (16.2) | 3 (8.1) |
| | d. Honey | 4 (10.8) | 4 (10.8) |
| | a. Any unsweetened food | 6 (16.2) | 3 (8.1) |

| | | | |
|---|---|---|---|
| 4) Which of the following is a "low energy food?" | b. Any food that has "fat free" on the label | 11 (29.7) | 5 (13.5) |
| | c. Any food that has "sugar free" on the label | 12 (32.4) | 2 (5.4) |
| | **d. Foods containing less than 40 kilocalories per 100 grams of solid foods and less than 20 kilocalories per 100 milliliters of liquid foods** | **8 (21.6)** | **27 (73)** |
| 5) A1C is a measure of your average blood glucose level for the past …… | a. Day | 6 (16.2) | 0 (0) |
| | b. Week | 9 (24.3) | 2 (5.4) |
| | **c. 6-12 weeks** | **6 (16.2)** | **34 (91.9)** |
| | d. 6 months | 16 (43.2) | 1 (2.7) |
| 6) Which is the best method for home glucose testing? | a. Urine testing | 1 (2.7) | 1 (2.7) |
| | **b. Blood testing** | **32 (86.4)** | **35 (94.6)** |
| | c. Both are equally good | 4 (10.8) | 1 (2.7) |
| 7) What effect does unsweetened fruit juice have on blood glucose? | a. Lowers it | 27 (73) | 1 (2.7) |
| | **b. Raises it** | **9 (24.3)** | **33 (89.2)** |
| | c. Has no effect | 1 (2.7) | 3 (8.1) |
| 8) Which should not be used to treat a low blood glucose? | a. 3 hard candies | 5 (13.5) | 1 (2.7) |
| | b. 1/2 cup orange juice | 1 (2.7) | 0 (0) |
| | **c. 1 cup diet soft drink** | **18 (48.7)** | **28 (75.7)** |
| | d. 1 cup skim milk | 13 (35.1) | 8 (21.6) |
| 9) For a person in good control, what effect does exercise have on blood glucose? | **a. Lowers it** | **25 (67.6)** | **31 (83.8)** |
| | b. Raises it | 1 (2.7) | 3 (8.1) |
| | c. Has no effect | 11 (29.7) | 3 (8.1) |
| 10) What effect will an infection most likely have on blood glucose? | a. Lowers it | 6 (16.2) | 1 (2.7) |
| | **b. Raises it** | **14 (37.8)** | **31 (83.8)** |
| | c. Has no effect | 17 (46) | 5 (13.5) |
| 11) The best way to take care of your feet is to: | **a. Look at and wash them each day** | **29 (78.4)** | **35 (94.6)** |
| | b. Massage them with alcohol each day | 0 (0) | 0 (0) |
| | c. Soak them for 1 hour each day | 8 (21.6) | 1 (2.7) |
| | d. Buy shoes a size larger than usual | 0 (0) | 1 (2.7) |
| 12) Eating foods lower in fat decreases your risk for: | a. Nerve disease | 3 (8.1) | 1 (2.7) |
| | b. Kidney disease | 3 (8.1) | 1 (2.7) |
| | **c. Heart disease** | **28 (75.7)** | **32 (86.5)** |
| | d. Eye disease | 3 (8.1) | 3 (8.1) |
| | a. Kidney disease | 7 (18.9) | 1 (2.7) |

| | | | |
|---|---|---|---|
| 13) Numbness and tingling may be symptoms of: | **b. Nerve disease** | **22 (59.5)** | **30 (81.1)** |
| | c. Eye disease | 2 (5.4) | 1 (2.7) |
| | d. Liver disease | 6 (16.2) | 5 (13.5) |
| 14) Which of the following is usually not associated with diabetes: | a. Eye disease | 2 (5.4) | 1 (2.7) |
| | b. Kidney disease | 5 (13.5) | 1 (2.7) |
| | c. Nerve disease | 5 (13.5) | 0 (0) |
| | **d. Lung disease** | **25 (67.6)** | **35 (94.6)** |
| 15) Signs of ketoacidosis (DKA) include: | a. Shakiness | 12 (32.4) | 4 (10.8) |
| | b. Sweating | 7 (18.9) | 4 (10.8) |
| | **c. Vomiting** | **3 (8.1)** | **22 (59.5)** |
| | d. Low blood glucose | 15 (40.5) | 7 (18.9) |
| 16) If you are sick with the flu, you should: | a. Take less insulin | 7 (18.9) | 2 (5.4) |
| | b. Drink less liquids | 2 (5.4) | 0 (0) |
| | c. Eat more proteins | 10 (27.0) | 4 (10.8) |
| | **d. Test blood glucose more often** | **18 (48.7)** | **31 (83.8)** |
| 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** | **28 (75.7)** | **32 (86.5)** |
| | b. 3-5 hours | 8 (21.6) | 5 (13.5) |
| | c. 6-12 hours | 1 (2.7) | 0 (0) |
| | d. More than 13 hours | 0 (0) | 0 (0) |
| 18) You realize just before lunch that you forgot to take your insulin at breakfast. What would you do? | a. Skip lunch to lower your blood glucose | 2 (5.4) | 0 (0) |
| | b. Take insulin that you usually take at breakfast | 3 (8.1) | 1 (2,7) |
| | c. Take twice as much insulin as you usually take at breakfast | 10 (27.0) | 5 (13,5) |
| | **d. Check your blood glucose level to decide how much insulin to take** | **22 (59.5)** | **31 (83.8)** |
| 19) If you are beginning to have a low blood glucose reaction, you should: | a. Exercise | 1 (2.7) | 0 (0) |
| | b. Lie down and rest | 4 (10.8) | 3 (8.1) |
| | **c. Drink some juice** | **31 (83.8)** | **34 (91.9)** |
| | d. Take rapid-acting insulin | 1 (2.7) | 0 (0) |
| 20) A low blood glucose reaction may be caused by: | **a. Too much insulin** | **26 (70.3)** | **29 (78.4)** |
| | b. Too little insulin | 2 (5.4) | 2 (5.4) |
| | c. Too much food | 2 (5.4) | 1 (2.7) |
| | d. Too little exercise | 7 (18.9) | 5 (13.5) |
| 21) If you take your morning insulin but skip breakfast, your blood glucose level will usually: | a. Increase | 2 (5.4) | 2 (5.4) |
| | **b. Decrease** | **30 (81.1)** | **30 (81.1)** |
| | c. Remain the same | 5 (13.5) | 5 (13.5) |

| | | | |
|---|---|---|---|
| 22) High blood glucose may be caused by: | **a. Not enough insulin** | **22 (59.5)** | **28 (75.7)** |
| | b. Skipping meals | 7 (18.9) | 4 (10.8) |
| | c. Delaying your snack | 4 (10.8) | 1 (2.7) |
| | d. Skipping your exercise | 4 (10.8) | 4 (10.8) |
| 23) A low blood glucose reaction may be caused by: | **a. Heavy exercise** | **17 (46)** | **25 (67.6)** |
| | b. Infection | 9 (24.3) | 7 (18.9) |
| | c. Overeating | 1 (2.7) | 0 (0) |
| | d. Not taking your insulin | 10 (27.0) | 5 (13.5) |

*Bold sentences are indicating the correct answers of the questions.

n: Number of participants.

The mean total score of the patients from DKT2 was significantly increased after patient education (Table 3).

**Table 3.** Comparison of total mean scores for DKT2 before and after education

| | Pre-test (Mean±SD) | Post-test (Mean±SD) | t | p |
|---|---|---|---|---|
| Revised Diabetes Knowledge Test Total Score | 13.57±5.57 | 19.08±5.05 | -8.152 | **.000** |

All of the patients' total mean score was increased from 13.57±5.57 to 19.08±5.05 after education. However, a statistically significant score difference was detected between some of the patients such as patients having 8 years or less education and patients having more than 8 years of education [18 (48.6%), 19 (51.3%) respectively], patients having type 1 DM and others [2 (5.4%), 16 (43.2%), 19 (51.4%), respectively] (Table 4).

**Table 4.** Distribution of total mean scores for DKT2 before and after education

| **Variables** | | **Revised Diabetes Knowledge Test Total Score Pre-test (Mean ± SD)** | t | p | **Revised Diabetes Knowledge Test Total Score Post-test (Mean ± SD)** | t | p |
|---|---|---|---|---|---|---|---|
| **Sex** | **Female** | 13.69 ± 5.76 | | | 18.88 ± 4.62 | | |
| | **Male** | 13.48 ± 5.56 | 0.113 | 0.91 | 19.24 ± 5.46 | -0.214 | 0.83 |
| **Education status** | **>8 years of education** | 16.47 ± 4.05 | 3.834 | 0.001 | 20.68 ± 3.38 | | |
| | **≤8 years of education** | 10.5 ± 5.37 | | | 17.39 ± 5.99 | 2.074 | **0.045** |
| **Duration of DM** | **5 years or less** | 13.62 ± 5.87 | | | 18.77 ± 6.25 | | |
| | **6 – 10 years** | 14.86 ± 5.64 | 0.936 | 0.40 | 19.14 ± 4.7 | 0.043 | 0.96 |
| | **11 years or more** | 11.7 ± 5.06 | | | 19.4 ± 4.2 | | |
| **Having family history of DM** | **Having family history of DM** | 13.62 ± 5.87 | | | 11.7 ± 5.06 | | |
| | **Not having family history of DM** | 14.86 ± 5.64 | -0.176 | 0.86 | 18.77 ± 6.25 | 1.137 | 0.26 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Types of diabetes mellitus** | **Type 1** | 13.5 ± 3.54 | | | 25 ± 7.07 | | |
| | **Type 2** | 15.94 ± 4.88 | 2.953 | 0.07 | 21.13 ± 1.5 | 6.074 | **0.006** |
| | **I don't know** | 11.58 ± 5.68 | | | 16.74 ± 5.73 | | |
| **Having diabetes education before** | **Having diabetes education before** | 17.08 ± 4.7 | 3.154 | 0.003 | 21.46 ± 1.33 | | |
| | **Not having diabetes education before** | 11.67 ± 5.12 | | | 17.79 ± 5.83 | 2.225 | **0.033** |
| **Types of medicine used for DM treatment** | **Insulin** | 11.62 ± 6.08 | -1.604 | 0.12 | 16.08 ± 5.94 | -2.933 | **0.006** |
| | **Insulin + Tablet** | 14.63 ± 5.09 | | | 20.71 ± 3.69 | | |

## 3. DISCUSSION

DM is one of the major illnesses on the list of the 21st century's global health emergencies. One of the most important factors in increasing the quality of life of diabetic patients to use their medications correctly and regularly and to manage their own health by paying attention to their diet. To successfully manage their treatment on a daily basis, these patients must gain the essential knowledge and abilities [16, 17]. Knowledge is a necessity to reach better compliance with medical treatment. According to a study conducted by Mohammadi, diabetes patients' knowledge and self-care management were deficient [10, 18]. Similarly with Mohammadi's study the knowledge of the patients in our study was not adequate. Even though the 64.8% (n=24) of the participants were having diabetes for more than 5 years, about half of the participants in our study (51.4%) did not know what type of diabetes they had.

Researches have shown that individuals with a family history of diabetes are more inclined to perceive a greater risk of developing the disease [19]. This shows that family history influences perceptions of illness risk, particularly in the case of diabetes [19]. Despite the fact that 70.27% of the patients in this study stated that they had diabetes in their family, no significant difference in knowledge level was found between patients who had a family history of DM and those who did not. Another remarkable point in our study is that diabetes is seen in spouses with a rate of 13.51%. This rate is very close to the rate of first-degree relatives such as mother (13.51%) and father (16.22%). This result is in line with the existing literature, as indicated by the study conducted by Jurj et al. It suggests that there is a similarity in lifestyle between spouses, which has the potential to impact the health of both individuals. Thus, health promotion strategies should aim to focus on shared lifestyle and risk factors that affect the health of both patients and their spouses by targeting the spouses of patients [20].

According to the findings in the literature, diabetes mellitus is a disease accompanied by many comorbidities [21]. In a study conducted on 405 type 2 DM patients by Sweileh et al., it was reported that 46.2% of the patients had hypertension and 36.8% of them had dyslipidemia as an additional disease to diabetes [22]. In another study conducted by İdiz et al., hypertension was reported as the first disease accompanying diabetes with a rate of 60.8% [23]. Similar to the literature, in our study, hyperlipidemia with a rate of 64.86% and hypertension with a rate of 62.16% were the most common comorbidities with diabetes.

Controlled and planned education can slow or stop the progression of diabetes, thereby minimizing the likelihood of diabetes complications. This improves the health status and quality of life of diabetic patients, while reducing the risk of disease-related morbidity and mortality [13]. When the literature is examined, the importance of pharmacists in diabetes management and education is clearly seen [24, 25]. In the study of the role of pharmacist in diabetes management by Krass et al. in Australia, significant improvements were seen in the diabetes service model in which pharmacists took part [24]. In our study, only 13.51% of the patients have received patient education from a pharmacist, others have received patient education from a physician or a nurse, and 64.86% of the patients stated that they have never received diabetes education from anyone else before. These results emphasize the need for pharmacists to assume a greater responsibility in educating patients with diabetes. By taking on a more prominent role in patient education, pharmacists can play a pivotal part in empowering individuals with diabetes to effectively manage their condition and minimize the risk of complications [25].

In this study, the most incorrectly answered question before the patient education was the one asking about the sign of diabetic ketoacidosis. 91.89% of the patients in our study gave an incorrect answer to this question. In Murata et al.'s study, the same question received the most incorrect answers from DM patients, with a percentage quite close to ours (87%). This is also an indication that the majority of individuals in both studies did not appear to understand what the term "ketoacidosis" meant. In addition, in the study of Murata et al., the question about the HbA1c test was answered incorrectly by 56%, while in our study, this question was the second most incorrectly answered question with an incorrect answer rate of 83.78% [26]. These results indicate a lack of knowledge in understanding the true purpose of the HbA1c test. However, the rate of correct responses to these questions exhibited a remarkable improvement after the patient education.

When the total score of the DKT2 obtained in our study is compared before and after the education, it supports the evidence in the literature that the level of diabetes knowledge will increase with pharmacist education. While the total score was 13.57±5.57 before the patient education, this number significantly increased to 19.08±5.05 after the patient education. Dağdelen's study, which aims to assess patients' knowledge level of diabetes and the impact of education, revealed a similar outcome. The study revealed that untrained patients had a total score of 10.68±5.20, whereas trained patients demonstrated a significantly higher score of 15.53±4.19 [27]. These findings highlight the positive impact of receiving proper patient education on patients' knowledge and understanding of diabetes management.

This study has some limitations. Firstly, due to time constraints we couldn't reach the calculated number of participants. Secondly the participants' medication adherence evaluation is missing. Further studies on larger groups are required to better evaluate the generalizability of the study.

## 4. CONCLUSION

Despite the fact that the number of diabetic patients is continually increasing worldwide, the data from this study supported important implications and shown that there is still a dearth of knowledge regarding DM reported by a moderate DKT2 score. On the other hand, the significant increase on the DKT2 score after education clearly demonstrates the effectiveness of pharmacist-driven educational interventions in improving patients' diabetes knowledge. As patients esteem the counselling provided by community pharmacists, interventions should aim to enhance awareness of DM and improve knowledge of this condition and its management through specialized patient education. This would get pharmacists especially effective in enhancing the health of their patients.

## 5. MATERIALS AND METHODS

### 5.1. Study design

This was a cross-sectional, pilot study designed to include diabetes mellitus patients aged between 18 and 65 who use insulin and came to a community pharmacy in Istanbul between 24/08/2022 and 24/01/2023. The aim of the study was explained to all patients individually and the patients were informed that participation was voluntary and assured of their anonymity and confidentiality of response. Questionnaires were administered face-to-face to patients who met the inclusion criteria and provided written consent to participate in the study. At the end of the questionnaire, a brief education on diabetes mellitus was provided to the participants, the content of which was: definition and symptoms of diabetes, diagnostic methods (fasting blood glucose, postprandial blood glucose and HbA1c test), diabetes control and healthy eating (protein, fat and carbohydrate balance, methods of reading the labels of food packages), relationship between physical activity and diabetes, diabetes treatment (insulin use and correct dosing, regular nutrition and timing in insulin therapy) and acute complications of diabetes (ketoacidosis and hypoglycemia). One month after the education, the questionnaire was repeated to measure the effect of the education.

### 5.2. Sample size

The sample size of this study was calculated to include at least 46 diabetic patients between the ages of 18-65, who came to a community pharmacy and used insulin, with a 95% confidence interval and ±10% precision. A total of 124 patients were invited to the study. 38 of these 124 patients were those who came to the pharmacy for the first time and others 86 patients were those who were already registered in the pharmacy system. Eighteen of the 38 patients who came to the pharmacy for the first time and 33 of the 86 patients registered in the pharmacy system agreed to participate in the study. Later 8 patients refused to join to the

second step of the study and 6 patients excluded due to missing data and finally the study is completed with 37 patients (Figure 2).

Inclusion criteria:

- Patients with DM who were between the ages of 18 and 65 and were using insulin.

Exclusion criteria:

- Patients not between the ages of 18 and 65.
- Patients who declined to participate in the study.

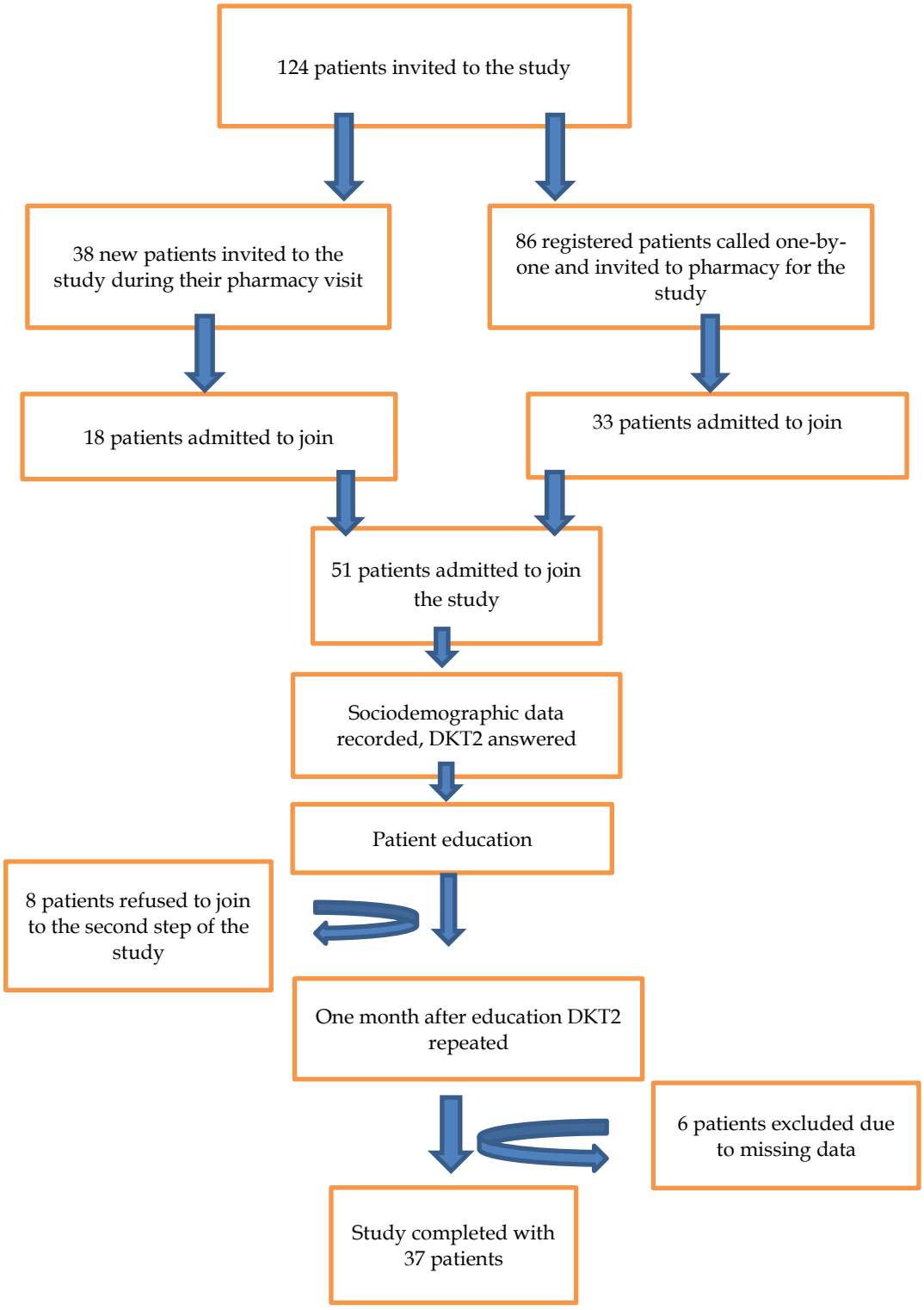

Figure 2. Flowchart of the study

### 5.3. Data collection

A questionnaire including 37 items and two parts was used as the data collection tool. In the first section, a volunteer data form which included 14 items was used to record sociodemographic data and disease information of the participants (age, gender, weight, height, education level, occupation, duration of disease, presence of other diabetic patients in the family and their degree of relation, other existing diseases and their durations, smoking and alcohol use, type of diabetes, medications used for diabetes, and whether the patient had previously received diabetes education). In the second part, the Turkish version of the Revised Diabetes Knowledge Test (DKT2) was administered to measure the diabetes knowledge level of the patients.

#### *5.3.1. Michigan Diabetes Research and Training Center's Revised Diabetes Knowledge Test*

The Michigan Diabetes Research and Training Center's Diabetes Knowledge Test was developed by Michigan Diabetes Research and Training Center in 1998 and later revised by Fitzgerald et al. in 2016 [28]. Revised Diabetes Knowledge Test (DKT2) consists of 23 questions. The first 14 questions measure general knowledge about diabetes, while the other 9 questions are specific to patients who use insulin. Each question has four answer choices, with only one correct answer. Correct and incorrect answers were scored for statistical analysis. Turkish validation of the DKT2 was performed by Cemile İdiz et al. and permission to use the scale was obtained from the researchers [23].

The scale was used twice, before and one month after the education. At the end of first survey, the education was provided by pharmacist. The education content was developed by the clinical pharmacist based on the literature. The score calculation of the scale was done by determining the number of correct answers before and after the education. The highest score that can be obtained from the test is 23. There are no pass/fail threshold and no ranges such as high, medium, low in the evaluation for the test, as it is used for comparisons such as pre- and post-education in different patient groups. This test includes questions related to diabetic nutrition, glucose measurement, the relationship between diabetes and exercise, diabetic complications and their management, and insulin usage.

### 5.4. Data analysis

Analyses were conducted using the SPSS version 22. All data were considered statistically significant at p-value<0.05 and 95% confidence interval. Categorical data were analyzed using frequency and percentage. Scores on DKT2 were examined using mean standard deviation. In the analysis of the data, t-test in related samples, t-test in independent samples and one-way analysis of variance were performed.

### 5.5. Ethical consideration

Ethical approval for the study was obtained from Acibadem Mehmet Ali Aydinlar University and Acibadem Healthcare Institutions Medical Research Ethics Committee (2022-13/04). The study was conducted in accordance with the institutional research committee's ethical standards and the 1964 Helsinki Declaration.

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## REFERENCES

[1] American Diabetes Association. Standards of medical care in diabetes-2022. Diabetes Care. 2022; 45(1): S1-S2. https://doi.org/10.2337/dc22-Sint

[2] American Diabetes Association. Diagnosis and classification of diabetes mellitus. Diabetes Care. 2014; 37(1):81-90. https://doi.org/10.2337/dc14-S081

[3] Thomas CC, Philipson LH. Update on diabetes classification. Med Clin North Am. 2015; 99(1): 1-16. https://doi.org/10.1016/j.mcna.2014.08.015

[4] Saeedi P, Salpea P, Karuranga S, Petersohn I, Malanda B, Gregg EW, Unwin N, Wild SH, Williams R. Mortality attributable to diabetes in 20–79 years old adults, 2019 estimates: Results from the International Diabetes Federation Diabetes Atlas, 9th edition. Diabetes Res Clin Pract. 2020; 162: 108086. https://doi.org/10.1016/j.diabres.2020.108086

[5] Burki T. Country in Focus: diabetes prevalence on the rise in Turkey. Lancet Diabetes Endocrinol. 2016; 4 (5): 391-2. https://doi.org/10.1016/S2213-8587(16)00090-5

[6] Satman I, Omer B, Tutuncu Y, Kalaca S, Gedik S, Dinccag N, Karsidag K, Genc S, Telci A, Canbaz B, Turker F, Yilmaz T, Cakir B, Tuomiletho J, TURDEP-II Study Group. Twelve-year trends in the prevalence and risk factors of diabetes and prediabetes in Turkish adults. Eur J Epidemiol. 2013; 28 (2):169–180. https://doi.org/10.1007/s10654-013-9771-5

[7] Yavuz KE, Erol S. Developing a diabetes knowledge scale for adults and its psychometric properties. Clin Exp Health Sci. 2022; 12(3): 711-718. https://doi.org/10.33808/clinexphealthsci.1014888

[8] Al-Maskari F, El-Sadig M, Al-Kaabi JM, Afandi B, Nagelkerke N, Yeatts KB. Knowledge, attitude and practices of diabetic patients in the United Arab Emirates. PLoS One. 2013; 8(1): e52857. https://doi.org/10.1371/journal.pone.0052857

[9] Duke SAS, Colagiuri S, Colagiuri R. Individual patient education for people with type 2 diabetes mellitus. Cochrane Database Syst Rev. 2009; 1(1): CD005268. https://doi.org/10.1002/14651858.CD005268.pub2

[10] Sami W, Ansari T, Butt NS, Hamid MRA. Effect of diet on type 2 diabetes mellitus: A review. Int J Health Sci (Qassim). 2017; 11(2): 65-71.

[11] Bohanny W, Wu VSF, Liu CY, Yeh SH, Tsay SL, Wang TJ. Health literacy, self-efficacy, and self-care behaviors in patients with type 2 diabetes mellitus. J Am Assoc Nurse Pract. 2013; 25(9): 495-502. https://doi.org/10.1111/1745-7599.12017

[12] Yılmaz Z, Sancar M, Okuyan B, Yeşildağ O, İzzettin FV. Impact of verbal and web-based patient education programs driven by clinical pharmacist on the adherence and illness perception of hypertensive patients. IJPER. 2020; 54(3s): s695-s704. https://doi.org/10.5530/ijper.54.3s.170

[13] Nazar CMJ, Bojerenu MM, Safdar M, Marwat J. Effectiveness of diabetes education and awareness of diabetes mellitus in combating diabetes in United Kingdom; a literature review. J Nephropharmacol. 2016; 5(2): 110-115.

[14] Campbell RK. Role of the pharmacist in diabetes management. Am J Health Syst Pharm. 2002; 59(9): 18-21. https://doi.org/10.1093/ajhp/59.suppl_9.S18

[15] Hughes JD, Wibowo Y, Sunderland B, Hoti K. The role of the pharmacist in the management of type 2 diabetes: current insights and future directions. Integr Pharm Res Pra. 2017; 6(1): 15-27. https://doi.org/10.2147/IPRP.S103783

[16] Fan W. Epidemiology in diabetes mellitus and cardiovascular disease. Cardiovasc Endocrinol. 2017; 6(1): 8-16. https://doi.org/10.1097/XCE.0000000000000116

[17] Funnell MM, Brown TL, Childs BP, Haas LB, Hosey GM, Jensen B, Maryniuk M, Peyrot M, Piette JD, Reader D, Siminerio LM, Weinger K, Weiss MA. National standards for diabetes self-management education. Diabetes Care. 2009; 32 (1): 87-94. https://doi.org/10.2337/dc09-S087

[18] Mohammadi S, Karim NA, Talib RA, Amani R. Knowledge, attitude and practices on diabetes among type 2 diabetic patients in Iran: A cross-sectional study. Sci J Public Health. 2015; 4(3): 520-524. https://doi.org/10.11648/j.sjph.20150304.20

[19] Choi J, Choi JY, Lee SA, Lee KM, Shin A, Oh J, Park J, Song M, Yang JJ, Lee JK, Kang D. Association between family history of diabetes and clusters of adherence to healthy behaviors: cross-sectional results from the Health Examinees-Gem (HEXA-G) study. BMJ Open. 2019; 9(6): e025477. https://doi.org/10.1136/bmjopen-2018-025477

[20] Jurj AL, Wen W, Li HL, Zheng W, Yang G, Xiang YB, Gao YT, Shu XO. Spousal correlations for lifestyle factors and selected diseases in Chinese couples. Ann Epidemiol. 2006; 16(4): 285-291. https://doi.org/10.1016/j.annepidem.2005.07.060

[21] Tsanani SE, Margalit A, Golan LN. Occurrence of comorbidities in newly diagnosed type 2 diabetes patients and their impact after 11 years' follow-up. Sci Rep. 2021; 11(1): 11071. https://doi.org/10.1038/s41598-021-90379-0

[22] Sweileh WM, Zyoud SH, Nab'a RJA, Deleg MI, Enaia MI, Nassar SM, Al-Jabi SW. Influence of patients' disease knowledge and beliefs about medicines on medication adherence: findings from a cross-sectional survey among patients with type 2 diabetes mellitus in Palestine. BMC Public Health. 2014; 14 (1): 94. https://doi.org/10.1186/1471-2458-14-94

[23] Idiz C, Celik S, Bağdemir E, Dişsiz M, Satman I. Turkish adaptation of Michigan Diabetes Research and Training Center's Revised Diabetes Knowledge Test and determination of factors affecting the knowledge level of diabetic individuals. Turk J Endocrinol Metab. 2020; 24(1): 38-46. https://doi.org/10.25179/tjem.2019-71974

[24] Krass I, Armour CL, Mitchell B, Brillant M, Dienaar R, Hughes J, Lau P, Peterson G,Stewart K, Taylor S, Wilkinson J. The pharmacy diabetes care program: assessment of a community pharmacy diabetes service model in Australia. Diabet Med. 2007; 24(6): 677-683. https://doi.org/10.1111/j.1464-5491.2007.02143.x

[25] Yılmaz Z, Al-Taie A. A cross sectional study of community pharmacists' self-reported disease knowledge and competence in the treatment of childhood autism spectrum disorder. Int J Clin Pharm. 2022. https://doi.org/10.1007/s11096-022-01530-4

[26] Murata GH, Shah JH, Adam KD, Wendel CS, Bokhari SU, Solvas PA, Hoffman RM, Duckworth WC. Factors affecting diabetes knowledge in type 2 diabetic veterans. Diabetologica. 2003; 46(8): 1170-1178. https://doi.org/10.1007/s00125-003-1161-1

[27] Dağdelen ZA. PhD Thesis. The awareness of diabetes mellitus in centrum of Aydın: Diabetes associated knowledge level and related factors. Department of Family Medicine, Faculty of Medicine, Adnan Menderes University, Aydın, Turkey, 2012.

[28] 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(2): 178-187. https://doi.org/10.1177/0145721715624968