



Glycaemic control among adults with type 2 diabetes mellitus in the Gulf Cooperation Council countries: an updated review

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Abstract

Type 2 diabetes mellitus (T2DM) has become a major public health concern, causing significant disability and death worldwide. Fuelled by a modern sedentary lifestyle and poor dietary practices, T2DM affects at least 10.5% of the world's population. This paper seeks to review the progress made by the Gulf Cooperation Council (GCC) countries (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates) in addressing T2DM, focusing on glycaemic control proportions and comparing it with the 2015 review. The results indicate no significant improvement in glycaemic control proportions since the last review, with only 9.2% to 56.9% of patients having good control (glycosylated haemoglobin < 7%). However, there are no significant differences in glycaemic control between the GCC countries and other places worldwide despite being considered hotbeds of T2DM. Many factors contribute to poor glycaemic control. Specifically, evidence shows that being overweight or obese is the most common modifiable risk factor for T2DM incidence and poor glycaemic control. The GCC countries have higher rates of obesity. Additionally, poor glycaemic control is mainly related to a lack of adherence to insulin and medication use. Poor diet, rich in calories and low in fruits and vegetables, and a sedentary lifestyle also significantly contribute to poor glycaemic control and obesity. Therefore, to reduce the incidence of disease and improve glycaemic control in diabetic patients, educational programs promoting lifestyle changes should be implemented. Ongoing research is also necessary to assess the trend of glycaemic control and its risk factors in our region. (**Endokrynol Pol 2024; 75 (2): 159–169**)

Key words: Arab; HbA_{1c}; obesity; GCC; Middle East; Saudi Arabia

Introduction

Diabetes mellitus (DM) is a major chronic illness related to significant death and disability worldwide. Modern lifestyles characterised by reduced physical activity, consumption of high-calorie foods, and obesity significantly contribute to the development of type 2 diabetes mellitus (T2DM) [1]. As a result, more than 10.5% of people aged between 20 and 79 years were reported to have diabetes in 2021, with the disease expected to affect 1 in 8 adults by 2045 [2]. Additionally, DM was responsible for 6.7 million deaths in 2021 [2].

Glycaemic control, involving the regulation of blood glucose within levels that prevent both hyperglycaemia and hypoglycaemia, is a major valuable strategy in managing DM. The glycosylated haemoglobin (HbA_{1c}) level is the primary tool for assessing glycaemic control and has a strong predictive value for diabetes complications [3]. Poor glycaemic control, which is defined as HbA_{1c} ≥ 7%, is related to high management costs and an increased risk of diabetes complications, including retinopathy, neuropathy, and nephropathy

[3]. Despite over 200 years of research on the lifestyle management of DM and more than 50 years of comparative-effectiveness research in DM [4], the proportions of poor glycaemic control remain high in many patients [5].

The Gulf Cooperation Council (GCC) is a political, economic, and security regional organisation comprising 6 countries in the Arabian Peninsula [6]. The GCC countries include Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates (UAE). They are situated in Southwest Asia and are among the countries of the Middle East. The GCC countries are oil-rich and similar to a larger extent in many areas, including economy, environmental conditions, culture, socio-economic aspects, and environmental and healthcare capacities [7]. It is thus expected that the prevalence of T2DM and the challenges in management among populations are consistent among these populations.

A 2015 review placed the proportions of adequate glycaemic control in the GCC countries between 11% and 41%, which was not significantly different from other parts of the world [8]. Furthermore, findings also



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categorised most diabetic patients as either overweight or obese, which is negatively related to poor management [8]. With T2DM becoming a major public health problem and taking a significant portion of healthcare national budgets in these countries, there is a need to review the current trends and success in management efforts to address the disease. However, there have been few reviews of glycaemic control among patients with T2DM in the region since 2015. Two reviews were found. The first search was for related studies before May 2016 [9]. The other was published in 2022 but was more general about the Middle East and North Africa (MENA) region [10]. Therefore, this paper aims to review current studies focusing on glycaemic control among adult patients with T2DM in the GCC countries, published from 2015 to the end of 2023.

Prevalence of T2DM in the GCC countries

The prevalence of T2DM has been on an increasing trajectory worldwide [11]. According to the International Diabetes Federation (IDF), about 537 million adults aged 20 to 79 years (one in every 10 people) live with diabetes, an increase from 2014 [2]. This prevalence is higher in the GCC countries. Seven of the top 20 countries with the highest prevalence of DM worldwide are from the MENA region, making the area important in global efforts to address the disease [12]. While the GCC countries, which belong to the MENA region, are similar in many areas, the prevalence of T2DM varies [2, 12].

In a 2021 release, the IDF noted that the MENA region leads the world in the prevalence of diabetes: 16.2% vs. 10.5% worldwide [2]. The prevalence has increased significantly compared to the 2019 IDF report [13, 14]. In general, the relative trend in the prevalence of diabetes has been that of an increase in most countries compared to our last review [8]. According to the IDF estimates, Kuwait had the highest prevalence of DM among the GCC countries. Unfortunately, Kuwait is the third country in the world in terms of the highest prevalence of DM after Pakistan and French Polynesia [2] (Tab. 1).

No recent census between 2015 and 2023 has reported the prevalence of DM in the GCC countries. Further, none of the GCC countries have conducted national surveys to establish the prevalence of T2DM. However, recent regional studies provide relevant data and information concerning the prevalence of T2DM in these countries.

In Kuwait, few regional studies that examined the prevalence of T2DM have been published since 2015. In a cross-sectional study across several regions and hospitals in Kuwait conducted between 2011 and 2014, the overall adjusted prevalence of diabetes and prediabetes among adults aged 20 years or more

Table 1. Estimates of diabetes prevalence in adults 20–79 years old in the Gulf Council Cooperation countries according to the International Diabetes Federation (IDF) 2021

Country/region	Diabetes prevalence	95% CI
Kuwait	25.5%	23.9–29.1
Saudi Arabia	17.7%	11.6–16.1
Qatar	16.4%	14.4–18.8
United Arab Emirates	12.3%	11.6–16.1
Oman	11.8%	11.5–17.3
Bahrain	9.0%	8.8–17.3
The MENA region*	16.2%	8.5–18.3

CI — confidence interval; MENA — Middle East and North Africa; this region includes 21 countries

was 19.1% and 13.35%, respectively. The prevalence of diabetes among Kuwait nationals was established at 21.8%, with a prediabetes rate of 11.1% [15]. The rate was higher than that of foreigners living in the country, who recorded 18.2% and 14.3% for diabetes and prediabetes, respectively [15].

Qatar seems to have had a slight decline in rates of diabetes from the last review, albeit still reporting high prevalence. A 2019 Biobank study, which included 10,000 randomly selected individuals, placed the prevalence of adults with T2DM in Qatar at 17.4% [16]. These rates indicate a declining rate despite the region's rather significant challenges.

Based on one systematic review, the prevalence of T2DM in Saudi Arabia was reported to be 33% in 2016, with a projected increase to 45.8% in 2030 [17]. In contrast to IDF estimates, this systematic review showed a higher prevalence of diabetes in Saudi Arabia. This may be due to the difference in research methodology. For example, the prevalence of diabetes in the study by Al-Rubeaan *et al.* (one of the studies included in the systematic review) was 32.8%. However, the prevalence decreased to 16.7% when considering the age spectrum over 15 years old. Furthermore, the study included type 1 DM [18]. In a cross-sectional study involving individuals living in semi-urban Saudi Arabia, researchers found the prevalence of T2DM to be 34.6%, with older adults being more exposed than young people (44.6% versus 15.6%, respectively) [19]. This is a significant rise compared to the last review, in which the prevalence of diabetes was 30%.

In the UAE, one small study placed the prevalence of T2DM at 18.98% [20]. This figure is slightly higher than the IDF rate of 17.3% in 2017 [21]. This is an increase from the last review, where Emirati citizens' average prevalence rate was 15.9%. In another study conducted in 2013, the prevalence of DM was highest in UAE nationals (male 21% and female 23%) as well as

Asian non-Arabs (male 23% and female 20%) but lower in Westerners and African adults [22].

The case of diabetes in Oman is on an upward trajectory despite recording one of the lowest prevalences among the GCC countries. In the STEPS survey conducted in 2017 in the Sultanate of Oman involving 9053 households, diabetes was reported to be as high as 15.7%, while prediabetes was 11.8% [23]. This is a slight increase from the last review in which the prevalence was reported at 11.1%. Despite limited data on the prevalence of diabetes in the country, it shows an increase in case rates. Finally, no published studies have been found on the prevalence of diabetes in Bahrain since 2015. Bahrain has the lowest rate of diabetes among GCC countries, but the rate is still higher than the global prevalence [2].

Proportions of glycaemic control in the GCC Countries

Glycaemic control is related to positive outcomes of T2DM management. Despite reported government efforts to address diabetes in the GCC countries, including minimising the negative consequences of the disease, recent studies show a growing trend with reports of poor glycaemic control among patients [15]. Recent studies show poor glycaemic control among T2DM patients in the region, albeit with some improvements.

Type 2 diabetes places a significant financial burden on healthcare in the GCC countries, primarily due to costly diabetes-related complications [24].

We found 34 studies that included discussion about glycaemic control among adult patients with T2DM. More than half of these studies were conducted in Saudi Arabia, so we created a separate table for them (refer to Table 2). In contrast, the other 15 studies from different countries are included in Table 3.

The most recently published study was from Saudi Arabia, where the proportion of good glycaemic control ($HbA_{1c} < 7\%$) among patients with T2DM was about 49% [25]. Glycaemic control varies across different studies in Saudi Arabia [25–43]. The studies show that good glycaemic control ranges from about 9% to 57%. The lowest poor glycaemic control proportion was found in a study conducted in Jizan, where the proportion of good glycaemic control was only 9.2% [28]. Similarly, adequate glycaemic control in other studies was relatively low, ranging from 9.6% to 25.6% [30, 31, 33, 34, 40, 41]. In contrast, other studies found better results. For example, the percentage of patients with T2DM who had good glycaemic control in one tertiary academic hospital was 56.9% [37].

In the other GCC countries, 3 studies were conducted in the UAE [20, 44, 45]. The prevalence of good glycaemic control ranged from 15.4% to 46.6%.

Table 2. Original studies on glycaemic control among adults with type 2 diabetes mellitus in Saudi Arabia published since 2015

Authors, publication year*	Study description	The proportion of good glycaemic control [#]	Factors examined/notes
Abubaker et al., 2023 [25]	This is a retrospective cohort study including all adults with T2DM at the family medicine clinic at one tertiary hospital from 2015 to 2021	Out of 370 patients, the proportion of good glycaemic control was 49.2%	Serum vitamin D has a significant inverse relationship with HbA_{1c} levels
Alqahtani & Alsulami, 2023 [26]	A cross-sectional study was conducted at the Jeddah Center for the Care of Diabetes and Blood Pressure Patients. It included 152 patients between 2015 and 2022	The proportion of good glycaemic control was 21.9%	The aim was to examine the correlation between HbA_{1c} and vitamin D levels among patients with DM
Ewid et al., 2023 [27]	A cross-sectional study was conducted in the Qassim region. Two hundred patients with T2DM were enrolled.	Only 22.5% of patients had $HbA_{1c} < 7\%$.	Longer diabetes duration was significantly associated with poor glycaemic control (OR = 1.006, $p < 0.005$)
Elfaki et al., 2023 [28]	A cross-sectional study of patients with T2DM at the Endocrinology and Diabetes Centre in Jazan included 315 participants	More than 90% of the patients had poor HbA_{1c} levels	43.8% and 37.1% of patients were overweight and obese, respectively. Multivariate logistic regression revealed that the consumption of fruit significantly decreased HbA_{1c} , while the consumption of pastries/pizza significantly increased it
Al Luhidan et al., 2022 [29]	A 5-year retrospective chart review including 319 diabetic patients in a tertiary care centre and linked primary healthcare clinics in Riyadh from January 2016 to December 2020	The mean HbA_{1c} during the study period was $8.30\% \pm 1.9$; 55.1% had HbA_{1c} levels higher than 8	Higher HbA_{1c} levels correlated significantly with higher LDL levels



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Authors, publication year*	Study description	The proportion of good glycaemic control [#]	Factors examined/notes
Shaqra et al., 2022 [30]	A cross-sectional study was conducted on a sample of T2DM patients attending the PCCs in Makkah City	The study included 293 patients, blood glucose was uncontrolled in 90.4% of patients	The level of knowledge about DM was not significantly different between patients whose HbA _{1c} was 7% compared to those with higher levels
Alfadhli et al., 2021 [31]	A cross-sectional study was conducted on 692 diabetic patients, followed by 15 PCCs in Madinah between January 2016 to December 2017	The mean HbA _{1c} was 8.39 ± 1.7, and glycaemic goals were achieved in 15.7%.	Younger age, longer diabetes duration, and higher LDL levels were associated with poor glycaemic control
Almalki et al., 2021 [32]	This cross-sectional study aimed to assess the prevalence of glycaemic control and risk factors among diabetic patients in one hospital in Al-Kharj in 2019	Of 1,010 diabetic patients involved in the study sample, poor glycaemic control represented 49.1%	Patients who were at risk of having poor glycaemic control included those between 45 and 65 years old, obese, and diagnosed with asthma
Abouammoh & Alshamrani, 2020 [33]	A cross-sectional design with a random sampling technique was carried out among patients of the Security Forces Hospital, Riyadh	A total of 435 patients were recruited; good glycaemic control was observed in 14.0%	The objective of the study is to identify the extent of knowledge related to diabetes and glycaemic controls in various diabetic patients
Ghabban et al., 2020 [34]	Data were reviewed for all patients with T2DM who attended the chronic illness clinic at King Khaled Hospital in Tabuk	A total of 697 patients were included. The overall prevalence of poor glycaemic control was 81.5%	In the logistic regression, longer disease duration and the usage of combined insulin and tablet treatments were more prone to poor glycaemic control. Older patients were less prone to poor glycaemic control
Al Dossari et al., 2020 [35]	This retrospective study included 200 patients with T2DM who visited a university hospital in Al-Kharj in 2015	Good glycaemic control was observed in 63.5% of patients	The mean serum vitamin D was significantly higher in the control glycaemic group
Alzahrani et al., 2019 [36]	A cross-sectional study was accomplished at a tertiary care hospital in Jeddah between April and July 2018	Of 206 patients with T2DM, 43.69% had HbA _{1c} levels < 7%	HbA _{1c} was associated with TGs, while no significant associations were found with age, BMI, or others
Almetwazi et al., 2019 [37]	Data were extracted from the electronic health record database of King Khaled University Hospital, Riyadh, for 2016	Among 728 patients, the percentage of good glycaemic control was 56.9%	The multivariate logistic regression showed that participants who were older than 65, with HTN, or with DLD were less likely to have controlled diabetes, while those with asthma were more likely to have controlled DM
AlHamwy et al., 2019 [38]	Between February and March 2017, the charts and laboratory records of adult patients with T2DM who received primary care services at Family Medicine clinics at King Fahad Medical City, Riyadh, were retrospectively reviewed	A total of 268 patients were included in the study. Patients who achieved goals for glycaemic control were 43.7%	In multivariate analysis, glycaemic control was independently associated with the type of diabetic medications, diet control, and smoking status
Alzaheeb & Altemani, 2018 [39]	A cross-sectional study examined T2DM patients at a diabetic centre in Tabuk between September 2016 and July 2017	A total of 423 patients were included. 74.9% of the patients had poor blood glycaemic control	Logistic regression revealed that a family history of diabetes, longer diabetic durations, insufficient physical exercise, or being overweight or obese were associated with poor glycaemic control
Alramadan et al., 2018 [40]	A total of 1,111 T2DM patients were recruited from Riyadh, Hofuf, and Jeddah between May and November 2017	About 24.1% of participants had good glycaemic control	Multivariable analysis showed that age ≤ 60 years, longer duration of diabetes, living in a remote location, low household income, low intake of fruit and vegetables, low level of physical activity, lack of knowledge about HbA _{1c} , high waist-hip ratio, low adherence to medication, and using injectable medications were risk factors for poor glycaemic control
Bakhsh et al., 2017 [41]	This was a cross-sectional study involving adult patients with T2DM visiting PCCs in Jeddah	Diabetes control was optimal in 25.6% of the 359 patients	In univariate binary logistic regression, predictors of optimal glycaemic control included age ≥ 60 years, high educational level, diabetes duration 6–10 years, treatment regimen comprising insulin, and excellent quality of self-management

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Authors, publication year*	Study description	The proportion of good glycaemic control [#]	Factors examined/notes
Alrasheedi, 2017 [42]	A cross-sectional design was conducted in January 2017 on adults with T2DM attending the medical clinics of Qassim University	Of 222 patients, 46.3% had HbA _{1c} less than 7%	The number of diabetic medications is associated with poor glycaemic control
Alsulaiman et al., 2016 [43]	A cross-sectional study was conducted to assess glycaemic control among patients with T2DM in the King Abdulaziz Housing City population, Riyadh, between 2011 and 2015	The rate of uncontrolled diabetes was 59.3%	Males were more likely to have uncontrolled diabetes (OR: 1.44, CI: 1.17–1.76, p = 0.0004)

HbA_{1c} — glycosylated haemoglobin; T2DM — type 2 diabetes mellitus; OR — odds ratio; PCCs — primary care clinics; LDL — low-density lipoprotein; TG — triglycerides; BMI — body mass index; HTN — hypertension; DLD — dyslipidemia; CI — confidence interval. [#]Good glycaemic control is defined as HbA_{1c} < 7%.

Table 3. Original studies on glycaemic control among adults with type 2 diabetes mellitus in the Gulf Council Cooperation countries other than Saudi Arabia published since 2015

Authors, publication year, country*	Study description	The proportion of good glycaemic control [#]	Risk factors examined/notes
Alawainati et al., 2023, Bahrain [54]	This study was conducted at 5 PCCs. A total of 732 participants were included	About 59.8% of patients had HbA _{1c} levels of more than 7%	Obesity is prevalent among T2DM patients and is associated with poor glycaemic outcomes
Alkandari et al., 2022, Kuwait [50]	Using data from 2 national cross-sectional surveys, the levels of risk factor control were assessed in 1,801 adults with diabetes aged 18–82 years	The percentage of adults with diabetes achieving control was 39.2%	In binary logistic regression models, after adjusting for age, sex, and nationality, the waist-hip ratio was the only factor associated with uncontrolled glycaemia
Tayyem et al., 2022, Qatar [46]	Qatar Biobank data on 2,448 T2DM patients aged 18–60 years were obtained	The prevalence of poor glycaemic control was approximately 50%	The study aimed to highlight the possible association between following different types of diet and glycaemic control
Alaradi et al., 2021, Qatar [47]	By cross-sectional analysis using data from the Qatar Biobank Study, 1000 adults with T2DM were enrolled	The prevalence of poor glycaemic control was 57.6%.	The study was conducted to assess the association between dietary patterns and glycaemic control among Qatari adults with T2DM
Hussein et al., 2021, Kuwait [51]	356 patients with T2DM were selected from 27 primary care clinics covering the state of Kuwait	The prevalence of uncontrolled HbA _{1c} was 77.8%	Patients on diet alone or OHAs alone have a lower prevalence of uncontrolled HbA _{1c} compared to those on mixed treatment regimens
Abdullah et al., 2020, Kuwait [52]	Participants' demographics, medical history, physical measurements, and blood biochemistry were assessed. A total of 2561 Kuwaitis aged 18–69 years were involved	Adequate glycaemic control was 34.5%	Mean BMI and fasting serum triglycerides were significantly higher in those with an inadequate HbA _{1c} . Women with diabetes were almost twice as likely to have inadequate HbA _{1c} levels as men with diabetes
Mohamed et al., 2020, Qatar [48]	A cross-sectional study was conducted and included 510 T2DM patients attending non-communicable disease clinics at 9 PCCs	About 63.7% of patients had poor glycaemic control	Poor glycaemic control was higher among patients with a duration of diabetes of ≥ 10 years, patients who do not practice self-monitoring of blood glucose, and those on a combination of OHAs and insulin
Dabous et al., 2019, the UAE [44]	The electronic medical records of all patients who attended the Dubai Diabetes Centre for an initial visit in 2015 were reviewed	A total of 84.6% of the 371 patients had an HbA _{1c} ≥ 7%.	Patients who attended frequent follow-up visits (≥ 4 visits) within one year were found to have significantly lower HbA _{1c} levels at the end of the 12-month study period
Al-Rumayhi et al., 2019, Bahrain [55]	Data from 205 participants from the Endocrinology Clinic, King Hamad University Hospital were reviewed	28.9% had good glycaemic control	Factors that significantly affected the mean HbA _{1c} were diet, medication adherence, and receiving a combination of insulin and OHAs



Table 3. Original studies on glycaemic control among adults with type 2 diabetes mellitus in the Gulf Council Cooperation countries other than Saudi Arabia published since 2015

Authors, publication year, country*	Study description	The proportion of good glycaemic control [#]	Risk factors examined/notes
Qaddoumi et al., 2019, Kuwait [53]	Data from 963 patients with T2DM were retrospectively collected from the Health Records at the Dasman Diabetes Institute during 2011–2014	The proportion of patients with good glycaemic control was 29.5%	Factors significantly associated with poor glycaemic control included insulin use
Alawadi et al., 2019, the UAE [20]	A retrospective analysis of the electronic medical records of all diabetic patients who attended primary and tertiary care centres within the Dubai Health Authority between 2012 and 2016	A total of 26,447 patients were included in the study; 37.7% achieved HbA _{1c} < 7%	This is the largest study in the region evaluating the glycaemic control of patients with diabetes
Lee et al., 2018, the UAE [45]	This retrospective cohort study used data handled by the Abu Dhabi Health Authority (January 2010 to June 2012) to determine glycaemic control and diabetes-related treatment costs	A total of 4,058 patients were involved. 46.6% of the patients achieved HbA _{1c} < 7%	Older age, female sex, better insurance coverage, non-use of insulin in the index diagnosis month, and non-use of antidiabetic medications during the follow-up period were significantly associated with improved glycaemic control
Saleh et al., 2016, Qatar [49]	A cross-sectional study was conducted to assess the quality of life in 281 adult patients with T2DM attending non-communicable disease clinics in PCCs	The proportion of good glycaemic control was 31.3%	Data analysis was applied to identify the significant predictors of quality of life
Al-Rubaei et al., 2016, Oman [58]	Data were obtained retrospectively from electronic clinical records in three PCCs in the Dhankh province	Of 567 patients with T2DM, 28.4% had HbA _{1c} < 7%.	Almost half of all patients (43.40%) had a BMI > 30.
D'Souza et al., 2015, Oman [57]	A cross-sectional descriptive study was led among 300 Arab adults living in Oman with T2DM in an outpatient diabetes clinic	About half of the percentage had uncontrolled HbA _{1c} > 7% (49.5%)	Adults with T2DM who actively collaborate in the decision-making process are able to achieve glycaemic control

PCCs — primary care clinics, HbA_{1c} — glycosylated haemoglobin; T2DM — type 2 diabetes mellitus; OHAs — oral hypoglycaemic agents; BMI — body mass index; UAE — The United Arab Emirates. [#]Good glycaemic control is defined as HbA_{1c} < 7%

In one study, the prevalence of poor glycaemic control was 62.3%, with patients in primary care clinics (PCCs) being less affected than those in tertiary care (60% vs. 65.1%) [20]. However, the researchers noted that with 40% achieving optimum glycaemic levels, there is an improvement trend related to sustained efforts in the educational and clinical sectors. In another study, the difference in HbA_{1c} was significantly greater in the group that attended frequent follow-ups compared to those that did not: 1.88% versus 0.13% ($p = 0.002$) [44]. Meanwhile, in Qatar, studies have shown that good glycaemic control is between 31% and 50% [46–49].

In Kuwait, several studies reported the proportions of glycaemic control. The proportions of adequate glycaemic control ranged from 22.2% to 39.2% [50–53]. Lastly, a few studies about glycaemic control among adults with T2DM in Bahrain and Oman were found. In Bahrain, a cross-sectional study noted the level of poor glycaemic control as 59.8% [54]. In another study aimed at evaluating the factors that influence glycaemic control among T2DM patients, researchers found that only 28.9% of participants had effective control [55]. In Oman, a study showed that the mean HbA_{1c} for Omani

patients was 8.8% [56]. In 2 other studies, diabetic patients with HbA_{1c} < 7% were 50.5% and 28.4% [57, 58].

Factors associated with poor glycaemic control in the GCC countries

Based on a systematic review that looked for articles published between 2020 and 2022, low education level, female gender, obesity, the duration of T2DM, the number of anti-diabetics, and lack of regular exercise were associated with poor glycaemic control [59]. Al-ma'aitah *et al.* carried out a systematic review to examine the factors that have been linked to glycaemic control in patients with T2DM in the MENA region; they found that pooled data showed an increased risk of poor glycaemic control in smokers, obese patients, patients with elevated waist-to-hip ratio, and longer disease duration [10]. At the same time, adequate control was associated with physical activity and self-management [10]. Both systematic reviews were consistent regarding obesity and the duration of DM [10, 59].

Several studies have assessed factors associated with poor glycaemic control among people with T2DM in the GCC countries. However, the studies are generally

inconsistent (see Tables 2 and 3). For example, some studies have shown that age 65 years or older is associated with poor glycaemic control [37], while others have shown the opposite [31, 32, 34, 40, 41, 45].

Low level of education, longer duration of diabetes, poor compliance to diet and medication, poor attitude towards the disease, poor self-management behaviour, anxiety, depression, renal impairment, hypertension, and dyslipidaemia were associated with inadequate diabetes [37]. Evidence suggests that obesity, physical inactivity, urbanisation, and poor nutritional habits have contributed to the high prevalence of diabetes and prediabetes in the GCC countries [12]. In addition, increased life expectancy, healthcare expenditures, and incidence of T2DM among children and young persons impact the prevalence in this region [14]. In Bahrain, poor diet, obesity, and non-adherence to medication were the primary causes of poor glycaemic control [54]. Similarly, poor dietary practices, including excess consumption of fast foods, were associated with poor glycaemic control [47].

Obesity among diabetic patients in the GCC countries

Overweight and obesity are the primary modifiable factors that have been driving increasing rates of diabetes in the world [60]. Moreover, overweight and obesity make diabetes management difficult, and common diabetes medications (insulin and some oral hypoglycaemic agents) can lead to weight gain [60]. Obesity and overweight are common among adults in developed and developing nations. Countries in the MENA region are the most affected by the obesity and overweight epidemic, hence leading to the prevalence of T2DM [12, 61]. Specifically, the GCC countries have a higher prevalence of obesity. According to World Obesity, Kuwait, Qatar, and Bahrain rank 14th, 20th, and 17th in the highest obesity rates among adults

worldwide [61] (Tab. 4). Women had a much higher prevalence of obesity than men, particularly in the ages 35-64 years [12, 62, 63].

The prevalence of diabetes and obesity go hand-in-hand among GCC countries. Childhood obesity and overweight are highest in Qatar, with 44% and 45.6% of male and female children being obese and 40.4% and 40.9% being overweight, respectively [64]. Among adults, 35.9% of men and 46.1% of women are obese [65]. A recent extensive survey collected data from all regions in Saudi Arabia, revealing a 24.7% obesity prevalence [66]. Similarly, a Saudi study published in 2023 showed that overweight and obesity were prevalent in 32.8% and 23% of the adult population, respectively [67]. These rates are slightly higher than what was reported by World Obesity.

Among T2DM patients in Saudi Arabia, researchers found that 89.6% were overweight or obese, representing 62.4% and 27.2%, respectively [68]. In another study, the majority of patients with T2DM (83.7%) had a body mass index (BMI) of 25 or higher [29]. In the Tabuk study, only 27.7% of participants had a healthy weight. Overweight or obese T2DM patients were at higher risk of poorly controlled diabetes [39]. Almalki's study found that approximately half of T2DM patients had obesity, which was associated with poor glycaemic control [32].

In the UAE, researchers reported that 49.5% and 35.5% of diabetic patients visiting PCCs in Dubai were obese and overweight, respectively [69]. In another study, 87.8% of participants were either overweight or obese [44]. Unfortunately, among Qatari adults with T2DM, only 8.7% had a normal BMI; 57.2% were obese [47]. Likewise, about half of the diabetic patients were obese, which was significantly associated with poor control [48].

For the GCC country with the worst obesity, Kuwait, the prevalence of obesity and overweight among people with diabetes was 59% and 32%, respectively

Table 4. The prevalence of obesity and overweight among adults in the Gulf Cooperation Council (GCC) area according to World Obesity

Countries	The estimated prevalence of adult overweight*	The estimated prevalence of adult obesity*	Worldwide rank based on the prevalence of adult obesity#
Kuwait	36.01%	43.75%	14 th
Qatar	28.70%	41.40%	20 th
Bahrain	35.50%	36.90%	27 th
Oman	35.00%	30.70%	49 th
UAE	40.10%	27.80%	60 th
Saudi Arabia	38.20%	20.20%	106 th

UAE — The United Arab Emirates. *Overweight is defined as body mass index (BMI) 25–25.99 kg/m², obesity if BMI is ≥ 30 kg/m²; #Out of 249 countries/territories (last updated 6 November 2023)

[15]. The mean BMI was significantly higher in individuals with inadequate glycaemic control than those with adequate control [52]. Qaddoumi *et al.* found that two-thirds of patients with poor glycaemic control attending the Dasman Diabetes Institute in Kuwait were obese [53].

In a cross-sectional study involving 732 T2DM patients in Bahrain, 47.5% were obese, while another 35% were overweight [54]. Similarly, about 68% and 26% of adults with T2DM were obese and overweight, respectively [55]. According to an Omani study, almost half of the patients had a BMI > 30. Moreover, the progression of BMI is associated with poor glycaemic control; those who had a BMI > 40 had the worst glycaemic control ($p < 0.001$) [58]. Although Oman is one of the Gulf countries with the least obesity, obesity explained 56.7% of T2DM cases in Oman in 2020 and 71.4% in 2050 based on mathematical modelling analyses [70].

Discussion

Type 2 diabetes mellitus is a disease that is becoming more and more prevalent, and it has many associated complications. Globally, by 2030, 643 million, and by 2045, 783 million adults aged 20-79 years are projected to live with diabetes [2]. Thus, while the world's population is estimated to grow by 20% over this period, the number of people with diabetes is estimated to increase by 46% [2]. In the GCC countries, despite efforts by governments to improve healthcare and control non-communicable diseases, including T2DM, there is a steady rise in prevalence rates [71]. So, any potential benefits from improved glycaemic control will be outweighed by the continuing rise in diabetes prevalence. The rates of T2DM in these countries remain high compared to the world average. However, these rates are similar to other countries in the Middle East. For example, the estimated prevalence of diabetes in Egypt is 21%, while in Pakistan, it is approximately 31% [2].

This disease strongly connects with the lifestyle, habits, and income of patients and communities. Evidence shows that being overweight or obese is the most common modifiable risk factor for T2DM [14]. Unfortunately, the GCC countries have a higher prevalence of overweight and obesity. Kuwait is the first among the GCC countries in obesity prevalence as well as T2DM, while Oman has the lowest estimated prevalence of obesity, with approximately 27% of adults [14]. Moreover, the prevalence of obesity and overweight among patients with T2DM is higher. Specifically, over 80% of these patients in the GCC countries are either overweight or obese. Many factors contribute to obesity in GCC countries. As people age, they have a higher chance of becoming overweight or obese. Physical

activity, sedentary behaviour, dietary habits, and sociodemographic factors such as low education levels, marriage, living in urban areas, and unemployment are significantly associated with overweight and obesity among adults in the Gulf region [14, 72]. Low physical activity was found more among women and with increasing age [72].

Regarding glycaemic control among T2DM patients in the GCC countries, the present review showed that adequate glycaemic control rates remain low, but there has been a slight improvement since the 2015 review [8]. In Saudi Arabia, good glycaemic control proportions varied. According to 9 studies, they were between 9.6% and 25.6%, while 4 other studies showed better proportions, ranging from 44% to 57%. According to the 2015 review, the proportions of good glycaemic control ranged between 20% and 32% [8]. In the UAE, the proportions of good glycaemic control ranged from 15% to 47%, while they were between 31% and 41% before 2015. In the other GCC countries, adequate glycaemic control proportions varied between 22% and 42%, slightly improving compared to before 2015. Of all the studies included, a good glycaemic control proportion of 9% was the worst, and 63% was the best, both of which were studies from Saudi Arabia.

Based on one systematic review that looked for articles published between 2020 and 2022, the global range of good glycaemic control was between 7% and 54%, reflecting a high prevalence of poor control [5]. This range is near to what the present review found. Furthermore, glycaemic control outcomes among GCC countries are almost similar to those of other Arab nations. Poor glycaemic control is prevalent in Lebanon, where the good glycaemic control proportion was 29% [73]. Similarly, Morocco had good glycaemic control: 33.7% [74]. In Iraq, it was about 23% [75]. In contrast, Egypt has the poorest glycaemic control proportion, in which 7% of patients with T2DM achieved $HgA_{1c} < 7\%$ [5, 76].

The proportions of poor glycaemic control among T2DM patients reported in Western and other countries are not better than in the GCC countries. In Canada, poor glycaemic control among patients with T2DM is 55% and 59% in males and females, respectively [77]. While in the United States of America, 51% had poor glycaemic control [78]. A longitudinal study from China placed the rate of poor glycaemic control among diabetic patients at 80% [79]. In India, 55,639 eligible records were reviewed to assess diabetic control. Nearly 76.6% of patients had uncontrolled glycaemic control [80]. In Nigeria, poor glycaemic control is 40% [81]. In another African country, good glycaemic control was reported in the range of 32% to 42% [82-84].

Regarding the factors associated with poor glycaemic control, poor adherence to insulin and medication

use guidelines is the primary factor related to poor glycaemic control among T2DM patients in the GCC countries. Young, recently diagnosed patients are at a greater risk of missing diabetic medication and have poor glycaemic control than older patients with several years of medication [84]. Dietary practices are another major contributor to poor glycaemic control. Dietary factors, including excess consumption of saturated fats, sugar, and high-calorie diets, are the primary cause of poor glycaemic control among T2DM patients in GCC countries. Most Arabic countries' diets involve high energy and sugar intakes and low fiber consumption. For example, Qatar's National Household Income Expenditure found the mean sugar intake to be 105 g/day [85]. The study also found higher than average consumption of meat, sodium, and refined carbohydrates and low fiber and calcium consumption [85]. Studies have linked poor glycaemic control to low intake of fruits among the GCC countries [47, 55, 85].

Lack of physical exercise and a sedentary lifestyle are other major risk factors for poor glycaemic control among T2DM patients in GCC countries. Researchers found a correlation between poor glycaemic control and low physical activity among diabetic patients [9, 55, 86]. Certain factors, including comorbidities, heart diseases, arthritis, and obesity, contribute to low physical activity levels among T2DM patients [23, 54]. Together with a high-calorie diet, a sedentary lifestyle contributes to obesity and overweight, which further compound poor glycaemic control. Finally, inadequate knowledge of the management of diabetes, including the use of medication, physical exercise, and diet, is another significant factor related to poor glycaemic control among T2DM patients in GCC countries.

There are some limitations to this review. This review might not comprehensively include all articles that discussed glycaemic control among patients with T2DM in the GCC countries since 2015. However, we think that most of them were included. Furthermore, the studies differ in methodology to some extent, which may affect the results. Moreover, we only included peer-reviewed English language articles to ensure high-quality methodologies. The identified articles were mainly cross-sectional studies, so a causal relationship between the risk factors and glycaemic control cannot be established.

On the other hand, the strengths of this review include the relatively large number of included studies, and the results can be compared with the 2015 review. Additionally, the findings can be beneficial for all GCC countries. This is because these countries share similar cultures and lifestyles and provide all citizens with free healthcare services and medications.

Conclusions

Poor glycaemic control continues to be a significant drawback in the fight against T2DM. Glycaemic control in the GCC countries has not significantly improved since 2015, with only 9.2% to 56.9% of patients having good control. However, this is not much different from other Arab countries and the world. The problem is not limited to glycaemic control but also encompasses the increasing prevalence of diabetes. Evidence shows that being overweight or obese is among the common modifiable risk factors for T2DM and poor glycaemic control. The GCC countries have higher obesity rates. Also, poor adherence to medication use, an unhealthy diet, and a sedentary life are associated with poor diabetic control. Educational programs promoting lifestyle changes should be implemented to reduce disease incidence and improve glycaemic control in diabetic patients. Ongoing research is also necessary to assess the trend of glycaemic control and its risk factors in the region.

Author contributions

The author (A.A.) made substantial contributions to the conception and design, acquisition of data, and analysis and interpretation of data; 2) drafting the article or revising it critically for important intellectual content; and 3) final approval of the version to be published. To the best of our knowledge, no conflict of interest, financial or other, exists.

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Conflict of interest

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