Review Article

Prevalence and reasons of increased type 2 diabetes in Gulf Cooperation Council Countries

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ABSTRACT

تهدف هذه الدراسة إلى مراجعة البيانات المنشورة حول انتشار مرض السكري من النوع الثاني واستكشاف الأسباب الكامنة وراء ارتفاع معدل انتشاره في دول مجلس التعاون الخليجي. تستعرض هذه الورقة انتشار مرض السكري من والمنشور في (IDF) النوع الثاني كما ورد في أطلس الاتحاد الدولي للسكري عام 2019م والمقالات الأخرى ذات الصلة. حاولت هذه الدراسة استعراض اتجاه انتشار مرض السكري على مدار السنوات الماضية وفقًا لمنشورات الاتحاد الدولي للسكري ومراجعة الأبحاث المنشورة لاستكشاف الأسباب الكامنة وراء زيادة انتشار مرض السكري من النوع الثاني بمنطقة دول مجلس التعاون الخليجي. يقدر معدل انتشار مرض السكري في دول مجلس التعاون الخليجي ما بين 8 و22% وفقًا للتقرير الأخير للاتحاد الدولي للسكر. تؤثر العديد من العوامل على ارتفاع معدلات السكري في هذه المنطقة بما في ذلك السمنة ونمط الحياة غير الصحي وزيادة متوسط العمر المتوقع لدى أفراد هذه الدول وزيادة نفقات الرعاية الصحية، إضافة إلى زيادة انتشار مرض السكري من النوع الثاني بين الأطفال والمراهقين والقابلية الوراثية لدى سكان مجلس التعاون الخليجي. أظهرت هذه الدراسة حاجة دول مجلس التعاون الخليجي إلى التركيز على معدل وقوع الإصابة السنوي بالإضافة إلى معدل الانتشار في متابعة ومراقبة النوع الثاني لمرض السكر. هناك عدة تدخلات مقترحة لمواجهة مرض السكري لدى سكان الخليج العربي منها الفحص المبكر للسكان البالغين، والوقاية الأولية، والتوعية من خلال وسائل الإعلام، والضرائب على المشروبات المحلاة، وتطبيق نموذج الرعاية المزمنة في عيادات الرعاية الأولية، والمزيد من الأبحاث حول مرض السكري بين الشباب، والقابلية الوراثية لدى سكان مجلس التعاون الخليجي.

Arab Gulf Cooperation Council countries are considered as one of the most regions exhibiting a high prevalence of diabetes including the kingdom of Saudi Arabia, Bahrain, Qatar, Oman, Kuwait, and United Arab of Emirates, which have similar population characteristics (for example, religion, language, lifestyle, diet, and income). The frequency rate of diabetes in these countries ranged from 8 to 22% according to the last International Diabetes Federation (IDF) report. Many factors impact the prevalence in this region including obesity, unhealthy lifestyle, increased life expectancy, increased healthcare expenditures, increased the incidence of type 2 diabetic mellitus (T2DM) among children and young persons, and genetic susceptibility. This study aims to review the published papers on the incidence of T2DM and explore the most reasons behind elevated incidence of T2DM in these countries.

Keywords: diabetes mellitus type 2; incidence; prevalence; reasons; Gulf countries

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Approximately 415 million individuals worldwide are diabetic and this number is expected to be 642 million by 2040.[1] As evidence from the current literature suggests that more implications and surveillance approaches should be introduced, data from diabetes figures showed a notable growing through the last 2 decades in Gulf Cooperation Council (GCC) countries. In the kingdom of Saudi Arabia, the prevalence rate of diabetes has been estimated to be 9%-22% from the years 1980 to 2008 as reports in 2016 show that the number of Saudi patients having diabetes is estimated to be 7 million patients while another 3 million ones are thought to be prediabetic.[2,3] The same trends were also noticed in Kuwait as the prevalence rate for men and women was 19% in 1980 to be increased up to 22% in the current decade.[3,4]

Diabetes mellitus is considered a multifactorial disorder that can be generated secondary to the presence of a genetic predisposition that is triggered by environmental factors.[5,6] The main triggers and contributing factors would always remain the ones related to the lifestyle of the patient as diet, physical activity, smoking, and infections affecting the pancreas.[7-11] Moreover, the socio-economic status of each region affects the patients' abilities to have access to proper management modalities.[12] Although many investments have been made by the GCC officials to control the diseases and reduce the recently increasing prevalence rates, it would seem difficult to control due to the projected involvement of aging, population growth, and unhealthy life-styles in increasing such rates.[13] Age and obesity are considered the most risk

factors responsible for increasing the prevalence of type 2 diabetes mellitus (T2DM). In the GCC region, the incidence rate of obesity has been estimated to be up to 40%.[7,14] In a previous systematic review it was investigated that the prevalence of overweight and obesity increased from 4.3% in 1980 to 34.9% in 2009 in the Gulf countries.[14] Obesity is marked as the most common risk factor that contributes to the development of diabetes as it creates a state of insulin resistance by triggering metabolic syndrome.[15] Besides, the presence of comorbidities as hypertension and other chronic conditions might also be a contributing factor.[16] The author has reviewed studies in the literature to shed more light on the incidence of T2DM and discuss the most common risk factors developing T2DM in these countries.

The current study aims to narratively review previous studies to investigate the incidence rates of diabetes among the different GCC countries and the potential reasons behind the elevated incidence of T2DM based on the International Diabetes Federation (IDF) atlas 2019. The author tried to present the trends of diabetes prevalence over years as per IDF publications and analyzed the data of reasons for high prevalence supported by local and national studies in the GCC area.

Prevalence of type 2 diabetes mellitus in the GCC. Type 2 diabetes mellitus is an increasingly common disease with many associated complications. This disease has a strong connection with the lifestyle, habits, and income of patients and communities.[17] From 2000 to 2019, the estimated prevalence of T2DM has tripled from 151 to 463 million worldwide.[18] The burden of this disease is high. It is estimated that in 2017, approximately USD 727 billion was spent on patients with T2DM aged from 20 to 79 years old and in 2030 this it might reach to USD 825 billion worldwide in 2030.[18]

According to the IDF, diabetes' rate in 2019 was 9.3% which might react 10.9% by 2045 globally.[18] In the 6 GCC countries, diabetic rate increased[19] in 2015, among 149,600 deaths cases in these countries GCC, 73% of them were because of most non-communicable diseases (NCDs). Cancer, diabetes, respiratory, and cardiovascular diseases are the most non-communicable diseases.[20] The WHO and Bahrain government worked together to publish a report on Bahrain's health profile in 2015. They found that 77.9% of all deaths caused by NCDs, 12.7% of them were caused by diabetes mellitus.[21]

A previous study reported that the prevalence of T2DM in these countries ranged from 4.3% to 34.9%.[22] Type 2 diabetes mellitus prevalence among females in Arab countries was assessed in another study between 2002 and 2018. Qatar was the highest with 10.8% of patients with T2DM being female. However, the estimated weighted prevalence in other countries is 8.0% in the UAE, 8.0% in Saudi Arabia, 8.0% in Oman, and 5.4% in Kuwait.[23] The incidence rate of T2DM in 2000 was 23.7% and increased to 25.4% in 2009.[24] Using epidemiological modeling, the prevalence rate of T2DM increased from 8.5% in 1992 to 39.5% in 2022 among Saudi population. The prevalence of diabetes would expected to reduce by 10% in 2022 if the obesity prevalence decreased.[25] The incidence rate of T2DM in Oman ranged from 10.4% to 21.1% among population aged above 20 years and this percentage is expected to increase 174% by 2025.[26]

One prognostic study was conducted on diabetes in Qatar. This study predicts diabetes prevalence by 2050 compared to 2012 data. This study estimates that 24% of adult Qataris are going to be diabetic compared to 16.7% in 2012. The peak of the prevalence was noted among 55-64 years old as 35% of the patients with T2DM and decreased among the elderly (≥65 years).[27]

According to the IDF 2019 report, Kuwait comes first in diabetes prevalence among the 6 GCC countries with 22% of its population between 20 and 79 years old. However, the highest number of death cases due to diabetes are reported in Saudi, compared to other GCC countries.[18] **Table 1** gives more details about the prevalence of T2DM and other measures in GCC countries.[18] However, **Figure 1** shows the prevalence of diabetes starting from the IDF's first publication until its 9th edition.[18,28-34]

In the human development index, the GCC countries are classified as very high.[35] Only one study evaluated the association between diabetes' prevalence and human development index in the Arab countries. It found a strong correlation between high diabetes prevalence and high human development index (R=0.81).[36]

The next article explore most causes resulted in increasing the prevalence of T2DM in the GCC countries. Reasons for high prevalence of T2DM in GCC countries:

i) Overweight and obesity. Obesity prevalence has almost tripled worldwide since 1975 to 13% for adults (≥18 years) in 2016.[37] The burden of obesity-related

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Table 1 - Summary of diabetes prevalence and diabetes related deaths according to the International Diabetes Federation (IDF) 2019.

Countries	Adults with diabetes (20-79 years) In 1000S (CI)	Diabetes (20-79 years) National prevalence (%) (CI)	Diabetes age-adjusted (20-79 years) comparative prevalence (%) (CI)	Diabetes related deaths (20-79 years) (CI)
Saudi Arabia	4,275.2 (2,580.2 - 4,774.4)	18.3 (11.1 - 20.5)	15.8 (10.3 - 17.7)	15,038.7 (10,548.6 - 16,321.7)
Bahrain	202.7 (185.2 - 222.9)	16.3 (14.9 - 17.9)	15.6 (14.0 - 17.2)	537.9 (498.7 - 584.4)
United Arab Emirates	1,223.4 (1,079.1 - 1,444.4)	15.4 (13.6 - 18.2)	16.3 (13.6 - 19.2)	2,092.9 (1,886.2 - 2,384.1)
Oman	291.8 (232.6 - 526.1)	8.0 (6.3 - 14.3)	10.1 (7.9 - 16.6)	964.9 (776.9 - 1,493.5)
Qatar	347.0 (318.5 - 381.4)	15.5 (14.2 - 17.0)	15.6 (14.0 - 17.2)	644.4 (601.5 - 697.9)
Kuwait	681.1 (456.3 - 780.5)	22.0 (14.7 - 25.2)	12.2 (8.2 - 14.1)	1,692.6 (1,248.4 - 1,872.9)

CI: confidence interval

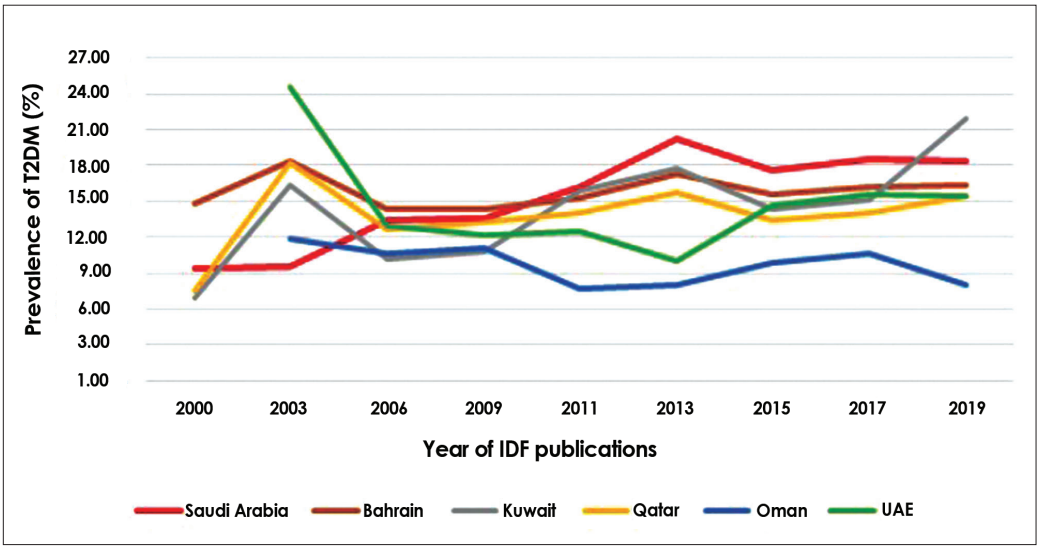

Figure 1 - Diabetes (20-79 years) national prevalence as per International Diabetes Federation (IDF) publication. T2DM: type 2 diabetic mellitus

Table 2 - Obesity prevalence in GCC area according to the world atlas.

Countries	Estimated prevalence	Worldwide rank
Kuwait	37.9%	11
Saudi Arabia	35.4%	14
Qatar	35.1%	15
UAE	31.7%	20
Bahrain	29.8%	25
Oman	27%	29

NCDs leads to approximately 36 million deaths each year.[38] The data showed that being overweight and obese are the most common risk factors for T2DM. Approximately 25 to 50% of the adult population is overweight and 10 to 50% of the GCC population is obese.[19] Kuwait is the first among the GCC countries in obesity prevalence as well as T2DM, while Oman has the lowest estimated prevalence with 27% of adults. Table 2 shows the prevalence of obesity in GCC countries according to the world atlas.[39]

It is estimated that 80% of Kuwaitis are obese.[40]

Forty-two to 44% of adult Kuwaiti women are obese.[40-42] In Saudi Arabia, the prevalence of obesity among population aged 25 years and above is estimated to be 41% by 2022 in males and 78% in females.[43]

Many factors play a role in obesity in GCC countries. As the average age increases, the chance of being overweight and obese also increases. Physical activity, sedentary behavior, dietary behaviors, and sociodemographic factors such as low educational level, married, urban residence, and who did not work are highly associated with overweight/obesity among adults in the Gulf region.[44]

ii) Increased life expectancy. More than one-third of diabetes cases resulted from population growth and aging, (28%) aging, and 32% from both of them.[34] The size of the general population in these GCC countries is expected to exceed 61.6 million by 2022 and the population' age and expanding size will likely exert huge pressure on the healthcare system.[20]

Increased life expectancy in the GCC is a reflection of improving health measures. Combating infectious disease, low rate of maternal and infant mortality, and the pan vaccination of all children has resulted in increased life expectancy.[45] As shown in Table 3, there is a huge jump between life expectancy at birth in 1960 and 2017 in the GCC area.[46] Gulf Cooperation Council countries provide free health services for all citizens. The number of hospitals in the GCC area increased from 622 hospitals in 2010 to 748 in 2016. The number of physicians per 10,000 people has increased from 20.4 physicians in 2010 to 22.8 in 2014. Also, the nursing staff included over 287,000 nurses in 2016 compared to 200,500 in 2010.

iii) Increased healthcare expenditures. According to the GCC Healthcare Sector Report (2015), the investment in healthcare infrastructure by GCC governments was significant in the last 25 years either medical cities or complexes. Healthcare expenditures in the GCC have increased on average from 2.95% in 2000 to 4.23% of the GDP in 2016 but, in general, is still below the 10% of GDP global average. Healthcare expenditures in these countries is expected to increase from USD 76.1 billion in 2017 to USD 104.6 billion in 2022.[20]

In the United States (2016) approximately 17% of the GDP was spent on healthcare while China spent around 4.98%.[47] France and Germany spent more than 11% of their GDP on healthcare in 2016.[47]

In contrast, Saudi Arabia is relatively higher than other GCC in total healthcare expenditures with 5.7% of its GDP in 2016. Other GCC members spent the following percentages of their GDP on healthcare:

Table 3 - Life expectancy at birth and crude death rate in the gcc area.

Country	Life expectancy at birth		Crude death rate	
	1960	2017	1960	2017
Saudi Arabia	45.638	74.874	20.319	3.446
Bahrain	51.869	77.032	14.694	2.368
United Arab Emirates	51.537	77.647	15.714	1.429
Oman	42.672	77.393	22.457	2.462
Qatar	61.094	79.981	9.398	1.169
Kuwait	59.343	75.311	9.544	2.601
World	52.58	72.283	17.714	7.542

Bahrain (4.9%), Oman (4.3%), Kuwait (3.9%), UAE (3.5%), and Qatar (3.1%). Between 2017 and 2022, the average growth rate of health expenditures in the GCC countries increased from 2.6% to 9.6%.[20] Figure 2 gives more details about the progression in health expenditure between 2000 and 2016.[47]

Worldwide, the estimated annual health expenditure on diabetes is estimated to be USD760 billion and projected to approach USD825 billion by 2030.[18] due to the increasing prevalence of T2DM and the costs per every diabetic patient with type 2, between 2012 and 2017, the economic costs of T2DM increased by 26%.[48]

Type 2 diabetes mellitus expenditures are still lower than expected in GCC countries. The North Africa and Middle East (MENA) region is expected to spend approximately USD24.7 billion on diabetes by 2030.[34] In the United States, 25% of health budget is spent on diabetes. Individuals with diabetes cost an average medical expenditure of approximately USD16,750 per year.

A previous study was conducted in Saudi Arabia and it was reported that the total annual medical cost for HbA1c <7 was USD1,384.19, while the cost for HbA1c 7-9% increased to USD2,036.11, and for HbA1c >9% the annual cost was USD3,104.86 with a significant difference of $p<0.001$. The high cost was related to diabetes-associated comorbidities.[49] While, for diabetes, the annual cost for 20 million patients was USD4.53 billion (17 billion Saudi Riyals) in 2014. Most costs due to arising of diabetes' complications, the total cost would be USD11.45 billion for those with glucose intolerance, which represent approximately 17.5% of the Saudi Ministry of Health's budget.[50]

Table 4 summarizes the mean diabetes-related expenditure per person aged from 20 to 79 years with diabetes in GCC,[18] which considered higher than in

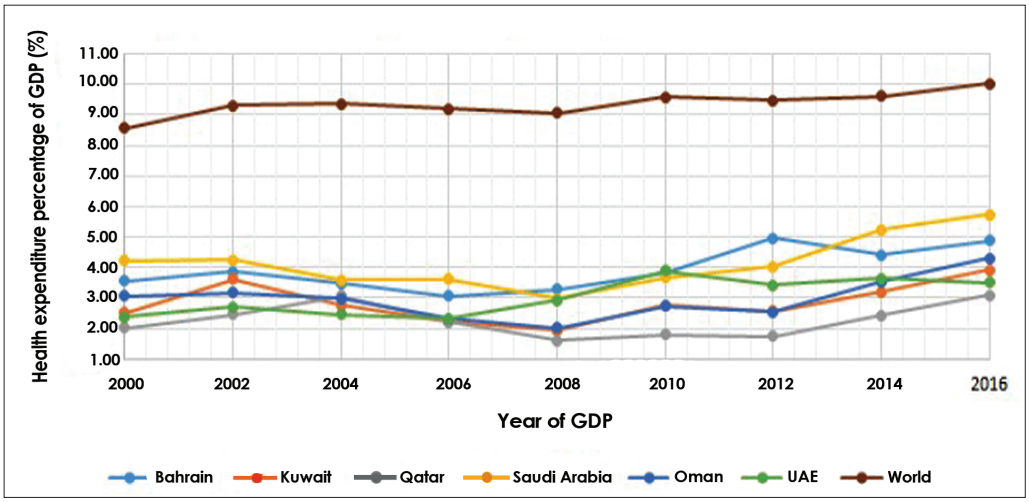

Figure 2 - Health expenditure of GDP (%) between 2000 and 2016. The World Health Organization

Table 4 - Mean diabetes-related expenditure per person in Gulf Cooperation Countries (GCC), Mena, and worldwide according to the International Diabetes Federation (IDF) 2019.

Country	Mean diabetes-related expenditure (USD) per person with diabetes (20-79 years)	Mean diabetes-related expenditure (ID) per person with diabetes (20-79 years)
Saudi Arabia	1,172.5	3,186.3
Bahrain	1,163.0	1,974.6
United Arab Emirates	1,237.3	2,381.1
Oman	752.6	3,283.2
Qatar	1,751.2	3,763.2
Kuwait	1,089.6	2,957.6
Mena	475.3	1,469.6
World	1,673.1	2,480.5

ID: international dollar

that in MENA region, according to the IDF 2019 report. Bahrain is the lowest among the GCC countries and less than the global average. However, Qatar is the highest with international dollar $3,763.2 in mean diabetes-related expenditures per person with diabetes.[18] Type 2 diabetes mellitus-associated health expenditures in Qatar might increase by 200 to 600% accounting for 32% of total health expenditures by 2050.[27]

iv) Physical inactivity. Among the GCC population the rate of physical activity is lower than in many developed countries.[51] It was showed that despite a low number of studies and lack of high-quality research, about 36.2 to 86% of men and 35 to 65.7% of women practice physical activity. However, a Saudi Study published in 2007 showed that only 6.1% of men and 1.9% of women are physically active.[52] In addition, physical activity is low among adolescent populations, particularly females.[53]

In Kuwait, 57.9 to 72% of adult Kuwaitis are physically inactive,[40,42,54] while 20% of adult Omanis sit for prolonged periods (≥7 hours). Twenty-two percent of them are male and 26.9% are female.[55]

Balhareth et al[44] concluded that elderly persons and women are less physically active, due to some cultural sensitivities that prevent women to practice exercise. Also, sandstorms, hot weather, passive transport opportunities, and urbanized environment are considered other barriers decreasing the physical activity.

v) Unhealthy diet. As economic growth increases so does the food per capita. Four out of 6 GCC countries were assessed by the Food and Agriculture Organization.[56] Gulf Cooperation Council countries consumed a higher dietary energy, compared with the average world daily per capita caloric supply. The energy consumption progressively increased and exceeded 3,000 Kcal/person/day for in these GCC countries.[56]

A study was conducted in Qatar and showed that Qatari households (HHs) purchased more food versus non-Qataris HHs (2,118 g/capita/day versus 1,373 g/capita/day).[57]

A previous survey was conducted in 4 private schools, Sharjah, Emirate and it was found that 34% of the students had a healthy behaviors in their eating and 19% ate fast food frequently or daily.[58]

In Kuwait, 83.8% reported consumed low fruit and vegetables per day, thus being at higher risk for NCDs in general. The proportion was higher for women than men (86% versus 81.4%). Consumption of both fruit and vegetables was less frequent in younger age groups.[42]

Urbanization and shifting from a traditional diet to westernized diet have been observed in the eastern Mediterranean region. Regarding urbanization diet, sugar, white bread, and excess fat are highly consumed, while grains, oils, vegetables, and legumes had a low consumption, which resulted in decreasing the availability of fruit by 7.8% and vegetables by 0.3% in these regions.[59]

vi) Increased prevalence of T2DM among children and adolescents. A significant increase in the incidence of T2DM was reported among children and adolescents. Type 2 diabetes mellitus represents almost 12% of all diabetes cases in children and adolescents.[60] There was an increase of 35% in T2DM prevalence between 2001 to 2009 in the United States.[61]

In Saudi Arabia, the overall prevalence of T2DM from 2006 to 2010 was 9% among obese and overweight children.[62] In a previous retrospective study, 11 patients are with T2DM out of 96 young diabetic patients in UAE. Of those patients, 9 (82%) patients were obese, with BMIs above the 85th percentile.[63]

Another study was carried out in Kuwait to assess the incidence rate of T2DM among patients randomly selected from 182 schools. Those children were between 6 and 18 years old. Almost 45 child had T2DM and the prevalence among males was 47.3, 95%, while it was 26.3, 95% among females with a highly significant different (p=0.026).[64]

Before 2008 in Qatar, there were no registered cases of T2DM among children or adolescents. Since, the prevalence of T1DM increased from 1.82/100,000 to 2.7/100,000 between 2012 and 2016.[65]

Increasing the rate of obesity and unhealthy lifestyles among children and adolescents in the GCC increased the risk of diabetes prevalence in those groups. More studies are needed to explore the magnitude of this problem in the GCC area.

vii) Genetic susceptibility. Genetics had a pivotal role in developing of T2DM.[66] As a race, Arab is considered an independent risk factor for the development of diabetes.[67] A study compared the prevalence of T2DM among Iraqi immigrants to native Swedes and found that T2DM was double among Iraqis compared with Swedes.[68]

One of the ways to assess gene-related diseases or phenotypes in a specific population is by analyzing single nucleotide polymorphism (SNP) alleles to identify loci that are associated with that disease or phenotype. There are several studies conducted in the GCC using SNP genotyping. One study examined the diabetes etiology among Saudi population by genotyping SNPs and assessed other associated risk factors. Consanguinity could promote the diabetes risk by onset of the disease and through strengthening the most possible genetic impacts on fasting blood glucose levels.[69] In Saudi Arabia, there was a weak or no association of T2DM with the 2-transcription factor (TCF7L2) variants or P12A peroxisome proliferator' polymorphism-activated receptor gene (PPAR-γ2).[70,71] However, another case-controlled study found a positive association between the E23K variant and T2DM in a Saudi population with an OR of 1.7 (p=0.0001).[72] A systematic review of genetic markers of T2DM in Saudis recognized 23 polymorphisms in 17 genes which are highly correlated with increasing the risk of T2DM in people of Saudi ethnicity. One of the limitations of this study is its small sample size compared to European studies.[73] Obesity and T2DM are known to be connected. So, one Saudi study tried to investigate the relation between obesity phenotypes and variants of 36 T2DM SNPs among Saudi population.[74]

In the UAE, data suggest that TCF7L2 and melanocortin 4 receptor (MC4R) increasing DM risks are correlated with variants,[75,76] the same findings were found in Qatar.[77] However, a study in Bahrain provided evidence of the potential involvement of T2DM risk factors adiponectin, C1Q, and collagen domain-containing (ADIPOQ), independent of insulin and obesity resistance.[78] While in Kuwait, the ACE I allele is associated with T2DM.[79]

In conclusion, some genetic variants might be associated with T2DM, but these data are inconsistent among GCC people. More local and regional studies are warranted to determine which gene variants are related to T2DM in this area.

Discussion. In addition to the previously mentioned points in this review, there are additional ones to be fully discussed in this literature. The variance in the prevalence rates among the reported countries can be noticed in this review. Therefore, it might not be right to apply the same interventional protocols to the same countries. Each country should apply its approaches based on the nature and demographics of its affected population and the prevalence of the aforementioned risk factors among them. As diabetes is a complex disorder with trending prevalence rates, the burden of the disease over the affected patients' life expectancies and healthcare,

and the economic status of each country is also increasing. Therefore, strong efforts by the patients and governments should be applied for proper prevention and control of the disease. For an early and proper intervention of diabetes, healthy life-style protocols as a healthy diet and more physical activities should reduce the incidence of sedentary life and obesity and reduce the risk for having diabetes.[80] There is a piece of strong evidence that these measures are very effective in the prevention and management of diabetes for prolonged time.[80-83] In addition to being efficacious, such measures are also deemed suitable for every patient and can be applied at all socioeconomic levels. Mass education should also be approached to encourage individuals about the benefits of a healthy lifestyle and warn against the consequences and complications that may result from obesity and sedentary life.[53] Other approaches by governments include making ways for easy access to the required healthcare resources and imposing taxes on the huge consumption of unhealthy food. In a study by Veerman et al,[84] the authors estimated that an annual reduction of 800 diabetes cases could be achieved by raising the taxes on sugar rates by 20%.

Another factor is the prevalence of diabetes per age group as more attention should be given to older patients as the prevalence rates seem to get higher as patients grow older which can be noticed in countries with higher life expectancies. The American Diabetes Association (ADA) previously showed that diabetes' mass screening should conduct by each country by the age of 45 years old by every country.[85] A previously published survey-based investigation that the estimated prevalence rates and the associated factors in the GCC countries showed that the age increased the incidence rate of diabetes, particularly among those aged 60 years or older.[13] However, this was not noticed with the population of Oman where the highest prevalence rate was noticed with the 50-59 age group which may be attributable to the differences in other factors as BMI, nutritional habits, and patients' education between the included countries.[13] On contrast, a UAE study by Sulaiman et al[86] showed that diabetes was significantly highly prevalent in patients ≥35 years old. Consequently, further research and mass-screening projects are needed for more accurate estimations.

For long-term management of diabetes, the ADA also suggested that a chronic care model protocol should be applied in the primary care centers.[87] To assess the integrity and efficacy of this model, Wan et al[88] conducted a 5-year cohort study investigating this approach in the management of 53,436 diabetic patients. The authors reported that reduced complications and overall mortality rates were significantly noticed in their population by the end of the study follow-up period, in addition to the significant reductions in healthcare resources.

Gestational diabetes mellitus (GDM) might be a predisposing factor as previous studies showed.[89,90] A previous study carried out in Saudi Arabia[91] showed that the incidence rate of GDM in their population was 12.8% and therefore, frequent monitoring and adequate management approaches should be conducted for pregnant women. This rate is similar to a study that was conducted in Kuwait by Groof et al[92] as the authors reported that the prevalence of GDM was 12.6% in pregnant women who had no previous history of diabetes, while women with polycystic ovary syndrome (PCOS) showed a higher developing diabetes risk.[93] In a Qatari study, the authors reported that among the patients that were diagnosed with PCOS, 19.4% of them had prediabetes and another 9.7% were diabetic.[94] Asthma, hypertension, chronic lung diseases, cardiovascular diseases, and arthritis might also contribute to the risk of having diabetes later on as illustrated by Morgan et al[13] and other studies.[95,96] The authors also showed that increased urbanization in some countries (Oman and Saudi Arabia) might also be contributing factors that increased the prevalence of type 2 diabetes. However, the analysis from the same study showed that the prevalence of diabetes among the rural population (10.5%) in the UAE was higher than the urban one (7.2%). These rates might be subjected to selection biases as the study was based on questionnaires for the targeted populations and therefore, future studies with better sampling and adequate population are needed. Alhyas et al[7] conducted a systematic review and showed that almost all of the included studies indicated that the frequency rate of diabetes was significantly higher in the urban than the rural population. This may be attributable to the stressful lifestyle and unhealthy dietary contents.

In conclusion, the prevalence of diabetes in the GCC countries is significantly high. Although many approaches have been made to reduce these high rates, no unified protocol has been sought which may be because the epidemiology of the disease is different by country. The author has discussed the relevant risk factors developing the disease. Furthermore, we would like to stress more on factors like urbanization, PCOS, and GDM because few investigations were published in this region. The prevention of diabetes is multifactorial and would require the integration of many approaches involving individuals as healthy diet intake and regular

exercising, and governments as mass screening for patients at risk and education.

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