Saudi Pharmaceutical Journal 27 (2019) 384–388

Contents lists available at ScienceDirect

Saudi Pharmaceutical Journal

journal homepage: www.sciencedirect.com

Original article

Factors associated with glycemic control in type 2 diabetic patients in Saudi Arabia

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ARTICLE INFO

Article history:
Received 12 September 2018
Accepted 23 December 2018
Available online 26 December 2018

Keywords:
Saudi Arabia
Type 2 diabetes
Factors

ABSTRACT

Objective: To identify factors associated with glycemic control in type 2 diabetes mellitus patients in tertiary academic hospital.

Research design and methods: This was a retrospective cross-sectional study of adults with type 2 diabetes mellitus. Data were extracted from the electronic health record (EHR) database for the period from 1st of January to 31st of December 2016. Participants were considered to have a glucose control if the HbA1c level was less than 7% [53 mmol/L]. Descriptive analysis and multivariable logistic regression model were performed to assess the factors associated with glycemic control.

Results: A total of 728 patients were included in the study for which (65%) were female, and about 60% of the sample size was between 45 and 60 years old. Multivariate logistic regression model showed participants older than the age of 65 were less likely to have controlled diabetes compared to the younger participants (OR: 0.53 [CI: 0.30–0.93]). Moreover, those who had hypertension (OR: 0.61 [CI: 0.43–0.86]) and dyslipidemia (OR: 0.53 [CI: 0.38–0.74]) were less likely to have controlled diabetes, while those with asthma (OR: 2.06 [CI: 1.16–3.68]) were more likely to have controlled diabetes. The model also showed that vitamin D deficiency was not associated with glycemic control in type 2 diabetes patients (OR 0.80 [95% CI 0.58–1.12]).

Conclusion: These findings highlighted the need for appropriate management in older adult patients to prevent the complication of type 2 diabetes. Furthermore, attention should be exercised for patients with factors associated with poor glycemic control such as hypertension and dyslipidemia.

1. Introduction

Diabetes mellitus (DM) is a major health problem worldwide. It is caused by either not producing insulin, or the body cannot use the insulin adequately, or a combination of these two reasons (Stumvoll et al., 2005). Uncontrolled DM can lead to serious complications such as cerebrovascular disease and coronary heart diseases, blindness, kidney failure and neuropathy diseases (Centers for Disease Control and Prevention, 2017; Zimmet et al., 2001).

Prevalence of DM is increased dramatically worldwide. According to the World Health Organization, the prevalence of diabetes in adults increased from 4.7% in 1980 to 8.5% in 2014 (Mathers and Loncar, 2006). In 2017, about 425 million adults had diabetes, and it is estimated to increase to 629 million in 2045 (International Diabetes Federation, 2017). In Saudi Arabia, DM increased from 7% in 1989 to 32% in 2009 (Alharbi et al., 2014). In 2017, there were 3,852,000 cases of diabetes in Saudi Arabia,

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Peer review under responsibility of King Saud University.

Production and hosting by Elsevier

https://doi.org/10.1016/j.jsps.2018.12.007
1319-0164/

which places Saudi Arabia globally among the top ten countries in prevalence of diabetes (Alzaheb et al., 2018). The Saudi vision 2030 puts a priority on quality of preventive and therapeutic health care services regarding the major three chronic diseases that threaten the nation health which are heart disease, diabetes, and cancer (Saudi vision 2030, 2018).

It is known that achieving glycemic control for patients with diabetes prevents many complications (Kemp et al., 2005; Ong et al., 2008; Stratton et al., 2000). Therefore, understanding the factors associated with glycemic control for patients with diabetes will help to improve the treatment and prevents the complications of diabetes. Many studies have addressed the factors associated with diabetes worldwide (Ahmad et al., 2014; Daly et al., 2009; Juarez et al., 2012; Khattab et al., 2010; Sanal et al., 2011). As the person get older mitochondria activity in muscles and brain is diminished, also fat started to accumulate in muscles and liver tissues leading to a defect in insulin secretion and insulin resistant (Lipska et al., 2016). Co-morbidity and polypharmacy also were found to affect the glycemic control which were increased with the number of chronic disease that the patient had (Teljeur et al., 2013). Vitamin D deficiency is identified as a modifiable factor thought to have a role in glycemic control and insulin secretion from beta cells (Nigil Haroon et al., 2015).

However, these factors are different from nation to nation due to differences in lifestyle. In Saudi Arabia, few studies addressed these factors for patient with type 2 diabetes (Abudawood et al., 2018; Al-Nuaim et al., 1998; Alzaheb and Altemani, 2018; Badedi et al., 2016). In those studies, hemoglobin A1C (HbA1c) wasn't used as an indicator for glycemic control. Moreover, they were limited to a certain population and focused on specific factors. Therefore, the purpose of this cross-sectional study was to explore the factors associated with glycemic control among Saudi population with type 2 diabetes in tertiary academic hospital using HbA1c as indicator of glycemic control.

2. Methods

2.1. Study design

This was a cross-sectional study. Data was extracted from the Electronic Health Record (EHR) of King Khaled University hospital, Riyadh, Saudi Arabia for the period from first January to 31st December 2016. The study was approved by the hospital Institutional Review Board (IRB) protocol number (16/0517/IRB).

2.2. Data source and data extraction

Data was exported to excel sheet into multiple files (demographics file, laboratory file, and clinical diagnosis file). The demographics file contained information about the participants' age and gender. The laboratory file provided information about the level of vitamin D and HbA1c. The clinical diagnosis file provided information about the clinical diagnosis using the International Classifications of Diseases – 9th edition, Clinical Modification (ICD-9-CM) codes. After extracting the data from each file, multiple observations for one participant each with different diagnosis (e.g. Hypertension, Dyslipidemia, T2DM) were converted to one observation to facilitate the analysis and prevent the duplication of the same participant. The demographics, laboratory, and clinical diagnosis files were merged into one file using the encrypted participant medical record number.

2.3. Study population

The study population composed of adult participant who had a diagnosis of type 2 diabetes (T2DM). Participants whose HbA1c were missing and those whose ages were less than 18 years were excluded.

2.4. Measures

2.4.1. Dependent variable

The dependent variable of this study was glycemic control. Participants were considered having controlled diabetes if their HbA1c was less than 7% according to the American Diabetes Association's (ADA) Standards of Care recommendation. (American Diabetes Association, "6. Glycemic Targets: Standards of Medical Care in Diabetes," 2018).

2.4.2. Independent variable

Independent variables included age groups (young adults [aged 18–44], middle age adults [ages 45–64], and older adults [>65 years]), and diagnosed chronic conditions (hypertension, dyslipidemia, ischemic heart disease, chronic kidney disease, asthma, osteoarthritis, osteoporosis, anxiety, and depression). These conditions were selected because they are highly prevalent among participants with diabetes (Teljeur et al., 2013; Iglay et al., 2016). For vitamin D, the participants were divided into two groups. The first group consisted of participants with serum vitamin D more than 50 nmol/L (non-vitamin D deficiency). The second group consisted of participants with serum vitamin D < 50 nmol/L (vitamin D deficiency).(Bordelon et al., 2009).

2.5. Statistical analysis

Descriptive analyses and chi square were conducted to describe the study population. A multivariable logistic regression model was used to predict the relationship between glycemic control (HbA1c < 7% [53 mmol/L]) and vitamin D deficiency. Odds ratios and 95% confidence intervals were used to present the results, and a P value < 0.05 was considered statistically significant. All the statistical analyses were performed using Stata/SE 13.1.

3. Results

A total of 728 patients were screened and were found eligible for the study. Demographics and co-morbidities characteristics presented in Table 1. Middle age adults (45–64 years) represents (59.62%) of the studied population and (65%) of them were female. Hypertension and dyslipidemia were the most prevalent comorbidities in the study sample. There were (7.83%) patients with anxiety and (1.51%) with depression. Sixty-seven patients from the study sample had asthma (9%). Chronic kidney disease and ischemic heart disease were the least reported comorbidities.

The results of multivariable logistic regression that showed in Table 2 revealed that patients with vitamin D deficiency were less likely to have controlled diabetes compared to those without vitamin D deficiency. Participants older than age of 65 were less likely to have controlled diabetes compared to the younger participants (Odds Ratio (OR): 0.53 [CI: 0.30–0.93]). Those who had hypertension (OR:0.61 [CI: 0.43–0.86]) and dyslipidemia (OR:0.53 [CI: 0.38–0.74]) were less likely to have controlled diabetes while those who had asthma (OR: 2.06 [CI: 1.16–3.68]) were more likely to have controlled diabetes. Other factors such as gender, osteoporosis, osteoarthritis, anxiety, ischemic heart disease, chronic kidney disease and depression were not significant.

Table 1
Demographic and co-morbidities characteristics.

Characteristic	Controlled DM 56.87% (414)	Uncontrolled DM 43.13% (314)	Total	p- value chi square
Vitamin D deficiency				
Yes	18.82% (137)	15.11% (110)	33.93% (247)	0.584
No	38.05% (277)	28.02% (204)	66.07% (481)	
Gender				
Male	20.74% (151)	14.42% (105)	35.16% (256)	0.396
Female	36.13% (263)	28.71% (209)	64.84% (472)	
Age				
Young adults (18–44 years)	17.03% (124)	7.14% (52)	24.18% (176)	<0.001*
Middle age adults (45–64 years)	32.55% (237)	27.06% (197)	59.62% (434)	
Older adults (>65 years)	7.28% (53)	8.93% (65)	16.21% (118)	
Hypertension				
Yes	26.37% (192)	28.16% (205)	54.53% (397)	<0.001*
No	30.49% (222)	14.97% (109)	45.47% (331)	
Dyslipidemia				
Yes	25.41% (185)	27.88% (203)	53.30% (388)	<0.001*
No	31.46% (229)	15.25% (111)	46.70% (340)	
Ischemic heart disease				
Yes	0.41% (3)	0.96% (7)	1.37% (10)	0.084
No	56.46% (411)	42.17% (307)	98.63% (718)	
Chronic kidney disease				
Yes	0.41% (3)	0.69% (5)	1.10% (8)	0.266
No	56.46% (411)	42.45% (309)	98.90% (720)	
Asthma				
Yes	6.59% (48)	2.61% (19)	9.20% (67)	0.010*
No	50.27% (366)	40.52% (295)	90.80% (661)	
Osteoarthritis				
Yes	3.02% (22)	2.75% (20)	5.77% (42)	0.545
No	53.85% (392)	40.38% (294)	94.23% (686)	
Osteoporosis				
Yes	2.43% (17)	1.51% (11)	3.85% (28)	0.675
No	54.53% (397)	41.62% (303)	96.15% (700)	
Anxiety				
Yes	5.63% (41)	2.20% (16)	7.83% (57)	0.017*
No	51.24% (373)	40.93% (298)	92.17% (671)	
Depression				
Yes	0.82% (6)	0.69% (5)	1.51% (11)	0.875
No	56.04% (408)	42.45% (309)	98.49% (717)	

* Statistical significant.

4. Discussion

The study assessed the factors that are associated with uncontrolled type 2 diabetes among patients in a tertiary academic hospital. The study used HbA1c as an indicator of controlled and uncontrolled diabetes because it gives an overall picture of the blood glucose level during the last three months. One of these factors is vitamin D level which is essential to increase absorption of calcium ion from gastrointestinal tract which plays a major role in insulin secretion (Sung et al., 2012). The results indicated that one third of diabetic population from the study sample had vitamin D deficiency. Based on a recent meta-analysis study, about 63% of a Saudi population had vitamin D deficiency, which is double of this study results in diabetic patients (Al-Alyani et al., 2018). This could be attributed to the fact that we only restrict this study to adult patients who used non-insulin therapy. A previous study that was done in diabetic (type 1 and type 2) in the United States population had the same results (Almetwazi et al., 2017). This indicated correction of vitamin D is less likely to have an impact on controlling diabetes.

One of the factors that were found to be associated with uncontrolled diabetes in this study was being an older adult. Based on the American Diabetes Association, about one-quarter of the population above 65 years old have diabetes, and nearly half of the them have prediabetes (American Diabetes Association, "11. Older Adults: Standards of Medical Care in Diabetes-2018," 2018). The results indicated that non-insulin user of type 2 diabetic patients older than 65 years were more likely to be glycemically uncontrolled compared to young adult. This result is expected due to the fact that this category of patients is at high risk of using multiple medications (polypharmacy), or having cognitive impairment, urinary incontinence, injurious falls, and persistent pain (American Diabetes Association, "11. Older Adults: Standards of Medical Care in Diabetes-2018," 2018). Therefore, it is highly recommended to monitor and follow up with this age category to slow the progression of diabetes and improve the quality of life of these patients.

Hypertension and dyslipidemia have been found to be associated with uncontrolled diabetes in this study. Although it is known that these three diseases increased the risk of morbidity and mortality from cardiovascular events, yet our patient who have hypertension or dyslipidemia tend to have uncontrolled diabetes (Ferrannini et al., 2012; Mooradian, 2009). Moreover, some medications that are used to treat hypertension such as thiazide diuretic, and statin that are used to treat dyslipidemia may contribute to these results (Maki et al., 2015; Stears et al., 2012).

Interestingly, the result indicated that patients who have asthma were more likely to have controlled diabetes. Although previous review study revealed that asthma is associated with

Table 2
Results of the logistic regression, for the effect of vitamin D deficiency in diabetic control.

Variables	Adjusted odds ratio (95%)	p- value
Vitamin D deficiency		
Non-deficient	–	Reference
Deficient	0.80 [CI: 0.58–1.12]	0.212
Gender		
Female	–	Reference
Male	1.03 [CI: 0.74–1.44]	0.825
Age		
Young adults (18–44 years)	–	Reference
Middle age adults (45–64 years)	0.72 [CI: 0.47–1.10]	0.134
Older adults (>65 years)	0.53 [CI: 0.30–0.93]	**0.028***
Hypertension		
No	–	Reference
Yes	0.61 [CI: 0.43–0.86]	**0.006***
Dyslipidemia		
No	–	Reference
Yes	0.53 [CI: 0.38–0.74]	**0.000***
Ischemic heart disease		
No	–	Reference
Yes	0.41 [CI: 0.10–1.69]	0.220
Chronic kidney disease		
No	–	Reference
Yes	0.49 [CI: 0.10–2.28]	0.364
Asthma		
No	–	Reference
Yes	2.06 [CI: 1.16–3.68]	**0.013***
Osteoarthritis		
No	–	Reference
Yes	1.08 [CI: 0.56–2.09]	0.803
Osteoporosis		
No	–	Reference
Yes	1.88 [CI: 0.81–4.32]	0.136
Anxiety		
No	–	Reference
Yes	1.53 [CI: 0.81–2.9]	0.186
Depression		
No	–	Reference
Yes	0.98 [CI: 0.28–3.44]	0.985

* Statistical significant.

diabetes diseases, no previous study found an association between asthma and diabetic control (Cazzola et al., 2013).

Lastly, other diseases that were included in this study were found to be not associated with glycemic control. These diseases are osteoporosis, osteoarthritis, anxiety, ischemic heart disease, chronic kidney disease and depression. Future studies with a large number of patients are needed to determine the association of these disease with glycemic control.

The sample of the study was taken from one largely academic hospital with which covers local citizens as well as residents, from the middle region of Saudi Arabia; the hospital also serves the entire country as a referral center. Therefore, finding of this study could be generalized to all local and foreign residence groups living in Saudi Arabia. Cross-sectional design is considering one of the limitations of this study. Future studies with different design and more variables are needed.

5. Conclusion

In conclusion, the study findings showed that advanced age is one of the main factors affecting glycemic control. Therefore, an appropriate management and close monitoring is advised to limit disease complications and improve the patients' health. Moreover, attention should be paid for patients with factors associated with poor glycemic control such as hypertension and dyslipidemia.

Acknowledgment

The authors extend their appreciation to the deanship of scientific research at King Saud University for funding this work through the research project No R17-02-44.

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