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Quick Response Code:

Website: www.jehp.net
DOI: 10.4103/jehp.jehp_265_19

Investigating the effects of human health resource changes on the basic health indicators in Iran: An econometric study

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Abstract:

INTRODUCTION: In the development perspective of each country, it is important to pay attention to the health sector and improve health indicators; therefore, planning in training and distribution of human resources in the health sector is an important factor to achieve the health system goals. The aim of this study was to investigate the effect of changes in health sector human resources on infant mortality rate (IMR), maternal mortality rate (MMR), and under-five mortality rate (U5MR) in Iran.

METHODS: This was an econometric study (data panel) that conducted retrospectively and used data from the period 2006 to 2017 among Iranian provinces. Three regression models were used to determine the effect of health sector human resources (physicians, nurses, and paramedical staff) on the IMR, MMR, and U5MR. The random-effects model was selected over the fixed-effects model to assess the effect of health sector human resources on health outcomes.

RESULTS: Results showed that the number of physicians in different models has a stronger impact on these mortality rates than those of nurses and paramedics, so that a 1% increase in the number of physicians leads to 2.1%, 3.8%, and 2.2% decrease in IMR, MMR, and U5MR, respectively. Furthermore, per capita income has a bigger impact on these mortality rates than human health resources.

CONCLUSION: Increasing the number of human resources in the health sector, especially the number of physicians, by investing in these resources by providing educational facilities, plays an important role in improving the mothers' and infants' health indicators.

Keywords:

Health outcomes, health workforce, Iran

Introduction

Health is one of the most important tools for country development and is one of the fundamental rights of all humans regardless of race, religion, political beliefs, or social or economic status.^[1] Access to global and national health standards in any country is an essential component of development goals. According to the World Health Organization (WHO), promotion

of health indicators, such as maternal mortality rates (IMRs), maternal mortality rates (MMRs), and life expectancy at birth are considered as one of the goals of development in any health system.^[2] Therefore, in order to achieve this development perspective goal, sufficient resources are essential. In addition to financial resources, human resources such as physicians, nurses, and other professionals in the health sector play an important role.^[3] In general, the role of human resources in the health sector has been taken into consideration since the early

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How to cite this article: Hadian M, Raeissi P, Shali M, Khalilabad TH, Niknam N. Investigating the effects of human health resource changes on the basic health indicators in Iran: An econometric study. *J Edu Health Promot* 2019;8:207.

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Received: 22-05-2019

Accepted: 19-07-2019

first decade of the 21st century, and accordingly, the WHO in a report in 2006 has been mentioned to the importance of human resources in the next years.^[4]

According to the WHO in 2006, 57 countries worldwide (especially less developed countries) faced a serious health professional shortage (physicians, nurses, and midwives).^[5] In these countries, there were only 2.3 health workers/1000 population, whereas according to the WHO, at least 2.5 medical professionals/1000 population are needed to provide minimum services such as primary health-care services.^[6]

In developing countries such as Iran, the shortage and the inappropriate distribution of human resources in the health sector have resulted in lack of access to pregnancy services which are one of the most important factors in the high maternal and neonatal death and even low life expectancy. In these countries, only 53% of childbirths were carried out under the supervision of a skilled specialist. This is while many of childbirth (43%) were done by traditional midwives and relatives or without any help. Accordingly, one hundred and fifty deaths occurred due to pregnancy and childbirth in Iran in 2016.^[7,8]

Therefore, implementing fundamental programs is needed to improve community health, including improving the health of infants and mothers.^[9,10] The increase in the number of the per capita general physicians is one of these programs. Currently, there is one health workforce for every 2500 people in the Iran. To increase the number of health workforce in country to reach the standard level of developed countries (one health workforce per thousand), programs such as a family physician plan need to be implemented.^[11]

Therefore, one of the ways to improve the state of health in the country is to increase the equipment and human resources of specialist physicians, nurses, and paramedical staff. Hence, the study of human health resource status in the country's health sector and its impact on health status is an information gap that needs more attention today. This study first seeks to investigate the status of human health resources and basic health indicators in Iran, and then, we will examine the impact of human resource changes on health indicators.

Methods

This was a descriptive-analytic and applied study that was carried out among the Iran's provinces (thirty provinces) during the period of 2006–2017. We used econometric models to evaluate the effect of human health resources such as the number of physicians, nurses, and paramedical workforces on health basic

indicators such as MMR, IMR, and children under-five mortality rate (U5MR).

The following models can be investigated according to the review of previous studies, consideration of theoretical principles, and model. The basic model employed was adopted from Anand' study, and all variables were included in the form of natural logarithms (ln).^[12]

$$\text{IMR}_{it} = \alpha_i + \beta_1 \ln(\text{PHY}_{it}) + \beta_2 \ln(\text{NUR}_{it}) + \beta_3 \ln(\text{PARM}_{it}) + \beta_4 \ln(\text{GDP}_{it}) + u_{it} \quad (1)$$

$$\text{MMR}_{it} = \alpha_i + \beta_1 \ln(\text{PHY}_{it}) + \beta_2 \ln(\text{NUR}_{it}) + \beta_3 \ln(\text{PARM}_{it}) + \beta_4 \ln(\text{GDP}_{it}) + u_{it} \quad (2)$$

$$\text{U5MR}_{it} = \alpha_i + \beta_1 \ln(\text{PHY}_{it}) + \beta_2 \ln(\text{NUR}_{it}) + \beta_3 \ln(\text{PARM}_{it}) + \beta_4 \ln(\text{GDP}_{it}) + u_{it} \quad (3)$$

In these models, *i* represents the province and *t* represents the time. Where IMR, MMR, and U5MR are infant mortality rate, maternal mortality rate, and under-five mortality rate, respectively. Furthermore, PHY, NUR, and PARM represent the number of physicians, nurses, and paramedical staff/1000 population, respectively. GDP represents the gross domestic product of each province and considers as a control variable to measure the impact of income in each province on the health indicators.

All the data used in this study were collected through the national databases of Iran, including the Central Bank of the Islamic Republic of Iran, the Statistical Center of Iran, and the Deputy of Statistic and Information Technology in the Ministry of Health and Medical Education.

Since this is a panel econometric study, the first issue to be considered in this study is to examine the stationary of all the variables in order to prevent spurious regression and problem. Moreover, augmented Dickey–Fuller and Dickey–Fuller stationary tests were used. In the next step, in order to determine the appropriate model, we used the Chow test to choose integrated or fixed-effects model. Furthermore, the Hausman test was used to select the best model between the fixed- and random-effects models. Eviews version 10 (IHS Global Inc., Irvine, CA, USA) was used to estimate the models.

Results

The descriptive analysis results of the study showed that during the period of 2006–2017, the total number of physicians, nurses, and paramedics increased per 1000 population. Accordingly, the number of human resources in the health sector (physician, nurse, and paramedic) has increased from 0.81 in 2006 to 2.01 in 2017/1000 population. Similarly, during the same period, IMR, MMR, and U5MRs experienced a

significant decline. Meanwhile, the number of health workforces in Iran showed that Tehran province with 950, 972, and 355 had the highest number of physicians, nurses, and paramedics/1000 population respectively, in 2014. Also, North Khorasan had the lowest number of physicians (77/1000 population) in 2009. Figure 1 shows the trend of human health resources and health indicators in Iran between 2006 and 2017.

In the first step of estimating a panel data model, it is necessary to check the stationary variables before selecting the appropriate model. The results of the Dickey–Fuller and augmented Dickey–Fuller tests showed that all variables were static at 5% significant level. In addition, other diagnostic tests showed that the model was correctly defined and the error sentences had a normal distribution.

Base on the likelihood ratio and Wooldridge test statistics did not exist heteroskedasticity and multicollinearity problems in the models (the probability of statistics is >5% so null hypothesis is rejected). The results of the heteroskedasticity and multicollinearity tests are demonstrated in Table 1.

In the following to select a proper model, the Chow test (choosing panel or pool model) and Hausman test (choosing fixed- or random-effects model) were used. These results are demonstrated in Table 2.

According to the results in Table 2, results indicated that the random-effects model was favored over the fixed effects in all models. In the next step, we estimate models with random effects. These results are reported in Table 3.

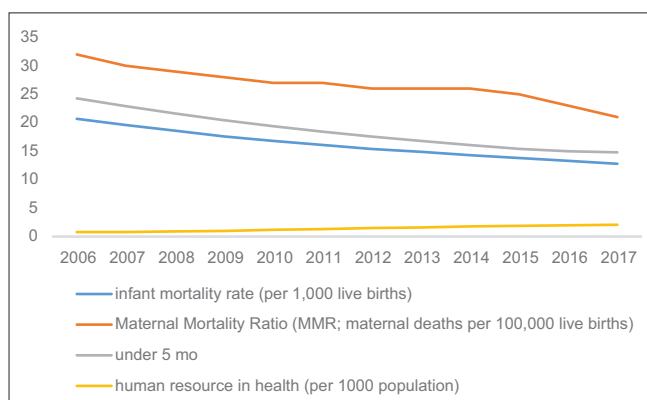


Figure 1: The trend of human health resources and health indicators in Iran between 2006 and 2017

The results of the panel data for thirty provinces showed that in all models, human health resources, including physicians, nurses, and paramedics, had a significant effect on the population health status. Accordingly, the results showed that the physician among all the human health resources of the health sector had a greater effect on the improvement of health indicators. A 1% increase in the number of physicians leads to 2.1%, 3.8%, and 2.2% decrease in IMR, MMR, and U5MR indicators, respectively. Furthermore, a 1% increase in the number of nurses resulted in a 1.01%, 2.25%, and 1.9% reduction in IMR, MMR, and U5MR indicators, respectively. However, the number of paramedical staff had the least impact on health indicators among other human health resources, so that a 1% increase in the number of paramedics in the country’s provinces resulted in 0.8%, 0.89%, and 0.98% decrease in IMR, MMR, and U5MR, respectively. On the other hand, per capita income had a greater impact on health indicators in comparing to human health resources, so that a 1% improvement in income status resulted in a 2.58%, 3.9%, and 3.3% reduction in IMR, MMR, and U5MR, respectively.

Furthermore, the obtained F-statistics in three models indicate the significance of entire regression. On the other hand, the Durbin–Watson statistic was close to 2 in all models, so there was no problem of autocorrelation. The coefficients of determination (R^2) for these models are 0.88, 0.79, and 0.79, indicating the high proportion of the variance in the dependent variable that can be predicted from the independent variable.

Discussion

The aim of this study was to investigate the role of human resources in health sector on health status in Iran. In this study, physicians, nurses, and paramedics were considered as the main human resources in the health sector and as independent variables that play an important role in improving the IMR, MMR, and U5MR as dependent variables. In general, the results showed that increasing the number of human health resources (physicians, nurses, and paramedical staff) improves health indicators.^[13]

Results showed that the number of physicians in the country health sector had a significant effect on mortality rates, so that increase in the number of physicians in each province resulted in improvement in health indicators, which these results are also consistent

Table 1: The results of the heteroskedasticity and multicollinearity tests

Test	Test statistics	Statistics value (prob)		
		Model 1	Model 2	Model 3
Heteroskedasticity test	Likelihood ratio	350.12 (0.01)	322.01 (0.02)	160.94 (0.03)
Multicollinearity test	Wooldridge	153.28 (0.01)	353 (0.00)	350.12 (0.00)

Table 2: Chow and Hausman test results in order to select proper model

Test	Model	Test statistics (prob)	Degree of freedom
Chow test (F)	1	6.31 (0.01)	7, 198
	2	8.7 (0.00)	7, 198
	3	7.9 (0.00)	7, 198
Hausman test (χ^2)	1	0.00 (1.00)	5
	2	0.01 (1.00)	5
	3	0.00 (1.00)	5

Table 3: The results of random-effects model with dependent variables of infant mortality rate (model 1), maternal mortality rate (model 2), and under-five mortality rate (model 3) for provinces of the Iran

Variable	Coefficient (prob)		
	Model 1	Model 2	Model 3
Constant	51.27 (0.1)	110.01 (0.21)	97.4 (0.4)
PHY _{it}	-2.1 (0.00)	-3.8 (0.02)	-2.2 (0.00)
NUR _{it}	-1.01 (0.00)	-2.25 (0.03)	-1.9 (0.00)
PARM _{it}	-0.8 (0.04)	-0.89 (0.00)	-0.98 (0.00)
GDP _{it}	-2.58 (0.01)	-3.9 (0.05)	-3.3 (0.02)
Coefficients of determination (R ²)	0.88	0.79	0.79
Durbin-Watson statistic	2.3	1.92	1.93
F statistic	17.05 (0.00)	15 (0.00)	13.25 (0.01)

PHY=Number of physicians, NUR=Number of nurses, PARM=Number of paramedical staff, GDP=Gross domestic product

with other studies by Zerehi^[14] and Hosseini Jebeli *et al.*^[15] and a study by Macinko *et al.*^[16] According to Macinko study, a 1% increase in the number of physicians/1000 population leads to a 5.3% decrease in all mortality rates. Furthermore, Pando found that a 1% increase in the number of physicians resulted in a 9.21% decrease in IMRs.^[6] The results of the study showed that the number of physicians has the greatest impact on mortality rates among all human resources in the health sector which is consistent with the results of other studies.^[16,17] Anand and Bärnighausen showed that the number of physicians in different models has a stronger impact on these mortality rates than those of nurses and paramedics.^[12]

On the other hand, the results of the present study showed that the increase in the number of nurses and paramedical health workers decreases the IMR, MMR, and U5MR. Nguyen *et al.* in their study showed that a 1% increase in the number of nurses resulted in a 13% reduction in IMR and U5MR.^[17]

Furthermore, by comparing the coefficients obtained in all three models, the results showed that an increase in human health resources had the greatest impact on the reduction of MMRs. It is believed that this might be due to the high ability of health workers in the management of risk factors that affect the mother's health.^[12,18,19] Furthermore, an increase in human health resources had

the greater impact on the U5MR reduction in compare to IMR reduction.^[18] It is believed that infant health status is more related to breastfeeding status and maternal health status. In other words, the health of infants is more a function of maternal health.

The results of the present study showed that per capita income as a variable for measure economic status had a negative effect on mortality rates. Accordingly, improving the economic status of the people in each province will reduce IMR, MMR, and U5MR, which is consistent with the other studies.^[18,20-22] Increasing household income will improve the quality of life and increase the household purchasing power to buy health-care services, which prevents many mortalities by increasing the overall health level.

Conclusion

Regarding the results, an increasing number of human resources in the health sector such as physicians, nurses, and paramedical staff have a significant effect in the improvement of maternal and neonatal health. Therefore, investing in these resources through providing educational facilities and creating financial incentives for training forces can play an important role in increasing the number of physicians, nurses, and paramedical staff. In addition to increasing the number of human health resources, fair and equitable distribution of these resources can play a role in improving the health status which should consider in future studies.

Acknowledgments

The researchers would like to thank the members of the Deputy of Statistic and Information Technology in the Ministry of Health and Medical Education for their cooperation.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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