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RESEARCH ARTICLE

The impacts of the refugee population, renewable energy consumption, carbon emissions, and economic growth on health expenditure in Turkey: new evidence from Fourier-based analyses

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Abstract

Health expenditures are affected by different macroeconomic variables. This study aims to examine the impact of renewable energy consumption, carbon emissions, the refugee population, and economic growth on Turkey's health expenditures from 1975 to 2019. For this purpose, firstly, the stationarity orders of the variables were examined with the Fourier-based stationarity test. The long-run effects of the variables on health expenditures were also examined using the Fourier-based cointegration test. The results show that there is a long-run relationship between health expenditures and the explanatory variables. In addition, long-run coefficients were calculated, and it was concluded that carbon emissions and the refugee population increased health expenditures while renewable energy consumption decreased. The causality results indicate that there is unidirectional permanent causality from health expenditures to renewable energy consumption and economic growth and bidirectional permanent causality between carbon emissions and health expenditures. Overall, adopting environmentally and renewable energy-friendly policies and controlling the refugee population are essential policy tools in terms of health expenditures.

Keywords Refugee population · Health expenditure · Renewable energy · Carbon emissions · Fourier

JEL Classification C32 · I15 · I18 · O49 · Q56

Introduction

Almost all of the world's population (99%) breathes air that exceeds the air quality limits set by the World Health Organization (WHO) and threatens health. When the air quality data in 117 countries and over 6000 cities are examined, it is seen that the people living in these areas breathe fine particulate matter and nitrogen dioxide at a harmful rate to the body, and these harmful elements are mostly found in the air in developing countries (WHO 2022a). Developing countries are relatively vulnerable to air pollution as they attract heavily polluting industries regarding their opportunities under their development goals. Mainly such a situation arises from the fact that developing countries have cheap or abundant labor forces compared to developed countries, and their environmental regulations are weak. Therefore, considering the strict environmental regulations in developed countries, developing countries turn into pollution havens (Yahaya et al. 2016).

Particulate matter, especially PM2.5, penetrates deep into the lungs and enters the bloodstream, causing cardiovascular, cerebrovascular (paralysis), and respiratory effects. There is also evidence that this particulate matter affects other organs and causes other diseases (WHO 2022a). Indeed, societies and governments increasingly realize the need to accurately estimate the health costs associated with environmental quality and recognize the substantial impact of environmental degradation on human health. Because

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the improvement of the factors related to the general health status of the population led to a significant increase in life expectancy and contributed to the increase in the welfare level of the countries. Therefore, one of today's most important problems is that decision-makers seek solutions to both health and environmental problems with scarce resources (Badulescu et al. 2019; Blázquez-Fernández et al. 2019).

In this context, it can be said that air pollution is one of the biggest environmental threats to human health and climate change. Air pollution is accepted as the main source of environmental cost in the literature. WHO estimates show that approximately 7 million deaths, mostly from non-communicable diseases, are due to the combined effects of ambient and household air pollution. Similar global assessments of ambient air pollution reveal that it alone causes between 4 and 9 million deaths and hundreds of millions of healthy life years lost annually, with the largest attributable burden of disease occurring in low and middle-income countries (WHO 2021). It is noteworthy that these serious consequences are more than deaths from COVID-19, which has affected the world.

On the other hand, air pollution is, directly and indirectly, damaging to social welfare. For example, air pollution, which negatively affects human health, also has a negative effect on labor productivity. This, in turn, affects industrial output or national output, thus affecting the growth of firms and the economy (Narayan and Narayan 2008; Yahaya et al. 2016; Apergis et al. 2018). Moreover, air quality increases the global burden of diseases caused by various respiratory diseases, increasing the resources of both individuals and governments for health. If air quality is improved, the discomfort will decrease, and government and private health expenditures will drop (Yahaya et al. 2016). Especially as Pearce and Turner (1990) argue, the costs of environmental pollution are indisputable, but it potentially intensifies the demand for health expenditures, thus increasing the burden on public finances. Also, as economic growth or welfare increases, the demand for health services increases, and therefore, health expenditures increase. In this context, researchers have recently paid special attention to the relationship between environmental quality, economic growth, and health expenditures. When the empirical literature is examined (Narayan and Narayan 2008; Chaabouni et al. 2016; Khoshnevis Yazdi and Khanalizadeh 2017; Apergis et al. 2018, 2020; Haseeb et al. 2019; Chen et al. 2019; Ullah et al. 2019; Badulescu et al. 2019; Shahzad et al. 2020; Ampon-Wireko et al. 2021; Mujtaba and Ashfaq 2022), there is a consensus that air pollution and economic growth increase health expenditures. In addition to air pollution and economic growth, it is observed in the literature that environmentally friendly renewable energy reduces health expenditures (Badulescu et al. 2019; Shahzad et al. 2020; Mujtaba and Shahzad 2021; Mujtaba and Ashfaq 2022). In summary, the demand for health services and health expenditure increase as a result of environmental degradation and rising level of income. On the other hand, the consumption of environmentally friendly renewable energy reduces air pollution, as emphasized by Dogan and Seker (2016), Gormus and Aydin (2020), Namahoro et al. (2021a, b), and Pata et al. (2021). As a result of this effect, the demand for health services is controlled or reduced (as a healthier and more sustainable environment is established), reducing health expenditures. Therefore, environmental pollution, economic growth, and renewable energy consumption are important determinants of health expenditures. However, some countries are exposed to an additional burden of environmental pollution and health expenditures as they host refugees as well as their populations. According to the United Nations High Commissioner for Refugees (UNHCR 2022), Turkey hosts the highest number of refugees, with 3.7 million people. After the civil war in Syria in 2011, there was a massive influx of refugees to Turkey. It is possible to see this effect in Fig. 1:

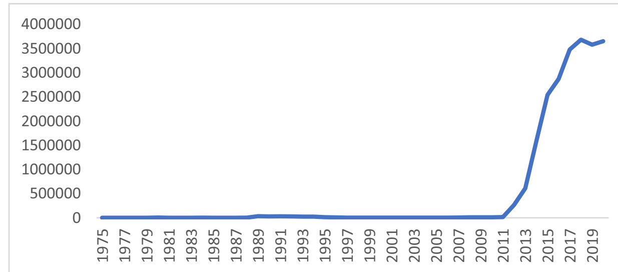


Fig. 1 Refugee population in Turkey (1975–2020)

It can be said that refugees are the most vulnerable part of society, mostly due to xenophobia, discrimination, poor housing, and working conditions. Refugees are often considered to have insufficient access to health services despite their physical and mental health problems (WHO 2022b). However, refugees in Turkey can easily access and benefit from health services like regular citizens. This ease of access and benefit applies not only to health but also to all public services. Considering that Turkey hosts twice as many refugees as Colombia (1.7 million), which is the closest refugee host, this causes various fiscal, environmental, and health problems for Turkey. In this context, to the best of our knowledge, there is no study investigating the effect of the refugee population on health expenditures. Therefore, it is thought that analyzing the impact of the refugee population on health expenditures in Turkey will make an original contribution to the literature. While doing this, carbon emissions, income level, and renewable energy's impact on health expenditures are also examined. Another contribution to the literature is investigating the temporary and permanent causality relations between health expenditures and refugee population, carbon emissions, economic growth, and renewable energy consumption using the frequency domain causality method.

The remainder of the study is organized as follows: "Literature Review" introduces the empirical literature. "Data, Model, and Methodology" explains the data, methodology, and empirical model. "Empirical Results" presents empirical results. "Discussion" discusses conclusions. "Conclusion and Policy Recommendations" offers discussion and policy recommendations.

Literature review

As far as we know, the relationship between health expenditures and the environment was first studied by Jerrett et al. (2003). The authors examined the relationship between health expenditures and environmental variables in 49 counties of Ontario, Canada, using the 1991–1992 cross-sectional data and two-stage regression method. As a result of the study, counties with higher pollution allocate higher resources to health expenditures, while counties that spend more to protect environmental quality allocate fewer resources to health services. Subsequently, Narayan and Narayan (2008) investigated the effects of per capita income, carbon monoxide emissions, sulfur oxide emissions, and nitrogen oxide emissions on health expenditures in 8 OECD countries during the 1980–1999 period using the panel cointegration method. Research findings point to the positive and statistical significance of per capita income, carbon monoxide, and sulfur oxide emissions (nitrogen oxide emissions insignificance) on health expenditures in the long run.

Following the studies of Jerrett et al. (2003) and Narayan and Narayan (2008), the relationship between health expenditures and the environment has not received attention from researchers for a certain period. Then, together with the studies of Yahaya et al. (2016) and Chaabouni et al. (2016), the relationship between health expenditures, economic growth, and the environment has been a matter of curiosity in the literature. Recently, with the study of Badulescu et al. (2019), the impact of renewable energy on health expenditures has also started to attract attention in the empirical literature. The summary findings of empirical studies investigating the effects of environmental pollution, economic growth, and renewable energy consumption on health expenditures are presented in Table 6 (in the Appendix). Carbon emissions were mostly preferred as a proxy variable representing environmental degradation or air pollution. However, some studies have used carbon monoxide emissions, sulfur oxide emissions, nitrogen oxide emissions, and ecological footprint to describe environmental degradation or air pollution. Examples of these studies are Narayan and Narayan (2008), Yahaya et al. (2016), Blázquez-Fernández et al. (2019), Gunduz (2020), and Yang et al. (2021) can be given.

If we evaluate the empirical literature findings in general, it is possible to say the following: It is strongly supported by the empirical literature that environmental pollution and economic growth have a positive effect on health expenditure: Jerrett et al. (2003), Narayan and Narayan (2008), Yahaya et al. (2016), Chaabouni et al. (2016), Chaabouni and Saidi (2017), Khoshnevis Yazdi and Khanalizadeh (2017), Apergis et al. (2018), Usman et al. (2019), Haseeb et al. (2019), Chen et al. (2019), Ullah et al. (2019), Blázquez-Fernández et al. (2019), Badulescu et al. (2019), Apergis et al. (2020), Gunduz (2020), Shahzad et al. (2020), Mujtaba and Shahzad (2021), Yang et al. (2021), Ampon-Wireko et al. (2021), and Mujtaba and Ashfaq (2022). However, few studies point to different findings. For example, Zaidi and Saidi (2018) argue that environmental pollution does not have a significant effect on health expenditures. On the other hand, Wang et al. (2019b) emphasize that there is a negative relationship between economic growth and health expenditures. Li et al. (2022) concluded that carbon emissions, economic growth, and health expenditures do not act together in the long run. Although there are such findings, the evidence that environmental pollution and economic growth increase health expenditures are relatively dominant. In addition to environmental pollution and economic growth, the effect of renewable energy consumption on health expenditures is limited in the empirical literature, but the results are clear. Badulescu et al. (2019), Shahzad et al. (2020), Mujtaba and Shahzad (2021), and Mujtaba and Ashfaq (2022) share the conclusion that renewable energy consumption reduces health expenditures. To summarize the empirical findings, while environmental pollution and economic growth increase health expenditures, renewable energy consumption decreases health expenditures.

Finally, to the best of our knowledge, there is no study investigating the impact of the refugee population on health expenditures for Turkey or any other country group. Moreover, the effects of environmental pollution, economic growth, and renewable energy consumption on health expenditures in Turkey have not been examined. Therefore, it is aimed to make an important contribution to the literature by testing the effect of the refugee population, environmental pollution, economic growth, and renewable energy consumption on health expenditures. Again, to the best of our knowledge, this is the first time to reveal the temporary-permanent causality between this variable set and health expenditures.

Data, model, and methodology

This study used annual data for the 1975–2019 period from Turkey. The data sources are as follows: refugee population, per capita gross domestic product (GDP, constant 2015 US$) as a proxy of economic growth, health expenditure measured as the share of GDP, per capita renewable energy consumption measured as kWh, and per capita carbon emissions measured as the million tons. We obtained the refugee population and GDP data from the World Bank database (World Development Indicators).[1] Renewable energy consumption and carbon emissions data were obtained from Ritchie and Roser (2020) and BP statistical review database, respectively. Health expenditure data came from the OECD database. All the data were used in logarithmic form. We used the following model to investigate the impacts of the refugee population (ref), renewable energy consumption (ren), carbon emissions (co2), and economic growth (GDP) on health expenditures (he).

$$\ln he_t = \beta_0 + \beta_1 \ln ref_t + \beta_2 \ln ren_t + \beta_3 \ln co2_t + \beta_4 \ln gdp_t + \varepsilon_t \quad (1)$$

where β_0, β_1, β_2, β_3, and β_4 are the coefficients of the constant, refugee population, renewable energy consumption, carbon emissions, and economic growth, respectively. ε_t is the error term. We expect the refugee population, carbon emissions, and economic growth to impact health expenditures and increase them significantly. However, we expect renewable energy consumption to have a significant and reducing effect on health expenditures.

The shocks that time series are exposed to during the period are called structural breaks. These shocks can be economical or financial crises, political fluctuations, or natural disasters. Ignoring these structural breaks can lead to biased results. Structural breaks can be in a sharp or smooth form. Considering smooth structural breaks using Fourier terms allows for more sensitive and reliable results. For this reason, Fourier-based tests were preferred in this study. Becker et al. (2006) extended the Kwiatkowski et al. (1992) stationarity test using Fourier terms. Accordingly, they have developed a stationarity test that allows smooth structural breaks that do not require prior information on the form and number of structural breaks. The data generation process for the Fourier KPSS (FKPSS) test is as follows.

$$\begin{aligned} y_t &= X_t'\beta + Z_t'\gamma + r_t + \varepsilon_t \\ r_t &= r_{t-1} + u_t \end{aligned} \quad (2)$$

where $Z_t = \left[\sin(2\pi kt/T), \cos(2\pi kt/T)\right]'$. ε_t is the error term. The model used for the FKPSS test is as follows.

$$y_t = \alpha_1 + \delta t + \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 \cos\left(\frac{2\pi kt}{T}\right) + u_1 \quad (3)$$

The test statistic for testing the null hypothesis showing trend stationarity against the unit root alternative hypothesis is calculated as follows.

$$\tau_\tau(k) = \frac{1}{T^2} \frac{\sum_{t=1}^{T} \widetilde{S}_t(k)^2}{\widetilde{\sigma}^2} \quad (4)$$

where $\widetilde{S}_t = \sum_{j=1}^{t} \hat{e}_j$ and $\hat{e}_j$ are the residuals obtained from regressing yt on xt. The significance of Fourier terms is tested with the help of the F-test. The null hypothesis ($H_0 : \gamma_1 = \gamma_2 = 0$) that the Fourier terms are not significant is tested against the alternative hypothesis ($H_1 : \gamma_1 \neq \gamma_2 \neq 0$) that the Fourier terms are significant. If the Fourier terms are significant, the FKPSS test is used, and if it is not significant, it is recommended to use the KPSS test.

Tsong et al. (2016) extended Shin's (1994) methodology with Fourier terms and developed a cointegration test that takes into account smooth structural breaks. The regression model used for the Fourier-Shin cointegration test is as follows.

$$y_t = d_t + x_t'\beta + \eta_t,\ \eta_t = \gamma_t + \upsilon_{1t},\ \gamma_t = \gamma_{t-1} + u_t,\ \ x_t = x_{t-1} + \upsilon_{2t} \quad (5)$$

where d_t denotes the deterministic term and is defined as $d_t = \delta_0 + f_t$, and the f_t in this equation expresses the Fourier functions and is defined as follows.

$$f_t = \alpha_k \sin(2\pi kt/T) + \beta_k \cos(2\pi kt/T) \quad (6)$$

The final equation used for cointegration is defined as follows.

$$y_t = \sum_{i=0}^{m} \delta_i t^i + \alpha_k \sin(2\pi kt/T) + \beta_k \cos(2\pi kt/T) + x_t'\beta + \upsilon_{1t} \quad (7)$$

The null hypothesis, which states that there is cointegration, is tested against the alternative hypothesis, which states no cointegration. The test statistic used to test these hypotheses is defined as follows.

$$CI_m^f = T^{-2}\hat{\omega}_1^{-2} \sum_{t=1}^{T} S_t^2 \ \ S_t = \sum_{t=1}^{T} \hat{\upsilon}_{1t} \quad (8)$$

Tsong et al. (2016) finally test the significance of Fourier terms with the help of the F-test. While the Fourier

[1] https://databank.worldbank.org/source/world-development-indicators/preview/on

Table 1 Descriptive statistics of the variables

	HE	*REN*	*CO2*	*REF*	*GDP*
Mean	3.449	1.499	2.976	420,343.800	6755.385
Std. dev	1.263	0.754	0.983	1,046,537.049	2476.488
CV	36.620	50.277	33.028	248.972	36.659

CV indicates the coefficient of variation

Table 2 FKPSS stationarity test results

Variables	I(0)	1%	5%	10%	I(1)	1%	5%	10%
lngdp	1.562 (1)*	0.269	0.172	0.131	0.214 (5)	0.738	0.462	0.351
lnhe	0.584 (1)*	0.269	0.172	0.131	0.136 (5)	0.738	0.462	0.351
lnren	1.322 (1)*	0.269	0.172	0.131	0.051 (5)	0.738	0.462	0.351
lnco2	1.559 (1)*	0.269	0.172	0.131	0.101 (4)	0.722	0.459	0.347
lnref	2.192 (2)*	0.667	0.415	0.315	0.150 (2)	0.667	0.415	0.315

[*] indicates the rejection of the null hypothesis at 1% significance level. Values in parentheses indicate optimal frequency numbers. The null hypothesis shows stationarity

Table 3 Shin cointegration tests results

Tests	Values	*k*	1%	5%	10%	*F*-stat
Fourier Shin	0.007	1	0.050	0.038	0.034	2.048
Shin	0.010	-	0.109	0.073	0.056	-

Since the *F*-statistic of the Fourier terms is insignificant, the results of the Shin test are also reported. The null hypothesis shows cointegration

Shin cointegration test can be used if the Fourier terms are significant, they suggested using the Shin cointegration test if they are not significant.

The frequency causality test was first proposed by Granger (1969) and then improved by Geweke (1982), Hosoya (1991), and Breitung and Candelon (2006), respectively. Breitung and Candelon (2006) generalized Geweke's (1982) procedure for bivariate vector autoregressive models. They proposed the frequency domain causality test based on a bivariate finite-order VAR model.

$$\begin{pmatrix} Q_{11}(L) & Q_{12}(L) \\ Q_{21}(L) & Q_{22}(L) \end{pmatrix} \begin{pmatrix} X_t \\ Y_t \end{pmatrix} = \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{pmatrix} \quad (9)$$

where $Q(L)$ is an autoregressive polynomial that is defined as $1 - \sum_{i=1}^{p} Q_i L^i$. They used the following VAR(p) model to investigate frequency causality:

$$X_t = \sum_{k=1}^{p} \theta_{11,k} X_{t-k} + \sum_{k=1}^{p} \theta_{12,k} Y_{t-k} + \varepsilon_t \quad (10)$$

The chi-square distribution with two degrees of freedom is used to test the null hypothesis, which states that there is no Granger causality at the frequency w.

Empirical results

We present descriptive statistics before starting the empirical analysis to learn more about the structures of the variables. Table 1 indicates the descriptive statistics of the variables. According to the results, the refugee population variable has the highest variation, followed by renewable energy consumption, economic growth, health expenditure, and carbon emissions. The variation in the refugee population is particularly striking, and its impact on health expenditures is worth investigating.

We first investigated the order of integration degrees of the variables using the stationarity test, which considers the structural breaks. Table 2 shows the Fourier-based stationarity test results. The results indicate that while all variables have a unit root at level, they are stationary at first differences. Accordingly, the order of integration is 1 for all the variables. We used this information to examine the long-run relationship and causality between variables.

Table 3 presents the results of the Fourier-based cointegration test, and the results show that health expenditures move together with the refugee population, renewable energy consumption, carbon emissions, and economic growth in the long-run. In other words, it is seen that there is cointegration for model 1.

The estimated coefficients for model 1 using the Fourier-based long-run estimator are reported in Table 4. The results show that the refugee population and carbon emissions have a significant and increasing effect on health expenditures. On the other hand, the impact of renewable energy consumption on health expenditures is significant and negative.

Table 4 Fourier-based DOLS long-run estimation results

Independent variables	Coefficient	*P*-value
lnren	−1.435*	0.001
lnco2	3.684**	0.029
lnref	0.127*	0.005
lngdp	−2.359	0.197

* and ** indicate the rejection of the null hypothesis at the 1% and 5% significance levels, respectively

Table 5 Frequency domain causality test results

	Long-run	*Short-run*	
Null hypothesis	*w* = *0.5*	*w* = *2.5*	*10%*
lnhe ↛ lnref	0.0121	0.0153	0.1283
lnref ↛ lnhe	0.0382	0.0218	0.1203
lnhe ↛ lnren	0.1510*	0.0799	0.1064
lnren ↛ lnhe	0.0226	0.0239	0.1223
lnhe ↛ lnco2	0.1089*	0.0651	0.0987
lnco2 ↛ lnhe	0.2270*	0.0408	0.0946
lngdp ↛ lnhe	0.1044	0.0085	0.1113
lnhe ↛ lngdp	0.2146*	0.0295	0.1018

w indicates the frequency length. * indicates the rejection of the null hypothesis at 10% significance level

Finally, we examined the effect of the explanatory variables in model 1 on health expenditures with causality analysis. For this purpose, we used the frequency domain causality test, which allows us to examine the relationship between variables separately in the short and long term. Table 5 indicates the results of the frequency domain causality test. In Table 5, $w = 0.5$ shows permanent causality, and $w = 2.5$ shows temporary causality.

Firstly, according to the results, there is unidirectional permanent (long-run) causality from health expenditure to renewable energy consumption. Secondly, there is bidirectional permanent causality between health expenditure and carbon emissions. Lastly, there is unidirectional permanent causality from health expenditure to economic growth. Figure 2 (in the Appendix) introduces summary results of the causality test. Moreover, Figs. 3 and 4 (in the Appendix) provide a graphical representation of the causality test results.

Discussion

In this study, the effect of the refugee population, carbon emissions, economic growth, and renewable energy on health expenditures in Turkey during the 1975–2019 period was analyzed with Fourier-based econometric methods. In addition, the frequency domain causality method examined temporary and permanent causal relationships between health expenditures and explanatory variables. Firstly, the stationarity properties of the series were investigated with the FKPSS stationarity test, and it was decided that all series were *I* (1). Then, the cointegration relationship between the series was examined by the Fourier-Shin method. It was concluded that health expenditures, refugee population, carbon emissions, economic growth, and renewable energy act together in the long run. The long-term Fourier-based DOLS findings are as follows:

Carbon emissions affect health expenditures positively and significantly. In other words, air pollution increases health expenditures. Such a finding is in agreement with the majority of the literature (Narayan and Narayan 2008; Chaabouni et al. 2016; Khoshnevis Yazdi and Khanalizadeh 2017; Apergis et al. 2018, 2020; Wang et al. 2019b; Haseeb et al. 2019; Chen et al. 2019; Ullah et al. 2019; Badulescu et al. 2019; Shahzad et al. 2020; Ampon-Wireko et al. 2021). Moreover, a permanent bidirectional causal relationship was obtained between health expenditures and carbon emissions. The mutual and permanent causal relationship between both variables implies that health expenditures also affect carbon emissions. It is confirmed by the empirical literature (Chaabouni et al. 2016; Chaabouni and Saidi 2017; Ullah et al. 2019; Wang et al. 2019a; Alola and Kirikkaleli 2019; Apergis et al. 2020; Sasmaz et al. 2021; Yang et al. 2021, 2022; Li et al. 2022) that health expenditures increase carbon emissions. On the other hand, it has been determined that renewable energy has a negative and significant effect on health expenditures. In other words, the increase in the use of renewable energy reduces health expenditures. This finding agrees with the empirical literature (Badulescu et al. 2019; Shahzad et al. 2020; Mujtaba and Shahzad 2021; Mujtaba and Ashfaq 2022). Also, a unidirectional causality from health expenditures to renewable energy was determined. However, contrary to expectations, it was concluded that economic growth did not have a statistically significant effect on health expenditures. Among the possible reasons for this finding, it can be argued that a very large part of health expenditures in Turkey, regardless of income, are provided by the government. For example, approximately 77% of total health expenditures are financed by the government, while the remaining expenditures are voluntary and out-of-pocket expenditures. Since total health expenditures are given in this study, it can be reasonably assumed that health services are provided regardless of income, so economic growth is statistically insignificant. In addition, causality findings support our view by showing that economic growth is not effective on health expenditures. Finally, as far as we know in the literature, the effect of the refugee population on health expenditures was investigated for the first time in this study. Our findings imply that the refugee population has significantly increased health expenditures. However, causality findings imply that there is no permanent or temporary causal relationship between the refugee population and health expenditures.

Conclusion and policy recommendations

This study has important policy implications within the framework of the findings obtained. The main issue on which both this study and the majority of the literature agree is that air pollution increases health expenditures. Because the increase in air pollution causes serious complications in citizens' health regardless of the countries' development level (Remoundou and Koundouri 2009), therefore, this undesirable situation increases health expenditures. In this context, while designing the health policy, environmental quality or air pollution must be considered, and a coordinated approach between countries is needed. In fact, above all, it is necessary for a healthy society. In particular, investments in public health and environmental protection can contribute to reducing health expenditures. If environmental quality is not considered, health policy may increase health expenditures. Therefore, environmental factors must be considered in cost-based discussions on health expenditures (Jerrett et al. 2003). Otherwise, both people's health will deteriorate, and limited resources will be allocated to more health expenditures. If more resources are allocated to health expenditures or a sustained increase in health expenditures, as Usman et al. (2019) stated, scarce resources may be allocated less to the infrastructure, education, environment, and social sectors. This can put fiscal pressure on governments and hinder economic growth and development in the long run.

On the other hand, the study has confirmed that environmentally health-friendly renewable energy reduces health expenditures. It is also known that renewable energy improves environmental quality. Renewable energy production and consumption are increasing worldwide in order to have direct access to energy sources, to balance unstable energy prices, and most importantly to reduce the undesirable effects of climate change. So, policymakers should quickly implement regulations that will motivate investors and encourage energy markets to increase renewable energy production. Considering that approximately 85% of the general energy consumption in Turkey consists of fossil fuels, the importance of renewable energy is increasing. Nonrenewable energy consumption increases carbon emissions and causes environmental degradation (Aydin and Turan 2020). In this context, policymakers encourage the use of cleaner energy sources (via subsidies) and discourage the use of more polluted energy (via taxation). Thus, society's health will be protected or improved, and health expenditures will be reduced. However, it is emphasized by the literature that the health sector also causes significant air pollution. Although it has been determined that reducing air pollution and increasing renewable energy reduces health expenditures, it has been determined that health services are also the cause of air pollution. Especially in healthcare services, green technology innovations should be utilized. As highlighted by Madaleno et al. (2022), green technology innovations are a driving factor for a healthier and more sustainable environment. Thus, the quality of life will be improved, traditional energy demand will decrease, and environmental pollution will be taken under control. Therefore, policymakers' transformation of health services into more energy-efficient and environmentally friendly will indirectly reduce health expenditures. For example, by reducing medical waste or evaluating medical waste within the scope of a circular economy, obtaining the energy used in health services from renewable energy can make significant contributions. As another policy recommendation, the financial sector should provide more credit, and R&D studies should be supported by the government in order to increase energy efficiency and develop green technological innovations in the health sector.

Finally, this study draws attention to the refugee population, which is a point that has not been mentioned before regarding health expenditures. Turkey is the country that hosts the most (3.7 million) refugees in the world, especially with the Syrian civil war that broke out in 2011. Refugees in Turkey, like regular citizens, have easy access to health services and increase their health expenditures. It can be argued that the refugee population is an important determinant of health expenditures, especially in countries hosting refugee populations (e.g., Colombia, 1.7 million; Uganda, 1.5 million; Pakistan, 1.4 million; and Germany, 1.2 million). In this context, the efforts of future studies to control this finding we have obtained for Turkey will provide important guidance to policymakers about the factors that determine health expenditures.

Appendix

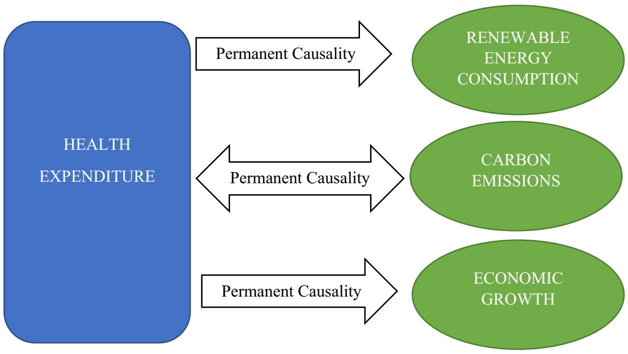
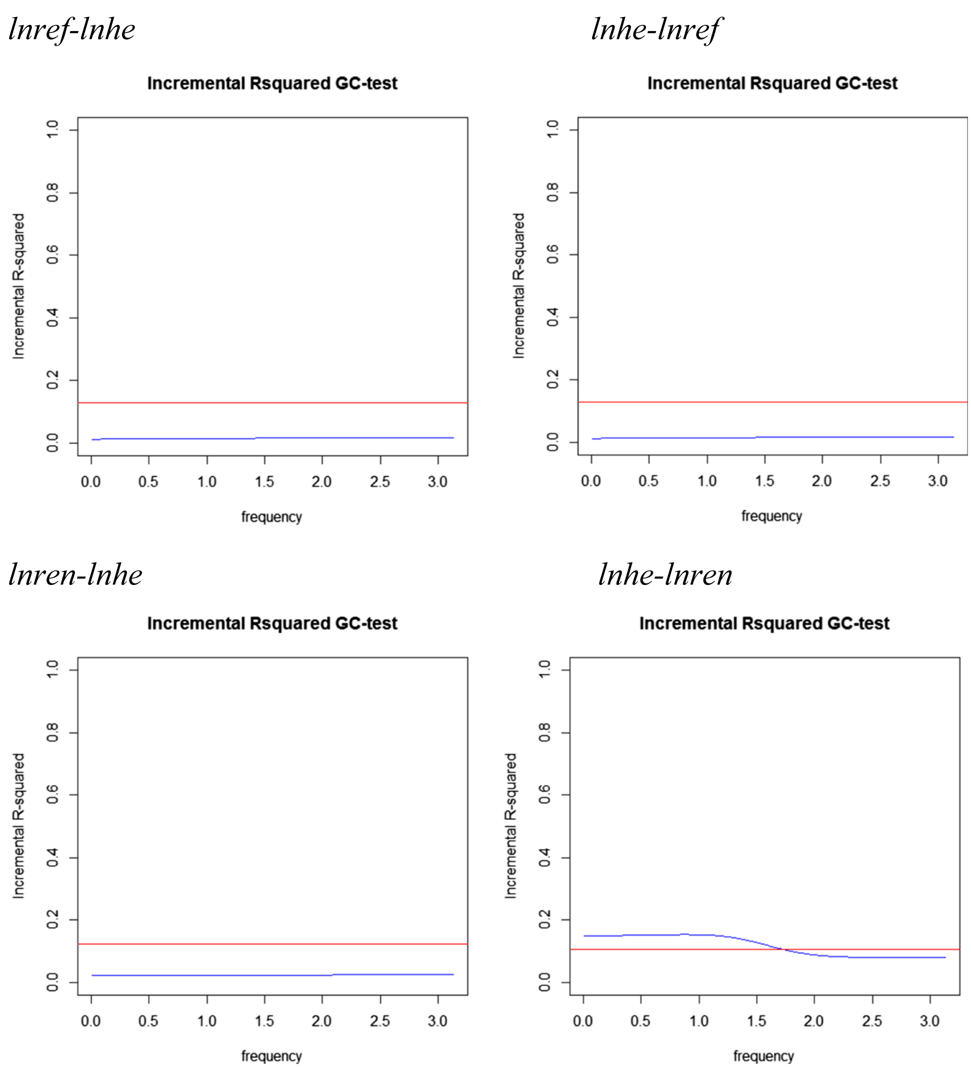


Fig. 2 Summary results of the causality test. Source: Authors

Fig. 3 Graphical results of the causality test (lnref-lnhe, lnren-lnhe). Source: Authors



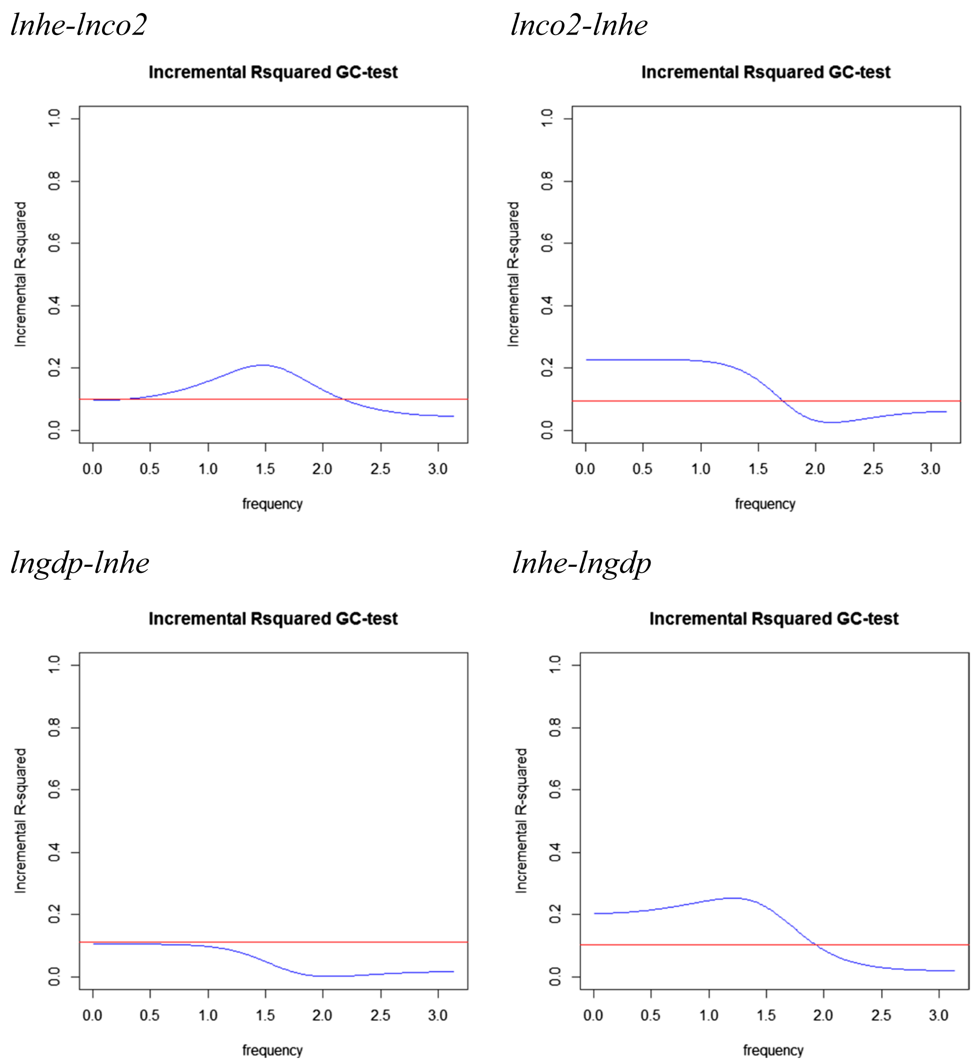


Fig. 4 Graphical results of the causality test (lnhe-lnco2, lngdp-lnhe). Source: Authors

Table 6 Literature review of the variables

Author (s)	Sample/period	Method	Results	Causality
Jerrett et al. (2003)	1991–1992 Canada	-Cross section -2SLS	EP (+)	-
Narayan and Narayan (2008)	1980–1999 OECD	-Panel cointegration	EP (+) GDP (+)	-
Yahaya et al. (2016)	1995–2012 125 Developing C	-Panel cointegration	EP (+) GDP (+)	-
Chaabouni et al. (2016)	1995–2013 51 countries	- System GMM	EP (+) GDP (+)	-
Chaabouni and Saidi (2017)	1995–2013 51 countries	- System GMM	EP (+) GDP (+)	-
Khoshnevis Yazdi and Khanalizadeh (2017)	1995–2015 MENA countries	-Panel cointegration	EP (+) GDP (+)	-
Zaidi and Saidi (2018)	1990–2015 26 Sub-Saharan African countries	-Panel cointegration	EP (?) GDP (+)	-
Apergis et al. (2018)	1966–2019 50 USA states	-Panel cointegration	EP (+)	-
Usman et al. (2019)	1994–2017 13 EM countries	-Panel cointegration -Panel causality	EP (+) GDP (+)	$EP \rightarrow HE$ $GDP \rightarrow HE$
Wang et al. (2019a)	1975–2017 18 OECD countries	-Panel causality	-	$GDP \rightarrow HE$ $EP \leftrightarrow HE$
Wang et al. (2019b)	1995–2017 Pakistan	-ARDL -Granger causality	EP (+) GDP (-)	$EP \rightarrow HE$
Aydin (2019a)	1980–2015 OECD countries	-Panel causality	-	$RE \leftrightarrow GDP$
Haseeb et al. (2019)	2009–2018 ASEAN countries	-Panel cointegration	EP (+) GDP (+)	-
Gorus and Aydin (2019)	1975–2014 MENA countries	-Panel causality	-	Mixed by country
Chen et al. (2019)	2005–2016 30 China provinces	- Quantile regression	EP (+)	-
Ullah et al. (2019)	1990–2017 China	-2SLS -3SLS	EP (+)	$EP \rightarrow HE$
Aydin (2019b)	BRICS 1992–2013	-Panel causality	-	Mixed by country
Blázquez-Fernández et al. (2019)	1995–2014 29 OECD countries	-Panel data	EP (+) GDP (+)	-
Alola and Kirikkaleli (2019)	1990–2018 USA	-Time and frequency domain causality	-	$EP \leftrightarrow HE$
Badulescu et al. (2019)	2000–2014 28 EU countries	-Panel cointegration	EP (+) GDP (+) RE (−)	-
Apergis et al. (2020)	1995–2017 178 countries	-Panel GMM	EP (+) GDP (+)	-
Gunduz (2020)	1970–2016 USA	-Hidden cointegration	EP (+)	-
Pata and Aydin (2020)	1965–2016 Six hydropower energy-consuming countries	-Granger Causality	-	Mixed by country
Shahzad et al. (2020)	1995–2017 Pakistan	-ARDL -Granger causality	EP (+) GDP (+) RE (−)	$GDP \rightarrow HE$ $RE \rightarrow HE$ $HE \rightarrow EP$
Mujtaba and Shahzad (2021)	2002–2018 28 OECD countries	-Panel cointegration	EP (+) GDP (+) RE (−)	-

Table 6 (Continued)

Author (s)	Sample/period	Method	Results	Causality
Yang et al. (2021)	1995–2018 10 countries	-Panel cointegration -Panel causality	EP (+) GDP (+)	*EP ↔ HE* *GDP ↔ HE*
Ampon-Wireko et al. (2021)	2000–2018 25 Developing C	Panel cointegration -Panel causality	EP (+) GDP (+)	*HE → EP* *GDP ↔ HE*
Sasmaz et al. (2021)	2004–2017 27 EU countries	-Panel causality	-	Mixed by country
Yang et al. (2022)	1985–2019 G-7 countries	-Panel causality	-	*GDP ↔ HE* *EP ↔ HE* *RE ↔ HE*
Mujtaba and Ashfaq (2022)	2000–2019 27 countries	-Panel cointegration	EP (+) GDP (+) RE (−)	-
Li et al. (2022)	2000–2019 BRICS countries	- Fourier ARDL -Granger causality	Not cointegration	Mixed by country

EP, HE, GDP, and RE indicate environmental pollution, health expenditures, economic growth, and renewable energy, respectively

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