Journal of Biology and Today's World

Journal home page: http://journals.lexispublisher.com/jbtw

Received: 03 August 2016 • Accepted: 11 November 2016

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doi:10.15412/J.JBTW.01051202

Ranking Eastern Mediterranean Region Countries (EMRO) based on the Health Impact Indicators Using Multi-criteria Decision Approach

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ABSTRACT

Health indicators and their determinants are important in appropriate policy making at the national level and throughout the world. This study attempts to explain the health impact indicators and rank the eastern Mediterranean region's countries using the combination approach of TOPSIS-AHP. This study is both descriptive and analytical, and is conducted through cross-sectional methods. In order to weight life expectancy and mortality indicators as impact indicators by AHP, 25 experts completed a paired comparison questionnaire. Expert Choice 11 was used to weight indicators and TOPSIS software was used to rank the countries. Based on the Analytic Hierarchy Process and paired comparisons in health impact indicators, it was found that the highest weight was related to the infant mortality rate (IMR) with a weight of 0.284, and the lowest weight was related to the life expectancy indicator at age 60 with a weight of 0.030. After ranking the countries according to the health impact indicators and by using the TOPSIS method, it was found that Bahrain is the first and Somalia is the last among the studied countries. Existing facilities and potentials shall be guided first to the countries with unsuitable health indicators; these countries shall be focused on more than other countries within the region. The most important strategies that the countries can apply to improve the health indicators are raising awareness about health related issues, eliminating financial barriers that decrease access to health, focusing on inter-sectoral cooperation, and promoting the other sectors to participate.

Key words: life expectancy, mortality, Eastern Mediterranean, multi-criteria decision.

Journal of Biology and Today's World is published by *Lexis Publisher*; Journal p-ISSN 2476-5376; Journal e-ISSN 2322-3308.

1. INTRODUCTION

Health indicators are one of the main criteria for assessing the quality of government performance in the delivery of health services to the covered population (1). Based on the definition provided by the World Health Organization, indicators are variables that help to measure changes directly; this means that they specify a certain state and hence can be used to measure changes (2, 3). Health indicators and their determinants are important in appropriate policy making at the national level and throughout the world (4, 5). Indicators are divided into three main categories: input, process, and impact. Impact indicators refer to the health status of the target population. This indicator does not show progress in a limited time (6). Life expectancy and mortality are some of the most important impact indicators, and they are published by the World Health Organization (7). Life expectancy represents the average expected survival in years of a group of people if current mortality conditions remain stable (8). Data on mortality indicate the number of deaths in terms of time, place, and cause of death (9). Multi-attribute decision making is a process that incorporates multiple criteria in an analysis. In this decision-making approach, analysis and optimal selection for decision making is possible by prioritizing the criteria (10, 11). Analytical Hierarchy Process (AHP) is one of the most prominent approaches to multi-criteria decision making. Its focus is on obtaining the relative weights of factors and the overall values of each option based on the determined weights (12). TOPSIS is also a multi-criteria decision-making method based on the selection of the best option. This method indicates the shortest distance from the positive ideal solution (the best possible), and the

longest distance from the negative ideal solution (worst possible) (13). Since many studies such as those by Sorayaei et al (14), Kalhor et al. (15), Balouei Jam Khaneh et al. (16), and Barrios et al. (17) have used the combined approach of AHP- TOPSIS to weight and rank their option, we have attempted to use the methods of TOPSIS and AHP to rank the eastern Mediterranean countries based on the life expectancy and mortality indicators.

2. MATERIALS AND METHODS

The present study is a descriptive analytical study conducted by cross-sectional methods. Given that the design of research was multi-criteria decision techniques and the total target population was to be studied as the sample of the study, all 23 countries covered by the Eastern Mediterranean Regional Office (EMRO) were selected as the study population. These countries are Saudi Arabia, Egypt, Lebanon, Iran, Iraq, Tunisia, Libya, Qatar, Oman, Syria, Sudan, Bahrain, Yemen, Jordan, Afghanistan, Pakistan, Kuwait, the United Arabic Emirates, Djibouti, Morocco, Somalia, Cyprus, and Palestine. However, Cyprus and Palestine were excluded from the study population because of the lack of information on the indicators.

The research was conducted in the following steps:

2.1. Defining the Impact Indicators

The impact indicators were selected because they are indicative of the state of public health. The impact indicators of life expectancy and mortality were studied including seven indicators of life expectancy at birth, life expectancy at age 60, healthy life expectancy at birth, neonatal mortality rate (NMR), infant mortality rate (IMR), under-five mortality rate, and adult mortality rate (between 15 and 60 years old).

2.2. Weighting Indicators

A unique feature of AHP is its inherent capacity to give weight to a large number of factors and criteria as qualitative and quantitative data by utilizing the principle of pairwise comparisons (18, 19). Pairwise comparison of indicators was completed and collected through distributing health indicators' weighting questionnaires (life expectancy and mortality) among 25 experts who were fully aware of the indicators. The inclusion criteria for this study were relevant education, holding at least a master's degree and 5 years of experience in the health domain. Expert Choice 11 software was used in this phase of the study.

2.3. Ranking the Countries

At this stage, the countries were ranked using weights obtained by AHP and TOPSIS methods and information about the indicators of countries extracted from the World Health Organization (World Health Statistics 2015) and World Bank. The TOPSIS method of problem solving involves formation of a decision matrix, the conversion of the decision matrix to a distance matrix, the formation of a distance weighted matrix, and identification of positive and negative ideal solutions in the final stage of calculating the relative proximity index. The higher relative proximity index indicates the highest rank for the concerned countries. Also, to determine the difference between oil and non-oil-producing countries in terms of the relative proximity index, the Mann-Whitney test was performed by using the software SPSS18.

3. RESULTS AND DISCUSSION

3.1. Weighting the indicators of life expectancy and mortality

According to Table 1, the 25 experts who filled out the paired comparison questionnaire of indicators were sixteen males (64%) and nine females (36%). Seven of them (28%) had a master's degree and 18 (72%) people held doctorate degrees. Of these degrees 48% had studied Healthcare Services Management, 20% had Health Policy degrees, 16% had Public Health degrees and 16% had medical degrees.

Table 1. Participants' demographic information

Item	Background variable	Frequency	Percentage
Gender	Man	16	64
	Woman	9	36
Degree	MSc	7	28
	PhD	18	72
Field of study	Health-care Services Management	12	48
	Health Policy	5	20
	Public Health	4	16
	Physician	4	16

Based on Analytic Hierarchy Process and opinions of samples, two indicators of infant mortality rate (IMR) and life expectancy at age 60 had the highest and lowest rank and weight among the 7 indicators of life expectancy and mortality (Table 2).

Table 2. Weight of impact indicators from the perspectives of the samples

Sign	Indicators	Weight of indicators	Rank
O1	Life expectancy at birth	0.103	5
O2	Life expectancy at age 60	0.030	7
O3	Healthy life expectancy at birth	0.127	4
O4	Neonatal mortality rate (NMR)	0.186	2
O5	Infant mortality rate (IMR)	0.284	1
O6	Under-five mortality rate	0.172	3
O7	Adult mortality rate (probability of dying between 15 and 60 years of age)	0.099	6

The inconsistency rate for this group of indicators was 0.08. Rates of less than 0.1 indicated that there was a positive consistency between the responses of samples in the pairwise comparisons.

3.2. Ranking the countries based on the impact indicators

Regarding the impact indicators, twenty-one countries of EMRO were studied through the TOPSIS method. Based on the seven parameters, the relative proximity index and their ranks were calculated. According to the TOPSIS method in impact indicators, Bahrain ranked first and Somalia ranked last among the studied countries (Table 3).

Table 3. Ranking of the countries and their relative closeness indicators through TOPSIS method and based on the impact indicators

Country	Oil-rich	relative proximity index	Rank
Bahrain	✓	0.064	1
Qatar	✓	0.063	2
United Arab Emirate	✓	0.063	3
Lebanon	-	0.062	4
Kuwait	✓	0.062	5
Oman	✓	0.060	6
Syrian Arab Republic	✓	0.059	7
Libya	✓	0.058	8
Saudi Arabia	✓	0.058	9
Tunisia	-	0.058	10
Iran	✓	0.057	11
Jordan	-	0.056	12
Egypt	✓	0.053	13
Morocco	-	0.048	14
Iraq	✓	0.047	15
Yemen	✓	0.038	16
Sudan	✓	0.029	17
Djibouti	-	0.027	18
Pakistan	-	0.019	19
Afghanistan	-	0.017	20
Somalia	-	0.000	21

Table 4. The results of Mann-Whitney test to determine the difference between oil and non-oil-rich countries in terms of the relative proximity index

P-value	Sum of Ranks	Mean Rank	Numbers	Statistics / Country
0.03	172.50	13.27	13	Oil-rich
	58.50	7.31	8	Non-Oil-rich

According to the findings shown in Table 4, there is a significant difference between oil and non-oil producing countries in terms of the relative proximity index ($p < 0.05$). According to the findings of the study, and through the Analytical Hierarchy Process, the infant mortality rate (IMR) has the highest weight. The indicator of infant mortality rate (IMR) is an important indicator in assessing the health status of the population and is closely related to the welfare of a society and its development. In addition, mortality in this age group when compared with other groups depends on socio-economic conditions of a society (20-22). The Studies of Rezaei et al. (23), Frey et al. (24), and many other studies, such as the present study, prove the importance of infant and neonatal mortality indicators. Many studies have also stressed the importance of life expectancy at birth and infant mortality rate (25-28). Life expectancy in several studies is used as an indicator to measure the performance of a country's health system (29); however, in this study life expectancy was the fourth priority in terms of weight. Rank and the relative proximity index of the Eastern Mediterranean countries are estimated by TOPSIS and the impact indicators; the results show that

Bahrain, Qatar, and United Arabic Emirates ranked first, second, and third, respectively. Somalia, Afghanistan, and Pakistan are ranked last. Iran is the eleventh in this ranking. The study of Shetty (30) showed that Afghanistan is in an undesirable condition regarding the impact indicators (infant mortality rate). It is indicated in the studies of Imani that among the countries of the Eastern Mediterranean Region, Kuwait, the UAE, and Qatar were ranked firsts in terms of impact indicators; whereas, among non-oil-rich countries, Cyprus was ranked first (31). The results also showed that Libya has had the highest child mortality compared to the two countries of Qatar and the United Arabic Emirates (32). Cultural poverty and ignorance are the main causes of undesirable conditions in countries with poor impact indicators. In Afghanistan and Pakistan, illiteracy of mothers and their lack of awareness of children's health issues increase the risk factors related to neonatal and infant mortality rates. The results of this research show that oil-rich countries have better conditions than non-oil-rich countries in terms of impact indicators, and have allocated the first ranks. In oil-rich countries such as Bahrain, Qatar, and the UAE, comprehensive health care is provided for all people, and the whole range of prevention, promotion, treatment, and rehabilitation services are available to the whole population. The health indicators of these countries reflect the appropriate state of health caused by the right infrastructures in the health sector and high public awareness resulting from the high level of literacy of the population. The limitations of this study were a lack of information about Cyprus and Palestine and the inability to generalize the results of this study to other areas of the WHO.

4. CONCLUSION

Health issues are closely related to the progress and development of the health care system within a country. The health of a community is measured by its health indicators. This study showed that infant mortality rate (IMR) is a more significant indicator than other indicators in assessing the health status of a population. Regarding the studied impact indicators, the oil-rich countries of Bahrain, Qatar, and the UAE were the highest ranked countries. These countries allocate a greater share of their budgets to health spending. Moreover, the main causes of these countries' favorable status of health indicators are strong infrastructures and health sectors, improvement in community health education, knowledge and awareness of the population, and high economic power. It is recommended that the potentials and existing facilities be directed to the countries with undesirable health conditions. The most important strategies to improve the health indicators of countries are raising awareness about health related issues, removing financial barriers to access to health, and focusing on inter-sectoral cooperation, promotion, and participation of other sectors. Finally, we suggest that future studies prioritize health indicators based on effectiveness and use other methods of prioritizing and ranking.

ACKNOWLEDGMENT

We would like to extend our gratitude to the Experts for participating in this study and completing questionnaires.

FUNDING/SUPPORT

This paper extracted from a Master's thesis in Qazvin University of Medical Sciences.

AUTHORS CONTRIBUTION

This work was carried out in collaboration among all authors.

CONFLICT OF INTEREST

The authors declared no potential conflicts of interests with respect to the authorship and/or publication of this paper.

REFERENCES

1. Asadi M, Esfandiary S, Mirghafori SH, Arani ZS. Clinics of Yazd: Efficient or Inefficient? Director General. 2013;9(6).
2. Arab M, Akbari F, Tajvar M. Relation between leadership styles and hospital performance indicators. J Qazvin Univ Med Sci. 2007; 10 (4) :70-75.
3. Jonidi N, Sadegi M, Ezadi M, Ranjbar R. Comparative performance indicators of a hospital in Tehran with the national standards. Military Medicine. 2010;12(4):223-8.
4. Davis KE, Kingsbury B, Merry SE. Indicators as a technology of global governance. Law & Society Review. 2012;46(1):71-104.
5. Wagenaar AC, Toomey TL. Effects of minimum drinking age laws: review and analyses of the literature from 1960 to 2000. Journal of Studies on Alcohol, supplement. 2002 (14):206-25.
6. Chung H, Muntaner C. Political and welfare state determinants of infant and child health indicators: an analysis of wealthy countries. Social science & medicine. 2006;63(3):829-42.
7. Organization WH. World health statistics 2010: World Health Organization; 2010.
8. Sugiura Y, Ju Y-S, Yasuoka J, Jimba M. Rapid increase in Japanese life expectancy after World War II. Biosci Trends. 2010;4(1):9-16.
9. Organization WH. World health statistics 2016: Monitoring health for the SDGs, sustainable development goals. 2016.
10. Asgharpour MJ. Multiple criteria decision making. Tehran University. 1998.
11. Hsu S-C, Wang T-C. Solving multi-criteria decision making with incomplete linguistic preference relations. Expert Systems with Applications. 2011;38(9):10882-8.
12. Torfi F, Farahani RZ, Rezapour S. Fuzzy AHP to determine the relative weights of evaluation criteria and Fuzzy TOPSIS to rank the alternatives. Applied Soft Computing. 2010;10(2):520-8.
13. Kelemenis A, Askounis D. A new TOPSIS-based multi-criteria approach to personnel selection. Expert Systems with Applications. 2010;37(7):4999-5008.
14. Sorayaei A, Pakari A, Nejad MRD, Soufi M. Performance indexes evaluation and ranking of the industrial laboratory equipment's importers in Iran by TOPSIS-AHP. Advances in Environmental Biology. 2013:1300-6.
15. Kalhor R, Kiaei MZ, Mohebbifar R, Bahrami ES, Mafi L, Kalhor L, et al. Prioritizing the Options for Health-care waste Man-agement in Qazvin: Using a Multi-Criteria Decision Making Approach. Journal of Biology and Today's World. 2016;5(6):101-6.
16. Balouei Jamkhaneh H, Ketabi S, Pourmostafa Khoshkerodi M. Rating hospitals of Mazandaran University of Medical Sciences, based on the quality of health services using a combination approach fuzzy AHP–TOPSIS. Health Inf Manage. 2013;10(7):901-11.
17. Barrios MAO, De Felice F, Negrete KP, Romero BA, Arenas AY, Petrillo A. An AHP-Topsis Integrated Model for Selecting the Most Appropriate Tomography Equipment. International Journal of Information Technology & Decision Making. 2016;15(04):861-85.
18. Liberatore MJ, Nydick RL. The analytic hierarchy process in medical and health care decision making: A literature review. European Journal of Operational Research. 2008;189(1):194-207.
19. Salmeron JL, Herrero I. An AHP-based methodology to rank critical success factors of executive information systems. Computer Standards & Interfaces. 2005;28(1):1-12.
20. Fantini MP, Stivanello E, Dallolio L, Loghi M, Savoia E. Persistent geographical disparities in infant mortality rates in Italy (1999–2001): comparison with France, England, Germany, and Portugal. The European Journal of Public Health. 2006;16(4):429-32.
21. Reidpath DD, Allotey P. Infant mortality rate as an indicator of population health. Journal of epidemiology and community health. 2003;57(5):344-6.

22. Rosicova K, Geckova AM, van Dijk JP, Kollarova J, Rosic M, Groothoff JW. Regional socioeconomic indicators and ethnicity as predictors of regional infant mortality rate in Slovakia. International journal of public health. 2011;56(5):523-31.
23. Rezaei S, Jamshidi K, Moradi K. Impact of Socioeconomic and Health System Factors on Infant Mortality Rate in Organization of the Petroleum Exporting Countries (OPEC): Evidence from 2004 to 2013. International Journal of Pediatrics. 2015;3(2.2):493-9.
24. Frey RS, Field C. The determinants of infant mortality in the less developed countries: a cross-national test of five theories. Social Indicators Research. 2000;52(3):215-34.
25. Harper S. Commentary: What explains widening geographic differences in life expectancy in New Zealand? International journal of epidemiology. 2006;35(3):604-6.
26. Wood R, Sutton M, Clark D, McKeon A, Bain M. Measuring inequalities in health: the case for healthy life expectancy. Journal of Epidemiology and Community Health. 2006;60(12):1089-92.
27. Murray CJ, Lopez AD. Alternative projections of mortality and disability by cause 1990–2020: Global Burden of Disease Study. The Lancet. 1997;349(9064):1498-504.
28. Oeppen J, Vaupel JW. Broken limits to life expectancy. Science. 2002;296(5570):1029-31.
29. Nixon J, Ulmann P. The relationship between health care expenditure and health outcomes. The European Journal of Health Economics. 2006;7(1):7-18.
30. Shetty A, Shetty S. The correlation of health spending and infant mortality rate in Asian countries. International Journal of Contemporary Pediatrics. 2014;1(2):100-5.
31. El-Jardali F, Jamal D, Abdallah A, Kassak K. Human resources for health planning and management in the Eastern Mediterranean region: facts, gaps and forward thinking for research and policy. Human Resources for Health. 2007;5(1):1.
32. Al-Lagilli SAM, Jeremic V, Seke K, Jeremic D, Radojicic Z. Evaluating the health of nations: a Libyan perspective. Libyan journal of medicine. 2011;6.