

Estimated mortality and burden of disease related to air pollution in Albania during 1990-2021

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Abstract

We aimed at assessing mortality and disease burden attributable to air pollution in Albania. This analysis was based on the mortality and morbidity estimates for Albania supplied by the Global Burden of Disease 1990 and 2021 studies, reported by the Institute for Health Metrics and Evaluation. In Albania, during 1990-2021, the decline in mortality rate and promotional mortality due to air pollution was among the steepest in the Southeastern European region. The (age-standardized) proportional mortality due to air pollution in Albania in 1990 ($\approx 25\%$) was considerably higher than in Central Europe (17%), in Eastern Europe (15%), and especially in the Western European region (9%). Nonetheless, in 2021, this difference was substantially reduced: 9% (Albania), 6% (Central Europe), 5% (Eastern Europe), and 3% (Western Europe). Seemingly, interventions targeting household air pollution have been effective in Albania. Future efforts, however, should focus on controlling outdoor air pollution, particularly fine particulate matter (PM_{2.5}), to prevent an increase in respiratory and cardiovascular diseases. Hence, continued focus on reducing ambient particulate matter pollution in Albania is needed to further align with the European Union standards.

Key words: air pollution, Albania, burden of disease, Disability-Adjusted Life Year (DALYs), Institute for Health Metrics and Evaluation (IHME), morbidity, mortality.

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Introduction

In its last report on global air quality guidelines, the World Health Organization (WHO) highlights that, each year, air pollution exposure is estimated to contribute to millions of deaths and lost years of healthy life each year.¹ Furthermore, the disease burden caused by air pollution is currently considered comparable to other major global health risks, including unhealthy diets and tobacco smoking.^{1,2} As a matter of fact, according to WHO, air pollution is now acknowledged as the greatest environmental threat to human health.^{1,3,4}

In addition, in synergy with tobacco smoking, air pollution accounts for about one-third of the burden of Non-Communicable Diseases (NCDs).^{2,5} As one of the two main leading causes of NCDs, at a global scale, air pollution is responsible for about 6.7 million deaths every year.^{2,5} Notably, almost 90% of mortality due to ambient/outdoor air pollution is registered in Low-and Middle-Income Countries (LMICs), which are characterized by rapid industrialization and urbanization processes resulting in substantial emissions.^{1,2,6} Also, one-third of the global population, mainly concentrated in LMICs, still depends on solid fuels including wood, coal, and dung for cooking and heating,⁷ leading to increased exposure to household air pollution.²

The evidence that has guided the revision of the WHO air qual-

ity guidelines¹ has emerged from two robust systematic reviews and meta-analysis,^{8,9} which assessed the health effects of long-term exposure to ambient particles and gases [nitrogen dioxide (NO₂) and ozone (O₃)]. A fairly recent meta-analysis including 83 studies for NO₂ and 26 studies for O₃,¹⁰ has reported annual exposure to NO₂ to be linked to mortality outcomes (all causes, respiratory diseases, chronic obstructive pulmonary disease, acute lower respiratory infections), except for cerebrovascular mortality and O₃ linked to respiratory mortality.¹⁰

Environmental exposures are increasingly acknowledged as key contributors to the burden of cardiovascular disease,¹¹ which constitutes the leading cause of death worldwide.¹² As the leading environmental risk factor, air pollution is globally involved in 6-9 million deaths, mainly due to ischaemic heart disease and stroke.^{3,13} Strong evidence identifies fine Particulate Matter (PM_{2.5}) as the primary component of air pollution responsible for the most significant health effects, consistently linked to adverse health outcomes.^{3,14}

PM_{2.5} pollution is contributed by both household air pollution and ambient sources.³ Notwithstanding considerable variations in sources and chemical composition, the health effects from both these sources of pollution are acknowledged as causal factors in a range of NCDs including cardiovascular disease.^{3,11,15}

Albania, a post-communist country in Southeastern Europe,

has boarded in the past three decades on a challenging transition to a market-oriented economy, which has been also marked by significant changes in the health status of the general population.¹⁶ The increase in life expectancy, the decline in fertility rate, and the continuous population ageing have all contributed to a remarkable shift in morbidity and mortality patterns in the Albanian population.^{16,17} In 2021, the crude mortality rate from all NCDs in Albania was more than two times higher than in 1990,¹⁸ a year which corresponds to the breakdown of the communist system.¹⁶ Cardiovascular diseases are the main cause of death in the Albanian population, comprising 47% of the overall proportional mortality.¹⁸ Within cardiovascular diseases, ischemic heart disease is the main cause of death, involving about one fifth of the overall mortality in the Albania population.¹⁸

However, there is scarce evidence and lack of scientific reports on the health effects of air pollution or other environmental factors in the Albanian population. In this context, the aim of this analysis was to assess the mortality and disease burden attributable to air pollution in the general population of Albania, based on the most recent estimates provided by the Institute for Health Metrics and Evaluation (IHME).¹⁸

Materials and Methods

This analysis was based on the mortality and morbidity estimates for Albania supplied by the Global Burden of Disease (GBD) 1990 and 2021 studies, which are reported by IHME.¹⁸ IHME estimates mortality for all countries employing a combination of approaches, including statistical modelling, disease-specific models, and cause-of-death analysis.^{18,19} IHME's statistical modelling relies on data from vital registration systems, surveys, and other available national and international sources of information.¹⁹ The envisaged models account for variations in data quality and completeness, as well as differences in mortality rates across age groups and regions globally.^{18,19}

Furthermore, IHME uses disease-specific models to estimate mortality for selected diseases or conditions.^{18,19} Additionally, cause-of-death modelling is employed to estimate mortality by specific causes, which is essential for identifying the main causes of death across different populations, including Albania.¹⁹ These models incorporate data from medical certifications, verbal autopsy, and other sources to estimate cause-specific mortality rates.^{18,19} To ensure accuracy, the IHME's methodology includes data quality assessments, adjustments for misclassification and incomplete reporting, and reconciliation of conflicting sources.¹⁹

Also, IHME uses "ensemble modelling", which is a method that combines multiple models to produce more accurate estimates of mortality. This approach evaluates strengths and weaknesses of different modelling methods and includes uncertainty into the estimates provided.^{18,19} These advanced statistical techniques, including "cause of death ensemble model" and Bayesian hierarchical models, are used by IHME to refine estimates across different age groups, sexes, and regions.^{18,19} The approach employed by IHME also includes trend analysis and forecasting to track historical mortality patterns and predict future health outcomes.^{18,19}

For Albania, IHME primarily relies on data provided by the National Institute of Statistics (INSTAT) to estimate mortality and cause-of-death patterns.¹⁸ This data includes official records from the civil registration system, population censuses, and household surveys that track demographic and health indicators in Albania. In cases where vital registration data may be incomplete or inconsis-

tent, IHME applies statistical adjustments and integrates supplementary sources including international health databases, to improve accuracy.¹⁹ Combination of multiple data streams by IHME ensures that its mortality estimates for Albania and other countries are as comprehensive and reliable as possible.^{18,19}

In our analysis, crude and age-standardized estimates for mortality and disease burden expressed in Disability-Adjusted Life Years (DALYs) attributable to air pollution were employed for Albania for the year 1990 (breakdown of the communist regime) and 2021 (most recent estimates reported by IHME; Table 1).

Next, the age-standardized estimates of mortality and burden of disease due to air pollution for Albania were compared with the neighbouring countries (Montenegro, North Macedonia, Bosnia and Herzegovina, Serbia, Croatia, and Slovenia; Table 2).

Subsequently, the age-standardized estimates of proportional mortality and burden of disease due to air pollution for Albania were compared with the following European regions: Eastern Europe, Central Europe, and Western Europe¹⁸ (Figure 1).

Results

Table 1 presents selected indicators on mortality and burden of disease attributable to air pollution in Albania in 1990 and in 2021. There was evidence of a decrease in the crude mortality rate due to air pollution in the Albanian population (upper panel), which was even steeper for the age-standardized rates (from 215 to 66 deaths per 100,000 population, respectively). In line with the overall mortality, there was a significant decrease in mortality level from chronic respiratory diseases attributable to air pollution from 1990 to 2021 (age-standardized rates: about 27 vs. 4 deaths per 100,000 population, respectively). Notably, the (age-standardized) proportional share of chronic respiratory disease deaths among all deaths due to air pollution dropped from around 46% to 17%. Furthermore, deaths due to household air pollution from solid fuels decreased significantly in Albania (age-standardized rates: from 168 deaths in 1990 to 18 deaths in 2021, per 100,000 population), likely due to reduced reliance on traditional biomass fuels. In contrast, mortality rate from ambient particulate matter pollution increased in Albania from 1990 to 2021 (age-standardized rates: approximately 45 to 48 deaths per 100,000 population, respectively), indicating that outdoor pollution has become a more prominent concern. The burden of disease trends (lower panel) exhibited a similar pattern as the mortality rates.

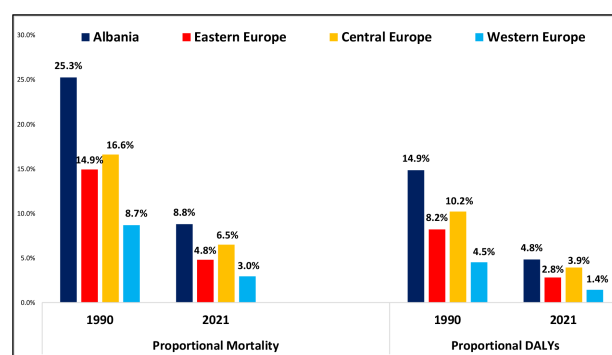


Figure 1. Age-standardized all-cause proportional mortality and disease burden (*expressed in DALYs*) attributable to air pollution in Albania vis-à-vis different European regions in 1990 and in 2021.¹⁸

Table 2 presents (age-standardized) mortality and disease burden indicators attributable to air pollution in Albania and its neighbouring countries in 1990 and in 2021. In Albania, the decline in air pollution mortality rate was among the steepest in the region (first panel). Hence, in 1990, Albania had one of the highest air pollution mortality rates in the Southeastern European region (215 deaths per 100,000 population), second only to Serbia (255 deaths per 100,000 population). By 2021, Albania's mortality rate due to air pollution dropped to 66 per 100,000 population, exhibiting a substantial improvement, whereas countries like Montenegro and especially North Macedonia still faced higher rates (respectively with 96 and 133 deaths per 100,000 population). Furthermore, the proportional mortality from air pollution decreased more in Albania compared with the other countries in the region (second panel). Thus, in 1990, slightly more than one in four deaths in Albania were attributed to air pollution, representing one of the highest estimates in the region. By 2021, this figure dropped to about around 9%, a larger reduction than in Bosnia (from about 27% to 12%) or Serbia (from 21% to 10%). Additionally, in 1990, Albania had one of the highest chronic respiratory disease mortality rates (27 deaths per 100,000 population), which was much higher than in Croatia and particularly in Montenegro (6.4 and 2.5 deaths per 100,000 population, respectively; first panel). In 2021, mortality rate from chronic respiratory diseases in Albania had decreased to 3.6 deaths per 100,000 population, which was even lower than in Croatia, but not in Slovenia. In line with the decrease in mortality rates, there was evidence of a similar decline in the

burden of disease (expressed in DALYs) attributable to air pollution in the Albanian population (third panel). In 1990, Albania had one of the highest air pollution-related DALYs (around 5000 per 100,000) among all countries in the region. By 2021, however, it decreased to slightly less than 1300 DALYs per 100,000, which was lower than most of the Western Balkan countries, though still higher than Croatia and especially Slovenia. Likewise, during the period 1990-2021, the proportional burden of disease attributable to air pollution declined in Albania more significantly than in other Southeastern European countries (fourth panel).

Compared to the average estimates in different European regions (Figure 1), the (age-standardized) proportional mortality due to air pollution in Albania in 1990 (about 25%) was considerably higher than in Central Europe (17%), in Eastern Europe (15%), and especially in the Western European region (9%). Nonetheless, in 2021, this difference was substantially reduced: 9% (Albania), 6% (Central Europe), 5% (Eastern Europe), and 3% (Western Europe). A similar trend was evident for the proportional disease burden due to air pollution in Albania vis-à-vis different European regions (Figure 1).

Discussion

This analysis provides useful evidence about the mortality and morbidity trends related to air pollution in the Albanian population during the period 1990-2021. Notably, findings from this analysis

Table 1. Mortality and disease burden indicators attributable to air pollution in Albania in 1990 and in 2021.¹⁸

Upper panel: mortality indicators				
Indicator	Crude		Age-standardized	
	1990	2021	1990	2021
All-cause mortality due to air pollution (deaths per 100,000 population)	119	100	215	66
Proportional all-cause mortality due to air pollution (percentage of all deaths)	22.8	8.9	25.3	8.8
Chronic respiratory disease mortality due to air pollution (deaths per 100,000 population)	13.1	5.6	26.6	3.6
Proportional chronic disease mortality due to air pollution (percentage of all deaths)	46.2	17.2	47.6	17.2
All-cause mortality due to particulate matter pollution (deaths per 100,000 population)	118	99	213	66
Proportional all-cause mortality due to particulate matter pollution (percentage of all deaths)	22.6	8.8	25.0	8.7
All-cause mortality due to ambient particulate matter pollution (deaths per 100,000 population)	25.1	72.2	45.2	47.9
Proportional all-cause mortality due to ambient particulate matter pollution (percentage of all deaths)	4.8	6.4	5.3	6.4
All-cause mortality due to household air pollution from solid fuels (deaths per 100,000 population)	93	27	168	18
Proportional all-cause mortality due to household air pollution from solid fuels (percentage of all deaths)	17.8	2.4	19.7	2.4
Lower panel: burden of disease indicators [Disability-Adjusted Life Years (DALYs)]				
Indicator	Crude		Age-standardized	
	1990	2021	1990	2021
All-cause burden of disease due to air pollution (DALYs per 100,000)	3721	1854	5027	1287
Proportional all-cause burden of disease due to air pollution (percentage of all DALYs)	12.9	5.3	14.9	4.8
Chronic respiratory disease burden due to air pollution (DALYs per 100,000)	274	122	493	77
Proportional chronic respiratory disease burden due to air pollution (percentage of all DALYs)	36.2	15.0	40.9	13.7
Asthma burden due to air pollution (DALYs per 100,000)	1.5	1.2	1.3	1.9
Proportional asthma burden due to air pollution (percentage of all DALYs)	0.6	0.6	0.4	1.2
All-cause burden of disease due to particulate matter pollution (DALYs per 100,000)	3701	1841	4993	1278
Proportional all-cause burden of disease due to particulate matter pollution (percentage of all DALYs)	12.9	5.3	14.8	4.8
All-cause burden of disease due to ambient particulate matter pollution (DALYs per 100,000)	766	1342	1046	931
Proportional all-cause burden of disease due to ambient particulate matter pollution (percentage of all DALYs)	2.7	3.9	3.1	3.5
All-cause burden of disease due to household air pollution from solid fuels (DALYs per 100,000)	2935	498	3946	346
Proportional all-cause burden of disease due to household air pollution from solid fuels (percentage of all DALYs)	10.2	1.4	11.7	1.3

indicate that, while overall air pollution-related health impacts have decreased in the Albanian population in the past three decades, urban air quality appears to be worsening, as observed in the increase in the all-cause mortality due to ambient particulate matter pollution. On the other hand, our analysis indicates that Albania has made significant progress in reducing air pollution-related health impacts compared to neighbouring countries. However, despite improvements, Albania still has a higher air pollution disease burden than European Union (EU) countries like Slovenia and Croatia.

During communist regime in Albania, the mining industry and mineral processing, and the old technology of former chemical industry had caused several environmental problems to the country.²⁰ Nonetheless, there was no official data reported on metal atmospheric deposition in Albania during communist era. The first moss biomonitoring dated from 2010 with its first contribution to the data on European moss biomonitoring.²⁰ Since, there have been several periodic reports on metal concentrations and contamination levels in Albania.^{20–22} The first survey conducted in 2010 has reported high metal concentrations levels and a relatively high contamination level evaluated by moss biomonitoring.^{21,22} More recently, an evaluation of air quality in Albania by moss biomonitoring and metals atmospheric deposition found significant differences in the concentrations of heavy metals compared with 2010.²⁰ According to this study, the pollution loading index that

was employed for assessment of the content of metal contamination indicated moderate pollution throughout Albania.²⁰ Yet, heavy metal concentration in mosses in Albania exhibited various patterns for different elements by presenting a diverse geographic variability.²⁰ The eastern region of Albania can be classified as

highly a polluted area from anthropogenic elements derived by geological and anthropogenic emission sources.²⁰ This may impact crop cultivation for human and animal consumption, leading to the accumulation of trace metals and posing potential health risks.²⁰ On the other hand, the western agricultural land area in Albania is a relatively safer zone for food production.²⁰

On another aspect, an analysis of the most recent data from the Albanian Demographic and Health Survey has documented significant associations between household air pollution and risk of hypertension among Albanian adults.²³ Hence, overall, participants exposed to household polluting fuels in Albania were 17% more likely to develop hypertension than those not exposed to household air pollution.²³ The risk was especially higher among women, low-income households, participants with no education, and those residing in rural areas of Albania.²³

Conversely, a study conducted in 2012 in some regions of Albania has reported that dust levels in streets and houses were comparable to those on roads, indicating that substantial amounts of particulate matter were emitted both indoors and outdoors in Albania.²⁴ While this may be no longer the case in Albania, fine particulate matter (PM_{2.5}) continues to be a serious cause of concern which should raise the awareness of policymakers and decision-makers in this EU candidate country.

Our analysis is constrained by its dependence on secondary data from the Global Burden of Disease studies, which may not entirely reflect local differences or the most recent trends in Albania. GBD estimates for Albania are derived from models, and any gaps, flaws, or methodological variations in data collection and reporting may impact the validity of the estimates. Furthermore, our analysis does not include primary data sources in

Table 2. Mortality and disease burden indicators attributable to air pollution in Albania and its neighbouring countries in 1990 and in 2021.¹⁸

First panel: mortality rates (deaths per 100,000 population)														
Mortality rates*	Albania		Montenegro		North Macedonia		Bosnia and Herzegovina		Serbia		Croatia		Slovenia	
	1990	2021	1990	2021	1990	2021	1990	2021	1990	2021	1990	2021	1990	2021
All-causes	215	66	127	96	224	133	211	92	255	92	131	41	76	17
Chronic respiratory diseases	27	3.6	2.5	1.7	15	6.2	22.2	6.3	16.0	5.2	6.4	4.5	28.9	2.7
Second panel: proportional mortality (percent of all deaths)														
Proportional mortality*	Albania		Montenegro		North Macedonia		Bosnia and Herzegovina		Serbia		Croatia		Slovenia	
	1990	2021	1990	2021	1990	2021	1990	2021	1990	2021	1990	2021	1990	2021
All-causes	25.3	8.8	17.5	8.4	22.5	10.7	26.6	12.2	21.3	10.3	13.1	6.1	10.0	3.7
Chronic respiratory diseases	48	17	37	26	42	26	64	35	39	23	26	22	29	20
Third panel: burden of disease indicators (DALYs per 100,000)														
Burden of disease	Albania		Montenegro		North Macedonia		Bosnia and Herzegovina		Serbia		Croatia		Slovenia	
	1990	2021	1990	2021	1990	2021	1990	2021	1990	2021	1990	2021	1990	2021
All-causes	5027	1287	2947	1771	5188	2401	4861	1961	5130	1839	2599	821	1704	404
Chronic respiratory diseases	493	77	74	47	323	131	489	150	321	122	145	88	190	55
Fourth panel: proportional burden of disease indicators (percent of all DALYs)														
Proportional burden of disease*	Albania		Montenegro		North Macedonia		Bosnia and Herzegovina		Serbia		Croatia		Slovenia	
	1990	2021	1990	2021	1990	2021	1990	2021	1990	2021	1990	2021	1990	2021
All-causes	15	4.8	10	5.4	14	6.8	16	7.2	13	6.4	7.8	3.4	5.7	2.0
Chronic respiratory diseases	41	14	21	13	29	18	49	23	32	18	18	15	20	10

* Age-standardized for both 1990 and 2021.

the Albanian population based on exposure levels to air pollution and its related mortality and morbidity indicators. The absence of primary data on air pollution exposure and disease-related indicators presents significant limitations in accurately assessing health impacts in the Albanian population. Reliance on modelled estimates or secondary data may not fully capture local pollution sources, seasonal variations, or population-specific exposure patterns. Additionally, differences in data collection methodologies, reporting inconsistencies, and potential biases in extrapolated findings can affect the reliability of health risk assessments for Albania and other countries in the Western Balkans region.^{18,19} Therefore, without direct measurements, it is challenging to establish precise exposure-response relationships, limiting the ability to assess the true burden of air pollution on population health.

Nevertheless, our analysis provides useful evidence about the health impact of air pollution in the Albanian population. Findings from this analysis suggest a need to address outdoor air pollution by implementing stricter air quality regulations, promoting public transportation, and encouraging green urban planning. Additionally, Albania should collaborate with neighbouring countries to address cross-border air pollution and implement joint policies for cleaner industries. On the other hand, Albania should increase investments in air pollution monitoring stations and integrate real-time data into health policies. Also, there is need to educate the general public in Albania on air pollution-related health risks and encourage behavioural changes.

Conclusions

Our analysis informs about the impact of air pollution on mortality and burden of disease in the Albanian population. On the face of it, interventions targeting household air pollution (such as shifting from solid fuels to cleaner energy sources) have been effective in Albania. Future efforts, however, should focus on controlling outdoor air pollution, especially fine particulate matter (PM_{2.5}), to prevent an increase in respiratory and cardiovascular diseases.

In conclusion, Albania's progress in air pollution reduction is commendable, but further measures are essential to prevent rising outdoor air pollution from reversing these gains. Hence, continued focus on reducing ambient particulate matter pollution in Albania is needed to further align with the EU standards.

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