Diabetic Complications and Factors Affecting Glycemic Control Among Patients With Type II Diabetes Mellitus Attending the Chronic Illness Clinics at Tabuk, Saudi Arabia

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Abstract

Background
Diabetes mellitus (DM) is one of the most common diseases worldwide and affects many patients all over the globe. Diabetic complications vary between microvascular and macrovascular, affecting a wide range of organs and systems in the body. Understanding, determining, and in return, preventing such factors is essential to alleviate the quality of life of diabetic patients. Therefore, we aim to determine the poor glycemic control and the factors associated with it in our diabetes population.

Methods
This is a retrospective study where data was reviewed for all patients with Type II DM (T2DM) who attended the chronic illness clinic at King Khaled Hospital in Tabuk. We included patients aged ≥ 18 years, of Saudi nationality, and residents of the Tabuk region. Any patient not satisfying all the inclusion criteria was excluded from the current study. Diagnosis with diabetes was made according to the American Diabetes Association guidelines, 2020. Patients' demographic data, medical history, and social and lifestyle history were extracted from records. In addition, age, body mass index (BMI), drugs (insulin vs. oral hypoglycemic agents), duration of the disease, lipid profile, and other comorbidities were also extracted from the files. A p-value of <0.05 was selected as the statistically significant level in all tests.

Results
A total of 697 patients were included in the current study, with a mean age of 58.2±11.6 years. The mean glycosylated hemoglobin (HbA1c) of the study participants was 8.4±1.7%, and their fasting blood sugar (FBS) level was 9.9±3.9 mmol/l. With HbA1c cut-off at 7%, the overall prevalence of poor glycemic control was 81.5% (565/693). A higher prevalence of poor glycemic control was reported among study participants with higher DM duration (p=0.002). Diabetes complications were found in 208 (29.8%) of the study participants, where microvascular complications were present in 140 patients, and microvascular ones were found in 102. In the logistic regression model, older patients were less prone to poor glycemic control (OR=0.98; 95% CI=0.96-0.99; p=0.010). In addition, longer disease duration was a predictive factor of poor glycemic control (OR=1.05; 95% CI=1.02-1.08; p=0.003). Furthermore, the usage of combined insulin and tablet treatments were associated with a higher risk of poor glycemic control when compared to insulin only treatments (OR=4.65; 95% CI=1.55-13.94; p=0.006).

Conclusion
The results of this study indicate a high prevalence rate of poor glycemic control among Saudi patients, which is higher than previous reports have shown. More interest should be given to awareness programs with regard to promoting self-control protocols for the disease.

Introduction
Diabetes mellitus (DM) is one of the most common diseases worldwide and affects many patients all over the globe. Additionally, the disease rates are rapidly growing, and it is now considered a world health emergency that puts a heavy burden on almost all countries [1]. An estimated 415 million adults have been diagnosed with diabetes, and this number is expected to rise to 642 million in the next two decades [2]. In 2013 alone, DM has killed 4.6 million patients worldwide [3]. The majority of DM patients are located in low and middle-income countries with prevalence rates of 77% and 88% for morbidity and mortality, respectively, in these
duration of the disease (p<0.001) as it was more likely for older age to have a higher duration of the disease statistically significant difference between treatment categories in terms of age groups (p=0.007) and the combination of insulin and tablets, and insulin alone was given to only 4.3% of the patients. There was a 10.8±7.3 years. Most patients (67.5%) were prescribed tablets only, 28.2% of patients were prescribed a A total of 697 patients were included in the current study, with a mean age of 58.2±11.6 years. The age group of 45-64 years contained the most patients (58.5%). Most of the patients were males (63.7%), and the Sociodemographic characteristics

Results

Materials And Methods

Study design

In this retrospective study data was reviewed for all patients with Type II DM (T2DM) who attended the chronic illness clinic at King Salman North West Armed Forces Hospital in Tabuk, Saudi Arabia. Diagnosis with diabetes was made according to the American Diabetes Association (ADA) guidelines, 2020 [15]. All patients satisfying the inclusion criteria were enrolled in the study. The inclusion criteria included an established diagnosis with T2DM, patients attending chronic illness clinics, aged > 18 years, Saudi nationality, and residents of the Tabuk region. Any patient not satisfying all the inclusion criteria was excluded from the current study.

Data collection

Clinical data of patients attending the chronic illness clinics at King Khaled Hospital in Tabuk between September 2019 and February 2020 were retrospectively reviewed. Patients' demographic data, medical history, and social and lifestyle history were extracted from records. In addition, age, body mass index (BMI), drugs (insulin vs. oral hypoglycemic agents), duration of the disease, Hba1c, lipid profile, and data about other comorbidities were also extracted for all patients. Moreover, chronic complications that developed after the proper diagnosis of T2DM and that could be attributed to diabetes were considered in this study, including glomerular filtration rate (GFR), microalbuminuria, retinopathy, neuropathy, and atherosclerotic cardiovascular disease. The cut-off levels were used according to the ADA guidelines, 2020 [15].

Statistical analysis

Data was analyzed by using the Statistical Package for the Social Sciences (SPSS V.26, IBM Inc., Armonk, USA). Descriptive statistics (frequency, mean, and standard deviation) were calculated for all variables. Also, comparative analyses were carried out by chi-square test or unpaired t-test based on the type of variable. Furthermore, logistic regression was conducted with a calculating odds ratio (OR) to assess the association between glycemic control in T2DM and different possible risk factors. A p-value of <0.05 was selected as the statistically significant level in all the tests.

Results

Sociodemographic characteristics

A total of 697 patients were included in the current study, with a mean age of 58.2±11.6 years. The age group of 45-64 years contained the most patients (58.5%). Most of the patients were males (63.7%), and the majority of them reported that they do not smoke tobacco (89.0%). The mean duration of DM disease was 10.8±7.3 years. Most patients (67.5%) were prescribed tablets only, 28.2% of patients were prescribed a combination of insulin and tablets, and insulin alone was given to only 4.3% of the patients. There was a statistically significant difference between treatment categories in terms of age groups (p=0.007) and the duration of the disease (p<0.001) as it was more likely for older age to have a higher duration of the disease.
TABLE 1: Sociodemographic characteristics of diabetes mellitus patients (N=697)

NA - not available; SD - standard deviation

* Statistically significant at <0.05 level; ** Statistically significant at <0.001 level

Prevalence of poor glycemic control

The data for HbA1c was only available for 693 of the included patients. The mean HbA1c of the study participants was 8.4±1.7%, and their fasting blood sugar (FBS) level was 9.9±3.9 mmol/l. With an HbA1c cutoff of 7%, the overall prevalence of poor glycemic control was 81.5% (565/693), whereas 18.5% of the patients showed good glycemic control (128/693).

Clinical and anthropometric measurements

A higher prevalence of poor glycemic control was reported among study participants with higher DM duration (p=0.002). In contrast, there was no statistically significant difference in poor glycemic control rates when it came to different BMI groups (p=0.504), systolic blood pressure (BP) (p=0.699), diastolic BP (p=0.400), low-density lipoproteins (LDL) levels in mg/dl (p=0.456), albumin-creatinine ratios (p=0.401), urine microalbumin (p=0.645), or estimated glomerular filtration rate (eGFR; p=0.208) (Table 2).
TABLE 2: Clinical and anthropometric measurements of diabetes mellitus patients (N=693)

| Variables                        | Glycemic control                  | P-value |
|----------------------------------|-----------------------------------|---------|
|                                  | Good n=128 (18.5%)                |         |
| Mean(SD)                         | Mean(SD)                          | Mean(SD)|         |
| Duration of disease (years)      | 9.0 (6.8)                         | 11.2 (7.3) | 10.8 (7.3) | 0.002*       |
| BMI                              | 31.6 (6.0)                        | 31.2 (5.7) | 31.3 (5.7) | 0.504        |
| Systolic BP                      | 134.4 (17.8)                      | 133.7 (15.7) | 133.8 (16.1) | 0.699        |
| Diastolic BP                     | 69.0 (10.1)                       | 69.8 (9.1) | 69.6 (9.3) | 0.400        |
| FBS (mmol/l)                     | 7.1 (2.7)                         | 10.5 (3.8) | 9.9 (3.9) | < 0.001**    |
| HbA1c (%)                        | 6.3 (0.5)                         | 8.9 (1.4) | 8.4 (1.7) | < 0.001**    |
| LDL (mg/dl)                      | 2.7 (0.9)                         | 2.8 (1.0) | 2.8 (1.0) | 0.456        |
| Albumin-creatinine ratio         | 189.3 (637.7)                     | 98.4 (314.4) | 112.0 (379.9) | 0.401        |
| Urine microalbumin               | 0.1 (0.2)                         | 0.2 (2.4) | 0.2 (2.2) | 0.645        |
| eGFR                             | 90.6 (25.5)                       | 95.3 (39.3) | 94.4 (37.1) | 0.208        |

BMI - body mass index; BP - blood pressure; eGFR - estimated glomerular filtration rate; FBS - fasting blood sugar test; HbA1c - glycated hemoglobin; LDL - low-density lipoproteins; SD - standard deviation

* Statistically significant at <0.05 level; ** Statistically significant at <0.001 level

Diabetes complications

Diabetes complications were found in 208 (29.8%) of study participants, where microvascular complications were present in 140 patients, and macrovascular complications were found in 102 patients. Ischemic heart disease was the most common macrovascular complication (n=60), followed by cerebrovascular accidents (n=8), myocardial infarction (n=7), non-specified heart disease (n=5), and coronary artery bypass grafting. Figure 1 shows the distribution of macrovascular complications according to glycemic control.
FIGURE 1: The distribution of macrovascular complications according to glycemic control

AHD - atherosclerotic heart disease; ASD - atrial septal defect; CABG - coronary artery bypass grafting; CHF - congestive heart failure; CVA - cerebrovascular accident; DVT - deep venous thrombosis; ECG - electrocardiogram; HF - heart failure; HHD - hypertensive heart disease; IHD - ischemic heart disease; MI - myocardial infarction; PAD - peripheral arterial disease; PVC - premature ventricular complex

In the same context, retinopathy was the common microvascular complication, which was found in 80 patients, followed by nephropathy (n=45), neuropathy (n=26), and macular complications (n=12). Figure 2 shows the distribution of microvascular complications according to glycemic control.
Factors associated with poor glycemic control

In the logistic regression model, older patients were less prone to poor glycemic control (OR=0.98; 95% CI=0.96-0.99; p=0.010). There was a significant increase in the risk of poor glycemic control in the 45-64 age group compared to the ≥65 age group (OR=1.55; 95% CI=1.02-2.37; p=0.041). Moreover, longer disease duration was a predictive factor of poor glycemic control (OR=1.05; 95% CI=1.02-1.08; p=0.003). Furthermore, the usage of combined insulin and tablet treatments was associated with a higher risk of poor glycemic control when compared to insulin only (OR=4.65; 95% CI=1.55-13.94; p=0.006) (Table 3).
TABLE 3: Logistic regression analysis of factors associated with poor glycemic control among DM patients (N=693)

BMI - body mass index; BP - blood pressure; LDL - low-density lipoproteins; SE - standard error; DM - diabetes mellitus

* Statistically significant at <0.05 level

Discussion

We conducted this study to identify the possible factors associated with poor glycemic control in diabetes patients. There was a significant increase in the risk of poor glycemic control in the 45-64 age group when compared to the ≥65 age group (OR=1.55; 95% CI=1.02-2.37; p=0.041). Moreover, longer disease duration was a predictive factor of poor glycemic control (OR=1.05; 95% CI=1.02-1.08; p=0.003). Meanwhile, microvascular complications were present in 140 patients, and macrovascular complications were found in 102 patients, with ischemic heart disease being the most common macrovascular complication (n=60), followed by cerebrovascular accidents (n=8), myocardial infarction (n=7), non-specified heart disease (n=5), and coronary artery bypass grafting. For this purpose, we have studied the association in patients whose HbA1c records were available. This method was utilized as HbA1c has been proved to be effective in measuring the glycemic control in a total of the previous three months. Therefore, it gives a better judgment beyond the fluctuations that may occur as a result of depending only on the blood glucose levels. In this study, the prevalence rate of poor glycemic control was estimated to be 81.5%. This rate is higher than other reported rates within Saudi Arabia. Alzaheb et al. [16] reported a prevalence rate of 74.9%, Al-Rasheedi et al. [17] reported a rate of 67.7%, which is similar to the 67.9% reported by Badedi et al. [18], while Khan et al. [19] reported a rate of 74%. High prevalence rates were also reported in diabetes patients from other Middle Eastern countries, such as Oman (65.0%), Kuwait (78.8%), United Arab Emirates (69.0%), and Jordan (65.1%) [20, 21]. This sheds light on the high prevalence of poor glycemic control in the region, and
Therefore, investigations should be undertaken to find the associated risk factors.

The logistic regression analysis showed that older patients were more likely to have better glycemic control. Ahmed et al. [11] reported that glycemic control was better in patients older than 65 years. Additionally, the authors reported that a 5% increase in the rate of achieving glycemic control was associated with a one-year increase in a diabetic patient. The authors justified their results by saying that older patients are usually assisted by other younger relatives [22]. Additionally, previous studies did not find any significance in the association between age and poor glycemic control [16]. Almetwazi et al. [23] even reported that older age was associated with higher rates of poor glycemic control due to the presence of co-morbidities and suggested that follow-ups should be conducted for these patients regularly.

Another associated factor was found to be the duration of the disease. Ahmad et al. [11] found that a rate of 5% reduction in glycemic control was associated with a one-year increase in the duration of having DM. These results are consistent with the results of previous studies in the literature, which showed that having DM for longer durations negatively impacts glycemic control [24]. This can be explained by the fact that β-cell dysfunction progresses with time, which increases the need to adjust the treatment regimens more regularly [25]. Another factor that was found to be associated with poor glycemic control is the combined use of insulin and oral drugs. This is consistent with the result found by Ahmad et al. [11]. Previous reports have also reported that a triple therapy of anti-diabetic drugs was an effective regimen in glycemic control [11, 26]. On the other hand, previous investigations reported that insulin alone or combined with oral antidiabetic agents significantly produces better glycemic control results [27, 28]. However, when using regimens such as these, frequent follow-ups and monitoring should be conducted to ensure the appropriate optimal doses are prescribed and increase the patients’ compliance.

In addition, we did not find any significance in terms of patients’ sex to be associated with poor glycemic control, which is consistent with the results of previous research [11, 18]. On the other hand, elevated HbA1c levels were reportedly more associated with female than male patients in Abudawood et al. [29]. Although previous reports have also found obesity, high LDL levels, and associated comorbidities to be associated with poor glycemic control, in this study and other studies, no association between BMI, LDL levels, comorbidities, and the poor glycemic effect was found [11].

A cause/effect association could not be done in this study due to the limitations of the study design. Another limitation is the self-reporting of some variables, such as tobacco use, which may have been subject to subjective or denial bias. Furthermore, drug compliance was not determined due to its subjective understanding from one patient to another.

Conclusions

The results of this study indicate the high prevalence rate of poor glycemic control among Saudi patients, which was higher than shown in previous reports. We also found that old age was associated with better glycemic control. On the other hand, longer durations of having diabetes, and the combined use of insulin and oral drugs, was associated with poor glycemic control. In addition, neither BMI, LDL levels, gender, or the occurrence of complications showed significant associations with poor glycemic control. More interest should be given to awareness programs promoting disease among older age groups as they are more prone to have poor glycemic control than younger patients.

Additional Information

Disclosures

Human subjects: Consent was obtained by all participants in this study. King Salman Northwest Armed Forces Hospital issued approval KSAFH-REC-2020-345. Animal subjects: All authors have confirmed that this study did not involve animal subjects or tissue. Conflicts of interest: In compliance with the ICMJE uniform disclosure form, all authors declare the following: Payment/services info: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. Financial relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. Other relationships: All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

References

1. Tabish SA: Is diabetes becoming the biggest epidemic of the twenty-first century? -. Int J Health Sci. 2007, 1:V-VIII.
2. Diabetes and cardiovascular disease. Brussels, Belgium: International Diabetes Federation. (2016). Accessed: May 2020: http://www.idf.org/cvd.
3. Aguirre F, Brown A, Cho NH, et al.: IDF Diabetes Atlas, 6th edition. Guariguata L, Nolan T, Beagley J, et al. (ed): International Diabetes Federation, Brussels; 2013.
4. Mathers CD, Loncar D: Projections of global mortality and burden of disease from 2002 to 2050 -. PLoS Med. 2006, 5:442-442. 10.1571/journal.pmed.0050442
5. Alzaheb RA, Altemani AH: The prevalence and determinants of poor glycemic control among adults with type 2 diabetes mellitus in Saudi Arabia. Diabetes Metab Syndr Obes. 2018, 11:15-21. 10.2147/DMSO.S6156214

6. Alharbi NS, Almutari R, Jones S, et al.: Trends in the prevalence of type 2 diabetes mellitus and obesity in the Arab Gulf States: systematic review and meta-analysis. Diabetes Res Clin Pract. 2014, 106:30-33. 10.1016/j.diabres.2014.08.019

7. Fatani HH, Mira SA, El-Zubier AG: Prevalence of diabetes mellitus in rural Saudi Arabia. Diabetes Care. 1987, 10:180-185. 10.2337/diacare.10.2.180

8. Alotaibi A, Perry L, Ghofzadeh L, Al-Ganni A: Incidence and prevalence rates of diabetes mellitus in Saudi Arabia: An overview. Clin Epidemiol Glob Health. 2017, 7:211-218. 10.1016/j.cephb.2017.10.001

9. Ong KL, Cheung BM, Wong LV, et al.: Prevalence, treatment, and control of diagnosed diabetes in the US National Health and Nutrition Examination Survey 1999-2004. Ann Epidemiol. 2008, 18:222-229. 10.1016/j.amepi.2007.10.007

10. Stratton IM, Adler AI, Neil HAW, et al.: Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35): prospective observational study. BMJ. 2000, 321:405-412. 10.1136/bmj.321.7258.405

11. Ahmad NS, Isahadin F, Paraadahathu T: Factors associated with good glycemic control among patients with type 2 diabetes mellitus. J Diabetes Invest. 2014, 5:563-569.

12. Khattab M, Khader YS, Al-Khawaldeh A, Aljouni K: Factors associated with poor glycemic control among patients with type 2 diabetes. J Diabetes Complications. 2010, 24:84-89. 10.1016/j.jdiacomp.2008.12.008

13. Lipska KJ, Krumholz H, Soones T, Lee SJ: Polypharmacy in the aging patient: a review of glycemic control in older adults with type 2 diabetes. JAMA. 2016, 315:1034-1045. 10.1001/jama.2016.0299

14. Teljeur C, Smith SM, Paul G, Kelly A, O'Dowd T: Multimorbidity in a cohort of patients with type 2 diabetes. Eur J Gen Pract. 2015, 19:17-22. 10.3109/13814788.2012.714768

15. American Diabetes Association: Classification and diagnosis of diabetes: standards of medical care in diabetes-2020. Diabetes Care. 2020, 43:45-14. 10.2337/dc20-S002

16. Alzaheb RA, Altemani AH: The prevalence and determinants of poor glycemic control among adults with type 2 diabetes mellitus in Saudi Arabia. Diabetes Metab Syndr Obes. 2018, 11:15-21. 10.2147/DMSO.S6156214

17. Al-Rasheed AA: The role of educational level in glycemic control among patients with type 2 diabetes mellitus. Int J Health Sci. 2014, 8:177-187. 10.12816/j.ijhsc.2014.8.1.177

18. Badedi M, Solan Y, Darraj H, et al.: Factors associated with long-term control of type 2 diabetes mellitus. J Diabetes Res. 2016, 2016:2109542. 10.1155/2016/2109542

19. Khan AR, Al-Abdul Lateef ZN, Al Aithan MA, et al.: Factors contributing to non-compliance among diabetics attending primary health centers in the Al Hasa district of Saudi Arabia. Family Community Med. 2012, 19:26-32. 10.4103/2230-8229.94008

20. Al Bahashi K, Al-Haddabi M, Al-Zakwani I, Al Za'abi M: Glycemic control among patients with type 2 diabetes at a primary health care center in Oman. Prim Care Diabetes. 2014, 8:239-245. 10.1016/j.pcd.2014.01.005

21. Al-Ibrahim AAH: Factors associated with compliance to diabetes self-care behaviors and glycemic control among Kuwaiti people with type 2 diabetes. University of Maryland, College Park, US; 2012.

22. Yeung W-J: Asian Fatherhood. J Fam Issues. 2013, 34:141-158. 10.1177/0192513x12461133

23. Almetwani M, Alwahbi M, Baikbi B, et al.: Factors associated with glycemic control in type 2 patients in Saudi Arabia. Saudi Pharm J. 2019, 27:384-388. 10.2337/txb.2019.21084

24. Khan AR, Al-Abdul Lateef ZN, Al Aithan MA, et al.: Factors contributing to non-compliance among diabetics attending primary health centers in the Al Hasa district of Saudi Arabia. Family Community Med. 2012, 19:26-32. 10.4103/2230-8229.94008

25. Al-Bahashi K, Al-Haddabi M, Al-Za'abi M: Glycemic control among patients with type 2 diabetes at a primary health care center in Oman. Prim Care Diabetes. 2014, 8:239-245. 10.1016/j.pcd.2014.01.005

26. Al-Ibrahim AAH: Factors associated with compliance to diabetes self-care behaviors and glycemic control among Kuwaiti people with type 2 diabetes. University of Maryland, College Park, US; 2012.

27. Yeung W-J: Asian Fatherhood. J Fam Issues. 2013, 34:141-158. 10.1177/0192513x12461133

28. Almetwani M, Alwahbi M, Baikbi B, et al.: Factors associated with glycemic control in type 2 patients in Saudi Arabia. Saudi Pharm J. 2019, 27:384-388. 10.2337/txb.2019.21084

29. Reisig V, Reitmair P, Döring A, et al.: Social inequalities and outcomes in type 2 diabetes in the German region of Augsburg. A cross-sectional survey. Int J Public Health. 2007, 52:158-165. 10.1007/s00038-007-0077-2

30. Chuang L, Tsai ST, Huang B, Tai T: The status of diabetes control in Asia a cross sectional survey of 24 317 patients with diabetes mellitus in 1998. Diabet Med. 2002, 19:978-985. 10.1046/j.1464-5491.2002.00833.x

31. Aaslid R, Carmona A, Grau S, et al.: Adherence and effectiveness of highly active antiretroviral therapy. Arch Intern Med. 1998, 158:1953.

32. Abudawood M, Tabassum H, Ansar S, et al.: Assessment of gender-related differences in vitamin D levels and cardiovascular risk factors in Saudi patients with type 2 diabetes mellitus. Saudi J Biol Sci. 2018, 25:31-36. 10.1016/j.sjbs.2017.04.001