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Cross-country Evaluation of Health Care Systems Performance on Mortality Indices

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Abstract: Explaining the impact of health care systems in determining variations in health status across countries has a significant role in health policy. This study explored the effects of variations in the volume of health care and in certain characteristics of health systems on mortality indices across 20 MENA (Middle East and North Africa) countries. Latent class regression model was used in a panel structure study for classification of 20 Middle East and North Africa countries, over the period 1985-2005, based on health systems performance on mortality indices and explore the most important determinants of between country variations in health care systems efficiency. The results suggest that among a wide range of health system inputs, physicians number, education, level of immunization coverage and political stability are the most important factors that significantly affect between-country variations in terms of the effectiveness of health systems in improving mortality indices. One of the most important challenges in public health systems in MENA region is "distinction between services and function" that mainly steams from weak performance by governments. Trying to optimizing in management and monitoring of services, directing health expenditures toward cost-effective programs and reducing the gaps in health coverage can effectively improve health systems functioning in this region.

Key words: Health systems efficiency, mortality indices, political stability, GDP, income inequality, health expenditures, education, latent class regression, MENA

INTRODUCTION

For much of the last three decades, many countries, particularly developing countries, have introduced reforms aimed at improving the performance of health system. Among them are Middle East and North African (MENA) countries.

The MENA region is diverse, covering over 20 countries from the Western Sahara to Iran. MENA has achieved significant improvements in health status in which over the past three decades, infant and child mortality rates have fallen, health service delivery has improved and overall life expectancy has risen. However, given these remarkable progress, MENA countries still face a number of obstacles in achieving efficient, equitable and sustainable health services for their populations. Health disparities are also a challenge both across the region and within each country (Pierre-Louis *et al*., 2004). Therefore, the study of factors behind the cross-country differences in health care systems efficiency would be necessary.

Evaluation of health care systems performance can be done by measuring the achievements of health systems across a range of objectives. The results of such evaluation correspond to the fundamental needs in health policy for policy makers. In comparative studies related to health systems performance between countries or organizations of particular interest is whether and how efficiency of systems vary and how they use different effective resources to improve health outcomes.

Hitiris and Posnett (1992), Grubaugh and Santerre (1994), Or (2001) and Or *et al.* (2005) showed that exists a positive relationship between population health status and the input measures such as the number of physicians, access to health facilities (e.g., the number of physician, medical centers, hospital beds) total payments

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in health systems and the level of real resources used by health system (Hitiris and Posnett, 1992; Grubaugh and Santerre, 1994; Or, 2001, Or *et al*., 2005).

The most comprehensive study about the influence of socio-economic factors on infant and child mortality has been done through framework (Mosely and Chen, 1984). These factors operate at community, household or individual levels through five proximate determinants (Behm, 1991; Sastry, 1997; Agha, 2000). For example outside of medical factors, education appears to be another important determinant of health status. It seems to determine many of decisions, which affect the quality of life, ability to select a healthy diet, avoiding unhealthy habits, efficient use of medical care and so on (Or *et al*., 2005; Valkonen, 1989; Madise *et al*., 1999; Macinko *et al*., 2006).

The framework developed by WHO for measuring and assessing health systems performance specifies three intrinsic goals of the health system: Improving the health status of population, equity in access to health care facilities, quality of health facilities provision and financial protection (WHO, 2000). Investigation about the impact of these factors on health status may help to provide guidelines for health policy makers.

According to directed goals by WHO for health systems, it can be seen that the scope of health is enormous implicitly suggesting that collecting and compiling of related data and information would not be an easy task to do. Therefore, study and estimation of health systems performance and comparison of their effects on health status among the countries will not be straightforward. This study requires a multidisciplinary approach to distinguish relative impact of these factors.

In one hand, considering the relevant health outcomes of population can be considered as the first step to assess and compare the countries performance in health sector. In other hand, wide range and complexity of coherence scope of health and health systems has led to development of composite measures of health system performance. The rationale for developing a composite measure is that no single metric can capture the concept of system performance. Instead, each of the component dimensions of performance is measured and then various components are combined into a single measure of whole system performance (Smith, 2002). Accordingly, this study using a suitable modeling approach i.e., "latent class regression" tries to provide a comprehensive indication of health status through providing a composite indicator (as dependent variable) based on three mortality indices i.e., “life expectancy at birth (LEB)”, “Infant Mortality Rate (IMR)” and “under five Mortality Rate (U5MR)” in order to investigate the impacts of a wide range of medical and non-medical effective factors on health status over 1985-2005 for Middle East and North African countries. We concentrating on one aspect of health outcomes i.e., “mortality indices". These indices among other indicators related to health status, especially at the national and international level provide reliable information to describe the population health status. In addition, they are readily available over a considerable time span.

Although, many studies on evaluating the national and cross-national level health systems performance have been done. However, such researches in the developing countries in this field are rare (Fuse and Crenshaw, 2006; McGuire, 2006). On the other hand, Actual knowledge on the determinants of health outcomes of populations, at country level and in the scope of comparative researches related to health systems efficiency, suffers from the partiality of the models and frameworks used in the empirical investigations.

Present study differs from much of the previous studies in some important aspects. To our knowledge, this is the first time that such a study, particularly, by applying of this modeling framework, as an alternative statistical modeling approach for health systems evaluation, in MENA region is done. In addition, the present study using a large sample (through panel data) and providing some methodological and conceptual controls through appropriate statistical model and introducing some important predictors, according to conditions of study countries, has tried to provide some alternative evidences of a statistically significant of determinants of health systems performance.

MATERIALS AND METHODS

Statistical method: Each measure of health status at national level over a time span gives a different picture of health status that has been improved over the time within the countries and may result in somewhat different ranking of the health across the countries at any point in time. Any modeling approach to explain or analyze of the performance of health systems will need to consider these differences across the various measures of health outcomes both in trend over time and in variation across the countries. Latent Class (LC) modeling is one of the flexible approaches for analyzing the data with such a structure (Deb and Trivedi, 2002; Jimenez-Martin *et al*., 2002).

It is well known that LC models can be used to combine the information contained in multiple observed

outcome variables. In LC analysis, a discrete unobserved variable with K categories is assumed to exist that affects the, usually multiple, responses of subjects. Each subject is assumed to belong to one of these K latent classes or mixture components.

In the present study, latent class regression is applied to modeling the cross-country heterogeneity in a flexible way that assumes no distribution for the unobserved country effects. Furthermore, it allows the distinction between latent classes of countries, which can vary as to the expected level of health status as well as to the responses to the covariates considered. Therefore, it is possible to assess to which extent the effects of the health system inputs (explanatory variables) considered in this study vary across different groups of countries (i.e., class specific covariates coefficients).

Variables and data

Variables

Outcome variables: For having a comprehensive perspective and may relieve some particular problems for a society, it may be useful to examine a range of measures rather than just one aspect of mortality in order to cover a wide range of population. Accordingly, in the present research, the outcomes of the health systems are restricted to three mortality indices including: LEB, IMR and U5MR within the years 1985-2005. They are commonly used for the comparison of health care systems, monitoring and designing of population health programs.

These variables play the role of the observed dependent variables in latent class regression modeling. Table 1 present the patterns of change in the considered mortality indices over the study period for MENA countries.

Predictor variables: An important problem in cross-national comparative studies on health systems performance, especially in developing countries, is availability and quality of data that affects the precise and robustness of statistical analysis. There are many potential determinants (medical and non-medical factors) of mortality which could be incorporated. An attempt was made in our study to fitting the most reliable predictor variables. The choice of predictor variables was done, among the most relevant available variables, based on economic theory, empirical evidence from earlier works in this area and considering the MENA's specific conditions. The predictors for entering them in the model are as follows:

- Number of physicians per 100,000 population, total health expenditures (as a percentage of GDP) converted to international prices for comparative purposes, immunization coverage for six target disease for WHO's EPI program (i.e., measles, diphtheria, pertussis, tetanus, tuberculosis and polio) as medical factors
- As non-medical factors, GDP per capita, GINI coefficient and rate of access to safe water and sanitations were introduced in fitted model. In order to determine the impact of socio-economic differences across countries as an important component of the environmental effective factors on the health outcomes, in the present study, GDP per capita, Gini coefficient and education that play key role in these differences were used. political-structural mechanisms and their interaction with national policies and institutions can play effective role on health outcomes. In the present study, due to the geopolitical conditions of Middle East and North African countries, "structural and political stability" was introduced as a predictor. Descriptive statistics including means and standard deviations for dependent and independent variables are presented in Table 2

Data sources: Due to lack of a comprehensive data source, specially, for the study countries in the present research, the data was gathered from several sources including: United Nations' Statistics Division, WHO's mortality database, United Nations' site for the MDG Indicators, UNICEF Statistics Division, the WORLD Bank Group (HNP Stats), Joint Monitoring Program for Water supply and Sanitation (WHO-UNICEF), Statistical, Economics and Social Research and Training Center for Islamic Countries (SESRETCIC), Country Analytical Website (CAW) countries' specific website and year books.

RESULTS

Descriptive results: Table 1 displays the trend of mortality indices in MENA during the last 25 years, also Table 1 shows health status of MENA countries comparing to the developed, developing, least developed countries and world.

Table 2 shows the means and standard deviations of dependent and independent variables during the 1985-2005 for MENA countries. One notable point in these results is the high standard deviations of the

Table 1: Comparison of MENA's mortality indicators with other regions

	Life expectancy at birth*						Infant mortality rate (IMR)**						Under five mortality rate (U5MR)**					
Region	1980	1985	1990	1995	2000	2005	1980	1985	1990	1995	2000	2005	1980	1985	1990	1995	2000	2005
MENA	58	61	64	65	67	68	91	76	59	55	49	43	132	99	81	71	62	54
World	63	64	65	66	67	68	79	70	65	62	58	52	119	105	95	90	84	76
Developed countries	74	75	76	77	78	79	13	11	9	7	6	5	15	12	10	8	7	15
Developing countries	65	66	68	68	69	69	88	79	71	68	63	57	133	120	105	98	92	83
Least developed countries	52	54	56	57	58	59	130	115	115	109	102	97	209	190	182	171	161	153

*years **Per 1000 live births

Table 2: Mean and standard deviation of the dependent and independent variables over the study period

Variables	Mean	Standard Deviation
Dependent variables		
LEB: Life expectancy at birth (years)	64.61	3.71
IMR: Infant mortality rate (per 1000 live birth)	49.82	17.90
U5MR:Under five mortality Rate (per 1000 live birth)	71.50	21.60
Independent variables		
Physician: Number of active physicians per 100,000 Persons	82.70	18.40
Education: Literacy rate in adult population	59.40	8.80
GDP: Gross domestic product per capita (US$)**	4501.00	1612.90
Gini coefficient (%)	41.30	6.49
Health expenditure (as percentage of GDP, US$)	23.00	187.60
Immunization coverage (%)	68.90	12.30
Political stability	3.70	4.10
Access to safe water and sanitation*	75.50	24.10

*%population-source: Joint monitoring program for water supply and sanitation ,WHO-UNICEF, www.wssinfo.org, **Gross domestic product based on purchasing-power-parity (PPP) per capita GDP

Table 3: The class specific mean values of mortality indices and the size of classes

	Class 1 (low)	Class 2 (medium)	Class 3 (high)
Class size (%)	28.6	47.6	23.8
Items (mean)			
LEB	54.1	66.1	73.6
IMR	91.8	40.5	15.1
U5MR	156.1	42.6	15.8

variables; it can be attributed to the wide discrepancies of countries in terms of studied indices.

Analytical results: One of the most relevant applications of latent class analysis is clustering or constructing typologies based on the observed variables.

In the present research, models with 1 to 5 classes were fitted and the 3-class model turned out to performs best in terms of the BIC criterion.

The results of the fitted latent class regression model to the data at hand for classification of MENA countries and the effects of covariates are presented in Table 3 and 4. In addition, Table 5 shows countries included in each constructed class.

The estimated size of each latent class in the 3-class model are 28.6, 47.6 and 23.8. The mean values of mortality indicators in each class are displayed in Table 3. Each class is named and its context (i.e., low, middle and high) can be interpreted based on the mean values of mortality indices. For example, class 1 contains the countries with low life expectancy and high infant and under five mortality rates. Accordingly, this class has the worst conditions among the three constructed classes in terms of studied mortality indices (Table 3, 5).

In latent class regression model, the class membership probabilities for subjects or individuals (here, countries) are modeled as a function of covariates. As a result the class membership can be modeled as a Multinomial Logit. The presence of the covariates improves the prediction of latent classes as well as provides class specific covariates coefficients.

In the fitted model, similar as multinomial logistic regression, the Class 1 was considered as a reference category. Therefore, the covariates coefficients can be interpreted as "log odds ratios" or Odds Ratio (OR) belonging to Classes 2 and 3 rather than Class 1 in terms of one unit change in the related covariate adjusted for the values of other covariates.

The investigation of covariates coefficients reveals that the physician numbers, education, immunization coverage and political stability had the highest log odds of being a country in Classes 2 and 3 rather than Class 1. For example, the effect of one unit increase in physician numbers in terms of log odds ratio for belonging a country in Classes 2 and 3 rather than Class 1 is 1.061 and 0.989, respectively.

Our findings indicated that education is the second important effective factor on health status in MENA. As Table 4 shows the effect of education on being a country in Classes of 2 and 3 rather than Class 1 is similar.

The effect of other covariates can be similarly interpreted.

We included a control term for years of observation in fitted regression model. This accomplishes two important objectives: (1) It controls for occurred improvements in health outcomes that not captured by changes in other entered covariates and (2) it prevents against a artificial association between trending variables. Our investigation based on fitting different models

Table 4: The estimated class specific covariates (health systems inputs) coefficients

Dependent variable (class)	Covariates	Coefficient	OR	p-value
2 (reference category: Class 1)	Intercept	0.313	-	0.021
	Physician	1.061	2.89	0.001
	Education	0.752	2.12	0.019
	Immunization	0.602	1.82	0.041
	GDP	0.213	1.24	0.107
	Gini coefficient	0.552	1.74	0.037
	Health expenditure	0.201	1.22	0.118
	Safe water and sanitation	0.198	1.21	0.042
	Political stability	0.359	1.43	0.026
	Time	0.602	1.83	0.008
3 (refrence category: Class 1)	Intercept	0.221	-	0.011
	Physician	0.989	2.69	0.004
	Education	0.710	2.03	0.012
	Immunization	0.506	1.66	0.023
	GDP	0.421	1.52	0.029
	Gini coefficient	0.432	1.54	0.065
	Health expenditure	0.328	1.39	0.037
	Safe water and sanitation	0.104	1.11	0.072
	Political stability	0.615	1.85	0.007
	Time	0.214	1.24	0.071

Table 5: Classification of countries based on posterior probability

Class 1	Iraq, Pakistan, Somalia, Sudan, Yemen
Class 2	Algeria, Egypt, Iran, Jordan, Lebanon, Libya, Morocco, Saudi
Class 3	Bahrain, Kuwait, Qatar, Oman, United Arabic Emirate

showed that the effect of time (t = 1, 2, 3, 4, 5) was linear and class dependent. As Table 5 shows, the effect of time in Class 2 compared with Class 3 was more statistically significant. This result indicates that the Class 2 has experienced higher growth rate over 1985-2005 in terms of improvement in mortality indicators compared with countries included in Class 3. The justification is that during the study period, countries starting with high life expectancy and low IMR and U5MR levels (third class countries) tended to improve less (maintained and optimized their status) in terms of mentioned indicators than countries starting with low life expectancy and high IMR and U5MR. Accordingly, the growth rate for countries belong to Class 3 comparing to the countries being in Class 2, was slower over this period. This can also be considered as a meaningful implication on the priority of the effects of most of considered covariates (Health inputs) on health status in Class 2 compared with Class 3 within the years 1985-2005.

Classification of countries: In latent class regression, the posterior probability of a subject's membership in each class can be computed and each subject (here, countries) is traditionally assigned to a group with the largest probability. Table 5 presents the results of assignment of each country to its most relevant class.

DISCUSSION

This research, as the first attempt on evaluating of the country-level determinants of population mortality indices over a time span in MENA countries, concluded that the cross-country variations in health status are substantially attributable to medical care facilities (i.e., physicians number, immunization coverage) education, income inequality, political conditions and partially to GDP and health expenditures.

In the present research, the most important effective factor is number of physicians. In many studies, physician's role on cross-country variation in evaluation of health systems, particularly in developed countries and somewhat in developing countries has been investigated and its importance has been approved (Robst and Graham, 1997; Robst, 2001; Nixon and Ulmann, 2006; Papageorgiou *et al*., 2004). The second effective predictor is level of education Literacy often has positive effects on individual's viewpoint and quality of life (through choice of job, ability to select a healthy diet, avoiding unhealthy habit, effective use of medical care and…) therefore, it can play an effective role on health status. Furthermore, parents' level of education has important implication for child survival. In particular, mothers' education level my increase their productivity in child care (preventive and curative health care) (O'Hara, 1980; Behrman and Wolfe, 1984; Kassouf and Senauer, 1996; Zakir and Wunnava, 1999; Currie and Moretti, 2003).

Regarding to the effect of immunization coverage we can see the coefficient value for this covariate in second class is relatively larger than third class, indicating that vaccination coverage could have a larger impact on infant and particularly under five mortality in countries being in the second class. This results, might be attributed to higher and stabilized coverage level for countries included in third class compared with the countries being in second class; consequently marginal health benefits from expanding of vaccination coverage are likely to be more significant in later countries. On the other hand, the implementation of immunization programs in countries included in first class, as reference class, was mainly

affected by instability in their structural and political conditions.

Income as a proxy for standard living leads to improving in public health infrastructures (safe water and sanitation, better nutrition ,better housing and ability to paying for health care) particularly through increasing the capability of governments and other policy makers to supply of the health care (Cutler *et al*., 2006). The obtained results by some researchers such as Casterline *et al*. (1989) on weak effect of income on infant and chilled mortality can be considered as implications of less importance of this factor in affecting the health status particularly in poor countries (Heerink, 1994; Casterline *et al*., 1989). Other researchers such as Cutler *et al*. (2006), Preston (1980), Caldwell (1986), Fogel (1994) and Palloni and Hill (1997) obtained similar results on weak effect of GDP on mortality (particularly on LEB). Most of these researchers believe that the operation of income on mortality indicators is through affecting the other effective parts of health systems such as development of public health infrastructure and improvement of nutrition.

Although, health expenditures are major inputs of health systems however, the effect this factor similar as GDP was weak on mortality indices especially in Class 2. The previous studies in this subject area have failed to identify a strong and consistent relationship between health expenditures and health outcomes (after controlling for other covariates). For example, Burnside and Dollar (1998) and Hill and Pebley (1989) found no significant relationship between health expenditures and change in infant mortality rate in low-income countries. Similarly, a number of other studies found that the effect of health expenditure on health status (infant and child mortality) is either small or statistically insignificant (Kim and Moody, 1992; Musgrove, 1996; Filmer and Pritchett, 1997, 1999). However, Gupta *et al*. (1999) using data of 50 developing and transition countries showed that health expenditures reduce child mortality (Gupta *et al*., 1999). They also provided further evidences from 70 countries on the importance of public spending on health status in low-income countries than higher-income countries (Gupta *et al*., 2001). Nixon and Ulmann (2006) in a study on EU countries within 1980-1995 showed health expenditures and physician numbers have significant contribution to improvement in infant mortality and life expectancy (Nixon and Ulmann, 2006). An important point about the effect of health expenditures in our study, unlike to all of mentioned studies in this area, is that they only investigated one aspect of health or different aspects of health separately, thus, our study provides a different perspective about the effects health expenditures on health status, especially in the developing countries.

According to the specific conditions of MENA region, some especial independent variables i.e., "immunization coverage", "rate of access to safe water and sanitation and particularly "political stability" as effective factors on health status were modeled. The results confirmed that these variables have significant effects on health outcomes particularly political stability through its interactive effects on other effective variables. Wide aspects of a society, particularly in developing countries, is affected by levels of stability in political conditions such as income distribution, organizational structures, values and how devoting of financial resources especially in health sector by governors and policy makers. Starfield (2007) investigated the pathways of the influence of equity in access to health facilities and fundamental effects of political and policy contexts on health status (Starfield, 2007).

More importantly, present findings highlight the significance of political-structural mechanisms and their interaction with national policies and institutions. According to the results of the present research and previous studies on public health challenges in MENA (Akala and El-Saharty, 2006; Pierre-Louis *et al*., 2004), it can be concluded that one of the most important challenges in public health systems in MENA region which is sensitive to country circumstances yet reflects their regional context is "distinction between services and function" that mainly steams from weak performance by governments affecting by political instability (indoor and outdoor conflicts) and its negative effect on organizational structures and policy makers. Trying to optimizing in management and monitoring of services, directing health expenditures toward cost-effective programs and reducing the gaps in health coverage can effectively improve health systems functioning in this region. Wagstaff and Claeson (2004) showed that good policies and institutions are important determinants of the impact of government health expenditures on health outcomes. In particular, as the quality of policies and institutions improves, the impact of government health expenditures on maternal, infant and under-five mortality and underweight children also increases and is statistically significant.

STUDY STRENGTHS AND LIMITATIONS

Although, many studies on national and cross-national levels on the evaluation of health care systems have been done. However, such researches in the developing countries are rare and to our knowledge, the present study is the first with special focus on MENA region.

Our study as the first model based in the scope of comparative studies related to health systems efficiency

on mortality indicators in MENA, using a suitable modeling approach i.e., latent class regression, provided a comprehensive framework towards the health systems evaluation, through combining the three health outcomes (LEB, IMR and U5MR) and evaluation the effects of a wide range of medical and non-medical effective factors on health status over the relatively wide study period.

The most important limitation of the present study was lack of a complete and reliable data set over the study period for MENA countries particularly for Djibouti, Afghanistan, Somalia and Yemen. Therefore, the study was restricted to the years: 1985, 1990, 1995, 2000 and 2005 in which over these years the more reliable data about the all considered countries had been provided, especially, by international organizations. Due to, most data over the considered years for Afghanistan and Djibouti was missing these countries were not included in the study.

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