Socio-economic determinants of inequality in child mortality rate among Iranian provinces: An ecological study

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Abstract
Background: To identify the determinants of the inequality in child mortality it is vital to take interventional measures to improve survival of children.

Objective: To estimate child mortality rate (CMR) for Iranian provinces and then assess the share of medical and socio-economic factors in CMR among Iranian provinces.

Methods: First, we estimated CMR for Iranian provinces from several sources. Then, we extracted socio-economic status of provinces from Iranian centre of statistics. We used correlation and multivariate linear regression for assessing association of CMR with socio-economic status.

Results: South Khorasan with 51 per 1000 live births and Mazandaran with 13 per 1000 live births had the highest and the lowest CMR among Iranian provinces. Correlation analysis showed that cost of health (-0.52) and literacy rate (-043) had the strongest association and the number of doctors with -0.24 had the weakest association with CMR. Results of multivariate analysis revealed that literacy rate and cost of health were statistically significant and explained about the 45% difference among Iranian provinces.

Conclusions: There is inequality in child mortality among Iranian provinces. However, literacy rate, cost of health and income per capita are the most effective determinants of inequality.

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Introduction
Despite all health and medical interventions to improve survival of children, it has remained as one of the major health challenges worldwide. According to the estimates by the World Health Organization (WHO), about six million children died before the age of five years in 2016[1]. Genesis of international perspectives such as Millennium Development Goals (MDG), which call for reduction of CMR by two thirds from 1990 to 2015, and after that, Sustainable Development Goals (SDG), which call for reduction of CMR to less than 25 per 1000 live birth in 2030, is associative of researchers and policy-makers' concerns on survival of children globally. This report show that, not only are the deaths not spread worldwide uniformly, but there is a wide gap among regions and countries in term of child mortality experience. Most deaths occur in African countries and regions and the lowest deaths take place in European regions[2,3].

Iran, as a member of the United Nations, has signed the international agenda including MDG and SDG and is committed to reduce the child mortality based on targets of interest. The same report shows that CMR has been reduced in Iran from 57 per 1000 live births in 1990 to 15 per 1000 live births in 2016 with an annual reduction rate of 5.1%[4]. Despite this promising reduction in child mortality at national level, the existing evidence indicates the presence of differences in the CMR and reduction rate among Iranian provinces. The studies show that child mortality ranged from 9 per 1000 live births in Mazandaran to 47 per 1000 live births in south Khorasan[5]. Previous studies reveal the determinants of CMR in the world and Iran, but these studies purely used individual data for exploring the determinate of inequality and did not consider the health and socio-economic attributes of the provinces[6,7]. Therefore, to reduce child mortality and achieve SDG in 2030 in Iran, it is necessary to identify these attributes to take interventional measures in provinces with high CMR.

Objective
In this study, we aimed to estimate the CMR for the Iranian provinces and then assess the share of medical and socio-economic factors in the CMR among the Iranian provinces.

Method

Data sources

Two sources, including death registration system and censuses, were used to estimate the CMR in Iran. Death data was registered by the Ministry of Health and Medical Education and was available for 2006 to 2011. Due to problems related to under-registration and mis-registration of death data[8-11], in addition to DRS, we used census data including summary birth history (SBH) method[12]. This method uses two questions asked from mothers aged 15 to 49 for estimating CMR. How many live children were borne by a mother? and How many children survived? Questions of SBH were analysed by use of two methods called Maternal Age Cohort (MAC) and Maternal Age Period (MAP) methods. In the next step, different estimates of different sources were combined by Gaussian Process Regression. This method uses spatio-temporal model as mean function of prior distribution and Gaussian distribution as likelihood function for generating posterior distribution. This question estimate CMR indirectly. We provided the detailed description of data sources and statistical analysis elsewhere[13].

On the other hand, we extracted independent variables including literacy rate, mean annual household income, percentage of urbanization, number of doctors for every province from Statistical Yearbooks (2006 to 2011) which were provided, prepared and disseminated by statistical centre of Iran[14].

Statistical analysis

To assess inequality among provinces, first we used simple correlation between CMR and independent covariates including mean maternal years of schooling, income level and number of doctors. Then, we used multivariate analysis to assess association between CMR with independent covariate independently controlling effect of other covariates. STATA software version 14.2 was used for analysis of data.

Results

The five-year mean of the under-five mortality rate (U5MR) in south Khorasan is the highest (51 per 1000 live births) and in Mazandaran is the lowest (14 per 1000 live births). Sistan and Baluchistan with 71% and Tehran with 91% have the lowest and the highest literacy rate respectively. Gilan with 20568964 Rials and Mazandaran with 94389664 Rials have the lowest and the highest income levels. Percentage of urbanization in Sistan and Baluchistan with 49% is the lowest and in Qazvin with 94% is the highest. The lowest and the highest number of doctors was in Ilam and Tehran respectively. Yazd with 8% and Loristan with 18% have the lowest and the highest unemployment rate. South Khorasan with 3095042.3 Rials has the lowest health cost and Kerman with 12140942 Rials has the highest health cost (Table 1).

Table 1: *Mean of child mortality rate of Iranian provinces with their socio-economic status*

Province	Child mortality rate	Unemployment	Literacy rate	Doctors	Urbanization	Cost of health	Income
Ardebil	25.8	11.5	80.3	486.2	61.2	6633226	6.96E+07
Kerman	26.7	11.5	82.3	1042.8	58	6167511	5.79E+07
Kermanshah	29.4	15.4	82	657.2	68.2	6482904	7.21E+07
Khuzestan	25	12.6	78.6	1813.7	69.1	7744205	8.70E+07
Kurdistan	40.3	11.8	77.7	609.3	62.7	4320545	6.54E+07
Lorestan	23	17.7	75.8	610	60.3	6219523	6.70E+07
Markazi	24.3	11.1	84.1	545.3	71.6	8006849	6.86E+07
Mazandaran	13.7	10.9	85.4	1810.7	54	8525808	9.44E+07
Qazvin	21.8	10.8	84.8	441.8	70.7	6417469	8.58E+07
Sistan	36.9	11.6	71.4	781.5	49.3	3168779	5.19E+07
Yazd	25.1	7.8	84	570.3	81.3	5598084	7.49E+07
Bushehr	24.9	11.1	84.8	462.3	66.7	6482458	7.80E+07
East Azerbaijan	25.2	8.3	81.8	1862.3	67.9	7786888	5.93E+07
Fars	30.3	15.1	86.4	1553.7	64.4	1.10E+07	8.57E+07
Gilan	19.9	14.2	83.7	1371	57.1	8698522	2.06E+07
Golestan	23	8.6	82.4	849.5	49.7	5363685	6.16E+07
Hamadan	26	14.2	82.2	744.5	58.4	4883790	7.05E+07
Hormuzgan	32.1	8.2	82.9	546.3	48.5	5899182	7.05E+07
Ilam	24.7	14.2	77.4	177.2	62.3	9017954	6.27E+07
Isfahan	21.8	11.8	87.6	1882.2	84.3	9329478	6.38E+07
Kohgiluye	26.3	15	81.7	355.3	50.2	6726901	7.42E+07
North Khorasan	37	8	82.6	158.7	49.9	5127295	5.97E+07
Qom	17.5	10.4	86.3	281.2	94.5	6668194	7.32E+07
Semnan	25.9	9.8	88.6	402.2	75.8	6250782	6.77E+07
Shahrekord	22.7	13.7	82.3	712.7	54.9	7955325	6.67E+07
South Khorasan	51	9.7	78.2	299.7	53.3	2309376	4.93E+07
South Razavi	32.8	9.3	86.2	1946.2	70.1	5102622	7.15E+07
Tehran	24.3	12.1	90.9	4295.7	92.3	8985129	3.70E+07
West Azerbaijan	34.2	11	77.8	1134	61.4	8247868	7.16E+07
Zanjan	29.5	9	82	482.3	60.2	6072995	5.81E+07

Simple correlation between U5MR and independent variables showed that maternal education with -0.43 and cost of health with - 0.52 had the strongest association and number of doctor with -0.24 had the weakest association respectively (Table 2).

Multivariate analysis showed that controlling the effect of other variables, three variables including literacy rate, unemployment rate and cost of health are statistically significant (Table 3). Therefore, other variables, namely number of doctors and urbanization and income are not significant. R-square for this model is 43%, it means these variables explained 38% difference between Iranian provinces in under-five mortality.

Table 2
Correlation of child mortality rates in Iranian provinces with their socio-economic status

Variable	Correlation coefficient
Literacy rate	-0.43
Number of Doctors	-0.24
Urbanization	-0.35
Cost of Health	-0.52
Income	-0.27

Table 3: *Multivariate analysis of association between child mortality rates in Iranian provinces with their socio-economic status*

Variable	Coefficient	Standard Error	P-value	R-Square
Literacy rate	-0.43	0.13	0.002	
Number of Doctors	-0.0003	0.00006	0.57	
Urbanization	-0.07	0.04	0.14	0.43
Cost of Health	-9.61	1.83	0.001	
Income	-1.94	2.22	0.38	

Discussion
Despite the remarkable improvement in survival of children worldwide, deaths of children occur unequally in communities. Therefore, informing and focusing on exploration of determinants of inequality among and within communities is helpful for health policy-makers for selection of the required interventions. In this study, we aimed to explore the role and share of each socio-economic factor in creation of inequality among Iranian provinces. This study provides evidence for the reduction of child mortality in Iran and for the presence of inequality among Iranian provinces. However, in this study, we originally aimed to scrutinize the factors affecting on presence of inequality among Iranian provinces. Our analysis showed that a significant and strong association exists between CMR in Iranian provinces and their socio-economic factors. Despite a significant association between CMR and all variables, the effects of all variables are not identical. In fact, the effect of maternal education level has the stronger effect on CMR than other variables including the number of doctors.

This study showed that effect of socio-economic status on disparity among Iranian provinces, especially maternal education level, is more important than access to health and medical services. In addition, another socio-economic factor, namely income per capita, has great effect on the presence of inequality between Iranian provinces. The Literacy rate influences the knowledge of nutrition, implantation of immunization, child health care and high job situation, and therefore, improves survival of children.

Several studies indicate the presence of inequality in child mortality in Iran. Hosseinpour in 2005 showed that the strongest association of infant mortality is with maternal education level and income level. However, the study did not investigate inequality among provinces[15]. Moreover, Amini Rarani's study revealed that inequality in child mortality between poor and rich has been reduced by 16%. However, share of household's economic status (49%) in inequality was greater than maternal education level (32%). Furthermore, examining change in inequality of child mortality indicate decrease in inequality from 2000 to 2010. Improvement of maternal education level was main responsible for this decline[6].

A study by Damghanian *et al* in Shahrood city showed that socio-economic status plays the main role in inequality of child mortality and maternal education level is the dominant determinant. The studies reveal that progress in survival of children does not depend on health expenditure, but through improving health outcomes such as leadership and partnerships across society, and evidence-informed, innovative, context-specific approaches[16]. However, the above mentioned studies run at individual unit and not aggregate unit, therefore, they could explore the difference between individuals. However, they could not reveal difference among provinces.

This study has several limitations. This is an ecological study, which has been conducted based on aggregated data and not individual data, so-called "ecological fallacy". The issue occurs when we analysed the grouped data, but we intent to interpret result and extract conclusion based on individual data. On the other hand, results of aggregated data may not be generalizable to individual data[17]. Second, due to unavailability of the required data, we could not use the recent data for child mortality and independent variables, therefore we are forced to confine our study to years with available data, however we can hope that status of CMR and independent variable of provinces are constant and not variable much more over time. Third, we did not investigate trend of inequality among provinces, therefore, we suggest the researchers to examine the trend and degree of inequality among Iranian provinces. Fourth, beside DRS data, we used SBH and CBH data for estimating child mortality rate. However, the validity of these methods rely on holding assumptions such as absence of recall bias and survival biases. If these assumption do not hold, the validity and reliability of the estimates are questionable[8,10,13,18]. Unfortunately, there is no way to check these assumptions and we are forced to accept holding the assumptions. Despite this, the validation study of the methods was confirmed in studies.

Conclusions
There is inequality in child mortality among Iranian provinces. However, literacy rate, cost of health and income per capita are the most effective determinants of inequality.

Acknowledgements

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