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Research Article
Investigating Cause-specific Mortality in GCC Countries Through Multivariate Statistical Methods

[1]Igor Barahona and [2]Tarifa Almulhim

[1]Institute of Mathematics, Cuernavaca Unit, National Autonomous University of Mexico, Universidad avenue, Chamilpa, Cuernavaca, 62210 Morelos
[2]College of Business Administration, King Faisal University, P.O. Box 380, Al-Ahsa 31982, Saudi Arabia

Abstract

Background and Objective: The Gulf Cooperation Council (GCC) is a group member of states, namely, Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates (UAE), which are currently high-income countries according to the World Bank. Several studies have been performed on cause-specific mortality in high-income and developed countries all over the world but no studies exist on cause-specific mortality in the GCC region. The aim of this study is to carry out a multivariate analysis and provide empirical (explanative) evidence regarding the most critical, frequent causes of mortality in GCC countries. **Materials and Methods:** The study was based on cause-specific mortality data for GCC countries from the World Health Organization (WHO). By applying a multiple correspondence analysis and heat maps, we investigate associations between a set of 19 types of non-communicable diseases for six GCC countries. **Results:** Mortality caused by non-communicable diseases show different prevalence and intensities on each country, however, two factors are identified as primary risk for all GCC countries: (i) Harmful habits and lifestyles (smoking, lack of physical activity, etc) and (ii) Extreme weather conditions that characterize the region. **Conclusion:** There are common risk factors causing mortality in GCC region. Policy makers in the healthcare, life insurance and actuarial sectors should find this work useful for improving decision making processes, since GCC countries have joint agreements in these areas.

Key words: Cause-specific mortality, GCC countries, data visualizations, multiple correspondence analysis, heat map, risk factors, non-communicable diseases

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Corresponding Author: Igor Barahona, Institute of Mathematics, Cuernavaca Unit, National Autonomous University of Mexico, Universidad avenue, Chamilpa, Cuernavaca, Morelos 62210 Tel: +52 7773291683

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

In several high-income countries, such as the Organization for Economic Cooperation and Development (OECD) countries, experts believe that general trends in life expectancy and mortality have been steadily changing for decades[1,2]. In the late 1980s, researchers began to study trends in mortality and life expectancy, with the objective of obtaining measures for constructing and analyzing various social policies, which were related to social health, insurance and pensions.

The Cooperation Council for the Arab States of the Arabian Gulf region, often referred to as the GCC, is a group of six countries, namely, Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates. A cooperative group framework for the GCC was formed in 1981. The GCC countries are rapidly developing wealthy nations with many similarities. They are some of the most rapidly increasing economies in the world due to growth in oil and natural gas incomes[3]. The GCC states have generally experienced continued population growth from the time when oil was first discovered in this region in the 1960s[3]. Moreover, the GCC countries' demographics and health outcomes have changed significantly over the past three decades[4]. While the lowest growth was registered in Oman, the biggest was shown in UAE. The population in these countries grown by a factor of 6.6 and 97.4, respectively. The foregoing can be explained in terms of the changes that both countries had experienced on their economies. In the early 1960s, oil resources generate approximately the 90% government's revenue for both countries. Six decades later, this number changed to 85% for Oman and 30% for UAE. Economy diversification and jobs creations have been a priority for UAE during the mentioned period. It has attracted families from all over the wold but specially from neighbour countries, which is manifested on rapid population growth.

Life expectancy and mortality have changed dramatically in GCC countries due to their growth and evolution. For this indicator, the lowest value is for Saudi Arabia with 76 years, in contrast with the highest, equal to 76 reported by Bahrain and Qatar[5,6]. Moreover, alongside economic changes and geopolitical developments of the GCC nations, health problems have been increasing. Certain groups of specific diseases are believed to be responsible for the majority of deaths[3,7,8]. For instance, indicators and measures that better describe causes of mortality by type, gender, region, season, etc. are necessary to provide policy makers with more accurate information. Better-informed decisions will inevitably be reflected in the prevention of diseases and improvements to the health and pension systems. To the best of our knowledge, in contrast with other regions around the world, research on cause-specific mortality for causes of death in GCC countries has been non-existent.

According to the World Health Organization report in 2010, mortality records indicate the numbers of individual deaths by place, time and specific cause such as non-communicable diseases[9-11]. The literature provides a very long history and a growing range of studies on mortality modelling, prediction and analysis. Lee and Carter[12] and McN own and Rogers[13], conducted two of the earliest works on the stochastic modelling of mortality. These reports were followed by numerous studies on mortality modelling and forecasting, which were reviewed by several authors[14,15]. Researchers such as statisticians, actuaries and demographers have used three broad methodological development approaches: Expectation, extrapolation and explanation[15-23]. Despite this progress, studies on cause-of-death mortality are lacking for many developing countries and GCC states.

According to the WHO Global status report on non-communicable diseases, up to 50% of people die before the age of 60 years from non-communicable diseases, which are characterized by long duration and very slow progression, such as heart disease, cancer, diabetes, chronic lung disease and other chronic respiratory diseases[24]. There is evidence that these non-communicable diseases constitute the majority of the diseases in GCC countries due to unhealthy lifestyles in GCC countries, which involve physical inactivity, high caloric intake, insufficient focus on disease management and prevention, a lack of early-stage disease interventions and insufficient treatment alternatives for managing non-communicable diseases and their complications. However, most developing countries still have limited data and information about mortality and causes of death of their populations as reported by WHO[24]. The GCC states have a poor history of demographic and mortality data collection[25,26]. Suppressive governmental policies or neglect by some governments of data collection and archiving were the main reasons behind the poor historical data availability in the GCC[11].

To the extent that the available data allow, this study has three specific objectives. The first objective is to perform an exploratory data analysis regarding the most frequent causes of death in GCC countries. The second is to propose a classification of the GCC countries according to which cause-specific mortality is most critical. Finally, this paper provides empirical (explanative) evidence regarding the most

critical causes of deaths, to support policy makers in fields such as healthcare, pensions and health and social insurance. At the time that this study was conducted, no other research had been conducted with these objectives within the context of GCC countries.

MATERIALS AND METHODS

This study focuses on mortality data based on The International Statistical Classification of Diseases and Related Health Problems (ICD) in the six GCC countries, Fig. 1 illustrates a map indicating GCC states and Table 1 shows total populations. The latest version is the 10th Revision, which was authorized by the Forty-third World Health Assembly in May 1990. For GCC countries, the WHO mortality database (www.who.int/healthinfo/mortality_data) provides data for the period 2000-2014. The ICD-10 was designed as a system of diagnostic codes for classifying diseases into 19 major categories, each of which includes a set of similar diseases. These categories are listed in Table 2. For the sake of simplicity, in this study, the 19 categories of ICD-10 are coded from T1-T19 as shown in Table 2.

However, the ICD-10 data on mortality are missing for some calendar years in some GCC countries, from these data can be inferred that Bahrain and Kuwait had implemented better data management systems, in contrast with UAE and Qatar.

Multiple correspondence analysis (MCA) is a multivariate statistical method that is suitable for investigating data composed of categorical variables. While principal component analysis is more appropriate for continuous data, MCA enables exploring relationships among discrete data. The factor scores in the MCA algorithm are obtained through the singular value decomposition by applying Eq. 1:

Table 1: Total populations of GCC countries[26]

	Total population (Thousands)						
Country	1960	1970	1980	1990	2000	2010	2015
Bahrain	162	213	360	496	665	1241	1372
Kuwait	270	747	1372	2100	2051	2998	3936
Oman	552	724	1154	1812	2268	3041	4200
Qatar	47	110	224	476	592	1780	2482
Saudi Arabia	4087	5836	9741	16327	20764	27426	31557
UAE	93	235	1042	1860	3155	8271	9154

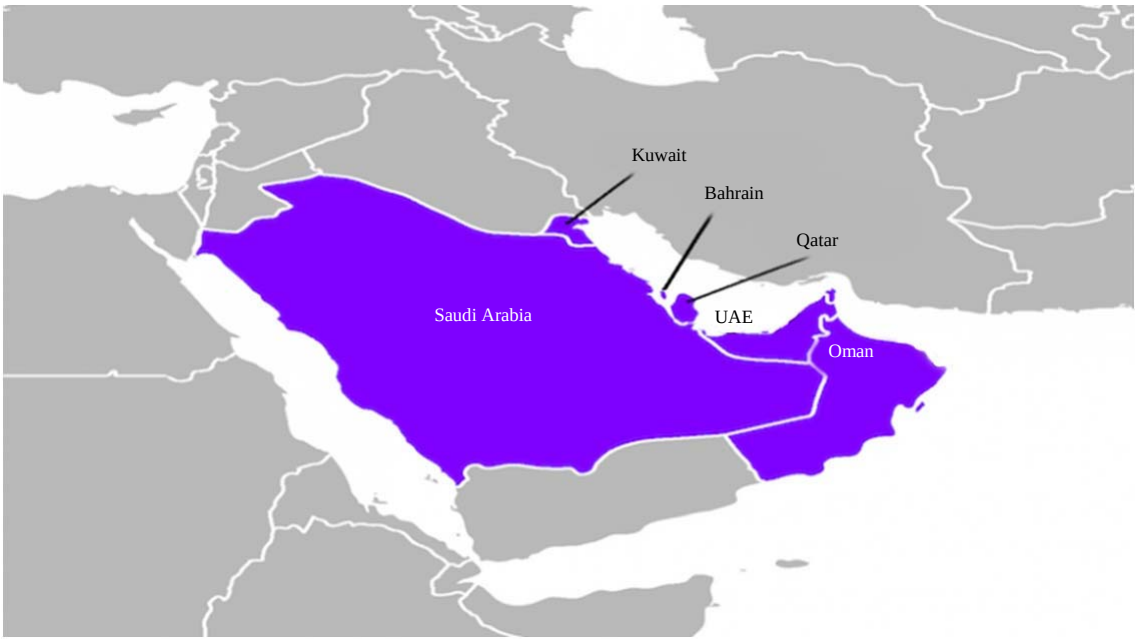

Fig. 1: Map indicating GCC member states (Sources: https://www.worldatlas.com/articles/gulf-cooperation-council-gcc-countries.html)

Table 2: International classification of diseases and related health problems, 10th revision

Codes	Type of disease
T1	Certain infectious and parasitic diseases
T2	Neoplasms
T3	Diseases of the blood and blood-forming organs
T4	Endocrine, Nutritional and Metabolic and Immunity disorders
T5	Mental disorders
T6	Diseases of the nervous system
T7	Diseases of the eye and adnexa
T8	Diseases of the ear and mastoid process
T9	Diseases of the circulatory system
T10	Diseases of the respiratory system
T11	Diseases of the digestive system
T12	Diseases of the skin and subcutaneous tissue
T13	Diseases of the musculoskeletal system and connective tissue
T14	Diseases of the genitourinary system
T15	Pregnancy, childbirth and the puerperium
T16	Conditions originating in the perinatal period
T17	Congenital malformations, deformations and abnormalities
T18	Symptoms, signs and abnormal clinical and laboratory findings
T19	External causes of morbidity and mortality

$$D_r^{(-½)} = (Z - rc^T)D_c^{(-½)} = P\Delta Q^T \quad (1)$$

On expression (1), the diagonal matrix of singular values is denoted by Δ and the matrix of eigenvalues by Δ^2. Note that in formula (1), P is related to the rows and Q is related to columns. After performing some algebra operations, the former expression is transformed on Eq. 2 and 3, which allow to obtain numerical approximations for factor scores:

$$F = D_r^{(-½)}P\Delta \quad (2)$$

$$G = D_c^{(-½)}Q\Delta \quad (3)$$

According to Abdi and Valentin[27], a remarkable property of MCA is its capacity for generating intuitive and "easy-to-read" visualizations, taking Eq. 2 and 3 as a starting point. Let $f_{i,j}$ be the absolute frequency for row i on variable j. Then, the squared cosines between i and factor l and j and factor l are obtained by the Eq. 3 and 4:

$$O_{i,l} = \frac{F_{i,l}^2}{d_{r,i}^2} \quad (4)$$

$$O_{j,l} = \frac{G_{j,l}^2}{d_{c,j}^2} \quad (5)$$

In literature is suggested that only those factors with eigenvalues greater than 1.0 should be considered in the analysis[28]. Thus, only the first l factors, which satisfy, $\lambda>1$ are retained.

For proximities between column-points (variables), some authors distinguish between two cases[27]. If the distance between different categorical variables is small, then they tend to have similar values for the investigated individuals. Second, if the distance between levels of the same categorical variable are not small, the existence of groups (clusters) of observations is indicated and each group might be related to a different category.

Based on previously presented formulations, this study applies MCA to investigate relationships among mortality data in GCC. Moreover, data is represented by using heat maps, which are ingenious formats for displaying data[29].

RESULTS

The MCA output, which comprises the 19 types of diseases for six countries, is presented in Fig. 2. The diseases are presented in blue and the countries are highlighted in red.

Additionally, results enabled us to cluster the investigated countries into three groups, according to the diseases that are most prevalent. Cluster I, which includes Bahrain and Oman, is highlighted in Fig. 2. Note that these countries are more closely related to diseases T3, T12, T13, T4 and T5. A second cluster is formed with three countries: Kuwait, Qatar and UAE. We identify these countries as related to diseases T1, T2, T6, T9, T10, T11, T17 and T19. Finally, Saudi comprises the third cluster, which is most closely related to diseases T14, T15, T16 and T18.

In brief, from these results, the following main findings are stand out:

- Conditions that originate in the perinatal period (T16) and symptoms, signs and abnormal clinical and laboratory findings (T18), show higher prevalence in Saudi Arabia
- Neoplasms (T2) and diseases of the circulatory system (T9) are more prevalent in Kuwait
- Diseases of the respiratory system (T10) and congenital malformations, deformations and abnormalities (T17) are more prevalent in UAE

Second part of results comprises heat maps. Head maps are obtained with two principal axes of the Multiple Correspondence Analysis. On figure 3, an aggregated measure of all diseases is given by red and blue colours. While the most intense red indicates higher presence of the studied diseases; the darkest blue refers to the least sick countries. In between, different tones and diseases levels. Clusters are highlighted with black lines). To visually distinguish between countries based on the prevalence of diseases, two colours were used.

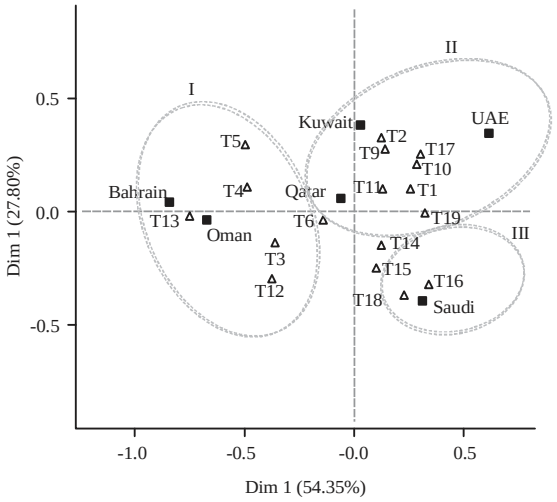

Fig. 2: Multiple correspondence analysis for diseases and countries

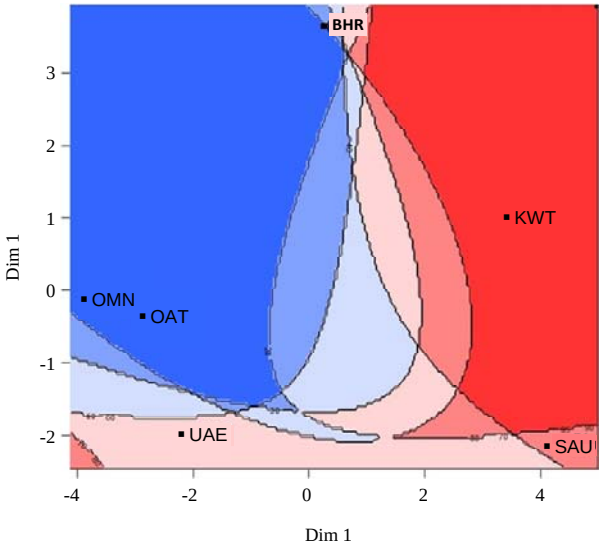

Fig. 3: Heat map for countries based on total numbers of diseases. An aggregated measure of all diseases is given by red and blue colours. While the most intense red indicates higher presence of the studied diseases; the darkest blue refers to the least sick countries. In between, different tones and diseases levels. Clusters are highlighted with black lines

Different tones of red are employed to indicate higher levels of all diseases, whereas blue tones indicate lower levels. Kuwait is identified as the country with the highest number of prevalence of diseases, followed by Saudi and UAE. More than 50% of the total number of diseases occur in these countries. In contrast, in blue, Oman is identified as the country with the fewest illnesses, followed by Qatar and Bahrain (Fig. 3).

Maps of the region on Fig. 4a-f are provided. Each country is coloured according to the prevalence of each disease. For the sake of simplicity, only the six diseases with the highest prevalence are projected onto the region maps. According to Fig. 4a, Kuwait clearly has most occurrences of disease T10, followed by Saudi Arabia and UAE. In the case of disease T15, Saudi Arabia has the highest percentage. Kuwait also has the highest percentage for disease T9. In the case of disease T13, Bahrain has the highest percentage. For disease T4, Kuwait has the highest percentage. Finally, in the case of disease T16, Saudi has the highest percentage.

As it is detailed explained on the following section, among the main causes for these results are some habits of the civil population and extreme weather conditions on the region.

DISCUSSION

One of the most intriguing findings is the increasing number of non-communicable diseases occurring in GCC countries, with special emphasis on Kuwait, Saudi Arabia and UAE. This increase may be because the emergence of non-communicable diseases is strongly correlated with certain habits and lifestyles. Specifically, smoking, physical inactivity and unhealthy diets are considered triggers for chronic diseases such as lung cancer, hypertension and diabetes.

According to a 2017 WHO report on the global tobacco epidemic[30], higher rates of smoking (for youth and adult tobacco use for both sexes) among GCC countries are found in Kuwait, Saudi Arabia and UAE. Unsurprisingly, the prevalence of certain diseases of the respiratory system is increasing (T10), with the highest prevalence in Kuwait, followed by Saudi Arabia and UAE (Fig. 4a). A second factor is related to weather conditions in the region. Specifically, dust storms and suspended particles are major sources of air pollution in the GCC countries. Strong dust storms frequently cover the entire region throughout the year[31]. Moreover, gas emissions, such as volatile and non-volatile organic carbon, sulfide compounds, hydrocarbons and nitrogen oxides, which result from energy production (e.g., oil and gas refineries) are very common sources of air pollution in many industrial sites in the GCC countries[31]. Other authors provided evidence that air quality and atmospheric pollution levels are associated with daily variations in mortality[32]. Probability of mortality from certain diseases that are closely related to the respiratory system (T10) is increasing in GCC countries, refer to Fig. 4a.

Meanwhile, regarding unhealthy dietary habits, in this region women represent a larger group and incorporate fewer fruits and vegetables into their diets than men[3]. Women also

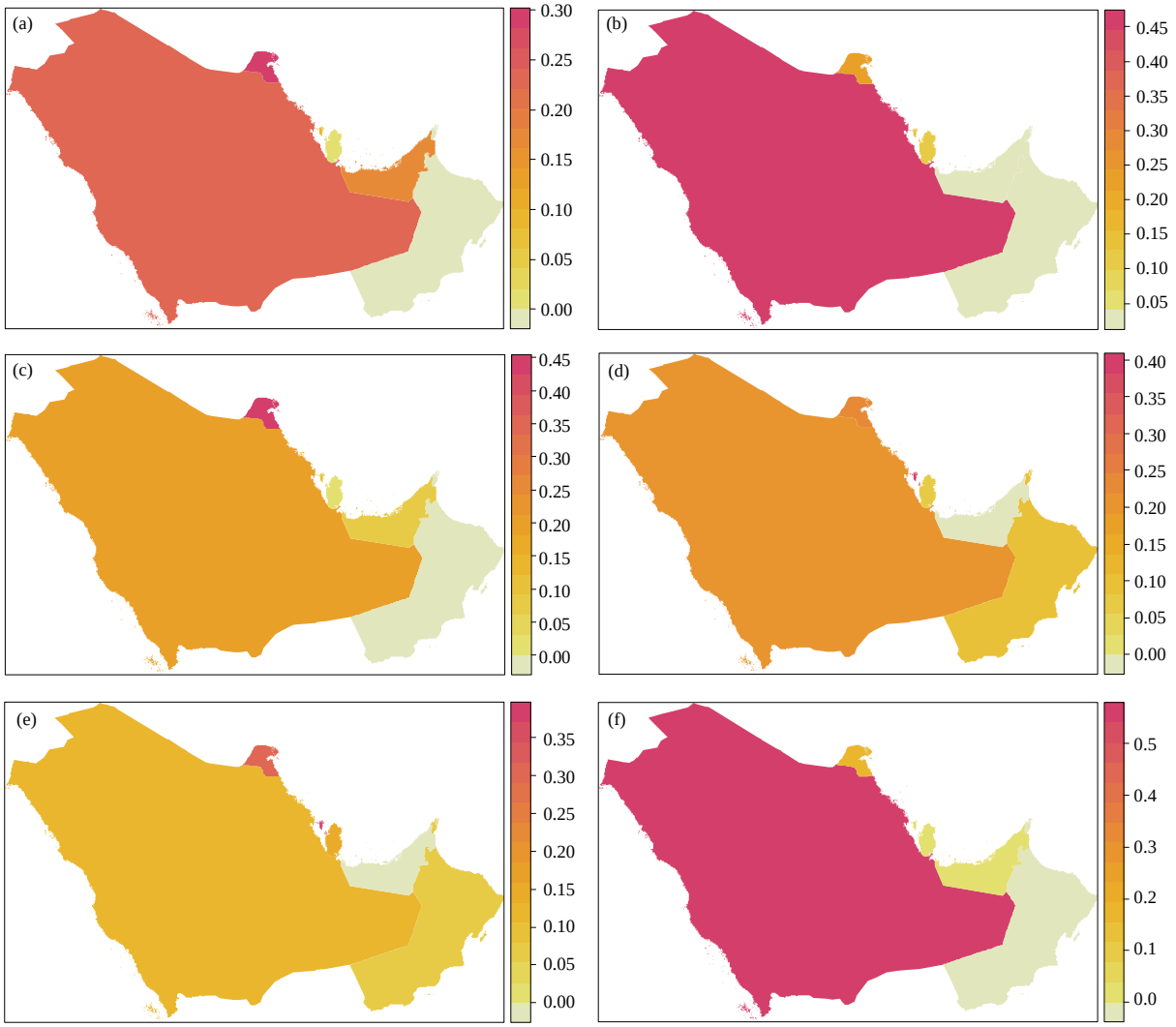

Fig. 4(a-f): (a)Diseases of respiratory system (T10), (b) Pregnancy, childbirth and the puerperium (T15), (c) Circulatory system disease (T9), (d) Musculoskeletal disease (T13), (e) Immunity disorders (T4) and (f) Conditions originating in the perinatal periodimmunity disorders (T16). Vertical axis refers to disease levels in six clusters and normalized between 0-1

engage in less physical activity. For this factor, Saudi Arabia has the highest rates and Oman the lowest. The extreme weather conditions that prevail in the region, which are characterized by high humidity and temperature, might explain why people are discouraged from engaging in outdoor activities. This may be why Saudi Arabia ranks in the top three in terms of prevalence of the following types of diseases: pregnancy, childbirth and the puerperium (T15) (45%), conditions originating in the perinatal period (T16) (65%) and symptoms, signs and abnormal clinical and laboratory findings (T18) (50%). In contrast, Oman has the lowest percentages of people with pregnancy, childbirth and the puerperium (T15) (4%) and conditions originating in the perinatal period (T16) (9%). Table 3 provides percentages for all investigated countries.

Regarding obesity and overweight problems, we observe that all GCC countries show rates higher than the threshold suggested by the WHO, except for Oman[9,24]. Kuwait has the highest obesity rate, followed by Saudi Arabia[3]. Moreover, obesity is one of main causes of circulatory system diseases (T9). Table 3 and Fig. 4c show that Kuwait has the highest mortality percentage for disease T9 (45%), followed by Saudi Arabia (22%) and UAE (16%).

Table 3: Disease prevalence by country

Country	T1 (%)	T2 (%)	T3 (%)	T4 (%)	T5 (%)	T6 (%)	T7 (%)	T8 (%)	T9 (%)	T10 (%)	T11 (%)	T12 (%)	T13 (%)	T14 (%)	T15 (%)	T16 (%)	T17 (%)	T18 (%)	T19 (%)	Total (%)
BHR	12	13	35	37	44	21	27	0	14	12	16	42	38	18	15	6	8	9	7	13
KWT	27	40	20	30	28	33	0	0	45	31	32	8	24	21	22	22	39	3	26	28
OMN	6	4	8	8	10	5	55	0	4	4	5	5	10	5	4	4	3	9	3	5
QAT	4	9	7	14	6	9	0	0	5	6	9	7	7	8	10	5	7	11	10	8
SAUDI	31	18	31	11	2	32	18	0	22	26	27	39	21	39	45	56	25	50	37	32
UAE	20	16	0	0	10	0	0	0	10	21	12	0	0	10	4	7	18	18	17	14

Several studies have found a correlation between rapid economic growth and risk of diabetes[33]. Other studies have shown that physical inactivity and fatty food are associated with an increased risk of diabetes[3,34,35]. This perception is compatible with our findings, in which Bahrain, Saudi Arabia and Kuwait have the highest percentages of mortality due to diseases related to blood and blood-forming organs (T3), refer to Table 3. In the same context, Saudi Arabia, Kuwait and Bahrain have the highest populations that eat less healthy food and engage in less physical activity as documented in literature[3]. Furthermore, Saudi Arabia's economy ranks third in the Middle East and North Africa region and Kuwait ranks 5th in the latest edition of the World Economic Forum's Global Competitiveness Report 2014-15[36]. Our results provide complementary evidence supporting a relation between diabetes risk and economic growth. Additional evidence points to the existence of a strong relation between the risk of non-communicable diseases and unhealthy habits (smoking, high-calorie foods, physical inactivity and overweight)[17,37,38]. This is consistent with the results of other studies, in which strong correlations between smoking, lack of physical activity and risk of lung cancer[17,37] and between air pollution and deaths associated with respiratory systems are demonstrated[32].

In GCC countries, the common systems of healthcare, pension and health and social insurance were created when the leaders of the GCC countries recognized the importance of the social and economic impacts of pension and social insurance policies on their citizens[25]. Based on the results of this MCA study, which are shown in Fig. 2, Kuwait, Qatar and UAE were identified as the countries that are most severely affected by diseases T1, T2, T6, T9, T10, T11, T17 and T19. Consequently, policy makers in the Secretariat General of the GCC should focus on those diseases when they write the laws and regulations for the healthcare agreements.

However, there is still a need to collect up-to-date data on cause-specific mortality in the GCC region, which is essential for decision makers in developing the regional healthcare system, pension and health and social insurance. For instance, until now, no reliable study has been reported on predicting current and future cause-specific mortality rates of non-communicable diseases. Such predictions are essential because they enable decision makers and actuaries in GCC countries to evaluate the impact of cause-specific mortality rates on pension and social insurance policies.

CONCLUSION

This study was carried out to investigate the cause-specific mortality in six GCC countries for a set of 19 types of non-communicable diseases from WHO. This study concluded that share common risk factors such as smoking, physical inactivity, unhealthy diets. Dust storms and oil and gas emissions are highly associated with cause-specific mortality in GCC countries. This should help researchers and policy makers in the healthcare, life insurance and actuarial sectors to better understand and evaluate the risk of cause-specific mortality.

SIGNIFICANCE STATEMENT

The present study applies a multivariate statistical method and heat map to addresses most frequent causes of mortality in the GCC region. It recommends a classification of the GCC countries according to which cause-specific mortality in order to provide explanative evidences for the common risk factors associated with the mortality in GCC countries. This is can be beneficial for policy makers in tackling the increased risk of non-communicable diseases, which will lead to growing cost and poorly quality in the healthcare and actuarial sectors in the GCC region. Critically, this can guide policy makers as to where interventions and improvements are needed. Thus, a new risk assessment model from an actuarial perspective will be the subject of future study.

REFERENCES

1. Antolin, P., 2007. Longevity risk and private pensions. OECD Working Papers on Insurance and Private Pensions, No. 3, OECD Publishing. https://www.oecd.org/finance/private-pensions/37977228.pdf
2. White, K.M., 2002. Longevity advances in high income countries, 1955-96. Popul. Dev. Rev., 28: 59-76.

3. Ng, S.W., S. Zaghloul, H.I. Ali, G. Harrison and B.M. Popkin, 2011. The prevalence and trends of overweight, obesity and nutrition related non communicable diseases in the Arabian Gulf States. Obes. Rev., 12: 1-13.
4. Yount, K.M. and A.M. Sibai, 2009. Demography of Aging in Arab Countries. In: International Handbook of Population Aging, Uhlenberg, P. (Ed.). Springer, Netherlands, ISBN: 978-1-4020-8355-6, pp: 277-315.
5. Alkraiji, A., O. El-Hassan and F. Amin, 2014. Health informatics opportunities and challenges: Preliminary study in the cooperation council for the Arab States of the Gulf. J. Health Inform. Dev. Countries, 8: 36-45.
6. ADG Center, 2011. Life evaluations in the GCC: Subjective well-being and health. ADG Center. https://news.gallup.com/poll/157064/life-evaluations-gcc-subjective-wellbeing-health.aspx
7. Mourshed, M., V. Hediger and T. Lambert, 2008. Gulf cooperation council health care: Challenges and opportunities. Global Competitiveness Reports. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.183.7279&rep=rep1&type=pdf
8. Quintero-Sarmiento, A., E. Cepeda-Cuervo and V. Nunez-Anton, 2012. Estimating infant mortality in Colombia: Some overdispersion modelling approaches. J. Applied Stat., 39: 1011-1036.
9. Winckler, O., 2009. Arab Political Demography: Population Growth, Labor Migration and Natalist Policies. Sussex Academic Press, Eastbourne, United Kingdom, ISBN: 9781845192389, Pages: 328.
10. Booth, H. and L. Tickle, 2011. Mortality modelling and forecasting: A review of methods. Ann. Actuarial Sci., 3: 3-43.
11. WHO., 2017. Noncommunicable Diseases Progress Monitor. World Health Organization, Geneva, ISBN: 978-92-4-151302-9, Pages: 231.
12. Lee, R.D. and L.R. Carter, 1992. Modeling and forecasting U.S. mortality. J. Am. Stat. Assoc., 87: 659-671.
13. McNown, R. and A. Rogers, 1989. Forecasting mortality: A parameterized time series approach. Demography, 26: 645-660.
14. Grover, G., R. Vajala and P.K. Swain, 2015. On the assessment of various factors effecting the improvement in CD4 count of aids patients undergoing antiretroviral therapy using generalized Poisson regression. J. Applied Stat., 42: 1291-1305.
15. Alho, J.M., 2000. "The Lee-Carter method for forecasting mortality, with various extensions and applications", Ronald Lee, January 2000. N. Am. Actuar. J., 4: 91-93.
16. Tabeau, E., A.V.D.B. Jeths and C. Heathcote, 2001. Forecasting Mortality in Developed Countries: Insights from a Statistical, Demographic and Epidemiological Perspective. Springer Science and Business Media Press, USA.
17. Bray, I., 2002. Application of Markov chain Monte Carlo methods to projecting cancer incidence and mortality. J. R. Stat. Soc. Applied Stat. Ser. C, 51: 151-164.
18. Brouhns, N., M. Denuit and J.K. Vermunt, 2002. A Poisson log-bilinear regression approach to the construction of projected lifetables. Insurance: Math. Econ., 31: 373-393.
19. Li, N., L. Ronald and T. Shripad, 2004. Using the Lee-Carter method to forecast mortality for populations with limited data. Int. Stat. Rev., 1: 19-36.
20. Currie, I.D., M. Durban and P.H.C. Eilers, 2004. Smoothing and forecasting mortality rates. Stat. Model., 4: 279-298.
21. Girosi, F. and G. King, 2008. Demographic Forecasting. Princeton University Press, Princeton, ISBN: 9780691130958, Pages: 267.
22. Cairns, A.J.G., D. Blake, K. Dowd, G.D. Coughlan and M. Khalaf-Allah, 2011. Bayesian stochastic mortality modelling for two populations. ASTIN Bull.: J. IAA., 41: 29-59.
23. Berchuck, S.I., J.L. Warren, A.H. Herring, K.R. Evenson, K.A. Moore, Y.K. Ranchod and A.V. Diez Roux, 2016. Spatially modelling the association between access to recreational facilities and exercise: The 'Multi ethnic study of atherosclerosis'. J. R. Stat. Soc.: Ser. A (Stat. Soc.), 179: 293-310.
24. WHO., 2014. Global Status Report on Noncommunicable Diseases 2014. WHO Press, Geneva, Switzerland, Pages: 298.
25. Nonneman, G., 2002. Nationals and expatriates: Population and labour dilemmas of the Gulf cooperation council states by Andrzej Kapiszewski. Br. J. Middle Eastern Stud., 29: 201-203.
26. United Nations, 2017. World population prospects: The 2002 revision (Vol. 2). Department of Economic, United Nations.
27. Abdi, H. and D. Valentin, 2007. Multiple Correspondence Analysis. In: Encyclopedia of Measurement and Statistics, Salkind, N.J. (Ed.). Sage, Thousand Oaks, California, pp: 651-657.
28. Kaiser, H.F., 1970. A second generation little jiffy. Psychometrika, 35: 401-415.
29. Wilkinson, L. and M. Friendly, 2009. The history of the cluster heat map. Am. Statistician, 63: 179-184.
30. WHO., 2017. WHO report on the global tobacco epidemic: Monitoring tobacco use and prevention policies. World Health Organization, Geneva, Switzerland. http://apps.who.int/iris/bitstream/10665/255874/1/9789241512824-eng.pdf
31. United Nations, 2015. Air quality and atmospheric pollution in the Arab region. United Nations Environment Programme, West Asia. http://www.un.org/esa/sustdev/csd/csd14/escwaRIM_bp1.pdf
32. Peng, R.D., F. Dominici and T.A. Louis, 2006. Model choice in time series studies of air pollution and mortality. J. R. Stat. Soc. Stat. Soc. Ser. A, 169: 179-203.

33. Ramachandran, A., C. Snehalatha, A.S. Shetty and A. Nanditha, 2012. Trends in prevalence of diabetes in Asian countries. World J. Diabetes, 3: 110-117.
34. Khan, Y. and O. Hamdy, 2017. Type 2 Diabetes in the Middle East and North Africa (MENA). In: Diabetes Mellitus in Developing Countries and Underserved Communities, Dagogo-Jack, S. (Ed.). Springer International Publishing, Cham, ISBN: 9783319415598, pp: 49-61.
35. Schellenberg, E.S., D.M. Dryden, B. Vandermeer, C. Ha and C. Korownyk, 2013. Lifestyle interventions for patients with and at risk for type 2 diabetes: A systematic review and meta-analysis. Ann. Internal Med., 159: 543-551.
36. Schwab, K., 2015. The global competitiveness report 2015-2016. World Economic Forum, Columbia University, New York. http://www3.weforum.org/docs/gcr/2015-2016/Global_Competitiveness_Report_2015-2016.pdf
37. Balia, S. and A.M. Jones, 2011. Catching the habit: A study of inequality of opportunity in smoking related mortality. J. R. Stat. Soc.: Ser. A (Stat. Soc.), 174: 175-194.
38. Toriola, O., 2018. A multinomial logistic regression analysis of the association between physical activity and body weight status of university women in Riyadh, Saudi Arabia. Asian J. Sci. Res., 11: 145-150.