Journal of Economics, Finance and Management (JEFM)
ISSN: 2958-7360
Vol. 3, No. 3, Mai 2024

The long and short-term effects of environmental quality on healthcare expenditure: An empirical analysis of MENA countries

MOUSSANE Aboutayeb (PhD student in economics)
Cadi Ayyad University/FSJES, Marrakech, Morocco

TARBALOUTI Essaid (teacher-researcher)
Cadi Ayyad University/FSJES, Marrakech, Morocco

OUALI Abderrazak (teacher-researcher)
Cadi Ayyad University/FSJES, Marrakech, Morocco

Abstract: This study examined air pollution and its implications for human health through a cointegrated panel analysis of data from MENA countries over the period 2000-2020. The central objective was to explore the correlation between air quality, focusing on two of its major components - CO_2 emissions and ambient air pollution - and health expenditure and the economy. The findings clearly establish that CO_2 and $PM_{2.5}$ are significant risk factors leading to a sustained increase in per capita healthcare expenditure in the region. It is therefore recommended that these countries pay particular attention to shifting subsidies from fossil fuels to renewable energies to promote a healthier environment. In addition, the introduction of costs linked to the consumption of fossil fuels, particularly through a carbon tax, specifically in electricity production, is seen as crucial in encouraging the private sector to invest in green energy projects.

Keywords : Air quality, Health expenditure, MENA countries, Panel cointegration.
Digital Object Identifier (DOI): https://doi.org/10.5281/zenodo.11197833

1. Introduction

Since air is a collective good, its efficient use requires a collective action (Ogden, 1966). However, where externalities are present, resources are unlikely to be allocated optimally. An ideal allocation of air resources would involve preventing pollutants from reaching levels in the atmosphere where the damage would exceed the cost of preventing pollution. Pollutants should be allowed to be emitted into the atmosphere when the cost of prevention exceeds the cost of external damage, without considering non-measurable economic costs.

The impact of air pollution on human health manifests itself through a series of complex mechanisms. These include respiratory disorders, aggravation of pre-existing respiratory and cardiovascular diseases, reduced immune defense systems, lung damage, carcinogenesis, and premature death. These effects translate into direct costs, such as hospital admissions, lost working days, school absences and increased medication consumption, resulting in additional expenditure for healthcare facilities (Hendryx et al., 2019).

As for most pollutants currently present in the atmosphere, they are generated by the imperfect combustion of fossil fuels, or the evaporation of liquids and gases used in modern industrial production. But air pollution imposes an external cost on the community, not considered in direct economic transactions and therefore not reflected in the prices of activities responsible for external damage. Economic considerations are needed to determine which sources of pollution need to be controlled, and to what extent does air pollution lead to additional health costs?

Most countries in the world are developing policies aimed at improving society's quality of life (Meira et al., 2020). These efforts are reflected in growing industrialization and urbanization, which are leading to increased energy consumption and waste production, contributing to serious environmental problems, including deteriorating air quality. In developing countries, this situation is often exacerbated by fast, unplanned growth in industrial activities, devoid of strict environmental rules and regulations (Kumar et al., 2023). The sources of air pollutants in the MENA region do not differ fundamentally from those in developed countries.

The main distinction lies in the standards of control, which are determined by viable and enforced environmental policies, laws, and actions. Strict environmental regulations in developed countries have turned developing countries into pollution havens for pollution-intensive industries. This reality places an additional burden on the health systems of MENA countries, and the economic repercussions can be substantial.

The countries of the Middle East and North Africa (MENA) region are among the world's leading emitters of air pollutants. In 2013, the MENA region recorded around 125,000 premature deaths due to air pollution, representing 7% of total premature deaths worldwide. These deaths also resulted in a loss of over $9 billion in annual labor income, as well as welfare losses equivalent to 2.2% of regional GDP (WHO, 2018). Some countries in the region, such as Iran, Saudi Arabia, Iraq, Turkey, and Egypt, stand out as major global contributors to carbon monoxide (CO) and nitrogen oxide (NOx) emissions, as highlighted by Waked and Afif (2012).

The existing literature shows that air pollution has a direct impact on healthcare costs. Researchers such as Zuidema and Nentjes (1998) examined the relationship between suspended particulates and working days lost to illness, while Hansen and Selte (2000) studied sick leave and its impact on work output, generally concluding that there is an inverse relationship between air pollution and human health. Other research, such as that by Narayan and Narayan (2008) and Mujtaba and Ashfaq (2022), has attempted to analyze the impact of environmental quality on health expenditure. Our study differs in scope and choice of environmental indicators.

Our research diverges from that of Narayan and Narayan (2008), as well as other similar studies, both in terms of scope and choice of environmental indicators. Whereas Narayan and Narayan used panel cointegration in eight OECD countries, excluding CO2 as an indicator, our study focuses on panel cointegration in 125 developing countries, given the persistent health challenges and ever-increasing health expenditure in these regions. In addition, we have considered a wider range of atmospheric emissions in addition to the environmental quality indicators they used.

Pedroni (1999) and Westerlund (2006) stipulate as a precondition that the fundamental variables of our models must be integrated of order one. If this condition is met, we then proceed to a panel cointegration analysis. These findings have major implications for elasticities, as it is imperative to establish that the elasticity is long-run only when the relevant variables are non-stationary and jointly exhibit a long-run relationship. What's more, if a long-term relationship is established, this makes it possible to evaluate short-term responses by transforming the variables into first differences. On the other hand, if no long-term relationship is established, we can only evaluate short-term elasticities. This distinction is crucial for policy planning and other econometric models, including future projections.

Pearce and Turner (1991) have indisputably underlined the fact that expenditure on environmental pollution exerts significant pressure on public finances, leading to an increase in demand for health care. This correlation between environmental conditions, public health policies, healthcare costs and the regulation of healthcare spending has been studied by Jarrett et al. (2003).

Thus, the current researchers are distinguished by its exploration of the role of air quality in the growth of healthcare expenditure. This study stands out for its specific examination of the impact of air pollutants, such as fine particulate matter (PM2.5) and carbon dioxide, on per capita healthcare expenditure in MENA countries.

The main objective of this study is to examine the determinants of healthcare expenditure in MENA countries, implementing several methodological innovations. First, we apply a panel cointegration framework to assess the impact of air quality on health expenditure. Our model, inspired by the work of Newhouse (1977), performs an in-depth analysis of panel data on the determinants of health expenditure in MENA countries, using a panel cointegration methodology recommended by Pedroni (1999). This enables us to estimate long-term elasticities. At the same time, we also calculate short-run elasticities from the long-run estimates to highlight response variations over time.

The structure of this article is divided into five distinct sections: Introduction, review of the literature on the link between health expenditure and air pollutants, discussion of the techniques used, discussion of the results and finally a conclusion. Each section aims to shed specific light on the different stages of our analysis, and to highlight the results obtained from this rigorous study of healthcare expenditure in MENA countries.

2. Literature review

The association between air pollution and human health has been widely documented in the literature. However, it is particularly complex to exhaustively review all the existing literature. For this reason, we carried out a review of works relevant to the topic under study.

In a study conducted by Jerrett et al (2003), cross-sectional statistical data from forty-nine countries in Ontario, Canada, were used to analyze the relationship between health spending, environmental quality as represented by air pollutants, and government spending on environmental protection. This research revealed that countries emitting the most pollutants have higher per capita health expenditure, while those devoting sufficient financial resources to environmental protection have lower health expenditure. Furthermore, it has been observed that air pollution has a direct and statistically significant impact on hospitalization of children for asthma (Neidell, 2004).

A study carried out in the USA between 1960 and 1987 on per capita health expenditure and its determinants revealed that health services and Medicare prices, GDP per capita, age, number of doctors, public health expenditure ratio were co-integrated and were important determinants for endogenous factors (Murthy and Ukpolo, 1995).

The use of a logit model in Oslo has shown that the number of sick days increases with the amount of particulate matter in the air. Human health deteriorates as air becomes more contaminated, labor productivity declines due to increased sick leave and, ultimately, the number of commercial and industrial agreements decreases (Hansen and Selte, 2000).

Karatzas (2000) conducted an in-depth study in the United States, exploring the link between per capita economic health expenditure, demographic structure, and health status. His findings reveal that income distribution, per capita income and the number of nurses and doctors have a direct and significant impact on per capita health spending. On the other hand, Karatzas finds that indicators such as the number of hospital beds, the health price index, as well as the population residing in cities with more than 100,000 inhabitants, show a notable inverse relationship with per capita healthcare expenditure. These results underline the importance of different demographic and economic variables in determining health expenditure levels at individual and regional levels.

Moreover, the study by Matteo and Matteo (1998) in Canada, covering the period from 1965 to 1991, highlights the direct impact of income and age on per capita healthcare expenditure. In addition, they observe an indirect effect of federal transfers on these expenditures, underlining the importance of government policies in shaping national healthcare systems.

Gerdtham et al (1992) undertook an analysis of 19 OECD member countries, using cross-sectional data, to examine the relationship between per capita health expenditure, per capita income, the number of doctors, the female workforce, the percentage of people living in cities, and the population aged over 65 in 1987. Their results revealed that income and the proportion of people over 65 had a substantial direct effect on per capita healthcare expenditure. On the other hand, urbanization and physician density had an indirect but significant effect on such expenditure.

In parallel, Hitiris and Posnett (1992) studied twenty OECD countries over the period from 1960 to 1987, using panel data. Their results confirmed that both population over 65 and income had a positive and statistically significant effect on healthcare expenditure. These studies highlight the importance of demographic and economic variables in determining health expenditure levels within OECD member countries.

This type of study highlights the crucial importance of assessing the impact of air pollutants on healthcare spending, particularly in regions where pollution is a major issue, such as the MENA region. By analyzing such relationships, it becomes possible to better understand the underlying mechanisms and guide public health and environmental policies more effectively.

3. Methodological approach

This study undertakes for the first time a comprehensive panel data analysis of the determinants of health expenditure for a group of MENA countries. Specifically, we apply a panel cointegration test suggested by Pedroni (1999). The choice of variables for estimation in this study is in line with the model developed by Evans et al, (2000), who used a production function approach for estimating the efficiency of health spending.

The specification of our model, first used by Newhouse (1977) and applied by most of the research literature, is to model per capita health expenditure as a function of per capita income and the impact of environmental quality, including emissions of fine particulates (PM2.5) and carbon dioxide. Our innovative contribution lies in the fact that our study differs from the work of Narayan and Narayan (2008) in its scope: while they examined OECD countries, we chose to focus on MENA countries, given that this region is among the world's largest contributors to air pollution (Waked and Afif, 2012).

This passage highlights the singularity of our methodological approach and underscores the importance of our specific geographical choice, thus highlighting the major implications of air pollution in the MENA region. The study focuses on a sample of Northern MENA countries. Data availability determines the selection of countries included in the analysis. The data used cover the period from 2000 to 2020 and are drawn exclusively from the World Bank database. It is important to note that data on PM2.5 levels are not available for all MENA countries.

In the present study, we focused on air pollution, concentrating on two of its main components: CO_2 emissions (in metric tons) per capita and ambient air pollution by PM2.5, measured in annual exposure in micrograms per cubic meter. Higher per capita healthcare expenditure is correlated with a more developed healthcare infrastructure and more qualified medical human resources, suggesting that air pollution leads to higher public health expenditure. In addition, given the interconnected nature of this study, we incorporated an economic variable designed to shed light on the country's economic situation: per capita income in real terms. Table 1 sets out the data used in this research, together with the definition of each variable. The study's dependent variable is healthcare expenditure per capita in real terms in the MENA region.

Table 1 : Data definition

Variable	Description
HE	Healthcare expenditure per capita in real terms (U$ PPP)
Y	Income per capita in real terms (US$ PPP)
CO2	Carbon dioxide emissions (metric tons) per capita
PM	Average annual exposure to PM2.5 ambient air pollution (micrograms per cubic meter)

Source: The author

To ensure the coherence of our analysis, missing values for this variable have been extrapolated for years when data were not available. The formation of our model is as follows:

$$HE_{it} = \beta_0 + \beta_1 Y_{it} + \beta_2 PM2.5_{it} + \beta_3 C02_{it} + \varepsilon_{it} \quad (1)$$

Where *HE* represents health expenditure per capita in real terms (U$ PPP), Y represents income per capita in real terms (US$ PPP), PM2.5 represents fine particle emissions which determine the degradation of environmental quality, CO2 represents carbon dioxide emissions and εit represents the restricted error term under conventional statistical assumptions. For the sake of clarity and understanding, all variables have been converted to logarithms to be interpreted as elasticities.

Increasing income and worsening environmental quality via increased emissions are expected to have a positive impact on health spending (β1 increases, (β2 + β3 + β4 + β4) > 0). The higher a country's income, the more it spends on its health. Studies that have empirically supported this hypothesis include Gerdtham et al. (1992). However, deterioration in environmental quality has negative repercussions on human health, and a decline in people's health leads to an increase in healthcare spending.

Pedroni's panel cointegration test begins by estimating the panel cointegration regression as follows:

$$lnHE_{it} = \beta_0 + \beta_1 lnY_{it} + \beta_2 lnPM2.5_{it} + \beta_3 lnC02_{it} + \varepsilon_{it} \quad (2)$$

Where t = 1,..., T; i = 1,..., N. In this respect, T represents the number of observations over time and N represents the individual panel members. After estimation, we store the ὲit residuals. Next, we differentiate the original data series for the individual members and calculate the residuals for the differentiated model:

$$\Delta lnHE_{it} = \alpha_i \Delta lnY_{it} + \gamma_i \Delta lnPM2.5_{it} + \theta_i \Delta lnC02_{it} + \eta_{it} \quad (3)$$

Afterwards, we calculate the long-term variance of ῆ and, using the residual εit from the original cointegrating equation, we calculate the autoregressive model. Through the above steps, the following statistics are obtained: Panel v-statistic; Panel rho-statistic; Panel pp-statistic; Panel ADF-statistic; Group rho-statistic; Group pp-statistic; and Group ADF-statistic will be performed, and we apply the appropriate mean and variance adjustment terms as suggested in Pedroni (1999).

4. Results and discussion

The main objective of this test is to determine the order of integration of the variables, conforming to the fundamental condition of the panel cointegration test, stipulating that all variables included in our model must be non-stationary and integrated in the same order. To assess this condition in the context of panel data, we resorted to various unit root tests, including the PP-Fisher of Im et al. (2003), Breitung (2001), Levin et al. (2002), as well as the chi-square W, ADF-Fisher statistics. These tests assume a heterogeneous or individual unit root process (Maddala and Wu, 1999), while sharing similar objectives but adopting different null hypotheses.

Specifically, IPS considers the null hypothesis as a unit root based on a common unit root process, while Breitung assumes an individual unit root process. The results presented in Table 1 reveal that the various tests (IPS and Breitung) failed to reject the null hypothesis that, at the level, all variables possess a unit root. However, after differentiating the variables once at log level, they all appear stationary, and the tests then reject the null hypothesis of unit root at the 1%, 5% and 10% significance levels respectively.

These findings demonstrate that the variables studied satisfy the essential condition of the cointegration test, since they appear non-stationary after transformation, paving the way for further analysis of their long-term relationship.

Table 2: Panel unit root tests

Variables	**Method**	**Level I(0)**		**First difference I(1)**		Ordre
		constante	**Constante et trend**	**constante**	**Constante et trend**	
Ln*HE*	Levin, Lin et Chu t*	-0.622(0.2669)	-0.775(0.2191)	-4.167(0.0000)*	-3.372(0.0004)*	**I(1)**
	Breitung t-stat		0.540 (0.705)		-3.166(0.0008)*	
	IPS W-stat	0.820 (0.7940)	0.304 (0.619)	-3.927(0.0000)*	-2.7823(0.0027)*	
	ADF-Fisher Chi-square	20.569(0.5474)	18.417(0.681)	52.509(0.0003)*	42.945(0.0048)*	
	PP-Fisher Chi-square	26.676(0.2238)	13.065(0.931)	102.302(0.000)*	102.288(0.0000)*	
LnY	Levin, Lin et Chu t*	-3.946(0.000)*	0.291(0.614)	-3.368(0.0004)*	-5.261(0.0000)*	**I(1)**
	Breitung t-stat		1.828 (0.966)		-2.324(0.0101)**	
	IPS W-stat	-1.118(0.131)	2.150 (0.984)	-2.809(0.002)*	-4.129(0.0000)*	
	ADF-Fisher Chi-square	27.033(0.210)	12.382(0.949)	42.635(0.005)*	58.050(0.0000)*	
	PP-Fisher Chi-square	19.877(0.590)	7.488(0.9983)	66.995(0.000)*	93.008(0.0000)*	
LnPM2.5	Levin, Lin	1.151(0.8753)	-5.471(0.000)*	-5.242(0.000)*		**I(1)**

	et Chu t*					
	Breitung t-stat		2.472(0.9933)			
	IPS W-stat	1.604 (0.9457)	0.155(0.5619)	-1.595(0.055)***		
	ADF-Fisher Chi-square	10.714 (0.978)	20.442(0.555)	36.389(0.027)**		
	PP-Fisher Chi-square	28.229(0.168)	94.653(0.000)*	118.990(0.000)*		
LnCO2	Levin, Lin et Chu t*	-3.959(0.000)*	0.822(0.7945)	-2.277(0.0114)**	-2.589(0.0048)*	**I(1)**
	Breitung t-stat		1.900(0.9713)		-0.698(0.2425)	
	IPS W-stat	-0.177(0.429)	2.616(0.9956)	-3.136(0.0009)*	-2.877(0.0020)*	
	ADF-Fisher Chi-square	24.82(0.305)	13.383(0.921)	51.868(0.0003)*	47.330(0.0013)*	
	PP-Fisher Chi-square	40.22(0.010)**	17.810(0.717)	317.057(0.000)*	128.610(0.000)*	

Note: *, **, *** significant level at 1%, 5% and 10% respectively **Source:** The author

4.1 Panel cointegration test

Given that the regression variables satisfy the I(1) same-order integration condition (after the first difference), the next step is to carry out the panel cointegration test. The results of Pedroni's (1999) cointegration test, presented in Table 3, reveal that per capita health expenditure, per capita income, particulate emissions responsible for environmental quality degradation, and carbon dioxide emissions are cointegrated, suggesting the existence of a long-term relationship between these variables. The panel PP and ADF statistics, as well as the group PP and ADF statistics, all indicate panel cointegration at the 1% significance level.

Table 3: Panel cointegration test

	t-statistics	Probability
ADF	1.16455	0.1221

Note: *, **, *** significant level at 1%, 5% and 10% respectively **Source:** The author

Examining the results presented in Table 4, it is notable that most tests are significant at the 1% significance level, confirming the cointegration of our variables and the validity of our model.

Table 4: Pedroni panel cointegration test

Alternative hypothesis: AR common coefs. (In a same dimension)				
	Statistic	**Probability**	**W- Statistic**	**Probability**
Panel v-Statistic	0.169739	0.4326	-2.496933	0.9937
Panel rho-Statistic	1.764733	0.9612***	1.661794	0.9517
Panel PP-Statistic	1.156698	0.8763	-0.934891	0.1749

Panel ADF-Statistic	3.413036	0.9997***	1.961243	0.9751
Alternative hypothesis: AR individuel coefs. (Between-dimension)				
	Statistic	**Probability**	**W- Statistic**	**Probability**
Group rho-Statistic	2.782568	0.9973***		
Group PP-Statistic	-1.127692	0.1297		
Group ADF-Statistic	4.589111	1.0000		

Note: *, **, *** significant level at 1%, 5% and 10% respectively **Source:** The author

4.2 Discussion of panel elasticities

The PMG estimator was used to estimate the long-term and short-term elasticities for our specified model. The corresponding results are presented in Table 4. Regarding long-term elasticities, the results for panel 1 indicate that (Y), PM2.5 and CO2 are statistically significant at 1%, 5% and 10% respectively. This suggests that these variables are important determinants of healthcare expenditure in the panel of MENA countries, as specified in our model.

Theoretically, the relationship between these variables is normally expressed by the direction of their movement. In this analysis, the direction of the relationship, as indicated by the signs of the coefficients for all variables, is positive. This means that an increase in the quantity of each explanatory variable will lead to a corresponding increase in healthcare expenditure. The precise impact of each variable depends on the magnitude of its coefficient. The results show that a 1% increase in (Y), PM2.5 and CO2 will lead to a corresponding increase in per capita healthcare expenditure of 30%, 40% and 25% respectively.

Again, as Table 5 illustrates, the Panel 2 results for short-term elasticities differ considerably from the long-term results in many cases. Firstly, the sign of the coefficients is not the same for all variables. Secondly, the variables are not statistically significant. In this context, we found that the coefficients of the variables do not require in-depth interpretation, as they do not influence healthcare spending in MENA countries in the short term. This implies that the impacts of per capita income, air quality and carbon dioxide emissions on health spending increase over time since the long-term coefficients are higher than the short-term ones.

Another peculiarity of this result lies in the continued significant impact of income (Y), PM2.5 and CO2 on healthcare expenditure. Indeed, although their coefficients decrease between the long-term and short-term results, they all remain non-statistically significant at 1%, 5% and 10% respectively. Furthermore, the coefficient of the error correction term (ECTt-1) is -0.679205 and is statistically significant at 1%. The negative sign of (ECTt-1) indicates the tendency of a system to return to equilibrium after a shock.

We therefore conclude that, since the ECT is negative and significant, healthcare expenditure can return to equilibrium after any shock to the system. This conclusion is based on the fact that the error correction term always measures the speed of adjustment to the equilibrium path after a shock. Similarly, since (ECTt-1) measures a speed of adjustment, its coefficient (0.67) represents the rate at which the system returns to normal. To be more explicit, the total period is equal to 1/ECT = 1.5. This implies that after a shock, it takes around 2 years to return to equilibrium. We can therefore conclude that the speed of adjustment is reasonable, as adjustment to macroeconomic shocks is normally within this range of 2 to 5 years.

Table 5: Results of long-term and short-term PMG elasticities

Variable	Coefficient	Ecart-Type	t-Statistic	P-value
Panel 1: Long term estimation (dependent variable: Ln HE)				
Ln CO2	0.253177	8.12E-05	3116.333	0.0000 **
Ln $PM_{2.5}$	-0.409232	5.21E-05	-7857.089	0.0000 **
Ln Y	0.309137	0.000104	2966.473	0.0000 **
Panel 2: Short-term estimation (dependent variable: Ln HE)				
ECT_{t-1}	-0.679205	0.265692	-2.556364	0.0135 **
D (Ln CO2)	-0.209495	0.437422	-0.478932	0.6340
D (Ln $PM_{2.5}$)	0.280957	0.182527	1.539267	0.1298
D (Ln Y)	0.021849	0.123623	0.176735	0.8604
C	-0.020393	0.101722	-0.200481	0.8419
Akaike info criterion		-5.273457		
Schwarz criterion		-3.849567		
S.E. of regression		0.019133		

Note: *, **, *** significant level at 1%, 5% and 10% respectively **Source:** The author

Table 6 shows short-term panels for the MENA region, including Algeria, Bahrain, Egypt, Iran, Israel, Jordan, Lebanon, Morocco, Saudi Arabia, Tunisia, and the United Arab Emirates. In these countries, healthcare spending depends on rising real per capita income, which should have a positive overall impact on human health. However, this positive impact of real per capita income on healthcare spending may not be immediately apparent in all countries.

In the case of Israel, Bahrain and Tunisia, real per capita income (Y) has a negative and significant impact on health spending at the 5% and 1% levels. In contrast, the Y coefficients are significant and have a positive effect on healthcare spending for the other MENA countries. These findings also corroborate the findings of Hitiris and Nixon (2001) and Yu et al, (2016), that increases in national income have a positive long-term effect on public health spending.

This implication suggests that increases in real per capita income tend to increase public health spending. Like Hitiris and Posnett (1992), we confirm that real per capita income (Y) has a positive effect on health spending for most MENA countries. These results highlight a correlation between national income and health expenditure, demonstrating that health spending is a necessity and not a luxury good.

For the coefficient elasticity of PM2.5 emissions, a significant negative effect on healthcare expenditure is observed in most countries of the region, apart from Morocco, Lebanon, and Algeria, where a positive effect is observed. Thus, we can conclude that PM2.5 emissions contribute to the increase in healthcare expenditure.

The coefficient of CO2 emissions is significant over the study period at a level of 5%. In our sample, the increase in CO2 emissions also explains the increase in healthcare expenditure, which is in line with the findings of Toor and Butt (2005) that pollution has the potential to boost public health spending. This suggests that air pollution increases public health spending, albeit at relatively low levels.

Table 6: Short-term estimates for each MENA country

	ECT_{t-1}	D(LnCO2)	D(LnPM2.5)	D(LnY)	C
Algeria	-0.083076 *	1.730058 *	0.132221 **	0.098972 *	0.012084 *
Saudi Arabia	-0.027581	-0.035889	0.202325 **	-0.166962	0.034773 *
Bahrain	-0.019858	0.985314 *	0.726244*	-0.216564***	0.007220**
Egypt	-0.401930*	0.667755*	0.357479*	-0.304743	0.126455 *
United Arab Emirates	-1.719174*	-1.322850	1.425585*	0.417633 **	-0.928491*
Iran	-0.087599	-3.854926	-0.598320	0.021966	0.032131 *
Israel	-1.029350*	0.058763*	0.278861*	-0.000844*	-0.238336*
Jordan	-0.519824**	0.208967	0.150776	-0.457561	0.148816*
Lebanon	-2.830920*	0.179449*	1.032778***	1.031232**	0.407724*
Morocco	-0.576231**	-0.510233	-0.497686**	0.182344*	0.118779*
Tunisia	-0.175707*	-0.410855*	-0.119731**	-0.167195*	0.054518*

Note: *, **, *** significant level at 1%, 5% and 10% respectively **Source:** The author

5. Conclusion

Access to cheap fossil fuels, supported by substantial government subsidies, is driving accelerated growth in gross domestic product (GDP) per capita in MENA countries. However, air pollution resulting from fossil fuel combustion has indirect costs, including public health problems such as respiratory diseases, lung cancer, a shrinking workforce, and a long-term economic burden.

The overall results of this study reveal a significant correlation between environmental quality, characterized by air pollutants, and health expenditure in MENA countries. Both short- and long-term analyses highlight a progressive increase in the impact of air pollutants on per capita health expenditure over time. The consistency of the individual results for each MENA country reinforces the robustness of our conclusions.

Among the various pollutants studied, CO2 stands out as having the strongest explanatory power on health expenditure, surpassing PM2.5. These findings corroborate Newhouse's (1977) theory of health expenditure, since income remains a positive and significant factor throughout our analysis, thus maintaining its influence on health expenditure.

A major achievement of this study is the inclusion of environmental variables in the Newhouse model applied to the panel of MENA countries. These results highlight the negative consequences of the establishment of highly polluting companies in the region, combined with economic growth, on environmental quality and healthcare spending in MENA countries.

To conclude, these observations underline the imperative for MENA countries to give top priority to the preservation of a healthy environment in their health policies. This requires the implementation of effective environmental policies and adequate control measures to reduce the pressure on healthcare expenditure. Particular attention must also be paid to other sources of pollution, such as suspended particulates (PM), land-based pollutants and those present in water, to carry out more in-depth studies and adopt appropriate preventive measures.

REFERENCES

1. Breitung, J. (2001). The local power of some unit root tests for panel data. *In Nonstationary panels, panel cointegration, and dynamic panels* (pp. 161-177). Emerald Group Publishing Limited.
2. Di Matteo, L., & Di Matteo, R. (1998). Evidence on the determinants of Canadian provincial government health expenditures: 1965–1991. *Journal of health economics, 17(2)*, 211-228.
3. Di, D., Zhang, L., Wu, X., & Leng, R. (2020, April). Long-term exposure to outdoor air pollution and the risk of development of rheumatoid arthritis: a systematic review and meta-analysis. *In Seminars in arthritis and rheumatism* (Vol. 50, No. 2, pp. 266-275). WB Saunders.
4. Dormont, B., Oliveira Martins, J., Pelgrin, F., & Suhrcke, M. (2008). Health expenditures, longevity, and growth. *Longevity and Growth*.
5. Evans, D. B., Tandon, A., Murray, C. J., & Lauer, J. A. (2001). Comparative efficiency of national health systems: cross national econometric analysis. *BMj, 323(7308)*, 307-310.
6. Fotourehchi, Z. (2016). Health effects of air pollution: An empirical analysis for developing countries. *Atmospheric Pollution Research, 7(1)*, 201-206.
7. Hansen, A. C., & Selte, H. K. (2000). Air pollution and sick-leaves. *Environmental and Resource Economics*, 16, 31-50.
8. Hendryx, M., Luo, J., Chojenta, C., & Byles, J. E. (2019). Air pollution exposures from multiple point sources and risk of incident chronic obstructive pulmonary disease (COPD) and asthma. *Environmental research, 179*, 108783.
9. Hitiris, T., & Nixon, J. (2001). Convergence of health care expenditure in the EU countries. *Applied Economics Letters, 8(4)*, 223-228.
10. Hitiris, T., & Posnett, J. (1992). The determinants and effects of health expenditure in developed countries. *Journal of health economics, 11(2)*, 173-181.
11. Im, K. S., Pesaran, M. H., & Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of econometrics, 115(1)*, 53-74.
12. Jerrett, M., Eyles, J., Dufournaud, C., & Birch, S. (2003). Environmental influences on healthcare expenditures: an exploratory analysis from Ontario, Canada. *Journal of Epidemiology and Community Health, 57(5)*, 334.
13. Kampa, M., & Castanas, E. (2008). Human health effects of air pollution. *Environmental pollution, 151(2)*, 362-367.
14. Karatzas, G. (2000). On the determination of the US aggregate health care expenditure. *Applied Economics, 32(9)*, 1085-1099.
15. Kumar, R. P., Perumpully, S. J., Samuel, C., & Gautam, S. (2023). Exposure and health: A progress update by evaluation and scientometric analysis. *Stochastic Environmental Research and Risk Assessment, 37(2)*, 453-465.
16. Levin, A., Lin, C. F., & Chu, C. S. J. (2002). Unit root tests in panel data: asymptotic and finite-sample properties. *Journal of econometrics, 108(1)*, 1-24.
17. Maddala, G. S., & Wu, S. (1999). A comparative study of unit root tests with panel data and a new simple test. *Oxford Bulletin of Economics and statistics, 61(S1)*, 631-652.
18. Meira, L. H., de Mello, C. A., Castro, Y. M., Oliveira, L. K., & Nascimento, C. D. O. L. (2020). Measuring social effective speed to improve sustainable mobility policies in developing countries. *Transportation Research Part D: Transport and Environment, 78*, 102200.

19. Mujtaba, G., & Ashfaq, S. (2022). The impact of environment degrading factors and remittances on health expenditure: an asymmetric ARDL and dynamic simulated ARDL approach. *Environmental Science and Pollution Research*, 1-17.
20. Narayan, P. K., & Narayan, S. (2008). Does environmental quality influence health expenditures? Empirical evidence from a panel of selected OECD countries. *Ecological economics*, *65(2)*, 367-374.
21. Neidell, M. J. (2004). Air pollution, health, and socio-economic status: the effect of outdoor air quality on childhood asthma. *Journal of health economics, 23(6)*, 1209-1236.
22. Newhouse, J. P. (1977). Medical-care expenditure: a cross-national survey. *The journal of human resources*, *12(1)*, 115-125.
23. Ogden, D. C. (1966). Economic analysis of air pollution. *Land Economics*, *42*(2), 137-147.
24. Pearce, D. W., & Turner, R. K. (1989). *Economics of natural resources and the environment*. Johns Hopkins University Press.
25. Pedroni, P. (1999). Critical values for cointegration tests in heterogeneous panels with multiple regressors. *Oxford Bulletin of Economics and statistics, 61(S1)*, 653-670.
26. Seaton, A., Godden, D., MacNee, W., & Donaldson, K. (1995). Particulate air pollution and acute health effects. *The lancet, 345(8943)*, 176-178.
27. United Nations Environment Program (UNEP) (2016).Environment for development, urban environment unit.
http://www. unep.org/urban_environment/Issues/urban_air.asp4/3/2016
28. Vasudeva Murthy, N. R., & Ukpolo, V. (1995). Aggregate health care expenditure in the United States: New results. *Applied Economics Letters, 2(11)*, 419-421.
29. Waked, A., & Afif, C. (2012). Emissions of air pollutants from road transport in Lebanon and other countries in the Middle East region. *Atmospheric Environment, 61*, 446-452.
30. Westerlund, J. (2006). Testing for panel cointegration with multiple structural breaks. *Oxford Bulletin of Economics and Statistics, 68(1),* 101-132.
31. World Health Organization (WHO), (2018). *Fact sheets on sustainable development goals: health targets, Air quality and health*. World Health Organization Regional Office for Europe.
32. Yahaya, A., Nor, N. M., Habibullah, M. S., Ghani, J. A., & Noor, Z. M. (2016). How relevant is environmental quality to per capita health expenditures? Empirical evidence from panel of developing countries. *SpringerPlus, 5*, 1-14.
33. Yu, Y., Zhang, L., & Zheng, X. (2016). On the nexus of environmental quality and public spending on health care in China: a panel cointegration analysis. *Economic and Political Studies, 4(3),* 319-331.
34. Zuidema, T., & Nentjes, A. (1998). Health damage of air pollution: an estimate of a dose-response relationship for The Netherlands. *In Studies in environmental science* (Vol. 72, pp. 981-1006). Elsevier.