

The Burden of Cancer in the United States: An Empirical Analysis

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Objective: The aim of this study was to investigate the relationship between the lung and bronchus cancer incidence rate, the lung and bronchus cancer mortality rate, economic growth, health expenditures, and environmental degradation using data from US states.

Methods: In the study, the cointegration and causality relationships among the time series data were examined. The autoregressive distributed lag (ARDL) bounds test was used to estimate the short- and long-term coefficients of the variables representing lung and bronchus cancer incidence bronchus and mortality rates, economic growth, health expenditures, and environmental degradation variables. The data used in the study cover the annual period from 1999 through 2020.

Results: According to the ARDL bounds test results, economic growth and environmental degradation increased lung and bronchus cancer incidence mortality rates, while health expenditures reduced them. Causality tests indicated that economic growth unidirectionally affected lung and bronchus cancer incidence and mortality rates and environmental degradation. The results of other causality tests are presented in the conclusion section.

Conclusion: Based on the findings, it is recommended to implement policies that reduce environmental degradation without hindering economic growth. By implementing such policies, cancer incidence and mortality rates may decrease, and at the same time, public welfare may increase. Policymakers should make decisions that advance both economic and human health objectives.

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Key words: Health Expenditures, Cancer, Economic Growth

One of the basic indicators of well-being is health. The right of every individual is to live a healthy life. Countries should design policies aimed at promoting the health of their populations. Health is also a fundamental indicator of a country's development. Healthy individuals and economic growth in a region interact with each other (1). Lung and bronchus cancer is a disease that not only adversely affects human health but also worsens socioeconomic inequalities. Consequently, lung and bronchus cancer represents a significant public health issue with implications for social development (2). The main purpose of this study was to develop policy recommendations aimed at improving population health. To formulate these recommendations, new methods addressing gaps in the literature were developed and empirically applied.

Cancer is the second leading cause of death in men and women in the US, after heart disease. In 2020, deaths from heart disease accounted for 20.6% of all deaths, while cancer accounted for 17.8% (3). The highest death rate due to cancer in both men and women is from lung and bronchus cancer. Lung and bronchus cancer is caused by environmental and genetic factors (4–6). Tobacco smoking is also an important factor (7). In 2020, the rate of death from lung and bronchus cancer was 26.8% in women and 38.0% in men. The highest state-specific mortality rate from lung and bronchus cancer in 2020 was reported in Kentucky (50.1 per 100,000). Overall, the most frequently diagnosed cancers in 2020 were female breast cancer, male prostate cancer, and lung and bronchus cancer (in both sexes) (8).

Lung and bronchus cancer is a disease that can affect people directly or indirectly. Although it has a direct impact on human health, it also has indirect socioeconomic effects. These effects can vary by sex, race, and geographic region (2).

The treatment of lung and bronchus cancer can be accomplished with combinations of surgery, chemotherapy, and radiation (9,10). In the US, the cost of cancer treatment ranks second after heart disease (11). Cancer expenditures in the US in 2020 were \$208.9 billion, while health expenditures for lung and bronchus cancer were \$23.8 billion (12).

The aim of this study was to investigate the relationships among lung and bronchus cancer incidence and mortality rates, economic growth, health expenditure, and environmental degradation across 50 US states and Washington, DC, for the period of 1999 through 2020. Since there is a serious deficiency in the literature on this subject, it is anticipated that the results of this research will contribute to the existing knowledge base. In previous studies, the effect of economic growth on cancer incidence is mixed. In their study of 122 countries, Luzzati et al. concluded that cancer incidence increases with economic

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growth (13). However, as a result of their empirical analysis of 27 EU countries, Ades et al. found that economic growth was associated with cancer incidence (14). One of the reasons for conducting this study was to investigate whether similarly mixed results observed in international studies might also apply to the US. In addition, although there are limited studies in the literature on mortality rates and economic growth (15), research on lung and bronchus cancer mortality remains even scarcer. Thus, this study aimed to contribute to the literature on this subject. Additionally, the research aimed to address the gap in the literature by conducting analyses at the state level over a specific time period.

This study was guided by 3 primary research questions. First, how can health expenditures drive lung and bronchus cancer incidence rate and mortality rate? Second, what is the impact of lung and bronchus cancer on economic growth? Third, what effect will rising levels of environmental degradation have on lung and bronchus cancer incidence rate and mortality rate? In line with these questions, the study evaluated gaps in the literature on lung and bronchus cancer incidence and mortality rates, with a view toward proposing solutions.

With the findings obtained, the study aimed to make basic policy recommendations for healthier generations. Another contribution of the study to the literature was the development of models that may serve as templates for future studies. As far as is known, the empirical models developed have not been applied in the US before.

The rest of the article is structured as follows: In the second part, the data set is defined, the econometric approach is discussed, and the methodology is explained. In the third section, empirical results and discussion are presented. In the last section, conclusions and policy recommendations are provided.

Data, Econometric models, and Methodology

Data

In this empirical study, data from the 50 US states and the District of Columbia for the period 1999 through 2020 were used. A wider range of years could not be used due to data limitations across states. The study used the following data: New lung and bronchus cancer incidence and mortality rates were measured as annual rates per 100,000 people. Economic growth (gross domestic product per capita in US\$), health expenditure (per capita in US\$), and carbon dioxide (CO₂) emissions (metric tons per person) were included in the analysis. Since CO₂ emissions are one of the significant factors that can affect lung and bronchus cancer, they were selected as being representative of environmental degradation. Descriptive statistics are presented in Table 1.

Econometric models

One of the aims of this article was to contribute to the literature by developing new econometric models. Three models in which lung and bronchus cancer incidence rate, lung and bronchus cancer mortality rate, and economic growth serve as dependent variables are described below. A potential limitation of the study is data variations across states. Based on a comprehensive literature search, the econometric methods used by Ades et al. (14) and Rasoulinezhad et al. (16) were adapted for this study.

Table 1. Description of variables

Variable	Symbol	Explanation	Source
Lung and bronchus cancer incidence rate	INC	Annual incidence rate per 100,000 people	CDC
Lung and bronchus cancer mortality rate	MOR	Annual mortality rate per 100,000 people	CDC
Economic growth	EG	Gross domestic product per capita (current US\$)	BEA
Health expenditure	HE	Health expenditure per capita (current US\$)	KFF
Environmental degradation	CO ₂	Carbon dioxide emissions, in metric tons per person	EIA

Abbreviations: BEA, Bureau of Economic Analysis; CDC, Centers for Disease Control and Prevention; EIA, Energy Information Administration; KFF, Kaiser Family Foundation.

The variables used in the following models are summarized in Table 1.

$$\text{MODEL 1: } INC = f(EG, HE, CO_2) \quad (1)$$

$$\text{MODEL 2: } MOR = f(EG, HE, CO_2) \quad (2)$$

$$\text{MODEL 3: } EG = f(INC, MOR, HE, CO_2) \quad (3)$$

where INC, MOR, EG, HE, and CO₂ denote lung and bronchus cancer incidence rate, lung and bronchus cancer mortality rate, economic growth, health expenditure, and CO₂ emissions, respectively. The econometric representations of Models 1, 2, and 3 are given below:

$$\text{MODEL 1: } INC_{it} = \theta_0 + \theta_1 EG_{it} + \theta_2 HE_{it} + \theta_3 CO_{2it} + \varepsilon_t \quad (4)$$

$$\text{MODEL 2: } MOR_{it} = \theta_0 + \theta_1 EG_{it} + \theta_2 HE_{it} + \theta_3 CO_{2it} + \varepsilon_t \quad (5)$$

$$\text{MODEL 3: } EG_{it} = \theta_0 + \theta_1 INC_{it} + \theta_2 MOR_{it} + \theta_3 HE_{it} + \theta_4 CO_{2it} + \varepsilon_{it} \quad (6)$$

where $t = 1999, \dots, 2020$; $i = 1, \dots, 51$ (which includes Washington, DC) represents the cross-section of US states, and ε_t represents the error term. The variables were log-transformed before being included in the model.

In the US, lung and bronchus cancer is associated with high incidence and mortality rates, ranking them second and third, respectively, among all cancers (8). Lung and bronchus cancer, a significant health problem in the US, and the damage it causes to the economy is not widely discussed in the literature. The effect of economic growth, one of the indicators of prosperity, on cancer (including lung and bronchus cancer) is a controversial issue. While some studies state that economic growth has an effect on reducing cancer (14), others claim the opposite (13). It is thought that researching the effect of economic growth on cancer will contribute to the literature.

With economic development, factors that increase lung and bronchus cancer may also emerge; environmental degradation is one of them. In particular, increasing CO₂ emissions may raise

lung and bronchus cancer incidence and mortality rates (13). Therefore, including CO₂ emissions in the empirical model and analyzing them with econometric methods may reveal the effect of air pollution on lung and bronchus cancer. This approach can help policymakers make more informed decisions regarding lung and bronchus cancer prevention. Health expenditures can have many positive effects on disease outcomes, including those associated with lung and bronchus cancer. One of these is reducing incidence and mortality rates (14). Analyzing the impact of health expenditures across the 50 US states and Washington, DC, provides insight into their effects on lung and bronchus cancer incidence and mortality rates. In this way, people's well-being will improve, and the way will be paved for them to live healthier lives.

Methods

First, in the empirical analysis, the cross-sectional dependencies of the variables were determined. For this, the Breusch–Pagan Lagrange multiplier (LM) test (17), the Pesaran scaled LM test (18), and the Pesaran cross-sectional dependence test (19), which last estimates cross-sectional dependence, were used. The null hypothesis of these tests is *There is no cross-sectional dependence*, and the alternative hypothesis is *There is cross-sectional dependence*.

Unit-Root tests

To determine the cointegration relationship between the variables, the stationarity of the variables is first assessed. For this purpose, first-generation panel unit-root tests (19) and the Fisher-Augmented Dickey–Fuller test modified by Maddala and Wu (20) were used. The panel unit-root test (21), one of the second-generation panel unit-root tests, was used. The aim was to ensure consistency in the results by using first- and second-generation panel unit-root tests together, thereby increasing the reliability of the cointegration and causality tests. The null hypothesis of these tests is *The variable has a unit root*, and the alternative hypothesis is *The variable is stationary*.

Cointegration tests

To estimate the long- and short-term coefficients of the variables, it is first necessary to determine their cointegration relationship. Accordingly, the Kao (22) and Banerjee and Carrion-i-Silvestre (23) panel cointegration tests were used in the study. The null hypothesis of these tests is *There is no cointegration between the variables*, and the alternative hypothesis is *There is cointegration between the variables*. Once cointegration between the variables is determined, the short- and long-term coefficients of the variables can be estimated.

The short- and long-term coefficients of the variables were estimated with the panel pooled mean group (PMG) estimate developed by Pesaran et al. (24). The PMG test provides homogeneous long-term coefficients and also allows for short-term dynamics. Below is the adaptation of the PMG test (autoregressive distributed lag [ARDL] limit test) to our updated models:

Model 1:

$$\Delta \ln INC_{it} = \alpha_0 + \sum_{i=1}^m \alpha_{1i} \Delta INC_{i,t-1} + \sum_{i=1}^m \alpha_{2i} \Delta EG_{i,t-1} + \sum_{i=1}^m \alpha_{3i} \Delta HE_{i,t-1} + \sum_{i=1}^m \alpha_{4i} \Delta CO_{2i,t-1} + \delta_1 INC_{i,t-1} + \delta_2 EG_{i,t-1} + \delta_3 HE_{i,t-1} + \delta_4 CO_{2i,t-1} + \varepsilon_t \quad (7)$$

Model 2:

$$\Delta \ln MOR_{it} = \alpha_0 + \sum_{i=1}^m \alpha_{1i} \Delta MOR_{i,t-1} + \sum_{i=1}^m \alpha_{2i} \Delta EG_{i,t-1} + \sum_{i=1}^m \alpha_{3i} \Delta HE_{i,t-1} + \sum_{i=1}^m \alpha_{4i} \Delta CO_{2i,t-1} + \delta_1 MOR_{i,t-1} + \delta_2 EG_{i,t-1} + \delta_3 HE_{i,t-1} + \delta_4 CO_{2i,t-1} + \varepsilon_t \quad (8)$$

Model 3:

$$\Delta \ln EG_{it} = \alpha_0 + \sum_{i=1}^m \alpha_{1i} \Delta EG_{i,t-1} + \sum_{i=1}^m \alpha_{2i} \Delta INC_{i,t-1} + \sum_{i=1}^m \alpha_{3i} \Delta MOR_{i,t-1} + \sum_{i=1}^m \alpha_{4i} \Delta HE_{i,t-1} + \sum_{i=1}^m \alpha_{5i} \Delta CO_{2i,t-1} + \delta_1 EG_{i,t-1} + \delta_2 INC_{i,t-1} + \delta_3 MOR_{i,t-1} + \delta_4 HE_{i,t-1} + \delta_5 CO_{2i,t-1} + \varepsilon_t \quad (9)$$

where $t = 1999, \dots, 2020$; $i = 1, \dots, 51$. INC, MOR, EG, HE, and CO₂ denote lung and bronchus cancer incidence rate, lung and bronchus cancer mortality rate, economic growth, health expenditure, and CO₂ emissions, respectively.

Causality test

Causal relationships between variables were evaluated using the Dumitrescu–Hurlin test (25). The Dumitrescu–Hurlin panel causality test is based on the simple average of Wald statistics:

$$W_{N,T}^{Hnc} = \frac{1}{N} \sum_{i=1}^N W_{i,T} \quad (10)$$

where $W_{i,T}$ denotes the Wald test statistic used to estimate Granger causality in the cross-section.

To obtain a standardized statistic, the following transformation is applied:

$$\tilde{Z}_{N,T}^{Hnc} = \frac{\sqrt{N} [W_{N,T}^{Hnc} - \sum_{i=1}^N E(\tilde{W}_{i,T})]}{\sqrt{\sum_{i=1}^N \text{Var}(\tilde{W}_{i,T})}} \quad (11)$$

where $T \geq 6 + 2K$. The corresponding mean and variance are defined as follows:

$$E(\tilde{W}_{i,T}) = N^{-1} \sum_{i=1}^N E(W_{i,T}) = K \times \frac{(T-2K-1)}{(T-2K-3)} \quad (12)$$

$$\text{Var}(\tilde{W}_{i,T}) = N^{-1} \sum_{i=1}^N \text{Var}(W_{i,T}) = 2K \times \frac{(T-2K-1)^2 \times (T-K-3)}{(T-2K-3)^2 \times (T-2K-5)} \quad (13)$$

The statistic $\tilde{Z}_{N,T}^{Hnc}$ also yields good results when the number of cross-sections is small. When the cross-sections have heterogeneous lag lengths, the following test statistic is used (26):

$$\tilde{Z}_{N,T}^{Hnc} = \frac{\sqrt{N} [W_{N,T}^{Hnc} - N^{-1} \sum_{i=1}^N E(\tilde{W}_{i,T})]}{\sqrt{N^{-1} \sum_{i=1}^N \text{Var}(\tilde{W}_{i,T})}} \quad (14)$$

Results

In this part of the study, the results and discussion of the empirical analysis are given. The empirical analyses began by determining the cross-sectional dependencies among the variables. In this way, it was determined whether a shock occurring in one state affected other states.

Table 2 displays the results of the cross-sectional dependence tests. These results show that the null hypothesis was rejected for all variables at the 1% significance level. Thus, it was determined that there was cross-sectional dependence in the variables. The cross-sectional dependence in the variables was determined, and the first- and second-generation unit-root test results are presented below.

Table 2. Outcomes of Cross-Sectional dependence analysis

	Breusch–Pagan LM	Pesaran scaled LM	Pesaran CD
	Statistic	Statistic	Statistic
INC	6763.176*	108.682*	47.092*
MOR	11212.080*	196.783*	21.177*
EG	25606.730*	481.840*	159.771*
HE	27830.270*	525.872*	166.823*
CO ₂	18512.280*	341.348*	127.658*

Abbreviations: CD, cross-sectional dependence; LM, Lagrange multiplier.
* $P < .01$.

Table 3 presents the results of the panel unit-root tests, which were conducted to determine the stationarity of the variables. The findings indicate that the null hypotheses at the level or at the first difference of the variables were rejected. Thus, the prerequisite for the ARDL bounds test was met, since the variables were stationary at level or at the first difference.

Table 3. Outcomes of panel Unit-Root analysis

	Level Statistic	First-Difference Statistic
Im, Pesaran, Shin		
INC	-0.026	-11.798*
MOR	4.861	-15.972*
EG	-1.789**	-9.080*
HE	0.625	-3.990*
CO ₂	10.193	-15.284*
ADF–Fisher chi-square		
INC	122.035	346.249*
MOR	73.554	440.744*
EG	124.822	262.196*
HE	86.771	133.332**
CO ₂	25.999	422.473*
Pesaran (2007)		
INC	-3.066*	
MOR	-1.872	-3.575*
EG	-1.453	-2.612*
HE	-2.005	-3.256*
CO ₂	-2.328*	-

Abbreviation: ADF, Augmented Dickey–Fuller test

* $P < .01$; ** $.01 \leq P < .05$. For the Fisher-Augmented Dickey–Fuller test modified by Maddala and Wu (20), the critical values at 1% and 5% are -2.25 and -2.11, respectively.

Table 4 presents the test results of the Kao panel cointegration test and the Banerjee and Carrion-i-Silvestre panel cointegration test. The null hypothesis was rejected at the 1% significance level in all 3 models, indicating the presence of cointegration. After confirming that the variables would move together in the long term, the long- and short-term coefficients were estimated.

Table 4. Outcomes of cointegration analysis

Panel cointegration test	Dependent variable: INC Statistic	Dependent variable: MOR Statistic	Dependent variable: EG Statistic
Kao (1999)	-6.910*	2.949*	-7.303*
Banerjee and Carrion-i-Silvestre (2017)	-3.460**	-3.384**	-2.483**

* $P < .01$; ** $.01 < P < .05$. Critical values at 5% and 10% are -2.22 and -2.14 for the Kao (22) and the Banerjee and Carrion-i-Silvestre (23) panel cointegration tests, respectively.

Long- and short-term coefficient estimates are given in Table 5. According to empirical results obtained using the ARDL limit test, EG and CO₂ positively and significantly affected lung and bronchus cancer incidence and mortality rates. Air pollution was seen to be one of the main causes of lung and bronchus cancer. Consequently, lung and bronchus cancer incidence and mortality rates were seen to have increased with rising air pollution levels. These findings are consistent with the previous literature (13). Conversely, health expenditures had a negative and significant impact on lung and bronchus cancer incidence and mortality rates. This result is consistent with the findings of Doshmangir et al. (27). An increase in health expenditures generally contributed to facilitating access to health services and improving disease screening and diagnostic and treatment processes. Thus, increased health expenditures may have had a significant impact on preventing many diseases (28).

The incidence of lung and bronchus cancer—or indeed of any disease—can undermine economic performance by increasing healthcare expenditures and reducing productivity. Evidence suggests that well-targeted health expenditures—particularly those that emphasize prevention and early intervention—can mitigate these economic burdens and support overall development (29).

Table 5. Outcomes of panel ARDL estimates

Variable	Dependent Variable: INC	Dependent Variable: MOR	Dependent Variable: EG
Long-run coefficient			
EG	0.245*	0.715*	
INC			-0.061*
MOR			-0.048
HE	-0.089*	-0.397*	0.790*
CO ₂	0.168*	0.171**	0.236*
Short-run coefficient			
ECT	-0.570*	-0.178*	-0.138*
Δ EG	0.273*	0.392	
Δ INC			0.112*
Δ MOR			0.001
Δ HE	-0.195	-0.630	0.210*
Δ CO ₂	0.097***	-0.514***	0.195*
Constant	1.068*	-0.140**	0.507*

Abbreviations: ARDL, autoregressive distributed lag; ECT, error correction term.

* $P < .01$; ** $.01 < P < .05$; *** $.05 < P < .10$.

Factors associated with higher CO₂ emissions are also linked to increased economic growth, which aligns with the finding of Govdeli (30). The question of whether to prioritize economic growth, which is an indicator of prosperity, or a cleaner environment, should be among the key policy considerations of nations. While economic growth increases welfare, environmental pollution reduces welfare. In order to overcome this dilemma, it is recommended to develop and implement policies that promote environmentally sustainable economic growth. Figure 1 shows the signs of the estimated long-term cointegration coefficients for models 1, 2, and 3.

Figure 1. Long-run cointegration estimator coefficient signs

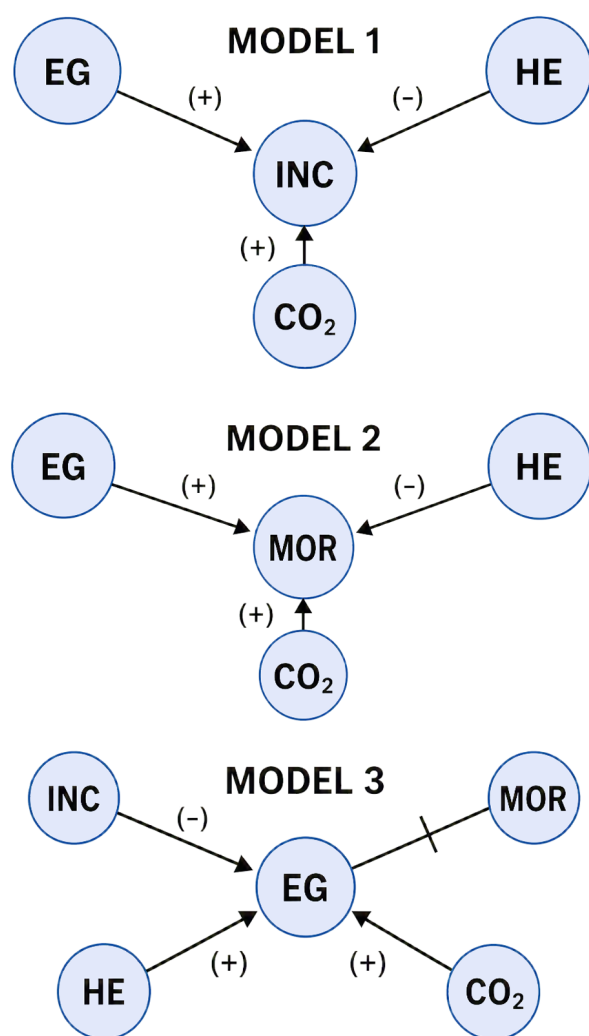


Table 6 presents the results of the Dumitrescu–Hurlin causality test (25). According to the results, economic growth caused changes in lung and bronchus cancer incidence and mortality rates. As economic activities increased, the incidence and mortality of lung and bronchus cancer also increased. The underlying fact is that economic growth contributes to environmental degradation (31).

Additionally, there was a unidirectional causal relationship from economic growth to CO₂ emissions. This finding is consistent with the results of Gövdeli (32). Increasing economic growth without adequate attention to environmental impacts may exacerbate environmental degradation. Another finding is that there was a unidirectional causal relationship from health expenditure to lung and bronchus cancer incidence rate. In addition, bidirectional causal relationships were found between economic growth and health expenditure; between lung and bronchus cancer mortality rate and health expenditure; between lung and bronchus cancer mortality rate and CO₂ emissions; between lung and bronchus cancer incidence rate and CO₂ emissions; and between health expenditure and CO₂ emissions. These findings are similar to the results of Narcisse et al. (33).

In line with these findings, it is recommended to introduce measures that reduce environmental degradation without compromising economic growth. By doing so, cancer incidence and mortality can be reduced while at the same time enhancing population welfare.

Table 6. Outcomes of panel causality analysis

	W-Statistic	Z-Statistic
EG → INC	2.934*	7.345
INC → EG	0.962	-0.669
EG → MOR	11.887*	43.716
MOR → EG	1.240	0.460
EG → HE	4.222*	12.574
HE → EG	2.362*	5.018
EG → CO ₂	6.362*	21.271
CO ₂ → EG	0.994	-0.537
INC → HE	1.498	1.509
HE → INC	3.254*	8.645
MOR → HE	3.362*	9.081
HE → MOR	8.201*	28.740
MOR → CO ₂	3.783*	10.792
CO ₂ → MOR	7.488*	25.846
INC → CO ₂	2.032*	3.679
CO ₂ → INC	2.083*	3.886
HE → CO ₂	5.589*	18.186
CO ₂ → HE	2.472*	5.487

*.01 < P < .05.

Conclusion

In this study, the relationships among the incidence and mortality rates of new cases of lung and bronchus cancer, economic growth, health expenditures, and environmental degradation were examined using the annual data from the 50 US states and Washington, DC (1999–2020). A cointegration relationship was found between the variables. According to the causality analysis, economic growth statistically predicted changes in lung and bronchus cancer incidence and mortality rates. In addition, bidirectional causal relationships were found between economic growth and health expenditure; between lung and bronchus cancer mortality rate and health expenditure; between lung and bronchus

cancer mortality rate and environmental degradation; between lung and bronchus cancer incidence rate and environmental degradation; and between health expenditure and environmental degradation.

An increase in the lung and bronchus cancer incidence rate may have a negative effect on economic growth. Using financial resources for lung and bronchus cancer treatments rather than in areas that will increase development may negatively affect the US economy. Instead, it is recommended that health expenditures be made more for preventive purposes than for treatment. By doing so, diseases can be prevented to some extent, and resources can be used in growth-enhancing areas. In addition, preventing disease can increase a population's standard of living and welfare.

Effective health policies require the careful planning of health expenditures and allocation of resources, taking into account disease prevalence and community needs. In addition, providing access to health services and health education as well as strengthening preventive measures might also significantly affect incidence rates and mortality rates.

Another strategy that can reduce lung and bronchus cancer is to make people and businesses more conscious. The findings of this study show that air pollution in particular will increase the incidence and mortality rates of lung and bronchus cancer. Policymakers should make people and businesses more aware of this issue. Measures to reduce greenhouse gases emitted by businesses should be strengthened. By providing appropriate penalties and incentives, CO₂ emissions can be reduced. Thus, lung and bronchus cancer incidence and mortality rates can be reduced.

Economic growth is one of the indicators of societal well-being. The rate of increase in the lung and bronchus cancer incidence rate negatively affects economic growth. Policymakers should prioritize policies that reduce the lung and bronchus cancer incidence rates while implementing policies that increase economic growth. Empirical results show that higher health expenditures are associated with increased economic growth and lower lung and bronchus cancer incidence and mortality rates. Increased health expenditures generally help to improve access to health services and enhance disease screening, diagnosis, and treatment, thereby reducing disease incidence rates. Therefore, if policymakers were to provide incentives and guidance for appropriate health expenditures, the country could develop further, enabling people to lead healthier lives.

Another factor that increases economic growth is the rise in industrial activity-related environmental degradation. CO₂ emissions released with production negatively affect human health, though they contribute to economic growth. CO₂ emissions may contribute to increases in lung and bronchus cancer incidence and mortality rates. Environmental degradation may increase the risk of cancer by adversely affecting human biology. Therefore, a cleaner environment is required to protect public health, meaning that policymakers should implement measures to reduce CO₂ emissions. While implementing these measures, it is recommended that care be taken not to adversely affect economic growth. Steps should be taken to reduce the complexity involved in maintaining the balance between economic growth and environmental regulation. The empirical findings obtained in this study provide a basis for making more rational decisions in public

health and environmental policy interventions. The data obtained in this study were limited by the year range. Further studies could contribute to the literature by expanding the data range.

Resumen

Objetivo: El objetivo de este estudio fue investigar la relación entre la tasa de incidencia del cáncer de pulmón y bronquios, la tasa de mortalidad por cáncer de pulmón y bronquios, el crecimiento económico, el gasto sanitario y la degradación medioambiental utilizando datos de los EE. UU. **Métodos:** En el estudio se reveló la relación de cointegración y causalidad entre los datos de series temporales. Se utilizó la prueba de límites de rezago distribuido autorregresivo (ARDL, por sus siglas en inglés) para estimar los coeficientes a corto y largo plazo de las variables de incidencia y mortalidad por cáncer de pulmón y bronquios, crecimiento económico, gasto en salud y degradación ambiental. Los datos utilizados en el estudio abarcan el período anual 1999–2020. **Resultados:** Según los resultados de la prueba de límites ARDL, el crecimiento económico y la degradación ambiental aumentaron la tasa de incidencia y la tasa de mortalidad por cáncer de pulmón y bronquios. El gasto en salud redujo la tasa de incidencia y la tasa de mortalidad por cáncer de pulmón y bronquios. Según los resultados de la prueba de causalidad, el crecimiento económico fue la causa de la incidencia y la mortalidad por cáncer de pulmón y bronquios, así como de la degradación ambiental. Los resultados de otras pruebas de causalidad se indican en la sección de conclusiones. **Conclusión:** Como resultado de los resultados obtenidos, se recomienda implementar políticas que reduzcan la degradación ambiental sin afectar el crecimiento económico. De esta manera, se puede disminuir la incidencia y la mortalidad por cáncer, a la vez que se mejora el bienestar de las personas. Los responsables políticos deben tomar decisiones que favorezcan tanto la economía como la salud humana al desarrollar políticas.

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