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Modelling the Number of People per Physician, Nurse, and Midwives in Turkey in Terms of Reproductive Health Indicators

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Abstract
Health worker density and distribution is critical for a strong health system and therefore has been listed among 1 of the Sustainable Development Goal (SDG) targets. The present study aims to model the number of persons per physician, nurse, and midwives in Turkey until 2030 and to make estimates for better reproductive health outcomes. We used time series of people per physician, nurse, and midwife between the years 1928 and 2018. Estimates were obtained via the Box-Jenkins and Brown Exponential Smoothing Methods. The results of this study showed that both designed models provide a high diagnostic value to predict the number of person per doctor, nurse, and midwives. The goodness of fit criteria for both models was statistically significant. The results predict a slight decrease in the number of people per physician, a more significant decrease in the number of people per nurse, but no decrease in the number of people per midwives until 2030. We argue that there will not be much progress in reproductive health indicators if the health workforce progresses with the same trend in the coming years. We recommend decision-makers to re-consider the health workforce planning, especially in terms of the number of the person per nurses, for better reproductive health outcomes.

Keywords
time series, forecasting, reproductive health, nurse, health workforce

What do we already know about this topic?
The number and distribution of the health workforce and the number of people per health personnel are of great importance in terms of the quality and sustainability of the service.

How does your research contribute to the field?
The primary purpose of this paper is to propose a long term forecasting model to predict the number of persons per doctor, nurse, and midwives for the next 10 years (up to 2030) via Box-Jenkins and Brown Exponential Smoothing Methods, and to make suggestions based on reproductive health indicators.

What are your research's implications toward theory, practice, or policy?
We estimate that there will be a decrease in the number of person per physician, nurse, and midwife, but when compared with other countries, this decrease will not be enough to improve reproductive health indicators, which means many preventable maternal and neonatal deaths will not be prevented.

Introduction

A well-prepared health workforce is essential for a strong health system. Doctors, nurses, and midwives are key persons involved in emergencies, daily health care, and health promotion. For this reason, the number and distribution of the health workforce and the number of people per health personnel are of great importance in terms of the quality and sustainability of the service. There has been a lot of progress

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in the field of health, but the rate of recovery has slowed, especially in the last 2 years, with the effect of the Covid-19 pandemic. Many countries will have a hard time meeting the health targets of the 2030 Sustainable Development Goals (SDGs) (Goal 3).[1] The most important solution to overcome this difficulty will be to increase the number of health personnel. For this reason, the World Health Assembly declared 2020 as the Year of the Nurse and Midwife.[2]

Although there has been an effort in health workforce planning in the world and our country, it is not possible to say that effective and realistic planning has been made so far. There are many possible reasons why efforts might be insufficient. This may be due to the mismatch between macro plans and micro plans, differences in the private sector and public service output/expectations, the fact that planning is made for short periods and mainly to overcome crises, the frequent change of governments and the change in priorities of each government, economic problems, the inadequate communication between educational institutions where health personnel are trained and decision-making bodies at the point of employment.[3]

Health workforce has been added as a key strategy to achieve Sustainable Development Goal (SDG) 3.[1] The number of people per healthcare professional significantly affects the quality of the health service to be provided. Significant differences and inequalities are observed in the number of people per healthcare professional in different parts of the world. Statistics show that over 40% of World Health Organization (WHO) Member Countries report having less than 10 medical doctors and over 55% of countries report having less than 40 nursing and midwifery personnel per 10.000 population.[4] Considering the period up to the present day since 1928, a significant improvement in health services and health status indicators were recorded in Turkey. While the number of doctors, nurse, and midwife were 1.078, 130, and 377 respectively in 1928, these numbers raised to 91.949, 72.393, and 41.479 in 2002. According to the data of 2018, there are 153.128 doctors, 190.499 nurses, and 56.351 midwives in Turkey.[5,6]

Of course, due to population growth and changing conditions, it is not possible to evaluate health services only with the number of health professionals. The main issue to be examined is the workload of health professionals that is the number of people per health personnel. Turkey has a steady decline in the number of persons per health personnel. While in 1928 there were 12.841 persons per physician, 106.485 per nurse, and 36.719 per midwife, in 2018 these numbers were 536 for physicians, 430 for nurses, and 1.455 for midwives.[6] However, it is difficult to say that this change is sufficient. In an estimation of staffing requirements in primary care in Turkey, using the Workload Indicators of Staffing Needs (WISN) method, the results showed that there is a 16% shortage of family physicians and 25% of family health workers (which predominantly consist of nurses and midwives).[7] International comparisons also support this deficiency. Among OECD (Organisation for Economic Co-operation and Development) countries, Turkey ranks last in terms of the number of physicians, nurses, and midwives per 100.000. Among G20 Countries, Turkey takes place in the 13th row in terms of physicians and the 10th row in terms of nurses and midwives per 10.000.[4]

Differences in the number and distribution of health personnel affect health indicators. Maternal Mortality Ratio (MMR) and Neonatal Mortality Rate (NMR), are just 2 of the reproductive health (RH) related indicators of the SDGs.[1] However, these indicators are considered among the most important indicators for the general health services of the countries and reflect improvements in global health.[8] Turkey has made important progress in terms of reproductive health indicators. However, a plateau has been observed in recent years. On the contrary, there is an unwanted increase in cesarean delivery rates, which is also an important health indicator.[9]

Health forecasting is of great importance to epidemiologists, healthcare providers, and health policymakers. It is a valuable tool for estimating future health events, planning health services, and determining future healthcare needs. Most of the models are using time series epidemiological data.[10-12] In a report of The European Commission estimated that there will be a gap in supply of human resources in health and that almost 15% of demand for healthcare across the European Union (EU) will not be covered by the available workforce.[13] In the same report, it is mentioned that predicting possible future shortages in the health sector is challenging—due to multiple aspects and scenarios—but important. In a policy review, implementing strategies in a flexible manner based on careful monitoring was mentioned as one of the key elements for health workforce planning. It was mentioned that plans should be open to adaption and change and should be tested and revised when necessary.[14] Although major improvements have been reached, reproductive health indicators in Turkey draw a plateau in recent years, and no significant improvement is observed in terms of reproductive health measures. Other studies using forecasting to estimate shortages of health personnel, especially of nurses, in the future years, also mention the importance of monitoring.[15]

The primary purpose of this paper is to propose a long term forecasting model to predict the number of persons per doctor, nurse, and midwives for the next 10 years (up to 2030) via Box-Jenkins and Brown Exponential Smoothing Methods, and to make suggestions based on reproductive health indicators.

Methods

In this study, the estimates obtained using the Auto-Regressive Integrated Moving Average (ARIMA) and Brown Exponential Smoothing Method in time series analysis were evaluated. SPSS, version 25.0 (SPSS Inc., Chicago, IL, USA) was used for analysis.

Data Collection

Research data consist of the number of people per physician, nurse, and midwife between the years 1928 and 2018 in Turkey. Raw data were obtained from publicly accessible databases published by the Turkish Statistical Institute (TUIK) (see Online Supplemental Table 1).[6] Using these data, estimates were made until 2030.

Time series is a sequence obtained from observations made in periodic time intervals. These series enable us to develop appropriate models using statistics and to make estimations for the future.[16] To obtain realistic estimates from time series, the series must be stationary. Since non-stationary series contain highly variable and highly fluctuating values, the margin of error in these estimates may be high.[17] Stationarity, in general, implies that the statistic or model parameter of interest does not change over time.[18,19] Several tests are used to investigate stationarity. The most common of these methods are; Autocorrelation Function (ACF), Partial Autocorrelation Function (PACF), graphics, and the Augmented Dickey Fuller Unit Root Tests (ADF).[20] In non-stationary series, the logarithm of the series is taken and the differences between the values of the series are reduced to provide stationary.

Box-Jenkins Method (ARIMA)

This method, developed by Box and Jenkins, consists of a combination of 2 different processes. The first process refers to the Autoregression Model (AR) and the second process refers to Moving Average (MA). Box-Jenkins method is expressed with the "Autoregressive Moving Average Model" (ARMA) model, which is the combination of these 2 models. However, in the Box-Jenkins method, the series is required to be stationary. For the stabilization process, the difference of degree *d* from the series is obtained and added to the ARMA model, which gives us the "Autoregressive Integrated Moving Average" (ARIMA). This model is widely used in predicting time-series events due to its statistical properties and model structure.[21]

The essence of the Box-Jenkins method is the selection of the most suitable ARIMA model from a variety of model options, depending on the structure of the available data with a limited number of parameters. The representation of these non-seasonal models as a whole is ARIMA (*p*, *d*, *q*). The "*p*" in the models represents the AR degree, "*q*" as the MA degree, and "*d*" as the degree non-seasonal difference. The ARMA model is represented in equation (1).[22]

$$Y_t = \sum_{i=1}^{q} \beta_i \varepsilon_{t-i} + \sum_{i=1}^{p} \alpha_i Y_{t-i} + \varepsilon_t \tag{1}$$

Equation (2) is obtained when the difference of the non-stationary X_t time series is taken once.

$$\nabla X_t = X_t - X_{t-1} = X_t' \tag{2}$$

If the *Xt'* series is still not stationary, the differential process is repeated and the degree of difference becomes $d=2$.

$$\nabla^2 X_t = \nabla\left(X_t'\right) = X_t' - X_{t-1}' = X_t - 2X_{t-1} + X_{t-2} \tag{3}$$

If the series is still not stationary, the difference process continues *d* times until the stationarity is achieved and with its general expression, the ARIMA (*p*, *d*, *g*) model is obtained.[23]

$$X_t = \nabla^d Y_t = (1-B)^d Y_t \tag{4}$$

Seasonal Box-Jenkins models are generally expressed as ARIMA (*p*, *d*, *q*) (*P*, *D*, *Q*), where "*P*" is the degree of the seasonal autoregression (SAR) model, "*D*" is the number of seasonal differentiation operations, "*Q*" is the degree of the seasonal moving average (SMA) model, and "*s*" is the period.[18]

$$\begin{aligned} &\left(1-\phi_1 B-\phi_2 B^2-\ldots.-\phi_p B^p\right) \\ &\quad\left(1-\phi_1 B^s-\phi_2 B^{2s}-\ldots.-\phi_p B^{ps}\right) \\ &\quad\left(1-B\right)^d\left(1-B^s\right)^D Z_t \\ &\qquad=\left(1-\theta_1 B-\theta_2 B^2-\ldots.-\theta_q B^q\right) \\ &\qquad\left(1-\Theta_1 B^s-\Theta_2 B^{2s}-\ldots.-\Theta_Q B^{Qs}\right)\varepsilon_t \end{aligned} \tag{5}$$

Brown Exponential Smoothing Method

Brown Exponential Smoothing Method is an exponential smoothing method used when there is a trend in the series while making estimations. The trend appears in many real data.

Additive model

$$x_t = a + b_t \tag{6}$$

$$x_t = a\varepsilon_t$$

$$M_t = \frac{\left(x_1\right)+\left(x_{t-1}\right)+\ldots.+\left(x_{t-N}\right)+1}{N} \tag{7}$$

The equation for the updated trend component is given in equation (8).

$$M_t = M_{t-1}\frac{\left(x_t\right)-\left(x_{t-N}\right)}{N} \tag{8}$$

The equation for the updated component is given in equation (9).

$$S_t\left(x\right) = \alpha\left(x_t\right)+\left(1-\alpha\right)S_{t-1}\left(x\right) \tag{9}$$

$$S_t\left(x\right) = \alpha\left(x_t\right)+\left(1-\alpha\right)[\alpha\left(x_{t-1}\right)+\left(1-\alpha\right)S_{t-2}\left(x\right) \tag{10}$$

$$\begin{aligned} S_t\left(x\right) &= \alpha\sum_{k_0}^{t-1}\left(1-\alpha\right)^k\left(x_{t-k}\right)+\left(1-\alpha\right)^t\left(x_0\right) \\ &\quad+\left(1-\alpha\right)[\alpha\left(x_{t-1}\right)+\left(1-\alpha\right)S_{t-2}\left(x\right) \end{aligned} \tag{11}$$

Table 1. Box-Jenkins Models' Forecasts About the Number of Persons per Physician, Nurse, and Midwives Between 2019 and 2030.

Year	Physician	LCL_ Physician	UCL_ Physician	Nurse	LCL_Nurse	UCL_Nurse	Midwife	LCL_ Midwife	UCL_ Midwife
2019	51 978	42 788	62 568	41 849	30 838	5556	141 146	113 985	172 871
2020	50 406	38 178	65 344	40 144	27 554	56 599	136 923	100 881	181 804
2021	48 881	34 695	67 004	37 495	24 998	54 152	132 826	91 094	1874
2022	47 402	31 829	68 059	35 436	22 526	532	128 852	83 115	191 172
2023	45 968	29 378	68 713	33 653	20 414	52 439	124 996	7634	193 729
2024	44 577	27 232	69 075	31 793	18 596	5097	121 256	70 448	195 397
2025	43 229	25 326	69 213	30 038	16 956	49 487	117 628	65 245	196 376
2026	41 921	23 613	69 173	28 425	15 487	48 099	114 109	60 596	196 803
2027	40 653	22 064	68 987	26 885	14 172	46 625	110 694	56 409	196 775
2028	39 423	20 652	6868	2542	12 985	45 112	107 382	52 614	196 366
2029	3823	1936	68 271	24 041	1191	43 618	104 169	49 154	195 635
2030	37 074	18 172	67 776	22 737	10 936	42 132	101 052	45 988	194 629

LCL = lower confidence level; UCL = upper confidence level.

Results

Time series analysis was conducted for the data between 1928 and 2018 to estimate the number of people per physician, nurse, and midwife until 2030. The time-series sequence chart for 1928 to 2018 showed breakdowns and the series was in a trend towards a decrease (see Online Supplemental Figure 1). According to ACF and PACF graphs, the series was not stationary (see Online Supplemental Figures 2 and 3). After taking the difference for the trend once and providing a logarithmic transformation, it was observed that the series became stationary (see Online Supplemental Figures 4–6). Besides, the unit-root analysis of the series was checked using the ADF test. According to the ADF test result, the series was not stationary before the differencing ($t = -0.118$; $P = .669$), but became stationary after the differencing process ($t = -14.117$; $P = .001$). While trying to create the appropriate model by using these procedures, several different models were studied and the most suitable models for the number of people per healthcare personnel were ARIMA(0,1,0) for the physician, ARIMA(2,1,0) for the nurse, and ARIMA(0,1,0) for the midwives.

The number of people per physician, nurse, and midwife from 2019 to 2030 which were estimated with the Box-Jenkins method and the estimated values are given in Table 1. The estimated values are summarized visually with a longitudinal graph in Figure 1. According to the results of the Box-Jenkins model, a decreasing trend was observed in the number of people per physician, nurse, and midwives until 2030.

Table 2 illustrates the goodness of fit criteria of the obtained models. R^2 is a commonly known standard for the excellence of fit criterion of the linear model, also known as the coefficient of determination. It ranges from 0 to 1 and higher values indicate that the model fits well with the data. Stationary R^2 is a measure that compares the stationary part of the model with the basic model. It is preferred where there is a trend or a seasonal pattern. RMSE stands for the square root of mean square errors. It is used to express how the dependent series differ from the level estimated by the model. Smaller values indicate that model estimates are better. MAPE shows the mean absolute percent error and can also be used to compare different series. MAE indicates the mean absolute error and is expressed in units of the series. Maximum Absolute Percentage Error (MaxAPE) is the highest absolute percentage error measure. It shows the highest error among the predicted values and is expressed as percentages and is independent of units. This measure can be used for the worst-case scenarios among estimations. Maximum Absolute Error (MaxAE) indicates the highest absolute error and is expressed in the same unit as the dependent series. Normalized Bayesian Information Criteria (BIC) is the general measure of the total fit of the model. This measure is used to compare different models for the same series, and lower values indicate a better model.[24]

Box-Jenkins models, in which the number of people per physician, nurse, and midwife was created for the years 2019 to 2030, are statistically significant ($P < .05$). The MAPE value shows that the series comprises highly usable estimates (Table 2).

As an alternative method, the number of people per physician, nurse, and midwife was estimated using the Brown Exponential Smoothing Method. The estimated values are given in Table 3 and are summarized visually with a longitudinal graph in Figure 2. When the estimation values obtained according to the Brown Exponential Smoothing model are examined, it is seen that the decrease in the trend between 2019 and 2030 is less when compared to the Box-Jenkins Model. Stagnation was observed especially in the number of people per midwife.

The red line in Figures 1 and 2 represents observed data from previous years. The blue line indicates the predictive

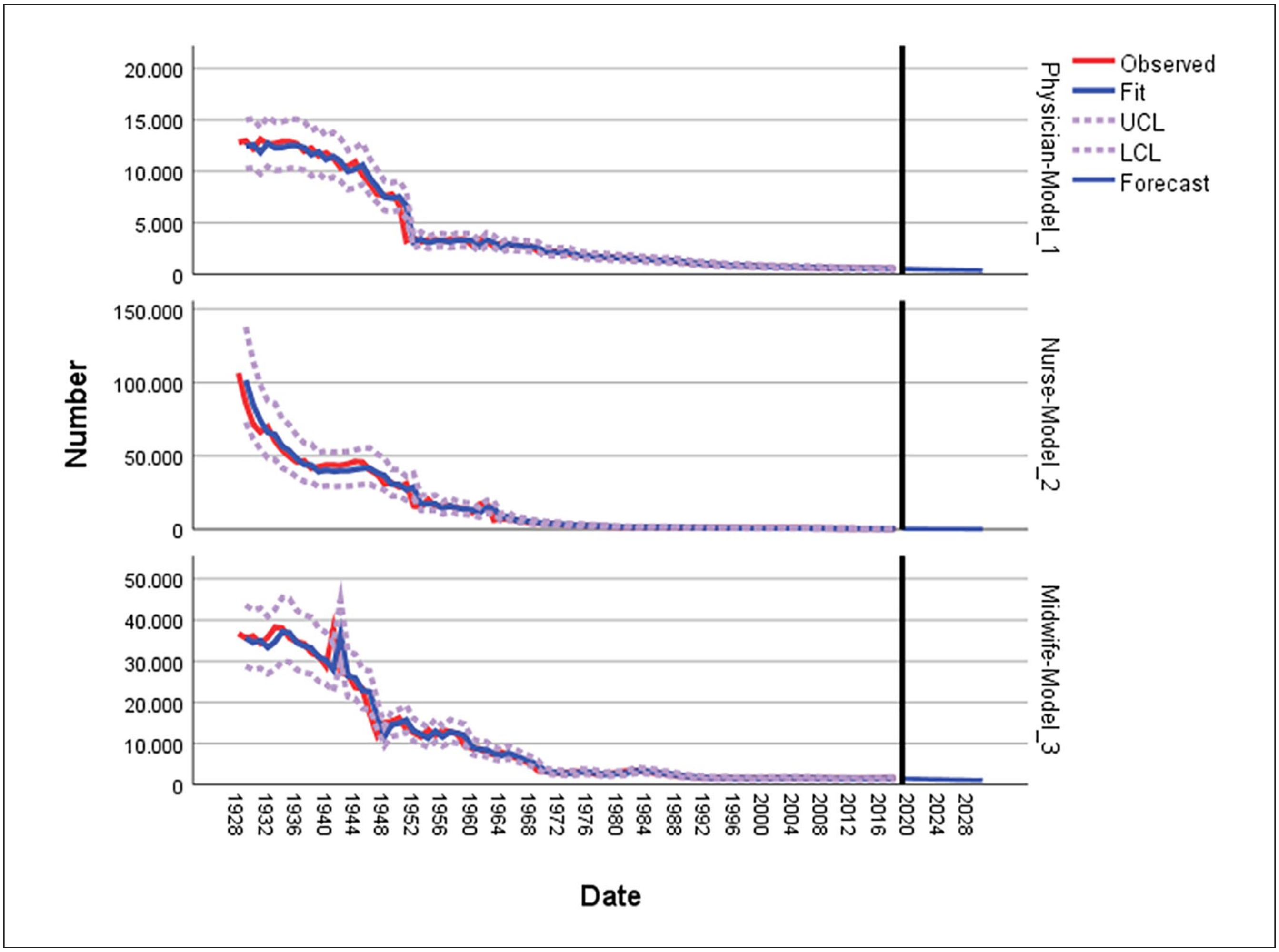

Figure 1. Box-Jenkins model forecast graph for the number of people per physician, nurse, and midwives by year.

Table 2. Box-Jenkins Model Goodness of Fit Criteria of Forecasts for the Number of Persons per Physician, Nurse and Midwives Between 2019 and 2030.

Model fit	Number of persons per health physician, 1928-2018-Model_1			Number of persons per health nurse, 1928-2018-Model_1			Number of persons per health midwife, 1928-2018-Model_1		
Fit statistic	Mean	Minimum	Maximum	Mean	Minimum	Maximum	Mean	Minimum	Maximum
R^2	0.987	0.987	0.987	0.973	0.973	0.973	0.975	0.975	0.975
RMSE	488 702	488 702	488 702	3 478 948	3 478 948	3 478 948	1 870 656	1 870 656	1 870 656
MAPE	4996	4996	4996	9800	9800	9800	7091	7091	7091
MaxAPE	105 593	105 593	105 593	133 174	133 174	133 174	45 249	45 249	45 249
MAE	226 545	226 545	226 545	1 718 145	1 718 145	1 718 145	817 953	817 953	817 953
MaxAE	3 431 526	3 431 526	3 431 526	15 364 093	15 364 093	15 364 093	9 875 578	9 875 578	9 875 578
Normalized BIC	12 434	12 434	12 434	16 459	16 459	16 459	15 118	15 118	15 118
Model Ljung-Box Q	Ljung-Box Q (18)			Ljung-Box Q (18)			Ljung-Box Q (18)		
	Statistics	DF	*P*	Statistics	DF	*P*	Statistics	DF	*P*
	23 050	18	.019	17 950	16	.033	18 022	18	.045

Table 3. Brown Exponential Smoothing Models' Forecasts for the Number of Persons per Physician, Nurse, and Midwives Between 2019 and 2030.

Year	Physician	LCL_ Physician	UCL_ Physician	Nurse_	LCL_Nurse	UCL_Nurse	Midwife	LCL_ Midwife	UCL_ Midwife
2019	52 569	−48 597	153 734	41 527	−649 323	732 377	147 801	−222 597	518 199
2020	51 726	−81 901	185 354	39 416	−956 653	1 035 485	147 774	−306 052	6016
2021	50 883	−119 767	221 534	37 502	−1 277 783	1 352 787	147 747	−401 085	696 579
2022	50 041	−161 477	261 558	35 766	−1 608 782	1 680 314	14 772	−505 945	801 385
2023	49 198	−206 576	304 972	34 192	−1 946 264	2 014 648	147 694	−619 412	914 799
2024	48 355	−254 751	351 461	32 765	−2 287 515	2 353 045	147 667	−740 614	1 035 948
2025	47 513	−305 768	400 793	31 471	−2 630 391	2 693 332	14 764	−868 904	1 164 184
2026	4667	−359 449	452 789	30 297	−2 973 207	3 033 802	147 613	−1 003 785	1 299 011
2027	45 827	−415 647	507 301	29 233	−3 314 643	3 373 109	147 586	−114 486	1 440 033
2028	44 984	−47 424	564 209	28 268	−3 653 665	3 710 201	14 756	−1 291 804	1 586 923
2029	44 142	−535 124	623 408	27 393	−3 989 469	4 044 256	147 533	−1 444 346	1 739 412
2030	43 299	−59 821	684 808	266	−4 321 438	4 374 638	147 506	−1 602 253	1 897 265

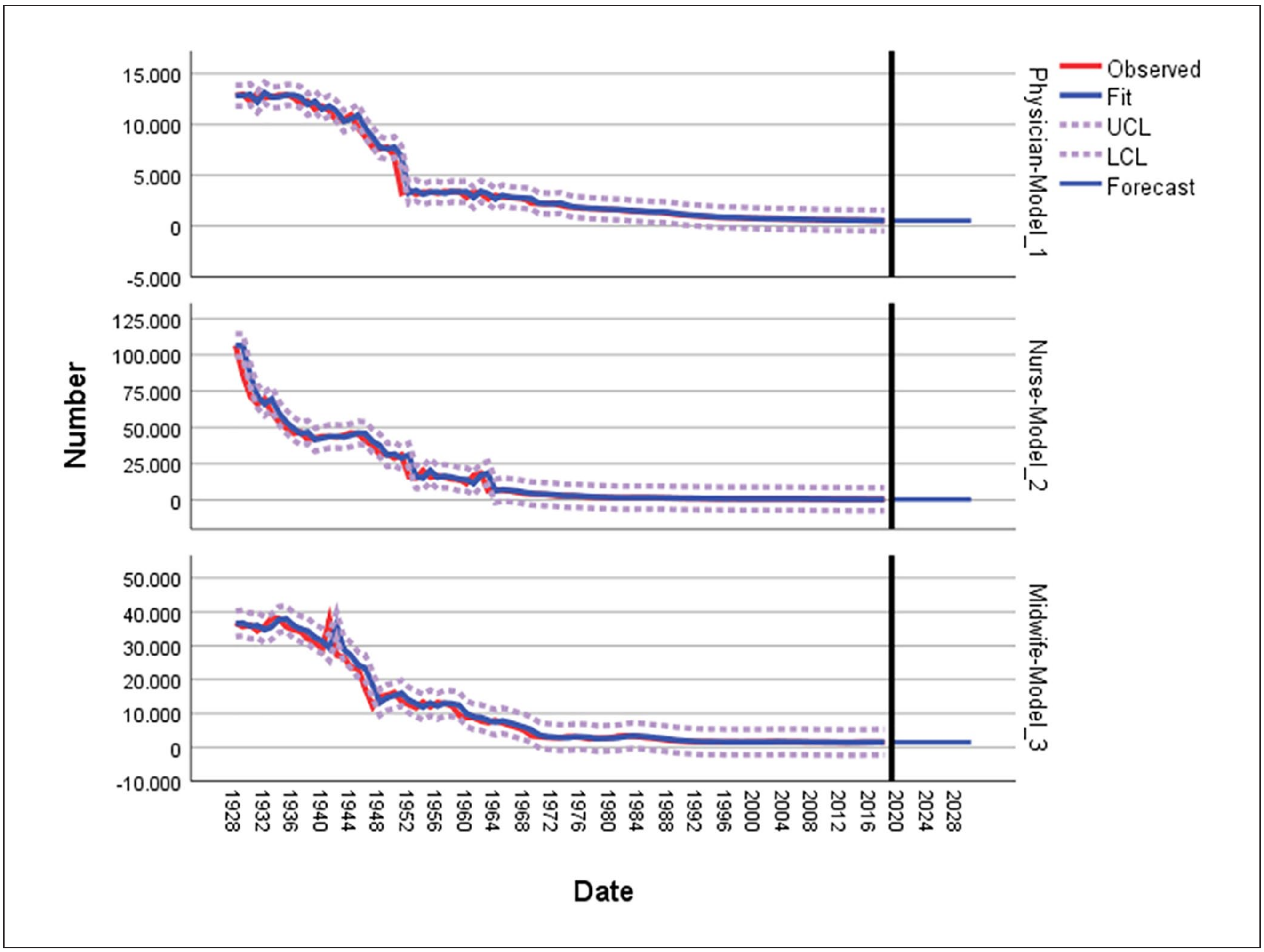

Figure 2. Brown exponential smoothing models forecast graph for the number of people per physician, nurse, and midwives by year.

Table 4. Brown Exponential Smoothing Method Goodness of Fit Criteria of Forecasts for the Number of Persons per Physician, Nurse and Midwives Between 2019 and 2030.

Model fit	Number of persons per health physician, 1928-2018-Model_1			Number of persons per health nurse, 1928-2018-Model_1			Number of persons per health midwife, 1928-2018-Model_1		
Fit statistic	Mean	Minimum	Maximum	Mean	Minimum	Maximum	Mean	Minimum	Maximum
R^2	0.986	0.986	0.986	0.978	0.978	0.978	0.976	0.976	0.976
RMSE	509221	509221	509221	3476343	3476343	3476343	1864411	1864411	1864411
MAPE	6156	6156	6156	9571	9571	9571	9601	9601	9601
MaxAPE	99571	99571	99571	204010	204010	204010	41784	41784	41784
MAE	252645	252645	252645	1572655	1572655	1572655	981108	981108	981108
MaxAE	3235840	3235840	3235840	13523487	13523487	13523487	9182619	9182619	9182619
Normalized BIC	12515	12515	12515	16456	16456	16456	15111	15111	15111
Model Ljung-Box Q	Ljung-Box Q (18)			Ljung-Box Q (18)			Ljung-Box Q (18)		
	Statistics	DF	*P*	Statistics	DF	*P*	Statistics	DF	*P*
	26001	17000	.004	27764	15000	.023	31758	17000	.016

values before and after 2018. It is observed that the 95% confidence interval in the graphs is narrower for the values calculated with Brown Exponential Smoothing method, which indicates more reliable data when compared to the Box-Jenkins Method.

The goodness of fit criteria for Brown Exponential Smoothing method is also statistically significant ($P < .05$) (Table 4).

Discussion

This study aimed to forecast the number of persons per physician, nurse, and midwives in the future through predictive analysis by producing different models and determining the best fit. In the analysis, both the Box-Jenkins Method and the Brown Exponential Smoothing Method gave statistically significant results.

As a result of the increase in the number of health care personnel between 1928 and 2018, there has been a dramatic decrease in the number of people per physician, nurse, and midwives in Turkey. Especially, this decrease in the number of people per nurse is quite evident. The number of people per midwife, however, has been progressing steadily since the 2000s. In our study, this situation continues in the estimations for 2030: while the number of people per doctor and nurse is decreasing, it is predicted that the number of people per midwife will remain at the same level.

The number of people per healthcare personnel is related to the quality of service and health indicators. Nurses and midwives are particularly important when it comes to reproductive health. One of the most important reproductive health indicators is the maternal mortality ratio (MMR). When 2017 to 2018 data for G20 countries are analyzed, while Indonesia, India, and South Africa have the highest MMRs (177, 145, and 199 per hundred thousand, respectively), Italy, Japan, and Australia possess the lowest (2, 5, and 6 per hundred thousand, respectively). In Turkey, the estimated MMR for 1990 was reported as 97 per hundred thousand. This ratio decreased to 42 per hundred thousand in 2000 and 17 per hundred thousand in 2017.[4]

Another important reproductive health indicator is the neonatal mortality rate (NMR). Mortality during the neonatal period is considered to be a useful indicator of both maternal and newborn neonatal health and care. Similar to MMR among G20 countries, India, Indonesia, and South Africa had the highest NMR (22.62; 12.88 and 11.44 per thousand, respectively), while Japan, the Republic of Korea, and Italy had the lowest (0.86; 1.56 and 1.97 per thousand, respectively). While the NMR for Turkey was 68.23 in 1955, this rate decreased to 18.65 in 2000 and 5.28 per thousand in 2018.[4]

The common feature of countries with low MMR and NMRs is the lower number of people per physician, nurse, and midwives. For example, among the G20 countries, in Indonesia, which has high MMR and NMRs, 2342 people per physician and 414 per nurse/midwife have been reported. Statistics show that there are 1167 people per physician, 579 per nurse/midwife in India, and 1105 people per physician and 765 per nurse/midwife in South Africa. The situation is different in countries with low MMR and NMRs: 415 people per physician and 82 per nurse/midwife in Japan; 252 people per physician and 174 per nurse/midwife in Italy; and 271 per physician and 80 per nurse/midwife in Australia. In Turkey, these numbers have been reported as 541 people per physician and 369 per nurses/midwives.[4]

Turkey has reached SDGs targets, but in recent years, reproductive health indicators draw a plateau and no significant improvement is observed in terms of MMR and NMRs. Targets and strategies have been determined to prevent all preventable maternal and neonatal deaths in the world until 2030.[1,25] When compared to developed countries indicators, it is prominent that still many preventable maternal and newborn deaths occur in Turkey. To avoid these preventable deaths, planning similar to those in countries with better reproductive health indicators may be considered. This requires an increase in the number of physicians and especially nurses in the coming years. Studies to identify the need for the health workforce in Turkey also reveals that need. For instance, it is foreseen to assign a population of 3000 to each family physician and to assign 1 nurse/midwife to each family physician. However, in the estimation of staffing requirements in primary care in Turkey, results showed, that having 1 nurse/midwife for 1 family physician was insufficient and the number of nurse/midwives should be 12% more than the number of family physicians.[3]

Cesarean rates also have an important place among reproductive health indicators. Although the percentage of births by caesarean section is an indicator of access to and use of emergency health care during childbirth, unnecessary cesarean will have negative consequences. Cesarean delivery rates have risen in the last years especially in high-income countries.[9] Reducing cesarean birth rates continues to be a goal of many nations; WHO advocates a rate of no more than 15% of all births.[19] Among the G20 countries, Brazil has the highest cesarean rate with 55.5%. Turkey follows Brazil with 48.1% and Mexico with 40.7%. In G20 countries with low MMR and NMRs, cesarean rates are observed to be around 30% and below. As an example, cesarean rates are reported as 30.5% for Germany, 35%for Italy, 19.7% for Japan, and 19.6% for France.[1] The rate of cesarean section was 37% in Turkey in 2008 and increased to 55% in 2018.[6] The cesarean rate in Indonesia, which has high MMR and NMR, is reported as 12.3%. This situation suggests that there are unmet needs for real cesarean section indications. However, the high rates of cesarean section in countries with good reproductive health indicators do not seem to be entirely due to medical reasons. Non-medical cesarean sections may be due to many different causes. Some possible reasons for unnecessary cesarean sections are reported as fear of pain, concerns about genital modifications after vaginal birth, believing that CS is safer for the baby.[9] These concerns and misconceptions might be avoided by health education, training programs, and workshops.[26] Health professionals who are expected to perform these practices should have sufficient time apart from teaching. A study in France showed that high staffing levels for obstetricians and midwives in a maternity unit are associated with lower cesarean rates.[27] The presence of midwives is even more crucial for people living in rural areas. Studies show that midwives provide safe maternity care to rural parturient women and offer a choice of birthplace.[28]

Nurses and midwives can meet the majority of the need for reproductive health services.[29] The number of patients per nurse in this study is particularly high. While the number of people per nurse in Germany, Australia, and Japan are 60, 76, and 80 respectively, a nurse is responsible for 427 people in Turkey.[30] Whereas, the number of people per midwives in Turkey is 1449. These numbers are around 3000 in countries such as Germany, France, Italy, Japan.[30] The contribution of midwives to better reproductive health outcomes, and, their role should not be undervalued.[31] There is evidence that midwives have an impact on reducing maternal and neonatal mortality, especially in low and middle-income countries.[32]

In disaster situations such as the pandemic we are experiencing today, the problem of reproductive health services may deepen. Changing healthcare priorities due to the COVID19 pandemic and the assignment of healthcare professionals to outbreak control may have deepened the barrier to access routine reproductive health services or reduced the quality of service.[33,34]

Limitations

The data of this study does not reflect purely the personnel working in reproductive health services. However when discussed with reproductive health indicators and when compared with other countries data, our comments have their strengths and are worth considering.

Although the estimates in this study are useful for governments and policy-makers to plan and resource utilization, they are at country level averages. Planning should be done considering the differences between regions and inequalities in access to health services should be prevented.

Conclusion

The results of our study predict that a slight decrease in the number of people per physician will continue until 2030, the number of people per nurse will decrease more significantly than the number of physicians, and there will not be a significant decrease in the number of people per midwives. When compared with other countries, this decrease will not be enough to improve reproductive health indicators, which means many preventable maternal and neonatal deaths will not be prevented. It is essential to plan for the solution of health problems by determining priorities in service by following health level indicators. Although there has been a significant improvement in MMR and NMR, there has been a discontinuance in this development in recent years: many preventable maternal deaths and neonatal deaths still cannot be prevented. On the other hand, there is an increase in unnecessary cesarean rates. It is recommended to consider reviewing the health workforce planning to reduce the number of patients per physician and especially nurse in the coming years.

The pandemic we are experiencing today has once again revealed the necessity of being prepared for emergencies while planning health services. Reproductive health services cannot be postponed and are among the priority health services. In future studies, it will be useful to investigate how the assignment of reproductive health workers to other jobs reflects on reproductive health outcomes.

It will be valuable to conduct prospective and longitudinal studies by improving the number of personnel in line with the recommendations of our current study in regions where reproductive health indicators are poor and the number of people per staff member is high. Such studies will require collaboration with healthcare administrators who have the authority to deploy health personnel. Policy makers should be aware of the increasing need for healthcare worker employment and the need to show flexibility in the face of changing priorities.

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Supplemental Material

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