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Abstract

Background: Type 2 diabetes mellitus (T2D) is associated with various complications and imposes significant economic pressures.

Aims: The aim of this study was to determine the epidemiological status and the burden of T2D in the Middle East and North Africa (MENA) countries during 1990–2019; to inform targeting of prevention strategies.

Methods: The study population included 21 countries, covering a population of about 400 million. The global burden of disease 2019 database was used. Disability-adjusted life years (DALYs) were computed by summing up the years of life lost and the years lived with disability. Prevalence, incidence, death rates and DALY rates per 100 000 people for all locations by age-standardized rates were calculated.

Results: In 2019, Qatar had the highest prevalence [16312.4; 95% unit interval (UI): 15050.0–17723.2] and incidence rates (818.0; 95% UI: 773.9–868.7) of T2D Bahrain had the highest death (127.0; 95% UI: 102.5–154.6) and DALYs (3232.5; 95% UI: 2622.4–3929.3) rates In the MENA area, average DALY rates increased by nearly 31% (808.3 to 1060.8) and average death rates increased by 0.2% (24.8 to 25.2) during 1990–2019. The highest increase for T2D-related DALYs (516.5 to 958.1; 85%) and the highest increase for T2D-related deaths (12.5 to 22.0; 76%) was in the Islamic Republic of Iran.

Conclusion: Prevalence, incidence, deaths and DALYs rates for T2D have continued to increase in most of the MENA countries. Health care systems must make efforts to control modifiable risk factors.

Keywords: diabetes mellitus, epidemiology, MENA, DALYs, type 2 diabetes

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Introduction

The diabetes mellitus epidemic, as a serious global health threat, is associated with various adverse outcomes and an increased risk of premature death and disability. Diabetes imposes considerable economic pressure on individuals, families, health care systems and societies. It causes premature death, disability, job losses, and disruption to education, which all have negative economic effects on countries. These indirect costs contribute to approximately one-third of total costs, an estimated US$ 1.31 trillion (1).

There are 3 main types of diabetes mellitus: type 1 diabetes mellitus, type 2 diabetes mellitus (T2D) and gestational diabetes mellitus, with T2D responsible for about 90% of all diabetes (2). In 2019, the International Diabetes Federation estimated that 463 million people worldwide aged 20–79 years were living with diabetes, representing 9.3% of the global adult population. These estimates are forecast to increase to 578 million (10.2%) in 2030 and 700 million (10.9%) in 2045, and the greatest increase will be in the low- and middle-income countries (3). The increasing trend for diabetes may be due to an ageing population, urbanization, unhealthy diet, the obesity epidemic, sedentary lifestyles, etc. The International Diabetes Federation estimated that 4 million people died from diabetes and its complications in 2019, and nearly half of these

deaths occurred in the working-age group (3).

Despite the variation in certain health and disease indices, countries of the Middle East and North Africa (MENA) region have similar cultural, economic and medical status. Global burden of disease (GBD) studies are unique in that they estimate incidence, prevalence, deaths and disability-adjusted life years (DALYs) of diseases for all regions. The GBD studies longitudinally report disease burden and create an opportunity to compare countries and explain the pattern of diseases. These studies set priorities, present health experiences of other countries, help with allocation of resources and assist in tailoring effective health interventions.

The aim of this study was to describe the epidemiological status and the burden of T2D in the MENA countries from 1990 to 2019. Our findings may help in targeting T2D prevention strategies across the region.

Methods

Location and population

The MENA region, with a population of more than 600 million, comprises 21 countries: Afghanistan, Algeria, Bahrain, Egypt, Islamic Republic of Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Palestine, Oman, Qatar, Saudi Arabia, Sudan, Syrian Arab Republic, Tunisia, Turkey, United Arab Emirates and Yemen (4), which were compared in terms of age, sex and risk factors for T2D.

Data collection and quality control

We used the latest data from the GBD (2019 update) in the current study. The GBD dataset reported the prevalence, incidence, death and DALY of T2D in all regions and countries annually from 1990 to 2019. These data estimate the incidence, prevalence, mortality and DALYs of 369 diseases and injuries, and 84 risk factors in terms of location, age and sex in 204 countries and regions (https://vizhub.healthdata.org/).

The methodological details of GBD 2019 have been documented elsewhere (5–7). Data used in the report comprise vital registration systems, sample registration systems, household surveys, censuses and demographic surveillance sites. Validation and data quality have been reported previously (6,8,9). In the GBD dataset, designing for all countries was based on the quality and accessibility of data. To ensure reliable and accurate comparisons between various countries and times, the same method was applied for each location and year in the MENA region.

Because to the public availability of GBD, ethics approval and informed consent were not required for this study.

Definition of type 2 diabetes mellitus

In the GBD 2019, diabetes includes all encoded diagnoses, E10 to E14, according to the 10th edition of the International Classification of Diseases (ICD-10) (6). Type 2 diabetes is defined as insulin secretory defects due to pancreatic β-cell dysfunction and insulin resistance in target organs, as shown by a fasting plasma glucose ≥ 7.0 mmol/L (126 mg/dL) or 2-h plasma glucose ≥ 11.1 mmol/L (200 mg/dL) and/or history of medication for diabetes treatment (insulin and/or oral hypoglycaemic agents (6).

The GBD study evaluated the various risk factors attributable to T2D-related DALYs, including metabolic risk factors such as high body mass index (BMI), environmental risk factors such as air pollution and non-optimal temperature, and behavioural risk factors such as tobacco (smoking, second hand smoke), low physical activity and dietary risks (diet low in fruits, fibre nuts and whole grains; diet high in red meat; diet high in processed foods) (10). Further information is available at http://vizhub.healthdata.org/gbd-compare/.

DALY calculation

From the GBD dataset, we analysed data on the incidence, prevalence, mortality, DALYs and attributable risk factors for T2D. The DALYs are computed by summing up years of life lost and years lived with disability (11,12). Years of life lost are computed as the estimated number of deaths multiplied by a standard life expectancy at the age at which death occurs. Years lived with disability are counted as the prevalence of individual sequelae of the disease multiplied by their corresponding disability weights, without age weighting. The age-standardized rate (ASR), age-standardized incidence rate, age-standardized prevalence, age-standardized death rate and age-standardized DALY rate are reported to universalize the population size and age structure, i.e. rates per 100 000 people for all locations (13,14).

To carry out this study, all data were extracted from the GBD (https://vizhub.healthdata.org/). We then analysed the data based on the study objectives, age group, risk factor, sex, etc. All estimates were reported with 95% uncertainty interval. All analyses were performed using Microsoft Excel, 2016.

Ethical approval

The ethics committee of the Kermanshah University of Medical Sciences approved this study.

Results

In 1990, the highest prevalence of T2D via ASR were in Qatar [16312.4; 95% UI: 15050.0–17723.2] and Bahrain (7546.0; 95% UI: 682.4–8259.7) (Table 1). Bahrain (14 234.9; 95% UI: 13 261.9–15 287.2) continued to have the highest prevalence rate in 2019. In 1990, Egypt had the lowest prevalence rate (2392.2; 95% UI: 2172.6–2629.7) of T2D. But in 2019, Yemen had the lowest prevalence rate (4686.9; 95% UI: 4150.6–5245.5). In 2019, in all countries of the MENA region except for Yemen (4686.9; 95% UI: 4150.6–5245.5) and Turkey (5082.0; 95% UI: 4584.6–5564.4), the prevalence of T2D was higher than the average global rate (5282.9; 95% UI: 4853.6–5752.1).

The highest incidence rates in 1990 were in Qatar (493.1, 95% UI: 453.7–534.1) followed by Bahrain (442.5; 95% UI: 409.2–476.7) (Table 1). Egypt (140.8; 95% UI: 130.4–151.7) had the lowest incidence of T2D. In 2019, Qatar (818.0; 95% UI: 773.9–868.7) and Bahrain (757.6; 95% UI: 721.3–795.9) continued to have the highest incidence rates; the lowest rate was in Yemen (241.7; 95% UI: 217.4–268.6). Except for Yemen (241.7; 95% UI: 217.4–268.6), in 2019, the incidence of T2D was greater than the average global rate (259.9; 95% UI: 240.4–281.4).

In 1990, the highest ASRs for deaths attributed to T2D were in Qatar (111.2; 95% UI: 94.4–130.9) and Bahrain (77.8; 95% UI: 66.2–91.0) (Table 1). Tunisia (10.9, 95% UI: 8.7–15.0) had the lowest death rate in 1990. Bahrain (127.0; 95% UI: 102.5–154.6) and Qatar (122.1; 95% UI: 98.9–151.5) continued to have the highest death rates in 2019, but Yemen had the lowest death rate (14.2; 95% UI: 10.2–19.8). In 2019, the death rate for T2D in the MENA region (25.2; 95% UI: 22.4–28.2) was higher than the global average (18.5 95% UI: 17.2–19.7).

The highest DALYs rates for T2D in 1990 were in Qatar (2528.1; 95% UI: 2147.5–2948.9) and Bahrain (2067.6; 95% UI: 1751.7–2415.8); Yemen (467.3; 95% UI: 354.5–626.4) had the lowest rate (Table 1). In 2019, the highest rates were again in the same 2 countries, with Bahrain (3232.5; 95% UI: 2622.4–3929.3) and Qatar (2975.3; 95% UI: 2401.2–3673.1), while Yemen (676.5; 95% UI: 512.3–878.8) continued to have the lowest DALYs rate. In 2019, except for Yemen, the DALYs rate for T2D, calculated using the ASR, was reported to be higher than the average global rate (801.6; 95% UI: 670.6–954.4).

The global DALYs rate for T2D in men (856.2; 95% UI: 721.2–1030.7) was higher than in women (743.7; 95% UI: 621.8–889.0). In the MENA countries, the DALYs rate for T2D in

women (1096.2; 95% UI: 902.4–1324.9) was higher than that in men (1025.5; 95% UI: 840.8–1243.2). In terms of the ASR, Qatari women (3628.6; 95% UI: 2952.6–4381.6) had the highest DALYs rate of T2D in the region. In Bahrain, men (3200.8; 95% UI: 2597.6–3885.6) had the highest DALYs rates in the region (Figure 1).

In the MENA region, the incidence of T2D in men (354.4; 95% UI: 326.3–385.0) was greater than that of women (351.5; 95% UI: 325.3–381.9) (Figure 1). Likewise, the prevalence of T2D in men (6794.8; 95% UI: 6201.7–7431.4) was greater than that in women (6706.2; 95% UI: 6129.1–7328.4).

In the MENA region, the average DALYs rates (calculated using ASR) increased by nearly 31% between 1990 and 2019, (808.3; 95% UI: 696.9–944.3 in 1990 and 1060.8; 95% UI: 872.1–1279.1 in 2019) (Table 1). During this period, the greatest decrease in the T2D-related DALYs (24%) was in Turkey (1141.6 to 870.0). The greatest increase in the T2D-related DALYs, with an 85% rise, was in the Islamic Republic of Iran (516.5 to 958.1) Figure 2 . There was no significant peak between 1990 and 2019 among the countries of the Region.

Global death rates (calculated using ASR) increased by nearly 11% between 1990 and 2019 (16.7 to 18.5). In the MENA region, the average death rate increased by nearly 0.2% between 1990 and 2019 (24.8 to 25.2). Between 1990 and 2019, the greatest reduction in the T2D-related death, a 44% was in Turkey (40.4 to 22.7), while the greatest increase in the T2D-related death, 76%, was in the Islamic Republic of Iran (12.5 to 22.0) (Figure 3).

The prevalence of T2D increased from 1990 to 2019 in all countries of the MENA region. Average prevalence rates (calculated using ASR) increased by nearly 86.0% from 1990 to 2019 (3640.4 to 6753.3). Moreover, the incidence rate of T2D increased from 1990 to 2019 in all countries of the MENA region. In MENA, average incidence rates by ASR increased by nearly 80.0% from 1990 to 2019 (196.6 to 353.2). Egypt, Morocco and Sudan had the highest increase in both prevalence and incidence between 1990 and 2019 (Figure 3).

In 2019, the T2D-related DALYs increased with age. Most DALYs showed an increase for age 45–49 years and above. In Qatar and Bahrain, the T2D-related DALYs increased at a much faster rate and the final values were extremely high compared with the other (Figure 4).

High BMI, air pollution and smoking had the greatest effect on the DALYs in all the MENA countries (Figure 5). The highest T2D-related DALYs rate was documented for women in Saudi Arabia (87.4%) and Kuwait (86.7%), and was attributed to high BMI. The highest DALYs rate attributed to air pollution was documented in women (26%) and men (25%) in Afghanistan, followed by women and men in Qatar (both 24%). The highest DALYs rate due to smoking was documented in Lebanese men (23%).

Discussion

Diabetes is recognized as a critical health problem, which imposes an adverse impact on human life, the health system and socioeconomic development. People with diabetes have a 2–3-fold greater risk of all-cause death. Diabetes has the second highest negative total effect on decreasing global health-adjusted life expectancy across the world (15–17).

In the MENA region the prevalence and incidence rates of T2D increased from 1990 to 2019 in all countries. Average prevalence increased by nearly 86.0% and average incidence by nearly 80.0%. To the best of our knowledge, population aging, urbanization, obesity, unhealthy diets, and low physical activity may be strong reasons for these increases in 2019.

Alarmingly high prevalence, incidence, death and DALYs rates of T2D were reported in Qatar and Bahrain, driven by the high prevalence of obesity (18). For patients with T2D in Qatar and Bahrain, weight loss through the use of intensive lifestyle interventions are indicated to reverse diabetes (19,20).

The estimated global prevalence of T2D has increased almost 1.5-fold since 1990. However, we found that prevalence in the MENA region was greater than the global average, although in Yemen and Turkey it was lower. The incidence of T2D in the MENA region was greater than the global average, but in Yemen, it was lower. This may be due to higher consumption of carbohydrate, fat and sugar and lower consumption of protein and vegetables in most developing countries than the global rates (21).

In low- and middle-income countries, infrastructure is inadequate to support healthy lifestyles, health care systems are not capable of diagnosing T2D early, and are not able to provide timely access to treatment. Also westernized diet is expanding in these countries, so the people may be more vulnerable to developing T2D. Low prevalence and incidence of T2D in Yemen could be attributed to malnutrition due to armed conflict, less industrialization, poor economy and the more traditional lifestyle in a country whose economy depends on animal husbandry and

agriculture. Likewise, between 2003 and 2013, Turkey applied very successful health reforms such as the family medicine model, organizing a universal health coverage plan, developing primary health care and applying integrated care (22). Other countries could use similar health reforms to reduce the burden of T2D.

Despite considerable investment and improvement in clinical care and pharmaceutical research, there was an increasing trend between 1990 to 2019 in the DALYs (increasing about 31.0%) and death rate (increasing about 0.2%) caused by T2D in the MENA region. Therefore, we hypothesized that the current approach for managing T2D, which focuses on expensive medications and cross-sectional reduction of blood glucose levels, is not efficient in reducing DALYs and all-cause mortality among people with diabetes. These may be caused by non-modifiable risk factors like population aging and positive family history (23), although other risk factors like high calorie diet and sedentary lifestyle may also be involved. The DALYs counts for T2D increased from 1990 to 2019 in all countries in the region, but in Jordan, Turkey and the United Arab Emirates they decreased. These countries are known as the destinations for medical tourism in the MENA region (22,24,25). The T2D-related DALYs and deaths in the countries of MENA region except for Yemen was higher than the global average. In fact, the prevalence and incidence in Yemen were low, consequently, T2D-related DALYs were low.

High BMI, air pollution and smoking had the greatest effect on the T2D-related DALYs in all countries. As already reported, high BMI is mostly responsible for T2D and has been continuously increasing (26). In 2019, women in Saudi Arabia and Kuwait had the highest DALYs in the region due to high BMI. Research has shown that persons with BMI under 25.0 kg/m2 usually have the lowest rates of T2D (17,27). With increasing BMI, the risk of T2D is increased too. Nearly half of adults suffering from T2D are obese (28). Emerging hypermarkets increase accessibility to processed, high-fat, energy-dense, sugar-loaded, low-nutrient and salt-laden foods at relatively low prices, and are implicated for the decrease in the consumption of whole grains, fruits and vegetables. High BMI is mostly caused by unhealthy diet and sedentary lifestyle. We suggest the health systems should encourage greater motivation and desire for exercise and consuming whole grains, fruits, vegetables, etc., and restrict the availability of unhealthy products.

Air pollution is a critical risk factor worldwide. Outdoor and indoor air pollution may alter lung function. Vascular homeostasis and insulin sensitivity, lead to disorders in glucose homeostasis (29). Efficient air pollution management is critically required for a healthy lifestyle. The highest proportion of total DALYs attributed to air pollution was in both women and men in Afghanistan and Qatar. The highest proportion of total DALYs attributed to smoking was among Lebanese men.

The global DALYs rate of T2D in men was higher than in women. However, in MENA, the DALYs rate for T2D in women was higher than in men. We infer that less employment opportunities outside the home, meaning physical activity is restricted to housework, may be responsible for the higher frequencies of obesity and sedentary lifestyles and consequently diabetes among women in the region. On the other hand, in women, obesity, diabetes and hypertension are prevalent after childbirth (30,31). Qatari women and Bahraini men had the highest DALYs rates according to ASR. This difference may be ascribed to the distribution of risk factors between men and women across populations.

From 1990 to 2019, Turkey had the highest decrease in T2D-related DALYs (from 8th to 18th rank) and deaths (from 8th to 10th rank). This decrease was a result of Turkey improving its health care system in recent decades (22). The Islamic Republic of Iran had the highest increase in T2D-related DALYs (from 18th to 16th rank in 2019) and death (from 18th to 10th rank in 2019). This increase may be attributed to the consequences of armed conflict and sanctions, dispersion, destabilization of health care systems, poor access to prevention, care and treatment, and poor education.

The T2D-related DALYs increased sharply with age. We found that the highest rate of T2D was reported in ages 45–49 years and higher. In fact, increasing life expectancy will result in a greater burden of T2D in the elderly.

The strengths of the present study include comparing the data of countries that have similar information registration systems and sociodemographic indices. Other strengths were the comprehensive estimations of the T2D burden reported as prevalence, incidence, death and DALYs among different countries from 1990 to 2019, hence, it can detect the strengths and weaknesses of the health care systems in these countries. All limitations of the GBD study are detailed elsewhere (7) and our study was wholly subject to those limitations.

We did not cover type 1 diabetes mellitus and gestational diabetes mellitus, these will be the subject of separate studies. In July 2011, South Sudan gained independence and separated from Sudan but in this study, the data for Sudan and South Sudan are reported as one country. Deaths reported in the GBD are the deaths directly caused by T2D, which may underestimate the mortality attributable to T2D. Certainly, T2D is associated with the increased risk of death, cardiovascular disease, cancer and infectious diseases which result in a higher indirect death rate. The estimates in the GBD are updated annually, therefore these limitations should be addressed.

Conclusion

T2D has continued to increase in prevalence, incidence, deaths and DALYs rates in most countries of the MENA region. This increasing trend may be attributed to ageing population, social and economic transformation, urbanization, the obesity epidemic, and unhealthy diets such as processed and high-fat diet, sedentary lifestyles and inability of health care systems to diagnose T2D early or provide access to treatment. Given that most of the T2D burden is advanced by modifiable risk factors, health care systems are crucially needed to set policies, allocate resources, tailor educational interventions to modify unhealthy lifestyles, efficiently address overweight and obesity, smoking and exposure to air pollution.

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Situation épidémiologique du diabète sucré de type 2 dans la Région Moyen-Orient et Afrique du Nord, 1990-2019

Résumé

Introduction : Le diabète sucré de type 2 est associé à diverses complications et impose des contraintes économiques importantes.

Objectifs : La présente étude visait à déterminer le statut épidémiologique et la charge du diabète sucré de type 2 dans les pays du Moyen-Orient et d'Afrique du Nord au cours de la période 1990-2019 afin de mieux cibler les stratégies de prévention.

Méthodes : La population d'étude était composée de 21 pays, couvrant près de 400 millions de personnes. La base de données de 2019 sur la charge mondiale de morbidité a été utilisée. Les années de vie ajustées sur l'incapacité (DALY) sont calculées en additionnant les années de vie perdues et les années vécues avec une incapacité. Les taux de prévalence, d'incidence, de mortalité et de DALY pour 100 000 personnes ont été calculés pour tous les lieux en utilisant

des taux standardisés selon l'âge.

Résultats : En 2019, le Qatar présentait les taux de prévalence [16 312,4 ; 95 % intervalle unitaire (UI) : 15 050,0-17 723,2] et d'incidence (818,0 ; 95 % UI : 773,9-868,7) les plus élevés. Bahreïn présentait les taux de mortalité (127,0 ; UI à 95 % : 102,5-154,6) et de DALY (3232,5 ; UI à 95 % : 2622,4-3929,3) les plus élevés. Dans la Région Moyen-Orient et Afrique du Nord, les taux moyens de DALY ont augmenté de près de 31 % (808,3 à 1060,8) et les taux moyens de mortalité ont enregistré une hausse de 0,4 % (24,8 % à 25,2 %) au cours de la période 1990-2019. La plus forte augmentation des DALY liées au diabète sucré de type 2 (516,5 à 958,1 ; 85 %) et la hausse la plus importante des décès liés au diabète sucré de type 2 (12,5 à 22,0 ; 76 %) ont été enregistrées en République islamique d'Iran.

Conclusion : Les taux de prévalence, d'incidence, de décès et de DALY liés au diabète sucré de type 2 ont continué à augmenter dans la plupart des pays de la Région Moyen-Orient et Afrique du Nord. Les systèmes de santé doivent s'efforcer de maîtriser les facteurs de risque modifiables.

1990-2019

WHO EMRO | Epidemiological status of type 2 diabetes mellitus in the Middle East and North Africa, 199

100 ألف شخص في جميع المواقع باستخدام المعدلات المُوحَّدة حسب السن .

: في عام 2019 ، كانت قطر بها أعلى معدل انتشار بواقع 16312.4 (95% UI :النتائ ج
17723.2–15050.0) ومعدلات إصابة 818.0 (95% UI: 868.7–773.9). وكانت البحرين بها أعلى
معدل وفيات (127.0 ؛ 95% UI: 154.6–102.5) ومعدلات سنوات العمر المصححة باحتساب مدد
الإعاقة (3232.5 ؛ 95% UI: 3929.3–2622.4). وفي منطقة الشرق الأوسط وشمال أفريقيا، ارتفع
متوسط معدلات سنوات العمر المصححة باحتساب مدد الإعاقة بنسبة 31% تقريبًا (808.3 إلى
1060.8) وارتفع متوسط معدلات الوفاة بنسبة 0.2% (24.8 إلى 25.2) خلال الفترة 1990-2019.
وسُجلت أعلى زيادة في سنوات العمر المصححة باحتساب مدد الإعاقة المرتبطة بالسكري من
النمط 2 (516.5 إلى 958.1 ؛ 85%) ، وأعلى زيادة في الوفيات المرتبطة بالسكري من النمط 2
(12.5 إلى 22.0 ؛ 76%) في جمهورية إيران الإسلامية .

: استمرت معدلات الانتشار والإصابة والوفيات ومعدلات سنوات العمر المصححةالاستنتاجات
باحتساب مدد الإعاقة للسكري من النمط 2 في الارتفاع في معظم بلدان الشرق الأوسط وشمال
أفريقيا . وينبغي لنُظُم الرعاية الصحية أن تبذل جهودًا للسيطرة على عوامل الخطر
القابلة للتعديل .

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