Available online at www.medicinescience.org

ORIGINAL ARTICLE

Medicine Science International Medical Journal

Medicine Science 2025;14(4):1085-90

The impact of smoking and air pollution exposure on lung cancer, ischemic heart disease, stroke, and copd mortality: The case of OECD countries

Tuncay Polat[1], Mustafa Ozer[1], Huseyin Bulut[1], Semsinnur Gocer[2]

[1]*Erzincan Binali Yıldırım University Vocational School of Health Services, Erzincan, Türkiye*
[2]*Yozgat Bozok University, Faculty of Medicine, Department of Public Health, Yozgat, Türkiye*

Received 23 April 2025; Accepted 14 June 2025
Available online 31 October 2025 with doi: 10.5455/medscience.2025.04.103

Abstract

This research investigates the influence of tobacco use and air pollution on the mortality rates associated with lung cancer, ischemic heart disease, stroke, and chronic obstructive pulmonary disease (COPD) in OECD member states. Employing a retrospective design, the study explores correlations and regression outcomes to assess the association between smoking, environmental pollution, and cause-specific mortality. The analysis incorporates air pollution metrics and smoking prevalence from 2019 OECD data, alongside mortality statistics obtained from the World Health Organization for the same year. Statistical evaluations were carried out using SPSS v25.0 and Microsoft Excel, with significance set at $p<0.05$. The results revealed a statistically significant and moderately positive correlation between smoking and mortality from lung cancer and stroke ($p<0.05$). However, air pollution did not exhibit a significant correlation with any of the selected mortality outcomes ($p>0.05$). According to simple regression analysis, smoking substantially influenced mortality rates for lung cancer and stroke, whereas air pollution showed no notable impact. Combined, smoking and air pollution accounted for 44.9% of lung cancer mortality variation and 25.7% for stroke ($p<0.05$). The findings underscore the prominent role of smoking in increasing the risk of lung cancer and stroke, while also highlighting the necessity of incorporating environmental determinants like air pollution into public health frameworks.

Keywords: Smoking, air pollution, lung cancer, stroke, COPD, ischemic heart disease

Introduction

Tobacco consumption remains one of the leading preventable causes of death worldwide, with nearly half of users succumbing to its direct or indirect health consequences. Over 8 million deaths annually are linked to tobacco, including around 1.3 million resulting from passive exposure. A striking 80% of the global tobacco-using population resides in low- and middle-income countries, which bear the brunt of smoking-related disease burden. No form or level of tobacco use is considered safe. Smoking, the most prevalent form of tobacco use, is a significant contributor to the development of chronic conditions such as COPD and is a major indoor air pollutant [1]. Previous cohort studies have demonstrated clear links between smoking and overall mortality, as well as specific diseases such as lung cancer, cardiovascular diseases, and stroke [2,3].

Environmental pollution, particularly from airborne particulate matter (PM), also poses a grave threat to global health. PM includes a variety of harmful substances like carbon, nitrates, sulfates, and biological agents. Fine particles (PM2.5), being small enough to penetrate deep into the lungs, are especially dangerous and can exacerbate chronic respiratory illnesses such as COPD, or even lead to premature death [4]. Exposure to PM increases hospital admissions and emergency visits among respiratory patients, and also serves as a vector for pathogens [5]. Airborne contaminants are increasingly being linked to cardiovascular and cerebrovascular disease progression, with long-term exposure leading to increased all-cause mortality [6,7]. Notably, ambient pollutants such as PM and nitrogen dioxide (NO2) have been associated with elevated lung cancer risk, particularly in densely populated urban environments [8].

CITATION
Polat T, Ozer M, Bulut H, Gocer S. The impact of smoking and air pollution exposure on lung cancer, ischemic heart disease, stroke, and copd mortality: The case of OECD countries. Med Science. 2025;14(4):1085-90.

Corresponding Author: Huseyin Bulut, Erzincan Binali Yıldırım University Vocational School of Health Services, Erzincan, Türkiye
Email: huseyinbulut@erzincan.edu.tr

In 2019, ischemic heart disease, stroke, and COPD were among the top global causes of mortality. Cardiovascular disease alone accounted for more than a quarter of all global deaths. While non-modifiable risk factors such as age and genetics play a role, behavioral and environmental determinants particularly smoking and air quality remain central to prevention strategies. Smoking alone was responsible for approximately two million ischemic heart disease deaths in 2019 [9]. Given the substantial contribution of both smoking and pollution to non-communicable disease mortality, a focused examination of these factors in OECD countries is essential. This study aims to analyze the role of smoking and air pollution exposure in influencing mortality from lung cancer, stroke, ischemic heart disease, and COPD, and to suggest public health strategies that address these modifiable risk factors.

Material and Methods

Research type and variables

This study is a retrospective correlation and regression analysis examining the relationship between smoking prevalence, air pollution levels, and deaths due to lung diseases and cardiovascular diseases using data from OECD countries for the year 2019.

Dependent Variables: Smoking prevalence and concentrations of air pollution indicators, PM10 and PM2.5.

Independent Variables: Mortality rates (per 100.000 people) due to lung cancer, ischemic heart disease, COPD, and stroke.

This study uses publicly available, anonymized data from the World Health Organization. Therefore, ethical approval was not required.

Research population and sample

The population of the study consists of OECD countries. Upon reviewing the available data, it was determined that the most recent data on air pollution exposure for OECD countries was from the year 2019, necessitating the use of data from this year. Due to the absence of data on both air pollution exposure and smoking prevalence for some countries in the specified year, the study includes data from 26 countries. The air pollution exposure and smoking prevalence data for these countries are presented in Figure 1, while the mortality data for lung cancer, ischemic heart disease, COPD, and stroke are shown in Figure 2. As shown in Figure 1, in 2019, Turkey had the highest smoking prevalence among individuals aged 15 and above, with a rate of 28%, while Iceland had the lowest at 8.2%. Regarding PM2.5 exposure, South Korea had the highest exposure level at 27.45 µg/m³, whereas Finland had the lowest at 5.64 µg/m³.

According to the OECD 2019 data shown in the Figure 2, the highest mortality rate from ischemic heart disease occurred in Lithuania, with 436.56 deaths per 100,000 people, while the lowest was in South Korea, with 53.83 deaths per 100.000 people. The country with the highest mortality rate from lung cancer was Greece, with 109.2 deaths per 100.000 people, whereas the lowest was in Israel, with 30.16 deaths per 100,000 people. The country with the highest number of deaths due to stroke was Latvia, with 200.07 deaths per 100,000 people, while the lowest was in Israel, with 26.85 deaths per 100,000 people. Finally, the country with the highest mortality rate from COPD was Hungary, with 74.79 deaths per 100.000 people, while Latvia had the lowest, with 14.8 deaths per 100.000 people.

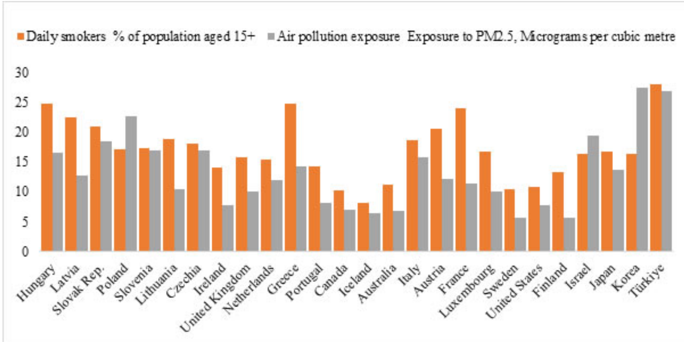

Figure 1. 2019 OECD air pollution exposure and smoking prevalence in individuals aged 15 and above

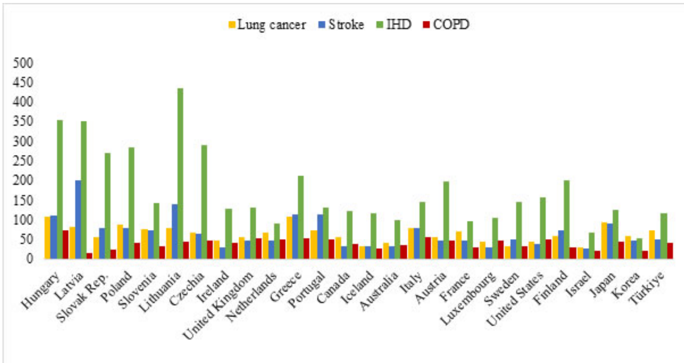

Figure 2. Mortality rates from lung cancer, ischemic heart disease, stroke, and copd (per 100.000 people)

Data collection method

Since data on air pollution exposure was only available for the year 2019, the data for this year was used for evaluation, and similarly, smoking prevalence for the same year was also considered. For mortality due to lung cancer, stroke, ischemic heart disease, and COPD, the 2019 World Health Organization (WHO) data were utilized.

Smoking prevalence

Data was obtained from the OECD Health Statistics 2019 and the WHO Global Health Observatory database.

Air pollution data

Data on air pollutants such as PM2.5, PM10, and NO2 was sourced from the OECD Air Quality Database and the European Environment Agency (EEA).

Mortality rates

Mortality rates due to lung cancer, ischemic heart disease, COPD,

 DOI: 10.5455/medscience.2025.04.103

and stroke were obtained from the WHO Mortality Database and the OECD Health Statistics reports.

Data Analyses

SPSS v25.0 and Microsoft Office Excel (Microsoft Corporation, Redmond, WA, USA) were used for data analysis. The normality of the variables was assessed using the Shapiro-Wilk test (n<50), Q-Q plot, and histogram graphs. Correlation and simple regression analyses were performed to evaluate relationships between variables. The assumptions required for simple regression analysis were checked. Correlation coefficients were used as a measure to determine the direction and strength of the relationship between variables [10].

Range of the correlation coefficient

The correlation coefficient (r) ranges from -1 to +1.

Negative correlation

Values between -1 and -0.70: Strong negative relationship
Values between -0.70 and -0.30: Moderate negative relationship
Values between -0.30 and 0: Weak negative relationship

Positive correlation

Values between 0 and 0.30: Weak positive relationship

Values between 0.30 and 0.70: Moderate positive relationship

Values between 0.70 and 1: Strong positive relationship

When the Correlation Coefficient is 0

It is considered that there is no relationship between the variables [10].

Results

According to the results of the Shapiro-Wilk normality test, the data on smoking prevalence in individuals aged 15 and above, air pollution exposure, lung cancer (p>0.05), and mortality due to COPD were normally distributed, while the data on stroke and ischemic heart disease were not normally distributed (p<0.05). For normally distributed data, correlation coefficients were calculated, while for non-normally distributed data, nonparametric correlation values were used. Details of the Descriptive Statistical Data of OECD Countries are given in Table 1.

Table 1. Descriptive statistical data of OECD countries

Variables	N	Mean	Median	Std. Deviation	Variance	Skewness	Kurtosis	Min.	Max.
Smoking Rate (%) for Ages 15+	26	17.16	16.75	5.04	25.37	0.29	-0.36	8.20	28.00
Exposure to Air Pollution	26	13.22	12.13	6.17	38.13	0.85	0.15	5.64	27.45
LC Mortality*	26	64.96	63.32	21.38	457.08	0.29	-0.37	30.16	109.20
Stroke Mortality*	26	68.64	50.98	40.59	1647.82	1.63	3.16	26.85	200.07
IDH Mortality*	26	175.78	136.55	97.97	9597.95	1.21	0.76	53.83	436.56
COPD Mortality*	26	40.15	40.99	13.02	169.59	0.26	0.79	14.80	74.79

*:Deaths are calculated per 100.000 people

The Relationship Between Smoking Prevalence, Air Pollution Exposure and Mortality Rate Data is shown in Table 2. A significant and moderate relationship was found between smoking prevalence and lung cancer mortality as well as stroke mortality (p<0.05). A significant and moderate relationship was also found between exposure to air pollution and lung cancer mortality (p<0.05).

A one-unit increase in smoking prevalence results in a 15.7% increase in lung cancer mortality and a 6.6-unit increase in stroke mortality (p<0.05). As shown in the table, the R^2 value explains 44.7% of the variance in lung cancer mortality due to smoking prevalence, and 20.4% of the variance in stroke mortality. A linear relationship between smoking prevalence and both lung cancer and stroke-related mortality is observed (p<0.05).

Simple regression coefficients and model fit measures for the relationship between smoking prevalence and mortality rate values are given in Table 3.

Table 2. Relationship between smoking prevalence, air pollution exposure, and mortality data

Variables	Test	LC Mortality*	Stroke Mortality	IDH Mortality	COPD Mortality
	r	.669**	.452**	.379	.180
Smoking Rate (%)	p	**.000**	**.010**	.028	.190
	n	26	26	26	26
	r	.364*	.087	.053	-.097
Exposure to Air Pollution	p	.034	.336	.399	.319
	n	26	26	26	26

p<0.05*; p<0.01**

Table 3. Simple regression coefficients and model fit measures for the relationship between smoking prevalence and mortality values

Smoking Rate[a]				General Model Test						
Dependent Variables	**R**	**R2**	**Adjusted R2**	**F**	**β**	**Standard Error**	**Standardized β**	**t**	**p**	**Dublin watson**
LC Mortality	.669	.447	.424	19.394	0.157	0.036	0.669	4.404	0.000	1.340
Stroke Mortality	.452	.204	.171	6.149	0.056	0.023	0.452	2.480	0.021	1.201
IDH Mortality	.379	.143	.108	4.014	0.019	0.010	0.379	2.003	0.057	1.001
COPD Mortality	.180	.032	0.008	0.800	0.069	0.078	0.180	0.894	0.380	0.922

$p<0.05$; [a]:Smoking prevalence is the independent variable

The simple regression analysis results show no relationship between air pollution exposure and mortality values ($p>0.05$). Simple Regression Model Coefficients and Goodness-of-Fit Measures for the Relationship Between Air Pollution Exposure and Mortality Rate Values are given in detail in Table 4.

The model explains 44.9% of the variance in lung cancer-related mortality and 25.7% of the variance in stroke-related mortality, and it is statistically significant ($p<0.05$). Details of the Fit Measures of the Simple Regression Model for the Relationship Between Air Pollution Exposure, Smoking Prevalence and Mortality Rate Values are given in Table 5.

Table 4. Simple regression model coefficients and fit measures for the relationship between air pollution exposure and mortality values

Exposure to Air Pollution[a]				General Model Test						
Dependent Variables	**R**	**R2**	**Adjusted R2**	**F**	**β**	**Standard Error**	**Standardized β**	**t**	**p**	**Dublin Watson**
LC Mortality	.364	.133	0.096	3.667	0.105	0.055	0.364	1.915	0.068	1.287
Stroke mortality	.087	.008	0.034	0.183	0.013	0.031	0.087	0.428	0.673	0.993
IDH Mortality	.053	.003	-0.039	0.066	0.003	0.013	0.053	0.258	0.799	0.933
COPD Mortality	.097	.009	-0.032	0.227	-0.046	0.096	-0.097	-0.476	0.638	0.952

$p<0.05$: Air pollution exposure is the independent variable

Table 5. Simple regression model fit measures for the relationship between air pollution exposure, smoking prevalence, and mortality values

Exposure to Air Pollution + Smoking Rate[a]				General Model Test			
Dependent Variables	**R**	**R2**	**Adjusted R2**	**F**	**df1**	**df2**	**p**
LC Mortality	0.670	0.449	0.401	9.377	2	23	0.001
Stroke Mortality	0.507	0.257	0.193	3.981	2	23	0.033
IDH Mortality	0.437	0.191	0.121	2.718	2	23	0.087
COPD Mortality	0.313	0.098	0.019	1.246	2	23	0.306

[a]: Air pollution exposure and smoking prevalence are the independent variables

Discussion

This study presents significant findings supporting the relationship between smoking prevalence, air pollution exposure, and lung cancer (LC) mortality. As seen in numerous epidemiological studies, smoking shows a strong relationship with the development of lung cancer and, consequently, mortality. The $p<0.05$ value obtained in this study demonstrates that the effect of smoking on lung cancer mortality is significant and moderate. It is well known that smoking causes the accumulation of harmful chemicals in lung tissues, accelerating the formation of cancer cells [2,3]. On the other hand, the relationship between air pollution exposure and lung cancer mortality is also noteworthy. Exposure to air pollution, particularly pollutants such as fine particles and toxic gases, can trigger cancer development due to their harmful effects on the respiratory system. The moderate and significant relationship found between air pollution exposure and lung cancer mortality in our study underscores the important role environmental factors play in influencing individuals' health. Some studies have also identified that air pollution significantly increases the risk of developing lung cancer [3,4,11]. Based on these findings, the study contributes to a better understanding of the impact of smoking and air pollution exposure on lung cancer mortality.

This study reveals that smoking prevalence has a significant impact on both LC and stroke mortality. A one-unit increase in smoking prevalence results in a 15.7% increase in lung cancer-related deaths and a 6.6-unit increase in stroke mortality ($p<0.05$). The findings of our study indicate that smoking prevalence has a substantial impact on both lung cancer and stroke mortality rates. It was concluded that smoking prevalence explains 44.7% of the variance in lung cancer mortality and 20.4% of the variance in stroke mortality. These results

DOI: 10.5455/medscience.2025.04.103

indicate that smoking plays a crucial role in these mortality rates and that there is a linear relationship between both health issues. The impact of smoking on lung cancer mortality is particularly striking. The 44.7% variance explained by smoking prevalence shows the strong influence of smoking on lung cancer-related deaths. It is well-documented in scientific literature that smoking triggers genetic changes in lung cells, promoting cancer development and increasing mortality rates [12-15]. This finding further affirms that smoking is one of the most significant risk factors for cancer. Although its impact on stroke is somewhat lower, the 20.4% variance explained clearly demonstrates that smoking is also a contributing factor to increased stroke risk. Smoking adversely affects vascular health, leading to increased blood clotting and arterial blockage, thus raising stroke risk. This relationship can be explained as a mechanism that leads to more prevalent cardiovascular diseases among smokers. Several studies also support our findings [16-22]. Based on this information, the linear relationship between smoking prevalence and both lung cancer and stroke mortality clearly highlights smoking as a primary risk factor for these health issues. These findings emphasize the importance of public health policies aimed at reducing smoking. Reducing the negative impacts of smoking could be a critical step in preventing fatal diseases such as cancer and stroke. In this regard, strengthening measures to prevent smoking could have long-term positive effects on public health.

According to the simple regression analysis conducted in this study, no significant relationship was found between air pollution exposure and mortality outcomes such as lung cancer, stroke, COPD, and ischemic heart disease. However, this finding may not fully reflect the interactions between air pollution and health, as the effects of environmental factors like air pollution are often long-term and multifactorial. Additionally, simple regression analysis only examines linear relationships, while the effects of air pollution on health may involve complex interactions and indirect factors. Future studies using more comprehensive analyses, interactions, and long-term data could provide a better understanding of this relationship.

As shown in Table 5, the effects of air pollution exposure and smoking prevalence on fatal diseases such as lung cancer and stroke are significantly explained. The regression analysis reveals that both factors play an important role in increasing the risk of these fatal diseases. The fact that air pollution exposure and smoking prevalence together explain 44.9% of the variance in lung cancer-related mortality and 25.7% of the variance in stroke-related mortality represents an important step in understanding the long-term effects of environmental and individual risk factors on health. Some studies in this field support our findings [2-5,14,15]. These findings underscore the necessity of strengthening policies aimed at reducing smoking and controlling air pollution levels in the development of public health strategies.

Conclusion

This study demonstrates that smoking has a significant impact on both LC and stroke mortality rates. A one-unit increase in smoking prevalence results in a 15.7% increase in lung cancer-related deaths and a 6.6% increase in stroke mortality ($p<0.05$). Furthermore, smoking accounts for 44.7% of the variance in lung cancer mortality and 20.4% of the variance in stroke mortality. The linear relationship between smoking and these fatal diseases emphasizes that smoking is a key risk factor contributing to these health issues. Additionally, the interaction between smoking and air pollution has been found to increase lung cancer mortality rates, highlighting the significant impact of these environmental factors on individuals' health. In conclusion, the effects of factors such as smoking and air pollution on lung cancer and stroke mortality rates should serve as an important guide in shaping public health policies. These findings underscore the need for more effective and comprehensive strategies to improve public health.

Conflict of Interests

The authors declare that there is no conflict of interest in the study.

Financial Disclosure

The authors declare that they have received no financial support for the study.

Ethical Approval

No ethical approval is required for the study.

References

1. WHO url-2, https://www.who.int/news-room/fact -sheets/detail/tobacco Access date 02.01.2025.
2. Tønnesen P, Carrozzi L, Fagerström KO, et al. Smoking cessation in patients with respiratory diseases: a high priority, integral component of therapy. Eur Respir J. 2007;29:390-417.
3. Carter BD, Abnet CC, Feskanich D, et al. Smoking and mortality—beyond established causes. N Engl J Med. 2015;372:631-40.
4. Brunekreef B, Holgate ST. Air pollution and health. The lancet. 2002;360(9341), 1233-1242.
5. Kelly FJ, Fussell JC. Air pollution and airway disease. Allergy. 2011;41:1059-71.
6. Jiang XQ, Mei XD, Feng D. Air pollution and chronic airway diseases: what should people know and do?. J Thorac Dis. 2016;8:E31.
7. American Thoracic Society. What constitutes an adverse health effect of air pollution?. Am J Respir Crit Care Med. 2000;161:665-63.
8. Nawrot TS, Nackaerts K, Hoet PH, Nemery B. Lung cancer mortality and fine particulate air pollution in Europe. Int J Cancer. 2007;120: 1825-6.
9. WHO url-1, https://www.who.int/news/item/09-12-2020-who-reveals-leading-causes-of-death-and-disability-worldwide-2000-2019 Access date 02.01.2025.
10. Pallant J. SPSS Kullanma Klavuzu SPSS ile Adım Adım Veri Analizi. (Trans. Balcı S. ve Ahi B.). Ankara:Anı Publishing. 2016.
11. Babatola SS. Global burden of diseases attributable to air pollution. J Public Health Afr. 2018;9:813.
12. Siegel RL, Miller KD, Fuchs HE, Jemal A. Cancer statistics, 2022. CA Cancer J Clin. 2022;72:7-33.

13. Jha P, Ramasundarahettige C, Landsman V, et al. 21st-century hazards of smoking and benefits of cessation in the United States. N Engl J Med. 2013; 24;368:341-50.

14. Gandini S, Botteri E, Iodice S, et al. Tobacco smoking and cancer: a meta-analysis. CA Cancer J Clin. 2008;122:155-64.

15. Walser T, Cui X, Yanagawa J, et al. Smoking and lung cancer: the role of inflammation. Am J Respir Crit Care Med. 2008;5:811-5.

16. Patel U, Patel N, Khurana M, et al. Effect comparison of e-cigarette and traditional smoking and association with stroke—a cross-sectional study of NHANES. Neurol Int. 2022;14:441-52.

17. Sifat AE, Nozohouri S, Archie SR, et al. Brain energy metabolism in ischemic stroke: effects of smoking and diabetes. Int J Mol Sci. 2022;23:8512.

18. Moon S, Yang YS, Kimm H, et al. Do Weight Changes Affect the Association between Smoking Cessation and the Risk of Stroke Subtypes in Korean Males?. Int J Environ Res Public Health. 2023;20:4712.

19. Bukhari S, Yaghi S, Bashir Z. Stroke in young adults. Med Educ. 2023;12:4999.

20. National Center for Chronic Disease Prevention and Health Promotion (US) Office on Smoking and Health. The Health Consequences of Smoking—50 Years of Progress: A Report of the Surgeon General. Atlanta: Centers for Disease Control and Prevention. 2014.

21. Thomson, B, Islami F. Association of smoking cessation and cardiovascular, cancer, and respiratory mortality. JAMA Intern Med. 2023;184:110-2.

22. Joshy G, Soga K, Thurber K, et al. Relationship of tobacco smoking to cause-specific mortality: contemporary estimates from Australia. BMC Med. 2025;23:115.