

# Awareness and Perception of Type 2 Diabetic Patients of Eastern Province in Saudi Arabia about Smart Glucometer Usage in Diabetes Management

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## Abstract:

**Objective:** The present study aims to identify awareness and perception of Type 2 diabetes mellitus (T2DM) patient on use of smart glucometer in diabetes management and to look for association of different demographic, clinical, behavioral factors with their awareness and perception on the usage of smart glucometer.

**Methods:** A cross-sectional study was conducted in Eastern Province of Saudi Arabia from 9<sup>th</sup> March to 7<sup>th</sup> April 2023. Convenience and snow-ball sampling method was used to recruit T2DM patients. An online survey questionnaire was used to collect data on awareness and perception. A total of 78 responses were received during this period. Demographic and clinical characteristics are presented as number and percentage, while perception about smart glucometer usage is presented as mean and standard deviation. p-value <0.05 is considered significant.

**Results:** Forty-six (59.0%) participants were aware about smart glucometer, while 20 (25.6%) participants reported to have a smart glucometer. The participant's perception scores for questions related to benefits of using and linking smart glucometer with Sehhaty application was high more than 4. The participant's behavior of sharing blood glucose levels with their physician and using Sehhaty application for diabetes management showed significantly higher perception scores than their counterpart.

**Conclusion:** Awareness about smart glucometer is moderate among participants and usage of smart glucometer for monitoring blood glucose level is low. The participants agreed that the usage and linking of smart glucometer would help them in diabetes management and reduce the errors in sharing data with physicians.

**Keywords:** Awareness, Diabetes Mellitus Management, Perception, Smart glucometer, T2DM.

## Introduction:

Diabetes is a group of metabolic disorders characterized by elevated levels of blood glucose, which leads over time to serious complications and significant morbidity and mortality worldwide. Diabetes Mellitus (DM) is one of the top five global causes of death. The major epidemiological diabetes traits are similar in Saudi Arabia. The prevalence of DM and its rapid rise make it one of the leading causes of illness and death in Saudi Arabia. A nationwide survey conducted in 2004 revealed that 23.7% of Saudi Arabia's adult population had diabetes [1]. A study conducted in 2004 reported that the prevalence of diabetes had

increased to 34.1% in males and 27.6% in females. Moreover, Saudi urban residents (25.5%) had a higher prevalence of DM compared to Saudi rural residents (19.5%) [2].

The World Health Organization (WHO) reports that Saudi Arabia has high rate of diabetes in the world and the second highest rate in the Middle East [3]. The proportion of DM was 8.5% among the Saudi Arabia population ( $\geq 15$  years) and was higher in male (10.3%) than female (9.9%). The prevalence of DM among the age group  $\geq 60$  years was the highest (49.2%), followed by the age group 45–64 years (38.9%) while the lowest prevalence was found among the younger group  $< 40$  years (15.3%) [4]. There was a large difference between regions ranging from 7.3% in Najran to 11% in Makkah [4].

The prevalence of DM among Saudi citizens is still rising, and currently more people are diagnosed with it and diabetes alone is responsible for 20% of all medical costs in Saudi Arabia [5]. Therefore, it is considered as country's most pressing social and economic health issues. The diabetes is associated with higher population's risk of developing amputations, renal disease, blindness, hypertension, stroke, heart disease, dental disease, and amputations. For better quality of life and diabetes management, awareness and knowledge of the condition, its complications, and risk factors are essential [6].

It is expected that the health burden from DM in Saudi Arabia would reach catastrophic levels unless a comprehensive epidemic management program is implemented, with a focus on promoting healthy diets, including exercise and active lives, and weight control. However, once the patients are diagnosed with DM, regular monitoring of blood glucose level is required to maintain its appropriate levels and to delay complications associated with DM. A number of factors like financial, transportation, time can affect the interaction between the patient and the physician to coordinate in the diabetes management.

According to the mHealth App Economic 2017 study 68% of mobile health app developers and publishers believe that diabetes continues to be the therapy field with the best market potential for digital health solutions within the near future [7]. Nowadays, the evolution of mobile technology provides a large number of health-related smartphone applications (apps), which aims to increase the self-management skills of the patient in chronic diseases, to facilitate the communication between the patient and healthcare providers, and to increase the patient's compliance with the treatment. In the field of diabetes there are also many diabetes-related mobile apps mainly focusing on self-management of diabetes, lifestyle modification, and medication adherence motivation [8].

Smart glucometer is a device that has advanced properties for the management of diabetes, which is a boon in the world of evolution and smart devices. It automatically transfers readings from the scale to the application of the smart phone or tablet and gives the patient a report frequently to save these readings, which enables the patient to share their data with the physician and to manage individualized treatment plan and can help in removing the barriers in diabetes management [9].

Saudi Arabia has launched the National Transformation Program (NTP), which is designed to transform the healthcare delivery system through technology and innovation. Sehhaty app is provided by the Ministry of Health in Saudi Arabia, in line with its vision to increase access to care, improve standards of healthcare and increase health awareness in the community. It is the health platform for all citizens' and residents' health information. Sehhaty is a mobile-based integrated medical care application that provides health services to people in Saudi Arabia. It enables the user to gain access to health information and numerous health services given by various authorities in the Kingdom's health sector.

According to Alharbi et al. (2021), the Saudi Arabian government opted for Sehhaty to provide a comprehensive spectrum of healthcare services to citizens [10]. Adoption of the app as the national platform reflects the country's commitment to leveraging technology to improve healthcare delivery and accessibility. Several techniques can be used to promote the Sehhaty app for preventative care in Saudi

Arabia. To begin, the government can work with healthcare providers and organizations to create awareness campaigns on the app's features and benefits. Distributing explanatory leaflets, organizing public seminars, and interacting with community leaders can all help to encourage the use of the app for preventative healthcare. Furthermore, healthcare practitioners can help promote the app to their patients. During consultations, they might highlight the app's functionality and emphasize its role in preventative care. This can be supplemented by giving training and instructional workshops for healthcare providers to ensure they are well-versed in using the app and can properly guide their patients. With the help of technology, the country is targeting to provide its citizens access to equitable, affordable and universal high-quality healthcare. It is expected in near future the chronic diseases like DM will be managed remotely with integrated patient-centered care. Therefore, it is important to study the awareness and perception of technology usage among the chronic patients in their disease management.

The present study aims to identify the awareness and perception of type 2 diabetic (T2DM) patient about use of smart glucometer in diabetes management and to look for association of demographic factors, clinical history and behavior towards diabetes management with their awareness and perception on usage of smart glucometer.

### **Methods:**

A cross-sectional study was conducted in the Eastern Province of Saudi Arabia from 9<sup>th</sup> March to 7<sup>th</sup> April 2023. The inclusion criteria were T2DM patients 18 years and older, having history of at least one year and resident of Eastern Province. A convenience and snow-ball sampling method was used to enroll the participants.

An online questionnaire was prepared using the published literature with minor modifications to make it appropriate for the current study settings [6, 11]. The questionnaire had five sections: First section included questions about demographics (age, education, employment, and marital status). Second section had questions on clinical profile of patient (duration of diabetes, treatment approaches, additional comorbidities, medication adherence) [12].

Third section was related to availability and use of smart phone application, and fourth section was about awareness of smart glucometer and their behavior towards diabetes management like monitoring blood glucose level, sharing the levels with physician, forget to record glucose level reading, entering wrong glucose reading, missing the document in which the reading was recorded. The fifth section was about perception on usage of smart glucometer. The response to perception questions were assessed on 5-likert scale with score for strongly disagree '1', disagree '2', neither agree nor disagree '3', agree '4' and strongly agree '5'. The questionnaire was created in both languages Arabic and English.

The study followed the Helsinki Declaration, and the study protocol was reviewed and approved by the Institutional Review Board of the University. Patient's written informed consent was obtained before enrolment into the study. The data was collected using electronic survey to investigate the awareness and perception of type 2 diabetes patients towards using Sehhaty application and smart glucometer as a diabetes management tool.

**Statistical analysis:** IBM SPSS Version 24 (IBM Corp, Armonk, NY, United States) was used for the statistical analysis. The demographic and clinical characteristics are presented as number and percentage, while perception about smart glucometer usage is presented as mean and standard deviation. The comparison for categorical data was conducted using Pearson's Chi-square test and for continuous data student's 't'-test and ANOVA were performed as applicable. p-value <0.05 is considered significant.

### **Results:**

Total 78 responses were received in the study period. The demographic of the participants showed that most of the participants were in age group 45-64 years (48, 61.5%), and were married (63, 80.8%). Among the

study participants male : female ratio and working : not working ratio were similar 37:41. Most of the participants 34 (43.6%) had graduation and above level of education, 29 (37.2%) participants had primary to high school level of education, while 15 (19.2%) participants had a diploma education. The clinical profile of the participants is shown in Table 1. Most of the participants 49 (62.8%) had diabetes for period of 5-10 years, 50 (66.7%) participants were on oral medication and 30 (38.5%) participants reported a comorbidity.

**Table 1: Clinical details of the participants**

| Clinical variables                                | Number (n=78) | Percentage |
|---------------------------------------------------|---------------|------------|
| Duration of diabetes (years)                      |               |            |
| 1-3                                               | 20            | 25.6       |
| 4-5                                               | 9             | 11.5       |
| 5-10                                              | 49            | 62.8       |
| Type of treatment                                 |               |            |
| Oral medication                                   | 52            | 66.7       |
| Insulin injection                                 | 16            | 20.5       |
| Both                                              | 10            | 12.8       |
| Medication regularity                             |               |            |
| Yes                                               | 60            | 76.9       |
| No                                                | 28            | 23.1       |
| Method used to remember the medicine              |               |            |
| -You remember to take medication yourself         | 53            | 88.3       |
| -Your family member takes care of your medication | 4             | 6.7        |
| -You use application to give alert notification   | 3             | 5.0        |
| How many times you missed medication in 6 months  |               |            |
| 1-2 times                                         | 8             | 44.4       |
| 3-5 times                                         | 2             | 11.2       |
| >5 times                                          | 8             | 44.4       |
| Comorbidity                                       | 30            | 38.5       |

All the participants reported to have a smart phone, 74 (94.9%) participants were familiar with using of smart phone applications and 73 (93.6%) reported Sehhaty application was available in their or their family members mobiles. Twenty (25.6%) participants used the Sehhaty application in diabetes management; all the 20 participants used the application for getting appointment for follow-up, while 7/20 (35.0%) used it for getting prescription. The behavior of the participants towards their diabetes management is shown in Table 2. Sixty-seven (85.9%) participants monitored their blood glucose level regularly, while 57 (73.1%) shared their data with the physician mainly by visiting the primary healthcare centre.

**Table 2: Behavior of the participants towards diabetes management**

| Behavior towards Diabetes Management                            | Number (n=78) | Percentage |
|-----------------------------------------------------------------|---------------|------------|
| Do you monitor your blood glucose level regularly?              |               |            |
| Yes                                                             | 67            | 85.9       |
| No                                                              | 11            | 14.1       |
| Do you share your blood glucose level data with your physician? |               |            |
| Yes                                                             | 57            | 73.1       |
| No                                                              | 21            | 26.9       |
| Which method you use to share your data with your physician?    |               |            |
| Visit Primary Healthcare Centre                                 | 52            | 91.2       |
| Email                                                           | 1             | 1.8        |

|                                                                                                |    |      |
|------------------------------------------------------------------------------------------------|----|------|
| SMS                                                                                            | 2  | 3.5  |
| Telephone call                                                                                 | 2  | 3.5  |
| Did you anytime forget to record glucose level readings to share with physician?               |    |      |
| Never                                                                                          | 20 | 33.9 |
| 1-2 times in 6 months                                                                          | 21 | 37.5 |
| >2 times in 6 months                                                                           | 16 | 28.6 |
| Did you any time entered wrong readings of your glucose level?                                 |    |      |
| Never                                                                                          | 43 | 75.4 |
| 1-2 times in 6 months                                                                          | 12 | 21.1 |
| >2 times in 6 months                                                                           | 2  | 3.5  |
| Did you anytime lost the document in which you recorded readings to share with your physician? |    |      |
| Never                                                                                          | 40 | 70.2 |
| 1-2 times in 6 months                                                                          | 13 | 22.8 |
| >2 times in 6 months                                                                           | 4  | 7.0  |

Forty-six (59.0%) participants responded that they have heard about the smart glucometer (a glucometer that can record the data and share it with the physician using application). However, 20 (25.6%) participants reported to have a smart glucometer; one participant shared the report through email and two participants shared the data through SMS. The participants score for the perception questions; “using smart glucometer will help in diabetes management”, “learning to use smart glucometer will be easy”, “linking smart glucometer with Sehhaty application will help to improve their diabetes management” and “linking smart glucometer with Sehhaty application will help to reduce errors caused by manual recording” was high more than 4. However, the mean score was low for “will you require help from family member to use smart glucometer” and “will you purchase a smart glucometer” (Figure 1).

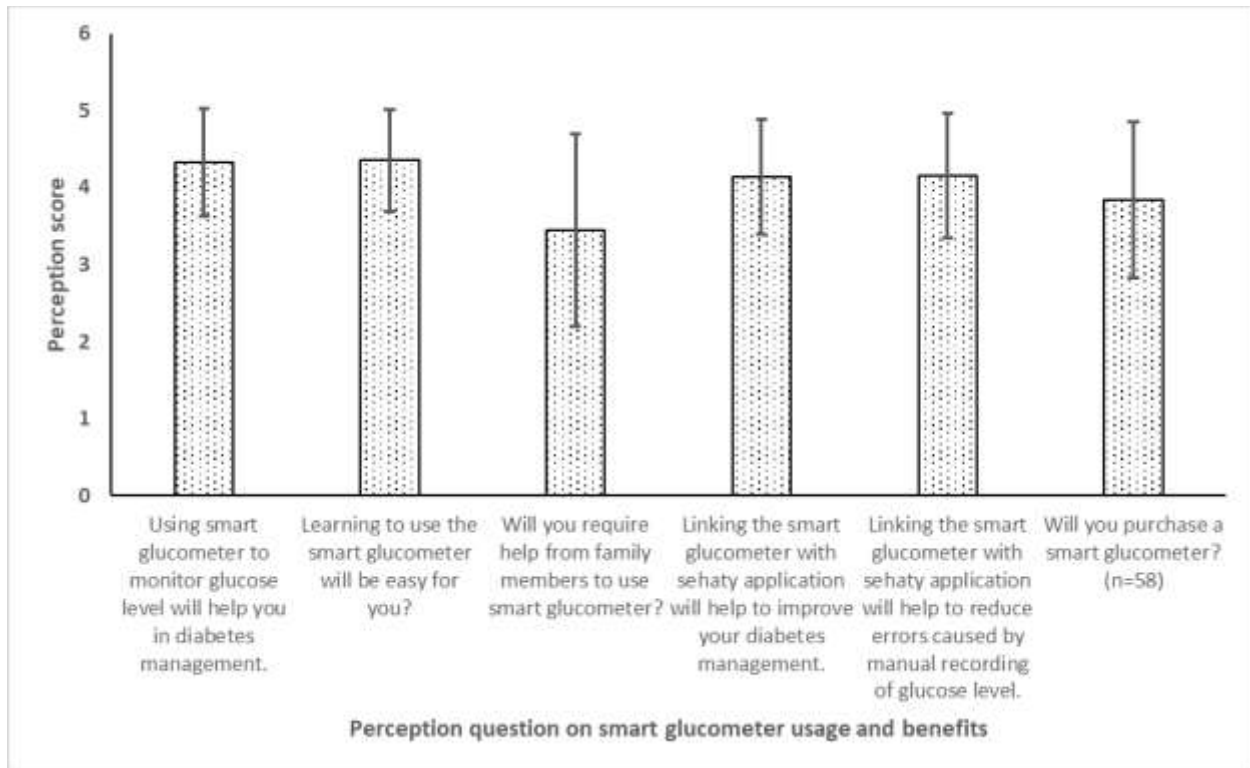


Figure 1: Mean  $\pm$  SD scores of 78 participants for perception questions.

Comparison of demographic and clinical parameters of participants with their awareness about the smart glucometer showed no significant difference (Table 3).

**Table 3: Association of demographics and clinical details of the participants with awareness about smart glucometer**

|                              | Awareness about smart glucometer |            | p-value |
|------------------------------|----------------------------------|------------|---------|
|                              | Yes (n=46)                       | No (n=32)  |         |
| Demographic characteristics  |                                  |            |         |
| Age (years)                  |                                  |            |         |
| 25-44                        | 16 (34.8%)                       | 14 (43.8%) | 0.423   |
| 45-64                        | 30 (65.2%)                       | 18 (56.3%) |         |
| Sex                          |                                  |            |         |
| Male                         | 23 (50.0%)                       | 14 (43.8%) | 0.296   |
| Female                       | 50 (50.0%)                       | 18 (56.3%) |         |
| Marital status               |                                  |            |         |
| Single/Widow/Separated       | 6 (13.0%)                        | 9 (28.1%)  | 0.096   |
| Married                      | 40 (87.0%)                       | 40 (71.9%) |         |
| Education                    |                                  |            |         |
| Primary to High School       | 18 (39.1%)                       | 11 (34.4%) | 0.880   |
| Diploma                      | 9 (19.6%)                        | 6 (18.8%)  |         |
| Graduate and postgraduate    | 19 (41.3%)                       | 15 (46.9%) |         |
| Employment status            |                                  |            |         |
| Not working                  | 24 (52.2%)                       | 17 (53.1%) | 0.934   |
| Working                      | 22 (47.8%)                       | 15 (46.9%) |         |
| Clinical characteristics     |                                  |            |         |
| Duration of diabetes (years) |                                  |            |         |
| 1-3                          | 10 (21.7%)                       | 10 (31.3%) | 0.610   |
| 4-5                          | 6 (13.0%)                        | 3 (9.4%)   |         |
| 5-10                         | 30 (65.2%)                       | 19 (59.4%) |         |
| Type of treatment            |                                  |            |         |
| Oral medication              | 27 (58.7%)                       | 25 (78.1%) | 0.171   |
| Insulin injection            | 11 (23.9%)                       | 5 (15.6%)  |         |
| Both                         | 8 (17.4%)                        | 2 (6.3%)   |         |
| Medication regularity        |                                  |            |         |
| Yes                          | 34 (73.9%)                       | 26 (81.3%) | 0.449   |
| No                           | 12 (26.1%)                       | 6 (18.8%)  |         |
| Comorbidity                  |                                  |            |         |
| Yes                          | 16 (34.8%)                       | 14 (43.8%) | 0.423   |
| No                           | 30 (65.2%)                       | 18 (56.3%) |         |

Comparison of demographic characteristics of the participants with their perception towards the benefits of smart glucometer usage in diabetes management showed no significant difference between the groups. Participants of all age group, male or female, single or married, all education levels and working or not working reported high scores for the questions on benefit of smart glucometer usage in diabetes management. Comparison of participant's behavior towards diabetes management with their perception on the benefits of smart glucometer usage in diabetes management showed that the participants who shared their blood glucose levels with the physician had significantly higher scores than those who do not share. Similarly, the participants who used Sehhaty application in diabetes management had significantly higher

scores for the questions on benefits of smart glucometer usage in diabetes management than their counterpart (Table 4).

**Table 4: Comparison of demographic, clinical, behavioral and usage of smart phone application with perception (Mean  $\pm$  SD) on usage of smart glucometer in diabetes management (n=46)**

|                                    | Using smart glucometer to monitor glucose level will help you in diabetes management. | Learning to use the smart glucometer will be easy for you? | Will you require help from family members to use smart glucometer? | Linking the smart glucometer with sehhaty application will help to improve your diabetes management. | Linking the smart glucometer with sehhaty application will help to reduce errors caused by manual recording of glucose level. | Will you purchase smart glucometer? |
|------------------------------------|---------------------------------------------------------------------------------------|------------------------------------------------------------|--------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|
|                                    | Mean $\pm$ SD                                                                         | Mean $\pm$ SD                                              | Mean $\pm$ SD                                                      | Mean $\pm$ SD                                                                                        | Mean $\pm$ SD                                                                                                                 | Mean $\pm$ SD                       |
| <b>Demographic characteristics</b> |                                                                                       |                                                            |                                                                    |                                                                                                      |                                                                                                                               |                                     |
| Age (years)                        |                                                                                       |                                                            |                                                                    |                                                                                                      |                                                                                                                               |                                     |
| 25-44 (n=16)                       | 4.44 $\pm$ 0.63                                                                       | 4.50 $\pm$ 0.52                                            | 3.19 $\pm$ 1.10                                                    | 4.06 $\pm$ 0.77                                                                                      | 4.25 $\pm$ 0.68                                                                                                               | 4.10 $\pm$ 0.99                     |
| 45-64 (n=30)                       | 4.47 $\pm$ 0.68                                                                       | 4.43 $\pm$ 0.68                                            | 3.27 $\pm$ 1.37                                                    | 4.20 $\pm$ 0.85                                                                                      | 4.30 $\pm$ 0.79                                                                                                               | 3.94 $\pm$ 0.                       |
| p-value                            | 0.888                                                                                 | 0.33                                                       | 0.843                                                              | 0.592                                                                                                | 0.832                                                                                                                         | 0.644                               |
| Sex                                |                                                                                       |                                                            |                                                                    |                                                                                                      |                                                                                                                               |                                     |
| Male (n=23)                        | 4.39 $\pm$ 0.66                                                                       | 4.35 $\pm$ 0.65                                            | 3.22 $\pm$ 1.17                                                    | 4.00 $\pm$ 0.90                                                                                      | 4.22 $\pm$ 0.79                                                                                                               | 3.93 $\pm$ 1.00                     |
| Female (n=23)                      | 4.52 $\pm$ 0.66                                                                       | 4.56 $\pm$ 0.59                                            | 3.26 $\pm$ 1.39                                                    | 4.30 $\pm$ 0.70                                                                                      | 4.35 $\pm$ 0.71                                                                                                               | 3.76 $\pm$ 0.20                     |
| p-value                            | 0.507                                                                                 | 0.240                                                      | 0.909                                                              | 0.209                                                                                                | 0.561                                                                                                                         | 0.526                               |
| Marital status                     |                                                                                       |                                                            |                                                                    |                                                                                                      |                                                                                                                               |                                     |
| Single/Widow/Separated (n=6)       | 4.67 $\pm$ 0.52                                                                       | 4.67 $\pm$ 0.88                                            | 2.83 $\pm$ 1.47                                                    | 4.17 $\pm$ 0.98                                                                                      | 4.17 $\pm$ 0.98                                                                                                               | 3.77 $\pm$ 1.30                     |
| Married (n=40)                     | 4.42 $\pm$ 0.67                                                                       | 4.41 $\pm$ 0.59                                            | 3.30 $\pm$ 1.24                                                    | 4.15 $\pm$ 0.80                                                                                      | 4.30 $\pm$ 0.72                                                                                                               | 3.87 $\pm$ 0.94                     |
| p-value                            | 0.407                                                                                 | 0.381                                                      | 0.407                                                              | 0.963                                                                                                | 0.690                                                                                                                         | 0.765                               |
| Education                          |                                                                                       |                                                            |                                                                    |                                                                                                      |                                                                                                                               |                                     |
| Primary to High School (n=)        | 4.31 $\pm$ 0.81                                                                       | 4.24 $\pm$ 0.79                                            | 3.79 $\pm$ 1.08                                                    | 4.28 $\pm$ 0.59                                                                                      | 4.31 $\pm$ 0.76                                                                                                               | 4.10 $\pm$ 0.97                     |
| Diploma (n=)                       | 4.53 $\pm$ 0.52                                                                       | 4.47 $\pm$ 0.64                                            | 3.13 $\pm$ 1.30                                                    | 4.40 $\pm$ 0.63                                                                                      | 4.13 $\pm$ 0.91                                                                                                               | 3.50 $\pm$ 1.24                     |
| Graduate and postgraduate (n=)     | 4.26 $\pm$ 0.66                                                                       | 4.38 $\pm$ 0.55                                            | 3.26 $\pm$ 1.33                                                    | 3.91 $\pm$ 0.87                                                                                      | 4.03 $\pm$ 0.80                                                                                                               | 3.81 $\pm$ 0.94                     |
| p-value                            | 0.455                                                                                 | 0.521                                                      | 0.146                                                              | 0.051                                                                                                | 0.390                                                                                                                         | 0.271                               |
| Employment status                  |                                                                                       |                                                            |                                                                    |                                                                                                      |                                                                                                                               |                                     |

|                                                                     |                    |                    |             |             |             |             |
|---------------------------------------------------------------------|--------------------|--------------------|-------------|-------------|-------------|-------------|
| Not working (n=24)                                                  | 4.54 ± 0.59        | 4.46 ± 0.66        | 3.12 ± 1.39 | 4.29 ± 0.80 | 4.33 ± 0.82 | 3.64 ± 1.06 |
| Working (n=22)                                                      | 4.36 ± 0.73        | 4.45 ± 0.59        | 3.36 ± 1.13 | 4.00 ± 0.82 | 4.23 ± 0.68 | 4.03 ± 0.96 |
| p-value                                                             | 0.364              | 0.984              | 0.530       | 0.230       | 0.637       | 0.148       |
| <b>Clinical details</b>                                             |                    |                    |             |             |             |             |
| Duration of diabetes (years)                                        |                    |                    |             |             |             |             |
| 1-3 (n=)                                                            | 4.35 ± 0.87        | 4.40 ± 0.75        | 3.50 ± 1.32 | 4.10 ± 0.85 | 4.05 ± 0.94 | 3.89 ± 1.20 |
| 4-5 (n=)                                                            | 4.22 ± 0.67        | 4.44 ± 0.53        | 3.67 ± 1.32 | 4.56 ± 0.53 | 4.56 ± 0.53 | 4.28 ± 1.11 |
| 5-10 (n=)                                                           | 4.35 ± 0.63        | 4.31 ± 0.65        | 3.37 ± 1.24 | 4.08 ± 0.73 | 4.12 ± 0.78 | 3.72 ± 0.89 |
| p-value                                                             | 0.881              | 0.779              | 0.782       | 0.213       | 0.271       | 0.407       |
| Type of treatment                                                   |                    |                    |             |             |             |             |
| Oral medication (n=)                                                | 4.29 ± 0.75        | 4.27 ± 0.69        | 3.50 ± 1.24 | 4.11 ± 0.78 | 4.10 ± 0.85 | 3.72 ± 1.10 |
| Insulin injection (n=)                                              | 4.25 ± 0.58        | 4.37 ± 0.62        | 3.50 ± 1.32 | 4.12 ± 0.72 | 4.25 ± 0.68 | 4.40 ± 0.52 |
| Both (n=)                                                           | 4.70 ± 0.48        | 4.70 ± 0.48        | 3.00 ± 1.25 | 4.30 ± 0.67 | 4.30 ± 0.82 | 3.80 ± 0.84 |
| p-value                                                             | 0.202              | 0.166              | 0.506       | 0.777       | 0.669       | 0.167       |
| Medication regularity                                               |                    |                    |             |             |             |             |
| Yes (n=34)                                                          | 4.53 ± 0.61        | 4.56 ± 0.50        | 3.00 ± 1.23 | 4.12 ± 0.81 | 4.26 ± 0.75 | 3.78 ± 1.03 |
| No (n=12)                                                           | 4.25 ± 0.75        | 4.17 ± 0.83        | 3.92 ± 1.16 | 4.25 ± 0.87 | 4.33 ± 0.78 | 4.08 ± 1.00 |
| p-value                                                             | 0.209              | 0.060              | 0.030*      | 0.634       | 0.789       | 0.369       |
| Comorbidity                                                         |                    |                    |             |             |             |             |
| Yes (n=16)                                                          | 4.37 ± 0.72        | 4.43 ± 0.63        | 3.62 ± 1.15 | 4.31 ± 0.87 | 4.50 ± 0.63 | 3.82 ± 0.91 |
| No (n=30)                                                           | 4.50 ± 0.63        | 4.47 ± 0.63        | 3.03 ± 1.30 | 4.0 ± 0.78  | 4.17 ± 0.79 | 3.86 ± 1.10 |
| p-value                                                             | 0.545              | 0.882              | 0.133       | 0.336       | 0.153       | 0.878       |
| <b>Behavior towards Diabetes Management</b>                         |                    |                    |             |             |             |             |
| Do you monitor your blood glucose level regularly?                  |                    |                    |             |             |             |             |
| Yes (n=42)                                                          | 4.45 ± 0.63        | 4.48 ± 0.59        | 3.26 ± 1.30 | 4.19 ± 0.80 | 4.33 ± 0.72 | 3.84 ± 1.05 |
| No (n=4)                                                            | 4.50 ± 1.00        | 4.25 ± 0.96        | 3.00 ± 0.82 | 3.75 ± 0.96 | 3.75 ± 0.96 | 3.89 ± 0.93 |
| p-value                                                             | 0.892              | 0.493              | 0.698       | 0.307       | 0.139       | 0.890       |
| Do you share your blood glucose level data with your physician?     |                    |                    |             |             |             |             |
| Yes (n=39)                                                          | 4.54 ± 0.60        | 4.56 ± 0.55        | 3.26 ± 1.33 | 4.23 ± 0.81 | 4.36 ± 0.74 | 4.03 ± 0.87 |
| No (n=7)                                                            | 4.00 ± 0.82        | 3.86 ± 0.69        | 3.14 ± 0.90 | 3.71 ± 0.76 | 3.40 ± 0.74 | 3.47 ± 1.22 |
| p-value                                                             | 0.044 <sup>a</sup> | 0.004 <sup>a</sup> | 0.830       | 0.124       | 0.104       | 0.053       |
| <b>Usage of smart phone application</b>                             |                    |                    |             |             |             |             |
| Do you have Sehhaty application in your/your family members' phone? |                    |                    |             |             |             |             |



|                                                        |             |             |             |                    |                    |             |
|--------------------------------------------------------|-------------|-------------|-------------|--------------------|--------------------|-------------|
| Yes (n=44)                                             | 4.45 ± 0.66 | 4.45 ± 0.63 | 3.20 ± 1.29 | 4.18 ± 0.82        | 4.29 ± 0.73        | 3.89 ± 1.01 |
| No (n=2)                                               | 4.50 ± 0.71 | 4.50 ± 0.71 | 4.00 ± 0.00 | 3.50 ± 0.71        | 4.00 ± 1.41        | 3.00 ± 1.00 |
| p-value                                                | 0.925       | 0.921       | -           | 0.252              | 0.592              | 0.130       |
| Do you use Sehhaty application in Diabetes Management? |             |             |             |                    |                    |             |
| Yes (n=17)                                             | 4.59 ± 0.62 | 4.59 ± 0.62 | 3.47 ± 1.42 | 4.47 ± 0.80        | 4.65 ± 0.49        | 4.14 ± 0.95 |
| No (n=29)                                              | 4.38 ± 0.68 | 4.38 ± 0.62 | 3.10 ± 1.17 | 3.96 ± 0.78        | 4.07 ± 0.80        | 3.75 ± 1.04 |
| p-value                                                | 0.303       | 0.260       | 0.349       | 0.041 <sup>a</sup> | 0.010 <sup>a</sup> | 0.197       |

<sup>a</sup>p-value significant

### Discussion:

The present study is the first to reports the prevalence of awareness about smart glucometer and the perception of type 2 diabetes patients on the usage of smart glucometer in diabetes management from Eastern Province of Saudi Arabia. The study results reflect that the type 2 diabetic patients are not well-informed about the availability (59.0%) and usage (25.6%) of the technology in diabetes management. This finding suggests that awareness programs are required to educate the target population about the gadgets that can help them to manage the disease effectively. Further, it was observed that the participants agreed (score higher than 4) that smart glucometer would help them in effective management of their disease. Especially the participants who had the behavior of sharing their blood glucose levels with the physicians agreed that the linking of smart glucometer with Sehhaty application would help to improve their diabetes management. The result highlights that the participants are having positive attitude for an integrated system of the healthcare service delivery using the technology for the management of diabetes remotely.

In the present study, monitoring of the blood glucose levels was 85.9%, while the sharing of the data with physicians was 73.1%. However, a study carried out in Saudi Arabia among the patients with type 1 or 2 diabetes using insulin reported a higher prevalence of monitoring the blood glucose level (95%) and lower prevalence of sharing the data with their physicians (57%), this difference might have arisen due to the differences in the type of treatment [13].

Further, the study reported that 55% of the participants recorded the data on paper, while the remaining used digital devices like laptops and smart phones. Moreover, they reported digitally recorded blood glucose measurements were shared three times higher than recorded on paper [13].

A survey carried out in Pakistan among type 1 and 2 DM patients on perception and understanding of DM technology reported 32/40 participants believed that technology will improve diabetes care and 22/40 felt that it would help to decrease risk of DM complications [14].

An intervention study carried out in Sri Lankan patients with diabetes reported that the usage of smart glucometer manager designed to support self-management of diabetes showed a positive correlation with A1c improvement [15].

A study conducted among type 2 DM in Australia on mobile phone applications and their use in self-management of type 2 diabetes mellitus reported that the patients who used mobile application had improved their T2DM self-management and health [8].

**Limitation:** The present study has a few limitations. Firstly, the questionnaire was distributed online which might have resulted in non-representativeness of samples, as the target population not having the access to

internet, and smart devices might have been missed. Secondly, as the study was carried out only in Eastern Province, the results have limited generalizability and as the survey was self-administered there is a possibility of occurrence of social desirability bias. Lastly, this study was a short-term project and the time constraint resulted in small sample size.

**Strength:** This is the first study, which reports about the awareness and usage of smart glucometer in diabetes management. The present study findings provide an insight into the perception of type 2 DM patients from Eastern Province on smart glucometer usage in diabetes management. Though the sample size of this study is less, the results of this study may guide the researchers to develop a larger study to know about barriers and facilitators associated with the smart glucometer use in diabetes management in Saudi.

#### **Conclusion:**

The awareness about smart glucometer is moderate among the type 2 DM patients and usage of smart glucometer for monitoring blood glucose level is very low in Eastern Province. The participants agreed that the use of smart glucometer will help them in diabetes management and linking of smart glucometer with Sehhaty application will improve their diabetes management and reduce the errors in sharing the data with the physicians. The participant's behavior of sharing the blood glucose levels with their physician and using Sehhaty application for diabetes management was associated with their perception on smart glucometer usage.

#### **Declarations:**

**Conflicting interests:** The authors declare that there is no conflict of interest.

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**Contribution:** SA: Concept and design of the study, data acquisition, statistical analysis and writing of the article. ZA: Researched literature and conceived the study, co-writing of the article, and interpretation of data. NBJ: Concept and designing of the study, analysis of data, interpretation of results and final editing of the article. All authors have reviewed and approved the final version of the article.

**Ethical approval:** The study was performed according to Helsinki Declaration and the Institutional Review Board of Saudi Electronic University reviewed and approved the research study (SEUREC-4428, dated: 6/2/2023).

**Informed consent:** All participants provided written informed consent before participating in the survey.

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