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Projecting the Shortages and Surpluses of General Practitioners in Iran

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ABSTRACT

Introduction: Due to the necessity of careful planning in the human capital of health and the effect of imbalance of general physician supply on economy and health status, this study aimed to estimate general practitioners' (GPs) demand and predict general practitioners' shortage and surplus in Iran.

Method: This study was an analytical and applied study conducted at the national level for Iran in 2019 using ARIMA (5,1,1) method for projecting supply and Vector Error Correction (VEC) models for projecting demand with Gross Domestic Product (GDP), out-of-pocket, aging and hospital beds variables. Data were annual time series from 1991 to 2017, extracted from the statistical yearbooks issued by the Statistical Center of Iran and the World Bank database. The required models and tests were estimated by Eviews 10 software at a 0.05 significance level.

Results: The general practitioners' elasticity to GDP, aging, and out-of-pocket were 0.33, 1.77, and -0.81, respectively. GDP per capita (0.11), aging (0.14), and the number of hospital beds (0.0007) had a positive impact, and out-of-pocket payments (-0.0001) had a negative impact on demand for GPs in Iran. Also, from 2018 to 2030, the mean GPs demand (0.23) was higher than the mean supply (0.20), and there was a shortage of GPs in these years (0.03).

Conclusion: Iran is facing a shortage of GPs by 2030. Therefore, there are suggested policies for increasing the admissions capacity at medical universities, maintaining and preventing the migration of physicians with appropriate incentives, establishing rules, and providing job satisfaction for physicians.

Keywords: General practitioners, Health workforce, Projection, Supply

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Introduction

The health workforce is an important factor in the functioning of the health system. Therefore, to have an efficient health system, sufficient workforce, and optimal ratio, it is necessary to ensure that practitioners are motivated enough to perform their assigned functions well (1). Human capital is also a key component of sustainable development (2), and physicians as human resources and human capital are among the most important factors affecting health system performance and sustainable growth and development. Accordingly, the imbalance between the supply and demand of the physician leads to the inefficiency of the health system. Shortage of physicians leads to major problems in accessing health services, and decreasing health status and physician surplus lead to the high expenditures of public health and waste of resources (3). Therefore, careful planning is necessary for the human capital of health, particularly providing an adequate and optimal number of general practitioners (GPs) because of the high cost and long duration of medical education courses.

GPs are the primary providers of community health services and, as the referral agents, play an important role in satisfying the requirements of society (4). In the Iranian health system, due to the lack of a central registration system and the multiplicity of statistical centers, there is no precise data on the number of active GPs (5). It has resulted in concerns about the implementation of the Family Medicine Program (5, 6). Moreover, there is no mandatory referral system for optimal use of health services. Therefore, patients are more inclined to use the medical services of the specialists and sub-specialists for simple illnesses, especially given the low difference between patient pay for the GPs and the specialist services, which has enhanced their motivations. On the other hand, since the tariffs for specialist physicians are also fixed, they also prefer to visit patients with simple illnesses, as it takes less of their time (7). Therefore, when the GPs and specialists are compared, the demand for GPs has been less than the demand for specialist physicians.

In addition to the competition among physicians, the supply and demand of the GPs are influenced by some other various factors, which can lead to a shortage or surplus of GPs. The physician demand is generally influenced by national income per capita, out-of-pocket (OOP), age structure, and others (1, 3, 8, 9). Besides, the physician supply is also affected by national laws for increasing or maintaining the capacity of medical education, migration and Health brain drain, and the death and retirement of the physicians (3, 10, 11). Therefore, due to the need for careful planning in human health capital, especially the GPs as the first providers of the health services and referring factors having a direct impact on the health status of individuals, the impact of the imbalance in the GPs supply on the economy and health status of the community, and the need to adopt appropriate policies regarding the shortage and surplus of GPs have been investigated. This study aims to estimate and predict the shortage and surplus of GPs in Iran and answer the following questions: What factors can influence the demand of general practitioners in Iran? Furthermore, are we facing a shortage or surplus of GPs in the future?

Numerous studies have been conducted on estimating the health workforce using different methods of need (12-16) and demand (8-10, 17, 18), some of which were cross-sectional, and some others were in time series. In recent studies, Scheffler and Arnold (3), Liu et al. (1), Dall et al. (19), and Chojnicki and Moullan (10) started to estimate and predict the physician while developing the conceptualized model for the physicians' demand by national statistics and time series. In line with these studies, the present study estimates the supply and demand functions of the GPs in Iran with time-series data at the national level and predicts the surplus or shortage of the GPs. Using Autoregressive Integrated Moving Average (20) and Vector Error Correction (VEC) econometric method to estimate and predict GPs supply and demand, perceptively, is the main difference between the present study and other studies.

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The supply of health workforce includes all people who have the necessary expertise and skills to work in the health labor market (1). The supply of the health workforce is always affected by various factors, which can be classified into two categories of entry into the labor market (immigration, graduates, wages, and others) and exit from the labor market (retirement, migration, death, and others) (21). Salary is another important factor for entering the healthcare job market. The higher wages are, the more willing the specialist to be employed will be in the labor market (1, 3). High school students are also more encouraged to study in the health-related fields. As a result, the number of entries to medical universities and the supply of health-care workforce are increased (1). Also, many students are studying experimental science in Iran to enter the medical universities, compared with the mathematics and technical majors. Although a flexible wage is needed to balance the supply and demand of the health workforce (22), wages in the health sector are often not flexible because legislators initially set health workers' wages in most countries. Secondly, the health professional workforce has the great bargaining power to raise wages, and third, it is not easy to employ health workers in specific places for low-wage (3). Immigration and emigration of the health workforce have a huge impact on the supply of health workforce, especially health professionals, such as physicians (3, 10). African countries have the highest rates of physician migration due to the better benefits physicians receive when they migrate (23, 24).

The demand for the health workforce indicates a willingness to pay for health care by buyers (government and the private sector) (1). In other words, demand for the health workforce is a derived demand from health care and services. As the demand for health care and services grows, so does the demand for the health workforce. Therefore, the demand for health workforce is influenced by factors such as family income, financial ability of the government, conditions of demographic and epidemiologic and health coverage levels. (1). Increasing family income, government expenditures in the health sector, and aging are expected to increase demand for the health workforce (1, 8-10).

Also, increasing the level of health coverage will lead to an increase in the demand for health labor because people are more able to buy health services (3, 25). There are several ways to predict the physician demand, including the need, demand, population ratio, and service target-based approaches (12, 14-16, 26, 27). Each of these approaches has its advantages and disadvantages (16, 26), of which usually the combination method is the most suitable one (10, 16). The developed models by Liu et al. (1), Scheffler and Arnold (3), Chojnicki and Moullan (10) were used to predict GPs demand in this study, even though the quantity and quality of GPs' services, epidemiological factors, innovation, and new technologies have not been taken into account in those models (28). However, they are the perfect models for functionally and theoretically expansion.

Methods

The present study is an analytical and applied study conducted nationally using ARIMA and VEC models. The statistical population was Iran, and sampling was not done. The data were annual time series, which were extracted from various databases. GDP per capita, Out of Pocket Payments Ratio (OOP), Ratio of people over 65 to 14-65 years (AGING) were extracted from World Bank databases (24). Moreover, general practitioners per 1000 population (GPs) and the number of hospital beds per 1000 population (BED) were extracted from the yearbooks of the Statistical Center of Iran for the years 1991-2017. Due to the nature of the time series variables, stationary of the variables was necessary to avoid the spurious regression. Augmented Dickey-Fuller (ADF) unit root test for stationary of the variables was used. In this test, the null hypothesis indicates the unit root or non-stationary of the variables. Therefore, if the calculated value of the test was greater than its critical value, the null hypothesis based on the non-stationary variable was rejected.

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Next, the models were used to estimate the supply and demand of GPs, and how to estimate its coefficients were described in separate sections. The models and required tests were estimated in Eviews 10 software at a 0.05 significance level. Ethical approval was not required for this study because it is based on secondary data that are fully anonymous and publicly available.

The ARIMA model for Supply of GPs

The past trend is generally used to predict the supply of the physician (1, 3, 9, 10). It is usually appropriate for these predictions to use univariate prediction models, including ARIMA, which are frequently used (29). The ARIMA method is one of the popular time series methods and a combination of three methods, including Auto Regression (AR), Moving Average (MA), and the integration, which are generally referred to as ARIMA (p, d, q) (26). P represents the order of the AR method and stands for the number of autoregressive terms, which associates the given variable with its previous values. Q is the order of the MA method and states that the desired variable is related to lagged error terms q times, and d denotes the integration order of the variable. The general form of the ARIMA model (p, d, q) is as follows:

(1)

$$y_t = \rho_1 y_{t-1} + \cdots, + \rho_p y_{t-p} + \theta_1 \varepsilon_{t-1} + \cdots, + \theta_q \varepsilon_{t-q}$$

ε_t: Error terms. If the order of integration y equals one, the y variable enters the equation as the first difference. The ARIMA method was used to predict GPs supply according to Box-Jenkins methodology in this study. Box-Jenkins proposed four steps for the ARIMA method (29). In the first step (identification), the ADF unit root test was used to determine the integrated degree (d) of the GPs. To determine p and q values, correlogram and partial correlogram were used. Therefore, at this stage, the ARIMA (5,1,1) was chosen. In the second step, the previous step model was estimated by the maximum likelihood method. In the third step, all the relevant models (25 models) were estimated to determine the best model, and ARIMA (5,1,1) model was selected because of the lowest degree of Akaike's Information Criterion (AIC). Finally, this model was used for forecasting within the sample period and outside the sample period in the fourth step.

The VEC model for the demand of GPs

In this study, the developed models by Liu et al. (1), Scheffler and Arnold (3), Chojnicki and Moullan (10) were used to predict GPs demand. At the macroeconomic level, most studies used Gross Domestic Product (GDP) and Gross National Income (GNI) to predict physician demand (8-10) because physician training courses are costly, and only countries with proper economic growth can invest in physician training. Demographic and health coverage measures were also entered into the model as factors influencing the physician demand (1, 3, 8). For the demographic measure, the ratio of the number of people over 65 to the number of people aged 14-65 years was used, and it is expected that by increasing this proportion, the demand for the health workforce increases. Many studies have also shown the direct influence of age structure and aging on physician demand (9, 10, 12, 14, 26). For the health coverage measure, the ratio of household out-of-pocket (OOP) payments to health expenditures was used. OOP payments for health care expenditures indicate the community's social support for the household health expenditures. Since the health insurance coverage, government subsidies, and other financial supports affect the OOP payments (1), the lower the level of health insurance coverage is, the greater the OOP payments will be. It is expected that using health services and consequently the demand of the GPs will decrease. Other factors that may affect GPs demand are the health resources used in the present study by the number of hospital beds per thousand populations, and it is expected that with the increase of this proportion, the GPs demand will increase as well. Additional structural factors, including training capacity, labor regulations, migration, and others, may also affect the labor market (1). However, they were not included in the model due to insufficient data.

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Therefore, the conceptual model of the present study was as follows:

GPs: General practitioners per 1000 population

LnGDP: Natural logarithm of GDP per capita based on purchasing power parity

OOP: Out of Pocket Payments Ratio for medical expenditure to total health expenditures

AGING: Ratio of people over 65 to 14-65 years

BED: The number of hospital beds per 1000 population

There are various methods for estimating and predicting the above model; however, since we expect GPs demand to be influenced by the current quantities of the independent model variables, they are also affected by their lagged values. The current GPs demand may also be affected by the demand for GPs in past years. Therefore, using a Vector Autoregressive (VAR) approach allowing for the indigenousness of all the variables in the model and the effect of different interruptions of the variables on one another seems good. On the other hand, since all model variables are time series and the possibility of a unit root and non-stationary that can lead to spurious regression and misleading results, it is necessary to use co-integration methods Vector Error Correction (VEC) models. Due to the co-integration of the model variables, the VEC model was used, the general structure of which for the model variables is as follows.

$$GP_s = \alpha_0 + \alpha_1 \ln GDP + \alpha_2 OOP + \alpha_3 AGING + \alpha_4 BED \quad (2)$$

$$DGP_t = \theta_1 + \sum_{i=1}^{P} \alpha_{1i} DGP_{t-i} + \sum_{i=1}^{P} \beta_{1i} D\ln GDP_{t-i} + \sum_{i=1}^{P} \sigma_{1i} DOOP_{t-i} + \sum_{i=1}^{P} \varphi_{1i} AGINGP_{t-i} + BED + ECM_1 + \varepsilon_{1t} \quad (3)$$

$$D\ln GDP_t = \theta_2 + \sum_{i=1}^{P} \alpha_{2i} DGP_{t-i} + \sum_{i=1}^{P} \beta_{2i} D\ln GDP_{t-i} + \sum_{i=1}^{P} \sigma_{2i} DOOP_{t-i} + \sum_{i=1}^{P} \varphi_{2i} DAGING_{t-i} + BED + ECM_2 + \varepsilon_{2t} \quad (4)$$

$$DOOP_t = \theta_3 + \sum_{i=1}^{P} \alpha_{3i} DGP_{t-i} + \sum_{i=1}^{P} \beta_{3i} D\ln GDP_{t-i} + \sum_{i=1}^{P} \sigma_{3i} DOOP_{t-i} + \sum_{i=1}^{P} \varphi_{3i} DAGING_{t-i} + BED + ECM_3 + \varepsilon_{3t} \quad (5)$$

$$DAGING_t = \theta_4 + \sum_{i=1}^{P} \alpha_{4i} DGP_{t-i} + \sum_{i=1}^{P} \beta_{4i} D\ln GDP_{t-i} + \sum_{i=1}^{P} \sigma_{4i} DOOP_{t-i} + \sum_{i=1}^{P} \varphi_{4i} DAGING_{t-i} + BED + ECM_4 + \varepsilon_{4t} \quad (6)$$

ECM: An Error Correction Component that represents a deviation from a long-run stochastic trend

D: first-order difference of the variables

P: Optimal lag

The Johansen method (30) was used to estimate the above equations and the long-run relationship between them. In this method, first, the optimal lags of the model should be selected based on the AIC, Schwartz Criterion (SC), Hanan-Quin (HQ), the final prediction error (FPE), and the LR test (LR), the optimal lags must have the least of these criteria. Secondly, the number of co-integration vectors is determined based on the maximum eigenvalue and Trace tests. In these two tests, the null hypothesis is the number of co-integration vectors, and if the value of these two tests is greater than the critical value, the null hypothesis will be rejected. After performing the above steps, the study models were estimated using VEC models (32, 33) in Eviews 10 software, and based on the results, the GPs demand was predicted.

Results

From 1990 to 2017, the GPs variable per 1000 people had a mean of 0.3022 ± 0.030 and moderate sinus growth; on average, its growth rate was 2.45%. Also, according to the Jarque-Bera statistic had a normal distribution. As a percentage of total health expenditures, the OOP payment variable had a slight downward, from 59.60% in 2000 to 38.79% in 2017, averaging 52.24 ± 7.07%. The number of hospital beds also had a slight upward trend per 1000 persons, which averaged 1.64 ± 0.13 over the period 1990–2017. This variable has multiplied since 2013. According to Table 1, ADF results showed that all the variables were non-stationary at the level, which was stationary at the first difference.

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Table 1. Augmented Dickey-Fuller (ADF) unit root test results

Variables	ADF test statistic	Critical values (5%)	p	Result
GPs	-1.02	-2.98	0.72	Non-Stationary
DGPs	-3.95	-3.01	0.006	Stationary
OOP	-0.099	-3.95	0.93	Non-Stationary
DOOP	-3.06	-2.95	0.04	Stationary
lnGDP	-0.012	-2.93	0.93	Non-Stationary
DlnGDP	-4.73	-2.98	0.009	Stationary
AGIMG	-2.62	-3.02	0.89	Non-Stationary
DAGIMG	-3.56	-3.02	0.016	Stationary
BED	0.188	-2.98	0.96	Non-Stationary
DBED	-8.77	-2.98	0.00	Stationary

D = 1'st difference
GPs: General practitioners per 1000 population
LnGDP: Natural logarithm of GDP per capita based on purchasing power parity
OOP: Out of Pocket Payments Ratio for medical expenditure to total health expenditures
AGING: Ratio of people over 65 to people 14-65 years old
BED: The number of hospital beds per 1000 population

Projecting supply for GPs

In the first step, the results of the ADF test showed that the non-stationary GPs variable became stationary by a one-time difference. Thus, it is integrated of order 1, I (1), (Table 1). Since the variable of GPs supply was I (1), the first-order difference of GPs variable was used to investigate the correlogram. The correlogram and partial correlogram results showed that AR (5) and MA (1) might likely exist. Therefore, at this stage, the ARIMA (5,1,1) was chosen. In the second step, the previous step model was estimated by the maximum likelihood method. In the third step, all the relevant models were estimated to determine the best model (Table 2), and the ARIMA model (5,1,1) had the lowest AIC (-6.06), so it was selected. The Jarque-Bera statistic was 0.87, with a probability of 0.61, indicating that the error terms were normal. Also, Kurtosis and skewness of the error terms were normal. Unit root test for error terms also showed that the value of ADF statistic was -4.6021, which is (1% significance) higher than the critical statistic value (-3.72). Accordingly, the null hypothesis or non-stationary of error terms is rejected, and error terms were stationary; then, this model was selected as the best model used in the forecasting stage. The ARIMA model was first used for good prediction within the sample period (1991-2017), and then, the prediction results were matched with actual GPs supply results (Figure 1). It was observed that the prediction values are very close to the actual values, so this model was used to predict outside the sample period (2018-2030). The results of the supply projection from 2018 to 2030 were presented in Table 3. Also ,the results of supply and demand projection for GPs were presented in Figure 2. The average GPs supply was estimated to be 0.2022 during the period 2018-2030.

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Table 2. The top models of ARIMA

ARIMA models	Log likelihood	AIC	SC	HQ
ARIMA (5,1,1)	86.81	-6.06	-5.87	-5.95
ARIMA (3,1,3)	86.72	-6.05	-5.66	-5.94
ARIMA (0,1,3)	83.57	-6.04	-5.80	-5.97
ARIMA (2,1,1)	83.50	-6.03	-5.79	-5.96
ARIMA (3,1,1)	83.18	-6.01	-5.72	-5.93

Table 3. GPs supply, demand, and surplus/shortage projections

Year	Supply Projection	Demand Projection	Surplus/Shortage (S-D)	Surplus/ shortage (as %of supply)
2018	0.20062	0.215023	-0.01440	-7.178891
2019	0.20421	0.220187	-0.01597	-7.82086
2020	0.20909	0.224977	-0.01588	-7.59533
2021	0.20588	0.227775	-0.02182	-10.5966
2022	0.21115	0.229512	-0.01836	-8.69272
2023	0.20763	0.229864	-0.02223	-10.7052
2024	0.20766	0.231619	-0.02395	-11.5329
2025	0.20639	0.234704	-0.02831	-13.7154
2026	0.20214	0.239214	-0.03707	-18.3397
2027	0.20084	0.244244	-0.04340	-21.6076
2028	0.19549	0.249666	-0.05410	-27.6758
2029	0.19172	0.254297	-0.06258	-32.6390
2030	0.18661	0.258014	-0.07140	-38.2637
Mean	0.20226	0.235304	-0.03303-	-16.6433

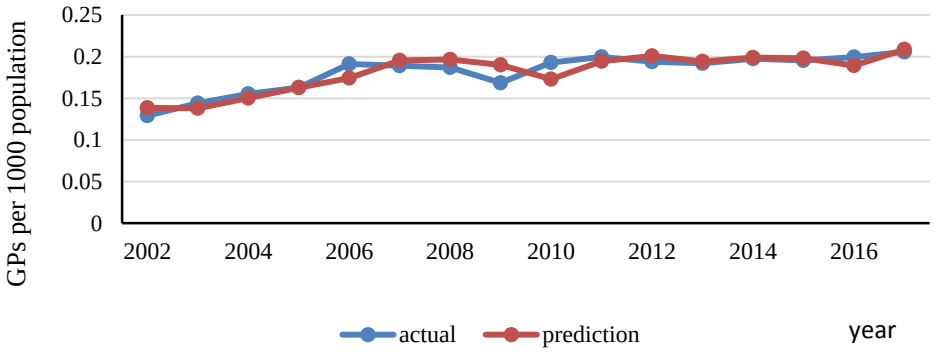


Figure 1. The prediction and actual values of GPs supply in the sample period

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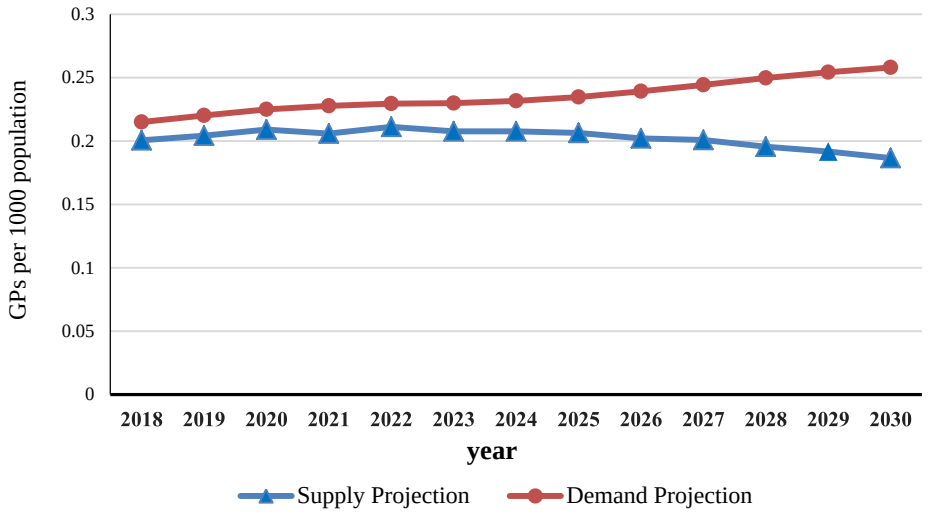


Figure 2. The projection of supply and demand for GPs (2018-2030)

Estimating and projecting demand for GPs

Models (3-6) were used to estimate and predict GPs demand. To avoid spurious regression results, the stationary of the variables was estimated. According to the results of Table 1, GPs, lnGDP, OOP, AGING, and BED are non-stationary at the level and stationary at the first-order difference, i.e., they are integrated with I (1), so there is a possibility of co-integrating vectors between them. Thus, Johansen co-integrating method (30) was used (32, 33). In this method, the optimal lags and the number of co-integrating vectors should be determined, and then the desired model is estimated using this information. According to AIC, SC, LR, FPE criteria, the optimal lags must have the least of these criteria.

Consequently, the first lag was determined as the optimal model lag (Table 4). Trace and maximum eigenvalues tests were performed to determine the number of co-integrating vectors. The results were presented in Table 5 and showed that the hypothesis of one co-integrating vector is not rejected at the 0.05 level. Therefore, there is at most one co-integration vector between the model variables. Due to a co-integration vector, the VEC models were used to estimate the models and investigate the relationship between the variables.

Table 4. Lag order selection

Lag	LR	FPE	AIC	SC	HQ
0	--	0.000185	2.757015	2.950162	2.766905
1	137.4552*	5.58e-09*	-7.738911*	-6.773175*	-7.689457
2	16.18212	6.77e-09	-5.050642	-6.312317	-7.961625*

Table 5. Cointegration rank tests

Trace Test			Maximum Eigenvalue Test			
P	Max-Eigen Statistic	Critical Value (5%)	P	Max-Eigen Statistic	Critical Value (5%)	P
0.0147	34.94886	30.81507	0.0147	34.94886	30.81507	0.0147
0.3135	17.33243	24.25202	0.3135	17.33243	24.25202	0.3135

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The long-term and short-term results of GPs demand were presented in Tables 6 and 7, respectively. For stability of the model coefficients, the inverse roots of the model were estimated, all of which were less than one and within a single circle. The error terms of the above model were tested for stationary by an ADF test. The statistic value was -4.36, which was greater than the critical value of -3.95 at the 5% level, so the error terms were stationary. The normality test of error terms showed that the chi-square values for Kurtosis and skewness were 4.05 and 2.36, respectively. Besides, the Jarque-Bera statistic value was 6.42, all indicating that the error terms were normal. The LM test of the residuals' Autocorrelation also showed no serial correlation at the model. Also, VEC residual Heteroskedasticity tests showed that the chi-square statistic value is 125.28, which is accepted the variance homogeneity with a probability of 0.36. Thus, the results of all diagnostic tests after estimating the model indicate the stability and reliability of the model results. Hence, this model was used to predict the number of GPs. Firstly, within the sample, forecasting was performed. Regarding the high consistency of the GPs prediction values and their actual value, this model was used for outside sample prediction from 2018 to 2030, and the results were presented in Table 3.

Table 6. Long-term demand results for GPs

Dependent variable		Independent variables			
		lnGDP			lnGDP
GPs	coefficients	0.0768***	GPs	coefficients	0.0768***
	standard error	0.0108		standard error	0.0108

*p < 0.10, **p < 0.05, ***p < 0.01.

Table 7. Short-term demand results for GPs

Dependent variable		Independent variables						
		DlnGPs (-1)	DlnGDP (-1)	DOOP (-1)	DAGING (-1)			DlnGPs (-1)
DGPs	coefficients	0.16787	0.11279***	-0.00012***	0.14238***	DGPs	coefficients	0.16787
	standard error	0.38392	0.16993	0.00179	0.17842		standard error	0.38392

*p < 0.10, **p < 0.05, ***p<0.01.
D= First Difference

The long-term results of GPs demand presented in Table 6 showed that the lnGDP coefficient is 0.076, i.e., the GDP per capita logarithm has a positive effect on GPs demand. However, since the GPs demand variable is not considered a logarithm, this coefficient is not elastic. On the other hand, according to the estimated coefficient, the elasticity of GPs to GDP can be calculated. (Iran's GDP per capita in 2017 is $ 19098 (PPP), which will increase by one percent to $ 19289 $\Delta \ln GDP = 0.00995$. Given the ratio of the changes of GP to lnGDP, the growth rate will $\Delta GP = 0.07 \times \Delta \ln GDP = 0.000696$ $GP_{2017} = 0.20551$ $GP_{2018} = 0.21247$ be increased by 0.33%.) This elasticity is 0.33, meaning that if GDP increases by one percent, GPs demand will increase by 0.33 percent. The OOP coefficient equals -0.0043, which indicates that if the OOP ratio has increased a unit, the demand for GPs will be reduced by 0.0043, which is in line with theoretical grounds. By converting the above coefficient to elasticity, if the OOP ratio increases by one percent, the demand for GPs will decrease by 0.81 percent. The AGING coefficient is equal to 0.0421, indicating that if the AGING increases by one unit, the demand for GPs will increase to 0.0421 persons. Similarly, if the AGING increases one percent, the demand for GPs per 1000 population will increase 1.77 percent. The coefficients obtained in the

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short-term VEC model (Table 7) are very complicated to interpret (29), but the relationship direction can be examined. The results showed that the first-order difference of GPs, lnGDP and AGING (with the lag) had a positive effect on the first-order difference of GPs, but the first-order difference of OOP had a negative effect on the first difference of GPs, i.e., the increased OOP payments in last year, has decreased the demand for GPs.

Discussion

This study aimed to estimate general practitioners' (GPs) demand and predict GPs' shortage and surplus in Iran. The results showed that GPs demand elasticity to GDP per capita in Iran is 0.33, i.e., if GDP increases by one percent, GPs demand will increase by 0.33 percent, indicating a positive relationship between GDP per capita and GPs demand in Iran. Liu et al. (1) calculated the elasticity 0.23 for the whole world, Scheffler and Arnold (3), Chojnicki and Moullan (10) calculated 0.40 and 0.32%, respectively for the OECD countries, and Sargen et al. (17) estimated it as 0.5% for the United States. In all studies, the physician demand includes all types of physicians, but the demand is only for GPs in this study. It can be said that the higher the income level of countries, the elasticity of the demand for physicians has increased relative to GDP. Given the long and high cost of medical education courses and the technology and expertise required (3, 10), higher-income countries can easily support physician admission to medical universities, thus increasing GDP. Therefore, Iran, a country with an upper middle income, can increase physician acceptance capacity. The increase of GDP may increase the capacity for admission of physicians.

Nevertheless, it must be borne in mind that physician growth is always related to government policy. These policies have generally been active in controlling government expenditures, ensuring the supply of the physician needed for the society, and supporting physicians (11). Even high-income and developed countries, such as France, Germany, Belgium, Australia, the US, and Britain, have specific budgetary policies, and, through balancing the physician supply, have kept the physician admission unchanged for many years (10).

Iran experienced an increasing trend in the supply of GPs during the years 1993-1998 and 2001-2005 (34). This increase was due to the admission of GPs students seven years earlier, the policy of increasing GPs in the years following the Islamic Revolution. The strategy was to reduce dependency on foreign physicians and improve health in the community, but after 2005 despite the growing population, the per capita supply of GPs has not increased significantly. Despite the increasing supply of GPs in these years, unequal distribution of GPs has worsened access to GPs and health status. Abbasi et al. (35) showed that the Gini coefficient increased, and the physician distribution became unequal from 2000 to 2008. Despite its increase, the uneven distribution of physicians in the Iranian provinces remains a serious problem (36). Also, the OOP ratio had a negative impact on GPs demand, so that if the OOP ratio increased by 1%, GPs demand would decrease by 0.81%. This result is consistent with the theory that the lower the level of health insurance coverage, the more out of pocket, and the demand for physicians and access to health services is expected to decrease. Previous studies have also suggested a negative relationship between OOP payments and physician demand (1, 3). Liu et al. (1) estimated the elasticity of the physician demand relative to the OOP payment globally by -0.099; though this elasticity is for the physician demand, there is a far difference between it and the estimated coefficient for the demand for GPs in this study. It can be said that due to the notable impact of the OOP payment on the demand for GPs in Iran, most people have not possibly referred to the physicians and the health centers in order to avoid paying the catastrophic health expenditures; such a failure in referring for precautionary measures health check-up is much more common in the healthy times. Therefore, it is expected that with a slight reduction in OOP payments, GPs demand will increase further. Insurance, especially supplementary insurance,

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protects patients from paying OOP is also very important (37, 38). Although supplementary insurance has recently been welcomed in Iran due to problems with basic insurance (38), the coordination and organizing insurance funds and supplementary insurances is necessary (37). Aging and the number of hospital beds also had a positive effect on GPs' demand. The elasticity of demand for GPs in Iran is 1.77 percent. Liu et al. (1) estimated this elasticity at 0.5% for the world, and Scheffler & Arnold (3) estimated it for the OECD countries at 2.4%. The physician demand is high in the developed countries because of aging; that is why they are dealing with aging challenges and taking into account the necessary measures for encountering these issues. Northern Europe, Australia, New Zealand, Canada, France, and Italy, facing an aging challenge, have more GPs per capita (5). Many studies have shown the direct impact of age structure and aging on physician demand (9, 10, 12, 14, 26).

The prediction results in Table 3 showed that during the period 2018- 2030, GPs demand is always higher than supply, so we are facing a shortage of GPs in these years. The ratio of shortage to supply of GPs in 2018 is 7.17%, rising to 11.53% in 2024 with an average growth rate of 9.16%, but the average growth rate of shortage/supply is 25% in 2024-2030, which is very different from the previous period. Generally, the mean of GPs shortage/supply ratio during 2018-2030 is 16.64%. Moreover, despite the shortage of physicians, unequal distribution of GPs has worsened access to GPs and health status (35, 36). By 2030, the shortage of physicians will reach 15 million worldwide. The shortage of physicians for upper-middle-income countries is because of the higher GDP and aging, which will result in the global competition for the specialist health workforce (1). OECD countries also will face an 8% shortage of physicians in 2030. Of the 32 OECD countries, only eight countries, including Germany, Mexico, Spain, and the United Kingdom, will have surplus physicians by 2030, but the rest will be short on physicians. Although many US and OECD physicians have already been trained in other countries and then have immigrated to these countries (25% and 17.3%, respectively) they will still face a shortage of physicians in 2030 (3). The United States and France are among the OECD countries with the highest shortage of physicians, resulting from the very low rate of medical graduates and the keeping unchanged the medical education capacity (3, 10, 17).

There will be a shortage of physicians in general and a shortage of primary care physicians and surgeons by 2030 (19), which shall be greater for African countries (1, 23). According to the study results, the average shortage of GPs will be 16.64% in Iran from 2018 to 2030, while there is a big difference between the number of GPs in Iran and developed countries. The GPs per capita in Iran is higher than in Southeast Asian countries and lower than in Northern Europe and Australia, New Zealand, Canada, France, and Italy (5).

Also, according to the present study results, Iran is facing a shortage of GPs during the years 2018-2030. There are usually different strategies to deal with this shortage. 1- Increasing the number of medical students 2- Recruiting physicians trained abroad 3- Increasing incentives to prevent the migration of physicians abroad (10). There are some advantages and disadvantages in each of these strategies (3, 9, 10), which shall be adopted according to the country's structure concerned. Another strategy is to increase the number of working hours to balance the physician shortages, though this policy may affect the patients' health (39). It is suggested that the countries facing a shortage of physicians in the demand-based approach use policies to increase the physician capacity and to preserve the physicians, and prevent their migration in the needs-based approach (9). Therefore, given the shortage of GPs in Iran, adopting a combination of the above policies is useful. This study has some limitations. Since income is the most important factor affecting GPs demand and is affected by the business cycles, then the GPs demand forecasts may not possibly be reliable for the far future. Also, the supply of GPs in Iran is subject to the policies and strategies of

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governments that may change dramatically. Other factors may affect the supply and demand of GPs, including inventions, new technologies, labor laws, migration, and others, which were not considered in the model due to insufficient data.

Conclusion

The forecasting of surplus or shortage of GPs may show a long-term horizon for health policy and planning, especially achieving the Millennium Development Goals and implementing a Family Medicine program (especially in Iran) are critical for the successful functioning of a country's health system. GDP per capita, aging, and the number of hospital beds have a positive impact, and OOP payments negatively impact GPs demand in Iran; the GDP, amongst them, is the most effective one. Forecasts of demand and supply of GPs have indicated that Iran is experiencing a shortage of GPs by 2030; thus, the policies for increasing the GPs through increasing the admissions capacities at medical universities are also suggested. Moreover, regarding the high quota of physician migration to the developed countries, maintaining the GPs and preventing them from migration through appropriate incentives, making laws, and providing job satisfaction may be an important factor in providing the physician required in the country. In addition to providing the physician quantitatively, the proper distribution of the physicians through appropriate conditions is very important.

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Authors' contribution

Study design: MSH; Data collection and analysis: MSH, SGH; Manuscript preparation: MSH, SGH; Writing, reviewing & Editing: MSH

Conflict of interest

The authors declare no conflict of interest

References

1. Liu JX, Goryakin Y, Maeda A, et al. Global Health Workforce Labor Market Projections for 2030. Human resources for health. 2017;15(11):1-12.
2. Shahraki M, Agheli L, Assari Arani A, et al. The relationship between mother's socioeconomic status and child health. Journal of Research and Health. 2018;8(2):143-51.
3. Scheffler RM, Arnold DR. Projecting shortages and surpluses of doctors and nurses in the OECD: what looms ahead. Health Economics, Policy and Law. 2018;14(2):274-90.
4. Sunaert P, Vandekerckhove M, Bastiaens H, et al. Why do GPs hesitate to refer diabetes patients to a self-management education program: a qualitative study. BMC Family Practice. 2011;12(1):1-11.
5. Shokri A, Akbari-Sari A, Bayat M, et al. Estimate General Practitioners Active Supply in Iran: Capture-Recapture Method for Three Data Sources. Iranian Journal of Public Health. 2019;48(12):2240-8.
6. Farzadi F, Mohammad K, Maftoun F, et al. General Practitioner Supply: Family Physician Program And Medical Workforce. Payesh. 2009;8(4):415-21.[Persian]
7. Mosadeghrad A, Jooya T. Factors influencing patient choice of a medical consultant in Tehran. Razi Journal of Medical Sciences. 2017; 24(160):62-72. [Persian].
8. Cooper RA, Getzen TE, Laud P. Economic expansion is a major determinant of physician supply and utilization. Health services research. 2003;38(2):675-96.
9. Scheffler RM, Liu JX, Kinfu Y, et al. Forecasting the global shortage of physicians: an economic- and needs-based approach. Bulletin of the World Health Organization. 2008;86(7):516-23b.
10. Chojnicki X, Moullan Y. Is there a 'pig cycle' in the labour supply of doctors? How training and immigration policies respond to physician shortages. Social science & medicine. 2018;200:227-37.
11. Nicholson S, Propper C. Medical Workforce. In: Pauly MV, McGuire TG, Barros P, editors. Handbook of Health Economics. 2. Holland: Elsevier.2011; 2: 873-925.

[Downloaded from jhr.ssu.ac.ir on 2026-11-19]

[DOI: 10.18502/jchr.v10i2.6588]

12. Faulkner LR. Implications of a needs-based approach to estimating psychiatric workforce requirements. Academic Psychiatry. 2003; 27(4):241-6.
13. Dreesch N, Dolea C, Dal Poz MR, et al. An approach to estimating human resource requirements to achieve the Millennium Development Goals. Health policy and planning. 2005; 20(5):267-76.
14. Birch S, Kephart G, Murphy GT, et al. Health human resources planning and the production of health: development of an extended analytical framework for needs-based health human resources planning. Journal of public health management and practice. 2009;15(6):S56-61.
15. Bärnighausen T, Bloom DE. The Global Health Workforce. In: Glied S, Smith PC, editors. Health Econ. New York: Oxford University Press. 2012:486-529.
16. Fakhri A, Seyedin H, Daviaud E. A Combined Approach for Estimating Health Staff Requirements. Iran J Public Health. 2014;43(1):107-15.
17. Sargen M, Hooker RS, Cooper RA. Gaps in the supply of physicians, advance practice nurses, and physician assistants. Journal of the American College of Surgeons. 2011; 212(6):991-9.
18. Ansah J, Koh V, de Korne D, et al. Comparing health workforce forecasting approaches for healthcare planning: The case for ophthalmologists. International Journal of Healthcare. 2017; 3(1):84-96.
19. Dall T, Reynolds R, Jones K, et al. The 2019 update: the complexities of physician supply and demand: projections from 2017 to 2032. Association of American Medical Colleges. 2019:1-72.
20. Panahi H, Falahi F, Mohammadzadeh P, et al. Factors Influencing the Out -of-Pocket Payments by Patients in the Hospital in Tabriz-Iran. Health Information Management. 2014;11(2):199-207 [Persian].
21. Joyce CM, McNeil JJ, Stoelwinder JU. More doctors, but not enough: Australian medical workforce supply 2001-2012. The Medical Journal of Australia. 2006;184(9):441-6.
22. Scheffler RM. Health Labor Market Analyses in Low- and Middle-Income Countries: An Evidence-Based Approach. In: Scheffler RM, Herbst CH, Lemiere C, Campbell J, editors. Tools and Data Needs to Guide Evidence-Based Policy Making on Human Resources for Health. Washington, DC: World Bank. 2016:11-30.
23. Naicker S, Eastwood JB, Plange-Rhule J, et al. Shortage of healthcare workers in sub-Saharan Africa: a nephrological perspective. Clinical nephrology. 2010;74(1):129-33.
24. world bank. Washington, D.C: world bank.2020 .Available from: https://data.worldbank.org/.
25. Bremer P. Forgone care and financial burden due to out-of-pocket payments within the German health care system. Health economics review. 2014;4(1):1-9.
26. Roberfroid D, Leonard C, Stordeur S. Physician supply forecast: better than peering in a crystal ball?. Human resources for health. 2009;7(1):1-13.
27. Vujicic M, Shengelia B, Alfano M, et al. Physician shortages in rural Vietnam: using a labor market approach to inform policy. Social science & medicine (1982). 2011;73(7):970-7.
28. Birch S. Demand-based models and market failure in health care: projecting shortages and surpluses in doctors and nurses. Health Economics, Policy and Law. 2018;14(2):291-4.
29. Gujarati D. Econometrics by example. Second edition ed. London: Palgrave; 2017.
30. Johansen S. Statistical analysis of cointegration vectors. Journal of Economic Dynamics and Control. 1988;12(2-3):231-54.
31. Johansen S. Determination of Cointegration Rank in the Presence of a Linear Trend. Oxford Bulletin of Economics and Statistics. 1992;54(3):383-97.
32. Shahraki M. Public and private health expenditure and life expectancy in Iran. Journal of the Iranian Institute for Health Sciences Research. 2019;18(3): 221-30[Persian].
33. Shahraki M, Ghaderi S. Investigating the Causal Relationship between Public Health Expenditure and Health Status; Panel Vector Auto-Regression Model. Health Research Journal. 2019;4(4): 220-6. [Persian]
34. Statistical Center of Iran. Statistical Center of Iran. 2019. Available from: https://www.amar.org.ir/english.
35. Abbasi M, Hasoumi M, Mohamadi E, et al. Analysis of the relationship between distributions of health sector inputs and health outcomes in iran; using gini coefficient. Journal of Bioethics. 2014;4(12):65-79 .[Persian]
36. Honarmand R, Mozhdehifard M, Kavosi Z. Geographic distribution indices of general practitioners, midwives, pediatricians, and gynecologists in the public sector of Iran. Electron Physician. 2017;9(6):4584-9.

[Downloaded from jhr.ssu.ac.ir on 2026-11-19]

[DOI: 10.18502/jchr.v10i2.6588]

37. Shahraki M, Ghaderi S. The Impact of medical Insurances on out-of-pocket payments among urban households in Iran: A Double-Sample selection Model. Journal of Health Administration. 2019;22(2):42-54. [Persian].
38. Shahraki M. Estimation of Supplementary Health Insurance Demand in Iranian Urban Household: Probit Model with Sample Selection. Iran Health Insurance Organization. 2019;2(1):10-6. [Persian].
39. Fletcher KE, Davis SQ, Underwood W, et al. Systematic review: effects of resident work hours on patient safety. Annals of Internal Medicine. 2004;141(11):851-7.

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