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The impact of health workforce and health expenditures on life expectancy and infant mortality rates in Turkiye

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ABSTRACT

Aims: This study examines the impact of the number of health personnel and health expenditures on life expectancy and infant mortality rates in Turkiye. The study's primary purpose is to determine the effect of increased health personnel and health expenditures on quality of life and infant mortality rates. Therefore, the impact of health personnel and expenses on life expectancy and infant mortality rates was investigated. It was analyzed how these variables shape the effectiveness of health services and how they affect public health.

Methods: This study used multiple regression analysis to assess the effects of healthcare workforce and expenditures on health outcomes in Turkiye between 2001 and 2021. Life expectancy and infant mortality rate were dependent variables, while per capita healthcare expenditure, the number of doctors, and the number of nurses were used as independent variables. Data were obtained from the World Health Organization (WHO) and the Organization for Economic Cooperation and Development (OECD) databases and analyzed using the SPSS software.

Results: The findings indicate that per capita healthcare expenditures positively and significantly affect life expectancy (B=0.015, p=0.016), suggesting that increases in healthcare spending contribute to longer life expectancy. Conversely, the effects of the number of doctors (B=-1.580, p=0.138) and nurses (B=0.232, p=0.400) were not statistically significant, indicating that workforce numbers alone may not directly impact life expectancy. Regarding infant mortality rate, healthcare expenditure (B=-0.016, p=0.166) and doctor availability (B=-1.503, p=0.467) showed negative associations, while the number of nurses had a positive but non-significant association (B=0.407, p=0.457). Although these variables theoretically demonstrated the potential to reduce infant mortality rates, none of these effects reached statistical significance. The model explained 82.5% (R^2=0.825) of the variance in life expectancy and 88.7% (R^2=0.887) in infant mortality rate, underscoring the model's robustness in explaining variations in these health outcomes.

Conclusion: The study findings suggest that while healthcare expenditures positively affect life expectancy, the number of healthcare workers alone is insufficient, and factors such as service quality and efficiency also play a role. In developing health policies, strategies should focus on systematically improving the quality of services rather than merely increasing the number of personnel. Particularly in rural and low-income areas, the scope and quality of healthcare services should be enhanced to reduce disparities in health indicators.

Keywords: Health expenditures, life expectancy, infant mortality, regression analysis

INTRODUCTION

The effectiveness of health services is critical to public health, and the success of health systems depends mainly on the quality, distribution, and adequacy of the health workforce. The education, experience, geographic distribution, and workload of health workers directly affect the quality and accessibility of health services. The health workforce directly impacts health indicators and can make significant differences in key indicators, particularly infant and overall mortality.[1,2] These indicators are used to evaluate the effectiveness of health systems and develop policies to improve public health.[3]

Inadequate health workforce in low-income countries around the world results in negative health indicators.[4,5] This situation is directly related to the quality and distribution of the health workforce. It is known that in regions where the number of health workers is insufficient and their education levels are low, infant mortality rates are higher, and access to health services is limited.[6] The adequacy of the health workforce plays a critical role in improving the quality of health services. In particular, an increase in essential health workers, such as nurses and doctors, can positively affect the quality and accessibility of health services.[7]

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The COVID-19 pandemic has once again highlighted the importance of the healthcare workforce in healthcare systems. During the pandemic, healthcare workers have faced increased workloads, insufficient protective equipment, and intense psychological pressure.[8,9] In this process, the burnout syndrome and stress faced by healthcare professionals in many countries have negatively affected the overall effectiveness of healthcare services and led to deterioration in health indicators.[10,11] Especially in low- and middle-income countries, the inadequacy of the health workforce during the COVID-19 period has caused health indicators to deteriorate.[12]

The regional distribution of the health workforce is an essential factor determining its impact on health indicators. Even in developed countries, imbalances in health workers between rural and urban areas lead to significant differences in the quality of health services.[13] A study conducted in Turkiye revealed that health workforce indicators, especially the number of nurses and doctors, significantly impact infant mortality rates.[2] These studies have shown that inequalities in the distribution of the health workforce directly affect access to and quality of health services.[4]

The mental health of the healthcare workforce can directly impact the quality of care. Especially during pandemics and times of crisis, the stress, burnout, and work-life balance issues faced by healthcare professionals can negatively affect the quality of healthcare services.[14,15] Studies conducted during the COVID-19 pandemic show that the psychological well-being of healthcare workers affects general health indicators.[9,16] Therefore, supporting the mental health of healthcare professionals and balancing their workload is strategically essential in improving healthcare services' quality.[10,11]

The level of education and continuing professional development of the health workforce are other important factors determining the quality of health services. Highly educated and specialized health professionals can provide more effective interventions in complex emergencies and improve health outcomes.[4] This becomes especially evident during times of crisis; for example, during the COVID-19 pandemic, trained healthcare professionals were seen to improve health indicators by providing rapid and effective interventions.[13,17] Continuous professional development of healthcare professionals is a sustainable solution to improve public health.[18]

During the pandemic, challenges faced by healthcare professionals have negatively affected healthcare services' overall performance. Factors such as workload, mental health, and work-life balance of healthcare professionals have a significant impact on health indicators such as infant mortality rate and overall mortality.[7,19] This situation reveals the need to support and strengthen the health workforce.[8] Reducing the workload of healthcare professionals, increasing training, and improving working conditions is a strategic priority for the sustainability of healthcare systems.[10,14]

Ecological studies conducted in Turkiye have examined the effects of socioeconomic factors and health service indicators on the infant mortality rate.[2,12] These studies have revealed that socioeconomic level determines the relationship between health service indicators and infant mortality rate.[2,12] Similarly, the impact of variables such as income level and education level on health indicators are critical elements to be considered in developing health policies.[9]

A balanced distribution of the health workforce is an important strategy to improve the performance of health systems and reduce health inequalities. Increasing the number of health workers, especially in rural and disadvantaged areas, can improve access to health services and achieve positive health indicators results.[4,5] The qualification and training of the health workforce provide sustainable solutions to improve public health.[18] Therefore, health policies must be planned to increase and develop the health workforce, especially in low-income and rural areas.[13]

As a result, the health workforce's quality, distribution, and workload are among the main factors that directly affect the overall effectiveness of health systems and public health. Improving health indicators will be possible by strengthening and supporting the health workforce. In this context, increasing the education of health workers, protecting their mental health, and improving their working conditions are strategic requirements to ensure the sustainability of health systems.[9,14]

METHODS

Type and Model of the Study

Since secondary data is used in the study, ethics committee approval is not required. This study used multiple regression analysis to evaluate the impact of health resources on significant health outcomes in Türkiye from 2001-2021. Regression models were structured to assess the health expenditure per capita, number of doctors per 10,000 people, and number of nurses per 10,000 people as independent variables, and life expectancy and infant mortality rate as dependent variables.

Statistical Analysis

Data were obtained from the World Health Organization (WHO) and the Organization for Economic Co-operation and Development (OECD) databases, and consistency and comparability were ensured throughout the period examined. Multiple regression analysis was performed to analyze how health expenditure and personnel distribution changes affected the selected health outcomes. The significance level was taken as 5% in each model. The analyses were performed in the SPSS Package program. Data sources are shown in **Table 1**.

After the data is obtained, the analysis includes variables such as life expectancy, infant mortality rate, health expenditures, and number of doctors and nurses. The variables used in the study are defined below.

- **Dependent Variables:**

Life Expectancy (Years): Indicates life expectancy in Turkiye.

Infant Mortality Rate (per 1000 Live Births): Indicates the proportion of babies who die within one year after birth.

Table 1. Sources of data for variables

Variables	Data source
Number of doctors per 10000 people	https://data.who.int/indicators/i/CCCEBB2/217795A?m49=792
Number of nurses per 10,000 people	https://data.who.int/indicators/i/B54EB15/5C8435F?m49=792
Health expenditure per capita	https://www.oecd.org/en/data/indicators/health-spending.html?oecdcontrol-38c744bfa4-var1=TUR&oecdcontrol-00b22b2429-var3=2001
Life expectancy	https://www.oecd.org/en/data/indicators/life-expectancy-at-birth.html?oecdcontrol-0ad85c6bab-var1=TUR&oecdcontrol-f42fb73652-var3=2001
Infant mortality rate per 1000 live births	https://platform.who.int/data/maternal-newborn-child-adolescent-ageing/indicator-explorer-new/MCA/infant-mortality-rate-(per-1000-live-births)

• Independent Variables:

Number of Doctors (Per Capita): Shows the number of doctors available per 1000 people.

Number of Nurses (Per Capita): Shows the number of nurses available per 1000 people.

Health Expenditure Per Capita (USD): The amount of spending on health services per person.

• The following steps were followed for data analysis:

1. **Descriptive Statistics:** Basic descriptive statistics were calculated to reveal the general characteristics of the data.
2. **Assumption Analysis:** Assumptions were tested and analyzed for multiple regression analysis. As a result of the study, necessary corrections were made to meet the assumptions.
3. **Regression Analysis:** Multiple regression analyses examined the relationships between dependent and independent variables. Two separate models were developed, the first of which evaluated the effects of independent variables on life expectancy and the second on infant mortality rate. The analysis was performed as a multiple regression analysis in the SPSS package program.

Assumption Tests and Corrections

A multicollinearity problem was detected in the analyses due to the high correlation between the independent variables. This problem was resolved using Principal Component Analysis (PCA). Although PCA is generally used for dimension reduction, it was preferred in this study to eliminate multicollinearity. Using only one component (PC1) from PCA means benefiting from a single combined effect rather than directly seeing the interaction of these variables.

As a result of PCA, the first principal component (PC1) was obtained, which explains 98.8% of the variance of the independent variables. PC1 consists of the following independent variables:

- Healthcare spending per capita (the variable contributing the highest weight),
- Number of doctors per 10,000 people,
- Number of nurses per 10,000 people.

The weight of each variable in PC1 is based on its capacity to represent the total variance of these variables. Multiple regression analyses were performed using this component.

To accurately evaluate the effects of independent variables, regression analysis assumptions were tested, and necessary corrections were made. Heteroskedasticity (non-constant variance) and autocorrelation (dependence of error terms on each other) problems were detected in error terms. These problems were resolved by using Newey-West standard errors. In addition, to better evaluate the effects of corrections, error terms, and model accuracy were checked in more detail in terms of repeatability. Regression analyses were applied using the OLS (Ordinary Least Squares) method, and care was taken to verify the assumptions.

The linearity assumption was tested by examining the relationships between the independent variables and the error terms, and it was determined that this assumption was met in both models. The normal distribution of the error terms was examined with the help of Q-Q plots. Although slight deviations were seen in the infant mortality rate model, the assumption was generally met. Heteroskedasticity problems were tested using the Breusch-Pagan test. It was determined that this problem existed for the life expectancy model, which was corrected using Newey-West standard errors. Autocorrelation problems were determined with the Durbin-Watson test, and autocorrelation was observed in both models. Newey-West standard errors also corrected these problems and provided reliable results. While making these corrections, the maximum lag length was taken as 1, and the HAC (Heteroskedasticity and Autocorrelation Consistent) matrix was used to minimize the autocorrelation and heteroskedasticity effects of the error terms. Multiple linearity problems were eliminated using PCA, and PC1 represented the common effects of the independent variables.

Q-Q plots examining the normal distribution of error terms are shown in **Figure 1** and **Figure 2**.

RESULTS

In the study, the data shown in **Table 2** were obtained using WHO and OECD databases.

According to **Figure 3**, life expectancy in Türkiye has generally shown a steady increase between 2001 and 2021. While the average life expectancy in 2001 was 71.5 years, this value increased to 77.5 years in 2021. This increase in life

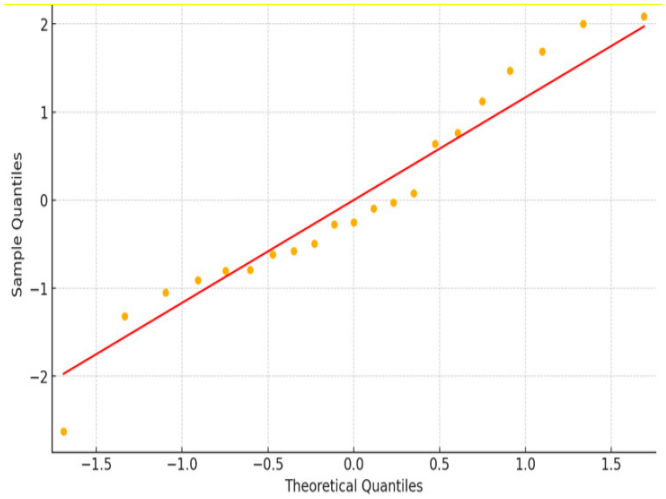

Figure 1. Quality of life Q-Q chart

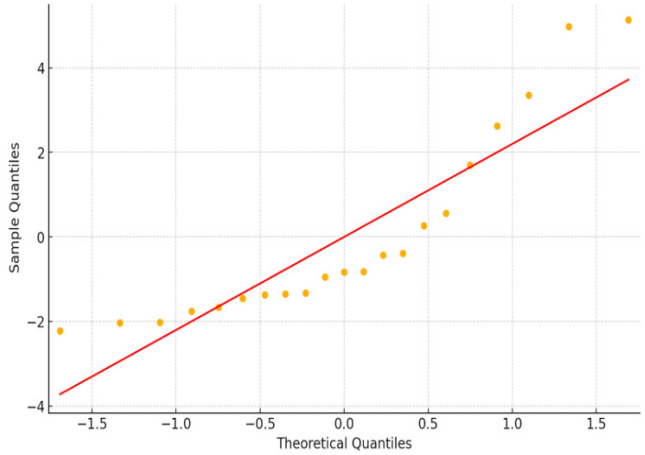

Figure 2. Infant mortality rate Q-Q chart

expectancy may reflect the improvements in Turkiye's health system and the positive effects of policies aimed at improving access to health services and public health. However, the slight decline in 2020 and 2021 also reveals the pressure of the COVID-19 pandemic on health systems and the effects of the pandemic on public health.

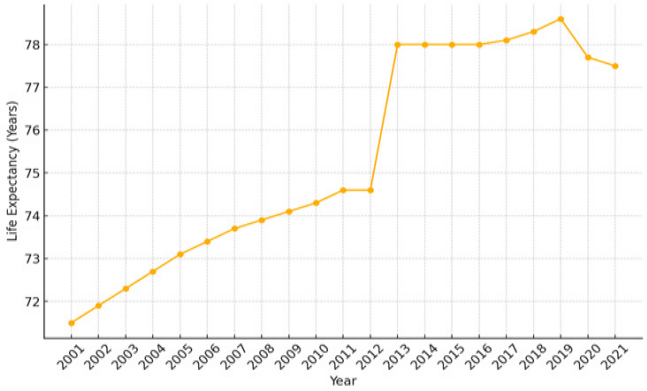

Figure 3. Change in life expectancy over the years

According to **Figure 4**, the infant mortality rate in Turkiye, which was 28.71 per 1,000 live births in 2001, has decreased to 8.62 in 2021. This decrease reflects the impact of improvements in Turkiye's infant health services, the expansion of prenatal care programs, and awareness-raising efforts for infant health. This decrease in infant mortality rates indicates the successful implementation of general health infrastructure and child health programs. This trend reveals that health standards in the country are rising and positively affect public health.

According to **Figure 5**, health expenditure per capita in Türkiye has shown a significant increase between 2001 and 2021. Health expenditure, which was 472.84 USD in 2001, increased

Tablo 2. Changes in variables over the years

Year	Life expectancy (years)	Infant mortality rate (per 1000 live births)	Health expenditure per capita (USD)	Number of doctors (per 10,000 people)	Number of nurses (per 10,000 people)
2001	71.5	28.71	472.84	13.8	17.6
2002	71.9	26.79	519.98	13.9	17.3
2003	72.3	24.99	509.73	14.1	17.4
2004	72.7	23.28	558.59	14.3	17.6
2005	73.1	21.70	588.13	14.7	17.7
2006	73.4	20.22	678.16	15.0	18.3
2007	73.7	18.86	733.36	15.4	20.1
2008	73.9	17.58	807.05	15.9	20.7
2009	74.1	16.42	815.07	16.4	21.4
2010	74.3	15.37	843.63	16.9	22.6
2011	74.6	14.43	888.31	17.0	23.8
2012	74.6	13.56	894.74	17.2	25.0
2013	78.0	12.78	947.74	17.5	25.2
2014	78.0	12.09	1006.77	17.4	25.0
2015	78.0	11.46	1040.11	17.7	25.9
2016	78.0	10.89	1128.75	17.9	25.4
2017	78.1	10.37	1175.66	18.3	26.8
2018	78.3	9.89	1205.31	18.5	29.8
2019	78.6	9.44	1231.63	19.3	30.4
2020	77.7	9.02	1304.71	20.4	34.0
2021	77.5	8.62	1559.54	21.7	34.2

Using these data, graphs showing the changes in the variables over the years will be obtained and interpreted.

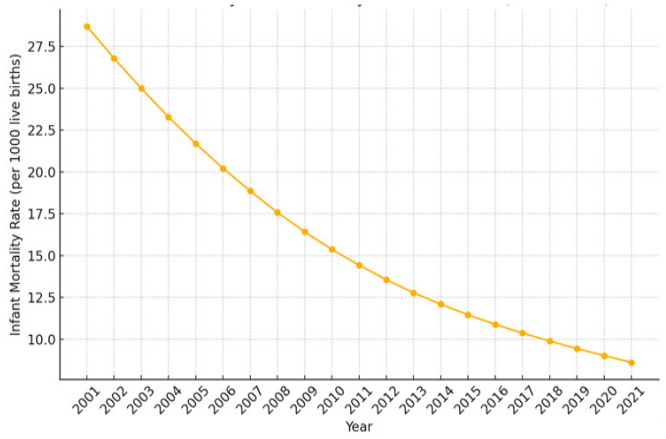

Figure 4. Change in infant mortality rate over the years

to 1559.54 USD in 2021. This increase indicates that public and private investments in health services have increased, and the health budget per capita has expanded. These increased health expenditures may also suggest improved access to and quality health services. In addition, the acceleration of the rise in health expenditures in 2020 and 2021 during the COVID-19 pandemic can be considered a reflection of efforts to strengthen the health system against the pandemic.

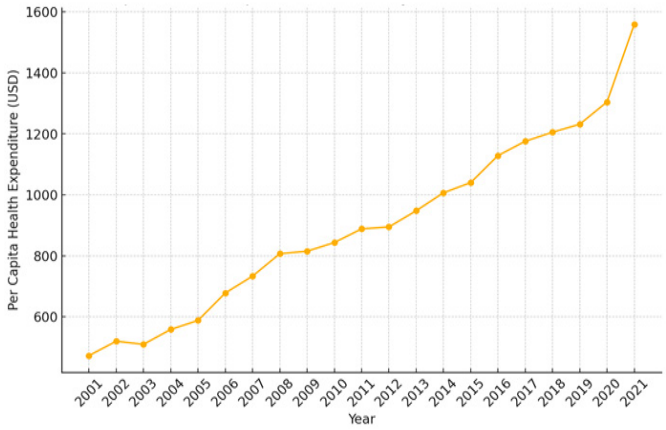

Figure 5. Change in health expenditure per capita over the years (USD)

According to **Figure 6**, there has been a continuous increase in the number of doctors and nurses per capita in Turkiye between 2001 and 2021. While the number of doctors was 13.8 per capita in 2001, it increased to 21.7 in 2021. The number of nurses, 17.6 per capita in 2001, reached 34.2 in 2021. These increases indicate Turkiye's strategic investments to increase its health workforce and support for medical education. The increase in the number of health workers has contributed to the expansion of access to health services, the increase in the quality of health services, and the reduction of the number of health workers per patient. The continuation of this increase during the pandemic supports the sustainability of Turkiye's long-term goals to strengthen its health system.

Table 3 above shows the multiple regression analysis results. The analyses revealed that the independent variables exhibited significant effects in both models. In particular, the increasing impact of PC1 on life expectancy shows that this component has a favorable structure originating from health expenditures and the number of doctors and nurses. The life expectancy

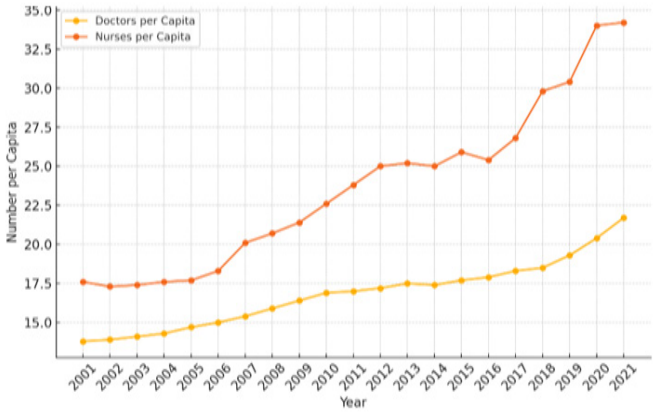

Figure 6. Change in the number of physicians and nurses per 10,000 people over the years

model is a strong model with an explanatory power of 77.3%, and the coefficient of PC1 was calculated at 1.25. This indicates that each unit increase in PC1 increases life expectancy by an average of 1.25 years.

The infant mortality rate model is even more impressive, with an explanatory power of 86.8%. The PC1 coefficient in this model was calculated as -3.28, which reveals that infant mortality rates decrease significantly with the increase in PC1.

These results suggest that increasing health expenditures and the number of health personnel alone may not be sufficient to reduce infant mortality. More comprehensive and systematic approaches, such as improving the quality of health services, strengthening health infrastructure, and improving access to health services, may be more effective in reducing infant mortality rates. In this context, it is considered necessary that health policies focus on increasing the system's overall efficiency, not just the number of personnel.

DISCUSSION

This study evaluated the effects of health expenditures and the distribution of health personnel on life expectancy and infant mortality rates in Turkiye. The findings reveal that health expenditures and various health personnel have a significant positive effect on life expectancy. The increase in the number of health personnel and increasing health expenditures contribute to the increase in life expectancy by improving the quality and accessibility of general health services. For example, Nixon and Ulmann state that health expenditures positively contribute to life expectancy, increasing access to treatment and improving service quality, thus affecting life expectancy.[20]

The effect of the number of health personnel on life expectancy in Turkiye is significant. However, increasing the number of health workers alone is not enough; the quality of service must also be improved. Studies by Anand and Bärnighausen[21] have indicated that health indicator improvements can be achieved by increasing the number of personnel and improving their professional competencies and education levels. This finding suggests that more investment should be made in training and development programs for healthcare professionals in Turkiye. Advanced training and development programs can positively

Table 3. Multiple regression analysis results

Model	R^2	PC1	PC1 std. error	t	p
Life expectancy	0.773	1.2488	0.217	5.752	0.000015
Infant mortality rate	0.868	-3.2758	0.499	-6.567	0.000003

affect health indicators by enabling healthcare professionals to intervene more effectively in complex situations.[22]

When evaluated regarding the infant mortality rate, it was concluded that health expenditure per capita and the number of health personnel could reduce it. In addition to health expenditure, socioeconomic conditions, access to health services, and infrastructure also play an essential role in infant mortality rates. Speybroeck and colleagues[23] stated that financial investments and the comprehensiveness of health services are critical in reducing the infant mortality rate. In this regard, Turkiye's health policies must focus on increasing access to health services in rural areas and strengthening the health infrastructure.

The COVID-19 pandemic has significantly increased the workload of healthcare professionals, which has negatively affected the effectiveness of healthcare services. The increased workload of healthcare professionals and increased psychological stress during the pandemic have led to a decrease in the quality of healthcare services and negative results in health indicators. Studies show that high workload and stress negatively affect the performance of healthcare professionals and lead to burnout syndrome.[24,25] Supporting the mental health of healthcare professionals during pandemic conditions is of strategic importance for both the sustainability of healthcare services and the improvement of health indicators in the long term.[12]

However, in addition to increasing the number of health workers, improving their qualifications is essential. The WHO report published in 2006 emphasized that health personnel should be strengthened not only in terms of numbers but also in terms of educational and professional skills.[26] Studies conducted in various countries have shown that trained health workers positively affect health outcomes. Khamisa et al.[25] stated that health workers' general health and job satisfaction increase health services' effectiveness and improve patient outcomes. Therefore, taking strategic steps towards training healthcare professionals in Turkiye may effectively improve health indicators.

Finally, balancing the workload of healthcare workers, protecting their mental health, and ensuring work-life balance are of great importance to ensure the sustainability of healthcare systems. The fact that healthcare workers constantly work under high workloads increases the turnover rate and leads to instability in healthcare services. Joshi and colleagues[16] argue that telehealth applications effectively alleviate this burden during the pandemic and can play an essential role in reducing the burden on healthcare workers in the future.

CONCLUSION

In conclusion, considering the positive impact of health expenditures and the number of health personnel on life expectancy and infant mortality rate in Turkiye, it can be said that efforts to increase financial resources of health policies can have positive results on public health. While it is necessary to increase the number of personnel to reduce infant mortality rates, it is also necessary to increase the quality of service, facilitate access to health services in rural areas and improve health infrastructure. Improving the qualifications of health workers and balancing their workload can also provide sustainable improvements in the health system.

ETHICAL DECLARATIONS

Ethics Committee Approval

Since secondary data is used in the study, ethics committee approval is not required.

Informed Consent

Written authorisation is not required as the study was not performed on patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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