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Original Article

Prevalence and correlation of glycemic control achievement in patients with type 2 diabetes in Iraq: A retrospective analysis of a tertiary care database over a 9-year period

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ABSTRACT

Background: This study was designed to assess the achievement of a glycated hemoglobin (HbA1c) target in Iraqi type 2 diabetes mellitus (T2DM) patients via retrospective analysis of a tertiary care database over a 9-year period.

Methods: A total of 12,869 patients with T2DM with mean (SEM) age: 51.4(0.1) years, and 54.4% were females registered into Faiha Specialized Diabetes, Endocrine and Metabolism Center(FDEMC) database between August 2008 and July 2017 were included in this retrospective study. Data were recorded for each patient during routine follow-up visits performed at the center every 3–12 months.

Results: Patients were under oral antidiabetic drugs (OAD; 45.8%) or insulin+ OAD (54.2%) therapy. Hypertension was evident in 42.0% of patients, while dyslipidemia was noted in 70.5%. Glycemic control (HbA1c <7%) was achieved by 13.8% of patients. Multivariate analysis revealed <55 years of age, female gender, >3 years duration of diabetes, HbA1c >10% at the first visit, presence of dyslipidemia, and insulin treatment as significant determinants of an increased risk of poor glycemic control. BMI <25 kg/m^2 and presence of hypertension were associated with a decreased risk of poor glycemic control.

Conclusion: Using data from the largest cohort of T2DM patients from Iraq to date, this tertiary care database analysis over a 9-year period indicated poor glycemic control. Younger patient age, female gender, longer disease duration, initially high HbA1c levels, dyslipidemia, insulin treatment, overweight and obesity, and lack of hypertension were associated with an increased risk of poor glycemic control in Iraqi T2DM patients.

1. Background

Consistent with worldwide trends for the prevalence of diabetes mellitus [1], diabetes has reached an epidemic status in Iraq over the last decade, with a dramatic (115%) increase from 19.58/1000 in the year 2000 to 42.27/1000 in 2015 [2–4].

Accordingly, diabetes is a major public health concern in Iraqis given its high prevalence rate, increasing incidence rate, and overall economic burden [3–5]. However, after the 2003 War that caused vast destruction to Iraqi health system infrastructure over decades along with economic sanctions leading to cuts in the health care budget and understaffed and weakly resourced hospitals, the Iraqi health system could not cope with increased load of diabetic patients in terms of provisions for essential diabetes care [4,6–10].

Alongside the lack of health insurance coverage among the entire Iraqi population, diabetic patients are currently treated in both primary and secondary/tertiary care settings without certified methods for glycated hemoglobin (HbA1c) measurements because it is not available on a wide scale except in a few tertiary centers and within the private sector. Despite the proposal of a free health

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system, most investigations for diabetes and drug treatment are not affordable. Primary care has just started to improve the situation, whereas because of extraordinarily increased numbers of patients with diabetes in the country, the health system requires significant efforts and budget costs to change the situation. In addition, the source of drug supplies to treat chronic noncommunicable disease, whether in primary or secondary/tertiary settings, has not been resolved in Iraq. The private sector plays an important role in the drug supply with out-of-pocket payments.

Given the importance of achieving tight glycemic control to reduce the risk of microvascular complications and to decrease mortality and morbidity in diabetic patients, an HbA1c target of <7.0% is recommended by the American Diabetes Association (ADA) [11] and the American Association of Clinical Endocrinologists and American College of Endocrinology (AACE/ACE) [12], while the American College of Physicians (ACP) recommends loosening the tight control parameters established for HbA1c from a target of less than 7% to a range between 7 and 8% in nonpregnant adults with T2DM [13].

Alongside the application of a stepwise treatment algorithm to achieve glycemic control including diet, exercise, glucose monitoring and pharmacologic therapy [14,15], the application of ADA-recommended ABC targets, including HbA1c, blood pressure and low density lipoprotein-cholesterol (LDL-C), constitutes an integral part of diabetes care and is important for cardiovascular risk reduction [16].

In a past study conducted in 2008 with 3395 type 2 diabetic patients from Iraq, poor glycemic control (HbA1c $\geq$ 7%) was noted 2571 (75.7%) patients, while most of the patients declared the current health situation in Iraq (i.e. no drug supply from primary health care center or drug shortage, drugs or laboratory expense, migration after war) were the causes of their poor glycemic control [9].

The Faiha Specialized Diabetes, Endocrine, and Metabolism Center (FDEMC) is a tertiary referral center located in Basrah, Southern Iraq that provides diabetes care in accordance with practice patterns recommended by the ADA [17] and is available at affordable costs for all people, as the cost is partially covered by the Ministry of Health. The center receives patients who are either self-referred or referred by doctors from private clinics and primary and secondary care facilities. The patients visit the center every 3–12 months and the primary target of the center is the provision of diabetes education and self-care practices with the initial prescription of anti-diabetic medications including oral antidiabetic drugs (OADs) or insulin medication, while public clinics are supposed to supply the medicine to the patients each month.

This study was designed to assess the achievement of an HbA1c glycemic target and to determine the correlations of poor glycemic control in Iraqi patients via a retrospective analysis of a FDEMC tertiary care database over a 9-year period.

2. Methods

2.1. Study population

A total of 12,869 patients with T2DM (mean (SEM) age: 51.4(0.1) years, 54.4% were females) registered into the FDEMC database between August 2008 and July 2017 were included in this retrospective study. All adult T2DM patients (aged $\geq$19 years) registered into the FDEMC database with available data on glycemic parameters were included in the study. Patients diagnosed with type 1 diabetes mellitus (T1DM), pregnant women, and those with single visit data or no HbA1c records at their latest visit were excluded from the study. This study was part of a project to assess the degree of three pillars of diabetes control, including blood glucose, blood pressure, and lipid control.

2.2. Assessments

Patient demographics (age and gender), anthropometrics (body mass index [BMI, kg/m^2] and weight gain [kg[]), diabetes characteristics (duration of diabetes, family history, treatments, and HbA1c target achievement) and comorbidities (hypertension, dyslipidemia) were recorded for each patient during routine follow-up visits performed at the center every 3–12 months. Screening for neuropathy based on symptoms and signs were done for all.

Routine eye and dental screening were not part of the routine care provided at our center.

The dates for the first and last visits and total number of visits within the study period were also recorded for each patient.

For all patients, routine blood biochemistry analysis including serum glucose, creatinine, lipid panel and HbA1c was performed in the early morning after an 8–12 h fasting period.

2.3. ABC treatment targets

Hypertension was considered in patients with an average office blood pressure >140/90 mm Hg on two different visits or currently undergoing antihypertensive treatment. Dyslipidemia was considered in patients with serum triglyceride levels >150 mg/dL, LDL-C >100 mg/dL, low HDL-C (men < 40 and women < 50 mg/dL), or receiving medications for dyslipidemia. BMI values were categorized as normal (18.5–24.9 mg/dL), overweight (25–29.9 mg/dL), moderate obesity (30–39.9 mg/dL) and severe obesity ($\geq$40 mg/dL) [18]. In accordance with the 2017 ADA criteria [17], the treatment targets were defined as HbA1c <7%, systolic/diastolic blood pressure <140/90 mmHg and LDL-C <100 mg/dL. The blood pressure and lipid control results will appear in future publications.

The ethical committee of FDEMC approved the study.

2.4. Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics for Windows, version 23.0 (IBM Corp., Armonk, NY, USA). The chi-square (χ^2) test was used for the comparison of categorical data. Paired sample T test was used to assess continuous variables in a normally distributed samples, otherwise, Wilcoxon signed ranks test was used. Univariate analysis was used to analyze relationships among continuous variables. If a variable had a significant effect on the glycemic control via univariate analysis, it was included in multivariate logistic regression analysis. Data were expressed as the "mean (standard error of mean; SEM) or (SD)", 95% confidence interval (CI) and percent (%) where appropriate. $p < 0.05$ was considered statistically significant.

3. Results

3.1. Demographic and clinical characteristics (n = 12,869)

Overall, 64.4% of patients were aged <55 years and 54.4% were female patients. The mean(SEM) BMI was 29.9(0.1) kg/m^2 ($\geq$25 kg/m^2 in 80.1% of patients) and weight gain was 1.6(0.1) kg. The average duration of diabetes was 9.7(0.1) years and patients were either under OAD (45.8%) or insulin + OAD (54.2%) therapy. **Neuropathy** were seen in **60.5**%,hypertension was evident in 42.0% of patients, while dyslipidemia was noted in 70.5%. Patients averaged 9.0 visits within 3.2 years of follow-up. The mean(SEM) HbA1c (%) was 10.1(0.2) at the first visit (>10% in 51.2% of patients) and 9.6(0.02) at the last measurement, with achievement of glycemic control (HbA1c <7%) in 13.8% of patients (Table 1). Out of the 12869

patients enrolled, 1446(11.2%) of them were newly diagnosed with diabetes, of those, 53(3.7%) had been initiated on insulin therapy since the first visit.

3.2. Demographic and clinical variables according to glycemic control

Glycemic control could not be achieved in younger (<55 year) vs. older (≥55 year) patients (87.2 vs. 84.3%, p < 0.001), in females vs. males (88.2% vs. 83.7%, p < 0.001), in >3 years vs. ≤3 years duration of diabetes (89.0 vs. 67.2%, p < 0.001), in those with vs. without a family history of diabetes (86.8 vs. 85.1%, p = 0.004) , in >2 years vs. ≤2 years of follow-up (88.8 vs. 81.3%, p < 0.001) and number of visit to the center >20 vs. ≤20 (90.9 vs. 85.6 %, p < 0.001) (Table 2).

Lack of hypertension (86.9 vs. 85.5%, p = 0.001), BMI <25 kg/m^2 (87.3 vs. 85.9%, p = 0.03), HbA1c >10% at the first visit (93.5 vs. 78.5%, p < 0.001), presence of dyslipidemia (87.5 vs. 82.8%, p < 0.001) and insulin treatment (93.2 vs. 77.8%, p < 0.001) were also associated with a higher risk of poor glycemic control in the univariate analysis (Table 2).

3.3. Multivariate logistic regression analysis for factors predicting an increased risk of poor glycemic control

Multivariate analysis revealed <55 years of age (OR 1.34, 95% CI 1.20-1.50, p < 0.001), female gender (OR 1.31, 95% CI 1.18-1.40, p < 0.001), >3 years duration of diabetes (OR 2.8, 95% CI 2.40-3.20, p < 0.001), HbA1c levels >10% at the first visit (OR 3.2, 95% CI 2.80-3.60, p < 0.001), presence of dyslipidemia (OR 1.4, 95% CI 1.20-1.50, p < 0.001), and insulin treatment (OR 2.6, 95% CI 2.30-2.90, p < 0.001) as significant determinants of an increased risk of poor glycemic control (Table 3).

BMI <25 kg/m^2 (OR 0.8, 95% CI 0.73-0.90, p = 0.01) and presence of hypertension (OR 0.8, 95% CI 0.70-0.90, p = 0.002) were associated with a decreased risk of poor glycemic control (Table 3).

3.4. Risk factors associated with weight gain under treatment

Out of the 12869-patient included in this study, 6630(51.5%) were having weight gain.The mean(SEM) weight gain under treatment was higher in males vs. females (1.88(0.92) vs. 1.43(0.85) kg, p < 0.001), >6 years vs. ≤6 years duration of diabetes (2.44(0.8) vs. -0.02(0.01) kg, p < 0.001), >8 years vs. ≤8 years duration of follow-up (4.67(0.45) vs. 1.52(0.06) kg, p < 0.001), >20 vs. ≤20 visits during follow-up (5.37(0.25) vs. 1.18(0.06) kg, p < 0.001), those with BMI <25 kg/m^2 vs. ≥25 kg/m^2 (4.47(0.15) vs. 0.90(0.70) kg, p < 0.001), HbA1c >15 vs. ≤15% at the first visit (4.90(0.52) vs. 1.56(0.06) kg, p < 0.001) and those under insulin vs. OAD treatment (3.06(0.93) vs. -0.06(0.01) kg, p < 0.001) (Table 4).

Analysis of some variables done at end to compare at the first visit and last visit according to achievement of glycemic control (Table 5).The weight, BMI and HbA1c were statistically higher in last visit in the uncontrolled group.No differences between random plasma glucose in the last visit between both groups.

4. Discussion

Using data from the largest cohort of T2DM patients from Iraq to date, this tertiary care database analysis over a 9-year period indicated poor glycemic control in Iraqi patients, with achievement of HbA1c target (<7%) by only 13.8% of patients who were followed

Table 1
Demographic and clinical characteristics (n = 12,869).

Patient demographics			
Age (year), mean (SEM)			51.4(0.1)
Age group, n(%)			
<55 year			8283(64.4)
≥55 year			4586(35.6)
Gender, n(%)			
Male			5866 (45.6)
Female			7003(54.4)
Anthropometrics			
BMI (kg/m^2), mean(SEM)			29.9(0.1)
BMI category, n(%)			
≥25 kg/m^2			10,302(80.1)
<25 kg/m^2			2567(19.9)
Weight gain (kg), mean(SD)			1.6(0.1)
Diabetes characteristics			
Duration of diabetes (year), mean(SEM)			9.7 (0.1)
Family history for diabetes, n(%)			8041(63.4)
Mode of treatment, n(%)			
OAD			5889(45.8)
Insulin + OAD			6980(54.2)
HbA1c (%)	At enrolment	mean(SEM)	10.1(0.02)
		>10%, n(%)	6595(51.2%)
		≤10%, n(%)	6274(48.8%)
	Last measurement, mean(SEM)		9.6(0.02)
Glycemic control, n(%)			
Achieved			1782(13.8)
Not achieved			11,087(86.2)
Comorbidities, n(%)			
Neuropathy			**7785(60.5)**
Hypertension			5410(42.0)
Dyslipidemia			9074(70.5)
Follow-up characteristics			
Duration of follow-up (year), mean(SEM)			3.2(0.02)
Number of visits, mean(SEM)			9.0(1.0)

BMI: Body mass index; OAD: Oral antidiabetic drugs; SEM: Standard error of the mean.

Table 2
Univariate analysis for demographic and clinical variables according to glycemic control.

n (%)		Glycemic control		OR	95% CI		p value
		Not achieved (n = 11087)	Achieved (n = 1782)		LB	UB	
Age	**<55 year**	7221(87.2)	1062(12.8)	**1.27**	1.14	1.40	**<0.001**
	≥55 year	3866(84.3)	720(15.7)				
Gender	**Females**	6179(88.2)	824(11.8)	**1.46**	1.32	1.62	**<0.001**
	Males	4908(83.7)	958(16.3)				
Duration of diabetes	**>3 years**	9956(89.0)	1231(11.0)	**3.52**	3.17	3.90	**<0.001**
	≤3 years	1131(67.2)	551(32.8)				
Family history of diabetes	**Yes**	6979(86.8)	1062(13.2)	**1.15**	1.04	1.27	**0.004**
	No	4065 (85.1)	711 (14.9)				
Duration of follow up	**>2 years**	7368(88.8)	929(11.2)	**1.82**	1.64	2.01	**<0.001**
	≤2 years	3719(81.3)	853(18.7)				
Number of visits	**>20**	1253(90.9)	126(9.1)	**1.68**	1.38	2.03	**<0.001**
	≤20	9834(85.6)	1656(14.4)				
Hypertension	**No**	6485 (86.9)	974 (13.1)	**1.17**	1.06	1.29	**0.001**
	Yes	4602 (85.1)	808 (14.9)				
BMI at first visit	<25 kg/m^2	2240 (87.3)	327 (12.7)	**1.12**	0.99	1.30	**0.031**
	≥25 kg/m^2	8847 (85.9)	1455 (14.1)				
HbA1c at first visit	**>10%**	6164(93.5)	431(6.5)	**3.93**	3.50	4.40	**<0.001**
	≤10%	4923(78.5)	1351(21.5)				
Lipid control	**No**	7943(87.5)	1131 (12.5)	**1.45**	1.31	1.62	**<0.001**
	Yes	3144 (82.8)	651 (17.2)				
Mode of treatment	**Insulin**[a]	6504(93.2)	476(6.8)	**3.89**	3.48	4.35	**<0.001**
	OAD	4583(77.8)	1306(22.2)				

BMI: body mass index; OR Odds ratio; CI: confidence interval; LB: lower bound; UB: upper bound; OAD: Oral antidiabetic drugs.
[a] This includes insulin in combination of OAD.

Table 3
Multivariate logistic regression analysis for factors predicting an increased risk of poor glycemic control.

Variables	OR	95% CI (LB-UB)	p value
Age <55 years	1.34	(1.20–1.50)	**<0.001**
Female	1.31	(1.18–1.40)	**<0.001**
Family history of diabetes	1.04	(0.90–1.17)	**0.4**
Duration of diabetes > 3 years	2.8	(2.40–3.20)	**<0.001**
Duration of follow up > 2 years	1.1	(0.90–1.20)	0.1
Number of visits > 20	0.9	(0.70–1.10)	0.4
BMI at first visit <25 kg/m^2	0.8	(0.73–0.90)	**0.01**
Hypertension	0.8	(0.70–0.90)	**0.002**
First HbA1c >10%	3.2	(2.80–3.60)	**<0.001**
Dyslipidemia	1.4	(1.20–1.50)	**<0.001**
Insulin treatment	2.6	(2.30–2.90)	**<0.001**

BMI: body mass index; Odds ratio; CI: confidence interval; LB: lower bound; UB: upper bound.

up an average of 3.2 years and under OAD treatment alone (45.8%) or in combination with insulin therapy (54.2%).

Our findings support the failure to achieve glycemic goals despite novel therapeutics that have been consistently reported among patients with T2DM worldwide for the achievement of a target HbA1c <7.0% by 53.6–63.8% of patients from USA or European countries [19,20]; by 11.1–28.2% of patients from Indonesia, Peru, Romania and South Africa [21] and by 13–50% of patients from Arabian Gulf Countries or the Middle East and North Africa (MENA) region [22–32].

Notably, the average duration of diabetes was 9.7 years in our cohort, while the mean patient age was 51.4 years, with 64.4% of patients being younger than 55 years of age. This emphasizes the likelihood of early-onset T2DM in a considerable portion of our patients and may also contribute to the high prevalence of poor glycemic control in our cohort given the association of early-onset

Table 4
Risk factors associated with weight gain under treatment in diabetes patients.

Variables		n(%)	Weight gain (kg)	p value
			mean(SEM)	
Gender	Males	5866 (45.6)	1.88(0.92)	**<0.001**
	Females	7003(54.4)	1.43(0.85)	
Duration of diabetes	>6 years	8644(67.2)	2.44(0.8)	**<0.001**
	≤6 years	4225(32.8)	−0.02(0.01)	
Duration of follow−up	>8 years	475(3.7)	4.67(0.45)	**<0.001**
	≤8 years	12394(96.3)	1.52(0.06)	
Number of visits	>20	1379(10.7)	5.37(0.25)	**<0.001**
	≤20	11490(89.3)	1.18(0.06)	
BMI at first visit	<25 kg/m2	2567(19.9)	4.47(0.15)	**<0.001**
	≥25 kg/m2	10,302(80.1)	0.90(0.70)	
HbA1c at first visit	>15%	319(2.5)	4.90(0.52)	**<0.001**
	≤15%	12550(97.5)	1.56(0.06)	
Mode of treatment	Insulin + OAD	6980(54.2)	3.06(0.93)	**<0.001**
	OAD	5889(45.8)	−0.06(0.01)	

BMI: body mass index; OAD: Oral antidiabetic drugs; SEM: Standard error of the mean.

Table 5
Comparison of different parameter at the first and last visits between patients with and without glycemic control.

		First visit mean (SD)	Last visit mean (SD)	p value
Weight kg	Total	78.8 ± 17.3	81.1 ± 15.7	<0.001
	Controlled	81.5 ± 17.2	82.0 ± 15.8	0.56
	Uncontrolled	78.5 ± 17.3	81.0 ± 15.7	<0.001
BMI	Total	29.9 ± 5.8	30.6 ± 5.6	<0.001
	Controlled	30.9 ± 5.9	30.9 ± 5.7	0.941
	Uncontrolled	29.8 ± 5.8	30.6 ± 5.6	<0.001
Random plasma glucose mg/dL	Total	257.8 ± 103.1	260.4 ± 107.4	0.619
	Controlled	171.6 ± 72.5	175.7 ± 78.9	0.920
	Uncontrolled	264.6 ± 102.1	267.0 ± 106.6	0.589
HbA1c %	Total	10.1 ± 2.4	9.6 ± 2.3	<0.001
	Controlled	6.2 ± 0.6	7.3 ± 1.8	<0.001
	Uncontrolled	10.5 ± 2.1	9.8 ± 2.3	<0.001

diabetes with poor glycemic control and a higher risk of comorbidities and complications [26,33].

Accordingly, younger (<55 years) patient age (OR 1.34, 95% CI 1.20–1.50, $p < 0.001$) and >3 years duration of diabetes (OR 2.9, 95% CI 2.50–3.34, $p < 0.001$) were among the factors found to predict an increased risk of poor glycemic control in our cohort.

Younger age groups (≤60 years) were also reported to be at higher risk of poor glycemic control in past studies conducted in the Arabian Gulf [26,31,32,34] as well as in other countries [35,36]. The authors noted the higher likelihood of being affected by lifestyle changes and lower adherence to a diabetes care plan due to active occupational and social life to be the factors underlying poor glycemic control in younger age groups of diabetes patients [34].

The association of >3 years of diabetes duration with poor glycemic control in our cohort supports the more challenging glycemic control among patients with longer durations of T2DM in relation to further deterioration of pancreatic function, increased insulin resistance and an increased risk of diabetes-related complications [26].

Likewise, the risk of early-onset diabetes has also been reported in a past study with T2DM patients from Saudi Arabia [26]. The authors emphasized the crucial role of diabetes screening programs to identify people at risk of diabetes and implementation of intensive management protocols aimed at tighter glycemic control once the diagnosis is made to delay diabetes-related complications and enable a better quality of life and longer life expectancy among young people with diabetes [26,37].

Identification of female gender as a significant risk factor for poor glycemic control in our cohort is important given that females to have a higher diabetes prevalence than males in countries located in the MENA region, including Iraq [1]. Poor glycemic control among females in our cohort seems to be in agreement with women with diabetes being less likely to achieve target HbA1c levels compared with men [38–43]. Differences in glucose homeostasis, treatment response and psychological factors have been attributed to the gender influence on glycemic control, along with the emphasis of the need for developing specific treatment guidelines for men and women [42]. Nonetheless, there are also studies reporting no gender influence on glycemic control or treatment adherence [44–47] as well as better glycemic control in females than in males among patients with T2DM [22,29,48,49].

Insulin resistance and progressive deterioration of β-cell function in T2DM eventually leads to failure to achieve glycemic control via OADs, necessitating insulin initiation [14,50,51]. In fact, even earlier and more intensive insulin initiation has been suggested in patients with newly diagnosed T2DM due to its association with improved glycemic control [52,53]. Patients in our cohort were suffering from diabetes for an average of 9.7 years, with initial HbA1c levels >10% in half of the patients, while 45.8% were insulin-naïve patients still under OAD therapy. This seems notable given that patients with diabetes are often exposed to a prolonged glycemic load, with the initiation of insulin treatment only after a high glycemic burden for 5 years with HbA1c >8%, for 10 years with HbA1c >7% [54] and with average HbA1c levels of ~10% at the time of insulin initiation [55,56].

Similarly, data from an 18-month observational VISION study on patterns of insulin initiation and intensification in T2DM patients in the MENA region revealed that 67.6% patients had HbA1c ≥ 9% at insulin initiation, with a mean HbA1c of 9.9%, despite 68.3% patients being on ≥2 OADs, indicating a significant delay in insulin initiation [57].

Hence, the association of insulin treatment with a higher risk of poor glycemic control in our cohort seems to be related to the initiation of insulin only after prolonged periods of poor glycemic control in a population with an already established risk of diabetes-related complications [54,55,58,59]. Likewise, the use of injectable medications was reported to be a strong predictor for poor glycemic control in past studies among T2DM patients [26,31,32,36], with the maintenance of high blood glucose levels even after insulin treatment in a considerable portion of patients [60]. Low patient adherence due to social stigmata, interference with daily activity, and fear of hypoglycemia as well as underlying disease progression, weight gain related to insulin use and polypharmacy have been suggested to increase the risk of poor glycemic control in insulin-treated patients [61,62].

The prevalence of obesity was reported to range from 53 to 62% in large-scale multinational studies with T2DM patients [63–65]. The identification of normal weight in only 20.0% of patients in our cohort seems consistent with data from the nationwide TEMD Obesity survey in Turkish T2DM patients, which indicated only 10% of patients ($n = 4648$) have normal a BMI, with other patients being either overweight (31%) or obese (59%) [66]. High overweight or obesity rates in our cohort are important given that having a normal weight (BMI<25 kg/m^2) was found among the predictors of a lower risk of poor glycemic control (OR 0.78). The identification of hypertension in 42% of our diabetic patients also seems important since hypertension was considered among the determinants of a higher obesity risk among T2DM patients [60]. Indeed, a multifactorial approach has been recommended for the management of diabetic patients with hypertension, involving simultaneous targeting of blood pressure and glucose levels [67,68]. Accordingly, the association of comorbid hypertension (OR 0.8) with a lower risk of poor glycemic control in our cohort may be related to a higher likelihood that younger diabetes patients with comorbid hypertension are assigned to both strict HbA1c and blood pressure targeting by physicians [68]. In Kuwaiti cohort that enrolled 7657 patients, the presence of hypertension was not associated with poor glycemic control [69].

Longer duration of diabetes, male gender, insulin therapy, initially high HbA1c levels and normal body weight were also associated with greater weight gain under treatment in our patients. This supports the association of a high baseline HbA1c and lower baseline BMI with greater weight gain in insulin-treated diabetes patients [70] and a higher likelihood of weight loss in females than males during anti-diabetic treatment [71]. Our findings also support the association of higher presenting HbA1c and dyslipidemia with an increased risk of poor glycemic control in T2DM patients [29,72].

The high prevalence of poor glycemic control in Iraqi patients with T2DM appears also to be related to the vast destruction of Iraqi health system infrastructure after the 2003 War, resulting in the failure to cope with the increased number of diabetic patients in terms of provisions for essential care [4,6–10]. Notably, in a past study on self-management practices of T2DM patients recruited from the National Diabetes Center in Baghdad, Iraq, the rarity of practicing daily diabetes self-management protocols as well as the impact of stressful life factors (i.e., lack of clean water and electricity and the political instability in Iraq) on hyperglycemia have been identified by the majority of participants [5]. Limited knowledge about diabetes self-management practices due to the unavailability of educational programs has also been emphasized in Iraqi diabetic patients [5,73,74].

Indeed, aside from the well-known factors limiting regular physician consultations, such as a lack of awareness, the cost of appointments, and time constraints [75], the likelihood of a negative attitude toward physicians, due to considerations that the most knowledgeable physicians immigrated outside of Iraq, has also been considered to be a unique factor challenging access to appropriate health care among Iraqi patients [5].

Hence, a more pragmatic approach appears to be necessary to improve diabetes care in Iraq, including a shift in glycemic control parameters towards less stringent HbA1c targets (7–8%), as recommended by the ACP [13], solving the issues of the unified drug supply and introducing insurance for all patients with chronic illness [76].

The major strength of this study is the inclusion of a database comprising 12,869 T2DM patients managed in a tertiary care setting over a 9-year period in Iraq, which enables our findings to be generalizable based on the presence of a representative sample of an overall population. However, certain limitations to this study should be considered. First, due to the retrospective single-center design of the present study, establishing temporality between the cause and effect is not possible. Second, the use of an HbA1c cut-off of 7% for all patients rather than individualized glycemic control targets is a second limitation. Third, the lack of data on other anti-hyperglycemic agents or treatment intensification is another limitation, which would otherwise extend the knowledge achieved in the current study.

5. Conclusion

Providing data from the largest cohort of T2DM patients from Iraq, this tertiary care database analysis over a 9-year period indicated poor glycemic control in Iraqi patients with achievement of an HbA1c target (<7%) by only 13.8% of patients who were followed up for an average of 3.2 years and were under OAD treatment alone or in combination with insulin therapy. Younger patient age, female gender, longer disease duration, initially high HbA1c levels, dyslipidemia, insulin treatment, overweight and obesity, and lack of hypertension were associated with an increased risk of poor glycemic control in Iraqi T2DM patients. Our findings emphasize the need for improved diabetes care practices in Iraq, with considerations for tailored treatment strategies and continuous education programs as well as the development of healthcare strategies and national system-based approaches to update and prioritize diabetes screening and management across the country to overcome the barriers of inadequate glycemic control.

Consent to publish

Permission was obtained from our institutional ethics committee for the use of patient data for publication purposes.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request without the need any administrative permissions.

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Authors' contributions

AAM contributed to conception and design of the study and acquisition and analysis of data; NTYA contributed to conception and design of the study; HAA contributed to conception and design of the study; AHAA contributed to conception and design of the study; AMSAA contributed to conception and design of the study; IAZ and MBK contributed to acquisition and analysis of data; RNH contributed to acquisition and analysis of data; HAN contributed to interpretation of data and drafting the work; AGM contributed to acquisition and analysis of data; DKJA contributed to interpretation of data and drafting the work; IHH contributed to interpretation of data and drafting the work. All authors read and approved the final manuscript. All authors equally contributed to this study. All authors read and approved the final manuscript.

Declaration of competing interest

The authors declare that they have no competing interests.

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Abbreviations

AACE/ACE	American Association of Clinical Endocrinologists and American College of Endocrinology
ACP	American College of Physicians
ADA	American Diabetes Association
FDEMC	Faiha Specialized Diabetes, Endocrine, and Metabolism Center
HbA1c	glycated hemoglobin
LDL-C	low density lipoprotein −cholesterol
OAD	oral antidiabetic drug
T2DM	type 2 diabetes mellitus

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