

The impact of diabetes mellitus on health and economy of Gulf Cooperation Council countries

Khalid Al-Rubeaan*



Practice Points

- United Nations have acknowledged that the global burden and threat of noncommunicable diseases constitute a major challenge for development in the 21st century.
- The rapid economic development in the Gulf Cooperation Council (GCC) countries has led to a soaring rate of diabetes, from approximately 6% in 1990 to over 20% in 2012 and put three of them among the top ten countries in terms of diabetes prevalence.
- The growth demand for health services in the GCC countries is 3.5% exceeding their Compound Annual Growth Rate of 2%.
- All the GCC countries offer free healthcare coverage for their citizens, although the standard of care in some of them is below what is available in the middle-income countries.
- Health expenditure on diabetes is still less than what is needed in the GCC countries, in spite of the increase in its demand.
- Launching prevention programs in the GCC countries utilizing the currently available quality and outcome indicators, as well as conducting diabetes economic impact studies are the main basis to stand against this diseases in those countries

SUMMARY Diabetes mellitus is a global health problem, where WHO recognized it as a chronic, debilitating and costly disease associated with severe complications, which poses severe risks for families, Member States and the entire world. This medical problem has put three Gulf Cooperation Council countries so far among the top ten countries facing high prevalence at a global level, to the extent that they could not meet the demand on health services or expenditure. Healthcare services in those countries need to be looked at, where primary care system should be empowered and health insurance is directed to have a better share in diabetes management. In spite of this disease challenge, none of the Gulf Cooperation Council countries so far have managed to start primary or secondary prevention programs. Studies on economic impact of diabetes are badly needed, which will be the basis for future plan to stand against this disease and its economical burden.

In today's global scenario, there is a rapid increase in epidemic of diabetes, in particular, Type 2 diabetes and impaired glucose tolerance (IGT). Diabetes has been linked directly to the shortening of patients' lives and causing a profound financial impact on the healthcare systems worldwide by affecting the

KEYWORDS

• diabetes in Gulf Cooperation Council countries • diabetes cost • economic impact • health expenditure • health services

*University Diabetes Center, Collage of Medicine, King Saud University, PO Box 18397, Riyadh 11415, Saudi Arabia; Tel.: +96 611 282 5402; Fax: +96 611 477 5696; krubeaan@ksu.edu.sa

Gross Domestic Product (GDP) [1]. The world prevalence of diabetes among adults is estimated to be 6.4% in 2010 and will increase to 7.7% by the year 2030 [2]. In the latest report provided by the International Diabetes Federation (IDF), 382 million people have been diagnosed with diabetes in 2013 and expected to reach 592 million by 2035 [3]. This report also highlights a significant fact that 80% of the people affected by diabetes reside in low- and middle-income countries [3]. The majority of diabetic population lies between 25 and 65 years of age, which is considered to be the most important time period for the social and economical productivity. For that reason, United Nations have acknowledged that the global burden and threat of noncommunicable diseases constitute a major challenge for development in the 21st century, which undermines social and economic development throughout the world and threatens the achievement of internationally agreed development goals [4].

In most societies worldwide, diabetes is considered to be the leading cause for the loss of vision, amputation, renal dialysis and high mortality secondary to coronary artery disease; thereby making it one of the world's most important cause of disability and economic loss.

Data from the Global Health Expenditure Database (GHED) show that the total global expenditure for health was US\$ 6.5 trillion averaging at US\$948 per person per year, with USA being the highest at US\$8362 and Eritrea being the lowest at US\$12 [5]. The minimum spending to provide basic life saving services for one person per year was estimated by WHO at US\$44 [5]. It was also observed that 34 WHO member states had their health spending lower than US\$ 50 per person per year and seven countries had their health spending less than US\$20 per person per year [5].

It is estimated that 10.8% of the total worldwide health expenditure in 2013 would be directly spent on diabetes [3] as a result of more outpatient and inpatient services. This is in addition to an increase in emergency visits requirements and long-term care provided to diabetic patients [6]. In 2012, the total economic cost of diagnosed diabetes cases in the USA was estimated at US\$245 billion, which is representing a 41% increase from the previous estimate of US\$174 billion (in 2007) [7]. The average medical expenditure for people with diabetes was found to be approximately 2.3-times higher than the people without diabetes [7].

Diabetes mellitus in the GCC countries

The Cooperation Council for the Arab States of the Gulf, known as the Gulf Cooperation Council (GCC), is a political and economic union of Arab states, namely Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates, where they share similar psychosocial structure and are known for their increased financial affluence.

The main cause for diabetes being one of the most prevalent chronic noncommunicable diseases in the GCC countries is the rapid economic development, which has led to major lifestyle modifications manifested by the tendency to a westernized diet, less physical activity, obesity and an increase in the smoking habits [8,9]. In 2013, three countries from the GCC states were ranked among the top ten countries with high prevalence of diabetes, namely Kingdom of Saudi Arabia (24.0%) ranked seventh, Kuwait (23.1%) ranked ninth and Qatar (22.9%) ranked tenth [3].

Data from the most recent global review published by nature in the year 2012, showed that, the rapid economic development in GCC countries has led to a soaring rate of diabetes, from approximately 6% in 1990 to over 20% in 2012 [10]. The same report found Qatar, Saudi Arabia and United Arab Emirates (UAE) to be the top three countries, respectively, when national diabetes prevalence alongside with the total expenditure per patient and number of diabetes-related deaths were considered. Although those three countries have the highest diabetes prevalence, the health expenditure rate per patient was found to be less than developed countries like Japan and Australia [10].

Figure 1 demonstrates the trends of diabetes prevalence in the six GCC countries during the period between 1980 and 2010 [11–26]. The epidemiological studies used to produce this figure had different diagnostic criteria, study designs and age groups. Although there are many epidemiological studies available in the literature about diabetes prevalence in those countries, only the studies published in ISI journals with significant impact have been chosen. Sixteen epidemiology studies from the six countries during the 30-year period were used to draw trend lines for diabetes prevalence.

There is an increased trend in diabetes prevalence in the six GCC countries represented by the trend line 'A' with coefficient of determination (R^2) of 0.532 as shown in **Figure 1**. Using

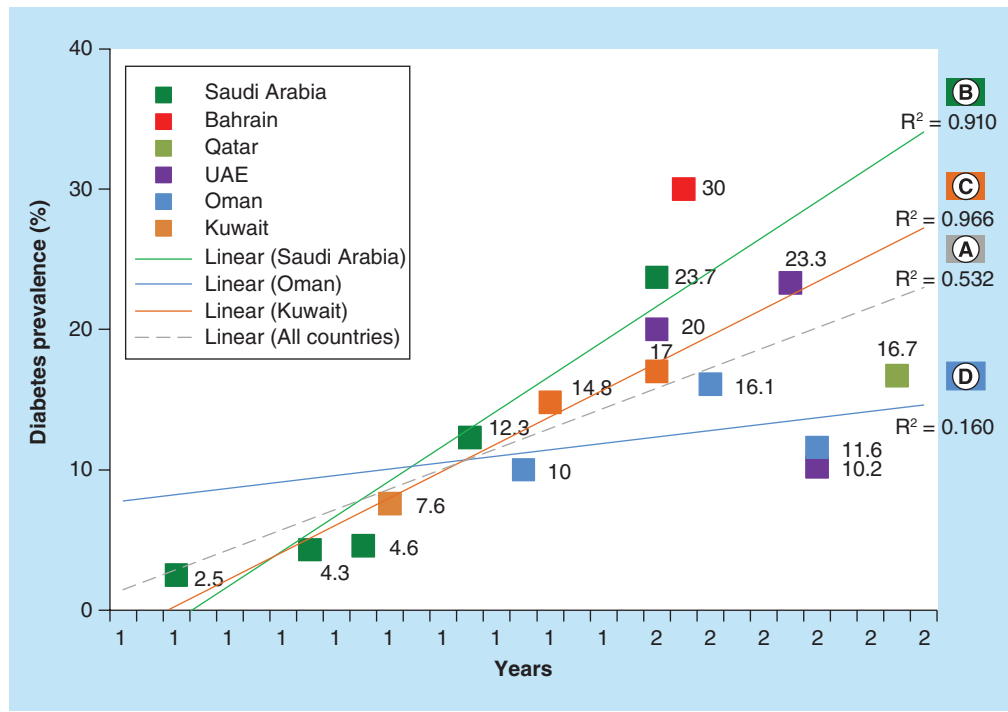


Figure 1. The trends of diabetes prevalence in the six Gulf Cooperation Council countries during the period between 1980 and 2010. (A) (Gray) The trend for all GCC countries; (B) (green) the trend for Saudi Arabia; (C) (orange) the trend for Kuwait; (D) (light blue) the trend for Oman.

UAE: United Arab Emirates.

regression equation for diabetes prevalence (diabetes prevalence: $0.719 \times \text{year} - 1421.462$), diabetes prevalence is expected to be 30.19, 37.38 and 51.75% in the years 2020, 2030 and 2050, respectively.

The countries with adequate and dispersed studies showed three different linear trends. The first linear trend with rapid increase as shown by the trend line 'B' ($R^2 = 0.910$) was observed from Saudi Arabia data. The second trend with less increase as shown by the trend line 'C' ($R^2 = 0.966$), was observed from Kuwait data and the third almost flat trend as shown by the trend line 'D' ($R^2 = 0.160$), was observed from Oman data, which warranted further studies and explanation. From this observation, it can be deduced that Saudi Arabia is expected to lead the GCC countries in the incidence of diabetes and the same can be expected for Bahrain if it had more studies. Kuwait settles just below Saudi Arabia at a lower rate as shown from the available studies, with UAE behaving in a similar pattern if it had more studies. There is not enough data available from Qatar to build up a trend line, but most likely, it will follow Kuwait and UAE trend pattern. Although **Figure 1** provides good insight on diabetes trend for those countries together

or individually, more epidemiological studies would give accurate forecasting.

These variations in prevalence trend between GCC countries could be explained by the degree and duration of economic changes seen in all GCC countries except Oman. This could explain the flat trend observed from Oman data, in addition to the fact that, Oman had started a limited primary care diabetes prevention program, which may have stabilized diabetes prevalence and markedly decreased its incidence.

Diabetes risk factors in those countries are similar, in which overweight and obesity are considered to be the most pronounced risk factors. Overweight prevalence ranges between 25 and 50% in adult population, while obesity prevalence ranges between 10 and 50%, with overweight to obesity ratio of 1:1. Both overweight and obesity prevalence are relatively higher among women and increase with age regardless of gender [27].

The aging process of GCC populations reflected by increased life expectancy, that exceeded 74 years according to the World Bank data 2011 [28], has subjected them to a higher chance of developing diabetes [29]. The prevalence estimates of GCC populations

Table 1. The health services and medical personals in the Gulf Cooperation Council countries with important health indicators.

Country	Government service [†]			Private service [†]			Number per 10,000 of population [‡]			Infant mortality rate/1,000 live births [§]	Maternal mortality ratio/100,000 live births [¶]	Population life expectancy [#]
	Hospital	Bed	Clinic	Hospital	Beds	Clinics	Hospital beds	Physician	Nurse			
Bahrain	10	1702	24	13	384	NA	19	14.4	37.3	8	20	76
Kuwait	30	5149	97	15	653	98	18	17.9	45.5	10	14	74
Oman	55	5430	217	5	189	817	19	19.0	41.1	10	32	76
Qatar	5	2564	30	4	394	177	14	27.6	73.7	7	7	78
Saudi Arabia	283	44,099	2037	125	11,833	2308	22	9.4	21.0	8	24	75
United Arab Emirates	32	6627	243	58	2549	2057	19	19.3	40.9	7	12	77

[†]Alpen Capital: GCC healthcare industry 2011 [36].

[‡]WHO: World health statistics 2011 [37].

[§]World bank: Mortality rate, infant (per 100 live birth) data as of 2011 [40].

[¶]World bank: Maternal mortality ratio (model estimates, per 100,000 live birth) data as of 2010 [41].

[#]World bank: life expectancy at birth, total (years), data as of 2011 [28].

NA: Not applicable.

participation in physical activity were found to be considerably lower than many developed countries. Only 39.0–42.1% of men and 26.3–28.4% of women practice physical activity for at least 150 minutes per week [30].

As reported by the Food and Agriculture Organization, three GCC countries, namely Kuwait, Saudi Arabia and UAE, are ranked the highest in dietary energy consumption when compared with other Middle Eastern countries [31]. This report also shows a progressive increase in the energy consumption between the years 1990 and 1992, and 2005 and 2007, which have exceeded 3000 Kcal/person/day for those three GCC countries.

Family history of diabetes was found to be one of the major contributors for the high prevalence of diabetes in the GCC countries, most likely secondary to the high rates of consanguinity in those populations [32,33]. Additionally, other risk factors like hypertension, dyslipidemia, and smoking are playing an important role for that high prevalence [27,34–35].

Health services in the GCC countries

The GCC countries, which are known worldwide for their wealthy economies projected by high per capita income, are also known for their high population growth rate at 3.3% [36]. This was reflected on the health services demand over the last 4 decades. With better health services, those countries achieved steady decrease in infant mortality rates and increase in life expectancy. It was coupled with changes in the disease

pattern from communicable to noncommunicable diseases over the last 50 years. This significant change in the disease pattern has caused a huge impact on the healthcare systems of those countries. This was reflected by the increase in demands for more hospital beds and medical personnel to the extent that the current healthcare infrastructure in the GCC countries have failed to comply with the international standards. In spite of the fact that Saudi Arabia contains the highest number of hospital beds per 10,000 of its inhabitants, it was 35% lower than the UK and 73% lower than Germany [37]. The other impending challenge facing those countries is the healthcare work force, which is increasing steadily, but cannot be compensated by the domestic graduation capacity of each individual GCC country. Currently 80% of the physicians in Saudi Arabia and UAE are expatriates, which is even worse for nurses, where approximately 90% of them are non-nationals [38].

The structure of the healthcare systems adopted by those GCC countries are divided into governmental and private sectors, which consist of hospitals, clinics and primary care centers. The demand for the health services in those countries is exceeding its growth rate, which could explain lagging behind American and European averages. The Compound Annual Growth Rate for GCC countries is approximately 2%, while the growth in demand for more hospital beds is exceeding 3.5% [38].

The most recent available data on health services in GCC countries was available from

WHO statistics for the year 2011 and GCC healthcare sector report 2011, published by Alpen Capital research house [36,37]. **Table 1** summarizes the number of government and private health services in those countries, where Saudi Arabia outmost all other GCC countries in hospital beds, followed by UAE, Kuwait and Oman, respectively. The lowest number of beds was seen in both Qatar and Bahrain. When looking at the number of hospital beds per 10,000 of population, Saudi Arabia is still the highest at a rate of 22 beds, which was not that far from other GCC countries ranging between 18 and 19 beds, except for Qatar that was 14 beds per 10,000 of population. The number of beds per 10,000 population in all those countries is still far below the real need, especially when compared with European Region, where it was 63 hospital beds per 10,000 population [39]. It seems that all GCC countries, especially Qatar, need to triple their hospital beds to meet their requirements. When looking at the number of physicians and nurses per 10,000 of population, Saudi Arabia is lagging behind all GCC countries, while Qatar has the highest number of physicians and nurses per 10,000 of population. All GCC countries are above the global rate for physicians and nurses (13 physicians and 28 nurses per 10,000 of population), except Saudi Arabia that has 9.4 physicians and 21 nurses per 10,000 of population. However, all GCC countries are below the European rate, which is 32 physicians and 79 nurses per 10,000 populations [39].

Infant mortality rate, as an indicator for the health status of a nation, is ranging between 7 and 10 per 1000 live births in the GCC countries, that was much lower than other Middle Eastern and north African countries [40,42]. Maternal mortality ratio per 100,000 live births was the highest in Oman at 32 and lowest in Qatar at seven deaths per 100,000 live birth, and was not far from what has been observed in developed countries [41]. Health services provided in the GCC countries had increased the life expectancy in their populations, exceeding 74 years recently [28].

Although health services had reduced both infant and maternal mortality and increased life expectancy, GCC countries are facing another challenge, namely chronic noncommunicable diseases, which would put huge pressure on the health system and economy. McKinsey & Company in their report about Gulf Cooperation Council Healthcare: Challenges

and Opportunities in 2006, have expected that, the overall treatment demand will increase by 240% by the year 2025 in the GCC countries [38], the highest demand being for cardiovascular diseases at 419% followed by diabetes at 323% and sense organ diseases (primarily eye) at 293% [38]. It is apparent from this report that diabetes would be the major cause of increase in the healthcare demands as it is considered to be a major risk factor for both cardiovascular and sense organ diseases.

Facing this demand, the GCC countries proposed the Gulf Executive plan for diabetes Control and established a national supreme council for control of diabetes. They also set a framework for national services for diabetes, and designed a unified Gulf research methodology, which deals with epidemiology, burden and economics of diabetes. This proposal has been adopted since 2006 but no actual implementation was made by any of the GCC countries for many plausible reasons. The most important obstacle facing the GCC countries to adopt good screening, clinical and other prevention programs, is the lack of the set up needed for such programs execution. This includes both trained medical personnel and proper facilities as been demonstrated in a previous study determining the quality of Type 2 diabetes management in the GCC countries by Alhawas *et al.* in 2011 [43]. This study had concluded that none of the GCC countries had adopted any structured clinical program, and was reflected by the poor glycemic control seen in those countries at a national level. The same study had also concluded that all the GCC countries are lacking primary prevention programs. This was also observed by a cross-sectional survey conducted in Kuwait in 2009 at the patient level, where there were major defects in the diet and self-care routine knowledge in Type 2 diabetic patients [44]. This observation was also confirmed by knowledge, attitude and practice-based assessment study among diabetic patients in UAE, wherein 31% of the patients had poor diabetes knowledge and 72% of the patients had negative attitude towards diabetes [45]. In another study conducted at primary healthcare level in Oman, education knowledge gaps were observed, wherein one quarter of patients could not recognize hypoglycemia or had any knowledge about its treatment [46].

Recently, all the GCC countries have put more weight on establishing diabetes centers that will serve as secondary or tertiary healthcare levels,

Table 2. Population and GDP per capita of the Gulf Cooperation Council countries and health expenditures in US dollars in the year 2012.

Country	Population [†]	GDP/ Capita [‡] (US\$)	Health expenditures [‡]				
			Total (billion)	Per capita	Household (%)	Government (%)	Others (%)
Bahrain	1,317,827	23,039	1.2	895	16	72	12
Kuwait	3,250,496	56,367	4.6	1428	16	83	2
Oman	3,314,001	26,330	2.0	690	12	80	8
Qatar	2,050,514	93,832	4.2	2029	9	84	8
Saudi Arabia	28,287,855	24,771	23	795	19	66	16
United Arab Emirates	9,205,651	47,348	11	1343	20	68	12

[†]World Bank: Population (total) data as of 2012 [47].

[‡]WHO: health systems financing by country [48].

but none yet have adopted a clear program at primary care level, where more than 90% of the patients are found. This may not be the case in Oman, where some incentives have been adopted at a primary care level as mentioned earlier. None of the GCC countries has clearly adopted primary prevention program to reduce the incidence of diabetes, and for that reason, diabetes will continue to be a real challenge facing those countries health systems and economy.

Health expenditures in the GCC countries

The WHO National Health Accounts Database reported that the health expenditure in GCC countries is 100% derived from domestic funding [48]. All the GCC countries offer free health-care coverage to their citizens through government hospitals and primary care centers, while the private sector has a limited share in health expenditure as a result of underdeveloped health insurance system.

The total population of all the GCC countries is around 45 million inhabitants, where more than 50% are in Saudi Arabia, while Bahrain is the least inhabited country with a total population of about one million inhabitants. UAE is the second most inhabited country after Saudi Arabia with a total population of about 10 million inhabitants. Kuwait, Oman and Qatar collectively are inhabited by another 10 million people as shown in Table 2.

In the GCC countries GDP per capita has a wide range from US\$93,000 in Qatar to US\$50,000 in both Kuwait and UAE, while Saudi Arabia and Bahrain are the lowest at US\$20,000. This has reflected on the health expenditure in those countries, where Saudi

Arabia is the country with the highest expenditure at US\$23 billion annually, followed by UAE at US\$11 billion. The spending in the remaining countries range between US\$1 to 4 billion annually.

Health expenditure per capita exceeded US\$2000 in Qatar, while it was over US\$1000 in Kuwait and UAE. Saudi Arabia, Oman and Bahrain had health expenditure per capita of around US\$700 (Table 2). The high health expenditure per capita in Qatar, Kuwait and UAE is a reflection of the small population size and high income, while the low health expenditure in Saudi Arabia is a result of the large population size, in spite of the high income.

Health expenditure is mainly governmental, although there is a small percentage paid by household and health insurance. In the GCC countries, more than 60% is paid by governments, while people have 9–20% share in the total health expenditure, the highest been observed in UAE. Saudi Arabia had adopted a policy for expatriates' health insurance and for that reason, it has the highest insurance percentage (16%) among the GCC countries. The lowest percentage of health expenditure by insurance companies was observed in Kuwait at 2% (Table 2).

According to the report by Alkhamis *et al.* in 2013, the GCC countries need to completely reform their healthcare systems including healthcare financing, since the current financing structure is causing misalignment between the budget and the demand for services. Despite the high income and GDP per capita, the current healthcare systems adopted by some of the GCC countries is below what is available in middle-income countries [49].

For that reason, there is an urgent need for other financing options that can improve health services in the GCC countries like empowering health insurance systems.

Diabetes cost in the GCC countries

The economical burden put forth by diabetes is very precisely documented in most of developed and some of the developing countries [7,50]. Having discussed the general estimates of the global diabetes impact earlier in the introduction part, it has to be said that more studies are needed to come up with better understanding and accurate estimation of this disease cost. The global expenditures made on diabetes care is not evenly distributed, since the world richest countries contribute to more than 80%. More than three-quarters of this expenditure is being used for people between 50 and 80 years of age [51]. The cost estimates of a chronic disease like diabetes is a real challenge given its wide scope and different entities mainly direct, indirect and intangible costs. In the USA, where most of diabetes cost studies were conducted, the direct cost of diabetes at a country level is estimated at US\$176 billion, and the indirect cost is US\$69 billion [7]. To correctly assess such cost, many epidemiological, clinical and economical parameters have to be available to estimate diabetes cost, which can be difficult in some countries.

The fourth edition of IDF Atlas published in 2010 attempted to come up with an estimate on the health expenditure for diabetes using general data produced by relatively simple formula, which is subjected to how well the assumptions used in the formula fits the situation in each country [51]. It was compared with the data obtained from developed countries where, the

direct diabetes cost was studied. These estimates were found to be less accurate for the developing countries as a result of poor quality data and the lack of well designed health economic studies.

Pondering upon the data published from the IDF Atlas on health expenditure for diabetes in the GCC countries [51] and as shown in **Table 3**, it is evident that there is an underestimation of the health expenditure on diabetes in those countries. This is clearly shown by the direct cost estimates published from UAE in 2010 where the annual direct cost for patients without complications amounted to US\$1605 [50]. Using IDF data, the direct health expenditure in UAE for diabetes in the year 2010 was approximately US\$1067. The UAE study also showed that this cost would increase by 2.2-times with any microvascular complications and by 4.6-times with any macrovascular complications, and by 9.4-times when both complications are present [50], thereby increasing the cost markedly.

Saudi Arabia is outmosting all GCC countries in health expenditure for diabetes and spending 21% of the total health expenditure on this disease. Other GCC countries are spending between 16 and 19% of their health expenditure on diabetes. The mean diabetes health expenditure per patient was very low in Saudi Arabia and Oman, while it was the highest in Qatar and moderate in UAE, Kuwait and Bahrain. This was far less than what is needed when comparing those countries with Nauru, which is facing the same challenge, but spent 41% of its total health expenditure on diabetes [52]. **Table 3** is also forecasting direct diabetes cost in the year 2030, where it is expected to increase by almost three-times. This increase is on the basis of increasing prevalence and number of diabetic patients.

Table 3. Gulf Cooperation Council countries diabetes health expenditure in the year 2010 and the increased expenditure in 2030[†].

Country	Health expenditure for diabetes in 2010 (‘000)				(%) diabetes of total health expenditure R = 2 [‡]	Mean diabetes health expenditure per person		Health expenditure for diabetes in 2030			
	US\$		International dollars			US\$ R = 2 [‡]	ID R=2 [‡]	US\$		International dollars	
	R = 2 [‡]	R = 3 [‡]	R = 2 [‡]	R = 3 [‡]				R = 2 [‡]	R = 3 [‡]	R = 2 [‡]	R = 3 [‡]
Bahrain	73,004	114,695	95,933	150,719	19	950	1248	135,284	221,460	177,775	291,018
Kuwait	232,650	373,650	165,937	266,504	16	1,010	720	561,520	924,309	400,502	659,267
Oman	91,422	149,041	114,277	186,301	18	507	634	187,995	313,389	234,993	391,737
Qatar	251,556	387,696	147,643	227,545	18	2960	1737	463,458	735,330	272,011	431,577
Saudi Arabia	1,409,562	2,246,478	1,793,416	2,858,242	21	682	868	2,989,442	4,836,078	3,803,532	6,153,046
United Arab Emirates	453,346	698,950	340,146	524,422	16	1,067	800	1,114,218	1,720,645	835,998	1,291,000

[†]International Diabetes Federation (IDF): Economic impact of diabetes [51].

[‡]R: the ratio of medical care expenditure for persons with diabetes to age- and sex-matched persons without diabetes.

Based on the findings mentioned above, it is strongly recommended to conduct cost analysis studies in those countries that would take in consideration the nature of the disease, psychosocial factors and economic impact. According to our current knowledge, the health expenditure for diabetes is suboptimal in the GCC countries and this gap will even widened if primary and secondary prevention programs are not initiated.

Future perspective

Diabetes mellitus is standing as a major health problem in the GCC countries that have clearly pressurized health services and economy owing to its increased prevalence. Diabetes chronic complications are posing another challenge by increasing morbidity and mortality among diabetic patients. This medical problem has put three GCC countries so far among the top ten countries facing high prevalence at a global level. With this health problem growing so fast, those countries could not meet the demand on health services or health expenditure. Healthcare services need to be looked at, where primary care system should be empowered and health insurance is directed to have its share in diabetes health expenditure. Modern and innovative disease management systems that are available nowadays, like e-health systems and web-based applications may help in providing good medical services effectively and at a lower cost [53].

In spite of the fact that, GCC countries are facing this disease challenge, none so far has managed to start primary or secondary prevention programs, except for some activities related to hospital based services and scattered public programs. There have been many primary prevention studies that proved, beyond no doubt, that lifestyle modification would reduce Type 2 diabetes incidence in different ethnicities [54–56]. This has led many countries in Europe to come up with their own prevention programs and develop quality and outcome indicators (i.e., IMAGE) [57], that could be adopted by the GCC countries as well.

The GCC countries are lacking studies that would expose direct and indirect diabetes cost, which will be the basis for future plan to stand against this disease and its economical burden.

Acknowledgements

The author would like to thanks The Cooperation Council for the Arab States of the Gulf represented by Prof. Tawfik Khoja for providing statistics data for GCC countries.

Financial & competing interests disclosure

The authors have no relevant affiliations or financial involvement with any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript. This includes employment, consultancies, honoraria, stock ownership or options, expert testimony, grants or patents received or pending, or royalties.

No writing assistance was utilized in the production of this manuscript.

References

Papers of special note have been highlighted as:
• of interest; •• of considerable interest

- 1 Yach D, Stuckler D, Brownell KD. Epidemiologic and economic consequences of the global epidemics of obesity and diabetes. *Nat. Med.* 12(1), 62–66 (2006).
- **Important commentary on epidemiologic and economic consequences of the global epidemics of obesity and diabetes that shouldn't be missed by the reader.**
- 2 Shaw JE, Sicree RA, Zimmer PZ. Global estimates of the prevalence of diabetes for 2010 and 2030. *Diabetes Res. Clin. Pract.* 87(1), 4–14 (2010).
- 3 International Diabetes federation IDF Diabetes Atlas (sixth edition). www.idf.org/sites/default/files/EN_6E_Atlas_Full_0.pdf
- 4 United Nations. General Assembly Resolution. A/RES/66/2. www.un.org/Docs/asp/ws.asp?m=A/RES/66/2
- 5 WHO Spending on health: a global overview. www.who.int/mediacentre/factsheets/fs319/en/
- 6 Zhang P, Zhang X, Brown JB *et al.* Global healthcare expenditure on diabetes for 2010 and 2030. *Diabet. Res. Clin. Pract.* 87, 293–301 (2010).
- 7 American Diabetes Association. Economic Costs of Diabetes in the U.S. in 2012. *Diabetes Care* 36(4), 1033–1046 (2013).
- **Well-performed prevalence based study providing detailed estimate for economic costs of diabetes and highlights its substantial burden on the society.**
- 8 Arab M. The economics of diabetes care in the Middle East. In: *International Textbook of Diabetes Mellitus (2nd Edition)*. Alberti K, Zimmer P, Defronzo R (Eds). John Wiley and Sons Ltd, Chichester, UK (1997).
- 9 World Bank. World Bank Data, WHO parameters, 1999–2000. World bank 2000. <http://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG?page=2>
- 10 Scully T. Diabetes in numbers. *Nature* 485, S2–S3 (2012).
- 11 Bacchus RA, Bell JL, Madkour M, Kilshaw B. The prevalence of diabetes mellitus in male Saudi Arabs. *Diabetologia* 23(4), 330–332 (1982).
- 12 Fatani HH, Mira SA, El-Zubier AG. Prevalence of diabetes mellitus in rural Saudi Arabia. *Diabetes Care* 10 (2), 180–183 (1987).
- 13 Abu-Zeid AH, Al-Kassab AS. Prevalence and health care features of hyperglycaemia in semi urban-rural communities in Southern Saudi Arabia. *Diabetes Care* 15(4), 484–489 (1992).
- 14 Abdella N, Khogali M, Al-Ali S, Guma K, Bajaj J. Known Type 2 diabetes mellitus among the Kuwaiti population. *Acta Diabetol.* 33(2), 145–149 (1996).
- 15 Al-Nozha M, Al-Maatouq M, Al-Mazrou YY *et al.* Diabetes mellitus in Saudi Arabia. *Saudi Med. J.* 25, 1603–1620 (2004).
- 16 Asfour MG, Lambourne A, Soliman A *et al.* High prevalence of diabetes mellitus and

- impaired glucose tolerance in the Sultanate of Oman: results of the 1991 national survey. *Diabetic Med.* 12(12), 1122–1125 (1995).
- 17 Al-Asi T. Overweight and obesity among Kuwait oil company employees: a cross-sectional study. *Occupational Med.* 53(7), 431–435 (2003).
 - 18 Al-Mahroos F, Al-Roomi K. Obesity among adult Bahraini population: impact of physical activity and educational level. *Ann. Saudi Med.* 21, 183–187 (2001).
 - 19 Al-Lawati AJ, Al Riyami AM, Mohammed AJ, Jousilahti P. Increasing prevalence of diabetes mellitus in Oman. *Diabet. Med.* 19(11), 954–957 (2002).
 - 20 Baynouna LM, Revel AD, Nagelerke NJ *et al.* High prevalence of the cardiovascular risk factors in Al-Ain, United Arab Emirates. An emerging health care priority. *Saudi Med. J.* 29(8), 1173–1178 (2008).
 - 21 Saadi H, Carruthers SG, Nagelkerke N *et al.* Prevalence of diabetes mellitus and its complications in a population-based sample in Al-Ain, United Arab Emirates. *Diabet. Res. Clin. Practice* 78(3), 369–377 (2007).
 - 22 Al-Moosa S, Allin S, Jemiai N, Al-Lawati J, Mossialos E. Diabetes and urbanization in the Omani population: an analysis of national survey data. *Popul. Health Metr.* 4, 5 (2006).
 - 23 Bener A, Zirie M, Janahi IM, Al-Hamag A, Musallam M, Wareham NJ. Prevalence of diagnosed and undiagnosed diabetes mellitus and its risk factors in a population based study of Qatar. *Diabet. Res. Clin. Practice* 84(1), 99–106 (2009).
 - 24 Malik M, Bakir A, Abi Saab B, Roglic G, King H. Glucose intolerance and associated factors in the multi-ethnic population of the United Arab Emirates: results of a national survey. *Diabet. Res. Clin. Practice* 69(2), 188–195 (2005).
 - 25 Al-Nuaim AR. Prevalence of glucose intolerance in urban and rural communities in Saudi Arabia. *Diabetic Med.* 14(7), 595–602 (1997).
 - 26 Abdella N, Al Arouj M, Al Nakhi A, Al Assoussi A, Moussa M. Non-insulin-dependent diabetes in Kuwait: prevalence rates and associated risk factors. *Diabet. Res. Clin. Pract.* 42(3), 187–196 (1998).
 - 27 Alhyas L, McKay A, Balasanthiran A, Majeed A. Prevalences of overweight, obesity, hyperglycaemia, hypertension and dyslipidaemia in the Gulf: systematic review. *JRS Med Short Rep.* 2(7), 55 (2011).
 - Excellent systematic review, synthesizing data from a large body of studies concerning the prevalence of overweight, obesity, hyperglycemia, hypertension and dyslipidemia in the Gulf.
 - 28 The World Bank. Life expectancy at birth, total (years), data as of 2011. http://data.worldbank.org/indicator/SP.DYN.LE00.IN?order=wbapi_data_value_2011+wbapi_data_value+wbapi_data_value-last&sort=asc,/
 - 29 2013 International Diabetes Federation. Risk factors. www.idf.org/about-diabetes/risk-factors
 - 30 Mabry RM, Reeves MM, Eakin EG, Owen N. Evidence of physical activity participation among men and women in the countries of the Gulf cooperation council: a review. *Obes. Rev.* 11(6), 457–464 (2010).
 - Excellent review for studies that examined the prevalence and gender differences in physical activity participation among Gulf Cooperation Council (GCC) adults.
 - 31 Badran M, Laher I. Type II diabetes mellitus in Arabic-speaking countries. *Int. J. Endocrinol.* 2012, 902873 (2012).
 - 32 Tadmouri GO, Nair P, Obeid T, Al Ali MT, Al Khaja N, Hamamy HA. Consanguinity and reproductive health among Arabs. *Reprod. Health* 6, 17 (2009).
 - 33 Al-Gazali L, Hamamy H, Al-Arrayad S. Genetic disorders in the Arab world. *BMJ* 333 (7573), 831–834 (2006).
 - 34 Akl EA, Gunukula SK, Aleem S *et al.* The prevalence of waterpipe tobacco smoking among the general and specific populations: a systematic review. *BMC Public Health* 11, 244 (2011).
 - 35 Jarallah JS, Al-Rubeaan KA, Al-Nuaim AA, Al-Ruhaily AA, Kalantan KA. Prevalence and determinants of smoking in three regions of Saudi Arabia. *Tob. Control* 8, 53–56 (1999).
 - 36 GCC Healthcare Industry. 13 December 2013. ALPEN CAPITAL. <http://itac.ca/wp-content/uploads/2013/03/Alpen-Capitals-GCC-Healthcare-report-2011.pdf>
 - 37 World Health Statistics 2011. www.who.int/whosis/whostat/2011/en/
 - 38 Mona Mourshed, Viktor Hediger, Toby Lambert. Gulf Cooperation Council Health Care: Challenges and Opportunities. McKinsey & Company. <http://faculty.ksu.edu.sa/al-hathloul/Health%20Economics/GCC%20Demand%20for%20Health%20Care.pdf>
 - Important document that interpreted the challenges and opportunities of health care in the GCC countries.
 - 39 WHO: World health statistics 2009: Health workforce, infrastructure, essential medicines. www.who.int/whosis/whostat/EN_WHS09_Table6.pdf
 - 40 The World Bank. Mortality rate, infant (per 1,000 live births). data as of 2011. <http://data.worldbank.org/indicator/SP.DYN.IMRT.IN>
 - 41 The World Bank. Maternal mortality ratio (model estimate, per100,000live births) data as of 2010. <http://data.worldbank.org/indicator/SH.STA.MMRT/>
 - 42 Elayne J Heisler. The U.S. Infant Mortality Rate: International Comparisons, Underlying Factors, and Federal Programs. *Congressional Research Service*. <http://fas.org/sgp/crs/misc/R41378.pdf>
 - 43 Alhyas L, McKay A, Balasanthiran A, Majeed A. Quality of Type 2 Diabetes Management in the States of The Co-Operation Council for the Arab States of the Gulf: A systematic Review. *PLoS ONE* 6(8), e22186 (2011).
 - First systematic review evaluating the quality of diabetes care in the GCC region by three major intermediate outcome measures (glycemic control, blood pressure, and lipid profile).
 - 44 Al-Adsani AM, Moussa MA, Al-Jasem LI, Abdella NA, Al-Hamad NM. The level and determinants of diabetes knowledge in Kuwaiti adults with Type 2 diabetes. *Diabetes Metab.* 35(2), 121–128 (2009).
 - 45 Al-Maskari F, El-Sadig M, Al-Kaabi JM, Afandi B, Nagelkerke N, Yeatts KB. Knowledge, Attitude and Practices of Diabetic Patients in the United Arab Emirates. *PLoS ONE* 8(1), e52857 (2011).
 - 46 Elliott JA, Abdulhadi NN, Al-Maniri AA, Al-Shafae MA, Wahlstrom R. Diabetes self-management and education of people living with diabetes: a survey in primary health care in Muscat Oman. *PLoS ONE* 8(2), e57400 (2013).
 - 47 The World Bank. Population (total) data as of 2012. <http://data.worldbank.org/indicator/SP.POP.TOTL>
 - 48 Health system financing profile by country. http://apps.who.int/nha/database/StandardReport.aspx?ID=REPORT_COUNTRY_PROFILE
 - 49 Alkhamis A, Hassan A, Cosgrove P. Financing healthcare in Gulf Cooperation Council countries: a focus on Saudi Arabia. *Int. J. Health Plann. Mgmt.* 29, e64–e82 (2014).
 - 50 Fatma M, Mohammed S, Nicholas N. Assessment of the direct medical costs of

- diabetes mellitus and its complications in the United Arab Emirates. *BMC Public Health* 10, 679 (2010).
- The first and only study from one of the GCC countries to assess the direct medical costs of diabetes mellitus and its complications.
- 51 Ping Zhang, Xinzhi Zhang, Jonathan Betz Brown, Dorte Vistisen, Richard A. Economic impact of diabetes. www.idf.org/sites/default/files/Economic_impact_of_Diabetes.pdf
- 52 Amina K, Philayrath P, Ben J S *et al.* Prevalence and risk factors of diabetes and impaired fasting glucose in Nauru. *BMC Public Health* 11,719 (2011).
- 53 Piette JD, Lun KC, Moura LA Jr *et al.* Impacts of e-health on the outcomes of care in low- and middle-income countries: where do we go from here? *Bull. World Health Organ.* 90, 365–372 (2012).
- 54 The diabetes prevention program research group. The Diabetes Prevention Program. Design and methods for a clinical trial in the prevention of Type 2 diabetes. *Diabetes Care* 22, 623–634 (1999).
- 55 Lindstrom J, Louheranta A, Mannelin M, I. The Finnish diabetes prevention study (dps): lifestyle intervention and 3-year results on diet and physical activity. *Diabetes Care* 26(12), 3230–3236 (2003).
- 56 Pan XR, Hu YH, Li GW *et al.* Impaired glucose tolerance and its relationship to ecgindicated coronary heart disease and risk factors among Chinese. Da Qing IGT and diabetes study. *Diabetes Care* 16(1), 150–156 1993).
- 57 Quality and Outcome Indicators for Prevention of Type 2 Diabetes In Europe – IMAGE (2010). www.thl.fi/thl-client/pdfs/9ddd6466-cf97-4e40-ba77-614a153251f2