Research Article

Open Access Journal

Assessing the Knowledge and Awareness of Self-Management among Diabetic Patients in Saudi Arabia

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Abstract

Background: The rate of diabetes mellitus (DM) around the world is increasing significantly, and is expected to upsurge to 578 million by 2030. According to World Health Organization (WHO), Saudi Arabia ranks the seventh in the world for the rate of DM. Thus, self-management is critical for controlling patient blood glucose levels and avoiding any serious complications. The aim of conducting this study was to measure the knowledge, and awareness of diabetic patients about the disease and perform self-management continuously.

Methods: This study was conducted in Saudi Arabia, using a questionnaire filled out by 204 male and female with DM, who participated in the study. A cross-sectional investigation was led to assess knowledge, learning, and regular monitoring and self-management.

Results: The result indicated that knowledge, attitudes, and practice were low, mild positive, and low respectively towards diabetic control and glucose monitoring among diabetic patients. 51% of the study participants had hyperglycemia, and about 16.7% used Glucophage as treatment. Although most of the participants 153 (75%) realized the importance of using a glucometer for monitoring their blood glucose levels and preventing further medical complications, few of them were following regular physical activity 73 (35.8%), a specific diet 62 (30.4%) and measuring the amount of daily intake of sugar 46 (22.5%).

Conclusion: The research showed that participants with DM had knowledge and awareness of their disease but they did not perform self-management appropriately, despite the popularity and ease of glucometer use. The ongoing study is being undertaken to evaluate the validity of this questionnaire and by extension their awareness of the test reliability and accuracy using different types of machines; glucometer, i-STAT system, and another lab analyzer.

Keywords: Awareness, Diabetes Mellitus, Type 2 diabetes, Monitoring, Glucometers.

INTRODUCTION

In 2019, the number of diabetic patients reached almost 436 million, according to the Saudi Ministry of Health, and the number of patients is expected to rise to 578 million by 2030 (Saudi Ministry of Health ,2021). Diabetes mellitus (DM) is a metabolic disorder that leads to rise in blood glucose levels (hyperglycemia), due to defects in insulin action, insulin secretion or both (Khan *et al.,* 2019). There are several types of diabetes mellitus such as Type 1 diabetes mellitus which is described by the American Diabetes Association as autoimmune β- cell disruption, as it typically causes total insulin deficiency, while type 2 diabetes mellitus as progressing β-cell insulin secretion decreased that often occurs as the result of insulin resistance (American Diabetes Association. 2019). Untreated diabetics patients' can cause several complications that are associated with long-term damage and organ dysfunction or failure, such as vascular disease, heart disease, kidney failure, diabetic neuropathy and other diseases (Khan *et al.,* 2019). Therefore, DM complications are divided into two main types; macrovascular (stroke, coronary artery disease and peripheral arterial disease) and microvascular (nephropathy, neuropathy, and retinopathy) that lead to decrease in life expectancy and thus increase the economic burden on the individual and society (Chawla, Chawla and Jaggi, 2016; Khan *et al.,* 2019). Thus, the imperative to look for interventions that enhance and improve self-care. A large number of variables affecting the disease were highly influential, including the type of diabetes (DM), insulin use, age, race, social contact, gender, emotional state, diet, and knowledge of the disease (Mata *et al.,* 2016).

Hence, it is becoming essential for health care professionals to develop proper monitoring of the population's blood glucose level to promote the appropriate diabetes management plan. Furthermore, glucose testing is an essential part of diabetes care by non–laboratory health care workers in order to monitor blood glucose fluctuations (Baygutalp *et al.*, 2018). One of the most prominent self-monitoring of glucose and point of care testing is a glucose meter or glucometer. It is a medical device that's based on electrochemical technology that use electrochemical test strips to perform a quick measurement of blood glucose level for controlling hypoglycemia and hyperglycemia conditions (Tonyushkina and Nichols, 2009; Baygutalp *et al.,* 2018). Some studies prove that the glucose meter has some advantage such as a rapid result in short test time, the small size of the apparatus, it considered smaller, lighter, easier to carry, simple usage, easy to navigate exclude the disease and finally need a small amount of blood (less blood sample required). on the other hand, there are some disadvantages which conformed by the studies as about glucose meter is the result accuracy or analytical performance. As some respondents' concerns regarding the safety of the meter were dependent on their perceptions of inaccuracy, also it is painful, costly, the diabetic patient may not comply with it sometimes may lead to skin damage or infection occurrence. To ensure its efficiency and effectiveness, it needs constant periodic examination. (Macdonald, Lunt, Downie, & Kendall, 2017; Zhang *et al,* 2019). Although these advantages of glucometer, some of them are less accurate than others depending on the quality of strips, devices, and the amount of blood used on the strip.

On the other hand, blood glucose level can be determined more precisely in a laboratory using a portable clinical analyzer designed for the examination of entire arterial, venous, or capillary blood at the point of care which is known i-STAT system (Abbot Point of Care Inc., Princeton, NJ, USA) (Lee, Lim and Lam, 2019). It is gaining popularity for blood analysis in human and veterinary medicine due to its easy operation and portability (Stoot *et al.*, 2014; Lee, Lim and Lam, 2019). Since i-STAT system is daily monitored using controls and calibrations by lab specialists, thus it will give the patient more accurate and precise results. Generally, laboratory analyzers demonstrate a higher level of accuracy than glucometers. Therefore, monitoring blood glucose level is an integral part of diabetes management, so the use of blood glucose meters is widespread in clinical practice and has beneficial effects on patients' health, but there is a need to ensure reliable results all the time. Hence, there are several variables that are known to be sources of error and can affect the efficacy and validity of the results, strip factors such as chemical strip composition that may damage them, expired

strips, manufacturer fluctuations, physical aspect (temperature, hypoxia, humidity), personal factors (hematocrit, extreme hypo-or hyperglycemic), circulatory damage, hypercholesterolemia more than 13 mmol/l and medication effect (Fonseca *et al.,* 2016; Ginsberg, 2009). Therefore, the aim of this research was to measure knowledge, attitude and practice of diabetic patients towards their self-management.

MATERIALS AND METHODS

Study Design

A cross-sectional study was conducted in Saudi Arabia to measure the knowledge and awareness of diabetic patients about the disease and conduct the examination continuously. The results were obtained from 204 participants (diabetic patients) especially, type 2 diabetics based on the questionnaire sent in this region.

Sampling

The questionnaire was approved by the Scientific Research Ethics Committee at Taif University (Research number/42-114). This questionnaire was used to measure the awareness and knowledge of diabetic patients of the importance of monitoring the level of glucose in the blood using glucose analyzers. It consisted of basic information, including age, gender, and marital status. It also contained statistical information about the condition of the diabetic patient (type of diabetes, hyperglycemia or hypoglycemia, family history, symptoms, complications of the disease, and when was diagnosed). Furthermore, those who used glucose devices to self-monitor their glucose level, and the importance of monitoring and conducting the necessary analysis, and using an insulin treatment. The questionnaire also included the importance of physical activity, following a specific diet, and measuring the adequate daily intake that may help in their treatment and reduce their complications.

Data Collection

This research targeted unhealthy people with diabetes of both genders within the age group of 25-55 years living in Saudi Arabia. Each group on the basis of gender was divided into male and female.

The descriptive data included information such as age, gender, diabetic type, and family history. The dependent variables were knowledge, awareness, and practice for those who learned about using glucometers for self-monitoring. Exclusion criteria for future work are an unhealthy adult with drug addiction, and bleeding disorders, pregnant women, and who delivered within three months.

Data Analysis

Proportions and percentages will be calculated and data will be analyzed using Prism 6 (Graph Pad Software) and Microsoft Office Excel. Also, data was converted into ratios and percentages.

Ethical Approval

 Based on the nature of this research, the questionnaire was conducted after getting ethical approval from the scientific research committee (Research number/42-114). Formal emails were sent to Vice Chancellor and Colleges deans in male and female departments to seek their permission to conduct the study.

Study Timeline

The study was conducted during the period from the 20th of November 2020 to the 22th of April 2021.

RESULTS

Table (1) shows that 7.8% of the study participants were less than 25 years old, 9.8% were between 25-29 years old and 4.9% were between 30-39 years old. Importantly, 22.1% of diabetic patients were between 40-49 years old, and 38.2% were between 50-55 years old. There were 17.1% of the study participants belong aged more than 55 years. In addition, It illustrates that less than one-third (31,9%) were male versus more than half of patients (68,1%) were female; 71.6% of them were married compared to less than one-fifth (17.2%) were single, less than one-tenth of participants (8.8%) were widow, and (2.5%) were divorced.

Table 1 | Frequency and Percentage of Data

Age	Total (n)	%
<25 years	16	7.8%
25-29 years	20	9.8%
30-39 years	10	4.9%
40-49 years	45	22.1%
50-59 years	78	38.2%
>55 years	35	17.1%
Gender		
Male	65	31.9%
Female	139	68.1%
Marital Status		
Single	35	17.2%
Married	146	71.6%
Divorced	5	2.5%
Widowed	18	8.8%

Table 2 | Characteristics of the total study population

General information	Yes (n)	%	No (n)	%
Do you have diabetes?	204	100	0	0
Do you have a family history of diabetes?	139	68.1	65	31.9
Do you have any symptoms?	116	56.9	88	43.1
Do you have one of the diabetes complications?	73	35.8	131	64.2
Monitor				
Do you regularly monitor your blood glucose?	130	63.7	74	36.3
Do you use a glucometer for monitoring your glucose level?	153	75	51	25
In your opinion does glucometer give accurate results?	102	50	22	10.8
Have you ever seen a difference between glucometer device measurements?	73	35.8	56	27.5
Have you heard about the i-STAT (Abbott Point of Care) analyzer before?	15	7.4	189	92.6
If yes, were the results different from the other laboratory analyzers and homes glucometer?	29	31.5	63	68.5
Have you performed other laboratory analysis in the hospital for diabetes?	181	88.7	23	11.3
Do you know about RBS test and/or HbA1c test?	177	86.8	27	13.2
Treatment				
The begin injecting insulin in the first three months of being diagnosed diabetes?	88	43.1	116	56.9
Do you take pills for your diabetes?	122	59.8	82	40.2
Have you ever had a diabetic coma either with hyperglycemia or hypoglycemia?	46	22.5	158	77.5
Have you ever been admitted in a hospital due to diabetes?	70	34.3	134	65.7
Life style (Diet/physical activity)				
Do you usually do you some physical activity?	73	35.8	131	64.2
Are you following specific diabetic diet?	62	30.4	142	69.7
Do you measure the amount of daily intake of sugar?	46	22.5	158	77.5
Others				
If you are a female, are you pregnant?	4	2.88	135	97.1
If No, are you delivered within three months ago?	3	2.16	131	94.2

Table (2) shows that 100% of study participants knew that they had diabetes. When participants were asked about family history of diabetes, the responses were that 68,1% had family history of diabetes versus 31.9% had not family history. Furthermore, only 56.9% of the study participants had diabetic symptoms, while 43.1% had not any symptoms. In addition, 35.8% of diabetic patients had diabetic complications, however 64.2% had not any complications of DM.

Then, most of the participated 153 (75%) used a glucometer for monitoring glucose level but 51(25%) they were not use a glucometer. Furthermore, 130 (63.7%) monitored their blood glucose regularly, however, 74 (36.3%) did not perform regular monitors of blood glucose. Most of the participants 110 (53.9%) did not know about the accuracy of glucometer. Nevertheless, 73 (35.8%) believed that a glucometer provides an accurate result but 21 (10.3%) did not believe that. Moreover, some of the participants 73 (35.8%) assumed a difference in the measurement of glucometer devices, and 75 (36.8%) of them did not know if there is any difference. However, 56 (27.5%) did not assume any differences. The majority of the participants 189 (92.6%) had never heard of the i-STAT (Abbott Point of care) analyzer but only 15 (7.4%) of them had heard about it. When the participants were asked whether laboratory analyzers' results were different from a home glucometer, 63 (68.5%) of them believed that there were no differences, whereas 29 (31.5%) believed that there were differences between these measurements methods.

Approximately 88.7% of participants had performed other laboratory tests for diabetes in the hospital, although 11.3 % did not. The random blood sugar (RBS) test and/or the Hemoglobin A1C (HbA1c) test were both known by 86.8% of participants, but 13.2% had never heard of any of these laboratory tests. Furthermore, In the first three months after being diagnosed with diabetes, approximately 56.6 % did not initiate insulin injections, and approximately 43.1 % did. While, 59.8% of the volunteers took diabetes pills, and 40.2% did not use them. Moreover, 77.5 % of the participants had been in a coma previously due to hyperglycemia or hypoglycemia, while 22.5 % had never been in a diabetic coma before. Also,

only 34.3 % of study participants had been admitted to a hospital because of diabetes.

The majority of participants 131 (64.2%) did not engage in physical activity for at least 30 minutes a day, whereas 73 (35.8%) participants were following regular exercise, as shown in Table 2. Additionally, there were 62 (30.4%) of participants who followed a specific diet, and those who did not follow a specific diet were the common 142 (69.7%). For the participants who were not interested in the amount of sugar in their diet were 158 (77.5%), whereas 46 (22.5%) of participants measured their daily intake of sugar.

Most of participating women were not pregnant 135, while the rests were pregnant (4 out of 139). Furthermore, the number of women who have not given birth during the past three months was 131 (94.24%) and those who have given birth were 3 (2.16%).

Figure (1) demonstrates the first diagnosis of diabetes for study participants, the higher percentage were diagnosed when they were older than 35 (54.40%), followed by 35 or younger (32.40%). However, a small percentage of them did not know when they were first diagnosed, and their percentage was approximately (13.20 %) (Figure.1).
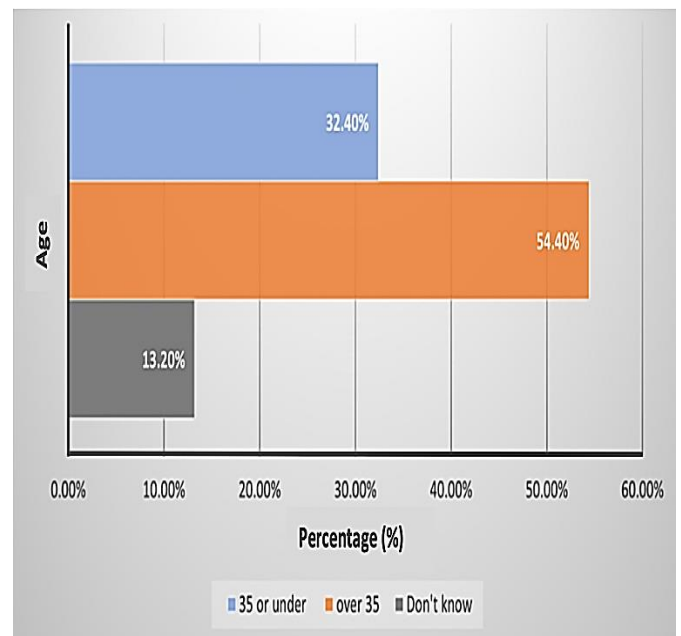
**Figure 1 | Age at first diagnosis of diabetes.**

Figure (2) shows that the highest percentage of participants from type II, which was 18% between the age of 50-55 years, 12% between the age of 40-49 years, 5% in participants more than 55

years, 2% between the age of 25-29, and 1% less than 25. In addition, the participants with type I represented 8.8% between the age of 50-55 years, 5.9% in the age group from less than 25 to 29 years, while 4% between the age of 30-39 years and 3.4% between the age of 40-49 years. Furthermore, gestational diabetes represented 0.5% of the study participants in the age groups of 25-55 years. There was a number of study participants, who didn't know which type of diabetes they had, representing 11% between the age of 50-55 years, 7% of patients more than 55 years, 6% between the age of 40-49 years, 2% between the age of 25-29 and 1% less than 25 years.
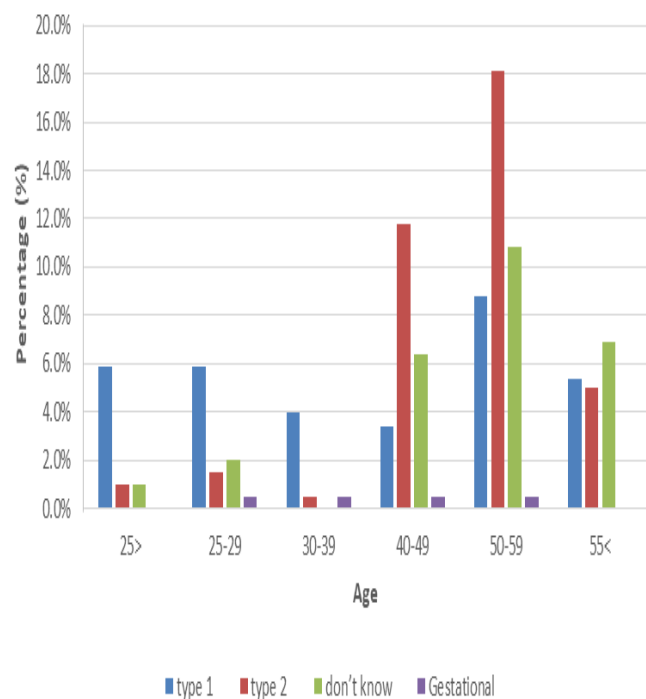

Figure 2 | Diabetes types according to participants' age.

The pie chart shows the types of blood glucose levels for diabetic patients either hyperglycemia, hypoglycemia, and/or both or nothing. It illustrates that the highest proportion of participants had hyperglycemia 51%. Whereas 28% of diabetic patients suffered from both, and the lowest percentage was hypoglycemia with 10%. The remaining 11% were without hyperglycemia or hypoglycemia (Figure 3).
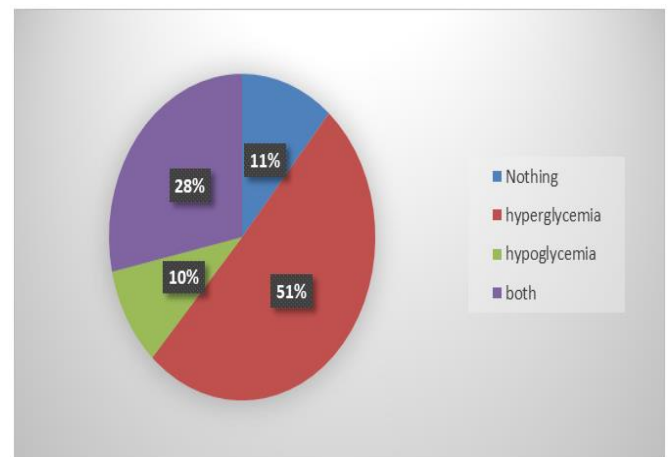
Figure 3 | Types of blood glucose levels for diabetic patients.

Figure (4) demonstrates the action of participants once they feel any symptoms of diabetes: either consulting a doctor, or using a glucometer, or nothing. Most of the participants 155 (76%) used glucometers when they feel a symptom of diabetes, while 29 (14%) were consulting a doctor, and 20 (10%) of them did not do anything.
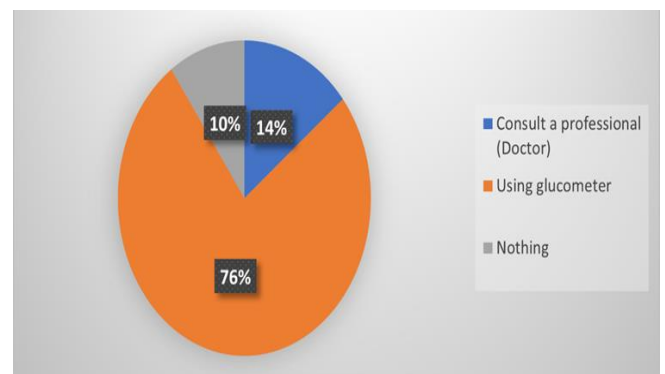
Figure 4 | The action when feeling any symptoms of diabetes.

Some volunteers had diabetes symptoms, the most common of which was excessive urination (12.30 %), then tired and dizziness (8 %), blurred vision and thirst (6.50 %), and dry mouth and shivering (4 %). Thenceforth, there were about 3% who experienced nervousness, headaches, and sweating and about 2.5% who felt tingling in their feet and had blood pressure issues. Moreover, 2% of them had limb numbness and muscle pain, about 1.5% even had a fever, 1% were underweight or overweight and starving, and about 0.5% had the acidity of the blood and thyroid gland problems (Figure 5).
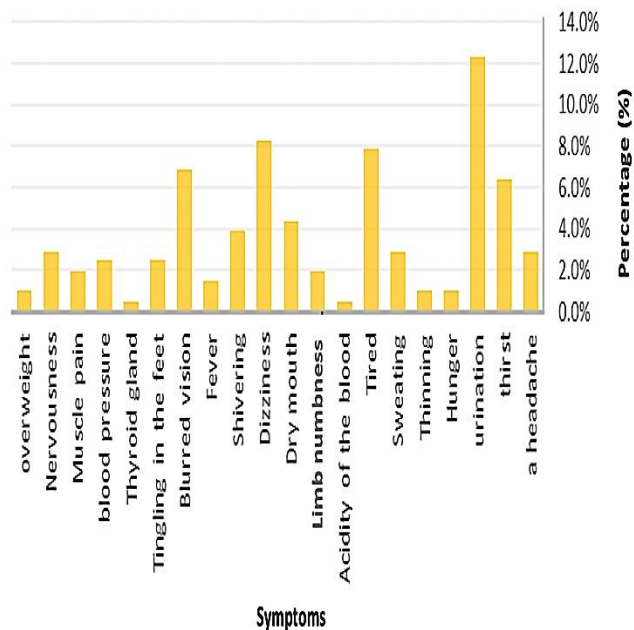
Figure 5 | Symptoms of diabetes.

Figure (6) shows participants' self-management, who were asked a question to find out how often their blood glucose level is monitored. The highest percentage was "rarely" around 87(43%), while 60 (29.5%) of them used more than once a day. Furthermore, approximately 39 (19%) of participants checked their blood once a day but 18 (8.8%) of them never use it. This indicates participants' interest in knowing their diabetes status and continuing to monitor their blood levels routinely.
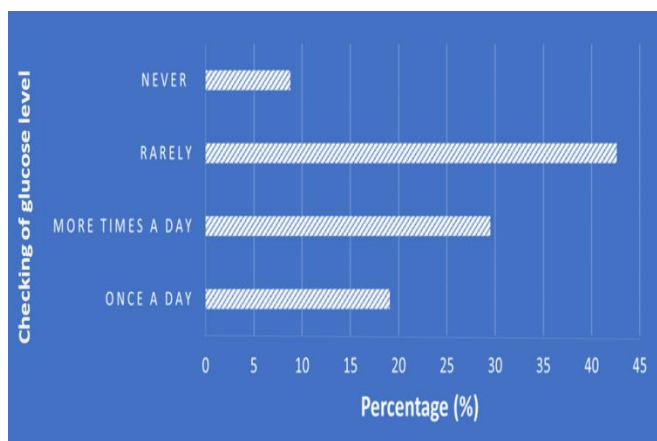

Figure 6 | Routine measure of the level of glucose in the blood

The pie chart shows the types of glucose meters used by patients. 36% represent the highest percentage of diabetics, who did not know the type of their devices. While, 25% of patients used the FreeStyle device, and 19% of patients used the

AccuChek device. As for One Touch, It is the least device that used, which was 18% only, and 2% they had other devices (Figure.7).
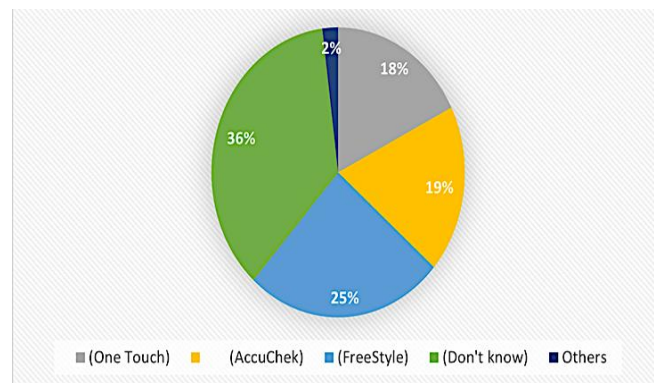

Figure 7 | Glucometer types.

Figure (8) demonstrates that most of the participants (16.67%) used diabetes pills (Glucophage) for treatment, while some of them (3.43%) used Januvia and Diamicron in similar percentages. Nevertheless, 2.94% of patients took Amaglime, while the others were close in proportion, as they had other treatments such as; Synjardy, Glim, Actos, Trajenta, Galvus, Diatab, Jan umet, Daonil, Metformin, Vildagliptin, Omformin, Jardiance, Glucofer, Glucare, Amaryl, Gliptamet, Formit, Insulin, and Trulicity (injection). In addition, 2% of study participants did not know their treatment name (For more details see Figure 8).
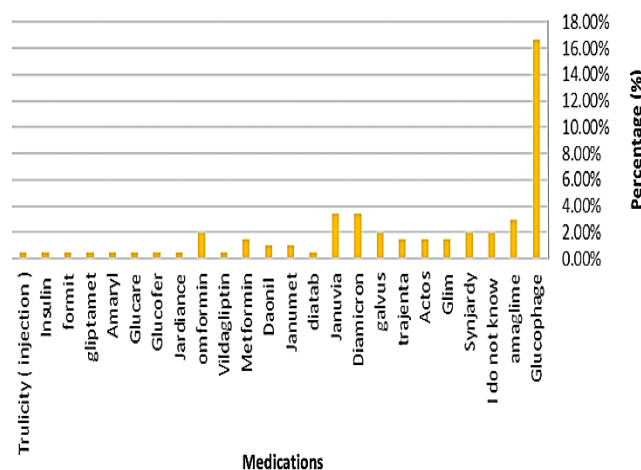

Figure 8 | Medications that are used to treat diabetes.

DISCUSSION

The aim of the study was to measure the knowledge, and awareness of diabetic patients about the disease and perform self-management continuously in Saudi Arabia. The study included

a total of 204 male and female participants, and the participant's age was divided into groups (less than 25 years old, 25-29 years old, 30-39 years old, 40-49 years old, 50-59 years old and more than 55 years). The questionnaire was designed around the condition of diabetic patients, and how they know their condition and deal with the disease.

The majority were female (68.1%) compared to male. most of them were married and they had a family history. Studies have shown that there is a relationship between a family history of type 2 diabetes and insulin activity in a diverse sample of normal-weight children (Denton, Jessica J., and Jose R. Fernandez, 2021). It is normal for them to exhibit symptoms of the disease when their blood glucose level is low or high. Furthermore, the most symptom had excessive urination (12.30%), which is consistence with a recent study that showed the prevalence of urinary incontinence (UI) was 34% in women with DM in Taif city in Saudi Arabia, and its risk factors, such as recurrent urinary infection and obstetric trauma in women (Basim M. Almalki *et al,* 2020).

In addition, most of the participants were using blood glucometers, also most of them were monitoring their glucose levels regularly, and this is evidence of the patient's interest in his health, which led to a decrease in the number of participants with diabetes-related comorbidities, such as diabetic nephropathy or retinopathy or foot damage or cardiovascular complications, and others. While, another study stated that some of the participants with Type 2 DM develop macrovascular complications through different pathogenetic that include hyperglycemia and insulin resistance (Viigimaa, Margus, *et al.,* 2020). A rural Indian study cited the prevalence of diabetic foot occurring, as a result of diabetic neuropathy among outpatient and inpatient diabetics (Singh, Satyam, *et al.,* 2020).

Since 1980, many studies have emerged about the reliability of glucometers, and some studies confirming the accuracy of glucometers, such as Bastan HM *et al,* have confirmed the accuracy of Glucocare, GlucoMen, and Glucotrend 2 with correlation of 95-97% to the standard procedure and Kermani *et al,* Accuracy was acceptable for the Accu-chek glucometer with sensitivity of 81%, specificity 65%, PPV 74% and NPV 74% (Kermani *et al.,* 2017) and (Bastan HM *et al.,*

2003). This explains why most participants believed that glucose meters were accurate. Though, there are other participants (35.8%) was believed that the difference in devices could lead to a difference in measurement, such as the study by Ribeiro Gama MP *et al.,* which confirmed that these devices, Optium Xceed, MediSense and One Touch, were not acceptable inaccurate, as this proves that the measurement differs from one device to another (Gama *et al.*, 2012) and (Kermani *et al.,* 2017).

The majority of participants (92.6%) had never heard of the i-STAT (Abbott Point of Care) analyzer due to its recent use in Saudi Arabia. Many Studies had discussed the reliability of glucometers, as it studied the differences between results of laboratory analyzers and home glucometer and prove that the glucometer provided poor validity and reliability results compared to the results provided by the reference laboratory analyzer such as the study of Salacinski, Alford, Drevets, Hart & Hunt that agrees with our study in part of why some participants (31.5%) assumed that there are differences between laboratory analyzers and glucometer. These differences may be due to various reasons, as the fluoride oxalate tube that is generally used for obtaining specimens for glucose analysis contains sodium fluoride, which acts as an essential inhibitor of glycolysis and potassium oxalate that may affect results. Also, the difference in reading between various methods may due to irregularities in the overall process of testing, glucometer stripes. Moreover, laboratory reagents are temperature sensitive that may be affected by extreme temperatures, and also the age of test strips, storage of strips because it contains enzymes, and humidity can alter the reliability of the results (Otokunefor & Ogu, 2018). While other studies prove a positive correlation between the three blood glucose measurement methods with the standard approach, significantly, which indicates acceptable accuracy (Kermani *et al.,* 2017). This study agrees with our study and explains why some participants (68.5%) agree that there were no differences between laboratory analyzers and glucometers. The majority of participants (88.7%) had performed other laboratory analyses in hospitals for diabetes. It acts as establishing proper quality control of all chemistry results produced in the hospital is the

main role of the laboratory, despite the familiarity and flexibility of utilizing glucometer, standardization and quality assurance are vital in accurately assessing blood glucose levels. Also, the majority of participants (86.8%) had known about the RBS test/ HBA1c test. RBS test is the testing of the blood sugar level at any time or random time of the day and done outside the regular testing schedule to confirm DM, during the treatment and after the treatment of DM, a level of 200 mg/dL or higher is an indication of diabetes mellitus (Urooj *et al.,* 2020). Furthermore, the HBA1c test represents the average level of blood sugar over the past 2 to 3 months (Zareban *et al.,* 2014). This knowledge level is due to the efforts made by Saudi Arabia to raise awareness by conducting educational programs that are aimed to improve health literacy and health outcomes among patients with chronic diseases.

Most of the participants, when diagnosed with diabetes, were taking pills as a treatment, while fewer of them used insulin injections. This study also supports the importance of treating diabetic patients, so that they do not have complications in high blood pressure, which leads to cardiovascular, nephropathy, and other diseases (Zoungas S, Chalmers J, Neal B, *et al.,* 2014). The majority of the participants with diabetes had not been admitted to the hospital before, due to any complications of diabetes. On the other hand, they did not develop a coma, as a result of exposure to hypoglycemia or hyperglycemia. It appears in this study that the reason for entering a diabetic coma was severe hypoglycemia, as a result of taking large amounts of insulin or anti-diabetic medication .

Many Studies, which had discussed the importance of performing a physical activity such as brisk walking, and prove their effectiveness that based brisk walking represents an equally effective intervention to modulate glycemic control and cardiovascular risk profile in type 2 diabetic patients (Praet *et al.,* 2008). This explains why 35.8% of participants perform physical activity, as it helps in controlling diabetes disease, although, there are large number of people who participate in the study (56.9%) did not perform any activity. Besides, the majority of studies had stressed the importance of following or adhering to the diabetic dietary regimen, such as the study

of The Reliability and Validity of the Perceived Dietary Adherence Questionnaire for People with Type 2 Diabetes that recommended and following the Canadian Diabetes Association (CDA) nutrition therapy guidelines is important for improving health outcomes in people with type 2 diabetes (Asaad *et al.,* 2015). In our study, only 30.4% followed the diabetic diet, while 69.6% did not follow the diabetic diet, so in the recommendation of this study, patients must instruct to follow diabetic diets to control their disease and improve their health. Furthermore, it is important for the diabetic patient to measure the amount of daily intake of sugar, as diabetes occurs as a result of a lack of insulin production or increased resistance to insulin, which allows for the regulation of the uptake of glucose. It is released in response to increased glucose levels in the blood and allows for individual cells to take up glucose from the blood to metabolize it. A high-sugar diet has been linked with an increased incidence of type 2 diabetes, the current recommendation for sugar intake is that it does not exceed 10% of daily energy intake, in our study we must focus on giving proper instructions for daily intake as 77.5% did not measure the amount of their intake, however, only 22.5% measure their daily intake. On other hand, when reviewing the responses, it was found that 77.4 % of the participants were over the age of 40, which means that the chances of becoming pregnant are minimal at this age.

The results showed that most of the participants between the ages of 50 - 55 had type 2 diabetes mellitus. As well as, the study showed type 2 diabetes has more prevalent among older adults (Guifeng Xu *et al.,* 2018). Also, as shown in Figure (3), the highest percentage of participants diagnosed with diabetes were over 35 years of age, then, 35 or younger. This study did examine the impact of age at diagnosis by different causes, which is reducing premature morbidity and mortality in type 2 diabetes (Lili Huo *et al.,* 2018).

In our study, we observed that 51% of participants suffered from hyperglycemia due to insulin resistance. Insulin usually degrades glycogen but it fails to do so in a condition of insulin resistance, leading to an overproduction of glucose. Also, The American Diabetes Association and the European Association found in large cardiovascular outcomes trials published in 2019

that most diabetic patient suffers from hyperglycemia due to insulin resistance. Meanwhile, 10% of the participants with the lowest blood sugar levels were observed, while 28% experienced both. Finally, 11% of them did not suffer from anything.

The study showed that a large number of participants use a glucometer to measure blood sugar when they feel symptoms of diabetes, and this is a suitable option to monitor the level of sugar and it is preferable to consult a doctor as soon as possible when seeing it is hypoglycemia or hyperglycemia as also shown by Daenen S. *et al.,* (2010) and others. While some participants prefer to visit the doctor when feeling symptoms because of their reassurance and saying that they do not have sufficient experience in dealing with glucose meters due to their advanced age, while a small group of research participants do not do anything from them, and this is a wrong choice for the risk of hypoglycemia or hyperglycemia. As a result, 50% of the participants had hyperglycemia, so most of the patients were suffering from symptoms of hyperglycemia such as polyuria and polydipsia, and fatigue, as well as developing neurological symptoms such as focal neurologic deficits due to high blood sugar (Mouri & Badireddy, 2020). This is explained by the fact that excessive urination is the most common symptom among participants, and that when the blood glucose level is elevated, the body's first response is excreting glucose into the kidneys and into the urine (Reddy, 2017).

Glucose monitoring either by self-monitoring of blood glucose plays an important role in diabetes management and in reducing the risk for diabetes-related complications. However, despite evidence supporting the role of glucose monitoring in better patient health outcomes, studies also reveal relatively poor adherence rates to regular checkups and numerous patient-reported barriers. Fortunately, some useful intervention strategies may use to produce short-term improvements in patient's adherence to a regular checkup including education, problem-solving, contingency management, goal setting, cognitive behavioral therapy, and motivational interviewing. (Patton, 2015; Peel, Douglas & Lawton, 2007). This correlates with our study that why there are differences in response to a frequent check of their glucose level, as 8.8% of patients did not perform

any checkup for their glucose level, 43% of patients rarely checked their glucose level, 19.4% of patients checked their glucose level once a day and 29.5% of patients checked their glucose level more than once a day. The study of A Glucose Meter Accuracy and Precision Comparison: The FreeStyle Flash Versus the Accu-Chek Advantage, Accu-Chek Compact Plus, Ascensia Contour, and the BD Logic which had discussed several types of glucometer that patients used as our study represents 18% of patient use One touch, while Freestyle represents 25%, Accu check 19%, also 36% did not know (Thomas, Kane, Bakst, Busch, Hamilton, & Abelseth, 2008).

Metformin is currently considered the first line of therapy for type 2 diabetes, as shown by the results of the participants, who were administered with metformin 16.67 % (Glucophage) (Paneni and Lüscher, 2017). This is mostly due to the fact that it is safe, reduces HbA1 levels by 1-2 %, does not raise the risk of hypoglycemia when used as monotherapy, and is cost-effective (Paneni and Lüscher, 2017).

CONCLUSION

This study focused on assessing the level of knowledge and awareness of diseases and the importance of maintaining continuous screening in diabetics patients, the participants included in this study have diabetes disease from different age groups, but the majority were more than 30 years old, females with different marital status, all study participants knew that they had diabetes, most of them had a family history of diabetes, and not all of the participants had symptoms or complications of diabetes. While, a large proportion of participants use a glucometer to monitor their glucose level to ensure effective patient management and prevent complications and most participants believe that the glucometer gave an accurate result, and the majority have never heard of I-STAT. They also believed that there was no difference as a result of this, most of them had laboratory tests for the RBS test and/or the HbA1c test were known by the majority of the participants, and in the first three months after their diagnosis of diabetes, the majority of them had not prescribed insulin injections and birth control pills. During pregnancy for diabetics, patients are evaluated (physical activity, adherence to a specific diet, and the amount of

sugar consumed in their diet). Most of them were from the second type and had hyperglycemia more than the complications of hypoglycemia. When feeling the symptoms of diabetes, most of the participants used glucometers, the most common symptoms of the patients were (frequent urination, Problems of numbness of the limbs, weight gain, and hunger) which were higher than most of the participants who "rarely" checked their glucose level regularly.

In conclusion, the study showed that participants with DM had knowledge and awareness of their disease but they did not perform self-management appropriately, although the popularity and ease of glucometer use. Future study needs to be performed in this field to evaluate the validity of this questionnaire and by extension their awareness of the test reliability and accuracy using different types of machines; glucometer, i-STAT system, and another lab analyzer, or making comparisons between different devices to reach to the best one.

Author contributions: Conceptualisation: A.F.G., A.E.A., A.S., M.M.B., and M.S.A.; data curation: S.A.A, S.N.A, S.A.A, D.S.A, and M.M.B.; formal analysis: S.A.A, S.N.A, S.A.A, D.S.A.; funding acquisition: A.A.A.; investigation S.A.A, S.N.A, S.A.A, D.S.A, and M.M.B.; methodology: S.A.A, S.N.A, S.A.A, D.S.A, and M.A.; project administration: M.M.B, A.F.G, A.A.A., and H.M.A.; resources: M.M.B.; validation: A.F.G, A.A.A and H.M.A.; visualisation: A.F.G., M.M.B., and A.A.A.; writing of the original draft: S.A.A, S.N.A, S.A.A, D.S.A, and M.M.B.; writing, reviewing and editing: S.A.A, S.N.A, S.A.A, D.S.A, A.F.G., and M.M.B. All authors have read and agreed to the published version of the article.

Conflict of interest: Authors state no conflict of interest.

Ethical statement: Our study was approved by the ethical committee of Taif University (approval no. 42-114), Taif University, Taif City, Saudi Arabia. All patients provided written informed consent prior to their enrolment in the study.

Data availability statement: Available from the corresponding author on reasonable request.

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