The impact of seven major noncommunicable diseases on direct medical costs, absenteeism, and presenteeism in Gulf Cooperation Council countries

Eric Andrew Finkelstein, Jesse D. Malkin, Drishti Baid, Ada Alqunaibet, Khaled Mahdi, Mohammed Bin Hamad Al-Thani, Buthaina Abdulla Bin Belaila, Ebrahim Al Nawakhtha, Saleh Alqahtani, Sameh El-Saharty, and Christopher H. Herbst

ABSTRACT

Aims: To estimate the current burden of seven major noncommunicable diseases on direct medical costs, absenteeism, and presenteeism in the six countries in the Gulf Cooperation Council: Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates.

Materials and methods: We used data from pre-existing datasets and the literature. We identified seven major noncommunicable diseases for which data were available: coronary heart disease, stroke, type-2 diabetes mellitus, breast cancer, colon cancer, chronic obstructive pulmonary disease, and asthma. We estimated the per unit cost (the annual cost of treating each illness for one person) of each disease, multiplied per unit cost by disease prevalence counts to generate disease-specific costs, and then summed across diseases. We calculated the cost of absenteeism and presenteeism by multiplying the gross domestic product per person in the labor force by the loss in productivity from each disease due to absenteeism and presenteeism, respectively, and the prevalence in the labor force of each disease.

Results: We estimate that the direct medical costs of seven major noncommunicable diseases in Gulf Cooperation Council countries are $16.7 billion (2019 International $), equal to 0.6% of gross domestic product. We estimate that absenteeism and presenteeism due to these seven noncommunicable diseases cost 0.5 and 2.2% of gross domestic product, respectively.

Limitations: Our study does not capture all noncommunicable diseases and does not capture all types of indirect costs. Our cost estimates are particularly sensitive to our assumptions regarding type-2 diabetes mellitus.

Conclusion: The economic burden of noncommunicable diseases in Gulf Cooperation Council countries is substantial, suggesting that successful preventive interventions have the potential to improve both population health and reduce costs. Further research is needed to capture a broader array of noncommunicable diseases and to develop more precise estimates.

Introduction

Much has been written about the economic costs of non-communicable diseases (NCDs) globally. NCDs not only increase the direct costs of health care, but also impose indirect costs such as increased absenteeism (lost output due to missed days of work) and presenteeism (lost output due to diminished productivity while at work). Quantifying these costs draws attention to the additional burden that NCDs impose, beyond traditional measures of morbidity and mortality. These costs are thus useful in planning and resource allocation decisions.

Relatively few studies have attempted to quantify economic costs caused by NCDs in the countries that comprise the Gulf Cooperation Council (GCC), an intergovernmental political and economic union that consists of all the Arab countries of the Persian Gulf region other than Iraq. To date, most of the few studies that have been conducted focused on one condition in one country. Salman, Al Sayyad, and Ludwig (2019), for example, estimated the direct cost of type-2 diabetes mellitus in Bahrain. Al-Busaidi, Habibullah, and Soriano (2013) estimated the direct cost of asthma in Oman. Khaddadah (2013) estimated the direct cost of asthma in Kuwait. Al-Maskari (2010) estimated the direct cost of...
type-2 diabetes mellitus among patients without complications in United Arab Emirates. Alzaabi, Alseiari, and Mahboub (2014) estimated the direct cost of treating asthma patients in Abu Dhabi, United Arab Emirates. These studies are not comparable, however, because they relied on different methods and data sources. Moreover, these studies estimated direct medical costs only, omitting indirect costs entirely.

Given the paucity of evidence on the economic burden of NCDs in GCC countries, the objective of this study was to provide estimates of direct and indirect costs in the six GCC countries: Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and United Arab Emirates. We estimated three types of costs that arise from seven major NCDs: (1) direct medical costs, including the cost of hospitalizations, outpatient visits, emergency department visits, general practitioner visits, and prescription drugs; and indirect costs arising from (2) absenteeism and (3) presenteeism.

Methods

Our analysis relied upon pre-existing datasets, as described below. We used a bottom-up approach to estimate costs. We started by identifying seven NCDs for which data were available: (1) coronary heart disease, (2) stroke, (3) type-2 diabetes mellitus, (4) breast cancer, (5) colon cancer, (6) chronic obstructive pulmonary disease (COPD), and (7) asthma. We excluded many NCDs for which data were not available such as major depression, anxiety disorders, Alzheimer’s, epilepsy, sleep disorders, and lung cancer.

To estimate direct medical costs, we began by estimating the prevalence and per unit cost—the annual cost of treating each illness for one person—for each of the seven NCDs separately in each of the six GCC countries. We used prevalence data from the Institute for Health Metrics and Evaluation’s Global Disease Burden database. Our per unit cost estimates for Saudi Arabia, Kuwait, Qatar, and United Arab Emirates for coronary heart disease, stroke, type-2 diabetes mellitus, breast cancer, and colon cancer are from Ding, Lawson, and Kolbe-Alexander et al. (2016). Since this study did not provide per unit cost estimates for Bahrain and Oman, we imputed per unit cost data for these two countries based on the median per unit cost in the other four GCC countries (i.e. the mean of the per unit costs in the middle two countries). We then multiplied this estimate by the ratio of per capita health spending in Bahrain or Oman, respectively, to median per capita health spending in the other four GCC countries to account for differences in overall health spending across countries.

Because Ding, Lawson, and Kolbe-Alexander et al. (2016) did not provide per unit cost estimates for COPD and asthma, we obtained estimates from the literature. Our per unit cost estimates for COPD were based on the per unit cost reported in a German study, adjusting for overall per capita health spending in each GCC country relative to Germany. We chose this study because the estimated per unit cost was the median among three studies identified in the literature. Our per unit cost estimates for asthma were based on estimates from Abu Dhabi, United Arab Emirates. As above, we adjusted these estimates by each country’s per capita health spending relative to per capita health spending in the United Arab Emirates.

We updated monetary figures in local currencies to 2019 costs using country-specific annual inflation rates. We then converted these figures to 2019 International dollars ($) by dividing local currency by the Purchasing Power Parity exchange rate. All our cost estimates are reported in 2019 International $. We multiplied the prevalence rate for each disease in each country by the population in each country to obtain estimates of the prevalence (number of cases) of each disease in each country, then multiplied the number of cases by per unit annual costs to arrive at an estimate of total annual direct medical costs for each condition in each country. We summed up the costs of each disease in each country to obtain estimates of total annual direct medical costs for all seven NCDs in each country.

We used the same estimates as Rasmussen, Sweeny, and Sheehan (2016) regarding the percentage productivity loss due to absenteeism and presenteeism per employee per year for each of the seven diseases in our analysis. These estimates were based upon earlier research by Goetzel, Long, and Ozminkowski et al. (2004) on productivity loss due to absenteeism and presenteeism by disease. We multiplied the loss of productivity due to absenteeism or presenteeism by the estimated number of cases of each disease among part- and full-time workers and by per capita gross domestic product (GDP) among those in the workforce to generate disease-specific absenteeism and presenteeism costs. To obtain estimates of total productivity losses, we summed absenteeism and presenteeism costs. We summed across diseases to generate total absenteeism, presenteeism, and productivity losses. For ease of comparison across countries, we compared direct medical costs to GDP in each GCC country. We also compared absenteeism, presenteeism, and productivity losses to each country’s GDP. These comparisons provide perspective of the burden of NCDs across GCC countries.

To test the variation of our results to our assumptions, we conducted several sensitivity analyses. We considered the impact of replacing our base case type-2 diabetes mellitus per unit cost estimates with lower and higher per unit cost estimates from published studies conducted in Saudi Arabia, adjusting these estimates upward or downward based on per capita health spending in each GCC country relative to Saudi Arabia. We also assessed the impact of imputing per unit COPD costs based on estimates from Greece or the United States, respectively, rather than from the German study used in our base case analysis. Again, we adjusted these estimates based on per capita health spending in each country relative to the United States or Germany, respectively. We replaced type 2 diabetes mellitus prevalence data from the GBD database with higher prevalence estimates from the International Diabetes Foundation. Finally, we replaced our estimates of the impact of stroke and type-2 diabetes mellitus on absenteeism and presenteeism with estimates used in a recent
unpublished Kuwait study. These estimates were derived from four previously published studies: Salman, Alsayyad, and Ludwig, Mitchell and Bates (2011), Wang, Beck, and Berglund et al. (2003), and Bommer, Heesemann, and Sagalova et al.

**Results**

Estimated mortality, prevalence, and per capita annual medical costs for each condition are presented in Table 1. In all six GCC countries, coronary heart disease causes the most deaths of the seven NCDs considered here; type-2 diabetes mellitus is the most prevalent, with estimates ranging from 4.4% in Oman to 13.3% in Bahrain. Following type-2 diabetes mellitus are asthma, with estimates ranging from 2.5% in Saudi Arabia to 6.8% in the United Arab Emirates, and coronary heart disease, where the lowest estimated prevalence is in Qatar (1.7%) and the highest is in Bahrain (3.5%). Breast and colon cancer are relatively uncommon in all countries, with prevalence rates no higher than 0.2% (breast cancer prevalence in Kuwait and Bahrain). Estimated per capita annual medical costs range from a low of $37 for asthma in Oman to a high of $4,569 for colon cancer in Qatar.

Multiplying these estimates by the number of individuals in each country with each condition and summing across conditions reveals that the annual total direct medical costs of these seven NCDs in the six GCC countries is $16.7 billion. Of this total, 61.2% is attributable to type-2 diabetes mellitus, 13.0% is due to COPD, 11.6% is due to stroke, and 8.8% is due to coronary heart disease. Only 0.5% is due to breast cancer and 0.5% is due to colon cancer. Table 2 provides a breakdown of estimated annual direct medical costs for each condition in each country.

The amount that each GCC country spends on these NCDs relative to its GDP is shown in Table 3. Relative to GDP, Oman and Qatar spend the least on these NCDs (0.4% of GDP) and Bahrain spends the most (1.0% of GDP).

Estimated absenteeism, presenteeism, and productivity costs are presented in Table 4. Across the six GCC countries, estimated absenteeism and presenteeism costs due to NCDs total $15.3 billion and $65.3 billion, respectively. Combining these two costs reveals that total productivity losses are $80.6 billion annually. The largest driver of absenteeism costs...
is asthma. Type-2 diabetes mellitus is the largest driver of presenteeism costs. By contrast, breast cancer and colon cancer—which are much less prevalent than type-2 diabetes mellitus and asthma—have relatively minor effects on absenteeism and presenteeism costs.

Estimated absenteeism, presenteeism, and total reduced productivity costs as percentages of GDP are shown in Table 5. Across all six GCC countries, absenteeism and presenteeism costs are equal to 0.5% of GDP and 2.2% of GDP, respectively. The cost of absenteeism is highest in Oman (1.8% of GDP) and lowest in Qatar and Saudi Arabia (0.4% of GDP). The cost of presenteeism is highest in Oman (6.9% of GDP) and lowest in Qatar and Saudi Arabia (2.0% of GDP).

Summing absenteeism and presenteeism costs reveals that the highest cost resulting from productivity losses is in Oman (8.7% of GDP) and the lowest is in Qatar and Saudi Arabia (2.4% of GDP).

In the above analyses, we relied on country-specific per unit type-2 diabetes mellitus costs from Kuwait, Qatar, Saudi Arabia, and United Arab Emirates reported by Ding, Lawson, Kolbe-Alexander et al.9. These estimates ranged from a low of $271 in Oman to a high of $3,456 in the United Arab Emirates. Replacing these with much higher estimates based on Mokdad, Tuffaha, Hanlon et al. (2015)16—who reported per unit costs of $9,009 in Saudi Arabia—increases combined direct medical costs in the six GCC countries more than twofold to $43.3 billion (1.5% of GDP). Replacing per unit type-2 diabetes mellitus costs with a lower estimate from Almutairi and Alkharfy (2013)17—who reported per unit costs of $1,605—reduces combined direct medical costs to $13.0 billion (0.4% of GDP). Replacing our base case type 2 diabetes mellitus prevalence estimates8 with higher estimates from the International Diabetes Foundation18 increases estimated direct medical costs, absenteeism costs, and presenteeism costs to $22.9 billion

| Table 3. Estimated total direct medical costs vis-à-vis GDP in GCC countries. |
|---------------------------------|---------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Total direct medical costs (millions of 2019 International $) | Total direct medical costs as a % of GDP (%) |  |  |  |  |  |  |
| Bahrain | 794 | 1.0 |  |  |  |  |  |
| Kuwait | 1,806 | 0.8 |  |  |  |  |  |
| Oman | 104 | 0.4 |  |  |  |  |  |
| Qatar | 1,172 | 0.4 |  |  |  |  |  |
| Saudi Arabia | 8,472 | 0.5 |  |  |  |  |  |
| UAE | 4,371 | 0.6 |  |  |  |  |  |
| GCC | 16,719 | 0.6 |  |  |  |  |  |

Abbreviations. NCD, noncommunicable disease; UAE, United Arab Emirates; GCC, Gulf Cooperation Council.

| Table 4. Estimated absenteeism, presenteeism, and productivity costs Due to NCDs in GCC countries. |
|---------------------------------|---------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Estimated annual absenteeism costs (millions of 2019 Int $) | Estimated annual presenteeism costs (millions of 2019 Int $) | Estimated annual productivity losses (millions of 2019 Int $) |  |  |  |  |
| Bahrain | 27 | 101 | 32 | 4 | 82 | 107 | 430 |
| Kuwait | 199 | 32 | 12 | 84 | 217 | 534 |
| Oman | 65 | 4 | 154 | 341 | 1,068 |
| Qatar | 254 | 9 | 182 | 333 | 1,027 |
| Saudi Arabia | 1,290 | 29 | 1,688 | 1,857 | 7,505 |
| UAE | 513 | 67 | 1,032 | 2,284 | 4,749 |
| Total | 2,616 | 372 | 3,223 | 5,140 | 15,314 |

Estimated annual productivity losses for each country were calculated as the sum of estimated annual absenteeism and presenteeism costs. This was then multiplied by the total number of working days per year to calculate the total annual productivity losses for each country. The total number of working days per year for each country was calculated as the product of the total number of working days per year and the percentage of the working age population.

| Table 5. Estimated absenteeism, presenteeism, and productivity costs vis-à-vis GDP in GCC countries. |
|---------------------------------|---------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Total costs (millions of 2019 International $) | Total costs as a % of GDP (%) |  |  |  |  |  |
| Absenteeism | Presenteeism | Productivity | Absenteeism (%) | Presenteeism (%) | Productivity (%) |  |  |  |
| Bahrain | 430 | 2,223 | 2,653 | 0.6 | 2.9 | 3.4 |
| Kuwait | 1,068 | 4,879 | 5,947 | 0.5 | 2.2 | 2.7 |
| Oman | 534 | 2,033 | 2,567 | 1.8 | 6.9 | 8.7 |
| Qatar | 1,027 | 5,441 | 6,468 | 0.4 | 2.0 | 2.4 |
| Saudi Arabia | 7,504 | 40,859 | 33,354 | 0.4 | 2.0 | 2.4 |
| UAE | 4,749 | 22,115 | 17,365 | 0.7 | 2.5 | 3.2 |
| GCC | 15,314 | 80,609 | 65,295 | 0.5 | 2.2 | 2.7 |

Abbreviations. UAE, United Arab Emirates; GCC, Gulf Cooperation Council. Sums may not add to totals due to rounding.

JOURNAL OF MEDICAL ECONOMICS 831
Higher diabetes prevalence $^{22.9} 0.8 16.8 0.6 86.1 2.9 102.9 3.5$
Lower COPD per unit cost $d 15.3 0.5 15.3$
Higher COPD per unit cost $c 18.3 0.6 15.3$
Lower diabetes per unit cost $b 13.0 0.4 15.3$

NCDs in Western countries

There is a large literature on the direct and indirect cost of NCDs in Western countries. \(^{23}\) By comparison, estimated direct medical costs in Saudi Arabia in our study were 0.5% of GDP.

A Kuwait study conducted by Ministry of Health Kuwait et al. (2020) \(^{19}\) estimated that the direct medical costs of four NCD categories—cardiovascular disease, diabetes, cancer, and respiratory illnesses—were equal to 37.3% of total health spending in 2018. By comparison, we estimate that the seven NCDs we examined led to direct medical costs equal to just 15.6% of health spending in Kuwait in 2019. These two analyses, however, are not comparable because of differences in the way the disease groups are defined. For example, we limited our analysis to Kuwaitis who had either breast or colon cancer (9,256 individuals, assuming no overlap), whereas the Kuwait analysis considered Kuwaitis with any form of cancer (30,999 individuals). Our analysis included Kuwait patients with COPD or asthma (213,299 individuals, assuming no overlap), whereas the Kuwait study examined individuals with any form of chronic respiratory disease (469,561 individuals). Had we considered broader disease categories—as the Kuwaiti authors did—our estimates would have been closer to those reported in the Kuwait study.

Previous studies have reported highly divergent estimates of the per unit cost of type-2 diabetes mellitus \(^{9,16,17}\), the largest driver of direct medical costs in our analyses. We took this uncertainty into account by performing sensitivity analyses using a range of estimates drawn from published sources. Our results are very sensitive to our assumptions regarding the per unit cost of type-2 diabetes mellitus. Our assumptions regarding type-2 diabetes mellitus prevalence also affected our results significantly, albeit to a smaller extent than our assumptions regarding the per unit cost. The reason for this is that type-2 diabetes mellitus prevalence estimates do not differ by as much as the per unit cost estimates.

Changing our estimate of the per unit cost of COPD had relatively little effect on our results because COPD is responsible for a relatively small proportion of NCD direct costs.

Indirect costs

Absenteeism and presenteeism costs resulting from the seven NCDs in Saudi Arabia are equal to 0.4 and 2.0% of GDP, respectively. By comparison, Rasmussen, Sweeny, and Sheehan \(^{14}\) estimated absenteeism and presenteeism costs due to NDCs in Saudi Arabia of 1.5 and 4.3% of GDP, respectively. The discrepancies between our estimates and theirs are due to our more limited list of NCDs; our estimates would be much higher if we were to include a larger number of NCDs in our analysis. No other comparable estimates in GCC countries were available.
As noted above, our results show that asthma is the largest driver of absenteeism costs whereas type-2 diabetes mellitus is the largest driver of presenteeism costs. There is some evidence that treatment of asthma has a greater beneficial effect on presenteeism than on absenteeism (Sadatsafavi, Rousseau, and Chen et al. 2014). It is possible that the inverse is true for type-2 diabetes mellitus, which (for various physiological reasons) often is associated with increased urination. In a Japanese survey of workers who had been treated for type-2 diabetes mellitus, 10.5% of respondents said they had to use the toilet frequently and that this adversely affected their work (Nakajima 2017). It is possible that other type 2 diabetes mellitus complications (e.g., sensitivity to light and neuropathy) and effects of poorly controlled blood sugar levels (e.g., diminished mental clarity) also adversely affect presenteeism to a greater extent than absenteeism.

On the other hand, it is also possible that our estimate of the impact of type 2 diabetes mellitus on presenteeism—drawn from Rasmussen, Sweeny, and Sheehan—is too high. Replacing our estimates with those used by the authors of the aforementioned Kuwait study sharply reduces the effect of type 2 diabetes mellitus on presenteeism costs.

Oman’s high productivity losses vis-à-vis other GCC countries (Table 5) reflect its large labor force (third-largest in the GCC behind Saudi Arabia and the United Arab Emirates) relative to the size of its economy (smallest GDP by far in the GCC). In other words, Oman’s economy is more labor-intensive than those of its GCC neighbors, so it incurs greater absenteeism and presenteeism costs when people are ill.

Conclusion

Overall, our base case analysis of direct medical costs of the included NCDs is conservative due to our use of type-2 diabetes mellitus per unit cost and prevalence estimates that are on the low end of published estimates. Moreover, as noted above, our analysis included only seven out of dozens of NCDs.

Our analysis of indirect costs, by contrast, may be either downwardly or upwardly biased: Downward bias results from the limited number of NCDs in our analysis, whereas upward bias may result from our use of a high-end estimate of the effect of type 2 diabetes mellitus on presenteeism.

The indirect costs of NCDs are not limited to the costs arising from absenteeism and presenteeism. Incorporating indirect costs due to premature mortality, reduced labor force participation, care provided by family and friends, and intangible costs such as pain and suffering would add to these totals. Such costs were omitted from our analysis.

Although it was not possible to catalogue all of the costs of NCDs—and some costs were not calculated with precision due to uncertainties in the underlying parameters—our results nevertheless indicate that NCDs impose a significant economic burden on GCC countries. This raises the possibility that interventions that prevent NCDs can simultaneously improve health outcomes and reduce economic costs. Since the median age in GCC countries is 28.4 years and those at highest risk of most NCDs are middle-aged and elderly adults, the economic burden of NCDs is likely to increase in the future in the absence of interventions, providing further financial justification for implementing programs aimed to reduce risk factors for NCDs.

Our analysis shows that the most significant driver of NCD costs is type-2 diabetes mellitus, which is heavily influenced by lifestyle factors—in particular diet and exercise choices that lead to obesity. Type-2 diabetes also has the potential to increase costs for the other included NCDs. Standard treatment typically includes healthy eating, frequent exercise, and weight loss, which would also reduce risk factors for many other NCDs. Diabetes treatment may also include diabetes medication or insulin therapy along with blood sugar monitoring. Preventive interventions that reduce obesity (and hence type-2 diabetes mellitus) should be strongly considered. This includes the interventions designated as “best buys” by the World Health Organization for prevention and treatment of NCDs and other cost-effective interventions such as Saudi Arabia’s excise tax on sugar-sweetened beverages.

Transparency

Declaration of funding

Funding for this research was provided by the World Bank under its advisory services program to the Gulf Cooperation Council countries. The sponsor—the World Bank—participated in the preparation of this paper.

Declaration of financial/other interests

No potential conflict of interest was reported by the author.

JME peer reviewers on this manuscript have no relevant financial or other relationships to disclose.

Author contributions

EAF, JM, CH, and SES conceived, designed, and coordinated the assessment. EAF and JM analyzed the data. All authors participated in drafting the manuscript. All authors read and agreed to publish the manuscript.

Acknowledgements

Open Access funding provided by the Qatar National Library. The authors are thankful to Issam Abousleiman, World Bank Country Director for GCC countries; Rekha Menon, Practice Manager for Health Nutrition and Population in the MENA region; and Keiko Meiwa, Regional Director for Human Development, World Bank, for the support throughout. The authors are also thankful to Wael Ahmed Shelpai and Hira Abdulrazzaq from the United Arab Emirates who provided critical technical inputs into the draft.

ORCID

Jesse D. Malkin http://orcid.org/0000-0001-7666-1532
Ada Alquaibet http://orcid.org/0000-0002-3193-2586
References

[1] Bloom D, Cafiero ET, Jané-Llopis E, et al. The global economic burden of noncommunicable diseases. Geneva: World Economic Forum, 2011.

[2] Muka T, Imo D, Jaspers L, et al. The global impact of non-communicable diseases on healthcare spending and national income: a systematic review. Eur J Epidemiol. 2015;30(4):251–277.

[3] Salman RA, AlSayyad AS, Ludwig C. Type 2 diabetes and healthcare resource utilisation in the Kingdom of Bahrain. BMC Health Serv Res. 2019;19(1):939.

[4] Al-Busaidi NH, Habibullah Z, Soriano JB. The asthma cost in Oman. SQUMJ. 2013;13(2):218–223.

[5] Khadadah M. The cost of asthma in Kuwait. Med Princ Pract. 2013;22(1):87–91.

[6] Al-Maskari F, El-Sadig M, Nagelkerke N. Assessment of the direct medical costs of diabetes mellitus and its complications in the United Arab Emirates. BMC Public Health. 2010;10:679. (Published 2010 Nov 8).

[7] Alzaabi A, Alseiari M, Mahboub B. Economic burden of asthma in Abu Dhabi: a retrospective study. Clinicoecon Outcomes Res. 2014;6:445–450.

[8] IHME (Institute for Health Metrics and Evaluation). 2021. Global burden of disease (GBD) database. http://ghdx.healthdata.org/gbd-results-tool.

[9] Ding D, Lawson KD, Kolbe-Alexander TL, et al. The economic burden of physical inactivity: a global analysis of major non-communicable diseases. Lancet. 2016;388(10051):1311–1124.

[10] Wacker ME, Jørges RA, Schulz H, COSYCONET-Consortium, et al. Direct and indirect costs of COPD and its comorbidities: results from the German COSYCONET study. Respir Med. 2016;111:39–46.

[11] Soulisiotis K, Kousoulakou H, Hillas G, et al. The direct and indirect costs of managing chronic obstructive pulmonary disease in Greece. Int J Chron Obstruct Pulmon Dis. 2017;12:1395–1400.

[12] Dalal AA, Christensen L, Liu F, et al. Direct costs of chronic obstructive pulmonary disease among managed care patients. Int J Chron Obstruct Pulmon Dis. 2010;5:341–349 (Published 2010 Oct 5).

[13] World population review; 2020 [cited 2020 Dec 1]. Available from: https://worldpopulationreview.com/.

[14] Rasmussen B, Sweeney K, Sheehan P, Health and the economy: the impact of wellness on workforce productivity in global markets. Washington (DC): U.S. Chamber of Commerce. 2016.

[15] Goetzel RZ, Long SR, Ozminkowski RJ, et al. Health, absence, disability, and presenteeism cost estimates of certain physical and mental health conditions affecting U.S. employers. J Occup Environ Med. 2004;46(4):398–412.

[16] Mokdad AH, Tufaha M, Hanlon M, et al. Cost of diabetes in the Kingdom of Saudi Arabia, 2014. J Diabet Metab. 2015;6:575.

[17] Almutairi N, Alkharfy KM. Direct medical cost and glycemic control in type 2 diabetic Saudi patients. Appl Health Econ Health Policy. 2013;11(6):671–675.

[18] International Diabetes Foundation. IDF diabetes atlas. 9th ed. Brussels (Belgium); 2019.

[19] Ministry of Health Kuwait, United Nations Development Programme, World Health Organization, Secretariat of the UN Inter-Agency Task Force on NCDs. Prevention and control of non-communicable diseases in Kuwait: The case for investment. United Nations Development Programme and the World Health Organization; 2020.

[20] Mitchell RJ, Bates P. Measuring health-related productivity loss. Popul Health Manag. 2011;14(2):93–98.

[21] Wang PS, Beck A, Berglund P, et al. Chronic medical conditions and work performance in the health and work performance questionnaire calibration surveys. J Occup Environ Med. 2003;45(12):1303–1311.

[22] Bommer C, Heesemann E, Sagalova V, et al. The global economic burden of diabetes in adults aged 20–79 years: a cost-of-illness study. Lancet Diabetes Endocrinol. 2017;5(6):423–430.

[23] American Diabetes Association. Economic costs of diabetes in the U.S. in 2017. Diabetes Care. 2018;41(5):917–928.

[24] Jacobs E, Hoyer A, Brinks R, et al. Healthcare costs of type 2 diabetes in Germany. Diabet Med. 2017;34(6):855–861.

[25] Charbonnel B, Simon D, Dallongeville J, et al. Direct medical costs of type 2 diabetes in France: an insurance claims database analysis. Pharmacoepic Open. 2018;2(2):209–219.

[26] Nurmegambetov T, Kuwahara R, Garbe P. The economic burden of asthma in the United States, 2008–2013. Ann Am Thorac Soc. 2018;15(3):348–356.

[27] Heidenreich PA, Trogdon JG, Khavjou OA, et al. Council on Cardiovascular Surgery and Anesthesia, and Interdisciplinary Council on Quality of Care and Outcomes Research. American Heart Association Advocacy Coordinating Committee; Stroke Council; Council on Cardiovascular Radiology and Intervention; Council on Clinical Cardiology; Council on Epidemiology and Prevention; Council on Arteriosclerosis; Thrombosis and Vascular Biology; Council on Cardiopulmonary; Critical Care; Perioperative and Resuscitation; Council on Cardiovascular Nursing; Council on the Kidney in Cardiovascular Disease; Council on Cardiovascular Surgery and Anesthesia, and Interdisciplinary Council on Quality of Care and Outcomes Research. Forecasting the future of cardiovascular disease in the United States: a policy statement from the American Heart Association. Circulation. 2011;123(8):934–944.

[28] Ford ES, Murphy LB, Khavjou O, et al. Total and state-specific medical and absenteeism costs of COPD among adults aged ≥18 years in the United States for 2010 and projections through 2020. Chest. 2015;147(1):31–45.

[29] Garg CC, Evans DB. What is the impact of non-communicable diseases on national health expenditures: a synthesis of available data. Discussion Paper 3, HSF and HSS. Geneva: WHO; 2011.

[30] UN Interagency Task Force on NCDs. The investment case for noncommunicable disease prevention and control in the Kingdom of Saudi Arabia: return on investment analysis & institutional and context analysis. 2017. Geneva: World Health Organization.

[31] Sadatsafavi M, Rousseau R, Chen W, et al. The preventable burden of productivity loss due to suboptimal asthma control: a population-based study. Chest. 2014;145(4):787–793.

[32] Nakajima E, Japan Organization of Occupational Health and Safety. Research reports on development and dissemination of support strategy for balancing work with treatment and for returning to work of workers with diabetes; the impact of diabetes status on presenteeism in Japan. J Occup Environ Med. 2017;62(8):654–661.

[33] World Health Organization. “Best buys” and other recommended interventions for the prevention and control of noncommunicable diseases; 2017 (cited 2020 Dec 10). Available from: https://www.who.int/ncds/management/WHO_Appendix_BestBuys_LS.pdf.

[34] Alsukait R, Wilde P, Bleich SN, et al. Evaluating Saudi Arabia’s 50% carbonated drink excise tax: Changes in prices and volume sales. Econ Hum Biol. 2020;38:100868.

[35] Alsukait R, Bleich S, Wilde P, et al. Sugary drink excise tax policy process and implementation: case study from Saudi Arabia. Food Policy. 2020;90:101789.