High Fasting Plasma Glucose, Diabetes, and Its Risk Factors in the Eastern Mediterranean Region, 1990–2013: Findings From the Global Burden of Disease Study 2013

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EPIDEMIOLOGY/HEALTH SERVICES RESEARCH

OBJECTIVE

The prevalence of diabetes in the Eastern Mediterranean Region (EMR) is among the highest in the world. We used findings from the Global Burden of Disease 2013 study to calculate the burden of diabetes in the EMR.

RESEARCH DESIGN AND METHODS

The burden of diabetes and burden attributable to high fasting plasma glucose (HFPG) were calculated for each of the 22 countries in the EMR between 1990 and 2013. A systematic analysis was performed on mortality and morbidity data to estimate prevalence, deaths, and disability-adjusted life years (DALYs).

RESULTS

The diabetes death rate increased by 60.7%, from 12.1 per 100,000 population (95% uncertainty interval [UI]: 11.2–13.2) in 1990 to 19.5 per 100,000 population (95% UI: 17.4–21.5) in 2013. The diabetes DALY rate increased from 589.9 per 100,000 (95% UI: 498.0–698.0) in 1990 to 883.5 per 100,000 population (95% UI: 732.2–1,051.5) in 2013. In 2013, HFPG accounted for 4.9% (95% UI: 4.4–5.3) of DALYs from all causes. Total DALYs from diabetes increased by 148.6% during 1990–2013; population growth accounted for a 62.9% increase, and aging and increase in age-specific DALY rates accounted for 31.8% and 53.9%, respectively.

CONCLUSIONS

Our findings show that diabetes causes a major burden in the EMR, which is increasing. Aging and population growth do not fully explain this increase in the diabetes burden. Programs and policies are urgently needed to reduce risk factors for diabetes, increase awareness of the disease, and improve diagnosis and control of diabetes to reduce its burden.

Diabetes accounted for ~1.3 million deaths (2.4% of all deaths) and 56 million disability-adjusted life years (DALYs) in 2013 (1,2). Its prevalence in the World Health Organization's (WHO) Eastern Mediterranean Region (EMR) is among the highest in the world and is expected to increase rapidly in the coming decades (3–6). Aging populations, urbanization, industrialization, nutrition transition, epidemics of obesity, and low

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**A full list of members of the Global Burden of Disease Collaborators on Eastern Mediterranean Region and Diabetes is available in the Supplementary Data online.*

physical activity all contribute to this increase. Also, genetic and epigenetic factors may play a role in the high prevalence of diabetes and its diversity in EMR countries (7). The EMR has high rates of overweight and obesity and inappropriate dietary habits and physical inactivity as the main modifiable risk factors of diabetes (8–10), as well as underdiagnosis of diabetes, underutilization of health services, and low quality of diabetes care (11–13). Moreover, millions of displaced people as a result of the armed conflicts have limited access to health services.

The prevalence of diabetes varies among EMR countries. Regional prevalence of diabetes is estimated at ∼9.2% in EMR adults aged 20–79 years (3,4). A systematic review of previous studies reported a heterogeneous prevalence range between 4.3% (rural area of Saudi Arabia) and ∼30% (Bahrainis aged 40–69 years) among the high-income countries of the region (14). A national survey of Saudi adults in 2013 showed a prevalence of 13.4% (15). A study in Tunisian adults in 2007 showed a prevalence of 9.9% and a twofold increase from 15 years earlier (16). In Pakistan, the prevalence of diabetes was reported at 12.1% for men and 9.8% for women aged 25 years or older (17). A systematic review on the prevalence of type 2 diabetes in Iran showed a range of 3% to 20% in different provinces (18), with higher rates among women. Prevalence of type 2 diabetes was reported at 8.5% in a 2008–2009 study in Lebanon (19) and 4.6% in Yemen in adults aged 25 years or older (20). It is estimated that ∼15% of the health budget in the Middle East and North Africa is spent on diabetes (4,21).

Impaired glucose tolerance (IGT), an intermediate step in the development of diabetes, is also very common in the region. Prevalence of IGT (or prediabetes) in countries in the Middle East and North Africa has been estimated at 7.8% (95% CI: 4.4–12.6) (4). This clearly indicates that a substantial number of individuals are at higher (than usual) risk for diabetes. Approximately 25% of individuals with IGT are predicted to progress toward diabetes within 3 to 5 years, and without preventive interventions, most of them will eventually develop diabetes (22).

In this report we present the burden of diabetes (complicated and uncomplicated), the burden attributable to high fasting plasma glucose (HFPG), and the burden of diabetes attributable to known risk factors at the regional and national level for the 22 EMR countries from 1990 to 2013.

RESEARCH DESIGN AND METHODS

The Global Burden of Diseases, Injuries, and Risk Factors Study 2013 (GBD 2013) covers 188 countries, 7 super regions, and 21 regions from 1990 to 2013. In total, 306 causes of diseases and injuries, 240 causes of deaths, and 79 risk factors were systematically analyzed. Details of the methodology of GBD studies and the main changes incorporated into the GBD 2013 methods have been explained in previous publications (1,2,23).

The EMR includes 22 countries: Egypt, Bahrain, Djibouti, Iraq, Afghanistan, Iran, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Pakistan, Palestine, Qatar, Yemen, Saudi Arabia, Somalia, Syria, Sudan, Tunisia, and the United Arab Emirates (UAE) (2).

The framework used in the assessment of the burden of HFPG (as an indicator of hyperglycemia), diabetes, and the attributable burden to its risk factors is presented in Fig. 1. We used the ICD-10 codes of E10–E10.11, E10.3–E11.1, E11.3–E12.1, E12.3–E13.11, E13.3–E14.1, E14.3–E14.9, P70.0–P70.2, and R73–R73.9 to define diabetes. We

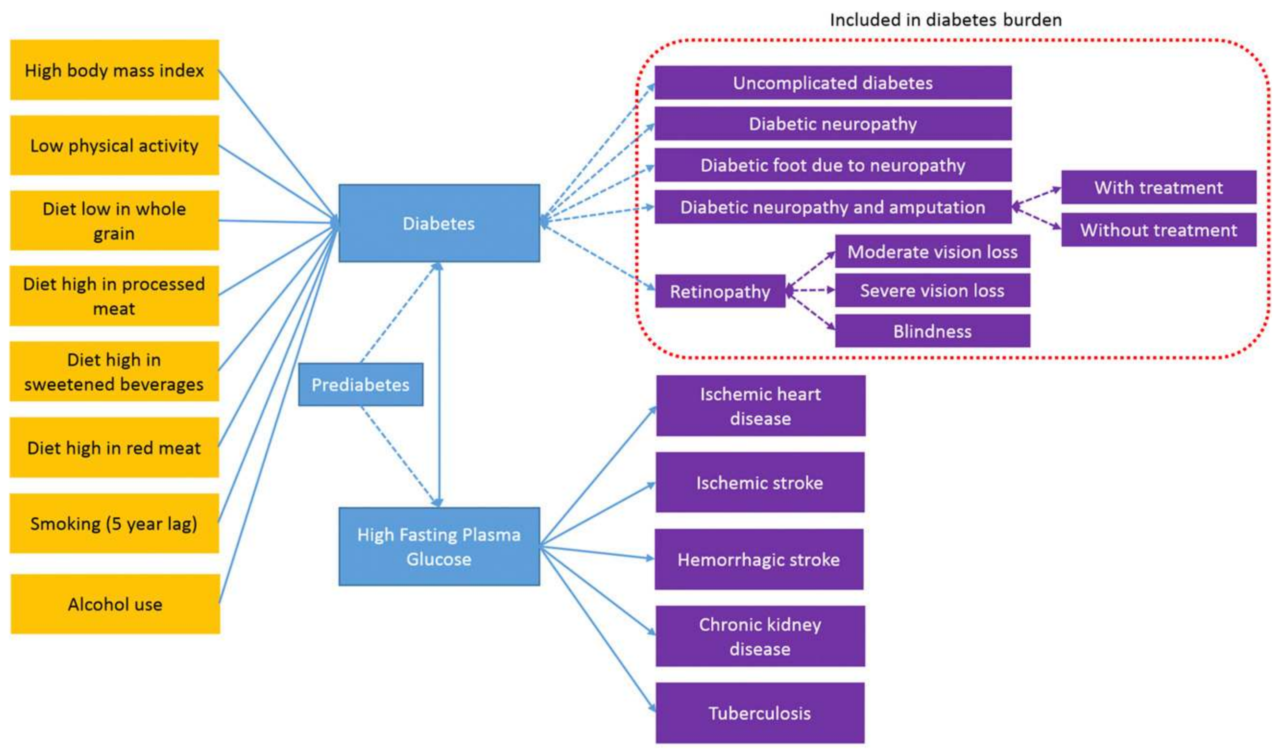

Figure 1—Dimensions of assessment of burden of HFPG, diabetes, and burden attributable to its risk factors in the GBD 2013 study.

calculated the burden of E10.2, E11.2, E12.2, and E13.2 (renal complications of diabetes) as part of the burden of chronic kidney diseases (CKD).

We used the GBD comparative risk assessment approach as an overarching conceptual framework for population risk assessment across the risks over time. We adopted the World Cancer Research Fund grading of evidence supporting the causal relationship between risk factor exposure and an outcome. Levels of evidence are defined as convincing, probable, possible, and insufficient. Only risk-outcome pairs judged to meet the criteria of convincing or probable were included for this analysis (24). The other criteria for including a risk factor were the importance of each risk factor to diabetes burden and/or policy, the availability of sufficient data to estimate level of exposure, availability of data to estimate effect sizes per unit of exposure increase, and the evidence of generalizability of these effects to a general population. The risk factors eventually selected were high BMI, low physical activity, diet low in whole grains, diet high in processed meat, diet high in sweetened beverages, diet high in red meat, diet low in nuts and seeds, alcohol use, and smoking using a 5-year time lag.

We calculated the attributable burden to each risk factor that reflects a possible reduction in the current diabetes burden if past population exposure had shifted to an alternative or counterfactual distribution of risk exposure. We used the theoretical minimum risk as this alternative (23).

To estimate the number of deaths from diabetes, all-cause mortality envelopes were first estimated for each country during the period 1990–2013. We used all accessible data from vital registration systems, sibling history surveys, sample registration data, and household recall of deaths to prepare these envelopes. We extracted causes of deaths data from the same sources, as well as available verbal autopsies, and then used cause of death ensemble modeling to estimate the number of deaths from diabetes by age, sex, country, and year (2).

In GBD 2013, we defined diabetes as a parent cause with the following sequelae: uncomplicated diabetes, vision loss caused by diabetes (moderate low vision, severe low vision, and blindness), and amputation resulting from diabetes, with or without a treatment that contains a prosthetic limb (Fig. 1).

Data were extracted by trained data analysts and checked and cleaned by the modeler before use in cause models. We extracted incidence, prevalence, and excess mortality data and assumed no remission for diabetes.

The main estimation method was the Bayesian meta-regression of epidemiological estimates through DisMod-MR 2.0, a specific software tool for this purpose. Input epidemiological data were used in combination with data on covariates and model assumptions to provide posterior epidemiological estimates for each country and year and by sex and age (25).

We used theoretical minimum risk exposure level of 4.8–5.4 mmol/L or 86.4–97.2 mg/dL for HFPG. This level is lower than the current cutoff point for diagnosis of diabetes (≥7.0 mmol/L or 126 mg/dL) (23). Although there is considerable overlap between diabetes and HPFG, they have some differences. People with prediabetes have HFPG (as a risk factor) but do not have diabetes, and some people with controlled diabetes might be at lower risk based on plasma glucose levels. We assumed from previous evidence that HFPG can increase the risk of ischemic heart disease, ischemic stroke, hemorrhagic stroke, CKD (hypertensive CKD, glomerulonephritis CKD, diabetes CKD, and other CKD), and tuberculosis. Relative risks for the association of HFPG and these outcomes have been provided elsewhere (23).

To decompose the role of population growth, aging, and change in age- and sex-specific rates of diabetes during 1990–2013, we estimated total DALYs under two scenarios of "2013 population, 1990 age- and sex-specific DALY rates and 1990 age structures" and "2013 population, 1990 age- and sex-specific DALY rates and 2013 age structures." We compared the expected burden under these scenarios with 1990 and 2013 total DALYs.

We report a 95% uncertainty interval (UI) for each quantity in our analysis. We estimated UIs by taking 1,000 samples from the posterior distribution of each quantity and used the 25th- and 975th-ordered draw of the uncertainty distribution.

RESULTS

Diabetes

The diabetes death rate per 100,000 population increased from 12.1 (95% UI: 11.2–13.2) in 1990 to 19.5 (95% UI: 17.4–21.5) in 2013 (Supplementary Table 1). A total of 121,552 diabetes deaths (95% UI: 108,552–134,239) occurred in 2013 in the EMR, 52.1% of which were among females. These deaths accounted for 3.3% (95% UI: 3.0–3.6) of all deaths in the region in 2013, up from 1.5% (95% UI: 1.4–1.6) of all deaths in 1990. Premature mortality caused by diabetes resulted in 1,148,517 years of life lost (YLLs) (95% UI: 1,057,605–1,243,755) in 1990 compared with 2,665,868 YLLs (95% UI: 2,371,987–2,962,670) in 2013. Death and YLL rates increased by 60.7% and 40.0%, respectively, during 1990–2013.

The prevalence of diabetes by age and sex in 2013 is presented in Fig. 2. The prevalence of diabetes in the EMR was higher than the global prevalence for almost all ages; this pattern was similar during 1990–2013. The total number of cases was estimated at 36,626,768 (95% UI: 29,014,044–44,868,410) in 2013. The range of age-standardized prevalence of diabetes in 2013 was between 1.4% in Yemen and 16.8% in Kuwait among males, compared with 1.9% in Somalia to 19.4% in Saudi Arabia for females (Fig. 3). The age-standardized prevalence in 2013 was higher than in 1990 in most of the EMR countries. The lowest and highest increase in age-standardized prevalence of diabetes was observed in Yemen and Saudi Arabia, respectively.

The years lived with disability caused by diabetes in the EMR increased from 1,072,316 (95% UI: 752,484–1,461,220) in 1990 to 2,848,083 (95% UI: 1,966,077–3,884,069) in 2013. The years lived with disability rate increased by 60.2% during 1990–2013 in EMR.

The rate of DALYs from diabetes per 100,000 population increased from 589.93 (95% UI: 498.0–698.0) in 1990 to 883.5 (95% UI: 732.2–1,051.5) in 2013, a 49.8% increase in the DALY rate for diabetes compared with an 8.4% reduction in the DALY rate for all other noncommunicable diseases in the EMR. The age-standardized DALY rate also increased by 28.6% during 1990–2013. Supplementary Table 2 reports rates of diabetes DALYs in the EMR and the world. The age-standardized DALY rates of diabetes in the EMR in 2013 were 1.52 and 1.79 times the global rates for males and females, respectively.

Supplementary Table 3 provides age-standardized and all-age rates of DALYs,

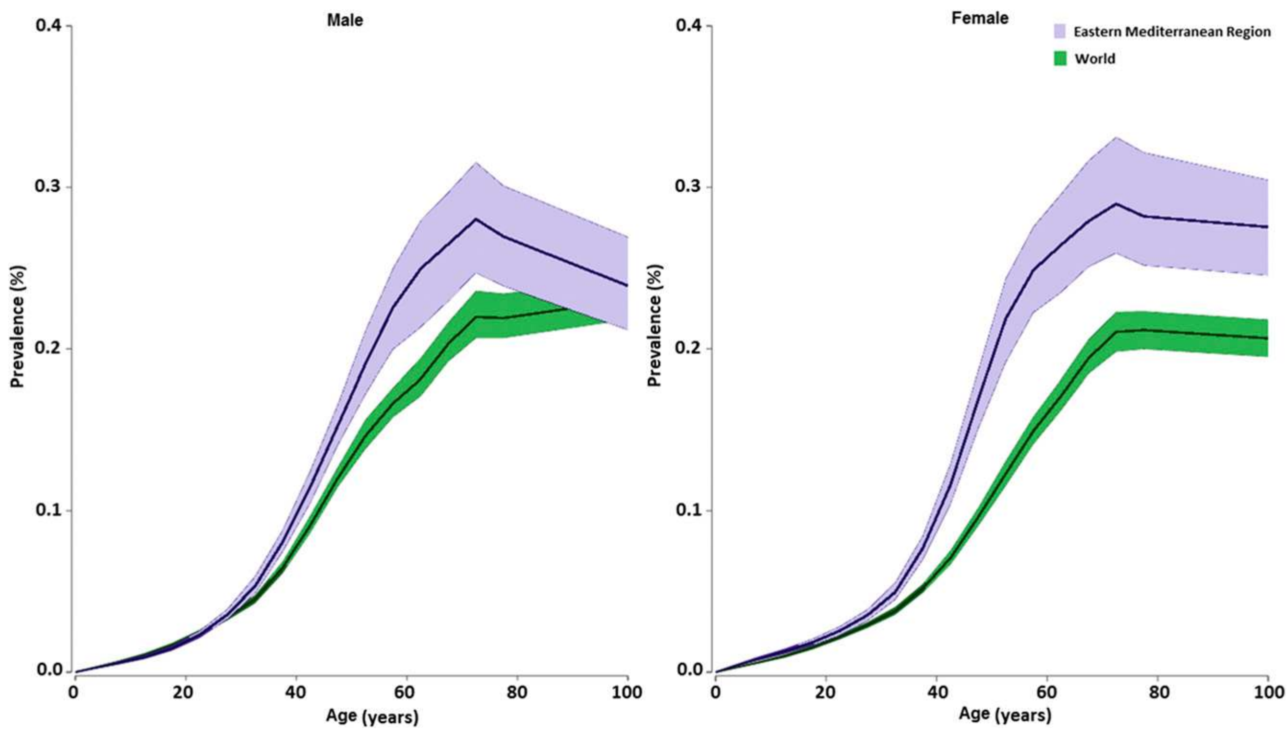

Figure 2—Prevalence (and 95% UI) of diabetes in the EMR and the world among males and females (2013).

deaths from diabetes by sex in 2013, as well as the proportion of YLLs to DALYs for all EMR countries. Countries with the highest age-standardized DALY rates were Bahrain, Oman, and Afghanistan. Diabetes DALY rates for all ages were highest in Saudi Arabia, Bahrain, and Lebanon among males, and in Morocco, Bahrain, and Saudi Arabia were highest among females. The YLLs to DALYs varied widely by sex and country, between 8.3% for females in Saudi Arabia to 83.6% for females in Afghanistan (Supplementary Table 3).

CKD Related to Diabetes

Between 1990 and 2013, CKD death rates per 100,000 population from

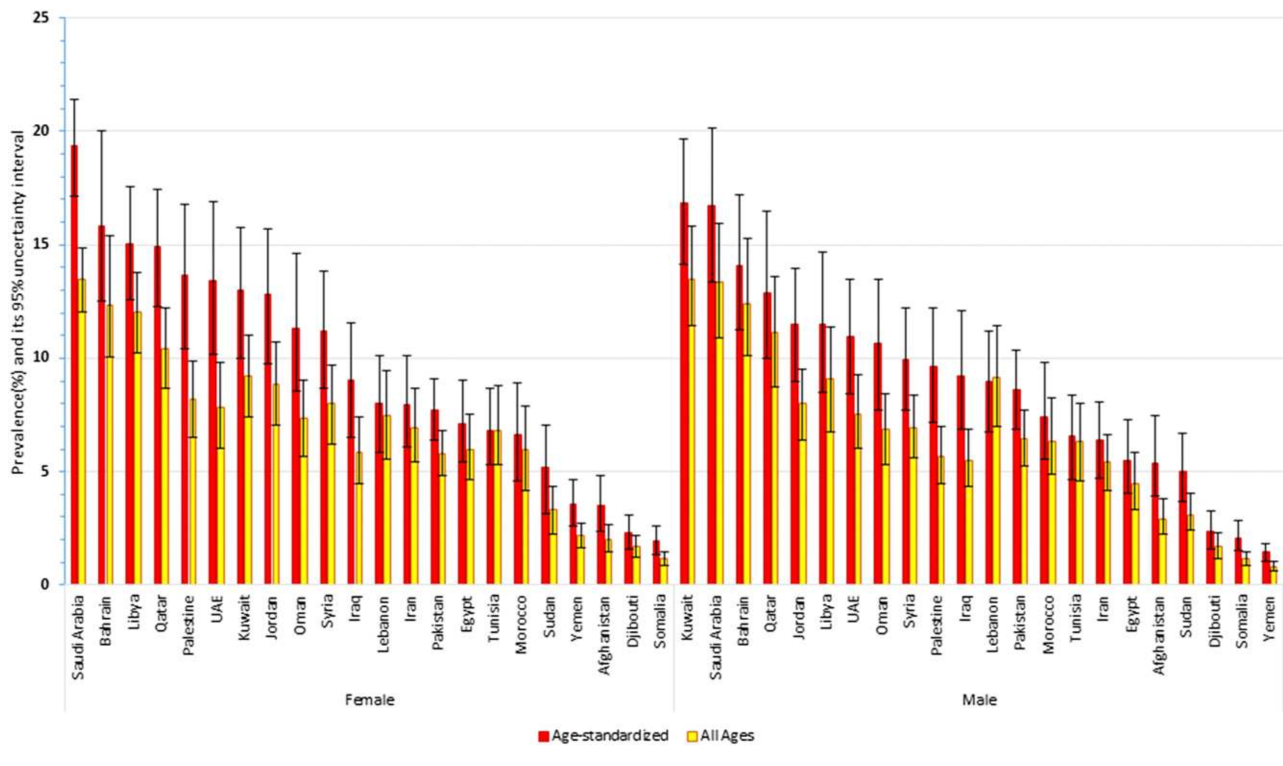

Figure 3—Age-standardized and overall prevalence of diabetes in the countries of the EMR, 2013 (sorted by age-standardized prevalence).

diabetes increased by 197.8%, from 0.3 (95% UI: 0.2–0.5) to 1.0 (95% UI: 0.7–1.2). The CKD age-standardized death rate from diabetes (2013) per 100,000 population was 2.0 (95% UI: 1.4–2.5) in the EMR compared with the global level of 2.9 (95% UI: 2.3–3.5). In 2013, 6,030 individuals (95% UI: 4,106–7,672) died of CKD caused by diabetes in EMR. Among the total number of CKD deaths caused by diabetes, 63.3% occurred among males.

The burden of CKD caused by diabetes per 100,000 population increased by 63.5%, from 29.4 DALYs (95% UI: 22.4–37.1) in 1990 to 48.12 (95% UI: 37.5–59.3) in 2013 for all ages. The age-standardized DALY rate per 100,000 population was 74.0 (95% UI: 58.3–89.8) in the EMR in 2013 compared with 90.8 (95% UI: 76.9–105.7) for the global level. Diabetes caused 6.1% of all CKD burden in the EMR in 1990, and it increased to 9.0% in 2013.

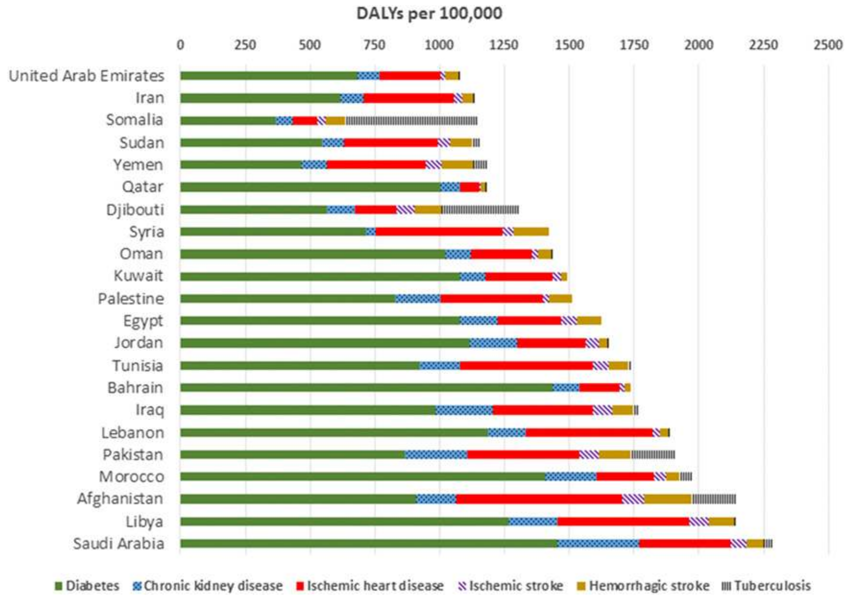

Figure 4—DALYs of different outcomes of HFPG in the countries of the EMR, 2013.

HFPG

Attributable DALYs

The population-attributable fraction (PAF) of HFPG, which was 2.4% (95% UI: 2.1–2.7) of DALYs from all causes in 1990, increased to 4.9% (95% UI: 4.4–5.3) in 2013. The PAF of HFPG was 31.7% (95% UI: 25.1–38.4) of CKD DALYs, 18.1% (95% UI: 14.1–22.5) of ischemic heart disease DALYs, 16.8% (95% UI: 11.5–22.4) of tuberculosis DALYs, 12.5% (95% UI: 7.5–18.5) of hemorrhagic stroke DALYs, and 12.3% (95% UI: 7.6–18.3) of ischemic stroke DALYs, as well as 100% of diabetes DALYs as our study assumption.

The attributable burden to HFPG was 1,298.4 DALYs per 100,000 population (95% UI: 1,126.3–1,471.0) in 1990, which increased by 28.1% to 1,663.1 (95% UI: 1,422.8–1,907.9) in 2013. The share of different outcomes from the total DALYs attributable to HFPG in 2013 was 53.1% for diabetes, 22.0% for ischemic heart disease, 10.2% for CKD, 5.7% for hemorrhagic stroke, 5.3% for tuberculosis, and 3.6% for ischemic stroke.

Figure 4 demonstrates DALYs of different outcomes of HFPG in each country of EMR. The highest attributable burden was observed in Saudi Arabia, Libya, and Afghanistan, at 2,281.3, 2,147.4, and 2,146.4 DALYs per 100,000 population, respectively.

Attributable Deaths

PAF of HPFG was 8.5% (95% UI: 7.4–9.7) of deaths from all causes in 2013. It was 34.6% (95% UI: 26.4–43.2) of CKD deaths, 19.9% (95% UI: 14.0–26.3) of tuberculosis deaths, 16.9% (95% UI: 13.1–21.1) of ischemic heart disease deaths, 10.3% (95% UI: 6.2–15.9) of hemorrhagic stroke deaths, 9.5% (95% UI: 5.0–16.0) of ischemic stroke deaths, as well as a 100% of diabetes deaths (as our study assumption).

During the 1990–2013 period, deaths attributable to HFPG increased from 39.1 (95% UI: 33.7–45.1) to 50.4 (95% UI: 43.5–57.3) per 100,000 population (a 28.8% increase in rate of attributable deaths). HFPG-attributable death fraction in 2013 was 38.6% for diabetes, 32.1% for ischemic heart disease, 10.5% for CKD, 7.1% for hemorrhagic stroke, 6.1% for ischemic stroke, and 5.3% for tuberculosis.

Risk Factors for Diabetes

Supplementary Tables 4 and 5 report the contribution of each risk factor to the diabetes burden in the EMR. High BMI, low consumption of whole grains, and low physical activity were the most important risk factors for diabetes in each of the countries in the EMR. Supplementary Table 6 shows PAF of diabetes DALYs and deaths for each risk factor, as well as rates of diabetes DALYs and deaths related to risk factors in the EMR in 2013.

Decomposition of Reasons for the Increase in DALYs

Between 1990 and 2013, total DALYs from diabetes increased by 148.2% (95% UI: 146.3–150.7%) in the EMR. Population growth accounted for a 62.9% increase in diabetes DALYs, and aging and changes in age- and sex-specific DALY rates accounted for 31.8% and 53.9% increases in DALYs, respectively (Supplementary Table 7).

CONCLUSIONS

Our study shows a high burden of diabetes in the EMR, with a rapid rise in burden since 1990; moreover, the increase is not fully explained by population growth and aging in the region. Clearly, changes in health behaviors are contributing to the rise in diabetes burden. Our findings call for regional, national, and local solutions to curb the rising diabetes burden. There is an urgent need to address upstream conditions, such as social and environmental circumstances, that prevent timely lifestyle and behavioral changes in at-risk regions and their populations. Programs and policies are urgently needed to reduce modifiable risk factors, increase awareness, and improve the diagnosis and control of diabetes. These activities need to involve a wide range of partners, from health, education, and agricultural sectors to food industries, outlets, and city planners, among others.

A strong correlation was found between the International Diabetes Federation (IDF) estimates and our estimates (>88%) for the number of 20- to 79-year-old people with diabetes in 2013. The differences between the IDF and GBD estimates for countries like Saudi Arabia, Tunisia, and Iran were small (≤5%); however, differences were high (>100%) for Somalia, Yemen, and Djibouti (26). Higher differences were mainly related to the countries with poor original data.

The 2013 IDF estimates suggest the Middle East and North Africa region had the highest prevalence of diabetes, which is compatible with our findings. High prevalence and burden of diabetes in this region is related to several factors and is mainly a combination of behavioral and metabolic risk factors. Our study showed that overweight/obesity is the main risk factor for diabetes in the EMR. Prevalence of overweight/obesity has increased in almost all countries of the region in recent decades (27) and is predicted to increase further in the coming years in the absence of effective interventions (28). Different factors, such as change in cultures and food systems, sedentary lifestyle, and specific aspects of traditional culture (such as showing hospitality through providing large amounts of foods), contribute to the high prevalence of overweight and obesity (29). Weight control strategies are expected to decrease the burden of diabetes in all countries of the region (9,30–32).

Physical activity has a protective effect both for individuals who are at risk for diabetes and in individuals with diabetes (33). Although there is a paucity of physical activity data in the region, some reports have shown an increasing trend of physical inactivity in both males and females in recent decades (34,35). High-income countries of the Arab world have some of the highest rates of physical inactivity in the world, with an age-standardized prevalence of ~69% in Saudi Arabia, 65% in Kuwait, and 63% in UAE (32). Physical inactivity is more prevalent in women, who generally have limited access to sporting venues, social and legally acceptable athletic attire, and role models. Moreover, some conservative sociocultural or religious norms are against promoting recreational physical activities and sports for women in the region (29).

Low intake of whole grains is a known risk factor for different diseases, including diabetes, coronary heart disease, and stroke (36). Our study showed that this is a major contributor to diabetes. However, consumption of whole grains has decreased by more than 20% during the past two decades in the region as a result of nutritional transition (23,36).

The role of smoking and high consumption of processed food and red meat as risk factors for diabetes burden are less often discussed. Including them as risk factors for diabetes (type 2) is based on epidemiological evidence and is beyond their effect on other diseases such as cancers and ischemic heart diseases (23). Our study shows that their contribution to diabetes is comparable with that of sugar-sweetened beverages.

The variation in diabetes burden across countries in the region is mainly related to the difference in risk factor distribution. In our study, most of the high-income countries of the region (especially Bahrain, Oman, Saudi Arabia, and Qatar) had high age-standardized DALY rates of diabetes. This is compatible with previous findings that showed a change in lifestyle caused by a rapid shift from occupations that required high physical activity (such as agriculture) to service jobs in the countries with higher income in the region (7).

Timely diagnosis of diabetes, health care utilization, and quality of diabetes care affect the burden of diabetes in a community or country. Previous evidence demonstrates the underutilization of diagnostic and therapeutic services for diabetes and low quality of care in different countries in the region (4,11–13). A national survey in Saudi Arabia, which has the highest burden of diabetes in the EMR, showed that only 42.2% of individuals with diabetes had been diagnosed (15) and that only 70.5% of those known to have diabetes reported taking medication for diabetes (12). In addition to health care services being available, they should be accessible, acceptable, and affordable for communities to benefit from their utilization and experience continuity of care.

Population prevention and control of diabetes need strong leadership and political support, underpinned by high-quality data. Therefore, our findings may be useful for informing policy, as already used by some of the countries in the region (34). A spectrum of strategies and interventions should be developed and implemented to achieve such a goal. First, efforts should be made to lower known diabetes risk factors, especially high BMI, low physical activity, and unhealthy diet (29,37). Second, early detection of diabetes should be improved. The reasons for low uptake of diagnostic measures might be different among the EMR countries. Risk stratification and screening through identification of individuals who are at higher risk of diabetes might be better than general screening. Third, plasma glucose and other impairments should be controlled through implementation of evidence-based clinical guidelines and educating patients. This can reduce the effect of diabetes on cardiovascular, renal, ophthalmic, sensorineural, and infectious diseases (such as tuberculosis). Fourth, the number of rehabilitation programs and patients' access to these programs should be increased to improve the functional status of individuals with diabetes. Finally, social support initiatives may improve the quality of life of diabetes patients. Increasing the entire population's awareness has an important role in most of the interventions.

Primary prevention at the community level, as well as primary health care interventions, are usually the most cost-effective programs to prevent and reduce the burden of diabetes (38,39). There is a wide range of available resources and health care expenditure for individuals with diabetes in the region (7). Moreover, quality of care is a major concern in some countries of the region (40). In general, however, there is an underinvestment in diabetes care, even in the high-income countries of the EMR compared with high-income Western countries (4,7). Political commitment, multisectoral partnerships, and consideration of the sociocultural norms of the target population are necessary for these interventions to succeed (9). However, several countries of the region are directly involved in armed conflicts or are indirectly influenced by displaced people from neighboring countries. The health systems in these countries are under intensive pressure and cannot even provide their usual services. It is too optimistic to expect successful installation of promotional programs in such situations.

New interventions will require extra financial resources at least in the short- and middle-term. However, without such investment in new interventions, costs of diabetes care will increase rapidly as a result of the high prevalence of risk factors, increasing disease prevalence (31), and diabetes complications. Policymakers should shift financial resources to cost-effective interventions. Currently, the most significant portion of diabetes-related costs goes toward managing complications and medications, which are financially demanding. A shift toward investment in primary or primordial preventive measures and health promotion would decrease overall costs in the future.

The Diabetes Prevention Program and Outcomes Study showed that diabetes is largely preventable or can be delayed through lifestyle interventions. Decreasing body weight reduced the risk of diabetes. In fact, a 10% loss of body weight at 6 months was associated with an 85% reduction in the incidence of type 2 diabetes after 3 years of follow-up. Moreover, the study showed that intensive lifestyle intervention was cost-saving for individuals aged 45 years or younger and was cost-effective for older age-groups (39).

Type 2 diabetes, the major subtype of diabetes, is largely preventable. The increased prevalence of diabetes cannot be attributed to genetics, because there is no evidence showing a change in the gene pool in EMR countries from 1990 to 2013. The rise in diabetes prevalence and burden is simply a result of changes in lifestyle and behaviors. Traditionally, the region was more active and had a healthier and more balanced diet (35). Behavioral change in the region is urgently needed. Risk-stratified screening instruments can be helpful, especially to identify individuals with prediabetes and encourage them to change their lifestyle. The region needs a champion for physical activity and healthy diet and the political will and support to achieve the goal of reducing diabetes.

Our study has some limitations. First, despite the comprehensive nature of the GBD data set, data for some countries within the EMR were limited. We used our standard GBD modeling processes to estimate the burden for countries with poor data. Our study highlights a need for better health information system data to track the diseases, risk factors, and responses to interventions in the region. Second, we did not incorporate the effect of joint distributions of risk factors, a process that could have inflated our estimated PAF. Third, we did not differentiate subtypes of diabetes for this study. Because the prevalence of type 1 diabetes is low, the results apply mainly to type 2 diabetes; however, despite most of the previous studies, which are limited to adults, our study covers all age-groups. Fourth, we did not examine the subnational burden within the countries. Previous studies have shown wide variations within a country in risk factors and prevalence of conditions, and subnational assessment will assist with policy guidance. Finally, it has been suggested that HFPG increases the risk of other conditions such as some cancers, chronic liver disease, cataracts, periodontitis, pneumonia, and other infectious diseases (in addition to tuberculosis) (41); thus, our attributable burden for HFPG might be underestimated. However, the best available and most robust evidence was used to select the list of risk factors (23).

Conclusion

Our findings show that diabetes causes a major burden in the EMR, which is increasing. Aging and population growth do not fully explain this increase in the diabetes burden.

Our study provides background information to EMR countries to base their future diabetes reduction programs on a solid foundation of evidence and will enable them to monitor programs' progress and policies' successes. Our study should be viewed as a wake-up call to rally the region's key players to prevent and control the growing and extremely costly burden of diabetes in the region. Programs and policies are urgently needed to increase awareness of the disease, reduce risk factors for diabetes, and improve diagnosis and control of diabetes to reduce its burden.

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