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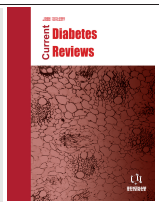

Diabetes Mellitus in Saudi Arabia: A Review of the Recent Literature

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Abstract: The World Health Organization (WHO) has reported that Saudi Arabia ranks the second highest in the Middle East, and is seventh in the world for the rate of diabetes. It is estimated that around 7 million of the population are diabetic and almost around 3 million have pre-diabetes. Even more worrying perhaps, is the increasing pattern of diabetes noted in Saudi Arabia in the recent past. In fact, diabetes has approximately registered a ten-fold increase in the past three eras in Saudi Arabia. Diabetes mellitus (DM) has been found to be related to high mortality, morbidity and vascular complications, accompanied by poor general health and lower quality of life. In Saudi Arabia, DM is quickly reaching disturbing proportions and becoming a significant cause of medical complications and even death. However, when compared with the developed countries, the research work conducted, focusing particularly on the incidence, prevalence and socio-demographic properties of DM is woefully inadequate. The health burden due to DM in Saudi Arabia is predicted to rise to catastrophic levels, unless a wide-ranging epidemic control program is incorporated, with great emphasis laid on advocating a healthy diet, including exercise and active lifestyles, and weight control. To properly manage the DM in Saudi Arabia, a multidisciplinary approach is required. In this review we discuss all the aspects of DM in Saudi Arabia drawing from the published literature currently available.

Keywords: Diabetes mellitus, diabetes complication, hyperglycemia, high blood sugar, obesity, saudi arabia.

INTRODUCTION

Diabetes mellitus (DM) is rapidly becoming one of the main health issues among humans in the 21st century and the number of patients is steadily increasing, globally, both in the developed and developing countries. It is a non-infectious chronic disease caused by the inability of the pancreas to effectively produce enough insulin or when the body in unable to properly use the insulin produced by it [1-2]. This chronic, complex disease is largely preventable and manageable, although it is almost impossible to cure [3-4]. Hyperglycemia or high blood sugar is the common result of uncontrolled diabetes. Over a period of time it can severely damage several systems in the body, including the nerves and blood vessels [5-6]. This most commonly observed non-communicable, chronic disorder has a multifactorial etiology involving both genetic and environmental factors in the course of its development [6]. Due to its chronic nature, the severity of the complications and the control methodologies required, diabetes is an expensive disease, affecting both the sufferer as well as his/her family and the health authorities as well [7-9].

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The causes for this widespread epidemic of DM globally, are the population explosion, aging, luxurious and sedentary patterns of living and unhealthy food choices which bring in their wake the deadly problems of obesity and physical inactivity [10-11]. The International Diabetes Federation (IDF) has estimated the total number of persons with DM across the world will rise from 171 million in 2000 to 366 million by 2030 [12]. Unfortunately, the prevalence of DM worldwide has already reached 366 million by 2011. Most recently the IDF has indicated that 8.3% of the adult 382 million population is diabetic [in 2013], and the numbers are expected to cross 592 million in less than 25 years [13]. The other major fear is that there are still about 175 million undiagnosed cases, a mind-boggling number, and who are blissfully unaware that they are progressing towards diabetes-related complications [14]. It is noteworthy that a huge percentage of the 382 million reported diabetics today are in the 40-59 age group, among whom 80% live in countries with low and middle-income economies [14-15]. The recent data from IDF strongly warn us regarding the future impact of diabetes as a major threat to global development [16]. Type 2 diabetes mellitus (T2DM) predominates, while type 1 diabetes mellitus (T1DM) continues to remain a significant public issue. As 70,000 young people are freshly identified every year, the occurrence of T1DM is also on the rise in both the developing and developed nations [16-17].

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DM imposes a burden which is evident by its rapid growth in numbers, as well as in the increasing incidence of premature deaths because of the disease [14]. In 2013, about half of all diabetes-related deaths in adults were in the age group below 60 years. In fact, every six seconds there is a diabetes-related death and in the more poorly-developed regions, that number can rise to 75% [14]. Earlier, the number of fatalities attributed to diabetes was a little more than 800,000. However, it is a well-known fact that the numbers are highly underestimated [18]. A figure closer to reality is likely to be around 4.6 million deaths annually, in the 20-79 age brackets. This accounts for 8.2% of the all-cause mortality for individuals in this age group across the world, with an estimated rate of one death per seven seconds [19]. Also, the number of deaths has risen by 13.3% from the 2010 estimates [20].

Due to the difference in environmental and lifestyle risk factors the incidence of DM varies substantially in each geographical location [21]. Therefore, it is important to note that 35 out of 219 countries [16% of the total] show very high prevalence of diabetes, more than 12% [14, 22]. These countries fall mainly in the regions of the Western Pacific, North Africa and Middle East [14, 22]. The Kingdom of Saudi Arabia (KSA), the largest country in the Middle East, extends over an area of 2,150,000 km2 with a population of more than 29 million [23-24]. DM is now being recognized as a common but rapidly rising problem and a significant cause for illnesses and death in Saudi Arabia [25-26]. Therefore, it has become one of the biggest social and economic medical issues here [27-29]. However, compared with the developing countries, the great dearth of research currently available on the occurrence and prevalence as well as the socio-demographic features of T2DM are certainly matters of concern, in particular the absence of relevant studies with this specific focus. In this review, we discuss the range of aspects related to T2DM in Saudi Arabia from the literature published.

METHODS

With the help of a senior researcher a literature search was done in the archives of the National Library of Medicine/PubMed as well as the Ovid Medline databases. General search engines were also employed and non-peer reviewed professional and specialist guidelines and workshops on diabetes mellitus websites only in English and Arabic were accessed. We selected the articles were by reviewing their titles and abstracts along with the additional references from the lists mentioned in selected articles.

1. SITUATION IN ARAB COUNTRIES

Based on the latest reports from the IDF, there is an increasing trend of incidence and prevalence of DM in the Arab region, which seems to be higher than the global average of increase in DM. The number of deaths attributed to diabetes in Saudi Arabia is about 170,000 adults, which is greater than 10% of all deaths in the country [30]. However, more than mortality, it is the temporary and permanent disabilities resulting from the diabetes-linked complications like blindness, amputations, kidney failure, psychological distress and cardio vascular diseases, that is worrisome [31-33]. Thus far, the Arab governments have not given the high prevalence of non-communicable diseases such as DM, as an adequately high priority, especially with respect to addressing the policy differences between countries and an overall poor implementation [34]. Thus, diabetes imposes a heavy economic burden both due to the treatment cost and productivity loss [35-36]. The IDF estimates the Arab region to incur an expense of USD 8.7 billion for diabetes treatment in 2011. It also reported that six of the top ten countries having the highest prevalence rates of diabetes globally are found in the Gulf region, viz., Kuwait, Lebanon, Qatar, Bahrain, UAE and Saudi Arabia [14, 19, 29]. From the data available, there are 20 Arab countries in which nearly 20.5 million people are living with diabetes and another 13.7 million are in the pre-diabetes stage, with Impaired Glucose Tolerance (IGT) [30, 37]. Data from Jordan, Libya, Morocco and Oman, reveal that diabetes has increased from approximately 3% prior to 1980 to an existing prevalence of 5% to 16%, [affecting more than 10% of the adult population] [38-39]. In Jordan, End-Stage Renal Disease (ESRD) was reportedly chiefly due to diabetes [29.2%], while in the United Arab Emirates the rate was 23.3%. Therefore, collectively, because 30% of diabetics develop kidney disease, it is likely that diabetic kidney disease is another major health problem in the Arab world [38-40].

2. SITUATION IN SAUDI ARABIA

The Kingdom of Saudi Arabia began to notice an insidious increase in the prevalence and incidence of DM soon after the rapid industrialization which resulted in a remarkable rise in the standard of living and adopting a more 'Westernized' lifestyle. The unhealthy dietary patterns and drop in the level of physical activity across the country saw the alarming rise in the level of diabetes to over 25% of the adult population. The rate is anticipated to more than double by 2030 [26, 41-43].

According to the World Health Organization (WHO), Saudi Arabia ranks second in the prevalence of diabetes in the Middle East region and seventh in the world [44]. More disturbing perhaps, is the rising tendency for diabetes in the recent years with a nearly ten-fold increase over the past thirty years in Saudi Arabia [45]. In fact Saudi Arabia reached a point where DM is considered an epidemic [45]. Moreover, studies conducted since the late 1980s have revealed a growing trend among adult Saudis, in which one of five adults had DM [46-49]. Further, a more recent study reported that the prevalence of diabetes had risen to 34.1% in males and 27.6% in females. It reported that the mean age for diabetes onset in males and females was 57.5 and 53.4 years, respectively [50]. Another study reported that the overall prevalence of DM in Saudi Arabia, and especially in the central region (Riyadh), was 23.7% (age group 30-70 years), while another 14.1% had impaired fasting glucose [51]. They further reported that the incidence of diabetes was significantly higher in the urban regions (25.5% as against 19.5% in the rural areas) [51]. A more recent study in Saudi Arabia reported that more than 50% of the population, 30 years or older, were either diabetic (25.4%) or pre-diabetic (25.5%), with a staggering 40.3% of diabetic patients being totally oblivious of their having the disease [52]. If current trends continue, it is not surprising given the higher preva-

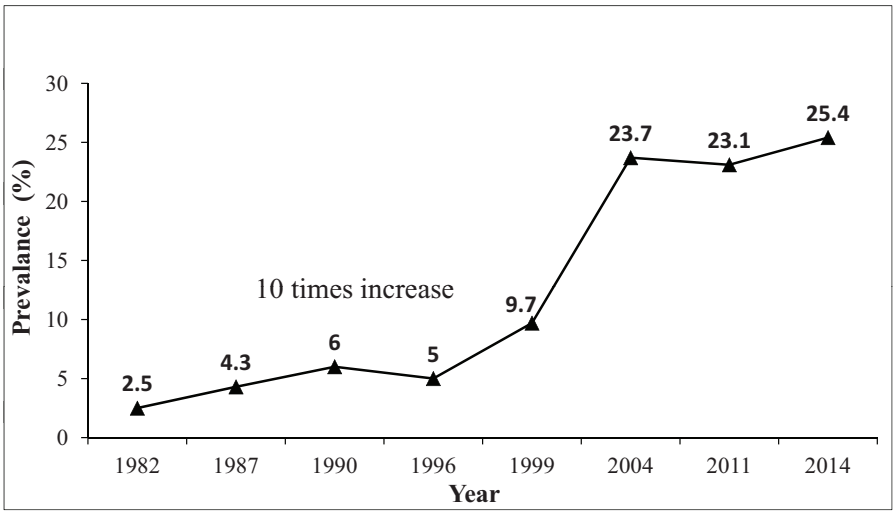

Fig. (1). Prevalence of diabetes mellitus among Saudi population [46, 47, 50-52,56].

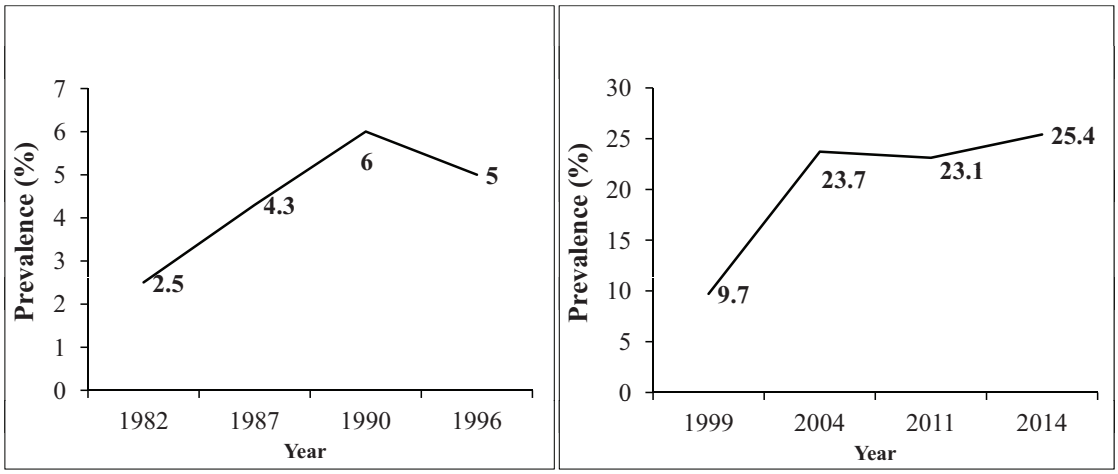

Fig. (2). (**a**) Prevalence during 1982-1996. (**b**) Prevalence during 1999-2014.

lence rate, which is more than 50% adults by 2030 (Figs. **1** and **2**). When T1DM alone was considered however, only a few studies regarding the epidemiology in Saudi Arabia were found. The research papers available reported that the incidence of T1DM was on the increase over the last 30 years and the prevalence of T1DM among the Saudi children and adolescents was 109.5 per 100,000, a figure much higher than that of many developed countries [41, 53]. On comparing the major cities in Middle East countries, Medina reported the highest incidence of T1DM. Further, the mean incidence of T1DM per 100 000 individuals per annum has reportedly almost doubled in Eastern Saudi Arabia from 18.05 in 1990–98 to 36.99 in 1999–2007 [41, 53]. These facts make it clear that the burden of diabetes in Saudi Arabia is likely to soar to catastrophic levels, unless a long-term comprehensive epidemic control program is strongly implemented, including promotion of a healthy diet, active lifestyle and exercise and obesity control [54-57].

3. DIABETES HEALTHCARE EXPENDITURE

As the diabetic population grows globally the treatment cost of the disease are increasing in an ever-upward spiraling percentage of the national health care budgets [58-59]. In the absence of primary prevention, the diabetes epidemic will only continue to increase unchecked [58-59]. Even more worrying is that diabetes has been projected to become one of the world's chief causes of disablement and even death in the next twenty-five years. Urgent remedial action is required to stem the spread of diabetes by introducing cost-effective treatment schemes to reverse the trend. Also, the treatment of diabetes incurs high healthcare costs, causes loss of labor productivity and decreases the rate of economic growth. Globally, the healthcare investment for the treatment and control of diabetes amounted to USD 465 billion in 2011, an equivalent of 11% of the total health expenditure. If investments in effective treatments for the prevention of diabetes and its associated complications are neglected, this figure is projected to rise to USD 595 billion by 2030. The World Economic Forum has consistently emphasized that non-communicable diseases (NCDs) including diabetes pose a risk to business and communities across the globe [60].

In Saudi Arabia, healthcare expenditure relegated for diabetes alone reveals the extra expense the nation is incurring to treat this one disease [61]. The MOH healthcare expenditure was over $9.4 billion dollars in 2010, of which approximately $0.9 billion was spent to treat diabetes, a re-

flection of $1 per every $11 of the MOH healthcare funds. Healthcare expenditures incurred by people with diabetes rose to more than 500% in the last 18 years. In 2010 on average, people diagnosed with diabetes spent ten times more towards medical healthcare expenditure [$3,686 vs. $380] than they would have in the absence of diabetes [59].

RISK FACTORS

4. MODIFIABLE RISK FACTORS

4.1. Lifestyle Patterns and Urbanization

During the last four decades Saudi Arabia has made rapid economic and commercial strides resulting in a significant elevation of the standard of living and the adoption of 'Westernized' lifestyle patterns. The unhealthy dietary choices and lowered physical activity have precipitated this crisis [56, 62]. Similarly, this upward trend of DM is also attributed to the genetic predisposition of the Saudi people to diabetes, and their high degree of consanguineous marriages, besides their sudden sedentary lifestyle changes [63-64].

One study revealed that both urbanization and monthly income influenced diabetes as the prevalence of DM was significantly higher in the urban areas even among the low or middle income groups. This was explained by the fact that high income could negate the influence of urbanization together with the effect of global urbanization, which has closed the gap between the lifestyles of the rural and urban dwellers [43].

The urban population of Saudi Arabia has 25.5% diabetics compared with the 19.5% of the rural population. Regional differences are also noted, with the Northern [27.9%] and Eastern [26.4%] provinces showing greater rates of the prevalence of DM than the Southern region [18.2%], which supports a more rural lifestyle and a population with less tendency for obesity than those of the Northern and Eastern provinces [51].

4.2. Dietary Pattern

Data is sadly lacking, in Saudi Arabia, on the effect of the environmental risk factors involved in diabetes. Specific dietary choices are indigenous to Saudi Arabia, for instance the regular intake of dates, baked products, desserts, and rice and meat dishes containing high fat and carbohydrate content [56]. A limited population-based study was done to study the relationship between dietary patterns and the risk of DM independent of the influences of gender, age, education, and family history of diabetes [56]. Also, some studies focused on specific dietary patterns that encourage the rise in the incidence of DM in Saudi Arabia. As foods like the kabsa (mixed rice dish), French fries and baked items are very common in Saudi Arabia, the study reported that they were the most significant determinants of DM in the Saudi population [56, 65].

4.3. Physical Activity

It is getting more sharply evident that the epidemic of DM rising across the world is related to decreasing activity levels. Irrespective of age, dynamic regular exercise is a recommended must in diabetes management where exercise increases the benefits of physiological as well as psychosocial health [66-67]. Earlier studies on the physical activity profile of Saudi adults indicate that in general the majority of the Saudi population is not physically active enough to reap the health benefits from physical exercise [62, 68-69]. Thus, the importance of promoting physical activity as a crucial component of prevention and management of DM, and T2DM in particular must be given high priority [70]. It was found that an alarming 81% of Saudi adult males in the city of Riyadh are inactive; an astonishing 99.5% of adult females from the Asir province also reported no exercise at all of any intensity [62]. This high incidence of inactivity in Saudi Arabia presents a major public health burden, as revealed by the high PAR of physical inactivity, compared with those of the USA, UK and other advanced countries. Further, due to the high prevalence of other risk factors among the Saudis, like CHD, the rate diabetes in the society will only continue to escalate to epidemic proportions in the near future [62].

4.4. Obesity

Compared with those having ideal weight, obese people run seven times higher risk of developing diabetes, and overweight people have a three times higher risk of diabetes [71-72]. As the lifestyle has shifted to more sedentary types accompanied by high fat diets resulting in obesity much of the increased prevalence of DM has become evident [71-74]. Both these characteristics are seen as normal in Saudi Arabia as they are highly prevalent, although both are easily preventable and reversible [74]. Data focusing on the relationship between lifestyle choices and diabetes prevalence in Saudi Arabia are still insufficient [19, 58, 75-76]. However, a few studies on the economic development and westernization in Saudi Arabia over the past four decades has popularized extremely wide dietary changes. From a high intake of dates, fresh vegetables and fruit milk, whole wheat bread and fish there is a shift to the present frequent consumption of foods rich in high saturated fats and refined carbohydrate foodstuffs accompanied by a low dietary fiber intake [77]. Such dietary changes are related with a sharp rise in the incidence of DM and obesity in Saudi Arabia [19, 58, 75-76, 78].

In a study on obesity in the Eastern Province of Saudi Arabia obesity among females, mainly older than 40 years, has achieved epidemic proportions. This age group included 78.4% over-nourished women while in the younger groups up to 30-40% were overweight or obese [74]. With such alarming statistics, it is not surprising that obesity related diseases such as diabetes are also high [74].

5. NON-MODIFIABLE RISK FACTORS

5.1. Gender Differences

The occurrence of DM was seen to rise sharply with age in both sexes. However, the global numbers projected a slight gender difference in the population with diabetes for 2013 or 2035. In reality 14 million more men than women suffer with diabetes [198 million men vs 184 million women]. However, this difference is expected to go up to 15

million (303 million men vs 288 million women) by 2035 [13-14].

Another study reported that gender played a role in the prevalence of DM, with the incidence of the disease being higher in men than in women. This difference was documented in a screening program of the same kind conducted in the central region of Saudi Arabia during 1990s [79]. Although it has been established that men normally have a shorter life expectancy than women, numerous studies have emphasized that it is the lifestyle risk factors that are the more frequent causes for death among the Saudi males. Some risk factors include their dietary habits, tobacco smoking, obesity and vitamin D deficiency [25, 79-80]. These factors cumulatively, although not entirely, reveal why DM and other chronic non-communicable disease affect the Saudi men more than the women. Furthermore, perhaps, because Saudi Arabia and the Arabian Peninsula as a whole follow a highly patriarchal society, their men may experience higher levels of chronic psychological stress than the women, which in turn could be a contributing factor to metabolic and inflammatory stress over time, resulting in many cell aging mechanisms and ultimately even to chronic non-communicable diseases like DM and CAD [81]. However, other studies have shown that the quality of diabetes control was definitely much less in women than in men at all ages, even from the mid-teens upwards. The author suggested that this could be due to the women often having to cope with both their own diabetes and the family needs. Male diabetics were reported to live more efficiently with diabetes, having a lower degree of depression and anxiety but with more energy and a better positive outlook. They also expressed greater satisfaction with their disease management methods and experienced less social anxiety. Gender differences become very significant when one has to learn to cope effectively with diabetes. Female diabetics must develop a greater positive attitude towards both the disease and its management [82-83]. Another study stated that there was a significant gender-specific difference in the understanding of the relationship between adherence and poor glycemic control. Among the men, 37% of the participants showed poor glycemic control due to non-adherence and 19% in those who reported adherence. On the other hand, in the women, poor glycemic control was observed in 19% of the participants reporting non-adherence and in 18% reporting adherence [84].

5.2. Age Differences

The prevalence of DM in adults in whom it is becoming prominent, has been projected to increase over the next twenty years with most of the increase happening in the developing countries, where most of the patients lie in the 45-64 age group [12-13].

In a study performed in Saudi Arabia age was indicated to be the single most significant risk factor for DM and age ≥ 60 years formed an independent risk factor for diabetes-related complications [85]. Another study revealed that compared with the younger age groups [30-44 years, 14.7%; and 45-65 years: 37.5%] individuals in the age group ≥65 years [44.7%] showed a higher degree of diabetes risk. The prevalence of diabetes increased by about 10% as age advanced by 10 years and peaked at 65 years [52]. The study also reported that the age group of ≥ 45 years was the strongest non-modifiable risk factor for diabetes in the Saudi Arabian cohort. This was found to be higher than the results reported for other ethnic groups [52]. It is noteworthy that almost one half of all the adults with diabetes lies in the age bracket of 40-59 years in Saudi Arabia. The proportion of the adult age group [15-64] has been steadily rising since 1980, where it went from 52.6% to 66.3% in 2010. It is now projected to achieve a peak of 74.2% in 2035 [86].

5.3. Genetic Factors

A strong inheritable genetic connection and DM has been observed; this implies that if some family member has DM, the other members are at an increased risk of DM. It is well known that specifically the first-degree relatives of diabetic patients are the ones at a higher risk of developing DM. Recent genetic researches have even identified the genetic variants connected with DM [7, 9]. Family history of diabetes is also used as a reliable predictor of DM when population-based screening programs are done. Almost 100% concordance is seen among monozygotic twins, with about 25% for those with the disease having a family history of DM [7, 9].

Besides the genetic predisposition of the Saudi people to diabetes, there is a high incidence of consanguineous marriages [64]. One study revealed that there was an overall prevalence of consanguinity of 56% with a first-degree cousin (33.6%) being the commonest (22.4%). Compared with the urban population (54.7%), the overall popularity of consanguineous marriages was definitely more common among the rural folks (59.5%) [87]. Another study reported a 57.7% rate of consanguinity with first cousin marriage being 28.4% followed by marriage to a distant relative at 14.6% [88].

6. DIABETES COMPLICATION

People living with DM have greater vulnerability to different types of complications, both short- and long-term, which often culminate in their early death. This tendency for higher morbidity and mortality rates is seen in patients with DM because of the prevalence of this type of DM, its subtle onset and late identification [89-90]. Also, several studies showed that DM is a major risk factor of heart disease and stroke and ranks among the top ten global causes of disability. Undiagnosed or poorly controlled diabetes can result in lower limb amputation, blindness and even kidney disease. DM can also aggravate major infectious diseases such as TB, HIV/AIDS and malaria [60].

According to the World Health Organization estimates, NCDs including DM will soon emerge as the major reason for morbidity and mortality in Saudi Arabia. The incidence of micro and macrovascular complications in DM patients is yet to be well documented in Saudi Arabia. Undoubtedly, such data are vital, because the vascular complications account for approximately 50% of all fatalities among DM patients in the developed countries [91].

In a recent study from the Al Ahsa district of Saudi Arabia a high degree of chronic complications was recorded among the diabetic patients [92]. The high percentage of

obesity, hypertension and dyslipidemia are among the significant comorbidity factors. Overall, 72.72% of the study participants actually had one or more complications from diabetic mellitus. Among them 33.3% had only a single complication, 25.2% had two complications and 15% suffered from more than two complications. The study also revealed that the overall prevalence of complication was significantly higher among the females than males [92]. Very recently, a Saudi National Diabetes Registry-based study showed that diabetic nephropathy in Saudi Arabia had an overall occurrence of 10.8%, distinguishable as 1.2% microalbuminuria, 8.1% macroalbuminuria and 1.5% end stage renal disease. Further, it stated that age and diabetes duration were very important risk factors which exerted a strong impact on the prevalence of diabetic nephropathy, ranging from 3.7% in patients in the 25-44 age group and a duration of >5 years, to 21.8% in patients ≥65 years with a diabetes course of ≥15 years. Diabetes duration, retinopathy, neuropathy, hypertension, age >45 years, hyperlipidemia, male gender, smoking, and chronologically, poor glycemic control all indicate a significantly high risk for diabetic nephropathy [93]. Diabetic nephropathy is largely responsible for the necessity for dialysis in Saudi Arabia, where the number of diabetic patients seeking renal replacement therapy rose sharply from 4% in the early 1980s to 14.8% in the mid-1990s. It rose even higher to 40% in the late 1990s. Most of the deaths [60%] in dialysis patients are of those with DM [19, 94-95]. Nearly 37–41% of diabetic patients in Saudi Arabia develop a stroke [19, 96-97], while 61% of them develop peripheral artery disease [19].

Regarding retinopathy, Saudi patients with DM for at least 10 years [98] show 31% prevalence of retinopathy, while statistics from the Western part of Saudi Arabia reveals that the prevalence of neuropathy in diabetic patients is about 82%. This is one of the highest rates in the world with another 57% being asymptomatic [99]. Another study showed that the overall occurrence of diabetic retinopathy is 19.7%, where 9.1% suffer from non-proliferative diabetic retinopathy, 10.6% have proliferative diabetic retinopathy and 5.7% have macular edema. The study mentioned concluded that the duration of diabetes and age are the most significant risk factors for diabetic retinopathy. Other factors which significantly increase the risk for diabetic retinopathy include nephropathy, neuropathy, insulin usage, poor glycemic control, hypertension and male gender. Smoking, hyperlipidemia and obesity were seen to significantly reduce the risk for diabetic retinopathy among type 2 diabetics in Saudi Arabia [44].

7. HEALTH RELATED QUALITY OF LIFE

Particularly over the past recent years, health related quality of life (HRQOL) has been increasingly seen as an important result of medical treatment and has become a vital issue in diabetes management [17, 100-101]. Quality of life (QOL) is an important factor in diabetes management because a low quality of life reduces self-care, which in turn results in poor glycemic control, increased risks of complications, and an increase in the disease, both from the short-term and the long-term perspective. Diabetes strongly impacts the quality of life defined as a multidimensional concept that includes the physical, emotional and social perception related to QoL [17, 100-101].

The Short Form Health Survey [SF-36] and WHO quality of life instruments were the chief tools used in all of the many studies done in Saudi Arabia [101]. The results of these studies showed that diabetics had lower HRQoL than nondiabetes. Better socioeconomic status and good control of cardiovascular risk factors were associated with higher HRQOL among the patients with diabetes [101].

A recent study in Saudi Arabia recorded lower HRQOL in females than in males, possibly because of a higher incidence of obesity among female. Diabetic patients with no control measures had lower HRQOL than the diabetics with control [102]. Another study in Saudi Arabia reported that patients above 50 years of age had poor HRQOL than those younger than 50 years. Those in the poor economic strata reported diabetic complications and the longer duration of diabetes was significantly associated with poor HRQOL [101]. The participants treated with a combination of therapies [oral medication plus insulin] reported better HRQOL than patients on insulin therapy alone. Further, the study also found that gender, economic status and complications of DM were independent risk factors for HRQOL [101].

8. MEASURABLE STRATEGIES

8.1. Early Screening and Diagnosis

Some studies reported that even when the diagnosis is made about 25% of patients with DM already have microvascular complications. This implies that they have had the disease for more than five years prior to the time of diagnosis [103]. Compared with no screening measures, the screening strategies certainly reduced the incidence of myocardial infarction (3-9 events were prevented per 1000 people screened) and diabetes-related microvascular complications (3-9 events were prevented per 1000 people). The ADA recommendation is that all adults 45 years and above undergo screening by their health care provider for type 2 diabetes once every three years. Other major health organizations, however, differ from the ADA guidelines in some degree. For example, the American Association of Clinical Endocrinologists recommends that high-risk adults be screened annually starting from age 30. Earlier studies in Saudi Arabia revealed the prevalence of diabetes was high in the 30-39 age group (between 12-20% *i.e.* almost 1 million people) (Table **1**). Therefore, it is recommended that every Saudi above 30 years of age should undergo screening for both type 2 diabetes and pre-diabetes in order to reduce the incidence of diabetes.

HbA1c and fructosamine are still useful indicators for determining blood sugar control over time [104-106]. However, other measures are frequently employed by practicing physicians besides those recommended. For many years, the presence of diabetes was diagnosed based on the plasma glucose criteria, either the Fasting Plasma Glucose (FPG) or the 2-h value in the 75-g oral Glucose Tolerance Test (OGTT). In July 2009, the International Expert Committee which included representatives of the ADA, the IDF, and the European Association for the Study of Diabetes (EASD) recommended the use of the A1C test in the diagnosis of

Table 1. Age differences in diabetes prevalence.

Age Groups	Al-Nozha *et al.* 2004	Alqurashi *et al*. 2011	Al Rubeaan *et al.* 2014
	%	%	%
< 20 years	-	2	-
20-29 years	-	4.6	-
30-39 years	**12**	**12.1**	**15.1 (male)** **9.2 (female)**
40-49 years	23	31.9	27.8 (male) 21 (female)
50-59 years	33.8	58.2	44.5 (male) 36.3 (female)
60-70 years	36.5	68.2	49.8 (male) 43.6 (female)

diabetes, with a threshold of ≥6.5%; the ADA adopted this criterion in 2010 [107-108].

A national diabetes plan is in development in Saudi Arabia, but no plans or policies for NCDs. No other Ministries besides Health even discuss the response to the diabetes challenge. Further, a clear framework for monitoring and surveillance of diabetes is lacking. Although the health system does provide services for early diagnosis and treatment, it is not universal. Less than 50% of the costs are covered and no services are provided for diabetes prevention. Specialized services are given to women but only limited self-education management services are available [109].

The Saudi National Diabetes Registry (SNDR) was recently established with the primary goal of developing a database including all the diagnosed national diabetic patients residing in the Kingdom of Saudi Arabia. The objective of the SNDR is to act as an electronic medical file to provide the medical teams correct clinical, investigational, and management data. It is also a surveillance-monitoring tool for clinical and epidemiology practitioners by identifying the significant performance indicators linked to this disease in either acute or chronic cases. The SNDR will also provide data relating to the association of diabetes with hypertension, hyperlipidemia, and obesity [110].

8.2. Awareness

If suitable action is not urgently implemented to prevent DM, then approximately three new persons every ten seconds, which accounts for almost ten million per year, will suffer from DM. Diabetes is largely considered a condition of low significance in the economically poorer nations. But the IDF estimates that as many as 183 million people are absolutely unaware that they have the disease [111]. Even policy makers at international and national levels, express a very low degree of awareness regarding public health and clinical importance of diabetes [112]. It is also noteworthy that in the low- and middle-income countries, the impact of diabetes goes mostly unrecognized. Yet today the world is experiencing a terrific rise in the prevalence of diabetes, mostly limited to the low- and middle-income countries. If left undiagnosed, untreated or poorly controlled, diabetes can precipitate devastating, irreversible complications linked to the disease [60].

From a recent study in Saudi Arabia it became evident that around 40.3% of diabetic patients were unaware of DM [52]. Another study reported that the diabetes knowledge score among the Saudi population was 67.4%; however, the scores for general knowledge on the disease, the risk factors, symptoms and complications were 71.1, 63.4, 80.8 and 47.7%, respectively [113]. Males in the population were nearly twice more likely to possess a better knowledge of the disease than the females. About two-thirds of the participants thought that diabetes is a curable disease. The study revealed a gross unawareness of diabetes associated secondary complications. Only 19.1% of participants had any knowledge regarding diabetes from the healthcare professionals. This clearly indicates the dire need for greater efforts in educating the general population on diabetes and the complications linked to it [113].

8.3. Delay/ Prevention of Diabetes

It is an alarming state of affairs when even in many of the economically poorer countries 'obesogenic'and 'diabetogenic' environments are becoming typical. WHO asserts that 80% of T2DM can be prevented by simple cost effective intervention. Therefore, major policy changes are needed to maintain healthy body weight and physical activity levels and control inappropriate nutrition and check obesity [60].

Many clinical trials established that simple but effective lifestyle intervention had the potential to prevent DM in high-risk individuals [114]. These studies strongly focused on increased physical activity and dietary modification, as well as weight reduction among the overweight participants [114]. T2DM can be prevented or its progression checked by incorporating lifestyle changes. Lifestyle modifications involve no associated costs, are usually free from side effects, and can confer as much [or even more] beneficial effects

than some pharmacological interventions [115]. Such lifestyle changes are often designed to reduce obesity, the result of indulgence in increased energy intake coupled with low physical activity levels [19]. Significantly, the current guidelines suggest that limited, modest but regular exercise is a beneficial strategy in the management of DM [116]. Several randomized clinical trials also confirm that diet and exercise can lower the incidence of T2DM [114].

This sharp rise in DM is because most of the population fails to understand the complex nature of the disease and its consequences [117-119]. The Ministry of Health in Saudi Arabia not only provides treatment to all DM patients but also makes the effort to offer preventive measures and mass education. However, there still is much to accomplish. Also, comprehensive studies on DM are urgently needed. The studies are most often cross-sectional with small sample sizes dealing with only some regions of the country.

CONCLUSION

Diabetes mellitus in Saudi Arabia is emerging as an epidemic of massive proportions, threatening to negate the benefits of modernization and economic revival. In Saudi Arabia there are many socioeconomic, dietary and lifestyle factors linked with DM. Comprehensive studies on the role of these factors and their contribution towards the incidence of DM, are the need of the hour. The studies are mostly cross-sectional involving limited sample sizes, which in most cases, include only some regions of the country. It is highly possible that healthy practices connected with the prevention and management of DM can easily be implemented in a manner that does not conflict with the cultural mores of Saudi Arabia. Diabetes, a disease highly prevalent among the Saudi population, represents a serious clinical and public health problem. According to the previous studies from Saudi Arabia we recommended every Saudi above 30 years of age should be screened for both type 2 diabetes and prediabetes to contain the disease. Also, a national prevention program which can check diabetes and address the modifiable risk factors at the community level, focusing on the high-risk groups, needs to be implemented as quickly as possible.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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REFERENCES

[1] Diagnosis and classification of diabetes mellitus. Diabetes Care. 2013; 36 Suppl 1: S67-74.
[2] Diagnosis and classification of diabetes mellitus. Diabetes Care. 2014; 37 Suppl 1: S81-90.
[3] Nathan DM, Cleary PA, Backlund JY, *et al.* Intensive diabetes treatment and cardiovascular disease in patients with type 1 diabetes. N Engl J Med. 2005; 353: 2643-53.
[4] Rosengren AH, Renstrom E. Autologous hematopoietic stem cell transplantation in type 1-diabetes. Islets. 2009; 1: 81-3.
[5] World Health Organization 2014.
[6] Martin-Timon I, Sevillano-Collantes C, Segura-Galindo A, Del Canizo-Gomez FJ. Type 2 diabetes and cardiovascular disease: Have all risk factors the same strength? World J Diabetes. 2014; 5: 444-70.
[7] Cornelis MC, Zaitlen N, Hu FB, Kraft P, Price AL. Genetic and environmental components of family history in type 2 diabetes. Hum Genet. 2015; 134: 259-67.
[8] Hu H, Sawhney M, Shi L, *et al*. A Systematic Review of the Direct Economic Burden of Type 2 Diabetes in China. Diabetes Ther. 2015; 6: 7-16.
[9] Li J, Gong YP, Li CL, Lu YH, Liu Y, Shao YH. Genetic basis of type 2 diabetes - recommendations based on meta-analysis. Eur Rev Med Pharmacol Sci. 2015; 19: 138-48.
[10] Parajuli J, Saleh F, Thapa N, Ali L. Factors associated with nonadherence to diet and physical activity among nepalese type 2 diabetes patients; a cross sectional study. BMC Res Notes. 2014; 7: 758.
[11] Pratley RE. Linagliptin use in older individuals with type 2 diabetes. Clin Interv Aging. 2014; 9: 1109-14.
[12] Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. Diabetes Care. 2004; 27: 1047-53.
[13] Forouhi NG, Wareham NJ. Epidemiology of diabetes. Medicine [Abingdon]. 2014; 42: 698-702.
[14] International Diabetes Federation, Diabetes Atlas, Sixth edition 2013.
[15] Katulanda P, Ranasinghe P, Jayawardena R. Prevalence of retinopathy among adults with self-reported diabetes mellitus: the Sri Lanka diabetes and Cardiovascular Study. BMC Ophthalmol. 2014; 14: 100.
[16] Diabetes Views. Global Perspectives on diabetes. Volume 56 (2), December 2011. Page no 4.
[17] Al Hayek AA, Robert AA, Al Saeed A, Alzaid AA, Al Sabaan FS. Factors Associated with Health-Related Quality of Life among Saudi Patients with Type 2 Diabetes Mellitus: A Cross-Sectional Survey. Diabetes Metab J. 2014; 38: 220-9.
[18] Diabetes: the cost of diabetes, Fact sheet N°236. World health organization. http: //www.who.int/mediacentre/factsheets/fs236/en/
[19] Badran M, Laher I. Type II Diabetes Mellitus in Arabic-Speaking Countries. Int J Endocrinol. 2012; 2012: 902873. doi: 10.1155/2012/90287.
[20] Roglic G, Unwin N. Mortality attributable to diabetes: estimates for the year 2010. Diabetes Res Clin Pract. 2010; 87: 15-9.
[21] Zimmet P, Alberti KG, Shaw J. Global and societal implications of the diabetes epidemic. Nature. 2001; 414: 782-7.
[22] Martiner, Ramon "Prevalence of Diabetes in the World, 2013." drupalgardens.com, November 18, 2013.
[23] World Bank 2015.
[24] Central Department of Statistics and information, Kingdom of Saudi Arabia.
[25] Al-Agha AE, Alafif MM, Abd-Elhameed IA. Glycemic control, complications, and associated autoimmune diseases in children and adolescents with type 1 diabetes in Jeddah, Saudi Arabia. Saudi Med J. 2015; 36: 26-31.
[26] Babiker AM, Al Jurayyan NA, Al Jurayyan RN, Al Gadi I, Drop SL. The clinical pattern of diabetes insipidus in a large university hospital in the Middle East. J Trop Pediatr. 2015; 61: 100-5.
[27] Al OM. Diabetes care and control: the effect of frequent visits to diabetes care center. Ann Saudi Med. 2014; 34: 229-34.
[28] Alhowaish AK. Economic costs of diabetes in Saudi Arabia. J Family Community Med. 2013; 20: 1-7.
[29] Almutairi N, Alkharfy KM. Direct medical cost and glycemic control in type 2 diabetic Saudi patients. Appl Health Econ Health Policy. 2013; 11: 671-5.
[30] Boutayeb, A, E. N. Lamlili, M., Boutayeb, W., Maamri, A., Ziyyat, A. and Ramdani, N. The rise of diabetes prevalence in the Arab region. Open J Epide, 2012; 2: 55-60.
[31] Choi JA, Ko SH, Park YR, Jee DH, Park CK. Retinal Nerve Fiber Layer Loss Is Associated with Urinary Albuimin Excretion in Patients with Type 2 Diabetes. Ophthalmology. 2015. pii: S0161-6420(15)00003-2.
[32] Co MA, Tan LS, Tai ES, *et al*. Factors associated with psychological distress, behavioral impact and health-related quality of life among patients with type 2 diabetes mellitus. J Diabetes Complications. 2015; 29: 378-83.

[33] Policardo L, Seghieri G, Francesconi P, *et al*. Gender difference in diabetes-associated risk of first-ever and recurrent ischemic stroke. J Diabetes Complications. 2014.

[34] Rahim HF, Sibai A, Khader Y, *et al*. Non-communicable diseases in the Arab world. Lancet. 2014; 383: 356-67.

[35] Alva ML, Gray A, Mihaylova B, Leal J, Holman RR. The impact of diabetes-related complications on healthcare costs: new results from the UKPDS [UKPDS 84]. Diabet Med. 2015; 32: 459-66.

[36] Arredondo A. Type 2 diabetes and health care costs in Latin America: exploring the need for greater preventive medicine. BMC Med. 2014; 12: 136.

[37] Mansour AA, Al-Maliky AA, Kasem B, Jabar A, Mosbeh KA. Prevalence of diagnosed and undiagnosed diabetes mellitus in adults aged 19 years and older in Basrah, Iraq. Diabetes Metab Syndr Obes. 2014; 7: 139-44.

[38] Albach NM: Increased prevalence rate of diabetes mellitus and associated risk factors in the Arab world. Poster 1364, presented at the 18th International Diabetes Federation Congress, Paris, August 24–29, 2003.

[39] Farag YM, Kari JA, Singh AK. Chronic kidney disease in the Arab world: a call for action. Nephron Clin Pract. 2012; 121: c120-3.

[40] International Diabetes Federation (2011) IDF Diabetes Atlas. 15th edition, International Diabetes Federation, Brussels.

[41] Al-Herbish AS, El-Mouzan MI, Al-Salloum AA, Al-Qurachi MM, Al-Omar AA. Prevalence of type 1 diabetes mellitus in Saudi Arabian children and adolescents. Saudi Med J. 2008; 29: 1285-8.

[42] Aljohani NJ. Metabolic syndrome: Risk factors among adults in Kingdom of Saudi Arabia. J Family Community Med. 2014; 21: 170-5.

[43] Al-Rubeaan K, Abu El-Asrar AM, Youssef AM, *et al*. Diabetic retinopathy and its risk factors in a society with a type 2 diabetes epidemic: a Saudi National Diabetes Registry-based study. Acta Ophthalmol. 2015; 93: e140-7.

[44] World Health Organization. Chapter 1- Chronic diseases: causes and health impacts. Preventing Chronic Diseases: A Vital Investment. Geneva: World Health Organization; 2005. p. 34-58.

[45] Alzaid A. Diabetes: a tale of two cultures. Br J Diabetes Vasc Dis 2012; 12: 57.

[46] Al-Daghri NM, Al-Attas OS, Alokail MS, *et al*. Diabetes mellitus type 2 and other chronic non-communicable diseases in the central region, Saudi Arabia [Riyadh cohort 2]: a decade of an epidemic. BMC Med. 2011; 9: 76.

[47] Fatani HH, Mira SA, el-Zubier AG. Prevalence of diabetes mellitus in rural Saudi Arabia. Diabetes Care. 1987; 10: 180-3.

[48] Gillies CL, Abrams KR, Lambert PC, Cooper NJ, Sutton AJ, Hsu RT, *et al*. Pharmacological and lifestyle interventions to prevent or delay type 2 diabetes in people with impaired glucose tolerance: systematic review and meta-analysis. BMJ. 2007; 334: 299.

[49] Wilson A, Gyi AA. The status and perspective of diabetes health education in China: inspiration from Australia. Int J Nurs Pract. 2010; 16: 92-8.

[50] Alqurashi KA, Aljabri KS, Bokhari SA. Prevalence of diabetes mellitus in a Saudi community. Ann Saudi Med. 2011; 31: 19-23.

[51] Al-Nozha MM, Al-Maatouq MA, Al-Mazrou YY, *et al*. Diabetes mellitus in Saudi Arabia. Saudi Med J. 2004; 25: 1603-10.

[52] Al-Rubeaan K, Al-Manaa HA, Khoja TA, *et al*. Epidemiology of abnormal glucose metabolism in a country facing its epidemic: SAUDI-DM study. J Diabetes. 2014 Sep 30. doi: 10.1111/1753-0407.12224.

[53] Cherian MP, Al-Kanani KA, Al Qahtani SS, *et al*. The rising incidence of type 1 diabetes mellitus and the role of environmental factors--three decade experience in a primary care health center in Saudi Arabia. J Pediatr Endocrinol Metab. 2010; 23: 685-95.

[54] Hussain A, Claussen B, Ramachandran A, Williams R. Prevention of type 2 diabetes: a review. Diabetes Res Clin Pract. 2007; 76: 317-26.

[55] Memish ZA, El Bcheraoui C, Tuffaha M, *et al*. Obesity and associated factors--Kingdom of Saudi Arabia, 2013. Prev Chronic Dis. 2014; 11: E174.

[56] Midhet FM, Al-Mohaimeed AA, Sharaf FK. Lifestyle related risk factors of type 2 diabetes mellitus in Saudi Arabia. Saudi Med J. 2010; 31: 768-74.

[57] Swinburn B. Sustaining dietary changes for preventing obesity and diabetes: lessons learned from the successes of other epidemic control programs. Asia Pac J Clin Nutr. 2002; 11 Suppl 3: S598-606.

[58] Misra A, Ramchandran A, Jayawardena R, Shrivastava U, Snehalatha C. Diabetes in South Asians. Diabet Med. 2014; 31: 1153-62.

[59] Szwergold BS, Miller CB. Potential of birds to serve as a pathology-free model of type 2 diabetes, Part 1: Is the apparent absence of the rage gene a factor in the resistance of avian organisms to chronic hyperglycemia? Rejuvenation Res. 2014; 17: 54-61.

[60] Global Diabetes Plan 2011-2021, International Diabetes Federation.

[61] Sherif S, Sumpio BE. Economic development and diabetes prevalence in MENA countries: Egypt and Saudi Arabia comparison. World J Diabetes. 2015 Mar 15; 6: 304-11.

[62] Al-Hazzaa HM. Prevalence of physical inactivity in Saudi Arabia: a brief review. East Mediterr Health J. 2004; 10: 663-70.

[63] Dzhavad-Zade MD, Agaev MM, Fel'dman VM, Torosian A, Akhmedova LA. (The diagnosis and dispensary care of pregnant patients with nephropathy). Urol Nefrol (Mosk). 1991: 3-8.

[64] Elhadd TA, Al-Amoudi AA, Alzahrani AS. Epidemiology, clinical and complications profile of diabetes in Saudi Arabia: a review. Ann Saudi Med. 2007; 27: 241-50.

[65] Miller CJ, Dunn EV, Hashim IB. Glycemic index of 3 varieties of dates. Saudi Med J. 2002; 23: 536-8.

[66] Mohajeri S, Riddell MC. Advances in Exercise, Physical Activity, and Diabetes Mellitus. Diabetes Technol Ther. 2015; 17(S1): S88-S95.

[67] Sukla P, Shrivastava SR, Shrivastava PS. A longitudinal study to assess the impact of exercise on clinical, biochemical, and anthropometric parameters among the type 2 diabetes patients of South India. Avicenna J Med. 2015; 5: 16-20.

[68] Al-Hazzaa HM, Alahmadi MA, Al-Sobayel HI, Abahussain NA, Qahwaji DM, Musaiger AO. Patterns and determinants of physical activity among Saudi adolescents. J Phys Act Health. 2014; 11: 1202-11.

[69] Awadalla NJ, Aboelyazed AE, Hassanein MA, *et al*. Assessment of physical inactivity and perceived barriers to physical activity among health college students, south-western Saudi Arabia. East Mediterr Health J. 2014; 20: 596-604.

[70] Zinman B, Ruderman N, Campaigne BN, Devlin JT, Schneider SH. Physical activity/exercise and diabetes mellitus. Diabetes Care. 2003; 26 Suppl 1: S73-7.

[71] Abdullah A, Peeters A, de Courten M, Stoelwinder J. The magnitude of association between overweight and obesity and the risk of diabetes: a meta-analysis of prospective cohort studies. Diabetes Res Clin Pract. 2010; 89: 309-19.

[72] Yoon K, Min K, Chun H, Jang SN, Cho SI. Effect change of obesity on diabetes depending on measurement: self-reported BMI from 2012 Community health survey vs. directly measured from KNHANES. Epidemiol Health. 2015; 37: e2015001. doi: 10.4178/epih/e2015001.

[73] Al Nohair S. Effectiveness of Levels of Health Education on HbA1c in Al-Qassim Region, Saudi Arabia. Int J Health Sci (Qassim). 2013; 7: 301-8.

[74] Rasheed P. Overweight status: Body image and weight control beliefs and practices among female college students. Ann Saudi Med. 1999; 19: 365-9.

[75] Galal O. Nutrition-related health patterns in the Middle East. Asia Pac J Clin Nutr. 2003; 12: 337-43.

[76] Madanat HN, Troutman KP, Al-Madi B. The nutrition transition in Jordan: the political, economic and food consumption contexts. Promot Educ. 2008; 15: 6-10.

[77] Musaiger AO. Diet and prevention of coronary heart disease in the Arab Middle East countries. Med Princ Pract. 2002; 11 Suppl 2: 9-16.

[78] Al-Muammar MN, El-Shafie M, Feroze S. Association between dietary habits and body mass index of adolescent females in intermediate schools in Riyadh, Saudi Arabia. East Mediterr Health J. 2014; 20: 39-45.

[79] El-Hazmi MA, Al-Swailem A, Warsy AS, Al-Sudairy F, Sulaimani R, Al-Meshari A. The prevalence of diabetes mellitus and impaired glucose tolerance in the population of Riyadh. Ann Saudi Med. 1995; 15: 598-601.

[80] Al-Rethaiaa AS, Fahmy AE, Al-Shwaiyat NM. Obesity and eating habits among college students in Saudi Arabia: a cross sectional study. Nutr J. 2010; 9: 39.

[81] Al-Attas OS, Al-Daghri NM, Alokail MS, *et al*. Adiposity and insulin resistance correlate with telomere length in middle-aged

Arabs: the influence of circulating adiponectin. Eur J Endocrinol. 2010; 163: 601-7.
[82] Pound N, Sturrock ND, Jeffcoate WJ. Age related changes in glycated haemoglobin in patients with insulin-dependent diabetes mellitus. Diabet Med. 1996; 13: 510-3.
[83] Siddiqui MA, Khan MF, Carline TE. Gender differences in living with diabetes mellitus. Mater Sociomed. 2013; 25: 140-2.
[84] Raum E, Kramer HU, Ruter G, *et al*. Medication non-adherence and poor glycaemic control in patients with type 2 diabetes mellitus. Diabetes Res Clin Pract. 2012; 97: 377-84.
[85] Ashley S, Brooks SG, Gehani AA, Kester RC, Rees MR. Thermal characteristics of sapphire contact probe delivery systems for laser angioplasty. Lasers Surg Med. 1990; 10: 234-44.
[86] Saudi Gazette report 2015.
[87] El-Mouzan MI, Al-Salloum AA, Al-Herbish AS, Qurachi MM, Al-Omar AA. Regional variations in the prevalence of consanguinity in Saudi Arabia. Saudi Med J. 2007; 28: 1881-4.
[88] el-Hazmi MA, al-Swailem AR, Warsy AS, al-Swailem AM, Sulaimani R, al-Meshari AA. Consanguinity among the Saudi Arabian population. J Med Genet. 1995; 32: 623-6.
[89] Cervantes-Garcia E, Garcia-Gonzalez R, Resendiz-Albor A, Salazar-Schettino PM. Infections of Diabetic Foot Ulcers With Methicillin-Resistant Staphylococcus aureus. Int J Low Extrem Wounds. 2015; 14: 44-9.
[90] Sud M, Wang X, Austin PC, Lipscombe LL, Newton GE, Tu JV, *et al*. Presentation blood glucose and death, hospitalization, and future diabetes risk in patients with acute heart failure syndromes. Eur Heart J. 2015; 36: 924-31.
[91] Uusitupa MI, Niskanen LK, Siitonen O, Voutilainen E, Pyorala K. Ten-year cardiovascular mortality in relation to risk factors and abnormalities in lipoprotein composition in type 2 [non-insulin-dependent] diabetic and non-diabetic subjects. Diabetologia. 1993; 36: 1175-84.
[92] Khan AR, Al Abdul Lateef ZN, Fatima S, Al Yousuf SA, Khan Afghan SZ, Al Marghani S. Prevalence of chronic complication among type 2 diabetics attending primary health care centers of Al Ahsa district of Saudi Arabia: a cross sectional survey. Glob J Health Sci. 2014; 6: 245-53.
[93] Al-Rubeaan K, Youssef AM, Subhani SN, *et al*. Diabetic nephropathy and its risk factors in a society with a type 2 diabetes epidemic: a Saudi National Diabetes Registry-based study. PLoS One. 2014; 9: e88956.
[94] Hussein MM, Mooij JM, Roujouleh H, el-Sayed H. Observations in a Saudi-Arabian dialysis population over a 13-year period. Nephrol Dial Transplant. 1994; 9: 1072-6.
[95] Jondeby MS, De-Los Santos GG, Al-Ghamdi AM, *et al*. Caring for hemodialysis patients in Saudi Arabia. Past, present and future. Saudi Med J. 2001; 22: 199-204.
[96] al-Rajeh S, Larbi EB, Bademosi O, *et al*. Stroke register: experience from the eastern province of Saudi Arabia. Cerebrovasc Dis. 1998; 8: 86-9.
[97] Awada A, al Rajeh S. The Saudi Stroke Data Bank. Analysis of the first 1000 cases. Acta Neurol Scand. 1999; 100: 265-9.
[98] El-Asrar AM, Al-Rubeaan KA, Al-Amro SA, Kangave D, Moharram OA. Risk factors for diabetic retinopathy among Saudi diabetics. Int Ophthalmol. 1998; 22: 155-61.
[99] Akbar DH, Mira SA, Zawawi TH, Malibary HM. Subclinical diabetic neuropathy: a common complication in Saudi diabetics. Saudi Med J. 2000; 21: 433-7.
[100] Kargar Jahromi M, Ramezanli S, Taheri L. Effectiveness of diabetes self-management education on quality of life in diabetic elderly females. Glob J Health Sci. 2015; 7: 10-5.
[101] Koh O, Lee J, Tan ML, *et al*. Establishing the thematic framework for a diabetes-specific health-related quality of life item bank for use in an english-speaking asian population. PLoS One. 2014; 9: e115654.
[102] Al-Shehri AH, Taha AZ, Bahnassy AA, Salah M. Health-related quality of life in type 2 diabetic patients. Ann Saudi Med. 2008; 28: 352-60.
[103] Gillett MJ. International Expert Committee report on the role of the A1c assay in the diagnosis of diabetes: Diabetes Care 2009; 32(7): 1327-1334. Clin Biochem Rev. 2009 Nov; 30(4): 197-200.
[104] Harris MI, Klein R, Welborn TA, Knuiman MW. Onset of NIDDM occurs at least 4-7 yr before clinical diagnosis. Diabetes Care. 1992; 15: 815-9.
[105] Lorenzo-Medina M, De-La-Iglesia S, Ropero P, Nogueira-Salgueiro P, Santana-Benitez J. Effects of hemoglobin variants on hemoglobin a1c values measured using a high-performance liquid chromatography method. J Diabetes Sci Technol. 2014; 8: 1168-76.
[106] Olokoba AB, Obateru OA, Olokoba LB. Type 2 diabetes mellitus: a review of current trends. Oman Med J. 2012; 27: 269-73.
[107] Nouya AY, Nansseu JR, Moor VJ, *et al*. Determinants of fructosamine levels in a multi-ethnic Sub-Saharan African population. Diabetes Res Clin Pract. 2015; 107: 123-9.
[108] Poon AK, Juraschek SP, Ballantyne CM, Steffes MW, Selvin E. Comparative associations of diabetes risk factors with five measures of hyperglycemia. BMJ Open Diabetes Res Care. 2014; 2: e000002.
[109] International Diabetes Federation 2013. Global Diabetes Scorecard Tracking Progress for Action. http: //www.idf.org/global-diabetes-scorecard/assets/downloads/Scorecard-29-07-14.pdf.
[110] Al-Rubeaan KA, Youssef AM, Subhani SN, Ahmad NA, Al-Sharqawi AH, Ibrahim HM. A Web-based interactive diabetes registry for health care management and planning in Saudi Arabia. J Med Internet Res. 2013; 15: e202.
[111] International Diabetic Federation. One adult in ten will have diabetes by 2030. Press release, Brussels, 14 November November 2011. available at http: //www.idf.org/mediaevents/press-releases/2011/diabetes-atlas-5thedition.[DA: 30th January 2012].
[112] Amanda M, Nigel U. Diabetes Action Now: WHO and IDF working together to raise awareness worldwide, IDF.
[113] Mohieldien, A.H, Alzohairy, M.A, Hasan, M. Awareness of diabetes mellitus among Saudi non-diabetic population in Al-Qassim region. 2011; 2: 14-19.
[114] Tuomilehto J, Schwarz P, Lindstrom J. Long-term benefits from lifestyle interventions for type 2 diabetes prevention: time to expand the efforts. Diabetes Care. 2011; 34 Suppl 2: S210-4.
[115] Salpeter SR, Buckley NS, Kahn JA, Salpeter EE. Meta-analysis: metformin treatment in persons at risk for diabetes mellitus. Am J Med. 2008; 121: 149-57 e2.
[116] Fritz T, Wandell P, Aberg H, Engfeldt P. Walking for exercise--does three times per week influence risk factors in type 2 diabetes? Diabetes Res Clin Pract. 2006; 71: 21-7.
[117] Basulaiman M, El Bcheraoui C, Tuffaha M, *et al*. Hypercholesterolemia and its associated risk factors-Kingdom of Saudi Arabia, 2013. Ann Epidemiol. 2014; 24: 801-8.
[118] Natalia De Sa P, Moura JR, Junior EB, De Almeida PC, De Macedo SF, Da Silva AR. (Knowledge, attitudes and practices for the prevention of diabetic foot). Rev Gaucha Enferm. 2014; 35: 36-42.
[119] Ronda MC, Dijkhorst-Oei LT, Rutten GE. Reasons and barriers for using a patient portal: survey among patients with diabetes mellitus. J Med Internet Res. 2014; 16: e263.