

Burden of Chronic Obstructive Pulmonary Disease Attributable to Air Pollution in Türkiye (1990–2021)

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Received: 21.12.2024
Accepted: 17.06.2025
Available Online: 09.09.2025

Objective: Exposure to particulate matter and ozone has been linked to decreased lung capacity, hospitalizations, and mortality from Chronic Obstructive Pulmonary Disease (COPD). This study aims to evaluate the mortality rate attributed to air pollution-related Chronic Obstructive Pulmonary Disease (COPD) in Türkiye over the past 30 years.

Materials and Methods: This was a epidemiological study. Age-standardized mortality statistics for COPD caused by outdoor (Particulate Matter 2.5 and Ozone) and indoor (solid fuel) air pollution were obtained from the Global Burden of Disease (GBD) database. Changes in cause-specific death rate trends in Türkiye between 1990 and 2021 were assessed using Joinpoint regression analysis to calculate annual percentage changes (APC) and average annual percentage changes.

Results: Age-standardized mortality rates (ASMRs) declined from 48.41 (per 100,000) (95% CI: 39.31; 55.91) to 35.78 (95% CI: 24.03; 44.40) with an APC of -0.26 (95% CI: -0.46; -0.04) over the 1990-2021 period for both sexes. While there is a consistent downward trend in ASMRs attributed to household air pollution from solid fuels for both genders, different upward trends were observed over the years for ASMRs attributed to ambient particulate matter pollution and ambient ozone pollution.

Conclusion: Over the last 30 years in Türkiye, while the mortality rate linked with solid fuel consumption has generally decreased, the mortality rates associated with PM and ozone have fluctuated. This suggests that legislation addressing indoor air quality has been effective, but health risks associated with outdoor air quality have persisted in Türkiye over the past 30 years.

Keywords: Air pollution, Chronic Obstructive Pulmonary Disease, Trend analysis, Türkiye

1. INTRODUCTION

The consumption of fossil fuels to ensure the economic development of societies is a significant underlying factor contributing to air pollution¹. Air pollution, defined by the World Health Organization (WHO) as the greatest environmental threat to human health, causes an annual premature death toll of 6.7 million. Nearly one-third of these deaths are attributed to household air pollution². Ambient particulate matter (PM) is a mixture of solid and liquid particles in air, with variations in size, chemical composition, and properties due to natural or human-induced sources such as driving vehicles and operating manufacturing or power plants³. Ground level (tropospheric) ozone is not emitted directly; rather, it results from a photochemical process in which pollutants such as nitrogen oxides (NOx) and volatile organic compounds (VOCs) react in the presence of sunlight⁴.

Air pollution is known to cause not only acute effects on human health, such as infections and asthma attacks but also chronic issues associated with atherosclerotic processes, leading to conditions like heart attacks, strokes, Chronic Obstructive Pulmonary Disease (COPD), and lung cancer⁵⁻⁷. Exposure to particulate matter and ozone has been linked to decreased lung capacity, hospitalizations, and mortality from Chronic Obstructive Pulmonary Disease (COPD)⁸. Chronic Obstructive Pulmonary Disease (COPD) is generally associated with smoking, presenting as a progressive disease with components of chronic bronchitis and emphysema⁹. In the etiology of COPD, apart from genetic predisposition, factors such as indoor and outdoor air pollution, occupational exposure, exposure to substances irritating the respiratory tract, and recurrent respiratory infections can be considered¹⁰. In 2019, Chronic Obstructive Pulmonary Disease (COPD) ranked as the third leading cause of global

Cite as: Uysal A, Han Yektaş D. Burden of chronic obstructive pulmonary disease attributable to air pollution in Türkiye (1990–2021). *Sakarya Med J*. 2025;15(3):208-217. doi:10.31832/smj.1605178

mortality with 3.23 million deaths. While tobacco smoking accounts for over 70% of COPD cases in high-income countries, it constitutes 30-40% of cases in low and middle-income countries, where household air pollution emerges as a significant risk factor¹¹. According to the guidelines set by the World Health Organization (WHO) in 2021, the annual average concentration limit for PM_{2.5} is set at 5 µg m⁻³. For PM₁₀, the annual average limit is 15 µg m⁻³. The 8-hour average concentration limit for Ozone (O₃) is set at 100 µg m⁻³¹². For existing pollutants, the EU limits are higher than those set by the WHO limits¹³. In Türkiye, according to the Black Report, the population affected by air pollution constitutes 9 out of every 10 individuals⁵. In Türkiye's national air quality legislation, PM₁₀ limits with an annual average value of 40 µg m⁻³ while there is no specified limit for PM_{2.5}¹⁴.

In the literature, there are numerous studies globally that utilize Global Burden of Disease (GBD) data to investigate the morbidity and mortality associated with air pollution^{15,16}. Despite the existence of studies in Türkiye that investigate the trend of air pollution¹⁷, there is currently no research specifically examining long time period of Chronic Obstructive Pulmonary Disease (COPD) mortality attributed to air pollution in the country. The purpose of this text is to examine the age-standardized mortality rate attributed to chronic obstructive pulmonary disease (COPD) due to air pollution in Türkiye between 1990 and 2021.

2. METHODOLOGY

2.1. Design and settings

The study has an epidemiological and descriptive design.

2.2. Data Sources and search parameters

This study focused on female and male patients in Türkiye who had been diagnosed with COPD due to a variety of risk factors. In the study, numbers, rates, age-standardized rates (adjusted to the WHO's standard population), and percentages of COPD fatalities attributed to risk factors were obtained from the Global Health Data Exchange (GHDx: <http://ghdx.healthdata.org/>). The age-

standardized mortality rates from chronic obstructive pulmonary disease caused by air pollution (ambient particulate matter pollution, household air pollution from solid fuels, and ambient ozone pollution) were collected from the freely available GBD Results Tools repository¹⁸. The search parameters were "chronic obstructive pulmonary disease" and specific estimated risk factors for cause; "ambient particulate matter pollution", "ambient ozone pollution", "household air pollution from solid fuels" for risk; "deaths" for measurements; "1990-2021" for years; "Türkiye" for location; and "number, rate, and percent" for metrics. The Guidelines for Accurate and Transparent Health Estimates Reporting guidelines were followed in this study.

2.3. GBD estimation framework

The GBD study's Cause of Death (COD) database is a collection of data from multiple primary source documents, such as vital registration, sample vital registration, and verbal autopsy reports. The incidence and mortality data go through a multi-step process that includes age-group adjustments and the aggregation of implausible and unspecified COD codes. The COPD estimates included the use of International Classification of Diseases (ICD) 10 codes (J40-J44)¹⁸.

2.4. Ethical considerations

Because the data for the study was gathered from online open access databases, ethical approval and institutional permission were not obtained. Informed permission was not acquired because disease-specific mortality statistics were used in the study.

2.5. Statistical analyses

The study analyzed COPD mortality proportions over 30 years from 1990 to 2019, using Joinpoint software to assess trends. Joinpoint regression equation is as follows;

$$(x_1, y_1), \dots, (x_n, y_n), x_1 \leq \dots \leq x_n$$

$$E[y/x] = \beta_0 + \beta_1 x + \delta_1 (x - \tau_1)^+ + \dots + \delta_k (x - \tau_k)^+$$

where x: independent variable (time), y: dependent variable, $\beta_0, \beta_1, \delta_1, \delta_k$: regression

coefficients, τ_k : unknown joinpoint, δ_k = differences in slope.

The analysis included logarithmic transformation, homoscedasticity, and the weighted Bayesian Information Criterion. The Average Annual Percentage Change (AAPC) is a weighted average of annual percentage changes from Joinpoint trend analysis, with each segment's length as weight. The Average Annual Percentage Change (AAPC) and its associated 95% Confidence Interval were calculated to assess the scale and trajectory of recent trends. To examine mortality trends, we utilized Joinpoint software version 5.0.2.0, which is accessible at <https://surveillance.cancer.gov/joinpoint/>¹⁹.

This software facilitates the fitting of consecutive linear segments to the trend in age-standardized rates. In our analysis, we specified options such as applying a logarithmic transformation to rates and percentages, ensuring consistent variance (homoscedasticity), and utilizing the weighted Bayesian Information Criterion (BIC) restricted with a maximum of 3 joinpoints. We presented the Annual Percentage Change (APC) by identifying breakpoints in the trend and calculating the APC's between these breakpoints. The study rejects the null hypothesis that the true AAPC is zero at a significance level of $\alpha < 0.05$.

3.RESULTS

In Türkiye, in the year 1990, 72,320.07 (95% CI: 64,626.47; 80,148.87) new cases of chronic obstructive pulmonary disease (COPD) for both sex were observed, while this number increased to

210,198.95 (95% CI: 190,484.36; 230,494.14) in the year 2021.

According to mortality data, in the year 1990, there were 16,229.55 (95% CI: 12,848.83; 18,924.69) count of deaths, whereas by the year 2021, this number had risen to 34,044.47 (95% CI: 28,218.89; 40,618.51) deaths.

From 1990 to 2021, the percentage of deaths due to chronic obstructive pulmonary disease (COPD) among all-cause mortality increased from 5.41% (95% CI: 4.88; 5.79) to 5.48% (95% CI: 4.96; 5.92). On the other hand age-standardized mortality rates (ASMR's) were declined from 57.54 (per 100 thousand) (95%CI: 45.02; 67.31) to 40.77 (95%CI: 33.86; 48.52) with -0,29 (95%CI:-0,44; -0,03) APC in 1990-2021 time period for both sex. Between the same years, a decrease in ASMRs was observed, declining from 33.73 to 26.49 in females and from 88.48 to 59.18 in males.

Table 1 presents data on COPD mortality attributed to three types of pollution: ambient particulate matter pollution (PM_{2.5}), ambient ozone pollution (O₃), and household air pollution from solid fuels over the period from 1990 to 2021. The number of deaths, percentage of deaths, rates per 100,000 population, and disability-adjusted life years (DALY) are provided for each type of pollution. The findings reveal that the number of deaths attributed to PM_{2.5} pollution increased from 315,191 in 1990 to 722,692 in 2021. During this period, the percentage of deaths remained stable at around 0.19% to 0.22%. Correspondingly, DALY associated with PM_{2.5} pollution increased substantially from 74,362.21 to 160,222.59.

Table 1.*COPD mortality attributed to some pollutants between the years 1990 and 2021 in Türkiye*

Year	Ambient particulate matter pollution (PM _{2.5})			Ambient Ozone Pollution (O ₃)			Household Air Pollution from Solid Fuels		
	Death Number	Rate*	DALY (year)	Death Number	Rate*	DALY (year)	Death Number	Rate*	DALY (year)
1990	3151,91	5,48	74362,21	1999,15	3,47	40282,04	963,77	1,67	22853,58
1991	3130,66	5,34	75668,52	1966,74	3,35	40340,97	880,72	1,50	21504,71
1992	3163,93	5,30	77220,23	1998,01	3,35	41153,61	820,04	1,37	20245,87
1993	3220,85	5,31	79048,51	2129,18	3,51	43882,27	766,42	1,26	19030,80
1994	3287,34	5,33	81047,89	2201,77	3,57	45389,44	717,24	1,16	17894,00
1995	3324,52	5,31	82288,90	2279,18	3,64	46914,72	664,05	1,06	16628,50
1996	3349,71	5,27	83146,10	2115,30	3,33	43379,77	607,71	0,95	15255,21
1997	3374,05	5,24	84026,00	2102,12	3,26	42928,31	551,55	0,85	13892,03
1998	3378,99	5,17	84621,35	1970,93	3,01	40115,98	494,29	0,75	12530,16
1999	3378,08	5,10	85232,60	1894,01	2,86	38477,58	443,85	0,67	11344,42
2000	3308,83	4,93	83776,19	1731,25	2,58	34787,18	395,45	0,58	10136,13
2001	3264,30	4,80	82773,75	1743,92	2,56	34667,99	360,24	0,53	9242,64
2002	3225,70	4,69	81899,46	1971,04	2,86	38794,57	330,85	0,48	8504,49
2003	3370,27	4,85	84696,72	2095,45	3,01	40902,58	320,53	0,46	8160,23
2004	3497,14	4,98	87072,78	2146,97	3,06	41521,07	307,39	0,43	7757,87
2005	3680,27	5,19	90723,25	2044,39	2,88	39188,54	293,63	0,41	7337,16
2006	3920,56	5,47	95590,20	2333,24	3,25	44229,55	271,14	0,37	6698,18
2007	4290,06	5,93	103041,33	2564,58	3,55	47920,68	246,89	0,34	5997,93
2008	4806,58	6,59	113159,57	2906,62	3,98	53489,40	224,91	0,30	5341,07
2009	5458,14	7,42	125827,94	2960,54	4,02	53897,91	206,52	0,28	4787,57
2010	5760,02	7,77	132138,98	2921,58	3,94	52996,12	179,15	0,24	4134,65
2011	5956,67	7,97	136142,10	3108,91	4,16	56233,24	153,50	0,20	3534,18
2012	6136,88	8,15	139013,17	3390,77	4,50	60835,78	128,37	0,17	2927,09
2013	6423,43	8,45	143328,88	3660,52	4,81	65009,90	106,71	0,14	2389,91
2014	6691,68	8,69	147499,19	3539,87	4,59	62325,03	88,05	0,11	1939,77
2015	6968,31	8,89	151745,75	3649,66	4,66	63610,74	73,80	0,09	1602,76
2016	7175,39	9,00	155393,01	3761,47	4,72	65236,57	62,52	0,07	1351,39
2017	7126,18	8,82	155115,36	3851,29	4,76	66777,03	50,81	0,06	1106,44
2018	6954,55	8,49	152861,03	3751,19	4,58	65160,04	40,74	0,04	897,18
2019	7089,45	8,57	154844,39	3879,23	4,69	66945,03	35,02	0,04	767,30
2020	6637,45	7,97	144792,28	3987,96	4,79	68761,40	31,53	0,03	689,73
2021	7226,92	8,64	160222,59	3925,36	4,69	68480,62	35,95	0,04	798,83

*Rate: Indicates per 100.000 population.

For ambient ozone pollution, the number of deaths ranged from 196,674 in 1991 to a peak of 398,796 in 2020. The percentage of deaths fluctuated slightly, remaining around 0.12% to 0.13%, before decreasing to 0.11% in recent years. The rate per 100,000 population varied, starting at 347 in 1991 and reaching up to 479 in 2020, before slightly decreasing. DALY associated with ozone pollution showed an increasing trend from 4,028,204 in 1990 to 6,876,140 in 2020.

Deaths due to household air pollution from solid fuels showed a marked decline from 96,377 in 1990 to 3,595 in 2021. The percentage of deaths

attributed to this source of pollution dropped from 0.059% to 0.001%. Similarly, the rate per 100,000 population decreased from 167 to 4, and DALY significantly declined from 2,285,358 in 1990 to 79,883 in 2021.

The trend analysis of age-standardized mortality rates (ASMR) attributed to COPD was performed considering different independent variables, including gender, pollution type, and various time periods (Table 2, Figure 1). For females exposed to ambient ozone pollution, five breakpoints were identified: 1990-1995, 1995-2000, 2000-2005, 2005-2008, 2008-2015, and 2015-2021.

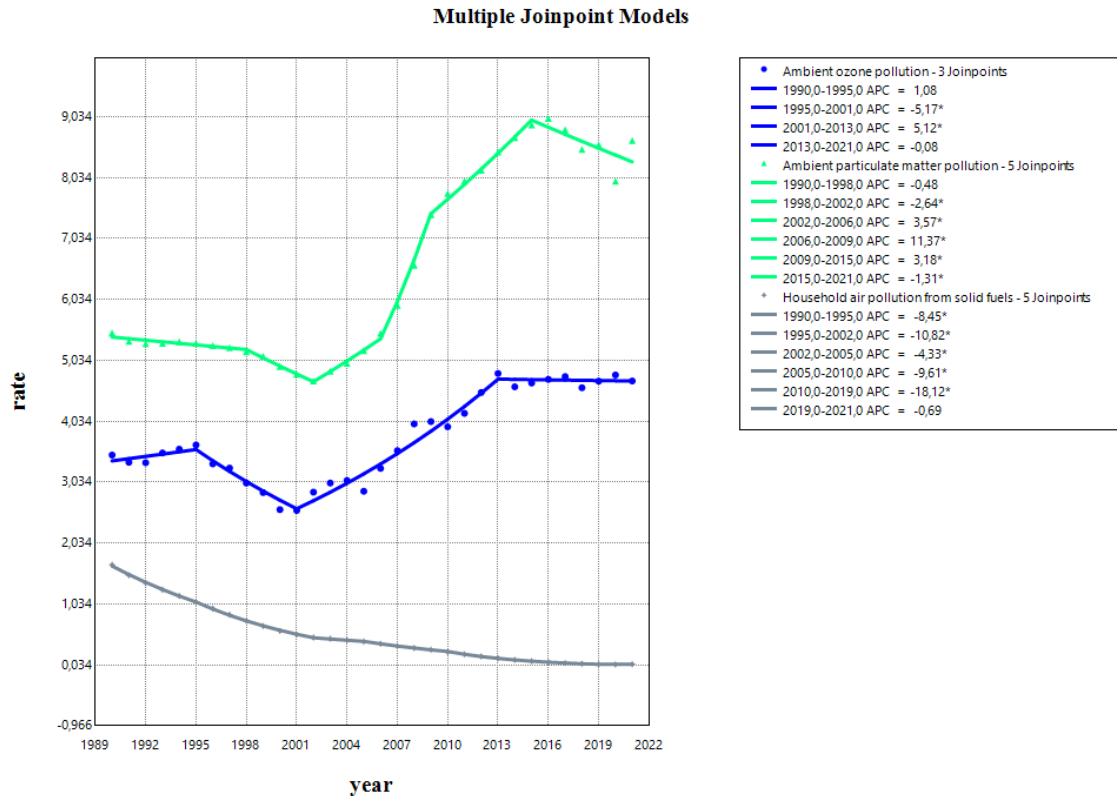
Table 2.*Trend analysis results of ASMR mortality rates attributed to COPD for some independent variables*

Gender	Pollution Type	Breakpoint count	Breakpoint Period	APC between breaks (95% CI)	p	AAPC (95% CI)	p
Female	Ambient Ozone Pollution	5	1990-1995	0.91 (-4.20; 6.29)	0.361	1.52 (1.11; 1.89)	<0.001
			1995-2000	-4.48 (-8.87; 4.54)	0.127		
			2000-2005	1.88 (-6.09; 10.68)	0.318		
			2005-2008	10.71 (-0.21; 19.96)	0.059		
			2008-2015	3.96 (-4.51; 8.92)	0.121		
			2015-2021	-0.32 (-5.61; 4.92)	0.655		
Male	Ambient Particulate Matter _{2.5}	3	1990-2005	-0.35 (-0.68; -0.04)	0.023	1.84 (1.65; 1.99)	<0.001
			2005-2009	12.47 (10.17; 15.81)	<0.001		
			2009-2016	3.77 (2.65; 5.07)	<0.001		
			2016-2021	-2.16 (-4.30; -0.77)	0.004		
	Household air pollution from solid fuels	4	1990-2002	-9.26 (-10.02; -8.85)	<0.001	-10.89 (-11.12; -10.75)	<0.001
			2002-2009	-6.92 (-7.89; -4.58)	<0.001		
			2009-2016	-16.17 (-16.75; -14.48)	<0.001		
			2016-2019	-20.72 (-22.42; -18.53)	<0.001		
			2019-2021	1.22 (-3.32; 4.86)	0.473		
Total	Ambient Particulate Matter _{2.5}	5	1990-1995	1.79 (-0.03; 4.06)	0.053	0.856 (0.63; 1.08)	<0.001
			1995-2000	-7.18 (-11.24; -5.41)	<0.001		
			2000-2013	4.44 (3.94; 5.14)	<0.001		
			2013-2021	-0.21 (-1.47; 0.73)	0.613		
	Household air pollution from solid fuels	5	1990-1997	-0.40 (-0.99; 0.62)	0.0231	1.16 (1.02; 1.28)	<0.001
			1997-2002	-2.95 (-5.13; -1.91)	0.025		
			2002-2006	4.45 (-0.15; 6.60)	0.055		
			2006-2010	8.63 (6.75; 10.58)	<0.001		
			2010-2015	2.03 (0.68; 3.71)	0.026		
Total	Household air pollution from solid fuels	5	2015-2021	-1.14 (-2.49; 0.43)	0.019	-11.48 (-11.70; -11.29)	<0.001
			1990-1995	-8.36 (-9.50; -5.97)	<0.001		
			1995-2002	-11.60 (-14.22; -10.92)	<0.001		
			2002-2005	-2.62 (-5.92; -0.98)	0.002		
			2005-2011	-11.72 (-13.03; -10.96)	<0.001		
			2011-2019	-18.93 (-19.93; -19.56)	<0.001		
Total	Ambient Particulate Matter _{2.5}	5	2019-2021	1.28 (-2.87; 4.22)	0.288	1.06 (0.82; 1.32)	<0.001
			1990-1995	1.07 (-0.73; 4.21)	0.239		
			1995-2001	-5.17 (-8.44; -3.61)	0.004		
			2001-2013	5.12 (4.48; 6.09)	0.002		
			2013-2021	-0.08 (-1.48; 0.92)	0.082		
	Household air pollution from solid fuels	5	1990-1998	-0.48 (-0.97; 0.77)	0.194	1.38 (1.25; 1.51)	<0.001
			1998-2002	-2.63 (-4.47; -0.11)	0.049		
			2002-2006	3.57 (0.67; 8.79)	0.031		
			2006-2009	11.36 (3.93; 12.82)	<0.001		
			2009-2015	3.18 (1.75; 4.06)	0.034		
Total	Household air pollution from solid fuels	5	2015-2021	-1.31 (-2.41; -0.44)	0.025	-11.23 (-11.50; -11.01)	<0.001
			1990-1995	-8.45 (-9.93; -4.36)	<0.001		
			1995-2002	-10.82 (-14.09; -5.54)	<0.001		
			2002-2005	-4.32 (-9.75; -2.30)	<0.001		
			2005-2010	-9.61 (-19.28; -8.67)	<0.001		
			2010-2019	-18.12 (-19.03; -17.18)	<0.001		
Total	Household air pollution from solid fuels	5	2019-2021	-0.69 (-5.79; 2.37)	<0.001		

APC: Annual Percentage Change; AAPC: Average Annual Percentage Change; 95%CI: 95% Confidence Interval.

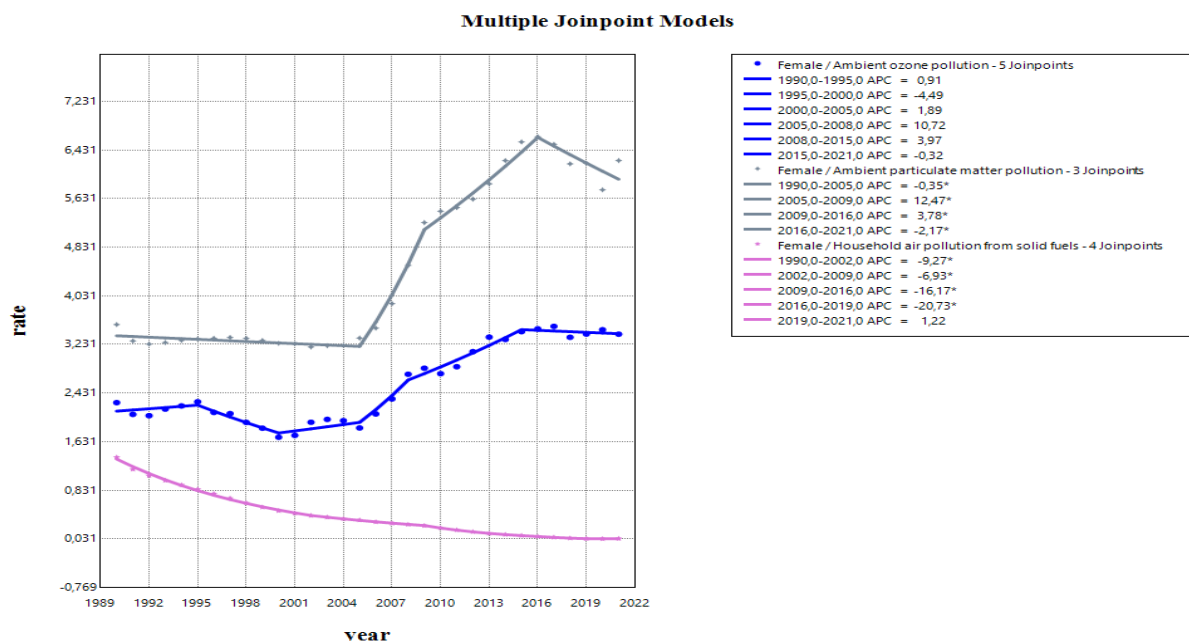
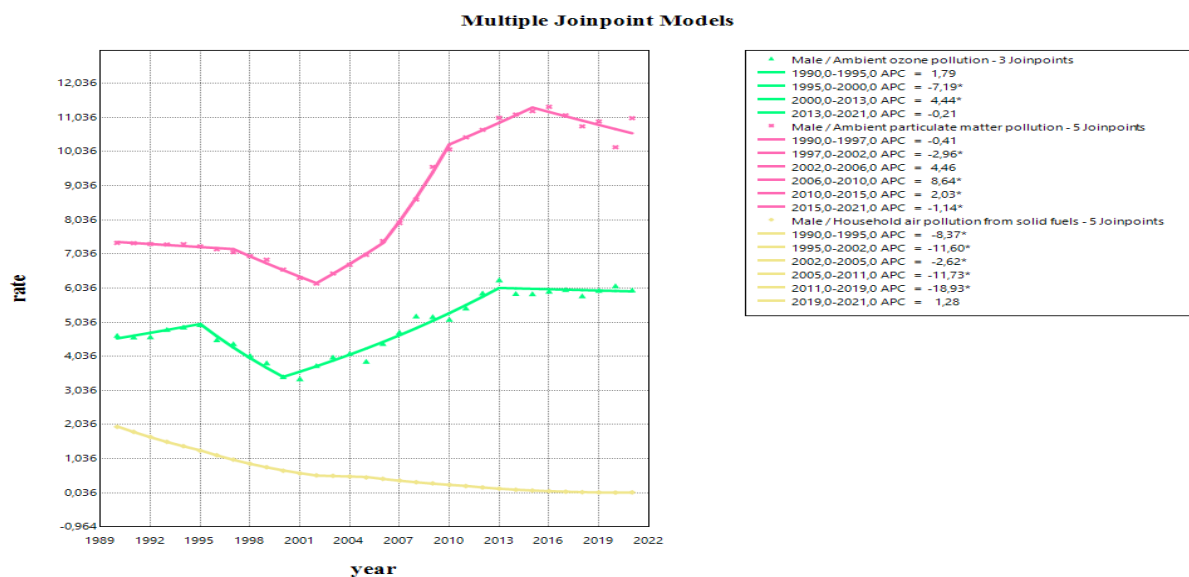
Figure 1.

Trend of age-standard mortality rates for COPD attributed to various pollutants, between the years 1990 and 2021 in Türkiye



The annual percentage change (APC) varied significantly between these periods, with notable increases and decreases. The average annual percentage change (AAPC) for this group was 1.52 (95% CI: 1.11-1.89), indicating a significant trend ($p < 0.001$). In the case of ambient particulate matter (PM_{2.5}), three breakpoints were identified for females: 1990-2005, 2005-2009, and 2009-2016, 2016-2021. Significant APC increases were observed, particularly a 12.47% rise from 2005 to 2009. The AAPC was 1.84 (95% CI: 1.65-1.99), suggesting a significant upward trend ($p < 0.001$). For household air pollution from solid fuels in females, four breakpoints were noted: 1990-2002, 2002-2009, 2009-2016, and 2016-2019, 2019-2021. The APC was generally negative, indicating a decline over these periods, with the most significant decrease being -20.72% from 2016 to 2019. The AAPC was -10.89 (95% CI: -11.12 to -10.75), ($p < 0.001$) (Figure 2). Among males, three

breakpoints were identified for ambient ozone pollution: 1990-1995, 1995-2000, 2000-2013, and 2013-2021. The APC showed both negative and positive values across different periods, with an AAPC of 0.856 (95% CI: 0.63-1.08), ($p < 0.001$). For ambient particulate matter (PM_{2.5}) in males, five breakpoints were found: 1990-1997, 1997-2002, 2002-2006, 2006-2010, 2010-2015, and 2015-2021. Significant APC changes were observed, such as an 8.63% increase from 2006 to 2010. The AAPC was 1.16 (95% CI: 1.02-1.28), ($p < 0.001$). Regarding household air pollution from solid fuels in males, five breakpoints were identified: 1990-1995, 1995-2002, 2002-2005, 2005-2011, and 2011-2019, 2019-2021. The APC values were mostly negative, indicating declines, with the largest decrease being -18.93% from 2011 to 2019. The AAPC was -11.48 (95% CI: -11.70 to -11.29), ($p < 0.001$) (Figure 3).

Figure 2.*JP Regression analysis of ASMRs attributed three risk factors in COPD for female gender***Figure 3.***JP Regression analysis of ASMRs attributed three risk factors in COPD for male gender*

For the total population, ambient ozone pollution showed three breakpoints: 1990-1995, 1995-2001, 2001-2013, and 2013-2021. The APC indicated mixed trends, with the AAPC being 1.06 (95% CI: 0.82-1.32), indicating a significant overall trend ($p < 0.001$). In terms of ambient particulate matter (PM_{2.5}) for the total population, five breakpoints were identified:

1990-1998, 1998-2002, 2002-2006, 2006-2009, 2009-2015, and 2015-2021. The APC values varied, with significant increases in some periods. The AAPC was 1.38 (95% CI: 1.25-1.51), indicating a significant trend ($p < 0.001$). Finally, for household air pollution from solid fuels in the total population, five breakpoints were observed: 1990-1995, 1995-2002, 2002-2005, 2005-2010,

2010-2019, and 2019-2021. The APC values were generally negative, indicating significant declines. The AAPC was -11.23 (95% CI: -11.50 to -11.01), reflecting a significant downward trend ($p < 0.001$).

4.DISCUSSION

Air pollution continues to affect many people today. In this study, the trend of Chronic Obstructive Pulmonary Disease (COPD) mortality associated with outdoor and indoor air pollution in Türkiye over the past 30 years has been examined. In Türkiye, during the specified period, the number of new COPD cases increased approximately threefold from around 70,000 to 210,000, while the mortality data showed a twofold increase from around 16,000 to 30,000. Although, according to the Global Burden of Disease (GBD) data, the mortality rate attributed to COPD among all causes of death in Türkiye increased from 5.41% to 5.48% between 1990 and 2021. The age-standardized mortality rate related to ambient particulate matter and ambient ozone pollution has increased, while the rate related to household air pollution from solid fuels has decreased.

According to a research study examining the trend of Chronic Obstructive Pulmonary Disease (COPD) mortality attributed to ambient particulate matter (PM) and solid fuel consumption on a global scale from 1990 to 2021, the Age-Standardized Mortality Rate (ASMR) related to solid fuel consumption showed a decreasing trend, while the COPD mortality trend associated with ambient PM exhibited a fluctuating pattern. Additionally, the ASMRs were found to be higher in the male gender²⁰. Our research findings are in line with the existing literature. Both in this study and in the literature, the higher prevalence of ASMR in men may contribute more to their employment²¹, and indirectly, it can be associated with increased exposure to outdoor air pollution. On the other hand, the transition from coal, which emits excessive amounts of carbon dioxide, to natural gas and renewable energy sources²², as well as indoor air quality regulations in Türkiye and around the World, may have contributed to a reduction in COPD mortality rates caused by

indoor air pollution. According to another research study examining respiratory diseases attributed to air pollution on a global scale over the past 30 years, it has been reported that the mortality rate attributed to Chronic Obstructive Pulmonary Disease (COPD) and lower respiratory tract infections shows a decreasing trend, while there is an increasing trend in the mortality rate of lung cancer²³. Our research has focused on the impact of air pollution on COPD mortality, but it is necessary to conduct additional studies on different health effects.

In Türkiye, the transition to heating with natural gas is a positive development in reducing indoor air pollution. However, 85% of the country's energy needs are still met by fossil fuels²⁴. Another improvement in indoor air quality is the implementation of smoke-free air policies under the Framework Convention on Tobacco Control²⁵. Nevertheless, issues related to outdoor air quality persist. Moreover, there is no legally defined limit for PM_{2.5} exposure, which is particularly concerning given its carcinogenic and chronic inflammatory effects^{26,27}. Additionally, the "Black Report" regularly published by the Clean Air Right Platform highlights problems such as the insufficient number and poor positioning of outdoor air quality monitoring stations, which prevent a full representation of the air pollution situation in Türkiye²⁸. COPD has various underlying etiological factors, with smoking being the most significant²⁹. Other determinants include occupational exposure, genetic factors such as alpha-1 antitrypsin deficiency, recurrent lung infections and chronic bronchitis³⁰. This study focuses on COPD mortality attributed to air pollution.

In conclusion, the transition from solid fuel consumption for heating purposes to alternative sources is believed to have resulted in a significant decrease in Age-Standardized Mortality Rates (ASMRs) attributed to household air pollution from solid fuels. However, despite this decline, it can be argued that the increase in the number of people, distorted urbanization, and rural-to-urban migration, along with the growing traffic, have led to observed fluctuations in ASMRs attributed to ambient particulate matter pollution.

and ambient ozone pollution during different periods. The lack of desired reductions in some intervals, along with identified increases in death rates during specific time intervals, is thought to be explainable by these factors.

Article Information Form

Authors' Contribution

Concept – AU, DHY; Supervision – DHY; Materials – AU; Data Collection and/or Processing – DHY; Analysis and/or Interpretation – AU, DHY; Writing –AU.

The Declaration of Conflict of Interest/ Common Interest

No conflict of interest or common interest has been declared by authors.

Artificial Intelligence Statement

No artificial intelligence tools were used while writing this article.

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REFERENCES

1. Lei R, Feng S, Lauvaux T. Country-scale trends in air pollution and fossil fuel CO₂ emissions during 2001–2018: Confronting the roles of national policies and economic growth. *Environmental Research Letters*. 2020;16(1):014006.
2. WHO. Ambient (outdoor) air pollution. Accessed 15.11.2023, 2023. [https://www.who.int/news-room/fact-sheets/detail/ambient-\(outdoor\)-air-quality-and-health](https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health)
3. Adams K, Greenbaum DS, Shaikh R, van Erp AM, Russell AG. Particulate matter components, sources, and health: Systematic approaches to testing effects. *Journal of the Air & Waste Management Association*. 2015;65(5):544-558.
4. Donzelli G, Suarez-Varela MM. Tropospheric Ozone: A Critical Review of the Literature on Emissions, Exposure, and Health Effects. *Atmosphere*. 2024;15(7):779.
5. Manisalidis I, Stavropoulou E, Stavropoulos A, Bezirtzoglou E. Environmental and health impacts of air pollution: A review. *Frontiers in Public Health*. 2020;8:14.
6. Robertson S, Miller MR. Ambient air pollution and thrombosis. *Particle and Fibre Toxicology*. 2018;15(1):1-16.
7. Wellenius GA, Burger MR, Coull BA, et al. Ambient air pollution and the risk of acute ischemic stroke. *Archives of internal medicine*. 2012;172(3):229-234.
8. Nakhjirgan P, Kashani H, Kermani M. Exposure to outdoor particulate matter and risk of respiratory diseases: A systematic review and meta-analysis. *Environmental Geochemistry and Health*. 2024;46(1):20.
9. Cazzola M, Blasi F. There is still no established and accepted definition of COPD. *Respiratory Medicine*. 2023;214
10. Stolz D, Mkorombindo T, Schumann DM, et al. Towards the elimination of chronic obstructive pulmonary disease: A Lancet Commission. *The Lancet*. 2022;400(10356):921-972.
11. WHO. Chronic obstructive pulmonary disease (COPD). Accessed 16.11.2023, 2023. <https://www.who.int/news-room/fact-sheets/detail/chronic-obstructive-pulmonary-disease-%28copd%29>
12. WHO. WHO global air quality guidelines: particulate matter (PM_{2.5} and PM₁₀), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide. Accessed 16.11.2023, 2023. <https://www.who.int/publications/i/item/9789240034228>
13. European Union. EU air quality standards. Accessed 16.11.2023, 2023. https://environment.ec.europa.eu/topics/air/air-quality/eu-air-quality-standards_en
14. Ministry of Environment UaCC. Air Quality Assessment and Management Regulation. Accessed 16.11.2023, 2023. <https://www.mevzuat.gov.tr/File/GeneratePdf?mevzuatNo=12188&mevzuatTur=Kuru mVeKurulusYonetmeli&mevzuatTertip=5>
15. Zou J, Sun T, Song X, et al. Distributions and trends of the global burden of COPD attributable to risk factors by SDI, age, and sex from 1990 to 2019: A systematic analysis of GBD 2019 data. *Respiratory Research*. 2022;23(1):90.

16. Cohen AJ, Brauer M, Burnett R, et al. Estimates and 25-year trends of the global burden of disease attributable to ambient air pollution: An analysis of data from the Global Burden of Diseases Study 2015. *The Lancet*. 2017;389(10082):1907-1918.
17. Inandi T, Eltaş MC, Kerman B. Türkiye'de Havadaki PM¹⁰ ve SO² Düzeyindeki Değişimler, 2005-2015. *Türkiye Klinikleri Tıp Bilimleri Dergisi*. 2018;38(3):209-217.
18. Vos T, Lim SS, Abbafati C, et al. Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019: A systematic analysis for the Global Burden of Disease Study 2019. *The Lancet*. 2020;396(10258):1204-1222.
19. NC I. Joinpoint regression program, Version 5.0.2. Accessed 27.11.2023, <https://surveillance.cancer.gov/joinpoint>
20. Wu Y, Zhang S, Zhuo B, et al. Global burden of chronic obstructive pulmonary disease attributable to ambient particulate matter pollution and household air pollution from solid fuels from 1990 to 2019. *Environmental Science and Pollution Research*. 2022;29(22):32788-32799.
21. Akdemir S, Özaktaş FD, Aksoy N. Türkiye'de ve seçilmiş ülkelerde kadının işgücü piyasasındaki yeri. *Karadeniz Uluslararası Bilimsel Dergi*. 2019;(43):184-202.
22. Özbektaş S, Şenel MC, Sungur B. Dünyada ve Türkiye'de yenilenebilir enerji durumu ve kuruluş maliyetleri. *Mühendis ve Makina*. 2023;64(711):317-351.
23. Wu Y, Song P, Lin S, et al. Global burden of respiratory diseases attributable to ambient particulate matter pollution: Findings from the global burden of disease study 2019. *Frontiers in Public Health*. 2021;9:740800.
24. T.C. Ministry of Environment U, and Climate Change. Türkiye ulusal enerji planı https://enerji.gov.tr//Media/Dizin/EIGM/tr/Raporlar/TUEP/T%C3%BCrkiye_Ulusal_Enerji_Plan%C4%B1.pdf
25. Aslan D. Dünyada ve Türkiye'de tütün kontrolünde yeni bir dönem başladı: Tütün Kontrolü Çerçeve Sözleşmesi. *Sürekli Tıp Eğitimi Dergisi*. 2005;14(1):19-21.
26. Feng S, Huang F, Zhang Y, et al. The pathophysiological and molecular mechanisms of atmospheric PM_{2.5} affecting cardiovascular health: A review. *Ecotoxicology and Environmental safety*. 2023;249:114444.
27. T.C. Ministry of Environment U, and Climate Change. Hava Kalitesi değerlendirme ve yönetimi yönetmeliği. 2008.
28. Report D. Dark Report reveals the health impacts of air pollution in Turkey. 2021;
29. Hikichi M, Mizumura K, Maruoka S, Gon Y. Pathogenesis of Chronic Obstructive Pulmonary Disease (COPD) induced by cigarette smoke. *Journal of Thoracic Disease*. 2019;11(Suppl 17):S2129.
30. Mannino DM, Buist AS. Global burden of COPD: Risk factors, prevalence, and future trends. *The Lancet*. 2007;370(9589):765-773.