

## Determinants of maternal mortality in Eastern Mediterranean region: A panel data analysis

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### Abstract

**Background:** As one of the main criteria of health outcomes, maternal mortality indicates the socioeconomic development level of countries. The present study aimed at identifying and analyzing the effective factors on maternal mortality in Eastern Mediterranean Region (EMR) of the World Health Organization (WHO).

**Methods:** Analytical model was developed based on the literature review. Panel data of 2004-2011 periods for 22 EMR countries was used. Required data were collected from WHO online database. Based on results of diagnostic tests for panel data model, parameters of model were estimated by fixed effects method.

**Results:** Descriptive statistics demonstrated the large disparities in social, economic, and health indicators among EMRO countries. Findings obtained from evaluating the model showed a negative, significant relationship between GDP per capita ( $\beta=-0.869$ ,  $p<0.01$ ), health expenditure)  $\beta=-0.525$ ,  $p<0.01$  (female literacy rate)  $\beta=-1.045$ ,  $<0.01$  (skilled birth attendance)  $\beta=-0.899$ ,  $p<0.05$ ) and maternal mortality rate.

**Conclusion:** Improved income and economic development, increased resources allocated to the health sector, improved delivery services particularly the increased use of trained staff in the delivery, improve quality of primary care centers, mitigating the risks of marginalization and its dangers, and especially improving the level of women's education and knowledge are the key factors in policy making related to maternal health promotion.

**Keywords:** Maternal mortality rate, Maternal health, Panel data model, EMRO.

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### Introduction

Maternal mortality rate is a very important indicator, reflecting a country's economic, cultural or health system development, also recognized worldwide (1). Perhaps one of the sensitive indicators of inequality in health is maternal and child health. This indicator also shows the quality and effectiveness of health policies (2). Maternal mortality includes the deaths dur-

ing pregnancies or the ones 42 days after deliveries. Traditionally, this indicator includes direct maternal deaths from pregnancy, indirect maternal deaths from pregnancy, and maternal deaths that occur during pregnancy, but do not relate to it (3,4). Hundreds of thousands of women in low-income countries die each year from complications of pregnancy, abortion and childbirth. It is estimated that every minute

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a woman and every day 16,000 women in the world die from pregnancy complications (5-7). According to other statistics, the maternal mortality rate is about 402 per 100000 live births which is approximately half million deaths a year (8). One of the Millennium Development Goals is maternal health improvement (MDG5). It aims at reducing the maternal mortality rate by 75% between 1990 and 2015 and the universal access to reproductive health by 2015 (9).

It has been globally reported that maternal mortality between 1990 and 2008 has reduced by 1.03% on average, which is lower than the 5.5% recommended by MDG5 (10). Failure to reduce the maternal mortality over the last 20 years has been one of the world's health problems (11). Hence, women's health is one of the most important priorities of the world health assemblies, and identifying the main factors of women's mortality as well as improving it depends on a correct definition of required priorities for appropriate prevention, diagnosis and treatment (12). Analyzing the factors affecting maternal mortality in ecological and macro levels may provide some credible information and evidence to health sector manager in order to make appropriate policies to improve maternal health. A few general studies on nonclinical determinants of maternal mortality have analyzed different factors including access to safe drinking water, government corruption, out-of-pocket payment, fertility rate, education level, delivery done by skill birth attendants, GDP per capita, health expenditures, life expectancy at birth, access to health services, and access to food (13-17). In the present study, the economic, social and healthcare system-related factors affecting maternal mortality in the EMR of WHO will be evaluated.

## Methods

### *Study setting*

The present study was an ecological cross-sectional and retrospective one that has used the panel data of the 22 countries

located in the Eastern Mediterranean Region (EMR) of the WHO. No sampling was done in this study. The study population was the countries located in the EMR and with regard to the availability of the intended data, such countries as Afghanistan, Bahrain, Djibouti, Egypt, Islamic Republic of Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Palestine, Oman, Pakistan, Qatar, Saudi Arabia, Somalia, Sudan, Syria, Tunisia, United Arab Emirates, Yemen, and Morocco were studied. The research period was from 2004 to 2011.

### *Data and Variables*

The data about the intended variables was collected from the WHO website where the information about the EMR was provided. The variables studied in this research were as follows:

Maternal mortality rate (the number of maternal deaths per 100000 live births); Gross domestic product per capita (in international dollar); primary health care center ratio; the total fertility rate; health expenditure share of gross domestic product (total health expenditure to GDP); urbanization (the proportion of urban population to total population); women's education (the 15-year-old and older women's literacy rate); and percentage of births attended by skilled health personnel.

### *Econometrics analysis*

The effects of economic, social and health system factors on maternal mortality rate can be studied using the model below.

The initial model is:  $MMR=f(S, E, H)$

Where MMR, S, E, and H are maternal mortality, social factors, economic factors, and health system-related factors, respectively. The model developed as follows using previous studies (e.g. 7,14,16) and accessing reliable data.

In the present study, the social factors included total fertility rate (TFR), urbanization rate (URB), and female's education level (EDU). The only economic determinant was the gross domestic product (GDP) per capita. Finally, the factors related to the

health system were health expenditure share of income (HE), percentage of births attended by skilled health personnel (BA), and percentage of primary healthcare centers (PHC). Therefore, the final econometric model presented as follows:

$$\text{LMMR}_{it} = \beta_0 + \beta_1 \text{LGDP}_{it} + \beta_2 \text{LHE}_{it} + \beta_3 \text{LEDU}_{it} + \beta_4 \text{LTFR}_{it} + \beta_5 \text{LBA}_{it} + \beta_6 \text{LPHC}_{it} + \beta_7 \text{LURB}_{it} + U_{it}$$

The variables are entered in the model as natural logarithms. Therefore, the coefficients  $\beta_1$  to  $\beta_7$  indicate the maternal mortality rate elasticity with respect to explanatory variables.  $U_{it}$  shows the error term with classic assumptions. To determine the method of estimation the parameters of model, diagnostic tests such as the Chow and Hausman tests were applied. Eviews5 software was also used for data analysis.

## Results

Table 1 shows the descriptive findings including the mean, median, maximum, minimum, and standard deviation of the studied variables for EMR from 2004 to 2011. On average, in the EMR 181.6 MMR has occurred per 100,000 live births. Other findings on maternal mortality indicate the disparity of this variable between the countries of the region so that the minimum and maximum rates have been between 0 and 1600. The EDU was almost low in this region and it was also remarkable disparate distribution. During pregnancies, on average woman in this region gives birth to more than 3 children.

The HE has been approximately 5% for the region. Generally, descriptive findings

show a significant disparity or inequality in economic, social, health systems-related, and maternal mortality variables. To select the best estimation method for the model, Chow and Hausman diagnostic tests were applied (Table 2). According to the results from Chow Test (F and Chi-Sq statistics), the null hypothesis based on using Pool effect method is not accepted at 90% confidence level. According to the results from Hausman Test Chi-Sq statistics, the null hypothesis based on using Random Effects (RE) method is not accepted at 99% confidence level. Consequently, the Fixed Effects (FE) method is selected to estimate the model of this study. Results of model estimation through the FE method are shown in Table 3. Since the independent variables and the dependent variable in the model are logarithmic, the estimated coefficients show the dependent variable (MMR) elasticity with respect to the explanatory variables. For example, the GDP coefficient (0.869) shows the MMR elasticity with respect to the GDP; this means that 1% increase in the MMR would lead to 0.86% MMR reduction. Coefficients of other variables can be interpreted the same way.

GDP, HE, EDU, and BA have had a negative, significant relationship with MMR in this region. Variables such as URB and PHC showed a positive, significant relationship with MMR, while the TFR did not have a significant effect on MMR.

Overall, significance of the model based on the F statistic ( $p < 0.001$ ) can be confirmed. In addition, the estimated value of the adjusted  $R^2$  (0.795) shows that almost 80% of the changes in maternal deaths can

Table 1. Descriptive statistics of the studied variables in the Eastern Mediterranean countries (2004-2011)

	Mean	SD	Min	Max	Median
Maternal mortality ratio per 100 000 live	181.60	337.95	0	1600	40
Gross Domestic Product Per Capita (GDP)	10702.7	17444.11	158	88990	2720.41
Health Expenditure as % of GDP (HE)	5.01	2.71	1.5	16	4.2
Literacy rate among Female adults aged 15+	67.34	22.05	5	95.6	74
Total Fertility Rate (TFR)	3.44	1.34	0.9	6.3	3.1
BA (% Births attended by skilled health) per-	82.90	23.88	14	100	95.5
Primary Healthcare units and Centers (PHC)	1.65	1.27	0.2	8	1.6
Urbanization Rate (URB)	67.27	23.23	22	100	71

Table 2. Results of diagnostic tests for model estimation method

Test	Statistic	p
Chow test	$\chi^2=15.204$	0.033
	F=2.032	0.057
Hausman test	$\chi^2=29.380$	<0.001

Table 3. Results of model estimation with fixed effects method for the Eastern Mediterranean countries (2004-2011)

Variable	Coefficients (Elasticity)	t-statistic	p
C	14.267	12.898	<0.001
LGDP	-0.869	-7.626	<0.001
LHE	-0.525	-2.957	0.003
LEDU	-1.045	-2.894	0.004
LTFR	0.394	1.618	0.108
LBA	-0.899	-2.002	0.047
LPHC	0.197	2.014	0.046
LURB	1.282	2.867	0.005
Goodness of fit		R <sup>2</sup> =0.818	
		Adjusted R <sup>2</sup> =0.795	
Overall significance of model		F-statistic=35.361	
		p≤0.001	

be explained by the economic, social and health system variables used in this study.

### Discussion

In the present study, it was seen that the GDP, HE, EDU, BA have had a negative, significant relationship with MMR in the EMR. That is to say, the increase of each abovementioned indicators would lead to maternal mortality reduction. This emphasizes on the importance of government investments in the health sector and the share of the health sector of the total government expenditures so that by increasing budgets for the health sector, great steps might be taken to improve the health of population especially mothers. Moreover, improving women's literacy and knowledge can significantly contribute to their health. Findings of a similar study by Luis Alvarez in Africa were similar to the present study so that there was a negative, significant relationship between maternal mortality rate and the GDP per capita, health expenditure, women literacy rate, and the number of deliveries by skilled birth attendance in this region (13). Another study concluded in Sub-Saharan African countries, birth in the presence of health professionals and the life expectancy at birth are highly correlated to maternal mortality. Furthermore, a very effective relationship was found between GDP per capita and health expenditure per

capita and maternal mortality (14). In other study in Pakistan villages, it was seen that mothers with a previous history of abortion were among those at high risk for mortality. Besides, a significant relationship was observed between having access to health services, professional health staff and healthcare during pregnancy and MMR so that maternal mortality reduced considerably as these situations improved (15). The positive impacts of GDP, HE, EDU on health outcome also, were reported in the other studies in EMR (18,19).

The present study suggested that variables such as URB and the PHC have a positive, significant relationship with MMR. The relationship between URB and MMR could be interpreted as follows: since the majority of the EMR are developing countries, migration from rural to urban areas and creating the marginalization phenomenon is one serious problem in these countries. Therefore, development of marginalization around big cities has caused high population areas that lack the minimum level of sanitary and welfare facilities. There were different findings from other studies; the positive (20) and also negative impact of urbanization on health outcomes reported in previous research (21).

The imbalance between population and resources in city fringes has caused a lot of problems, including the spread of different

diseases, increased mortality due to diseases, increased crime, and other health-related problems (22). Perhaps the reason for a positive relationship between the health centers ratio and MMR in this study is that this ratio is a little indicator of the primary care centers' conditions. Therefore, this positive relationship probably shows the lack of good performance and quality of these centers. In his study, Hertz evaluated the social and environmental factors affecting life expectancy as well as maternal and child mortality. Results showed a strong correlation between the factors related to food, available medical supplies, sanitation facilities and safe drinking water resources and maternal mortality so that improving them would significantly reduce maternal mortality (17).

In this study, the TFR had no significant effect on MMR. However, Muldoon (2009) found that fertility rates higher than 1 would bring about significant risk of maternal death (16).

As stated in descriptive findings, there exists considerable disparity between different countries of the region in terms of the studied variables. Therefore, one reason for the lack of compliance of some results such as the positive impact of urbanization or primary care centers on maternal mortality, with that of other studies is the heterogeneity of the data. Furthermore, the interpretation of the variable's coefficients has to be done with caution; results obtained from the entire EMR are considered as a unit of analysis and should not be extended to individual countries within the region.

### Conclusion

Mothers belong to the vulnerable groups of societies are seriously influenced by adverse conditions, especially in relation to health sector deficit. However, the maternal health is one of the most important indicators of economic, social and health development in countries. Improved earnings and economic development in the region, increasing the resources allocated to the health sector, improving delivery service

particularly the increased use of trained staff in deliveries, enhancing the quality of primary health care, reducing marginalization phenomenon and other urban hazards, and especially, improving the quantity and quality of women's knowledge and literacy are the most important factors in promoting women's health and reducing maternal mortality in the EMR.

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