Systematic Review (Research Article)

HEALTH SCIENCES MEDICINE

DOI: 10.32322/jhsm.1632229

J Health Sci Med. 2025;8(2):361-369

Factors affecting health expenditures: the case of MINT countries

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Cite this article as: Atalay Şimşek S, Karhan G, Şimşek H. Factors affecting health expenditures: the case of MINT countries. *J Health Sci Med.* 2025;8(2):361-369.

Received: 03.02.2025 • **Accepted**: 26.02.2025 • **Published**: 21.03.2025

ABSTRACT

Aims: Per capita income, carbon dioxide emissions and urbanization are factors that have significant effects on health expenditures, and the interaction between these variables shapes the level of health and access to services in societies. The objective of this study is to analyse the impact of economic growth, air pollution and urbanisation on health expenditures in MINT (Mexico, Indonesia, Nigeria and Turkiye) countries.

Methods: The environmental factors affecting health expenditures are investigated with DHausman and LM Bootstrap cointegration tests among panel data analysis methods. After determining that the series are cointegrated, the coefficients of the variables are investigated with the help of AMG and CCEMG coefficient tests.

Results: According to the cointegration test results, it is proved that there is a long-run relationship between the series. With reference to results of AMG and CCEMG coefficient estimation, the coefficient of carbon dioxide emission variable is statistically significant at 1% significance level, while the effects of other variables on health expenditures are not statistically significant. However, a 1% increase in carbon dioxide emissions in the MINT country group increases health expenditures (per capita) by 0.20-0.25%.

Conclusion: The MINT country groupshould implement policies to prevent air pollution in order to reduce the increasing effect of CO_2 emissions on health expenditures. JEL classification: E10, H10, O44.

Keywords: Economic growth, air pollution, health expenditures

INTRODUCTION

Economic growth, a primary macroeconomic objective of developing countries, has been demonstrated to result in an enhancement in overall welfare. However, this phenomenon is concomitant with the emergence of environmental concerns, including air, water, and soil pollution. Especially in developing countries, when economic development efforts proceed by compromising environmental regulations, the negative impacts on the environment become more pronounced. These impacts increase the demand for health services and lead to an increase in health expenditures (HE). According to OECD,[1] countries with high per capita income levels also have high health expenditures. This relationship between HE and income level was first addressed with the Grosman hypothesis. Grosman's[1] seminal work established the foundation for the study of traditional demand theory. This theory posits that each consumer possesses a utility function, defined by the goods and services procured within the market. The theory further stipulates that expenditures on these market goods and services must remain constrained by the individual's income. But the demand for health services is not like this. This is because when consumers demand health services, they do not actually aim to obtain the service itself, but to achieve a "better state of health". From this perspective, health is considered as an investment good rather than a consumption good. Individuals aim for a longer and more productive life with their investments in health, which shows that health services are economic capital. For this reason, Grosman[2] stated that health is a capital stock, that people are born with this capital stock, but that this stock loses value over time, and that the capital stock can be increased through investments in health.

Developing economies trying to achieve economic growth with disadvantages such as insufficient capital stock, unplanned industrialization and unplanned urbanization pave the way for increasing environmental problems. This situation creates negative impacts on public health by increasing environmental degradation such as air, water and soil pollution. Environmental problems trigger respiratory diseases, infectious diseases and other health problems, increasing the demand for health services and leading to increased health expenditures. In particular, environmental risks arising from unplanned urbanization, inadequate infrastructure and uncontrolled industrialization threaten public health and create additional cost pressure on health systems. Developing countries increase their health expenditures by having to make more health investments to solve these problems. Thus, the process of economic growth brings with it both environmental degradation and increased health expenditures.

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Air pollution, the most important type of environmental problem, has become the most binding type of pollution that requires mutual responsibility between countries.[3] Air pollution, which poses the greatest danger compared to other types of pollution, has reached dangerous dimensions with the increase in human activities today, although it emerged with natural events such as forest fires and volcanic eruptions before industrialization. Air pollution, which varies depending on industrialization, urbanization and population growth, is more common in regions with dense populations and high levels of industrialization and urbanization. On the other hand, air pollution is observed to be less in areas with low population and limited industrialization and urbanization.[4] In this study, the impact of environmental pollution on health expenditures in Mexico, Indonesia, Nigeria and Turkiye (MINT) countries representing developing countries is tried to be explained by using urbanization, CO_2 emissions and per capita income variables. While urbanization and carbon dioxide emission variables are included in the study to explain environmental pollution, per capita income variable is used to represent economic growth.

The MINT countries have become prominent among emerging economies after 2000, thanks to their rapid economic growth, young populations and vast natural resources. In addition to economic growth and socioeconomic development, these countries have also experienced environmental, social and political challenges. Table 1 presents the main macroeconomic data for MINT.

Table 1. Key economic indicators in MINT economies (2023)[5]

Countries	World nominal GDP ranking	GDP ($ billion)	GDP per capita ($)	Population (thousand)
Mexico	13	1.788	13.923	129.739
Indonesia	16	1.371	4.940	281.190
Nigeria	56	362	1.621	227.882
Turkiye	17	1.108	12.985	85.372

MINT: Mexico, Indonesia, Nigeria and Turkiye, GDP: Gross domestic product

When Table 1 is analyzed, it is seen that the other three economies in the MINT country group, except Nigeria, are among the top 20 countries in the world nominal income ranking. However, when we look at the per capita income values as a welfare indicator, Mexico and Turkiye are in the upper middle income countries category, while Nigeria and Indonesia are in the lower middle income countries group with their per capita income. In this respect, it is not possible to say that the MINT country group exhibits a completely homogeneous structure. These differences, which can be observed in terms of major macroeconomic indicators, are also similar in terms of health expenditures. The development of health expenditures in MINT countries between 2000 and 2020 is shown in Table 2.

When Table 2 is analyzed, the country with the highest increase in health expenditures (per capita) between 2000 and 2020 is Indonesia. Indonesia was followed by Nigeria, Mexico and Turkiye, respectively.

The objective of this study is to analyse the environmental factors that exert an influence on health expenditures in the group of MINT countries for the period 2000-2020. The variables used in the study are per capita income, urbanization, HE and CO_2 emissions. It is aimed to contribute to the literature by analyzing the long-run relationship between variables with the help of up-to-date econometric tests. Unlike other studies, the effects of environmental factors such as air pollution on HE are analyzed in detail. In line with the findings, the study aims to make a practical contribution by making concrete suggestions for the development of health and environmental policies specific to MINT countries.

Table 2. Health expenditures in MINT countries (per capita, USD)[5]

Years	Mexico	Indonesia	Nigeria	Turkiye
2000	273,1238	63,67851	49,85982	167,4208
2001	304,6524	67,12623	54,40167	146,541
2002	327,6472	71,3113	51,94444	141,0708
2003	393,2214	82,32534	118,7912	138,4138
2004	409,2666	83,14131	104,9848	150,7891
2005	428,9849	118,3174	110,8055	187,2508
2006	449,4225	126,5394	117,1218	217,6965
2007	466,8952	136,8011	116,7614	241,9372
2008	464,7726	135,3181	123,4492	227,6472
2009	481,6357	141,3308	134,8287	165,0358
2010	441,709	177,5219	124,2778	191,472
2011	436,1232	203,8243	126,1334	190,3858
2012	462,1742	204,3824	124,5118	190,6942
2013	472,9	202,1473	128,713	210,5444
2014	486,98	195,6156	134,9253	230,7062
2015	507,743	179,0354	140,9066	228,5881
2016	530,6382	170,8631	144,2839	241,2877
2017	540,7903	167,8927	150,0332	256,9776
2018	554,5211	170,4108	123,6057	259,3069
2019	560,8407	181,3332	114,55	261,2099
2020	561,7481	184,3907	130,8993	266,7091

MINT: Mexico, Indonesia, Nigeria and Turkiye

LITERATURE REVIEW

In the studies conducted in the literature, authors have obtained different results depending on the periods considered, the diversity of country groups and the variables used. When the studies in the literature are examined, variables such as economic growth, health expenditures, foreign trade deficit, population, foreign direct investments, research and development expenditures, renewable energy consumption, Human Development Index, carbon dioxide, particulate matter, non-renewable energy consumption, exports, urbanization, CO_2 emission, sulfur dioxide are some of the variables used for panel data analysis. Jaunky,[6] Arouri et al.[7] and Apergis et al.[8] concluded that the effect of the GDP variable on the CO_2 emission variable representing environmental pollution is positively related in the long run, that is, an increase in GDP increases CO_2. Ozcan,[9] on the other hand, found that the effect of GDP on environmental pollution is negative in the long run. When the results in the literature are evaluated in terms of health expenditures, among the studies that consider CO_2 emission as the dependent variable representing environmental pollution in the long run, Apergis et al. found that the effect of health expenditures on CO_2 emission is negative. Nasreen,[10] Haseeb et al.[11] and Yahaya et al.[12] found that the effect of CO_2 emissions on HE is positive in the long run. Among the studies that investigated the relationship between GDP and HE in the long run, Nasreen, Haseeb et al. and Yahaya et al. proved that there is a positive relationship between the variables.

In the literature, Doğan and Aslan[13] and Wang et al.[14] find bidirectional causality between CO_2 emissions and GDP. Ozcan[9] argues that there is no causality between CO_2 emissions and GDP. In addition, Hossain[15] Jaunky,[6] Arouri et al.,[7] Anastacio[16] Gövdeli[17] Bekun et al.[18] found that there is a unidirectional causality from GDP to CO_2 emission and Apergis et al.[8] found that there is a unidirectional causality from CO_2 emission to GDP.

According to causality analyses between HE and CO_2 emissions, Zaidi and Saidi[19] Wang et al.,[14] Akbar et al.[20] found that there is bidirectional causality. Gövdeli,[17] Haseeb et al.,[11] Keyifli and Recepoğlu,[21] Mujtaba and Shahzad[22] Nasreen[10] found a unidirectional causality from CO_2 emissions to HE.

When the causality analysis results between HE and GDP are evaluated, Elmi and Sadeghi[23] Gövdeli[17] and Nasreen[10] found bidirectional causality between HE and GDP, while Keyifli and Recepoğlu[21] could not find any causality relationship between these two variables. Zaidi and Saidi[19] and Haseeb et al.[11] proved unilateral causality from the GDP variable to the health expenditure variable. In addition, Şen et al.[24] proved the unilateral causality from health expenditure variable to GDP variable in his study. A summary of the literature is shown in Table 3.

Table 3. Literature summary

Author(s)	Region	Period	Variables	Method	Conclusion
Hossain[15]	NIC countries	1971-2007	CO_2, GDP, ET, DTA, URBAN	Granger causality	GDP→CO_2, DTA→CO_2, GDP→ET, URBAN→GDP, DTA→GDP, DTA→CITY
Jaunky[6]	36 countries	1980-2005	CO_2, GDP	GMM, VECM	In the short and long run, CO_2; GDP (+). According to the causality result; GDP→CO_2
Arouri et al.[7]	MENA countries	1981-2005	CO_2, GDP, ET	Panel cointegration test, granger causality	CO_2; ET (+) in the long run GDP (+) According to the causality result; GDP→CO_2
Elmi and Sadeghi[23]	Developing countries	1990-2009	HE, GDP	Granger causality	HE↔GDP
Omri[25]	MENA countries	1990-2011	CO_2, GDP, ET	Granger causality	ET↔GDP, ET→CO_2
Ozcan[9]	Middle east countries	1990-2008	CO_2, GDP, ET	FMOLS, granger causality	In the long run CO_2; GDP (-), ET (+) According to the causality result; ET≠CO_2, GDP≠CO_2
Şen et al.[24]	8 developed countries	1995-2012	HE, GDP, EH	Granger causality	For Brazil and Mexico, HE→GDP, for other countries except Indonesia, EH→GDP, HE→GDP
Li and Lin[26]	73 countries	1971-2010	CO_2, GDP, ET, URBAN, SAN	Panel threshold analysis	Low income group; URBAN; CO_2 (+), ET (-), Medium low and high income group; SAN; CO_2 (+), ET (-), Middle high income group; SAN; CO_2≠ET≠.
Yahaya et al.[12]	125 developing countries	1995-2012	HE, GDP, NO_2, SO_2, CO_2, CO	OLS, DOLS	In the long run HE; GDP(+), NO_2 (+), SO_2 (+), CO_2 (+), CO (+)
Anastacio[16]	3 North American countries	1980-2018	CO_2, GDP, ET, ELT	Granger causality	GDP→CO_2, ET→ CO_2, ELT→CO_2
Dogan and Aslan[13]	EU member and candidate countries	1995-2011	CO_2, GDP, ET, T	Panel causality	T→ CO_2, CO_2↔GDP, CO_2↔T
Yazdi and Khanalizadeh[27]	MENA countries	1995-2014	GDP, HE, CO_2, PM10	ARDL	In the long term, HE; GDP (+), CO_2 (+), PM10(+)
Apergis et al.[8]	42 sub-Saharan African countries	1995-2011	CO_2, GDP, YET, HE	FMOLS, DOLS, granger causality	In the long run CO_2; GDP (+) YET (-), HE (-) According to the causality result; YET↔CO_2, CO_2→GDP, HE ≠CO_2
Zaidi and Saidi[19]	Sub-Saharan African countries	1990-2015	HE, CO_2, GDP, NO_2	ARDL, PMG, VECM granger causality	In the long run HE; GDP (+), CO_2 (-), NO_2 (-), HE↔CO_2, GDP→HE, NO_2→HE
Gövdeli[17]	26 OECD countries	1992-2014	CO_2, GDP, HE	VECM granger causality	CO_2→HE, GDP→ CO_2, GDP↔HE
Haseeb et al.[11]	ASEAN countries	2009-2018	HE, CO_2, GDP, ET	ARDL, panel causality	In the long run HE; GDP (+), CO_2 (+), ET (-) According to the causality result; GDP→HE, CO_2→HE, ET→HE
Wang et al.[14]	18 OECD countries	1975-2017	HE, CO_2, GDP	ARDL, panel causality	In the short term, HE in Ireland, the Netherlands, the US, New Zealand and Norway; CO_2 (+), GDP (+) According to the causality result; for Germany and the US, GDP↔HE, Canada for Germany and for the USA, CO_2↔GDP, for New Zealand and Norway, HE↔CO_2
Keyifli and Recepoglu[21]	E7 countries	2000-2016	HE, CO_2, GDP, YET	Granger causality	For Turkiye, HE↔CO_2, for Brazil and Indonesia, HE→CO_2 for India and Russia, CO_2→HE, HE≠GDP, HE≠YET.
Bekun et al.[18]	EU countries	1990-2017	CO_2, GDP, EY	Dumitrescu hurlin causality	GDP→ CO_2, EY→ CO_2
Akbar et al.[20]	OECD	2006-2016	HE, CO_2, N, R&D, IG	Granger causality	CO_2↔HE, IG↔HE, R&D≠HE
Mujtaba and Shahzad[22]	OECD	2002-2018	CO_2, GDP, HE, YET	FMOLS, VECM	Long-term HE; YET (+), according to the causality result; CO_2→HE, YET→HE
Nasreen[10]	20 Asian countries	1995-2017	HE, CO_2, GDP	CEMG, AMG, Dumitrescu hurlin causality	In the long term, HE; GDP (+), CO_2 (+), according to the causality result; GDP↔HE, CO_2→HE

CO_2: Carbon dioxide, SO_2: Sulfur dioxide, GDP: Gross domestic product, ET: Energy consumption, ELT: Electricity consumption, HE: Health expenditures, DTA: Foreign trade deficit, T: Tourism, NF: Population, FDI: Foreign direct investments, R&D: Research and development expenditures, HDI: Human Development Index, PM: Particulate matter, E: Education expenditures, EY: Energy intensity, RE: Renewable energy consumption, SAN: Industry, EXP: Exports, URBAN: Urbanization, +: Positive relationship, -: There is a negative relationship, →: There is unidirectional causality, ↔: There is bidirectional causality, ≠: There is no causality relationship

METHODOLOGICAL FRAMEWORK

The model developed to ascertain the factors influencing health expenditures in the MINT country group between 2000 and 2020 is presented in Equation 1. In the literature, the first model in which HE (per capita) are used as the dependent variable and per capita income as the independent variable was constructed by Newhouse (1977). With the development of new test techniques in the following processes, different independent variables other than per capita income have been included in the models in the studies on the subject. The variables used in the model are consistent with the models of Samadi and Homaie Rad,[28] Zaidi and Saidi[19] and Yazdi and Khanalizadeh.[27]

$$HE_{it} = \alpha_i + \beta PGDP_{it} + \delta CO2_{it} + \partial URBAN_{it} + \varepsilon_{it} \quad \text{(Equation 1)}$$

i (country)=4 and

t (year)=1....21.

β, δ, ∂ are the parameters representing the coefficients of GDP per capita, CO_2 emissions per capita and urbanization rate, respectively. In order to avoid the problem of variance, natural logarithms of all variables were taken and included in the model. As illustrated in Table 4, the data for all the variables employed is derived from the World Bank database.

Table 4. Variable abbreviations and definitions used in the model

Variable abbreviation	Variable	Description	Source
HE	Health expenditures	Health expenditures per capita ($ in 2015 constant prices)	WB
PGDP	Per capita income	Gross domestic product per capita ($ in 2015 constant prices)	WB
CO_2	Carbon dioxide emission	Carbon dioxide emissions, in metric tons per capita	WB
URBAN	Urbanization	Urbanization rate	WB

The descriptive statistics of the variables employed in the panel data analysis are displayed in Table 5.

When the p-values of the Jarque-Bera normality test in Table 5 are analyzed, it is possible to say that the variables have a normal distribution. In this case, there is no drawback in using tests based on the assumption of normality.

Table 5. Descriptive statistics of variables

Variables	Number of observations	Min	Max	SD	Normality Jarque-Bera test
PGDP	84	7.28	9.40	0.28	3.97 (0.137)
CO_2	84	-0.71	1.64	0.78	9.52 (0.28)
URBAN	84	3.55	4.39	0.25	7.57 (0.210)
HE	84	3.90	6.33	0.60	1.03 (0.595)

Values in square brackets indicate p-values for the Jarque-Bera test, Min: Minimum, Max: Maximum, SD: Standard deviation, PGDP: Per capita income, CO_2: Carbon dioxide, URBAN: Urbanization

ECONOMETRIC ANALYSIS AND RESULTS

In this study, firstly, cross-section (CS) dependence and homogeneity tests will be applied to the data of the countries that make up the panel. Pursuant to the findings of the CS dependence and homogeneity test, the unit root test will be implemented to ascertain the stationarity of the series. When conducting panel data analysis, it is very important for the reliability of the analysis that the series do not have a unit root, that is, they are stationary. At this juncture, however, the utilization of first-generation unit root tests is recommended when CS dependence is absent. Conversely, in instances where CS dependence is present, the employment of second-generation unit root tests is advised. The selection of the most suitable unit root test is contingent upon the determination of CS dependence. In this study, CDLM1 and CDLM2 tests are applied if T>N, that is, if the time dimension is larger than the horizontal dimension. In the opposite case (N>T), the CDLM test is preferred in the analysis. In the context of MINT countries, the Breusch-Pagan[29] LM test is the preferred analytical approach due to the predominance of the time dimension over the horizontal dimension (T>N). A secondary rationale for this preference is the capacity of the test to function in data sets that exhibit unit roots in the presence of structural breaks. The hypotheses underlying the Breusch-Pagan[29] LM test are as follows:

- H0: There is no dependence between cross-sections.
- H1: There is dependence between cross-sections.

As can be seen in Table 6, when the test statistics and p-values of all variables are considered, it is seen that there is CS dependence both for individual variables and for the all panel. Therefore, it is possible to say that the variables of the

Table 6. CS dependence test results

	HE		CO_2		PGDP		URBAN	
	Ist.	Ol. value	Ist.	Ol. value	Ist.	Ol. value	Ist	Ol. value
CD_{LM1}[29]	101.05	0.000	45.837	0.000	78.296	0.000	125.86	0.000
CD_{LM2}[32]	27.440	0.000	11.500	0.000	20.870	0.000	34.603	0.000
CD_{LM}[32]	9.9928	0.000	-2.2690	0.0233	8.6536	0.000	11.219	0.000
LM_{adj}[31]	27.340	0.000	11.400	0.000	20.770	0.000	34.503	0.000

CS dependence test results for equation 1

	Statistic value	p-value
CD_{LM1}[29]	50.6323	0.000
CD_{LM2}[32]	17.8541	0.000
CD_{LM}[32]	5.71391	0.000
LM_{adj}[31]	12.8842	0.000

CS: Cross-section, HE: Health expenditures, CO_2: Carbon dioxide, CD: Candela, LM: Lumen countries in the MINT country group that make up the panel are mutually influenced by each other.

On the other hand, testing the similarity of the slope coefficients of the variables together with the CS dependence test is important for the efficiency of the study and the significance of the estimation results. The homogeneity test by Hsiao[29] is used to check if the slope coefficients of the countries are the same. This homogeneity test assumes three different hypotheses. If H0 is rejected, H1, H2 (alternative hypothesis of heterogeneity) and H3 (alternative hypothesis of partial heterogeneity) are concluded.

According to the homogeneity test results shown in **Table 7**, the hypothesis H0, which accepts homogeneity at 1% significance level, is rejected for all three hypotheses H1, H2 and H3. Accordingly, it is accepted that the coefficients are heterogeneous for hypotheses H1 and H2 and partially heterogeneous for hypothesis H3. Consequently, the decision was taken to utilise the CADF test, a second-generation unit root test that incorporates both cointegration and heterogeneity.

Table 7. Homogeneity test results

Hypothesis	F-statistic	p-value
H1	17.35270	0.0000
H2	15.76751	0.0000
H3	8.109944	0.0000

The presence of a genuine relationship between variables is indicated when the variables do not possess unit roots, that is, when stationarity is a subject of inquiry. Consequently, tests conducted without stationarity analysis can yield erroneous results. In the model delineated for MINT countries, the CADF unit root test developed by Pesaran[32] is employed. This test is a second-generation unit root test that incorporates heterogeneity and CS dependence. The CADF test operates under the assumption that the series possess a unit root, while the alternative hypothesis posits that the series are stationary. The determination of the appropriate lag length is achieved through the employment of the t statistic, with a maximum lag length of 3 established for the dependent variable and 2 for the independent variables, as per the Akaike information criterion (AIC).

According to the unit root test results shown in **Table 8**, when the CIPS test statistics, which test the entire panel, are compared with Pesaran[32] table values, it is understood that the series of all variables are non-stationary at level values. Conversely, it has been demonstrated that all series become stationary when the initial difference is taken. Following the testing of the stationarity of the series, it was determined that the Durbin-Hausman (D-H) test and the LM Bootstrap tests would be utilised. These tests permit cointegration at varying levels of stationarity, on the condition that the dependent variable is stationary at first difference, in order to investigate the long-run relationship between the variables.

Table 8. CADF unit root test results

Countries	Variables (level)	Lag	CADF t-ist	Variables (1st difference)	Lag	CADF t-ist.
Mexico	PGDP	2	-1.818	ΔPGDP	1	-1.495
Indonesia		1	-2.797		1	-3.159
Nigeria		2	-0.348		1	-3.128
Turkiye		1	-2.483		1	-2.821
CIPS t-ist.			-1.861			-2.651***
Mexico	CO_2	1	0.762	ΔCO_2	1	-1.085
Indonesia		1	-0.594		1	-1.831
Nigeria		1	-1.378		1	-2.455
Turkiye		1	-1.430		1	-3.114
CIPS t-ist.			-0.660			-2.221*
Mexico	URBAN	1	0.627	ΔURBAN	1	0.788
Indonesia		2	-1.114		1	-5.246
Nigeria		1	-1.092		1	-3.222
Turkiye		2	0.265		2	-5.270
CIPS t-ist.			-0.328			-3.238***
Mexico	HE	1	-1.573	ΔHE	1	-2.604
Indonesia		1	-2.626		1	-2.561
Nigeria		2	-3.205		1	-4.385
Turkiye		1	-1.719		1	-2.731
CIPS t-ist.			-2.201			-3.070***

***, **, * denote significance at 1%, 5% and 10% levels, respectively. Lag refers to lag length. CADF test is conducted for the model with constant. CADF critical values are -4.11%, -3.36%, -2.97% at 1%, 5% and 10% levels, respectively. CIPS critical values are -2.57, -2.33, -2.21. Critical values are taken from Pesaran.[32] CADF: Cross-sectionally augmented dickey-fuller, PGDP: Per capita income, CIPS: Chartered Institute of Purchasing and Supply, CO_2: Carbon dioxide, URBAN: Urbanization, HE: Health expenditures

The D-H test has been shown to produce reliable results when the independent variables are I (0), that is to say, stationary at level, and/or I (1), stationary at first difference, on the condition that the dependent variable is stationary at first difference I (1).[31] The hypotheses of the Durbin Hausman test are as follows.

- H0: There is no cointegration relationship between the series.
- H1: There is a cointegration relationship between the series.

This test developed by Westerlund[31] produces two different test statistics, panel and group. The D-H panel test statistics calculated when the autoregressive parameters are homogeneous is as follows.

$$DH_p = \hat{S}_n(\tilde{\phi} - \hat{\phi})^2 \sum_{i=1}^{n} \sum_{t=2}^{T} \hat{e}_{it-1}^2$$ (Equation 2)

If the panel test statistic is significant, the existence of a cointegration relationship for the entire panel is accepted. The other test statistic, the D-H group test statistic, is calculated when the autoregressive parameters, i.e. slope parameters, are heterogeneous. The D-H group test statistic is calculated as follows.

$$DH_g = \sum_{i=1}^{n} \hat{S}_i(\tilde{\phi}_i - \hat{\phi}_i)^2 \sum_{t=2}^{T} \hat{e}_{it-1}^2$$ (Equation 3)

The D-H test is used to test the cointegration relationship between the variables in Equation 1. The results are in Table 9.

Table 9. DH co-integration test results

Model	Calculation method	Test statistic	p-value
Equation 1	DH group statistic	-1.575	0.058
	DH panel statistics	-1.284	0.100

DH: Durbin-Hausman

Given the heterogeneity of the slope coefficients of the variables in Equation 1, the D-H test statistic (Table 9) indicates a cointegration relationship between the variables at the 10% significance level.

Another cointegration test used in the study is the panel LM boostrap test developed by Westerlund and Edgerton.[34] This test, like the D-H test, allows for heterogeneity and CS dependence. On the other hand, the LM Bootstrap panel cointegration test of Westerlund and Edgerton. allows for autocorrelation and heteroscedasticity in the cointegration equation, thus providing efficient results.[35] It is also observed that this test gives good results in small samples.[36] This test is calculated as follows;

$$LM_n^+ = \frac{1}{nT^2} \sum_{i=1}^{n} \sum_{t=1}^{T} \partial_i^{-2} \ell_{it}^2$$ (Equation 4)

ℓ_{it} represents the partial sum process and ∂_i^{-2} represents the long-run variance. The null hypothesis of the test tests the existence of cointegration in all horizontal sections, while the alternative hypothesis tests the absence of cointegration for some horizontal sections.[33] The results of the test are presented in Table 10.

Table 10. LM boostrap panel cointegration test results

	Test statistic	Boostrap p-value
LM_n^+	7.352	0.328

LM: Lagrange multiplier

Table 10 shows that the null hypothesis testing the existence of cointegration relationship is accepted (p>0.005). Since there is cross-sectional dependence in the countries forming the panel, only boostrap values are reported.

It is evident that both the D-H test and the LM Boostrap test offer robust evidence for the existence of a cointegration relationship between the variables incorporated within the model. However, it should be noted that these tests do not provide insight into the coefficients of the variables. Therefore, in the following part of the study, the long-run coefficients of the variables are investigated with the AMG method and CCEMG coefficient estimation developed by Pesaran[33] which are used under CS dependence and also allow the slope coefficients to be heterogeneous. With AMG and CCEMG methods, both coefficient results for the entire panel and separate results for each country in the panel can be obtained.

The Panel AMG method is an estimation method that can obtain effective results even in unbalanced panels by taking into account common factors and dynamic effects in the series. On the other hand, this method can be easily applied when there is endogeneity problem in the error term. The calculation of the coefficients according to this method is as follows.

i=1,.......,n and t=1,......,T

$$y_{it} = \beta_i' x_{it} + u_{it}$$

$$u_{it} = \alpha_i + \lambda_i' f_t + \varepsilon_{it}$$

$$x_{mit} = \pi_{mi} + \delta_{mi}' g_{mt} + \rho_{1mi} f_{1mt} + \ldots + \rho_{nmi} f_{nmt} + v_{mit}$$

Assuming that $m=1,\ldots,k;$ and $f_{.mt} \subset f_t$

$$f_t = o' f_{t-1} + \varepsilon_t \text{ and } g_t = k' g_{t-1} + \varepsilon_t$$ (Equation 5)

In the above equations, x_{it} is the vector of observed variables, α_i is the panel's truncation parameter, f_t is the set of common factors, λ_i' is the set of country-specific factors, and g_t is the country-specific factor loadings.

The CCEMG method used for estimating the long-run coefficients in this study is based on the least squares method. In this method, the multifactor error model for coefficient estimates is calculated as follows.

$$X_{it} = a_{1i} + \varphi_i f_t + \gamma_i g_t + \lambda_{it}$$

$$\mu_{it} = a_{2i} + \eta_i f_t + \varepsilon_{it}$$ (Equation 6)

Here f_t and g_t are unobservable time-varying common factors with country-specific factor loadings φ_i and γ_i . λ_{it} and ε_{it} are country-specific individual errors that are assumed to be independent of the common factors and distributed across panel units.

Table 11 presents the results of the AMG method developed by Eberhard[37] and the CCEMG coefficient test developed by Pesaran.[33]

According to the results of the AMG coefficient estimation for the entire panel, the coefficient of the CO_2 emission variable is statistically significant at the 1% level of significance, while the coefficient of the per capita income variable is statistically significant at the 10% level. The coefficient of the urbanization variable, however, is not statistically significant. From this perspective, a 1% increase in CO_2 emission in the MINT country group increases health expenditures (per capita) by 0.25%. Conversely, a 1% rise in per capita income in these countries results in a 0.07% reduction in HE.

One of the most important features of the AMG method developed by Eberthard[37] is that it can produce coefficient estimates both for the entire panel and for each country in the panel separately. When the country-by-country results are analyzed; a 1% increase in CO_2 emissions in Mexico

Table 11. Estimation of cointegration coefficients (AMG)

Results for the full panel							
Variable	**Coeff.**		**z-stat**			**p-value**	
CO_2	0.257510		4.05			0.000	
URBAN	1.055681		1.44			0.150	
PGDP	-0.074473		-1.77			0.078	
Const.	-1.725881		-0,66			0.510	
Ol. >Chi-squared test=0.000			**Wald Chi-squared test= 48.08**				
Results by country							
Mexico					**Indonesia**		
Variable	**Coeff.**	**z-stat**	**p-value**	**Variable**	**Coeff.**	**z-stat**	**p-value**
CO_2	0.125737	2.38	0.017	CO_2	0.1718	1.30	0.192
URBAN	2.323991	5.20	0.000	URBAN	1.2887	0.98	0.327
PGDP	-0.05257	-0.59	0.558	PGDP	-.14243	-0.36	0.719
Const.	-7.00253	-4.68	0.000	Const.	-1.8252	-0.87	0.385
Nigeria					**Turkiye**		
Variable	**Coeff.**	**z-stat**	**p-value**	**Variable**	**Coeff.**	**z-stat**	**p-value**
CO_2	0.373834	4.05	0.000	CO_2	0.3586	3.31	0.001
URBAN	-1.05088	-6.67	0.000	URBAN	1.6608	3.05	0.002
PGDP	0.035737	0.29	0.773	PGDP	-0.1386	-1.19	0.234
Const.	5.435483	5.87	0.000	Const.	3.5112	-2.20	0.028
Results for the full panel (CCEMG)							
Variable	**Coeff.**		**z-stat**			**p-value**	
CO_2	0.209626		7.58			0.000	
URBAN	-12.94971		-0.57			0.568	
PGDP	0.0239303		0.36			0.719	
Const.	41.85906		1.40			0.160	
Results by country							
Mexico					**Indonesia**		
Variable	**Coeff.**	**z-stat**	**p-value**	**Variable**	**Coeff.**	**z-stat**	**p-value**
CO_2	0.135913	0.95	0.343	CO_2	0.26997	1.09	0.277
URBAN	5.64293	0.52	0.600	URBAN	3.74380	0.58	0.560
PGDP	-0.171784	-0.82	0.413	PGDP	0.11160	0.15	0.877
Const.	-16.47543	-0.52	0.603	Const.	2.36804	0.27	0.790
Nigeria					**Turkiye**		
Variable	**Coeff.**	**z-stat**	**p-value**	**Variable**	**Coeff.**	**z-stat**	**p-value**
CO_2	0.219452	1.37	0.172	CO_2	0.21316	2.52	0.012
URBAN	18.96803	0.78	0.433	URBAN	1.51362	-3.11	0.002
PGDP	0.052206	0.29	0.774	PGDP	0.10369	0.72	0.470
Const.	69.37945	0.88	0.378	Const.	112.164	3.03	0.002

AMG: Augmented mean group, CO2: Carbon dioxide, URBAN: Urbanization, PGDP: Per capita income, CCEMG: Common correlated effects mean group increases HE (per capita) by 0.12%, while a 1% increase in the urbanization rate increases HE (per capita) by 2.32% in Mexico. The effect of per capita income on HE is statistically insignificant. According to the results of the AMG coefficient test calculated with the data of Indonesia for the years 2000-2020, the coefficients of the variables in Equation 1 are statistically insignificant.

When **Table 11** is analyzed in terms of probablity values, a 1% increase in CO_2 emissions in Nigeria increases HE (per capita) by 0.37%. On the other hand, a 1% increase in urbanization rate decreases HE (per capita) by 1.05%. The coefficient of the income per capita variable is statistically insignificant. Finally, in case of a 1% increase in CO_2 emissions in Turkiye, HE per capita will increase by 0.35%. A 1% increase in the urbanization rate increases HE per capita by 1.66%.

The CCEMG coefficient estimation results for the all panel indicate that the coefficient of the emission variable is statistically significant at the 1% level of significance. Conversely, the coefficients of the other variables are statistically insignificant. Consequently, a 1% increase in CO_2 emissions in the MINT country group is associated with a 0.20% increase in HE (per capita).

When the results by country are analyzed; according to the results of the CCEMG coefficient test calculated with the data for the years 2000-2020, the effect of all variables on HE is statistically insignificant for Mexico, Indonesia and Nigeria.

In Turkiye, a 1% increase in CO_2 emissions has been shown to result in a 0.21% rise in HE (per capita). Similarly, a 1% rise in the urbanization rate has been demonstrated to lead to a 1.51% increase in HE (per capita).

Given the heterogeneous slope coefficients of the variables, an analysis of the results considering the D-H group test statistic (-1.575*) in **Table 9** reveals a cointegration relationship between the variables at the 10% significance level. The LM bootstrap panel cointegration test, as presented in **Table 10**, indicates a 5% significance level (p>0.005) for the existence of a cointegration relationship between the variables. While the D-H and LM bootstrap tests offer a robust test for the presence of cointegration among the variables within the model, they do not provide insight into the coefficients of these variables. Consequently, the long-run coefficients are investigated with the AMG and CCEMG methods, which are used under CS dependence and also allow the slope coefficients to be heterogeneous. According to the AMG and CCEMG coefficient estimation results for the entire panel, the coefficient of the carbon dioxide emission variable is significant at the 1%. This outcome aligns with the findings reported by Yahaya et al.,[11] Haseeb et al.,[10] and Nasreen.[9]

CONCLUSION

HE are a critical indicator, providing valuable insights into a society's health status and quality of life. This study investigates the impact of urbanization rate, income (per capita), and CO_2 emission variables on HE (per capita) within the MINT country group. To this end, Durbin Hausman and LM Bootstrap cointegration tests are employed. Initially, the study undertakes a thorough investigation into CS dependence and homogeneity of slope coefficients through the implementation of appropriate tests. The analysis revealed that both CS dependence and slope coefficients exhibited heterogeneity within the MINT country group. Consequently, the decision was made to employ the CADF test, a second-generation unit root test that incorporates both CS dependence and heterogeneity. The determination of the appropriate lag length was conducted by examining the t statistics, and the maximum lag length was established as 3 for the dependent variable and 2 for the independent variables according to the AIC. The outcomes of the unit root test revealed that the series of all variables are non-stationary at the level value, but become stationary when the first difference is taken. Subsequent to the stationarity assessment of the series, the D-H test was employed to ascertain the presence of cointegration across disparate stationarity levels, contingent upon the stationarity of the dependent variable at the first difference. This approach was undertaken to investigate the long-run relationship between the variables. Thereafter, the LM Bootstrap panel cointegration test was implemented, a method that accounts for both CS dependence and heterogeneity. The coefficient of the per capita income variable is statistically significant at the 10% level of significance, as determined by the AMG coefficient test. However, the CCEMG coefficient test result indicates that the coefficient is insignificant. The coefficient of urbanization variable does not attain statistical significance, according to both tests. The MINT country group, as analyzed in the study, should implement policies to prevent air pollution in order to reduce the increasing effect of CO_2 emissions on HE. Carbon tax systems should be implemented to reduce fossil fuel use, as rapid industrialization in developing countries increases air pollution by increasing energy consumption. Tax revenues from carbon tax systems can also be used for the development of clean energy technologies. Furthermore, the transition to clean energy technologies in industrial production can be facilitated by offering tax incentives to private companies investing in renewable energy sources. These measures, when implemented, should naturally absorb CO_2 emissions into the atmosphere through afforestation projects. Countries within the MINT group that are deficient in developing clean energy technologies can collaborate with international organizations to facilitate the transfer of clean technologies. Additionally, the development of public health programs to prevent health problems related to air pollution is crucial. Screening and preventive health services should be expanded to combat lung diseases, respiratory infections, and chronic diseases. Increasing green areas in cities and developing clean transportation systems are critical for improving air quality. Electric public transportation systems should be expanded, and urban policies that reduce carbon emissions should be established.

ETHICAL DECLARATIONS

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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