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THE RELATIONSHIP BETWEEN HUMAN DEVELOPMENT AND HEALTH EXPENDITURES: EVIDENCE FROM THE DRISCOLL-KRAAY ESTIMATOR

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ABSTRACT

In this study employing panel data methods, it was aimed to econometrically test the relationship between human development and health expenditures in 25 OECD countries using data from the 2003-2019 period. For this purpose, in the econometric model established, the Human Development Index is included as the dependent variable to represent human development, while public health expenditures and household voluntary health expenditures are included as independent variables to represent health expenditures. The results of the empirical analyses indicate a positive and statistically significant relationship between health expenditures and human development. Accordingly, considering the overall panel based on the aforementioned period and group of countries, it is concluded that a 1unit increase in public health expenditures increases the Human Development Index value by 0.11 units. Similarly, it was observed that a 1unit increase in household voluntary health expenditures also increases the Human Development Index value by 0.03 units. Therefore, it is concluded that increases in investments in health, both by the public sector and at the household level, and thus the increase in health expenditures, will support human development in this group of countries.

Keywords: *Human Development Index, Health expenditures, Panel data.*

Jel Codes: *E1, H51, I31.*

1. INTRODUCTION

The concept of human development focuses on a perspective aiming to enhance the quality of life and welfare of individuals. This concept considers not only economic growth or income growth but also a range of factors, such as education, health, social justice, human rights, and improving living standards. The human development approach was first introduced in the Human Development Report published in the year 1990 by the United Nations Development Programme (UNDP). Arguing that development

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should not be based solely on economic indicators, this report emphasizes the importance of a human-centric approach (UNDP 2023a).

Human development is measured by using the Human Development Index (HDI), which was developed by UNDP in the year 1990 (UNDP 2023b). The HDI takes into account not only the economic growth of countries but also fundamental indicators of individuals such as life expectancy, education level, and living standards. The HDI is used in order to assess and compare the human development levels of countries. The human development approach encourages policymakers and decision-makers to direct their development strategies to improve people's welfare and living standards. In this context, indicators such as the Human Development Index are frequently used in supporting this approach and making comparisons between countries.

The HDI consists of three main components, namely life expectancy, education level, and living standard. Life expectancy, among the components used in calculating this index, is measured by the average expected lifespan in a country. It reflects the general health status and quality of life in that country. The education component is analyzed by using the average years of schooling and literacy rate in a country. This component is measured by using the schooling duration of adults aged 25 years and over and the expected years of schooling for children starting school. These indicators reflect the knowledge level and educational opportunities of people in a country. The living standard, which is the last component, is measured by using the Gross Domestic Product (GDP) per capita, considering the purchasing power parity. This component reflects the economic resources and living standards of individuals in a country (UNDP 2023b). These three components are combined in the calculation of the HDI, which is expressed as an index ranging from 0 to 1. An index value of 1 represents the highest human development, while 0 indicates the lowest level.

Although health is generally accepted as both a core objective and a significant outcome of development, the importance of investing in health to encourage economic development and reduce poverty was not sufficiently understood almost until the 21st century. However, it was realized over time that expanding critical health services can save millions of lives every year, reduce poverty, accelerate economic development, and support global security. In this context, the United Nations Millennium Summit emphasized that health is among the most important demands of people worldwide. The impact of disease and early death has caused health to become a fundamental concern for all societies and be considered as a basic human right. The principle that "health is wealth" is accepted by almost all societies. Health is the foundation of individual development for both individuals and families and also secures the future. Health is a significant factor in workforce productivity, learning capacity, and intellectual, physical, and emotional development (Sachs et al., 2001; Sach 2001). Health is vital not only for individual welfare but also for the development of societies and nations. Especially investments in health and the development of health services are leading to improvements in indicators that can be associated with a country's level of development. People's well-being is a critical factor for economic

growth, poverty reduction, and achieving sustainable development goals. Therefore, issues such as access to health services, reducing health inequalities, developing health policies, and strengthening the health system hold a significant place on the international agenda. The United Nations and other international organizations encourage cooperation between countries regarding health-related subjects and lead efforts to ensure universal access to health services.

Health expenditures are necessary for increasing societal welfare and ensuring its sustainability. In this context, health expenditures for preventive health services contribute to the expansion of such services and to raising public health awareness. These services facilitate treatment processes by diagnosing diseases early and reducing costs. Moreover, health expenditures include investing in the training and equipment of healthcare personnel and medical devices. Qualified healthcare personnel provide more effective and high-quality health services, positively affecting patients' health conditions. From another perspective, health expenditures contribute to the development of better diagnosis and treatment methods through supporting medical research and investing in advanced technologies. Thus, more successful results are obtained in combating diseases. Ensuring equal and fair access to health services for all segments of society through health expenditures, thereby reducing health inequalities, is important for improving the overall health level of societies. Lastly, another critical point is the need to protect the productive population of a society in order to support productivity and economic development sustainably through health expenditures. From this perspective, it can be said that healthy individuals will work more efficiently and contribute more to the economy.

The objective of this study is to econometrically test the relationship between both public and private health expenditures and HDI in 25 OECD countries by using panel data analysis methods. In this context, following this introduction section, a review of the relevant literature on the relationships between these variables is presented. Then, the dataset and method used in the study are introduced. Finally, the results of the empirical process are presented, and the paper is completed with the conclusion section.

2. LITERATURE REVIEW

In a study carried out by Opreana and Mihaiu (2011), the efficiency of public health expenditures and their effect on human development were investigated for 27 EU countries. The findings indicate a strong and statistically significant correlation between the efficiency of public health system and the level of human development.

In a study carried out by Razmi et al. in 2012, the data from the period 1990-2009 were used in empirically examining the causal relationship between the public health expenditures and the Human Development Index (HDI) in Iran. In light of the findings, it was stated that there was a one-way and significant causality relationship from public health expenditures to human development.

In a study carried out by Prasetyo and Zuhdi (2013), the data for the years 2006-2010 were used for 81 countries in order to conduct a data envelopment analysis to determine the efficiency levels of public expenditures on health, education, and other subsidies and transfers regarding human development. The findings revealed that only 16 of the countries included in the analysis (Armenia, Australia, Bangladesh, Chile, Georgia, Japan, Republic of Korea, Lao PDR, Madagascar, Niger, Norway, Philippines, Sierra Leone, Singapore, USA, and Zambia) had good efficiency levels during the period examined.

In a study carried out by Yalçın and Çakmak (2016), the relationship between public health expenditures and HDI in Turkey was analyzed for the period 1991-2013. Empirical findings indicate a positive and statistically significant relationship between public health expenditures and HDI. Accordingly, a 1% increase in public health expenditures increased HDI value by 0.06%.

In the study carried out by Şaşmaz et al. in 2019, the data from 34 OECD countries were used to investigate the relationship between health expenditures and development for the period 2000-2015. Given empirical analysis results, it was concluded that there is a bi-directional causality relationship between health expenditures and HDI.

Similarly, in a study carried out by Akbar et al. in 2020, the data from 33 OECD countries were used in order to investigate the relationships between health expenditures, and carbon dioxide (CO_2) emissions and HDI for the period 2006-2016. The main empirical findings of the study indicate a positive bi-directional causality between health expenditures and HDI.

In a study carried out by Maharda and Aulia in 2020, the data from Indonesia for the period 2010-2018 were used in order to investigate the relationship between HDI and public expenditures. Given the empirical results, it was concluded that there was a positive and significant relationship between HDI and public education expenditures during the period examined, but no statistically significant relationship was found between HDI and public health expenditures.

In a study carried out by Lescano et al. (2022), the data of the period 2000-2018 was used for a total of 57 developed and developing countries to analyze the relationship between HDI and public health and education expenditures. The empirical findings show that public health expenditures positively affected each component of HDI. However, considering the education expenditures, this positive effect was observed only on the educational dimension of HDI.

In a study carried out by Avcı in 2022 for Turkey, the data of the period 2000-2019 were used in investigating the relationships of HDI with income inequality and public expenditures on education and health. Given the empirical findings, a significant causality relationship was found only between public health expenditures and HDI. It was stated that a 1% increase in public health expenditures reduced HDI by 1.10% in the long term.

Considering the general review of the relevant literature, it can be seen that the majority of results point to a positive and significant relationship between health expenditures and HDI. In this context, it is hoped that the empirical findings to be obtained from this study would support these results and that, differing from the literature by estimating the econometric model with the chosen robust estimator, it would contribute to the literature.

3. ECONOMETRIC METHODOLOGY AND DATASET

In this study, an empirical test was conducted on the relationship between the Human Development Index and healthcare expenditures using a 17-year dataset from the selected 25 OECD countries for the period 2003-2019. The panel data analysis method was adopted as the methodology for this study. In economic research, panel data sets offer more advantages when compared to cross-sectional and time-series data sets. Use of both cross-sectional and time-series data in panel data analysis provides the researcher with more information, increases the degrees of freedom due to the higher number of observations, and enhances the effectiveness of economic estimations by eliminating the multicollinearity problem (Hsiao, 2003: 3).

Of the dataset established within the context of this study, the horizontal cross-sectional dimension is $N = 25$ and time dimension is $T = 17$. Therefore, the dataset consists of a total of $NxT = 425$ observations. The information regarding the variables used in this study is presented in Table 1.

Table 1. Introduction of Variables

Abbreviation	Explanation	Source
HDI	Human Development Index	www.undp.org
GHE	Share of Public Health Expenditures in GDP	https://data.oecd.org/
VHE	Household voluntary health expenditures / USD per capita (purchasing power parity)	https://data.oecd.org/

In this study, the Human Development Index (HDI) is used as the dependent variable. The share of public health expenditures (GHE) in Gross Domestic Product (GDP), and household voluntary health expenditures (VHE) are the independent variables. The variables were included in the analysis after a logarithmic conversion. The model to be applied in the study is as follows;

$$lnHDI_{it} = \beta_0 + \beta_1 lnGHE_{it} + \beta_2 lnVHE_{it} + u_{it} \quad (1)$$

In the present study, selected 25 OECD countries were involved in the analysis and these countries are presented in Table 2.

Table 2. Countries Involved in Analysis

Austria	Finland	Israel	Latvia	Portugal
Germany	France	Spain	Lithuania	Slovenia
USA	Holland	Japan	Hungary	Chile
Belgium	Switzerland	Canada	Mexico	Türkiye
Estonia	Italy	Korea	Poland	Greece

In this study, the correlation matrix was first examined to investigate the presence of multicollinearity issues. Subsequently, the F-test, LM test, and Hausman test were conducted to select the suitable model, and a decision was made on the valid model. In the chosen model, the problem of heteroscedasticity was investigated using the Wald test, and the autocorrelation issue was examined using the Durbin-Watson and Baltagi-Wu LBI tests. The model, which exhibited problems of heteroscedasticity and autocorrelation, was estimated using the robust estimator, specifically the Driscoll-Kraay regression with standard errors.

4. EMPIRICAL FINDINGS

Table 3 presents the descriptive statistics for the dependent and independent variables used in the empirical analysis. Accordingly, in the panel data set consisting of 425 observations for the period 2003-2020, it is observed that the average value of the HDI variable, indicating the Human Development Index, is -0.14 and its standard deviation is 0.06. In addition, the minimum value of this variable is -0.38, whereas the maximum value is -0.03. It was observed that the average value of the GHE variable, representing public health expenditures, is 1.73 and its standard deviation is 0.34. Moreover, the minimum value of this variable is 0.88, whereas the maximum value is 2.66. It can be seen that the average of the VHE variable, representing household voluntary health expenditures, is 4.86 and its standard deviation is 1.21. Finally, the minimum value of the relevant variable was determined to be 1.28, and the maximum value is 8.12.

Table 3. Descriptive Statistics of Variables

VARIABLE	MEAN	STANDARD ERROR	MINIMUM	MAXIMUM	NUMBER OF OBSERVATIONS
LNHDI	-0.1448631	0.065399	-0.3871342	-0.0387408	425
LNGHE	1.73007	0.3494069	0.8812851	2.666603	425
LNVHE	4.862112	1.214444	1.280934	8.1213	425

In the present study, initially, a correlation matrix was established to test for the problem of multicollinearity. The presence of a multicollinearity issue among the variables is not desired in a model. In the case of multicollinearity, the R-squared may take a very high value and, while the F-test results indicate that the model is overall significant, the coefficients of the model may be insignificant. Therefore, in the case of multicollinearity, the results will be inconsistent, and reliable outcomes will not be achieved (Babadağlı, 2019: 20).

Table 4. Correlation Matrix

	LNHDI	**LNGHE**	**LNVHE**
LNHDI	1.0000		
LNGHE	0.6461	1.0000	
LNVHE	0.5602	0.6435	1.0000

Examining the correlation matrix, it can be seen that the relationship between the variables is not very strong. There is a positive correlation between the share of public health expenditures in GDP and the Human Development Index, as well as between household voluntary health expenditures and human development, and between the share of public health expenditures in GDP and household voluntary health expenditures. However, since the correlation relationship between the variables is not higher than 0.80, it can be said that there is no multicollinearity between the variables.

Furthermore, Variance Inflation Factor (VIF) values were provided in Table 5 to test for the presence of multicollinearity. To avoid issues of multicollinearity, the centered VIF value should not exceed 5. Upon reviewing the results, with a value of 1.706867<5, it is evident that there is no problem of multicollinearity.

Table 5. Variance Inflation Factor (VIF) Values for Multicollinearity

Variable	**Uncentered VIF**	**Centered VIF**
lnGHE	43.65251	1.706867
lnVHE	29.13005	1.706867

The Breusch-Pagan (LM) test and the F test were conducted in order to determine the suitable model to be used in this study. The F test aims to determine whether the suitable model is the pooled or the fixed effects model. The Breusch-Pagan (LM) test is used to determine if the pooled model or the random effects model is suitable.

The fixed effects model is the one in which the intercept coefficients are different for each cross-section, while the slope coefficients are the same. The fixed effects model is expressed as follows (Savsar, 2012: 84):

$$y_{it} = \alpha_i + \beta' x_{it} + e_{it} \quad (2)$$

i = 1,…..,n ve t = 1,……,T

where, y_{it} refers to the dependent variable, whereas x_{it} refers to independent variables, α_i to the model constant, and β' to the number of independent variables.

Differences arising across units or over time are represented in the model as components of the error term in the random effects model. It is assumed that these differences are randomly drawn from the sample. The random effects model is expressed as follows (Yılancı, 2012: 26).

$$y_{it} = \mu + \beta' x_{it} + e_{it} \quad (3)$$

The Hausman (1978) test is used in order to test whether the suitable model is a fixed effects or random effects model. The Hausman test examines the presence of correlation between individual effects pertaining to the cross-section and the independent variables. The results of the F, LM, and Hausman tests are presented in Table 6.

Table 6. F, LM, and Hausman Test Results

F Test	**LM Test**	**Hausman Test**
F_{unit} = 26.967 (0.0000)	LM_{unit} = 1026.690 (0.0000)	
F_{period} = 6.553 (0.0000)	LM_{period}= 138.7951 (0.0000)	H = 13.882 (0.0010)
$F_{unit-period}$ = 43.390 (0.0000)	$LM_{unit-period}$= 1165.485 (0.0000)	
H_0: Pooled model is valid	H_0: Pooled model is valid	H_0: Random effects model is valid
H_1: Fixed effects model is valid	H_1: Random effects model is valid	H_1: Fixed effects model is valid

Examining the results of the F-test, the probability values are less than the critical value of 0.05 in all three cases, so H_0 is rejected. Given the results of the F-test, the suitable model is the fixed effects model. In the Breusch Pagan (LM) test results as well, the probability values are less than the critical value of 0.05, so H_0 is rejected. Given the LM test results, the suitable model is the random effects model. In this case, it was concluded that the suitable model is not the pooled OLS (Ordinary Least Squares). Based on the results of the Hausman test conducted in order to determine whether the model is fixed effects or random effects, the probability value is 0.0010 <0.05; therefore, H_0 was rejected, and it was concluded that the suitable model is the fixed effects model.

To ensure that the model to be established is effective and consistent, autocorrelation, multicollinearity, and heteroscedasticity tests should be conducted, and the estimation should proceed accordingly.

In the fixed effects model, the issue of changing variance is investigated with the modified Wald test, and the presence of autocorrelation is investigated with Baltagi, Wu LBI, and Bhargava's modified DW tests (Güriş, 2018: 90-95).

Table 7. Heteroscedasticity and Autocorrelation Test Results

Wald Test	
X^2 test statistic	23693.32
P value	0.0000
Autocorrelation test results	
Bhargava Corrected Durbin-Watson	0.18148861
Baltagi-Wu LBI	0.39065684
Bhargava- Franzini, Narendranathan, Durbin, Watson Test P value	0.0015

Examining the test results presented in Table 7, it can be observed that the probability value of the Wald test, which tests for the presence of heteroscedasticity, is less than 0.05. The null hypothesis, which suggests that the variance is constant, is rejected. Thus, it was found that there is a problem of heteroscedasticity in the model. To conclude that there is no autocorrelation problem in the model, the Durbin-Watson and Baltagi-Wu LBI test statistics, which test for the presence of autocorrelation, need to have values close to 2. Upon examining the results, it can be seen that the test statistics do not satisfy this condition. In this case, it is concluded that there is an autocorrelation problem in the model.

In case of the presence of autocorrelation and heteroscedasticity issues in the model, model estimations by using robust estimators yield more accurate results. In situations where the cross-sectional dimension is larger than the time dimension (N>T), the Driscoll-Kraay standard errors regression is more powerful (Yerdelen Tatoğlu, 2020: 48). The estimated model results, aiming to determine the relationship between health expenditures and human development for 25 selected OECD countries between the years 2003 and 2019, are presented in Table 8.

Tablo 8. Estimation with Fixed Effects Model with Driscoll-Kraay Standard-Error

lnHDI	**Coefficient**	**Standard Error**	**t-statistic**	**Probability value**
lnGHE	0.1103597	0.0136663	8.08	0.000
lnVHE	0.036275	0.0029628	12.24	0.000
c	-0.5121662	0.0292605	-17.50	0.000
R square = 0.3145		**F value =** 107.71 (0.0000)		

The model estimated according to the regression analysis results is as follows:

$$lnHDI = -0.5121662 + 0.1103597lnGHE + 0.036275lnVHE \quad (4)$$

Examining the estimation results of the fixed effects model with Driscoll-Kraay standard errors, as shown in Table 8, the effects of both variables on HDI are positive and significant, in parallel with economic theory and expectations. As public health expenditures and household voluntary health expenditures increase, the HDI rises. A one-unit increase in public health expenditures increases the HDI value by 0.11 units. A one-unit increase in household voluntary health expenditures increases the HDI value by 0.03 units. According to the analysis results, it has been concluded that health expenditures

are effective on the HDI in the selected OECD countries. The F-statistic probability value being less than 0.05 indicates that the model is statistically significant as a whole.

5. CONCLUSION

In order to support the human development and consequently the development, it is important for public health investments to be used in more effective and efficient areas. Nowadays, the studies on the efficient use of resources have been focused on and the efficiency of the government in health services has also begun to be evaluated. In this context, considering the efficiency, it might be useful for the government to fulfill its functions of planning, auditing, and regulation, rather than its traditional role in the provision and financing of health services. Another issue is the necessity of establishing a partnership between the public and private sectors. Such a partnership can combine the resources and efficiencies provided by both sectors. However, it is important for this partnership to be based on collaboration rather than competition. Collaborative work of the public and private sectors in the health industry can offer various advantages. The entrepreneurial and innovative structure of the private sector can contribute to increasing the efficiency and quality, whereas the public sector can ensure that the system operates in a balanced way in terms of fairness and accessibility through its role in auditing and regulation. This partnership holds the potential for better planning of health services, more effective use of resources, and achieving better results.

In this study, a panel data analysis was conducted in order to determine the direction of the relationship between the HDI and health expenditures in selected 25 OECD countries. The data used in the analysis cover the years between 2003 and 2019. In the present study, the F, LM, and Hausman tests were conducted first and it was decided that the suitable model is the fixed effects model. For the model's consistency, the autocorrelation, multicollinearity, and heteroscedasticity tests were conducted, and it was found that the model had autocorrelation and heteroscedasticity issues. Then, a robust estimator was used in order to make an efficient and consistent model estimation. The model was estimated by using the Driscoll-Kraay robust estimator, which can be used in the presence of autocorrelation and heteroscedasticity problems.

In this study, which examines the relationship between health expenditures and the level of human development, it was concluded that health expenditures have an effect on human development. It was determined that this relationship is positive and an increase in health expenditures increases the HDI. The empirical findings corroborate the results of the studies carried out by Razmi et al. (2012), Şaşmaz et al. (2019), Yalçın and Çakmak (2016), and Lescano et al. (2022).

Given the empirical findings of the present study and other studies in the literature, it is thought that investments in health infrastructure will lead to an improvement in the overall quality of life in countries and will have a positive effect on the HDI. All health expenditures are considered as an investment in people and are necessary for increasing and sustaining social welfare. Societies that

allocate sufficient resources to health tend to have a higher quality of life and better health conditions. However, an important point that needs to be focused on is the efficient management of health expenditures and allocation of the resources to the right areas. In this context, it is necessary to develop balanced and effective policies in order to ensure the sustainability of health systems and to provide fair health services to all segments of the societies. It can be emphasized that the traditional role of the state in health services needs to change in order to adapt to the paradigm shift in the field of health, particularly in the 21st century. It is suggested that the state should undertake the planning, auditing, and regulation functions more and focus on the effective use of resources rather than the provision and financing of health services. It is thought that strengthening the collaboration between the public and private sectors can contribute to making the health system more effective and efficient.

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Tartışma ve Yorum / *Discussion and Interpretation*	Bulguların değerlendirilmesinde ve sonuçlandırılmasında sorumluluk almak / *Taking responsibility in evaluating and finalizing the findings*	Asst. Prof. Rüya ATAKLI YAVUZ (Ph.D.) Refika Görkem YILMAZTÜRK
Literatür Taraması / *Literature Review*	Çalışma için gerekli literatürü taramak / *Review the literature required for the study*	Asst. Prof. Rüya ATAKLI YAVUZ (Ph.D.) Refika Görkem YILMAZTÜRK

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