How to Cite:
Shaqra, . S. S., Bashawri, H. A., Bahadur, . R. Y., Bahadur, . O. Y., Abdulmajeed , . R. H., Alshalihi, . M. M., Alharbi, A. A., & Alharbi, K. F. (2022). Assessment of diabetes mellitus related knowledge and its association with glycemic control level among adult diabetic patients attending ministry of health primary health care centers in Makkah al Mukarramah, Saudi Arabia. *International Journal of Health Sciences*, *6*(S7), 6429-6459. https://doi.org/10.53730/ijhs.v6nS7.13619

Assessment of diabetes mellitus related knowledge and its association with glycemic control level among adult diabetic patients attending ministry of health primary health care centers in Makkah al Mukarramah, Saudi Arabia

Sultan S. Shaqra
Family Medicine associate consultant, Department of Primary care, King Abdullah medical city, Makkah, Saudi Arabia
Email: Sultan_s.s@hotmail.com

Hisham A. Bashawri
Preventive Medicine Consultant, Department of Community and Prevention Medicine, Ministry of Health, Makkah, Saudi Arabia
Email: HI-BASHAWRI@moh.gov.sa_

Ruba Y. Bahadur
Family Medicine Resident, Department Family medicine, Family Medicine Academy, Makkah, Saudi Arabia
Email: Ruba.Bahadur@gmail.com

Ola Y. Bahadur
Medical intern, College of medicine, King Saud bin Abdulaziz University for Health Science, Jeddah, Saudi Arabi
Email: Ola.yb19@gmail.com

Ruaa Hussain Abdulmajeed
Consultant of Family Medicine, Department of Primary care, King Abdullah medical city, Makkah, Saudi Arabia
Email: Abdulmajeed.r@kamc.med.sa

Mashael Masoud Alshalihi
Family Medicine associate consultant, Department of Primary care, King Abdullah medical city, Makkah, Saudi Arabia
Email: Alshalihi.m@kamc.med.sa

Abrar Abdulaziz Alharbi
Family Medicine associate consultant, Department of Primary care, King Abdullah medical city, Makkah, Saudi Arabia
Email: Alharbi.a4@kamc.med.sa

Kholoud Faisal Alharbi
Family Medicine associate consultant, Department of Primary care, King Abdullah medical city, Makkah, Saudi Arabia
Email: kholoud1412@gmail.com

***Abstract*---**Background: Diabetes mellitus (DM) has a high prevalence rate in Saudi Arabia. Patients must have sufficient knowledge about DM to improve their self-management skills and prevent complications. This research was conducted to estimate the knowledge level among diabetic patients attending primary care centers about DM and its impact on their health. Methods A cross-sectional study was conducted on a sample of type II diabetic patients in Makkah city. Self-administered validated Arabic questionnaire was used to collect sociodemographic data, knowledge about the disease, and the level of control. Results The study included 293 patients, 50.2% were females and 85.3% were Saudis. Mean age was 50 years (ranged 31 -77). Blood glucose was uncontrolled in 90.4% of patients. The overall knowledge regarding DM score mean 8.3±2.5 SD (ranged 3 -16) out of 20 and a median (Interquartile range) of 8 (7-10). Higher educated patients (p=0.043) and those who practiced physical activities (p=0.007) were more knowledgeable than their counterparts. None of the diabetes-related variables was significantly related with participants` information. Score of knowledge was not significantly related with level of glycemic control. Conclusions: Patients with type II DM in Makkah had insufficient knowledge about their disease, its complications, and treatment. Blood glucose was uncontrolled among most patients with no association with their knowledge about diabetes.

***Keywords*---**Diabetes Mellitus, Type 2, Health Knowledge, Attitudes, Practice, Primary Health Care/education, Glycemic Control.

Introduction

Diabetes Mellitus is a significant health problem globally. It affects all ages and has several complications if not discovered early and treated adequately. The American diabetes association defined diabetes as" Group of metabolic disorders characterized by hyperglycemia which result from defects either in insulin secretion, insulin action, or both. The chronic hyperglycemia will cause damage, dysfunction, and failure of various organs, especially the eyes, kidneys, nerves, heart, and blood vessels" [1].To prevent diabetes complications, the patients need to control blood glucose to the recommended levels to delay such complications. The control level mostly is measured by glycosylated hemoglobin (HbA1C). The

glycosylated hemoglobin reflects the average blood glucose level over the course of the red blood cell's lifespan, roughly 120 days (3 months). Glycemic control considered acceptable when HbA1C is less than 7% in most adult diabetic patients [2].

World health organization (WHO) estimated the number of diabetic patients by around 422 million adults aged over 18 years in 2014 globally [3]. In the United States,30.3 million people have diabetes which is about 9.4% of United States population. The diabetic and non-diabetic patients cost the United States 322 billion dollars yearly either directly or because of diabetes-related compromises [4].

In Saudi Arabia, there are limited studies represent the prevalence of diabetes and actual number of diabetic patients. The prevalence of diabetes varies between studies. In a study conducted by Al-Rubeaan between 2007-2009,the prevalence of diabetes mellitus type 2 was approximately 25.4%with 40.3% being unaware of their disease [5]. In a more recent study conducted by Nasser M Al-Daghri in 2011, the crude prevalence of diabetes mellitus type 2 was 23.1%, and age-adjusted prevalence was 31.6% [5]. As a matter of fact, diabetes has expanded ten times in Saudi Arabia over the past 3 centuries [6].

To reduce previous numbers, we need to study the factors that help us to achievebetter glycemic control and to delay or prevent diabetes complications among diabetic patients. In meta-analysis study conducted by Susan L. Norris et al. in 2002 to evaluate the benefit of self-management education programs on HbA1C in adults with type 2 diabetes. Education programs improved HbA1C level which leads to better glycemic control [7]. The benefits from education programs lead us to evaluate the level of knowledge among diabetic patients and to study the impact of their knowledge on glycemic control levels.

In a retrospective study done in the United States by "Padmalatha Berikai" in 2007 among patients who received Diabetes Self-Management Education "DSME" offered by American Diabetes Association "ADA" the study concluded that" the patients who received DSME programs archived better glycemic control" [8].

In a study conducted by Sheikh Mohammed Shariful Islam in Bangladesh, 2015 to evaluate the level of knowledge and glycemic control among 515 diabetic patients. Among participants, 45.6% had a good level of knowledge, 37.7% had a moderate level of knowledgeand 16.7% had a poor level of knowledge. Correlation matrix showed a negative association between diabetes knowledge score and glycemic control ($p < 0.001$) [9].

In another randomized control trial study conducted in Port Said in Egypt by Marwa M. Ahmed et al. in 2015 to study the effect of educational intervention on knowledge, attitude, and glycemic control among 100 type 2 diabetic patients. They received three educational sessions about diabetes. Knowledge, attitude and glycemic control were assessed before and three months after the intervention. The educational intervention had significantly increased the participant's knowledge, attitude and efficiently improved patients glycemic control levels [10].

Another study conducted by Saad M. Al-Shareef et al. at King Saud medical city in Riyadh in 2017 which studied the relation between the role of knowledge about diabetes and glycemic control among 512 diabetic patients revealed that there are positive associations were found between medication adherence and diabetes knowledge. No associations were found between diabetes knowledge and glycemic control [11].

In a study conducted in Al-Kharj city by Khaled Aldossari et al. in 2015 to evaluate the level of knowledge, attitude, and practice among 393 diabetic patients.The study concluded that only 26% of the patients hada good level of knowledge while 57% had an average level and only 17% of the participant had poor level of knowledge [12].

In other study conducted by Noohu Abdulla Khan in Abha city, Saudi Arabia on 2012-2013 (published 2015) among 343 type 2 diabetic patients about knowledge, attitude, awareness and glycemic control. It was found that 35.12% of the patients had knowledge about diabetes mellitus. Only 15.12% had awareness about their diabetes type. The study showed that improvement in diabetic patient's knowledge, awareness, and attitude about the disease could do productive changes in the glycemic control [13].

As previously mentioned, there are several studies conducted to measure the level of knowledge among diabetic patients but only a few studies conducted to explore the relationship between the level of knowledge and level of glycemic control. No similar studies conducted in Makkah province including Makkah Al-Mukarramah city which has different demographic features, population, education level and cultural habits according to researcher knowledge. Measuring the level of knowledge is a valuable tool that helps us to evaluate and interfere to achieve better glycemic control since the previous studies recommended to conduct similar researches in other areas of Saudi Arabia to estimate the level of knowledge and its impact on glycemic control.

1.1 Rationale

Diabetes is a common chronic disease in Saudi Arabia [5], and its complication will lead to significant health consequences and financial compromises. By conducting this study, the researcher will evaluate the level of knowledge and its impact on glycemic control since there arecontradictory results as previously mentioned. All previous studies conducted either in foreign countries or other regions of Saudi Arabia. Up to the researcher knowledge, there are no studies conducted in the western area of Saudi Arabia including Makkah Al-Mukarramah which has its demographic characteristics, cultural habits, and also different education level. Many studies recommended measuring the knowledge level among population since this will help us to interfere and educate the patients if necessary to achieve better glycemic control [8,9,10,11].

Finally, the researcher is interested in diabetes mellitus because ofa strong family history in each generation of researcher's family and they need more knowledge since most of them are non-compliant with poor glycemic control.

1.2 Aim of the Study

This study aims to assess the patients' level of knowledge and its impact on their level of glycemic control

1.3 Objectives:

1.3.1 Primary objectives

To estimate the level of knowledge about diabetes mellitus among diabetic patients attending primary health care centers in Makkah Al-Mukarramah, 2018.

To determine the association between knowledge level and glycaemic control among diabetic patients attending primary health care centers in Makkah Al-Mukarramah, 2018.

To identify the factors that may influence the level of knowledge about diabetes mellitus among diabetic patients attending primary health care centers in Makkah Al-Mukarramah, 2018.

1.3.2 Secondary objective

To estimate the prevalence of diabetic patients with controlled glycemic level depending on HbA1C reading who were attending primary health care centers in Makkah Al-Mukarramah, 2018.

Materials & Methods

2.1 Study Design

A cross-sectional study was conducted to measure the level of knowledge and its impact on glycaemic control among diabetic patients.

2.2 Study Population

All diabetic patients who attended the primary health care centers in Makkah Al-Mukarramah within the city limits (urban area) during the period of the study were eligible for the study, provided that they had the inclusion criteria.

Eligibility Criteria:

a. Inclusion Criteria:

1. All adult patients (aged 18 years or older), males and females.

2. Type 2 diabetic patients attending primary health care centers inside Makkah Al-Mukarramah (within city limits/urban area).

3. Patients who can read and write in the Arabic and English languages.

b. Exclusion Criteria:

1. Unavailable HbA1C reading (either from the patient's files or lab result paper with written date).

2. Type 1 diabetes mellitus and gestational diabetic patients.

3. Severe ill patient or patients needed to transfer them to emergency department.

2.3 Study Area

Makkah Al-Mukarramah is city located in the western region of Saudi Arabia. It is the holy city for every Muslim in the earth. Makkah Al-Mukarramah has the attention of Saudi government to improve and develop its infrastructure for both city residents' and pilgrims' comfort. Regarding education, there are many schools for each level and one university named Umm Al-Qura University which has medical college. There are governmental and private healthcare sectors in Makkah. Also, there are 85 primary health care centers in Makkah region under seven sectors supervised by the Directorate of Health Affairs of Makkah Al-Mukarramah. Three sectors inside Makkah city (within city limits/urban area) with 37 primary health care centers underneath and four sectors are outside Makkah (outside city limits/rural area) with 48 primary health care centers to help villages related to Makkah Al-Mukarramah. The three healthcare sectors inside Makkah Al-Mukarramah are Al-Ka'akya healthcare sector with 11 primary healthcare centers, Al-Adl healthcare sector with 12 primary healthcare centers and Al-Zahir healthcare sector with 14 primary healthcare centers.

2.4 Sample Size

Sample size was calculated by using (raosoft.com) website while setting the confidence level of 95% and a sample error of 5%. The estimated sample size was 293 patients. The total number of populations is 27,087 who represents the total number of diabetic patients inside Makkah Al-Mukarramah limits (urban area) [14]. The researcher increased the sample size by 10% to compensate the incomplete or inadequate data and to fulfil the gaps during data collection period. The estimated prevalence is 26% which represents the level of good knowledge in the recent study which conducted in Al-Kharj city to evaluate the level of knowledge, attitude and practice among diabetic patients [12].

2.5 Sampling Technique

The healthcare sectors inside Makkah Al-Mukarramah are Al-Zahir sector with 11,327 diabetic patients, which represents (42%) of all diabetic patients inside Makkah Al-Mukarramah, Al-Adl sector with 8164 diabetic patients, which represents (30%) and Al-Ka'akya sector with 7596 diabetic patients, which represents (28%). Each primary health care center was chosen using a simple random sample technique with equal chance to be chosen. The total number of selected primary health care was three centers (i.e. one primary health care center in each sector) to cover the sample size. All primary health care centers in these three sectors were enumerated starting from number 1 and according to the

number of centers in each sector. The researcher used (randomizer.org) website to select the three primary health care centers. Regarding patients' selection, the researcher selected all adult diabetic patients attending the selected primary health care centers during data collection period (3 weeks initially) because of large sample size, data collection time limitation and limitation in team members. Also, the patients not followed up regularly according to their appointments and that decreased the number of patients attending the primary health care center in each day. The patient's selection was proportional depending on the percentage of diabetic patients in each healthcare sector to ensure that the sample represents the population as in Table1.

2.6 Data Collection Tool

The researcher used self-administered questionnaire derived from previous similar study after taking permission from the main author [9,15]. It was validated before and after translation. The pilot study was conducted on 10% of sample size and was reviewed by a statistician. The questionnaire was initially in the English language, and then translated to the Arabic language then converted again to the English language to make sure that every question is clear and near to the original question meaning. In the first page there was information about the study, the participant rights, written informed consent, reassurance about keeping participants information confidential, and finally researcher name and contacting methods (phone number, email). The questionnaire contains three parts: the first part is about personal data, sociodemographic data, height, weight, and data about other chronic diseases. The second part tests the level of knowledge of participants regarding general information about the disease, symptoms, pharmacological management, and complications in addition to physical activity level assessment which derived from International Physical Activity Questionnaire (IPAQ), which is a validated global questionnaire used to assess the level of physical activity [15]. The final section is about measuring the level of control by using last HbA1C reading (done prior six months or less from data collection day) taken from the patient's files to avoid recall bias in addition to questions to assess the presence of diabetes complications and type of treatment.

2.7 Data Collection Technique

The questionnaire was distributed to all patients attending chosen primary health care centers during the data collection period (which is three weeks initially). The researcher divided the sample size between selected primary health care centers equally because lacking diabetic patients numbers in each center in addition to 10% of a sample size to fill any gaps during data collection. In each primary health care, the number of the questionnaires was equally divided between male and female sections in primary health care because it is separated department. It was distributed in the waiting area after taking their Body Mass Index (BMI) from their files or calculate it after measuring their heights and weights using well-calibrated devices. Also, their HbA1C was recorded from available data after BMI during working hours of centers. The distribution process was carried out by well-trained Interns doctors from Umm Al-Qura University. Regarding female section, the questionnaire was distributed either by trained female medical students or by nurses working at the primary health care center

after proper training. The researcher used both Arabic and English versions of the questionnaire to ensure that every patient can participate and included in this study as possible. After that, the researcher collected the paper from the interns and students/nurses for data entry and analysis and provide educational material to all participants to thank them for their effort.

2.8 Study Variables:

Dependent Variable: level of knowledge of diabetes mellitus among diabetic patients.

Independent variables:

1) Age.

2) Gender.

3) Nationality (Saudi, Non-Saudi).

4) Marital status.

5) Education level.

6) Occupation.

7) Patient income/Family income.

8) Glycaemic control level (HbA1C).

9) Duration of disease.

10) Physical activity level.

11) Body Mass Index (BMI).

12) Positive family history of diabetes mellitus.

13) Presence of another chronic disease.

14) Treatment type (oral, injection, single treatment, multiple treatment).

2.9 Data Entry and Analysis

The researcher used the Statistical Package for Social Sciences (SPSS) program version 25.0 for data entry and analysis. Descriptive statistics in the form of number and percentage for categorical variables and mean±standard deviation, median, interquartile range and mean ranks for continuous variables were utilized. Since the knowledge score was abnormally distributed as indicated a significant Shapiro-Wilk test, non-parametric statistical tests were used for analysis. Mann-Whitnet test was applied to compare two groups whereas kruskal-Wallis test was applied to compare, more than two groups.

Significance: the researcher selected a p-value less than 0.05 as a level of significance and considered results significant if p-value <0.05.

2.10 Pilot Study

The researcher performed a pilot testing on 10% of sample size in another primary health care center from different healthcare sector. A full analysis was performed and checked. No changes were made as there was not any indication and it was removed in the final paper.

2.11 Ethical Considerations:

• Permission from research committee in the joint program of family medicine in Makkah Al-Mukarramah was obtained:

• Permission from director of the joint program of family medicine in Makkah Al-Mukarramah was obtained.

• Permission from the Directorate of Health Affairs of Makkah Al-Mukarramah was obtained.

• Permission from Administration of Public Health in Makkah Al-Mukarramah was obtained.

• Approval from the health care sectors administrators was obtained.

• Approval from primary health care directors was obtained.

• Written consent was obtained from all participants.

• All information was confidential, and results will be submitted to the department.

2.12 Relevance & Expectations:

By conducting this research, the level of knowledge was estimated and recommendation regarding the results were performed which might be an increase in patients' educational programs regarding diabetes. Also, according to study results if it leads to better glycaemic control this will be considered as an important result which clarifies the importance of educational programs as it is straightforward, affordable and leads to better outcome.

2.13 Budget:

The research was self-funded

Results

The study included 293 patients. They were recruited from the three healthcare sectors inside Makkah Al-Mukarramah, proportional to the population size in each sector as shown in figure *1*. Table *2* summarizes their socio-demographic characteristics. Nearly half of them (50.2%) were females and majority (85.3%) were Saudis. Their age ranged between 31 and 77 years with an arithmatic mean±Standard deviation (SD) of 50.01±9.33 years. Majority were married (85%).

Slightly less than half of the patients (46.7%) had higher education. Almost one-third of them (30.7%) were governmental employees whereas 22.5% were retired.

The personal income of almost two-thirds of the participants (62.4%) wasbelow 6000 SR/month whereas the family income of almost half of them (49.5%) ranged between 6000 and 12000 SR/month.

From figure *2*, it is evident that majority of the diabetics were either overweight (33.1%) or obese (49.1%).

History of other chronic diseases was observed among 44.4% of typr 2 diabetic patients as illustrated in figure *3*; mainly hypertension (32.4%), asthma (12.3%) and heart disease(11.9%). Figure *4*

Glycemic control

It is realized from figure *5* that the blood glucose was uncontrolled among the majority of diabetic patients (90.4%).

Diabetes-related characteristics

Table *3* presents the diabetes-related characteristics of diabetic patients. The duration of diabetes ranged between 0ne and thirty years with a mean±SD of 6.27±5.01 years. Thirty percent of patients reported alwys measuring of the blood sugar at home whereas 20.1% reported never measuring it. Majority of the paryicipants (86%) reported alwys taking diabetes medications regularly. Oral hypoglycemics were taken by majority of them (91.5%) whereas insulin was taken by 31.7% of them. Diabetic medications were taken three times daily by 39.6% of the patients and twice by 37.5% of them. Family history of diabetes was mentioned by almost half of them (47.4%).

About half of the patients (48.8%) reported following a diabetic diet as illustrated in figure *6*.

Habitual charcateristics

The rate of smoking among the diabetic patients was 33.8% as shown in figure *7*.

History of performing any physical activity rather than daily living activity was mentioned by only 26.3% of diabetic patients. Among those performng physical activity, level of physical activity was moderate among 42.9% of the diabetics

whilr it was vigorous among only 10.4% of them. Duration of performing physical activity ranged between one and three days/week among more than half of patients (55.8%) whereas it exceeded 5 days/week in only 16.9% of them. Duration of performing physical activity/day ranged between 30 and 49 minutes in 42.8% of the patients whereas it exceeded 60 minutes in only 2.6% of them (Table *4*).

Knowledge about diabetes

Table *5* summarized the responses of the participants to kanowledge statements regarding diabetes. Most of them (74.4%) could recognize that diabetes medications should be taken continuously. About two-thirds of the diabetics knew that cuts and abrasions on diabetes heal more slowly in diabetic patients (62.1%) and if they are diabetics, their children have a higher chance of being diabetics (61.6%). About half of them knew that diabetes can cause damage to the kidneys (56.7%), a fasting blood sugar level of 210 is too high (56%), lack of or resistance to insulin is a cause of diabetes (53.2%) and diabetes can cause loss of feeling in the hands, fingers,and feet (51.9%). On the other hand, about one-fourth of the patients or lower could recognize that frequent urination and thirst are not signs of low blood sugar (27.6%), using insulin injections are not important to treat all diabetic patients (25.3%), the best way to diagnose diabetes is not by doing urine analysis (22.5%), eating too much sugar and other sweet foods is not a cause of diabetes (16.4%) and diabetes is not caused by severe psychological stress or by psychological shock (11.3%).

The overall knowlegde ragarding diabetes mellitus score was abnormally distributee as evidenced by significant Shapiro-Wilk test, $p<0.001$. The score ranged between 3 and 16, out of a posible total of 20 with a mean±SD of 8.3±2.5 and a median (Interquartile range) of 8(7-10) (Figure *8*).

Factors associated with Diabetes mellitus knowledge

Socio-demographic factors

The highest level of knowledge regarding DM was observed among diabetic patients of intermediate school educational level (mean rank was 174.25), followed by higher educated patients (mean rank was 156.20) whereas the lowest level was reported among uneducated or elementary school educated patients (mean rank was 129.87). These differences were statistically significant, $p=0.043$. Other socio-demographic characteristics of patients were not significantly associated with knowledge regarding DM. Table *6*

There was no significant correlation between age of the participants and their knowledge about diabetes mellitus (Spearman's correlation coefficient=0.04, 9=0.500). Figure *9*

Body mass index

It is evident from table *7* that there was no statistically significant association between body mass index of the participants and their knowledge score about diabetes mellitus.

Medical factors

Diabetes-related

It is demonstrated from table *8* that none of the studied diabetes-related factors (measuring blood glucose level at home, taking diabetes medication regularly, type of diabetes treatment used, number of used diabetic medications, history of following a diabetic diet and family history of diabetes) was significantly associated with participants` knowledge about diabetes mellitus.

History of other chronic diseases

Patients with history of other chronic diseases had higher level of knowledge about DM compared to those without other chronic diseases (mean rank was 160.22 versus 140.76). However, this difference did not reach the statistical significance level, p=0.064 (Table *9*).

Habitual factors

Smoking

It is shown in table *10* that there was no statistically significant association between smoking history of the participants and their knowledge score about diabetes mellitus.

Physical activity

Table *11* shows that patients who reported history of performing any physical activity rather than daily living activity were more significantly knowlegeable about DM compared to those who did perform physical activities (mean ranks were 169.09 and 139.13, respectively), p=0.007. Other factors related to performing physical activity (level, duration (days/week and minutes/day) were not significantly associated with participants` knowledge about DM.

Glycemic control

Although the level of knowledge about DM was higher among patients whose HbA1c was <7% compared to those whose HbA1c was ≥7% (mean ranks were 169.14 and 144.66, respectively), the difference was not statistically significant, p>0.05 (Table *12*).

Discussion

On global level, Saudi Arabia has one of the highest prevalence rates of diabetes mellitus as according to a report by the Saudi Arabian Ministry of Health, approximately 2.5 million people were diagnosed with diabetes in 2010 [16]. It is mandatory for diabetic patients to have sufficient knowledge about the disease in order to improve their self-management skills and consequently prevent complications [17]. Despite the fact that diabetes is the most challenging health problem facing KSA, limited studies were conducted to assess patient`s knowledge regarding diabetes and its management.

In the present study, blood glucose was uncontrolled among the majority of diabetic patients (90.4%) and although the level of knowledge about DM was higher among patients whose HbA1c was <7% compared to those whose HbA1c was ≥7%, the difference was not statistically significant. This finding agrees with what has been reported recently in a study carried out in Riyadh by Al-Shareef et al, who concluded that diabetes knowledge was not associated with glycemic control [11]. Also, in Bangladish, a negative association between diabetes knowledge score and glycemic control has been observed [9]. In Abha city (KSA), Khan NA, et al reported that improvement in diabetic patient's knowledge and awareness regarding disease could result in changes in the glycemic control [13]. In a randomized control trial study conducted in Port Said (Egypt), the educational intervention had significantly increased the diabetic patient's knowledge and efficiently improved their glycemic control levels [10]. Recently, in Brazil, Gomes MB et al reported that diabetic patients who knew what is meant by HbA1c had a better glycemic control [18].

In the current study, the score of DM knowledge ranged between 3 and 16, out of a posible total of 20 with a mean±SD of 8.3±2.5 and a median of 8, which indicate insufficient level of knowledge. This conincides with what has been reported in Pakistan as only 13.6% of the type 2 diabetic patients had a good knowledge score [19]. On the other hand in Sri Lanka, a majority of type 2 diabetics (70.0%) had good or very good knowledge scores [17]. In Al-Kharj (KSA) [12], it was observed that more than half of type 2 diabetic patients had average (57%) and almost a quarter (26%) had good knowledge regarding DM and its self-management. In Abha city (KSA), 35.1% of the diabetic patients had sufficient knowledge about diabetes mellitus. However, only 15.1% were aware about their diabetes type [13]. In Oman [20], the knowledge of diabetes in a semi-urban area was described as suboptimal. In Bangladesh [21], 16% of diabetic patients (Type II) had good knowledge of DM. In another study conducted in Bangladesh, 45.6% of type 2 diabetic patients had a good level of knowledge [9]. In Democratic Republic of the Congo [22], majority (72.3%) of patients had poor knowledge about DM as they scored < 5 out of 10. In Cameron [23], Fezeu et al. observed that 80% of type 2 diabetics scored better than the total mean score. The variation observed in the knowledge level between different studies could be attributed to different socio-demographics of the participants, different resources and facilities as well as different tools used for defining level of knowledge.

Although the overall knowledge about DM in the present study was insufficient, almost three-quarters of the type 2 diabetic patients could recognize that diabetes

medications should be taken continuously, about two-thirds of the diabetics knew that cuts and abrasions on diabetes heal more slowly in diabetic patients and that the diabetes is an inherited disease. However, only 39.2% of the respondents could recognize that diabetes cannot be cured. Similarly, in another study carried out by Hashmi NR in Iran [24], majority of patients stated that diabetes is an inheritable disease; despite their overall DM knowledge level was inadequate. The same has been also observed in Sri Lanka [17]and Pakistan [25].

In the present study, only 56% of patients could recognize that a fasting blood sugar level of 210 is too high and 43.3% knew that HbA1c level<7% is the level of good control of the disease. This is consistent with findings of other studies carried out in the Asian [25] and African regions [17], where the majority of patients did not know the ideal blood glucose and HbA1c target levels.

As expected, more than 60% of the participants in this study didn't recognize that dates cause elevation in blood sugar level. This is an alarming figure as dates are a staple food in Saudi Arabia and form an essential part of the diet particularly during Ramadan, when they are traditionally eaten every evening to break the fast. Therefore, particular education about this issue is highly recommended for diabetic patients.

In the current study, 37.2% of the patients believed that it is not important to control the amount of taken foods as long as they take the diabetic medications as well as 30.2% believed that medication is more important than diet and exercise to control diabetes. Quite similar results have been reported in studies carried out in Sri Lanka [17] and Pakistan [24].

Concerning knowledge about diabetic complications, a considerable proportion of patients in the present study could not recognize neuropathy, retinopathy and kidney damage as complications of diabetes. The same has been reported by other [22].

Regarding factors associated with knowledge about diabetes mellitus, educational level of the participants was a significant factor associated with knowledge as the lowest educational level was associated with worst level of DM knowledge. The same has been observed by others in Congo [22].

None of the diabetes-related factors was associated with participants` knowledge about diabetes mellitus in this study. The same has been reported in a study carried out in USA by West and Goldberg [26]. However, other observed that a longer duration of the disease was associated with better knowledge [22].

Patients who reported history of performing any physical activity rather than daily living activity expressed higher level of knowledge about DM compared to those who did perform physical activities. The same has been observed in a recent study carried out in Senegal [27]. However, as a result of the design of the study we could not recognize which of the better knowledge about diabetes and practicing regularly physical activities leads to the other.

In this study, gender of patients was not significantly associated with knowledge about the disease. However, some similar studies carried out in Congo [22], and Cameron [23] observed that men were more knowledgeable about diabetes than women. They attributed this to lower educational level of women than men. However, in Brazil, women were more knowledgeable than men regarding DM [28].

Also, patient`s age was not related to DM knowledge in this study. This finding agrees with other studies carried out in Malysia [29]. However, in Congo [22], middle aged patients had better knowledge than older patients. Also, this was explained by higher educational level. In Switzerland [30], increasing age was positively associated with awareness of ofT2DM patients about their disease.

Strengths and limitations

Up to our knowledge, this is the first study of its kind to be conducted in Makkah among type 2 diabetic patients. The study has identified areas of gaps in patient knowledge, which could be utilized in organizing programmes to improve patient self-management. Despite of that, it has some limitations that should be acknowledged. First of all, the cross-sectional design of the study could not allow us to establish the causality of the study findings. Second, exclusion of a considerable percentage of patients due to unavailable HbA1C reading could be a limitation. Third, conduction of the study among only patients who attended primary healthcare centers could impact the generalizability of results. Finally, self-reporting of data is subjected to bias.

Conclusions

In the present study, type 2 diabetic patients in Makkah city had overall insufficient knowledge of DM, its complications and management. However, there was a sufficient knowledge regarding some few aspects of diabetes such as the continuous intake of diabetic medications and the inherited nature of the disease and its impact on slower healing of wounds. Higher educated patients, and those who practiced physical activities were more knowledgeable compared to their counterparts. However, none of the diabetes-related factors was associated with participants` knowledge about diabetes mellitus. Blood glucose was uncontrolled among the majority of diabetic patients with no association with their knowledge about diabetes.

Recommendations

1- The results shed light on the need for organizing comprehensive educational programs about different aspects of the diabetes, particularly for lowed educated patients.
2- Utilizing SMS service which could be an effective mean to transfer important information to patients about diabetes is recommended.
3- Primary healthcare staff should have an active role in educating diabetic patients about the disease, in particular the management and complications.
4- Establishing an effective system in keeping HbA1c results at primary health care centers is needed for further studies.

5- Further studies are recommended to assess diabetic knowledge in other health institutions as this study was only conducted in primary healthcare settings.

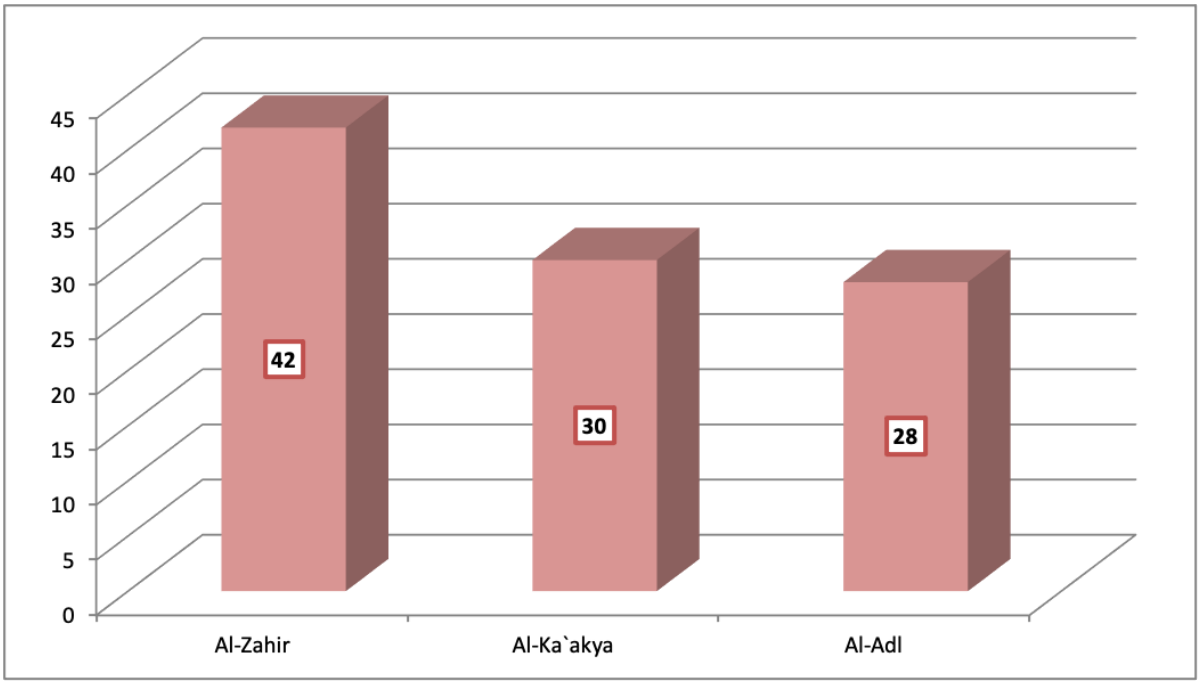

Figure 1. Distribution of the diabetic patients according to the healthcare sector, Makkah Al-Mukarramah

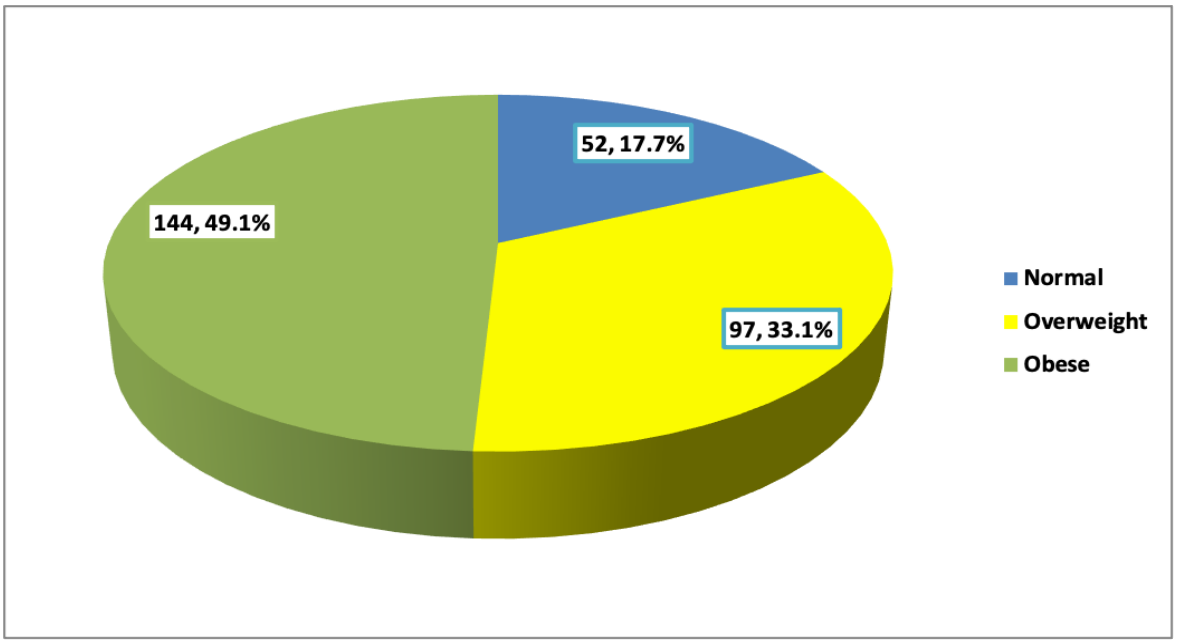

Figure 2. Distribution of the body mass index of the diabetic patients, Makkah Al-Mukarramah.

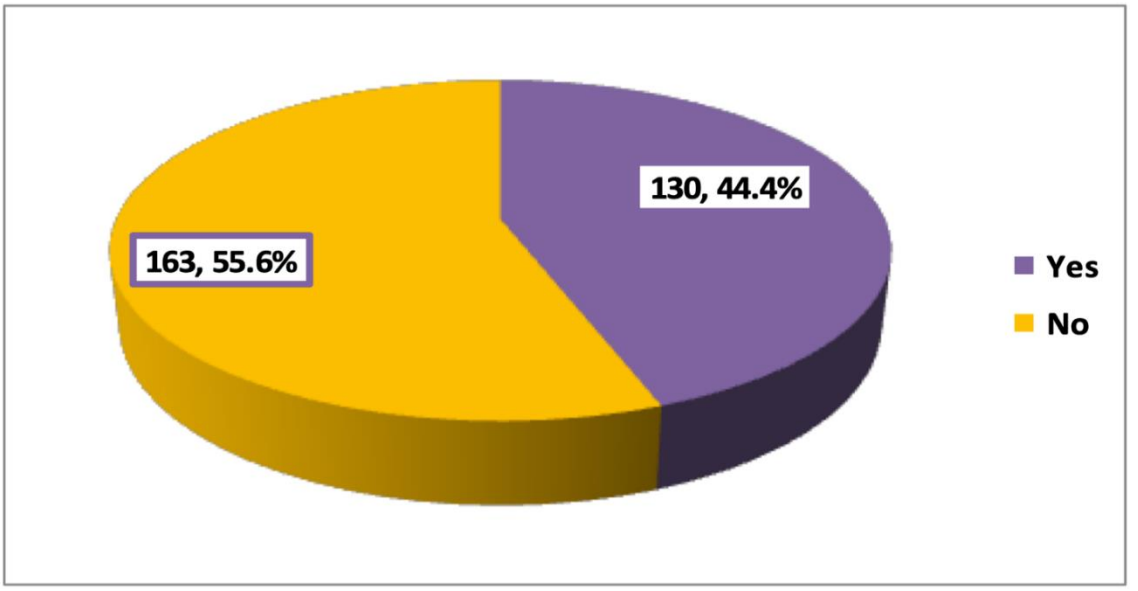

Figure 3. History of other chronic diseases among diabetic patients, Makkah Al-Mukarramah.

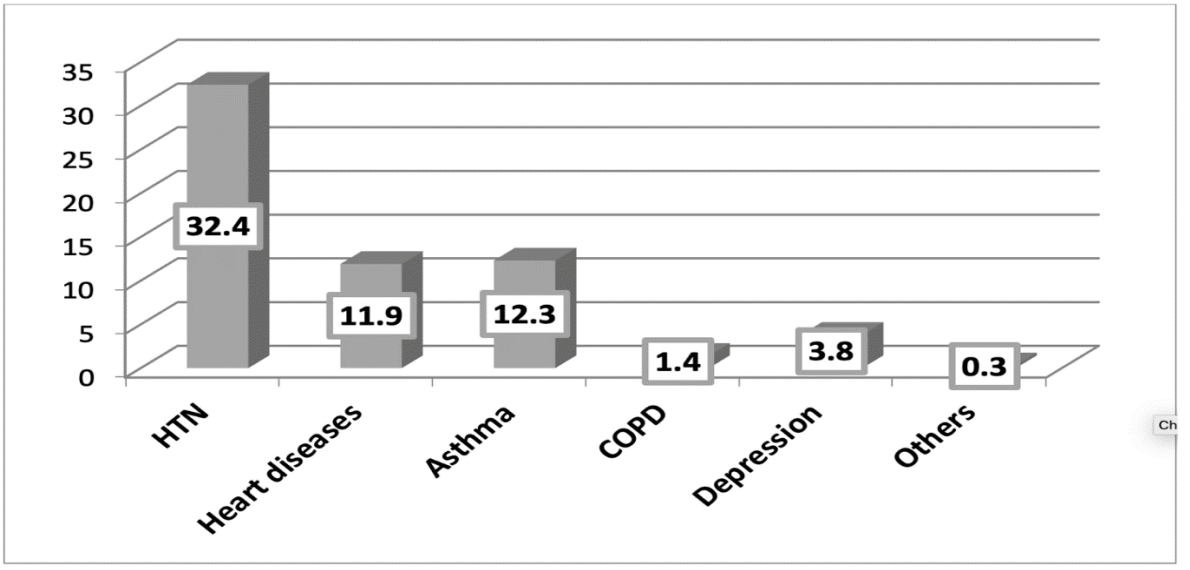

Figure 4. History of individual chronic diseases among diabetic patients. Makkah Al-Mukarramah.

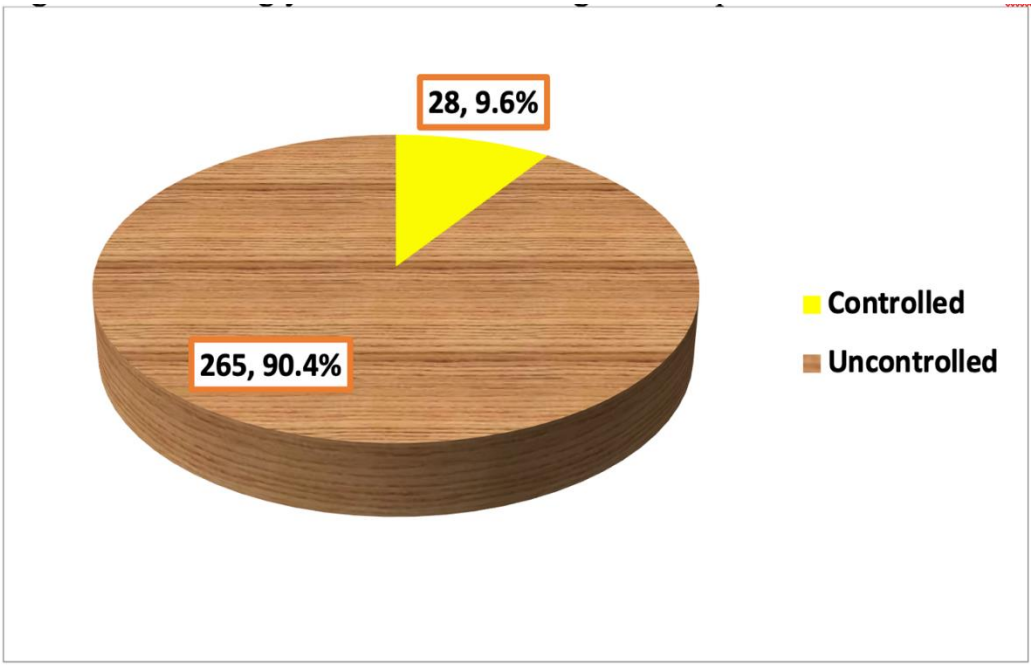

Figure 5. Level of glycemic control among diabetic patients. Makkah Al-Mukarramah.

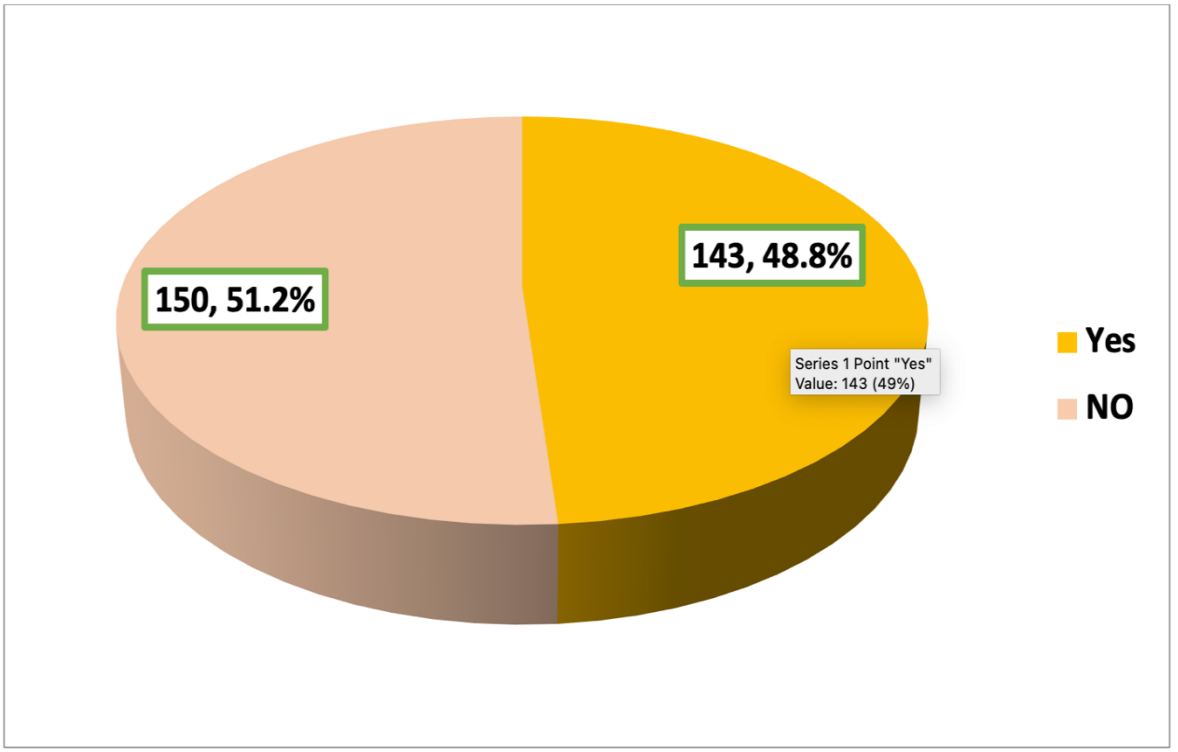

Figure 6. History of following a diabetic diet among diabetic patients, Makkah Al-Mukarramah.

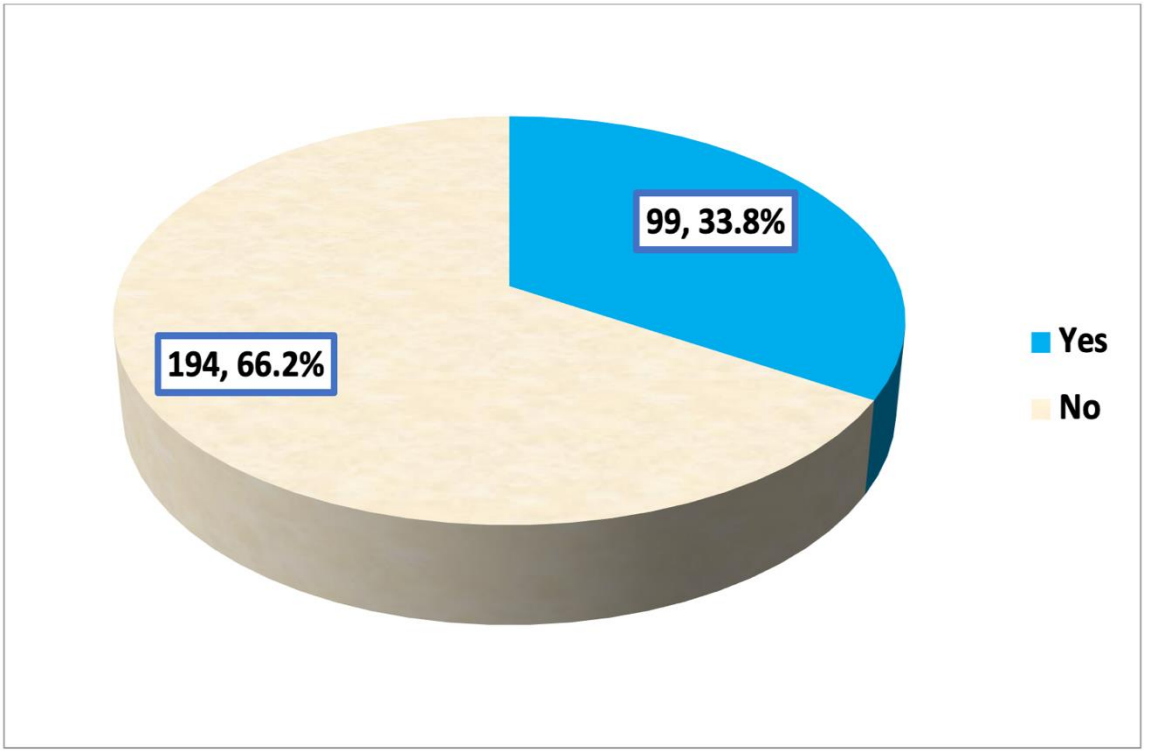

Figure 7. Smoking history among diabetic patients, Makkah Al-Mukarramah.

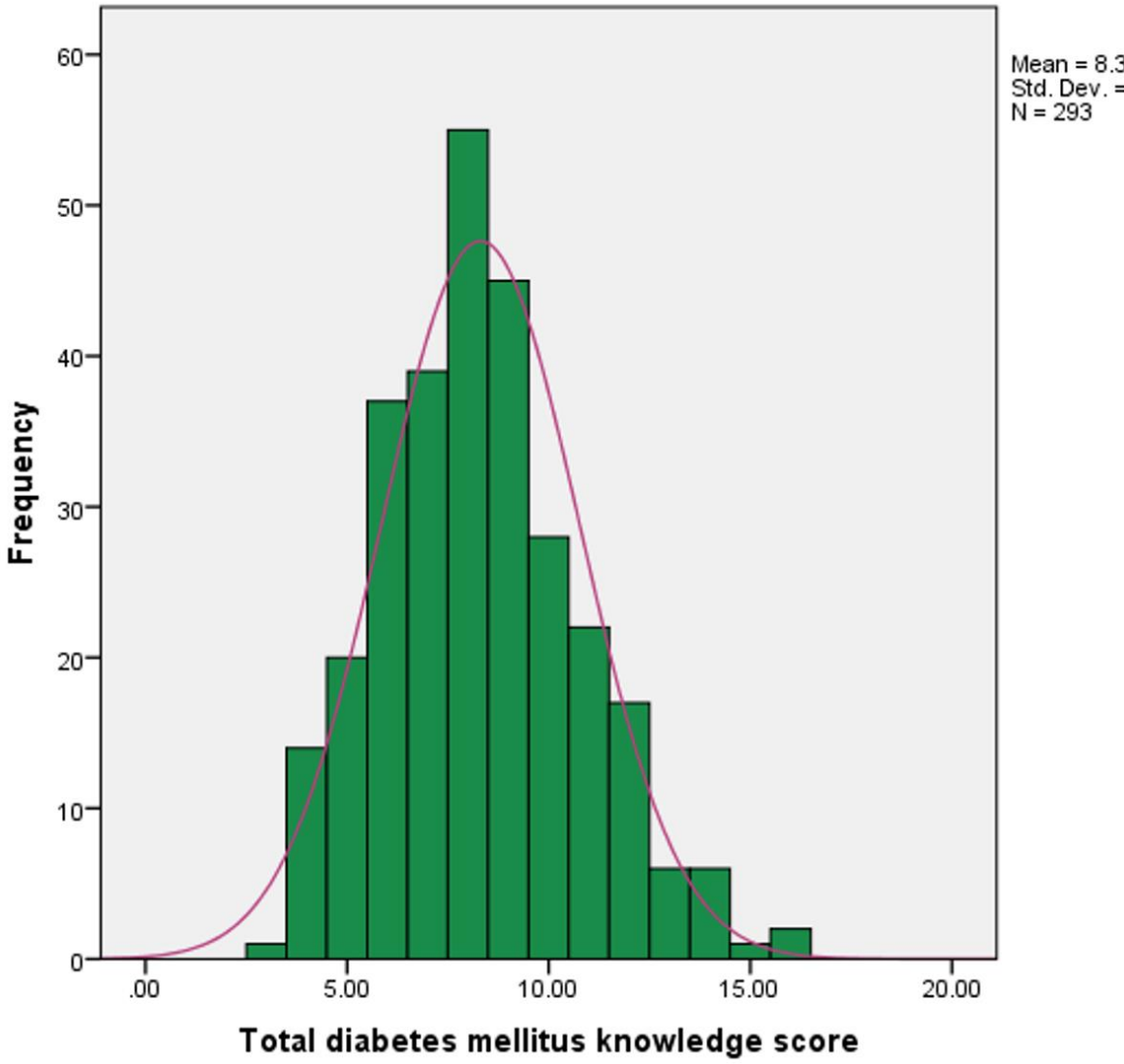

Figure 8. Distribution of the total knowledge score about diabetes and diabetic patients, Makkah Al-Mukarramah.

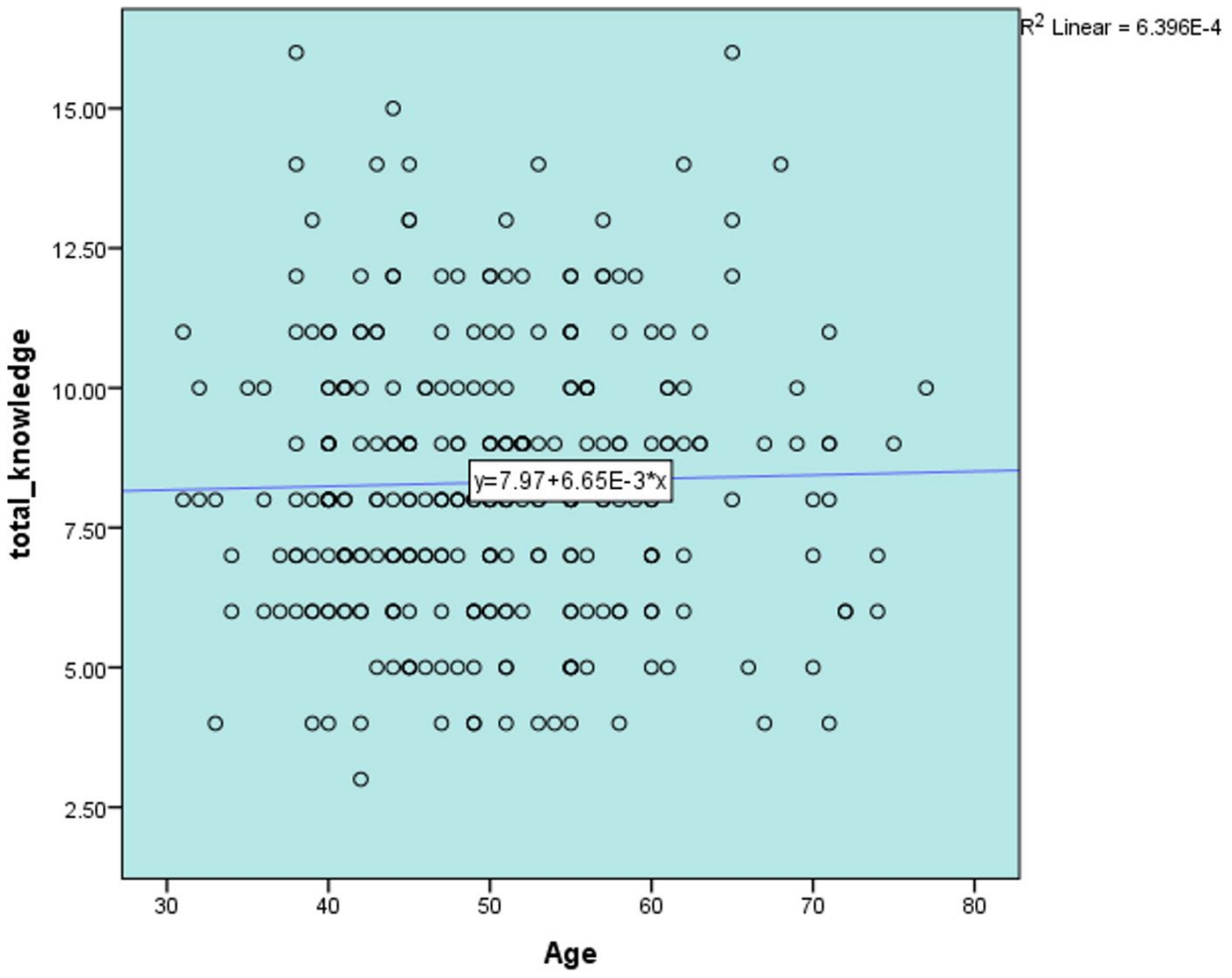

Figure 9. Correlation between diabetic patients` age and their knowledge regarding diabetes mellitus.

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Table 1: Percentage of diabetic patients in each healthcare sector

Health sector	Sample percentage	Sample number in each PHC	Male Section	Female Section
Al-Zahir	42%	123	62	61
Al-Ka'akya	30%	88	44	44
Al-Adl	28%	82	41	41

Table 2: Socio-demographic characteristics of the diabetic patients, Makkah Al-Mukarramah (n=293).

	Frequency	***Percentage***
Gender		
Male	*146*	*49.8*
Female	*147*	*50.2*
Nationality		
Saudi	*250*	*85.3*
Non-Saudi	*43*	*14.7*
Age (years)		
Range	*31-77*	
Mean±SD	*50.01±9.33*	
Marital status		
Single	*14*	*4.8*
Married	*249*	*85.0*
Divorced	*15*	*5.1*
Widow	*15*	*5.1*
Educational level		
Uneducated/Elementary school	*26*	*8.9*
Intermediate school	*24*	*8.2*
Secondary school	*106*	*36.2*
Higher education	*137*	*46.7*
Occupation		
Governmental sector	*90*	*30.7*
Private sector	*51*	*17.4*
Military	*13*	*4.4*
Retired	*66*	*22.5*
Unemployed	*9*	*3.1*
House wife	*64*	*21.9*
Personal income in SR/month		
<6000	*183*	*62.4*
6000-12000	*94*	*32.1*
>12000	*16*	*5.5*
Family income in SR/month		
<6000	*109*	*37.2*

6000-12000	*145*	*49.5*
>12000	*39*	*13.3*

Table 3: Diabetes-related characteristics of the diabetic patients, Makkah Al-Mukarramah (n=293).

	Frequency	***Percentage***
Duration of diabetes (years)		
Range	*1-30*	
Mean±SD	*6.27±5.01*	
Measuring the blood sager level at home		
Yes, always	*88*	*30.0*
Sometimes	*117*	*40.0*
Never	*59*	*20.1*
Only when feeling diabetic symptoms	*29*	*9.9*
Taking diabetes medications regularly		
Yes, always	*252*	*86.0*
Sometimes	*41*	*14.0*
*Type of diabetes treatment used**		
Following healthy food system	*155*	*52.9*
Oral tablets	*268*	*91.5*
Insulin injection	*138*	*31.7*
Number of used diabetic medications		
One	*45*	*15.4*
Two	*110*	*37.5*
Three	*116*	*39.6*
Four or more	*22*	*7.5*
Family history of diabetes		
No	*75*	*25.6*
Yes	*139*	*47.4*
Not sure	*79*	*27.0*

* Not mutually exclusive (percentage exceeded 100%)

Table 4: Physical activity among diabetic patients, Makkah Al-Mukarramah.

	Frequency	***Percentage***
History of performing any physical activity rather than daily living activity		
Yes	*77*	*26.3*
No	*216*	*73.7*
Level of physical activity (n=77)		
Mild	*36*	*46.7*
Moderate	*33*	*42.9*
Vigorous	*8*	*10.4*
Duration (days/ week) of performing physical activity (n=77)		

1-3	*43*	*55.8*
4-5	*21*	*27.3*
>5	*13*	*16.9*
Duration in minutes of performing physical activity/ day (n=77)		
10-29	*27*	*35.1*
30-49	*33*	*42.8*
50-60	*15*	*19.5*
>60	*2*	*2.6*

Table 5: Responses of the diabetic patients in Makkah Al-Mukarramah to knowledge statements about diabetes.

	Right answer	
	No.	*%*
Eating too much sugar and other sweet foods is a cause of diabetes (No)	*48*	*16.4*
lack of or resistance to insulin is a cause of diabetes (Yes)	*156*	*53.2*
If I am diabetic, my children have a higher chance of being diabetic (Yes)	*179*	*61.6*
Diabetes can be cured (No)	*115*	*39.2*
Kidneys produce insulin (No)	*121*	*41.3*
Diabetes is caused by severe psychological stress or by psychological shock (No)	*33*	*11.3*
The best way to diagnose diabetes is by doing urine analysis (No)	*66*	*22.5*
A fasting blood sugar level of 210 is too high (Yes)	*164*	*56.0*
Shaking and sweating are signs of high blood sugar (No)	*131*	*44.7*
Frequent urination and thirst are signs of low blood sugar (No)	*81*	*27.6*
If the HbA1C level (glycosylated hemoglobin) is less than 7%, he considered diabetic controlled patient (Yes)	*127*	*43.3*
Medication is more important than diet and exercise to control diabetes. (No)	*89*	*30.4*
It is not important to control the amount of food as long the patients taking their diabetes medications (No)	*109*	*37.2*
Using insulin injections are important to treat all diabetic patients (No)	*74*	*25.3*
Diabetes medications should be taken continuously (always) (Yes)	*218*	*74.4*
Dates do not cause elevation in blood sugar level (No)	*116*	*39.6*
Diabetes can cause damage to the kidneys (Yes)	*166*	*56.7*
Diabetes can cause loss of feeling in the hands, fingers,and feet. (Yes)	*152*	*51.9*
Diabetes does not affect the retina of the eyes (No)	*107*	*36.5*
Cuts and abrasions on diabetes heal more slowly in diabetic patients (Yes)	*182*	*62.1*

Table 6: Association between socio-demographic factors and knowledge about diabetes mellitus among the participants.

	DM Knowledge score			***p-value***
	Median	*IQR*	*Mean rank*	
Gender				
Male (n=146)	*8*	*6-9.25*	*143.24*	*0.446**
Female (n=147)	*8*	*7-10*	*150.73*	
Nationality				
Saudi (n=250)	*8*	*6-10*	*144.28*	*0.182**
Non-Saudi (n=43)	*9*	*7-10*	*162.79*	
Marital status				
Single (n=14)	*7.5*	*5.75-11*	*136.43*	*0.228***
Married (n=249)	*8*	*7-10*	*144.91*	
Divorced (n=15)	*8*	*6-10*	*148.40*	
Widow (n=15)	*10*	*7-12*	*190.10*	
Educational level				
Uneducated/Elementary school(n=26)	*7.5*	*6-9.25*	*129.87*	*0.043***
Intermediate school (n=24)	*9*	*7.25-10.75*	*174.25*	
Secondary school (n=106)	*8*	*6-9*	*133.14*	
Higher education (n=137)	*8*	*7-10*	*156.20*	
Occupation				
Governmental sector (n=90)	*8*	*7-10*	*154.56*	*0.531***
Private sector (n=51)	*8*	*6-10*	*140.27*	
Military (n=13)	*8*	*6-8.5*	*126.73*	
Retired (n=66)	*8.5*	*7-10*	*157.62*	
Unemployed (n=9)	*9*	*5.5-10.5*	*144.61*	
House wife (n=64)	*8*	*6-10*	*135.23*	
Personal income in SR/month				
<6000 (n=183)	*8*	*7-10*	*145.93*	*0.189***
6000-12000 (n=94)	*8*	*6-10*	*142.82*	
>12000 (n=16)	*9*	*8-11*	*183.81*	
Family income in SR/month				
<6000 (n=109)	*8*	*6-10*	*144.64*	*0.484***
6000-12000 (n=145)	*8*	*6-9.5*	*144.72*	
>12000 (n=39)	*8*	*7-10*	*162.09*	

IQR: Inter-quartile range
* Manntest-Whitney test ** Kruskal-Wallis

Table 7: Association between body mass index and knowledge about diabetes mellitus among the participants.

Body mass index	***DM Knowledge score***			***p-value***
	Median	*IQR*	*Mean rank*	
Normal (n=52)	*8*	*7-9*	*132.56*	*0.277*
Overweight (n=97)	*8*	*6.5-10*	*144.60*	
Obese (n=144)	*8*	*6-10*	*153.83*	

Table 8: Association between diabetes-related factors and knowledge about diabetes mellitus among the participants.

	DM Knowledge score			***p-value***
	Median	*IQR*	*Mean rank*	
Measuring the blood sager level at home				
Yes, always (n=88)	*8*	*7-10*	*152.81*	*0.358***
Sometimes (n=117)	*8*	*6-10*	*142.69*	
Never (n=59)	*8*	*6-9*	*136.99*	
Only when feeling diabetic symptoms (n=29)	*9*	*7.5-10.5*	*167.10*	
Taking diabetes medications regularly				
Yes, always (n=252)	*8*	*6.25-10*	*144.0*	*0.130**
Sometimes (n=41)	*9*	*7-10*	*165.43*	
*Type of diabetes treatment used**				
Following healthy food system				
No (n=138)	*8*	*6.75-10*	*145.55*	*0.781**
Yes (n=155)	*8*	*7-10*	*148.29*	
Oral tablets				
No (n=25)	*8*	*6-10*	*138.82*	*0.611**
Yes (n=268)	*8*	*7-10*	*147.76*	
Insulin injection				
No (n=155)	*8*	*7-10*	*155.76*	*0.059**
Yes (n=138)	*8*	*6-9.25*	*137.16*	
Number of used diabetic medications				
One (n=45)	*8*	*6.5-10*	*151.47*	*0.973***
Two (n=110)	*8*	*6-10*	*147.77*	
Three (n=116)	*8*	*7-10*	*145.24*	
Four or more (n=22)	*8*	*6.75-9.5*	*143.30*	
History of following a diabetic diet				
No (n=150)	*8*	*7-10*	*144.64*	*0.623**
Yes (n=143)	*8*	*6-10*	*149.47*	
Family history of diabetes				
No (n=75)	*8*	*6-10*	*139.82*	*0.553***
Yes (n=79)	*8*	*7-10*	*146.60*	

Not sure (n=139)	*8*	*6-10*	*154.52*	

* Mann-Whitney test ** Kruskal-Wallis test

Table 9: Association between history of other chronic diseases and knowledge about diabetes mellitus among the participants.

History of other chronic diseases	***DM Knowledge score***			***p-value***
	Median	*IQR*	*Mean rank*	
Yes (n=94)	*9*	*7-10.25*	*160.22*	*0.064**
No (n=199)	*8*	*6-10*	*140.76*	

* Mann-Whitney test

Table 10: Association between history of smoking and knowledge about diabetes mellitus among the participants.

History of smoking	***DM Knowledge score***			***p-value***
	Median	*IQR*	*Mean rank*	
No (n=194)	*8*	*7-10*	*149.47*	*0.482*
Yes (n=99)	*8*	*6-9*	*142.17*	

* Mann-Whitney test

Table 11: Association between history of physical activity and knowledge about diabetes mellitus among the participants.

	DM Knowledge score			***p-value***
	Median	*IQR*	*Mean rank*	
History of performing any physical activity rather than daily living activity				
Yes (n=77)	*9*	*7-11*	*169.09*	*0.007**
No (n=216)	*8*	*6-9*	*139.13*	
Level of physical activity (n=77)				
Mild (n=36)	*9*	*8-11*	*41.22*	*0.713***
Moderate (n=33)	*9*	*7-10.5*	*37.05*	
Vigorous (n=8)	*8*	*6.5-12*	*37.06*	
Duration (days/ week) of performing physical activity (n=77)				
1-3 (n=43)	*9*	*7-11*	*38.53*	*0.895***
4-5 (n=21)	*9*	*8-10.5*	*40.86*	
>5 (n=13)	*8*	*6-12.5*	*37.54*	
Duration in minutes of performing physical activity/ day (n=77)				
10-29 (n=27)	*9*	*8-11*	*42.28*	*0.710***
30-49 (n=33)	*9*	*7.5-10.5*	*38.67*	
50-60 (n=15)	*8*	*6-12*	*33.93*	
>60 (n=2)	*9*	*4-9*	*38.25*	

* Mann-Whitney test ** Kruskal-Wallis test

Table 12: Association between glycemic control and knowledge about diabetes mellitus among the participants.

HbA1c	***DM Knowledge score***			***p-value***
	Median	*IQR*	*Mean rank*	
<7% (n=28)	*9*	*7-11*	*169.14*	*0.143**
≥7% (n=265)	*8*	*6-10*	*144.66*	

* Mann-Whitney test