

REVIEW

Epidemiology of and Risk Factors for Type 2 Diabetes in Egypt



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Abstract

BACKGROUND Diabetes is a fast-growing health problem in Egypt with a significant impact on morbidity, mortality, and health care resources. Currently, the prevalence of type 2 diabetes (T2D) in Egypt is around 15.6% of all adults aged 20 to 79.

OBJECTIVE To describe the epidemiology, principal causes, associated risk factors, cultural aspects, and challenges that may contribute to the rapid rise in T2D in Egypt.

METHODS Review of papers in PubMed and relevant gray literature.

FINDINGS The International Diabetes Federation (IDF) has identified Egypt as the ninth leading country in the world for the number of patients with T2D. The prevalence of T2D in Egypt was almost tripled over the last 2 decades. This sharp rise could be attributed to either an increased pattern of the traditional risk factors for T2D such as obesity and physical inactivity and change in eating pattern or other risk factors unique to Egypt. These include increased exposure to environmental risk factors like pesticides and increased prevalence of chronic hepatitis C.

CONCLUSIONS Prevention, early identification, and effective intervention are integral components of effective T2D care in Egypt. These strategies may reduce the expanding economic burden associated with T2D care.

KEY WORDS diabetes, Egypt, hepatitis C infection, MENA, obesity, pesticide

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INTRODUCTION

Egypt is a North African, Mediterranean, and Middle Eastern country. The majority of its land is a desert except a longitudinal agricultural strip around the Nile River, where for the past 7000 years most Egyptians have lived. Egypt is bordered by the Mediterranean Sea in the north and the Red Sea in the east. In 2015, Egypt's population was estimated at 90

million, and its capital, Cairo, was ranked the 10th largest city in the world with a population of 18.41 million. Egyptian ethnicity is a strong, unified mix of native Egyptians and Arabs who have inhabited Egypt since the seventh century. Ninety percent of Egyptians are Sunni Muslims, and 10% are Christians, with 90% of those Orthodox Christians. The Egyptian gross domestic product (GDP) per capita is around \$11,194, with total GDP of \$990 billion.

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It is worth mentioning that the Egyptian physician “Hesy-Ra” first described diabetes at approximately 3000 BC, but diabetes was further described in detail—as “plentiful urine”—in the Upper Egyptian Ebers Papyrus dating back to 1550 BC (see issue cover). In the modern era, diabetes continues to be a public health problem with a significant burden on the Egyptian economy. Patients with type 2 diabetes (T2D) constitute approximately 90%-95% of all patients with diabetes worldwide and represent a growing epidemic.

In 2013, 382 million adults were diagnosed with diabetes worldwide. This number is expected to grow to 592 million in 2035. People with diabetes are at increased risk of macrovascular and microvascular complications, as well as early mortality. For instance, patients with diabetes are 2 to 4 times more likely to have fatal or nonfatal coronary events or a stroke. Almost 70%-80% of patients with T2D die from 1 of these 2 conditions. The American Heart Association considers diabetes as 1 of the 6 major controllable risk factors for cardiovascular disease. Researchers consider having T2D is a risk equivalent to having a prior heart attack. In addition, approximately 40% of patients with diabetes have chronic kidney disease and almost 60%-70% of patients with diabetes have mild to severe forms of nervous system damage. Moreover, diabetes is associated with significant health care costs. Around 11% of total health care expenditures worldwide are spent on diabetes.

EPIDEMIOLOGY OF DIABETES IN EGYPT

The International Diabetes Federation (IDF) listed Egypt among the world top 10 countries in the number of patients with diabetes. It is expected that the number of patients with diabetes in the Middle East and North Africa (MENA) region to grow by 96% from year 2013 to 2035 or from 34.6 million to 67.9 million. In Egypt, the prevalence of diabetes is around 15.56% among adults between 20 and 79 years of age, with an annual death of 86,478 related to diabetes. In 2013, the IDF estimated that 7.5 million individuals have diabetes and around 2.2 million have prediabetes in Egypt. Furthermore, reports indicate that 43% of patients with diabetes and most patients with prediabetes in Egypt are likely undiagnosed. It is alarming that diabetes prevalence in Egypt has increased rapidly within a relatively short period from approximately 4.4 million in 2007 to 7.5

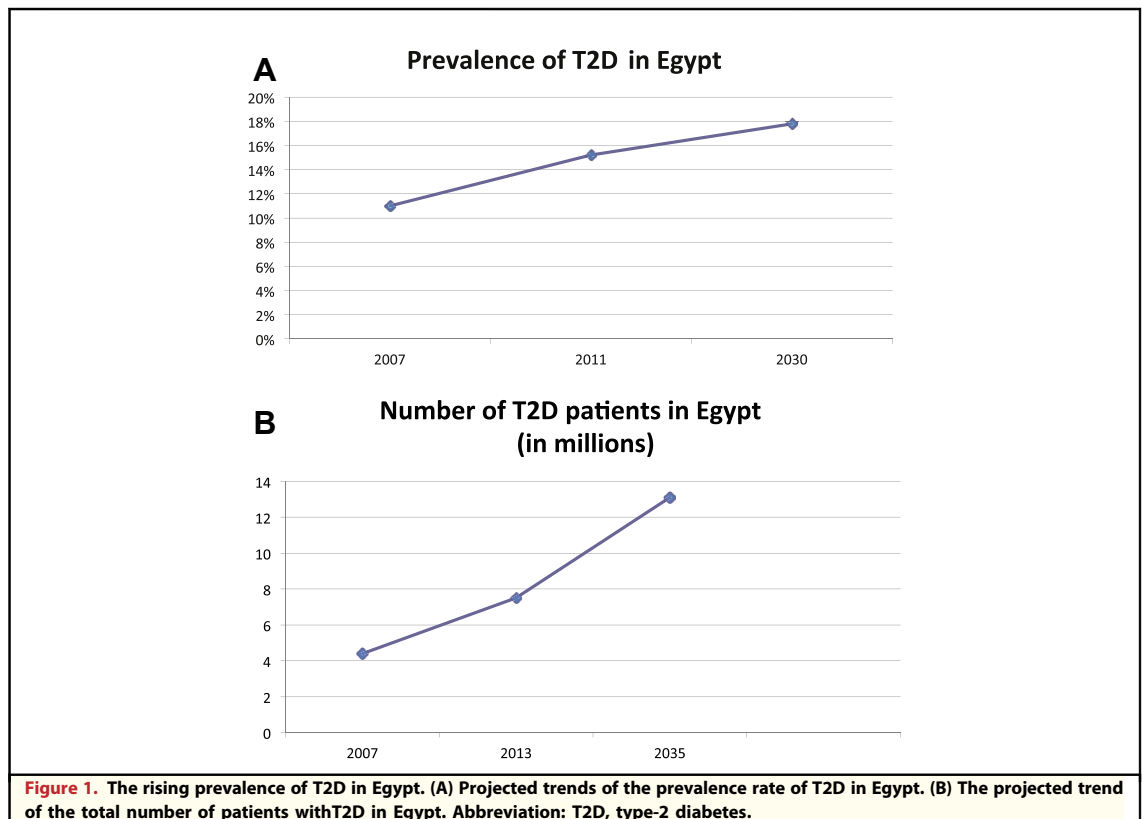
million in 2013. It is expected this number will jump up to 13.1 million by 2035 (Fig. 1).¹⁻⁴

In addition to being a major public health problem, it is estimated that Middle East region spent around \$13.6 billion on diabetes in 2013 (14% of its total health care expenditure), which accounts to only 2.5% of the global spending on the disease. Annual cost analysts estimated that the economic impact of T2D in Egypt was \$1.29 billion in 2010. This number excluded cost associated with prediabetes and cost related to loss of productivity. This figure, adjusted for inflation, will be doubled by year 2030. With a fast-growing population, the health authority in Egypt should address this problem and act swiftly without further delay to avoid major spending on health care in the coming years.

The Egyptian ministry of health (MOH) is currently the major provider of primary, preventive, and curative care in Egypt, with around 5000 health facilities and more than 80,000 hospital beds spread nationwide. There are no formal referral systems in the MOH delivery system, and most patients with diabetes are either treated in the private health care sector through out-of-pocket fee for service, in the limited number of academic hospitals, or in the scarce dedicated diabetes centers in Cairo and some other major cities. According to the IDF, the current spending on diabetes in Egypt is among the lowest in the MENA at \$116 per patient per year. This is far lower than the spending in developed countries, which usually ranges from \$2000 to \$7000 per patient per year and even lower than the general spending in the MENA region, which ranges from \$160 to \$3000 per patient per year. Currently, diabetes is a leading cause of vision loss in Egypt. It is estimated that 42% of patients with diabetes in Egypt have diabetic retinopathy, 5% are legally blind, and 22% had peripheral neuropathy. Diabetes is also the major cause of end-stage renal disease and leg amputation in Egypt.

RISK FACTORS FOR TYPE 2 DIABETES IN EGYPT

Obesity and Physical Inactivity. Obesity, especially visceral adiposity, and physical inactivity are major risk factors for diabetes in Egypt. The Egypt Demographic Survey (2008), which assessed the nutritional status of the population aged 15 to 59 years old, found that approximately 50% of Egyptian men and 65%-80% of Egyptian women are overweight or obese.⁵ A 2010 World Health Organization (WHO) report indicated that 30.3%



of Egyptian adults are obese. Egypt currently has the third highest prevalence of obesity in the MENA region, after Saudi Arabia and United Arab Emirates. Similar to the Hispanic and Native American populations, central adiposity is particularly common among Egyptians and is probably inherited. The Egyptian National Hypertension Survey Program, which was conducted in 6 Egyptian governorates and included 2313 adults older than 25 years of age, found that 50% of the surveyed individuals have central obesity. This was found to be strongly associated with an increased risk of diabetes and cardiovascular disease.^{6,7} Obesity is mostly related to an unhealthy eating pattern that emerged over the last few decades.

Physical inactivity is another major risk factor for the development of T2D in Egypt. Absence of weekly physical activity was reported among 81% of the 4918 households surveyed in Cairo in 1995.⁸ A recent survey in 2015, which included patients suffering from one or more chronic diseases like diabetes mellitus, hypertension, and dyslipidemia, found that the majority do not do any physical activity or walk regularly. The major reasons for decreased physical activity, particularly among

Egyptian women, include the general lack of exercise facilities, overcrowded urban cities, and poor physical education in schools.⁹

Chronic Hepatitis C Infection. Egypt has the highest prevalence of chronic hepatitis C (HCV) infection in the world. This statistic is attributed to the mass intravenous treatment campaign of bilharziasis between 1960 and 1980 with the use of poorly sterilized needles. The Egypt Demographic and Health Survey found that around 15% of Egyptians are serologically positive for HCV antibodies and 10% have active infection.¹⁰

The prevalence of T2D among patients with HCV is 13%–33%. A meta-analysis of the association of HCV and T2D found that patients with HCV are more prone to develop T2D. The odds ratio was particularly high among male patients (OR: 1.26, 95% CI: 1.03–1.54) and those older than 40 years of age (OR: 7.39, 95% CI: 5.82–9.38).¹¹

Not only does HCV increase T2D risk but it also worsens its control and is associated with increased prevalence of diabetes complications. A study of 438 patients with T2D (113 Egyptians and 325 Kuwaitis) found that poor glycemic control was mostly

seen in patients positive for HCV.¹² In another cross-sectional study of 489 patients with T2D who attended an outpatient clinic and dialysis unit in Egypt, the prevalence of HCV infection was 12.9% among patients attending that outpatient clinic and 18.7% among patients on dialysis.¹³

Early treatment of HCV can help prevent T2D. It was found that effective elimination of HCV in patients with prediabetes improved their glycemic tolerance and significantly reduced hemoglobin A1c (A1C) levels. Prospectively, 34.8% of those patients became normoglycemic and only 5.5% developed diabetes. The sustained response to antiviral therapy was the only independent predictor of improved glycemic control.¹⁴

Pesticide Exposure. Another potential risk factor for T2D in Egypt is the exposure to agricultural pesticides. Egypt is the fifth highest country in pesticide consumption in Africa. Exposure to pesticides occurs either directly among farmers and applicators or indirectly among most Egyptians as a result of chronic exposure to low levels of pesticides in contaminated food.^{15–19}

The most commonly used pesticides in Egypt are dichlorodiphenyltrichloroethane (DDT), which is an organochlorine compound, and chlorpyrifos and malathion, which are organophosphorus compounds.^{19,20} Growing evidence suggests a strong association between exposure to these pesticides and the increased risk for insulin resistance and T2D. Raafat et al. found a positive association between chronic exposure to malathion and insulin resistance/obesity.²¹ Another study found U-shaped dose-response associations between features of metabolic syndrome, such as high body mass index, dyslipidemia (increased serum triglycerides and low-density lipoprotein [LDL] cholesterol and/or decreased high-density lipoprotein [HDL] cholesterol), and insulin resistance, and exposures to various pesticides.²² A cross-sectional study that included 116 pesticide applicator and 92 control participants found a significant correlation between the degree of cumulative exposure to pyrethroids and development of prediabetes.²³

The adverse effects of pesticides on glycemic control had been illustrated by a plethora of preclinical research. For instance, subchronic exposure of the pregnant Long-Evans rats to chlorpyrifos by gavage from 7th day of gestational to the end of lactation (21st day postnatal) revealed excess weight gain of male offspring after the 45th day postnatal and leptin dysregulation.²⁴ Subtoxic neonatal exposure of Sprague-Dawley rats to chlorpyrifos

reproduced adulthood postprandial hyperinsulinemia through increasing responsiveness of the liver to gluconeogenic inputs from β -adrenoceptors or glucagon receptors by upregulation of adenylyl cyclase.²⁵ Male Sprague-Dawley rats were exposed to chlorpyrifos every other days for 8 consecutive weeks revealed increase in glucose-6 phosphatase and glycogen phosphorylase activities and decrease in hexokinase, succinate dehydrogenase, and lactate dehydrogenase levels. Additionally, decreases in glycogen content and in vitro uptake of ¹⁴C-d-glucose by liver were manifested.²⁶ Consistently, exposure of Wistar rats to malathion for 4 weeks revealed elevation of blood glucose and insulin levels and patchy degeneration (cytoplasmic vesicle, fibrosis and amyloidosis) of the islets of Langerhans.²⁷ Subchronic exposure of Wistar rats to malathion for 32 consecutive days resulted in increasing fasting blood glucose levels through stimulation of enzymes of gluconeogenesis and elevation in oxidative stress marker and inflammatory mediators like tumor necrosis factor α level.²⁸

Collectively, it is hypothesized that the rapid increase in prevalence of T2D in Egypt over the last few years might be partly attributed to the increased use of pesticides, notably DDT, malathion, and chlorpyrifos.

CULTURAL FACTORS AFFECTING TYPE 2 DIABETES IN EGYPT

Dietary Pattern. Egypt is a Mediterranean country and shares, to a great extent, most of the eating habits of the Mediterranean region. The Egyptian diet is traditionally rich in vegetables, legumes, fruits, and fish, with low to moderate amounts of animal protein. However, the Egyptian diet is also rich in foods of high glycemic load and high glycemic index, particularly white bread and polished rice. Several recent meta-analyses of observational and prospective cohort studies found a strong association between high glycemic load, high glycemic index, and high consumption of rice with an increased risk of T2D. Another poor dietary habit in Egypt is the high consumption of trans fat; Egypt and Pakistan are the world's highest consumers of this very unhealthy type of fat. In addition, Egyptians frequently use partially hydrogenated margarine for their daily cooking and for preparing common fried food. Higher consumption of trans fat has been found to increase risk of cardiovascular disease.

Over the last 3 decades, Egypt suffered a major shift in its traditional eating habits—referred to as “nutrition transition”—as a result of other demographic and economic transitions. Egyptians used to eat a relatively light breakfast and dinner with limited varieties of whole food, with a more substantial lunch, mainly containing rice, green salad, cooked vegetables, and a moderate amount of beef and veal, fish, or chicken, followed by a piece of seasonal fruit. Currently, a tendency toward higher consumption of fast food is seen in large cities. Availability of different varieties of processed food and particularly processed meat and dairy products led to their higher consumption, especially in urban cities and among Egyptians from the higher socioeconomic class. On the other hand, increased poverty in some areas of Egypt, especially in villages, led to a dramatic shift toward high consumption of carbohydrates and fatty diets with lower consumption of fish, beef and veal, and chicken. Although lunch remained the biggest meal followed by a lighter and relatively late dinner, many Egyptians are gradually shifting toward larger and later dinners or toward combining lunch and dinner in a bigger meal. This is caused by a gradual change in working hours from 2 working shifts per day to 1 longer working period. Together with social eating and family gatherings around food, these trends nudged Egyptians toward consumption of bigger portions, no doubt contributing to the increased prevalence of obesity.

Sedentary Lifestyle. The increased number of cars, the vast expansion of cities, and the hot weather contribute to decreased physical daily activities. Culturally, Egyptians have tendency toward avoiding exercise in public areas, although few are able to afford membership in athletic facilities. There are several strong social factors that prevent women from exercising in public areas. Egypt’s major sport is soccer, which is only played by men. Egyptians are rarely interested in other sports, but swimming and biking are becoming more popular in many urban cities over the last decade. Exercise facilities are limited and expensive and community sport facilities are scarce. Even in schools, reduced time for physical activities and common absence of yards for exercise or sport promote a sedentary lifestyle for Egyptian youth. Reduced exposure to sunlight with traditional clothing among female Egyptians may be one contributor to vitamin D deficiency, which has been linked to increased rates of obesity and T2D among female subjects.²⁹

Smoking. Smoking is very common in MENA regions and particularly in Tunisia, Libya, Jordan, Syria, and Lebanon. Around 39.7% of adult males in Egypt are smokers. Smoking is still rare among Egyptian women compared to other Middle Eastern and Mediterranean countries. As outlined earlier, smoking is directly linked to increased incidence of microvascular and macrovascular diseases in patients with diabetes. Despite high taxes on cigarettes and increasing public health education, smoking remains a common habit among Egyptian men.

Health Illiteracy. Health illiteracy is common in the MENA region, and Egypt is not an exception. Egyptians often consider obesity as a cosmetic problem and rarely view it as a disease. Patients with diabetes are rarely scheduled for routine eye or foot examinations. Except for a few initiatives, there is no routine annual checkup policy or screening program for chronic noncommunicable diseases in Egypt. Patients with diabetes rarely change their eating or exercise habits after a diabetes diagnosis. Routine daily glucose monitoring is essentially nonexistent or simply limited by high cost or fear of frequent finger sticks. Except in few centers, there is no routine follow-up or A1C testing for patients with diabetes. Patients with diabetes visit governmental health care centers to get their medications for free or for a small fee, but not for regular evaluation. Most patients with T2D think that diabetes should only be treated by oral medications, and they often resist insulin injections when indicated. These factors result in poor glycemic control, late diagnosis, and increased prevalence of diabetes complications. Unfortunately, most patients consider their disease and its complications as an inevitable fate and believe that they don’t have any role or power in altering or preventing it.

Poor Adherence. Poor adherence with diabetes management is common in Egypt. Daily testing of blood glucose is very rare. Frequent omission of insulin injections is common. Poor adherence with healthy eating and physical activity plans is common even among educated patients. Because most diabetes care is conducted in the private sector, which is relatively expensive for most Egyptians, routine checkups for A1C or renal function, for example, are uncommon. Diagnosis and management of microvascular complications, especially diabetic retinopathy and diabetic nephropathy, are often too late for effective prevention. The fear of hypoglycemia among patients treated with insulin leads to suboptimal control and frequent reduction in insulin

dosing, either intentionally or upon recommendation of treating physicians. The majority of 560 Egyptian patients with T2D who were surveyed believed that T2D is an infectious disease originally caused by stress. Moreover, only 38.4% of them had a positive attitude toward self-management. Interestingly, these study patients alleged that the efficacy of herbal medicine was sufficiently high and neglected the positive role of regular exercise. Most of the study patients thought that patients suffering from polyuria should reduce their volume of drinking water.³⁰

Health Care Quality. Koura et al. reported a major problem in delivering health education to T2D patients in 4 health care centers (2 rural and 2 urban) in Alexandria, Egypt, the second largest Egyptian city.³⁰ Although diabetes knowledge was satisfactory among the 88 Egyptian doctors surveyed in this study, 95.5% of those from rural areas and 89.8% of those from urban health centers neglected the fundamental role of patients' education and regular exercise in managing T2D.³⁰

STRATEGIES TO IMPROVE DIABETES CARE IN EGYPT

To improve diabetes care in Egypt the following points should be considered:

1. Government, through its public insurance plan, should implement an efficient screening program among high-risk individuals, especially adults who are overweight and obese with positive family history of diabetes.
2. The concept of a diabetes management team should be introduced that includes a certified diabetes educator (CDE) and registered dietitian (RD). Egyptian authorities should develop or encourage training programs that aim at preparing enough CDEs and RDs to populate sufficient teams across the country.
3. Health authorities should create a periodic follow-up program in its health care centers. Private physicians and patients alike should be encouraged to be involved in this process.
4. Education programs should incorporate self-management plans and dispel fears of finger sticks and insulin injections.
5. General diabetes and nutrition education should be conducted at schools, health care and community centers, and through public and private media. The aim is to improve dietary habits and particularly to reduce consumption of processed and fine

carbohydrates and trans fat in traditional Egyptian meals (e.g., rice, bread, and desserts).

6. The concept of early diagnosis and management of diabetes complications should be introduced, especially for diabetic retinopathy and nephropathy.
7. Encouraging a comprehensive and realistic lifestyle medicine program with simple methods to facilitate implementation on a large scale.
8. Most Egyptian use cellular phones, so using apps, reminders, and education material can be effective if this technology is properly used within a comprehensive diabetes management plan.
9. The risk of hepatitis C infection should be reduced to minimize health and economic burdens of diabetes. Early management and a focus toward elimination of HCV in infected patients can also reduce T2D risk.
10. Implementing an effective pesticide regulatory program, with regular surveying of pesticide residues in drinking water and food, should be mandated. Health education is warranted to reduce uncontrolled exposure to pesticides by minimizing the misuse and improper handling of pesticides and provide protective personal equipment. Further education should be provided regarding fumigation and medical consultation for poisoning. Special attention should be paid to avoiding the involvement of women and children in pesticides application.
11. Guidelines should be published for diabetes management that are culturally suitable for Egyptian patients. Such guidelines should put in consideration the unique risk factors highlighted in this chapter. Egyptian guidelines can help standardize clinical practice to improve patient care. There is a great opportunity for local diabetes associations and scientific bodies to champion the development of these guidelines and audit their implementation.

CONCLUSIONS

Diabetes is a growing public health problem in Egypt. Its high prevalence continues to increase as a result of increased prevalence of central obesity, sedentary lifestyle, change in eating habits, increased prevalence of hepatitis C, and possibly the increased use of uncontrolled pesticides. Smoking among men, health illiteracy, and poor adherence to treatment increased the frequency of diabetes complications. Egyptian authorities, through a limited health care budget, are striving to improve diabetes care, but many strategies and guidelines for standard of care are still needed to augment this effort.

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