ETC HE Report 2023/7

Health Risk Assessment of Air Pollution: assessing the environmental burden of disease in Europe in 2021

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Corrigendum to the report ETC HE 2023/7, published 22 November 2023

In the ETC HE Report 2023/7: Health Risk Assessment of Air Pollution: assessing the environmental burden of disease in Europe in 2021, published on 22/11/2023 https://www.eionet.europa.eu/etcs/etc-he/products/etc-he-products/etc-he-reports/etc-he-report-2023-7-health-risk-assessment-of-air-pollution-assessing-the-environmental-burden-of-disease-in-europe-in-2021/etc-he-report-2023-7-version-1-published-22-november-2023, an error occurred in the modelling of the cause-specific burden of disease estimates for ischaemic heart disease (IHD) related to long-term exposure to PM2.5. For this risk-outcome pair, this led to incorrect results for absolute attributable deaths (AD), years of life lost (YLL) and disability-adjusted life years (DALY) and their rates per 100 000 inhabitants. This applied both to the individual countries considered and to the aggregated values for Europe/all countries.

Following a correction of the calculation model, changes have been made to the original text, in particular in Sections 4.1.4 and 4.4, to the figures, in particular Figures 4.4 and 4.10, and to Annex Tables A2.13, A2.14 and A216.

Summary

The European Environment Agency and the European Topic Centre on Human Health and the Environment (ETC HE and its predecessors) have produced environmental burden of disease (EBD) air pollution assessments for almost a decade. These assessments, also known until now as health risk assessments (HRA) of air pollution, offer an objective and comparable estimate of the burden of disease due to air pollution at the country and European level since 2014. The burden of disease presented in this report expands from the work presented in previous Eionet reports on HRA. The estimates presented here include all-cause mortality and cause-specific mortality and morbidity health outcomes, with ten risk-outcome pairs considered for the cause-specific estimates. Aligning cause-specific mortality and morbidity allows assessing the overall impact on human health based on a common indicator, disability-adjusted life years (DALYs), and the respective shares contributing to the population mortality and morbidity effects comparatively across European countries. The work done to prepare this report also focused on creating a glossary of the terminology used for the EBD, leading to changes in how the EEA - ETC HE conveys the message about the extent of disease caused by environmental risks such as air pollution and helps to streamline the terminology and communication of results with other studies such as the Global Burden of Disease studies. Regardless, the methodology has stayed the same to estimate burden of disease indicators. We also adopted the term attributable deaths (AD) instead of premature deaths.

This report estimates the EBD related to air pollution in 2021. The estimations differentiate the EBD of the individual pollutants and make use of the air quality maps produced by the ETC HE. These maps are a product of data fusion based on the validated monitoring data reported by EEA Member States, modelling data and other supplementary information. The estimates consist of all-cause and cause-specific mortality indicators (attributable deaths (AD) and years of life lost (YLL)), cause-specific morbidity indicators (years lived with disability (YLD) and attributable hospitalisation cases), as well as (cause-specific) disability-adjusted life years (DALY) related to exposure to fine particulate matter ($PM_{2.5}$), nitrogen dioxide (NO_2), and ozone (O_3), both for the 27 Member States of the European Union (EU27) and for additional 14 European countries (Albania, Andorra, Bosnia and Herzegovina, Iceland, Kosovo under UNSCR 1244/99, Liechtenstein, Monaco, Montenegro, North Macedonia, Norway, San Marino, Serbia, Switzerland, and Türkiye). Türkiye is not included in the case of $PM_{2.5}$, as there was insufficient monitoring data to support the mapping production in the country with the required quality.

In 2021, long-term exposure to concentration levels above the 2021 World Health Organisation air quality guideline levels (5 µg/m3 for $PM_{2.5}$ and 10 µg/m3 for NO_2) resulted in 293 000 AD from all-causes related to PM2.5 and 69 000 related to NO_2. There were 27 000 AD related to short-term exposure to O_3 (annual sum of daily maximum running 8-h average concentrations over 35 ppb). For EU27, the AD were estimated at 253 000, 52 000 and 22 000, respectively. When considering both the number of deaths and the age at which it occurs, the YLL (YLL per 100 000 inhabitants) is 2 936 000 (618) for long-term exposure to $PM_{2.5}$ and 740 000 (132) to NO_2, and 299 000 (54) due to short-term exposure to O_3. For EU27, YLL (YLL per 100 000 inhabitants) are 2 584 000 (584), 532 000 (120), 234 000 (53), respectively. When comparing long-term exposure, both all-cause and cause-specific analyses point to $PM_{2.5}$ as the pollutant with the strongest health effects. The cause-specific estimates resulted in 2 510 442 DALY for all countries or 2 294 842 DALY for the EU27. The burden attributable to NO_2 was considerably lower, with 634 721 DALY and 403 788 DALY in all countries and in the EU27, respectively. Looking at the single disease entities, ischemic heart disease contributed the most to the overall burden of $PM_{2.5}$, with 741 383 DALY in all countries and 688 979 DALY in the EU27. The lowest burden was related to asthma (children), with 25 932 and 23 969 DALY within all countries and the EU27, respectively. For NO_2, the highest disease burden was associated with diabetes mellitus (314 574 DALY; EU27: 197 031 DALY) and the lowest with asthma (adults) (all countries: 115 425 DALY; EU27: 62 460 DALY). No corresponding indicators were calculated for O_3, yet short-term exposure to O_3 was associated with 15 986 attributable hospital admissions in the selected European countries.

When comparing the results, it is important to note that different age groups (i.e., children, adults, and elderly) were considered in the estimates according to the relevant concentration-response functions.

1 Introduction

Burden of disease describes the impact of a health outcome (e.g., a disease) on a population's health. It can be measured by different indicators, such as mortality, morbidity and costs. An Environmental Burden of Disease (EBD) assessment uses a systematic approach to estimate the share of the disease burden that can be attributed to exposure to an environmental risk factor, such as the exposure of a population to air pollution.

The European Environment Agency (EEA) and the European Topic Centre on Human Health and the Environment (ETC HE and its predecessors) have produced EBD assessments of air pollution for almost a decade. These assessments, also known as health risk assessments (HRA) of air pollution, offer an objective and comparable estimate of the burden of disease due to air pollution at the country and European level since 2014. The estimations differentiate the EBD of three individual pollutants, fine particulate matter ($PM_{2.5}$), nitrogen dioxide (NO_2), and ozone (O_3) and make use of the air quality maps produced by the ETC HE (e.g., ETC HE, 2023). These maps are a product of data fusion based on the validated monitoring data reported by EEA Member States, modelling data and other supplementary information. These EBD assessments have focused on the risk of all-cause natural mortality due to exposure to outdoor air pollution. All-cause natural deaths are classified by the International Classification of Diseases, Tenth Revision (ICD-10), an alphanumeric classification that contains codes for diseases, signs and symptoms, abnormal findings, social factors and external causes of mortality or morbidity, as the number of deaths excluding the ones due to accidents and a group of unspecified coded deaths (ICD 10 Codes R00-R99 "Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified"). From now on, all-cause natural mortality will be referred to as all-cause mortality. Until now, the focus has been on mortality health outcomes rather than morbidity since mortality generally captures a large share of the burden of disease. In addition, there was better availability and quality of mortality data from death registries than morbidity data.

Up to 2021, the assessments were based on the World Health Organisation (WHO) recommendations in the HRAPIE report (WHO, 2013) to estimate the all-cause mortality risk of exposure to outdoor air pollution in Europe. These assessments focused on estimating two mortality indicators: attributable deaths (AD) and years of life lost due to death (YLL). In 2022, the estimation of attributable mortality followed the updated WHO Air Quality Guidelines (AQG) (WHO, 2021a). The AQG provide up-to-date health-based guideline levels for major health-damaging air pollutants and updated recommendations on a concentration-response function (CRF) in relation to a critical health outcome for a relevant average time. Our EBD considers the health-based guideline levels for $PM_{2.5}$ and NO_2 as the concentration values above which are estimated to have an impact (counterfactual concentrations) as WHO considers that exceeding the recommended health-based guideline levels will carry substantial risks to human health. The Eionet report ETC HE 2022/10 (ETC HE, 2022a) assessed the sensitivity of the mortality outcomes estimation to these new CRF and counterfactual concentrations by comparing them with the ones previously used, i.e., those based on WHO (2013). The study concluded that changing assumptions on CRFs and counterfactual concentrations have implications for estimating the two mortality health outcomes.

The year 2022 also marks an expansion in the assessment, as the burden of disease for morbidity-related health outcomes was estimated for the first time and made publicly available in the Eionet report ETC HE 2022/11 (ETC HE, 2022b) and the corresponding EEA briefing (EEA, 2022). Although assessing the burden of disease considering only mortality captures an important share of the burden of disease (GBD 2019 Risk Factors Collaborators, 2020), it does not capture the comprehensive impact of diseases and risk factors on population health (Pifarré i Arolas et al., 2021; Plass et al., 2013). Studies show that ambient air pollution is associated with several acute and chronic conditions associated with air pollution exposure. For instance, the results of the Global Burden of Disease (GBD) 2019 study (GBD 2019 Diseases and Injuries Collaborators, 2020) clearly indicate that, for certain outcomes, the share of morbidity is not negligible. Even for diseases with high mortality burden, such as lung cancer (LC), ischemic heart disease (IHD), and chronic obstructive pulmonary disease (COPD), the share of morbidity in Western Europe was estimated at 1.4, 5, and 36 %, respectively (IHME, 2022).

Considering the evidence of the aggravation of chronic conditions due to air pollution and the improvement of the health data related to morbidity, the Eionet report ETC HE 2022/11 (ETC HE, 2022b) describes the methodological approach used. Also, it provides information on the evidence-base for the association between air pollutants and health outcomes, health data and concentration-response functions. It considers a wide range of morbidity health outcomes associated with different outdoor air pollutants in Europe, using a consistent methodology and data from European health databases. The assessment considered ten risk-outcome pairs, but the results showed that the highest morbidity in Europe is related to the burden of disease for $PM_{2.5}$ associated with COPD, for NO_2, the highest morbidity burden resulted from diabetes mellitus (DM) and for short-term O_3 exposure from hospital admissions due to respiratory diseases, which in case of O_3 was the only considered morbidity outcome.

Lastly, the work done to prepare this report focused on creating a glossary (see Annex 3) of the terminology used for the EBD, leading to changes in how the EEA - ETC HE conveys the message about the extent of disease caused by environmental risks such as air pollution. In addition, the new wording is intended to help streamline the terminology and communication of results with other studies, such as the GBD 2019 study (GBD 2019 Diseases and Injuries Collaborators, 2020). We have adopted the terminology EBD instead of HRA, as the latter is a more complex assessment process typically beginning with a problem formulation, followed by hazard identification, hazard characterization, exposure assessment and risk characterization (WHO, 2021b). We also adopted the term attributable deaths (AD) instead of premature deaths. Methodologically, a premature death is defined as a death occurring before a person has reached an expected or normatively set limit to life. When using the concept of remaining life expectancy, as done in these EBD assessments, every death is premature, even if occurring at ages over 95 years. Regardless of these changes in terminology, the methodology has stayed the same to estimate the burden of disease indicators.

This report presents the burden of disease due to air pollution associated with all-cause mortality and cause-specific mortality and morbidity outcomes. It builds on the work presented in the previously mentioned Eionet reports ETC HE 2022/10 (ETC HE, 2022a) and 2022/11 (ETC HE, 2022b) and complements the burden of disease assessment by providing results using the disability-adjusted life years (DALYs) as a summary measure of population health. All-cause estimations consider the CRFs estimated in epidemiological studies referenced in the WHO AQG (WHO, 2021a). Cause-specific estimations use mostly CRFs from the European ELAPSE project (Effects of Low-Level Air Pollution: A Study in Europe) that includes some of the most recent studies on the health effects at low air pollution levels by examining associations between exposures to relatively low levels of air pollution across Europe, including levels below the current EU standards. Both calculation approaches used the AQG annual values recommended by (WHO, 2021) for $PM_{2.5}$ and NO_2 and maintain the WHO (2013) for O_3. as counterfactual concentrations. Section 2 briefly describes the methodological approach to estimating the burden of disease for all-cause mortality and cause-specific morbidity and mortality. We present burden of disease estimates for $PM_{2.5}$, NO_2, and O_3 ambient concentration levels across 40 or 41 European countries in 2021 for all-cause mortality in Section 3 and combined cause-specific mortality and morbidity in Section 4. Section 5 discusses the differences between estimating all-cause mortality and cause-specific mortality and morbidity and the combination of the two. Section 6 lists other considerations about the present analysis and further work on the EBD presented by the EEA-ETC HE. The conclusions are laid down in Section 7.

2 Estimation of health outcomes

EBD (or HRA) assesses a specific health outcome or a set of health outcomes in a given population. In the present EBD, the risk of mortality or morbidity in a population due to exposure to air pollution is represented by the CRF, which is based on Relative Risk (RR), hazard ratios (HR), or odd Ratios (OR) estimates derived from epidemiological studies. The nature of these epidemiological studies differ in how to quantify the risk/or chance of having an outcome after a certain exposure, comparing an exposed group against a non or lower-exposed group.B Mortality or morbidity due to air pollution can be quantified by combining pollutant-dependent CRF with ambient air quality data, population data, and the baseline frequency of the health outcome, such as the number of death cases or the prevalence of a disease (demographic data per country, age, and sex).

In this assessment, the population health impact attributable to exposure to $PM_{2.5}$, NO_2, and O_3 in 41 European countries (the 27 EU member states (EU27), Albania, Andorra, Bosnia and Herzegovina, Iceland, Kosovo, Liechtenstein, Monaco, Montenegro, North Macedonia, Norway, San Marino, Serbia, Switzerland, and Türkiye (only for NO_2 and O_3)) is quantified in terms of four burden of disease indicators:

- **Number of attributable deaths (AD):** a death which is statistically attributable to exposure to a risk factor, e.g., $PM_{2.5}$. The attribution is based on the evidence from studies for the causal link between a risk factor and the health outcome leading to death. In previous EBD assessments, the term “premature death” was used instead to continue with the same term used since the beginning of the EBD calculations and to be aligned with the terminology used in the zero pollution action plan under the European Green Deal (EC, 2021). However, methodologically, a premature death is defined as a death occurring before a person has reached an expected or normatively set limit to life. When using the concept of remaining life expectancy, as done in the EEA-ETC HE analyses, every death is premature, even if occurring at ages over 95 years.
- **Years of life lost (YLL):** measures the years lost due to death before reaching a specifically selected life expectancy value. The YLL per 100 000 inhabitants is also used in this report as an indicator to be comparable across countries.
- **Years lived with disability (YLD):** measures years of life lost due to living in a state of reduced overall health. The YLD per 100 000 inhabitants is also used in this report as an indicator to be comparable across countries.
- **Disability-adjusted life years (DALY):** an indicator of the burden of disease, which counts losses of healthy life years resulting from a disease or attributable to a certain risk factor. The DALY combines the population-based mortality (YLL) and morbidity (YLD) effects and is a widely used summary measure of population health. It is used to compare the population health impacts of diseases, injuries and risk factors and is the sum of YLL and YLD. The DALY per 100 000 inhabitants is also used in this report as an indicator to be comparable across countries.

2.1 Methodology

The ETC/ATNI Report 2019/13 (ETC/ATNI, 2019) and references therein describe the steps to estimate the mortality-related indicators, and the ETC HE (2022b) report describes the cause-specific morbidity calculation. Since it is not the focus of this report, a summary of the methodology is found in Annex 1. At the same time, Section 2.2 describes the input data and preparatory steps for the estimations presented in this report on the burden of disease related to all-cause mortality and combined cause-specific mortality and morbidity.

As underlined by the ETC HE reports (ETC HE, 2022a and 2022b), there are differences in the methodology to estimate all-cause mortality and cause-specific mortality or morbidity burden of disease. The burden of disease based on all-cause mortality is estimated on a 1x1 km^2 grid using concentration and population density maps (see Section 2.2.1). The estimation at the grid cell level is then aggregated to obtain the health outcomes at the country and, e.g., EU27 level. In the case of cause-specific morbidity and mortality, the population exposure for an individual country is estimated for specific concentration classes using the concentration and population density maps in a 1x1 km^2 grid resolution and then aggregated to larger areas. The population data and the counterfactual concentrations to estimate the risk are the same, independent of the calculation approach (all-cause or cause-specific). However, there are different estimations between the two approaches based on stratified data by year, differing age intervals, and sex. Furthermore, different age groups, e.g., total population or adults over 30 years, are considered. These differences are explained in Section 2.2.

Two important aspects of the estimations need to be stressed. One is the shape of the risk function for the different pollutants considered here. The latest review by Chen and Hoek (2020) states that most of the studies analysed showed a linear or supra-linear relationship between the $PM_{2.5}$ levels and the respective health outcomes. Huangfu and Atkinson (2020) indicate that few studies have investigated the shape of the CRF, with the studies available pointing to a linear relationship between concentration and health outcomes for NO_2. A lesser degree of investigation on O_3 was done, and no conclusions were drawn. However, the WHO AQG (WHO, 2021a) has not recommended changes in the shape of the function for risk calculation for any of the pollutants discussed here. Thus, here, we assume a linear increase in the risk of mortality of x % for a y µg/m^3 increase in concentration. For instance, the all-cause mortality risk due to $PM_{2.5}$ exposure increases by 8 % for a 10 µg/m^3 increase in $PM_{2.5}$ annual mean concentrations when considering the 2021 WHO AQG recommendations.

The second aspect is that quantifications of health impacts for these air pollutants are done individually, and they cannot be added together, as they exhibit some degree of correlation — positive or negative. For example, HRAPIE (WHO, 2013) suggested that adding the all-cause mortality results for $PM_{2.5}$ and NO_2 may lead to a double counting the effects (overlap of up to 30 %).

2.2 Input data and preparatory steps

This section describes the input data and preparatory steps to estimate the EBD attributable to PM2.5, NO2, and O3 pollution, individually for each pollutant, in Europe in 2021.

2.2.1 Ambient air concentrations

The ETC HE produces concentration maps with annual statistics of the relevant pollutant metrics for 2021: annual mean for $PM_{2.5}$ and NO_2, and SOMO35 and SOMO10 for O_3. SOMO is based on the annual sum of daily maximum running 8-h average concentrations over a certain threshold, i.e., over 35 ppb (SOMO35) or 10 ppb (SOMO10). These maps are created on a 1x1 km^2 grid resolution for the 41 countries included in the assessment (40 in the case of $PM_{2.5}$, since Türkiye is excluded due to lack of sufficient $PM_{2.5}$ background stations to produce the map). The maps are produced based on a data fusion combining monitoring data from rural and urban background stations for $PM_{2.5}$, O_3, and NO_2 and urban traffic station data for NO_2 and $PM_{2.5}$, with results from the Copernicus Atmosphere Monitoring Service (CAMS) Ensemble and other supplementary data, such as altitude, meteorology, and population density. All the data supporting the Regression – Interpolation – Merging Mapping (RIMM) refers to 2021. The ETC HE Report 2023/7 (Eionet Report - ETC HE 2023/7) includes the analysis of the latest maps available, including the associated uncertainties. The overseas territories such as Madeira, Azores, Canary Islands, French Guiana, Guadeloupe, Martinique, Mayotte, and Réunion are not included in the concentration maps and, therefore, excluded from the EBD calculations.

In the case of cause-specific estimations, the mean value of the grid-cells falling into specific exposure intervals was used to assign the exposed population, as described in ETC HE (2023), for estimating the population exposure in Europe. The assignment is done to a specific concentration within the set intervals: 1 µg/m³ intervals for $PM_{2.5}$ and NO_2 annual concentrations and a 250 µg O_3/m³.days interval for SOMO35. Furthermore, as a preliminary step, the SOMO35 exposure values (annual sum) were converted into daily mean values (ETC HE, 2022a).

For both all-cause and cause-specific estimations, it was assumed that population exposure did not differ by age group.

2.2.2 Population, demographic and health data

Different datasets are used for estimating the health indicators, depending on the purpose. Most data is available from the Eurostat database, which provides high-quality European statistics. However, it is important to highlight that although it is not the most substantial parameter contributing to the uncertainty of the estimations (ETC-ATNI, 2020), there are uncertainties in the population, demographic, and health data due to statistical products and processes, and the data completeness depends on the availability of the raw data transmitted by the National Statistical Offices (ESS, 2012). Many countries report data with two or more years of delay or do not report at all, in which cases using a gap-filling methodology is required. The need for gap-filling is not optimal and may add extra uncertainty that cannot be quantified. However, it is important to stress that gap-filling is needed to provide results for each country included in the assessment.

Population

The population density distributed in a 1x1 km2 grid resolution is required to estimate the all-cause mortality. The density maps are created based on the GEOSTAT 2011 dataset (Eurostat, 2014) and scaled as proposed by the ETC-ATNI (2020), considering the total population data available country-wise from Eurostat (Eurostat, 2023a) to make it as consistent as possible with the population distribution in 2021. The scaling also accounts for excluding overseas territories in the mapping and including Greek and Turkish Cypriots in Cyprus population data by the GEOSTAT 2011. How the data was used, and the necessary gap-filling of missing information is thoroughly explained in Annex 1.

For cause-specific mortality and morbidity, population data were used to calculate the number of death and disease cases based on the mortality and prevalence rates of the respective health outcomes. Population data for 2021 per country, stratified by 1-year age intervals and sex, were available from Eurostat (Eurostat, 2023b). However, filling in the gaps in the missing information was necessary for several countries, years, and age groups. These procedures are carefully explained in Annex 1.

There is a slight difference between the preparatory steps for all-cause mortality and cause-specific mortality and morbidity for population totals. The total population used for cause-specific estimations is based on the Eurostat population data. However, the population for France, Spain and Portugal have not been corrected for the population in the respective overseas territories, nor has the northern Cypriot population been added to the overall population of Cyprus, as it was done in the case of all-cause mortality estimations. However, these corrections were enabled for the estimation of the population exposure. These corrections resulted in slight differences in the population totals between the burden of disease and exposure estimates. Still, the uncertainty range introduced by this step is marginal compared with other more decisive parameters, such as the choice of the CRF (ETC-ATNI, 2020). Further, when estimating rates per 100 000, the total population was used as the denominator in the all-cause mortality approach. For the cause-specific approach, only the population at risk (e.g., population over 25 years of age) was used to estimate the rates per 100 000.

Demographic and health data

Regarding demographics, data stratified by year, sex, and age groups are needed for the cause of death, the number of natural deaths, and life expectancy to calculate the burden of disease estimations. Eurostat compiles information on the number of deaths per cause (Eurostat, 2023c), total number of deaths (Eurostat, 2023d), and life expectancy (Eurostat, 2023e).

For all-cause mortality analyses, the number of natural deaths with a 1-year interval is estimated based on the interpolation of the ratio between all-natural deaths and all (natural + external) causes of death, described in 5-year intervals, and data on the total number of deaths given with a 1-year interval. After this operation, mortality data is aligned with life expectancy data. The life expectancy is then extrapolated for ages above 85, using regression on life expectancy data for age groups 79 – 85 to reflect all age groups available for mortality data (up to 95+). How the data was used and the necessary gap-filling of missing information is thoroughly explained in Annex 1.

For the cause-specific analyses, mortality data stratified by year, sex, age groups and cause of death to calculate AD and YLL was obtained from the Eurostat database (Eurostat, 2023c). Only the morbidity component was calculated for hospital admissions due to respiratory diseases. Therefore, no mortality data were needed for this outcome. We have used the prevalence-based approach to estimate the EBD. Therefore, we have used condition outcome-specific prevalence data from different sources. For asthma (adults), COPD, DM, and stroke, we used data from the European Health Interview Survey (EHIS, Eurostat (2023f)). Since EHIS does not provide prevalence data on asthma for children under 15 years of age, we used data from the GBD 2019 study (GBD 2019 Diseases and Injuries Collaborators, 2020). Data on lung cancer were obtained from the International Agency for Research on Cancer (IARC, 2020). Hospitalization data were also obtained from Eurostat (Eurostat, 2023g). The data were stratified by sex and different age groups (EHIS: 15-75+ years, at 10-year intervals; GBD 2019 study: 0 - 95+ years, at 5-year intervals; IARC: 0 - 70+ years, at 1-year intervals; Eurostat: 0 - 95+ years, at 5-year intervals). Additionally, it should be noted that in the GBD 2019 study and IARC, prevalence data on childhood asthma and lung cancer were presumably reported for Serbia including Kosovo. However, the derived rates were applied for both countries individually. More details on the prevalence data and the selection process can be found in ETC HE (2022b). An overview of the health data sources for cause-specific mortality and morbidity is presented in Table 2.1.

Table 2.1: Health data sources for considered outcomes (mortality and morbidity)

Health outcome	Data source ([a])	ICD10 code	Explanation	Remarks
Mortality (causes of death)				
Asthma (children, adults)	Eurostat	J45-46	Asthma and status asthmaticus	Register-based
COPD	Eurostat	J40-44 and J47	Other lower respiratory diseases	Register-based
DM	Eurostat	E10-14		Register- based
IHD	Eurostat	I20-25		Register- based
LC	Eurostat	C33-34	Malignant neoplasm of trachea, bronchus and lung	Register- based
Stroke	Eurostat	I60-I69	Cerebrovascular diseases	Register- based

Health outcome	Data source ([a])	ICD10 code	Explanation	Remarks
Morbidity (prevalence)				
Asthma (children)	GBD study	J45-46		Modelled
Asthma (adults)	EHIS	J45-46	Allergic asthma included	Self-reported
COPD	EHIS	J40-44 and J47	Chronic bronchitis, chronic obstructive pulmonary disease, emphysema	Self-reported
DM	EHIS	E10-14	Type 1 and 2 diabetes (gestational diabetes excluded)	Self-reported
Hospital admissions for respiratory diseases (in-patients) ([b])	Eurostat	J00-99	The data describe hospital discharges per 100 000 inhabitants	
IHD	EHIS	I20-25	Coronary heart disease or angina pectoris	Self-reported
LC	IARC	C33-34	Lung cancer cases	Register based
Stroke	EHIS	I60-69	Cerebral haemorrhage, cerebral ischaemia or chronic consequences of stroke	Self-reported

([a]) GBD 2019 study: Data for Serbia included data for Kosovo, IARC: data for Serbia presumably included data for Kosovo, EHIS: data for Serbia excluded data for Kosovo, EUROSTAT: data for Serbia excluded data for Kosovo.

([b]) It was assumed that hospital admissions can be approximated by hospital discharges.

Country-specific prevalence data, in particular, but also mortality data, were not always available for the reference year (2021). In these cases, the two previous years were considered, and the data of the most recent year was selected. Based on these data sets, corresponding mortality and prevalence rates were calculated, and it was assumed that these would also apply for 2021. For some European countries, neither prevalence nor mortality data were available for the two previous years. In these cases, we used data from neighbouring countries as proxies to fill in the gaps. In some cases, data from the GBD 2019 study was also used to compare mortality or prevalence rates between countries as an indicator for the fit of the proxy country. In the case of hospital admissions for respiratory diseases, for example, Romania was chosen as a rough proxy for Bulgaria and Greece. Due to geographical proximity, Romania was also chosen as a proxy for Türkiye. However, the rates for Türkiye were considerably underestimated. Table A1.3 shows which countries had missing health data and which countries were used as proxy for gap-filling.

Life expectancy data in all-cause mortality estimations are stratified by 1-year age intervals and sex to fit the population data available from Eurostat. However, since the cause-specific mortality data for the respective outcomes were mainly available in 5-year age groups, the data on life expectancy had to be recalculated for the cause-specific approach. The basis for this was the processed life expectancy data stratified by age and sex (0-100+ years in 1-year intervals), also used to calculate the all-cause mortality estimates. We then used the tool provided by the WHO to calculate abridged life expectancies (WHO, 2001) based on an interpolation of single-year life expectancy values between the beginning and end age of an age-group. However, for some countries, single-year life expectancy values were not available. For Türkiye, data from 2019 were used as a proxy for 2021. For the remaining countries without data on single-year life expectancy values, YLL rates from selected neighbouring countries were used to estimate the missing life expectancy values (Table A1.3). When interpreting the results, it should be kept in mind that the COVID-19 pandemic might have introduced reductions in life expectancies in Europe. However, as long as no final estimates on the changes are available, we keep the most recent published data as proxies. When new estimates on the country-specific life expectancies are available, the upcoming years' analyses will include these changes.

2.2.3 Concentration-response functions and counterfactual concentrations

Here, we describe the CRFs and counterfactual concentrations used for the estimations of the all-cause mortality and cause-specific mortality and morbidity analyses for the reference year 2021. For all-cause analyses, the baseline cases are described, as well as sensitivity scenarios used to estimate the impact of using different counterfactual concentrations on the magnitude of the all-cause mortality burden of disease.

All-cause (natural) mortality

Table 2.2 describes the CRFs, including the corresponding values for the 95 % confidence intervals (CI) and counterfactual concentrations for relevant averaging times, used to estimate the burden of disease for all-cause mortality. The CRFs are based on the studies by Chen and Hoek (2020) for $PM_{2.5}$ and NO_2, and by Orellano et al. (2020) for O_3, both referenced in the latest WHO AQG (WHO, 2021a). The estimation targets the long-term effect of $PM_{2.5}$ and NO_2 exposure, based on annual means, and the short-term (acute) effect of O_3, based on the annual sum of daily maximum running 8-h average concentrations above 35 ppb (or 70 µg/m^{3,} SOMO35) divided by the number of days in a year. Thus, the CRFs reflect long-term exposure to all pollutants except for O_3, which describes acute exposure (short-term).

Table 2.2: Concentration-response functions (as RR per pollutant concentration increase) and their associated 95 % confidence interval (CI), and counterfactual concentrations linking all-cause mortality and exposure to PM2.5, NO2, and O3 used for the baseline estimation and sensitivity analysis

Pollutant	Health outcome	RR per 10 µg/m^3 (95 % CI)	Exposure time	Counterfactual concentration		
				Baseline	Sensitivity 1	Sensitivity 2
$PM_{2.5}$	All-cause (natural) mortality in ages above 30 years old	1.08 (1.06 - 1.09)	year	5 µg/m^3	2.5 µg/m^3	0 µg/m^3
NO_2		1.02 (1.01 - 1.04)	year	10 µg/m^3	20 µg/m^3	0 µg/m^3
O_3	All-cause (natural) mortality in all ages	1.0043 (1.0034 - 1.0052)	day	35 ppb	10 ppb	-

Table 2.2 also reports the counterfactual concentrations (sensitivity 1 and 2) used in the sensitivity analysis to understand how this variable affects the estimations. The rationales for choosing the counterfactual concentrations described under sensitivity 1 and sensitivity 2 scenarios are the following:

- For $PM_{2.5}$, the sensitivity 1 scenario considers 2.5 µg/m^3 and the sensitivity 2 scenario considers 0 µg/m^3. The first value has been considered in prior assessments in the sensitivity analysis, e.g., ETC/ATNI (2021), because 2.5 µg/m^3 was the lowest average background concentration level observed in Europe (ETC/ACM, 2017) and the minimum observed exposure concentration in several epidemiolocal studies (Brauer et al., 2022; WHO, 2021a). The second has been considered a counterfactual concentration in the past EBD estimations (until 2021) because the HRAPIE report (WHO, 2013) indicates that the quantification of long-term impacts "should be calculated at all levels of $PM_{2.5}$". Furthermore, the Brunekreef et al. (2021) study points to no evidence of a minimum concentration below which no effect is expected. However, the level of evidence for RRs at very low concentration levels is not based on a large number of epidemiological studies and thus should be interpreted with caution.

- For NO_2, we consider the counterfactual concentration of 20 μg/m^3, based on the recommendations of the HRAPIE report (WHO, 2013), as the counterfactual concentration in the sensitivity 1 scenario. Sensitivity scenario 2 considers all concentration levels harmful to human health. Here, the same level of caution should be applied as for the comparable $PM_{2.5}$ scenario.
- For O_3, SOMO10 is still used as a sensitivity threshold, as recommended in HRAPIE (WHO, 2013). SOMO10 is based on the annual sum of daily maximum running 8-h average concentrations above 10 ppb (or 20 μg/m^3).

Cause-specific mortality and morbidity

Table 2.3 lists the selected CRF, including the corresponding values for the 95 % CI and characteristics for the respective risk-outcome pairs. The same CRFs were used for the morbidity calculations as in the report ETC HE (2022b). The only exception was the newly selected effect measure from Yang et al. (2020) for the associations between the prevalence of type 2 diabetes mellitus (T2DM) and $PM_{2.5}$ or NO_2. The function of $PM_{2.5}$ in relation to T2DM incidence was used in the impact assessment of the accompanying analyses for the draft of the proposed new EU Air Quality Directive by the European Commission (EC-DGE, 2022). Compared to the analyses in the ETC HE report (2022b), this new selection allowed for harmonising the age groups considered for DM with the analyses for most other outcomes, now only calculating the burden of disease for the population aged 25 years and over. Generally, the CRFs derived in the European ELAPSE project were used whenever possible. No specific CRF for the association with asthma mortality was identified, neither for children nor adults. We used the same CRF for the asthma morbidity calculations in each case as an approximation. However, as asthma is less likely to lead to death, it can be assumed that this approach may lead to an overestimation of the corresponding burden of disease. Regarding LC mortality, the selected CRF for an association with $PM_{2.5}$ by Chen and Hoek (2020) was based on a broader disease code list (ICD10 C30-39). In contrast, collected health data on the CRF for morbidity referred only to ICD10 codes C33-34 or C33, respectively. This might lead to overestimating the respective mortality-related burden of disease results. It should also be noted that the selected CRF for the association between $PM_{2.5}$ and IHD morbidity was non-significant (Wolf et al., 2021). The reader should be aware of this limitation and the resulting reduced robustness of the results in that particular case.

Table 2.3: Selected CRF for mortality and morbidity risk-outcome pairs (age group: ≥ 25 years, unless otherwise stated)

Pollutant	Outcome	Effect measure ([c]) (95 % CI)	Increment per unit ($\mu g \cdot m^{-3}$)	Counterfactual concentration	Reference
Mortality					
$PM_{2.5}$	Asthma (children, < 15)	HR: 1.03 (1.01-1.05)	1	5 $\mu g \cdot m^{-3}$	(Khreis et al., 2017)
	DM	HR: 1.32 (1.14-1.51)	5	5 $\mu g \cdot m^{-3}$	ELAPSE (Strak et al., 2021)
	COPD	HR: 1.131 (1.002-1.278)	5	5 $\mu g \cdot m^{-3}$	ELAPSE (Strak et al., 2021)
	IHD	HR: 1.11 (1.06-1.17)	5	5 $\mu g \cdot m^{-3}$	ELAPSE (Strak et al., 2021)
	LC	RR: 1.12 (1.07-1.16)	10	5 $\mu g \cdot m^{-3}$	(Chen and Hoek, 2020)
	Stroke	HR: 1.13 (1.05-1.21)	5	5 $\mu g \cdot m^{-3}$	ELAPSE (Strak et al., 2021)
NO_2	Asthma (adults, ≥ 15)	HR: 1.17 (1.10-1.25)	10	10 $\mu g \cdot m^{-3}$	ELAPSE (Liu et al., 2021a)
	DM	HR: 1.24 (1.11-1.38)	10	10 $\mu g \cdot m^{-3}$	ELAPSE (Strak et al., 2021)
	Stroke	HR: 1.07 (1.01-1.13)	10	10 $\mu g \cdot m^{-3}$	ELAPSE (Strak et al., 2021)
Morbidity					
$PM_{2.5}$	Asthma (children, < 15)	HR: 1.03 (1.01-1.05)	1	5 $\mu g \cdot m^{-3}$	(Khreis et al., 2017)
	COPD	HR: 1.17 (1.06-1.29)	5	5 $\mu g \cdot m^{-3}$	ELAPSE (Liu et al., 2021b)
	IHD	HR: 1.02 (0.95-1.10)	5	5 $\mu g \cdot m^{-3}$	ELAPSE (Wolf et al., 2021)
	LC	HR: 1.13 (1.05-1.23)	5	5 $\mu g \cdot m^{-3}$	ELAPSE (Hvidtfeldt et al., 2021)
	Stroke	HR: 1.10 (1.01-1.21)	5	5 $\mu g \cdot m^{-3}$	ELAPSE (Wolf et al., 2021)
	T2DM([a])	OR: 1.08 (1.04-1.12)	10	5 $\mu g \cdot m^{-3}$	(Yang et al., 2020)
NO_2	Asthma (adults, ≥ 15)	HR: 1.17 (1.10-1.25)	10	10 $\mu g \cdot m^{-3}$	ELAPSE (Liu et al., 2021a)
	Stroke	HR: 1.08 (1.04-1.12)	10	10 $\mu g \cdot m^{-3}$	ELAPSE (Wolf et al., 2021)
	T2DM([a])	OR: 1.07 (1.04-1.11)	10	10 $\mu g \cdot m^{-3}$	(Yang et al., 2020)
O_3	Hospital admissions for respiratory diseases (adults, ≥ 65)	RR: 1.0044 (1.0007-1.0083)([b])	10	35 ppb	HRAPIE (WHO, 2013)

([a]) For morbidity, the effect measure refers only to type 2 diabetes mellitus (T2DM), in contrast to mortality, which also includes type 1 diabetes.

([b]) The effect measure is defined as a percental increase in hospitalisations, and the coefficient is adjusted for PM_{10} in the two-pollutant model.

([c]) Effect measures quantify the strength of the association between exposures and outcomes. Hazard Ratios (HR), Relative Risks (RR) and Odds Ratios (OR) are used in different types of epidemiological studies to quantify the risk/or chance of having an outcome after a certain exposure, comparing an exposed group against a non or lower-exposed group.

The YLDs are estimated by multiplying age- and sex-specific number of cases (prevalence) by a disability weight (DW), indicating the severity of a disease on a scale from 0 (full health) to 1 (most severe health state equivalent to death). As described in ETC HE (2022b), the outcome-specific DW, stratified by sex and age groups, was derived from data from the GBD 2019 study (GBD 2019 Risk Factors Collaborators, 2020) by dividing the YLD by the number of prevalent cases of the respective diseases. We have not used country-specific DW because we do not expect any significant differences across Europe. Since country-specific DW calculation would be very time-consuming and DW should not vary significantly across Europe, we use the WHO European Region as the geographical reference for the DW estimation.

3 All-cause mortality outcomes

The population mortality attributable to exposure to $PM_{2.5}$, NO_2, and O_3 concentration levels in 2021 in Europe is estimated based on the CRFs recommended by the WHO AQG in 2021 (see Table 2.2). The counterfactual concentrations are 5 µg/m^3, 10 µg/m^3 and 35 ppb for $PM_{2.5}$, NO_2 and O_3, respectively, with the two first being the same value as the guideline levels suggested by the same WHO AQG. The estimations are presented for individual countries and aggregated areas (EU27, EEA32 and all countries). Note that the assessment is done for 41 countries, except for $PM_{2.5}$. Türkiye is not included in the interpolated map used for calculating $PM_{2.5}$ due to insufficient background stations. Map 3.1, Map 3.2, and Map 3.3 show the population-weighted mean concentration (panel A), the estimated number of attributable deaths (panel B), and the YLL per 100 000 inhabitants (panel C) at the national level for $PM_{2.5}$, NO_2, and O_3, respectively. The YLL per 100 000 inhabitants is shown instead of YLL because it exhibits the same distribution as YLL but provides a comparable way to assess the impact of a pollutant at the national level or across the years. Table 3.1 shows the total population, the population-weighted mean concentrations, and the estimated number of attributable deaths; Table 3.2 shows the YLL and the YLL per 100 000 inhabitants.

Panels A in Map 3.1, Map 3.2, and Map 3.3, on the population-weighted mean concentration, give an overview of the concentration levels to which a population in individual countries is exposed. The distribution of concentrations across the countries depends on the pollutant. However, typically, the concentrations are lower in the northern European countries. The levels of $PM_{2.5}$ and NO_2 are higher in the east than in western Europe, and O_3 concentrations are higher in the southern countries.

The exposure levels in 2021 resulted in 293 000 and 69 000 deaths attributable to long-term exposure to $PM_{2.5}$ and NO_2, respectively, and 27 000 attributable to short-term exposure to O_3. For EU27, the number of AD to long-term exposure to $PM_{2.5}$ and NO_2 are 253 000 and 52 000, respectively, and 22 000 are attributable to short-term exposure to O_3. When considering the life expectancy, the estimate points to 2 936 000 (618) YLL (YLL/100 000 inhabitants) due to long-term exposure to $PM_{2.5}$, 740 000 (132) due to long-term exposure to NO_2, and 299 000 (54) due to short-term exposure to O_3. For the EU27, YLL (YLL/100 000 inhabitants) are 2 584 000 (584), 532 000 (120), and 234 000 (53), respectively.

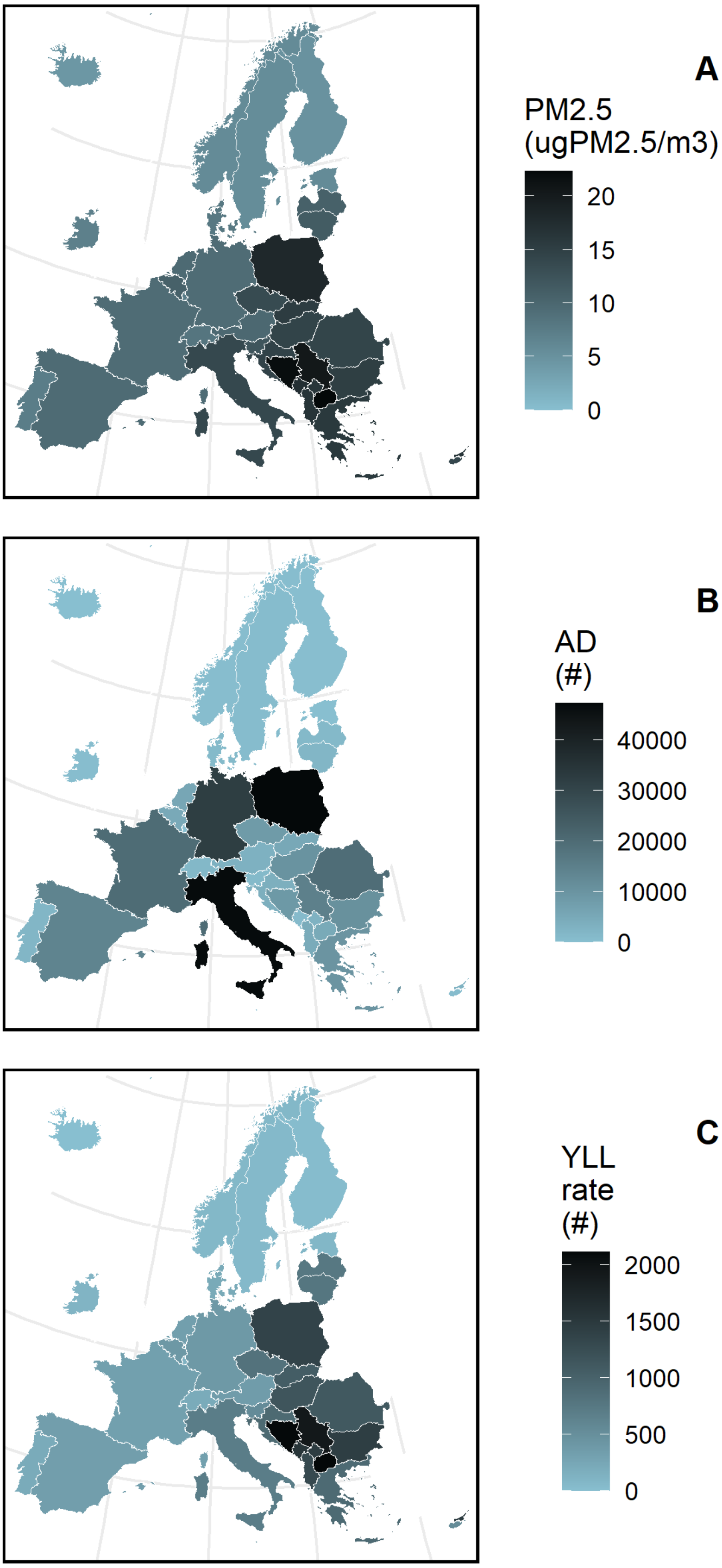
The impact at the country level depends on if the outcome describes the impact at absolute levels, such as the AD (or YLL), that considers the whole population, or in relative terms, i.e., when considering YLL per 100 000 inhabitants. The outcomes can differ, as seen in Map 3.1, Map 3.2, and Map 3.3, panels B (AD) and C (YLL per 100 000 inhabitants). The latter is used to make a comparison across countries.

For $PM_{2.5}$, the largest absolute health impacts (over 20 000 deaths) are estimated for France, Germany, Italy, and Poland (the highest). When considering YLL per 100 000 inhabitants, the largest relative impacts (over 1 500 YLL/100 000 inhabitants) are observed in central and eastern European countries, Montenegro, Serbia, Bosnia and Herzegovina, and North Macedonia (the highest), where the highest $PM_{2.5}$ concentrations are also observed. The smallest relative impacts are found in countries in the north and north-west of Europe, with the lowest being in Iceland, followed by Finland, Sweden, Norway, and Estonia, all below 100 YLL/100 000 inhabitants.

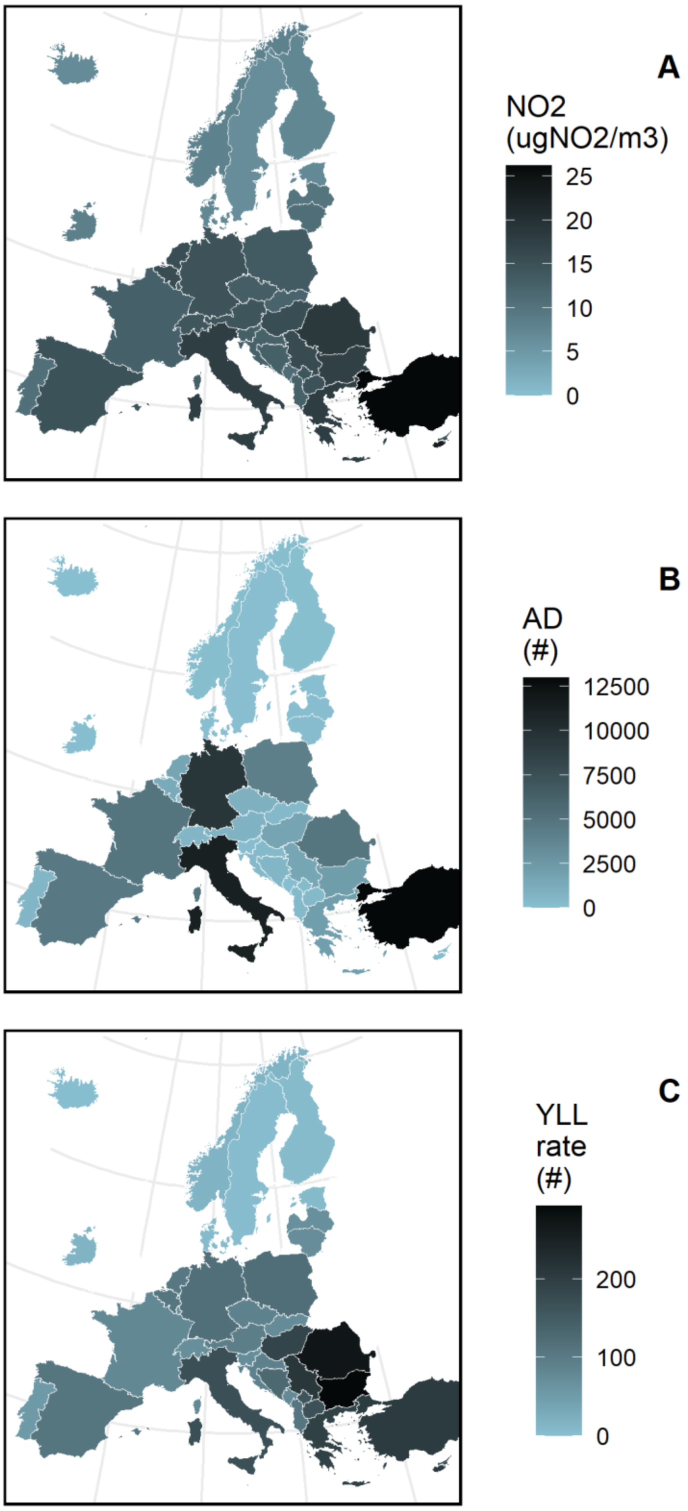
The largest absolute impacts from exposure to NO_2 are seen in Türkiye, followed by Italy and Germany, all with more than 9 000 AD in each country. When considering YLL per 100 000 inhabitants, the highest rates are found in Bulgaria, followed by Romania, Serbia, Cyprus and Türkiye, all with more than 200 YLL/100 000 inhabitants. The estimates point to a minor impact in Iceland and Liechtenstein, San Marino, Monaco, Estonia and Malta, all with fewer than 10 or fewer deaths related to exposure to NO_2. The smallest relative impact is found in Iceland, followed by Sweden, Finland, Estonia and Denmark, all with less than 10 YLL/100 000 inhabitants.

Regarding O_3, the countries with the largest absolute impacts estimated are Italy, followed by Germany, Türkiye, France and Spain, all with more than 2 000 deaths associated with O_3 levels. The countries with the highest rates of YLL per 100 000 inhabitants are Albania (the highest), Montenegro, Bosnia and Herzegovina, Greece, and Kosovo, all with more than 100 YLL per 100 000 inhabitants. The countries with the smallest number of deaths related to O_3 exposure are the small countries mentioned above, Iceland, and Luxembourg; the countries with the smallest relative impacts are Norway, followed by Iceland, Ireland, Finland, and Sweden, all with 20 or less YLL per 100 000 inhabitants.

Map 3.1: PM2.5 population-weighted mean concentration (µg/m3) A), number of attributable deaths (AD) (B) and years of life lost per 100 000 inhabitants (YLL rate) (C) due to long-term exposure to PM2.5 concentration levels in 2021 across Europe



Map 3.2: Population-weighted mean concentration (µg/m3) (A), number of attributable deaths (AD) (B) and years of life lost per 100 000 inhabitants (YLL rate) (C) due to long-term exposure to NO2 concentration levels in 2021 across Europe



Map 3.3: Population-weighted SOMO35 concentration (μg/m3.days) (A), number of attributable deaths (AD) (B) and years of life lost per 100 000 inhabitants (YLL rate) (C) due to short-term exposure to O3 concentration levels in 2021 across Europe

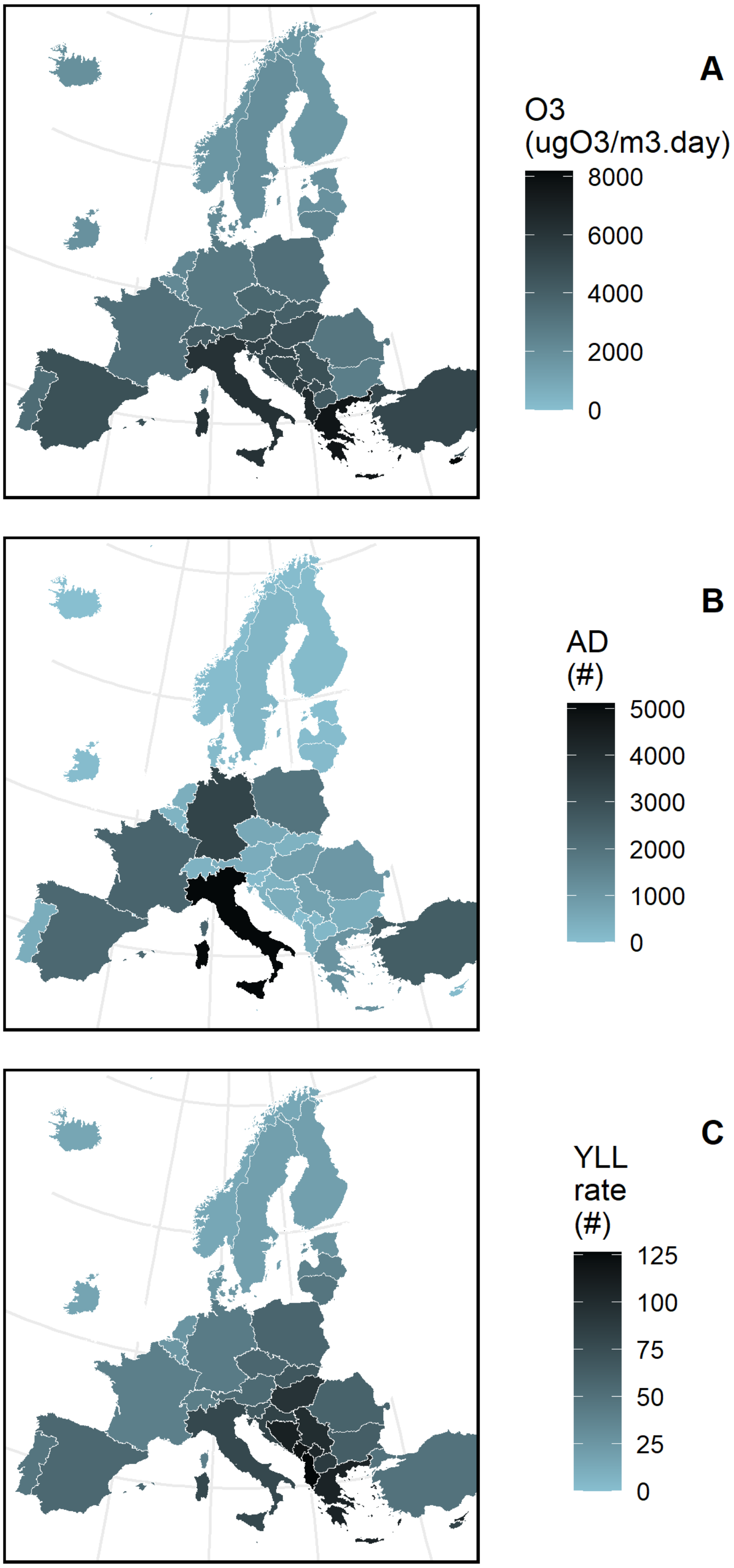


Table 3.1: Attributable deaths (AD) related to PM2.5 and NO2 long-term exposure and O3 short-term exposure in the EU27, the EEA32 and 40 (for PM2.5) or 41 European countries in 2021

		$PM_{2.5}$		NO_2		O_3	
Country	Population (1 000)	Annual mean (µg/m^3)	AD (#)	Annual mean (µg/m^3)	AD (#)	SOMO35 (µg/m^3.days)	AD (#)
Austria	8 933	9.9	3 200	14.4	830	4 599	470
Belgium	11 555	10.7	5 100	15.7	1 400	2 229	310
Bulgaria	6 916	15.1	10 800	17.5	2 200	2 668	460
Croatia	4 036	14.6	3 800	12.6	370	5 232	340
Cyprus	1 241	14	630	23	240	8 182	90
Czechia	10 495	13.5	8 500	13.1	930	3 651	580
Denmark	5 840	8	1 200	7.3	40	2 106	130
Estonia	1 330	5.8	100	7.1	10	1 849	30
Finland	5 534	5	160	7.3	30	1 597	110
France	65 504	9.4	20 100	12.7	4 900	3 302	2 400
Germany	83 154	9.4	32 300	14.7	9 500	2 949	3 300
Greece	10 678	15.9	10 000	18	2 100	7 660	1 100
Hungary	9 731	14.4	10 400	15.5	1 700	4 665	830
Ireland	5 006	7	460	8.4	60	1 866	70
Italy	59 236	13.9	46 800	17.8	11 300	6 149	5 100
Latvia	1 893	10.7	1 400	9.9	130	1 853	70
Lithuania	2 796	11.4	2 100	10.8	200	2 404	120
Luxembourg	635	7.4	80	14	40	2 380	10
Malta	516	11.6	190	10.3	10	6 649	30
Netherlands	17 475	9.7	5 700	15.5	1 800	2 312	430
Poland	37 840	18.1	47 300	13.7	4 200	3 309	1 900
Portugal	9 797	7.4	2 100	10.7	550	3 473	460
Romania	19 202	14.3	19 600	18.6	4 900	3 001	1 000
Slovakia	5 460	15.4	5 400	12.4	390	3 970	330
Slovenia	2 109	12.2	1 200	12.9	160	5 450	140
Spain	45 229	9.5	14 100	14.8	4 600	4 688	2 300
Sweden	10 379	5.6	650	6.5	40	1 976	220
Albania	2 830	16.5	4 600	12.6	380	6 635	430
Andorra	78	8.6	20	17	10	2 496	<5
Bosnia and Herzegovina	3 825	21.9	9 000	12.8	550	5 152	450
Iceland	369	4.4	<5	6.8	<5	1 924	<5
Kosovo	1 798	16.4	2 900	14.4	330	4 932	200
Liechtenstein	39	8.1	10	14.8	<5	4 355	<5
Monaco	38	9.6	10	18.4	10	6 917	<5
Montenegro	621	17.3	1 100	11	60	5 665	80
North Macedonia	2 069	22.3	5 000	14.9	400	4 248	200
Norway	5 391	5.8	400	8	90	1 677	80
San Marino	35	11.7	20	13.5	<5	5 303	<5
Serbia	6 871	20.5	14 800	15.9	1 600	4 693	740
Switzerland	8 670	8.3	1 700	14.2	580	4 154	320
Türkiye (TR)	83 614	N/A	N/A	26.2	13 000	5 127	2 600

		$PM_{2.5}$	NO_2			O_3	
Country	**Population (1 000)**	**Annual mean (µg/m^3)**	**AD (#)**	**Annual mean (µg/m^3)**	**AD (#)**	**SOMO35 (µg/m^3.days)**	**AD (#)**
EU27	442 519	11.4	253 000	14.4	52 000	3 794	22 000
EEA32 (no TR)	456 989	11.3	255 000				
EEA32	540 603			16.2	66 000	3 984	25 000
All countries (no TR)	475 154	11.6	293 000				
All countries	558 768			16.1	69 000	4 020	27 000

Notes: The annual mean is expressed as population-weighted concentration and is obtained according to the methodology described by ETC/ACM (2019a) and references therein and not only based on monitoring data.
The values are rounded for individual countries and aggregates, depending on the metric: the population is rounded to the nearest thousand; deaths are rounded to the nearest hundred if the number is above 1,000 and to the nearest ten if the number is below 1,000. The values for country aggregates are estimated by adding the original values for the individual countries and then rounded. Here, ADs are rounded to the nearest thousand.

Table 3.2: Years of life lost (YLL) and YLL per 100 000 inhabitants (YLL/105 inhabitants) related to PM2.5 and NO2 long-term exposure and O3 short-term exposure in the EU27, the EEA32 and 40 (for PM2.5) or 41 European countries in 2021

	$PM_{2.5}$		NO_2		O_3	
Country	**YLL (#)**	**YLL/10^5 inhab. (#)**	**YLL (#)**	**YLL/10^5 inhab. (#)**	**YLL (#)**	**YLL/10^5 inhab. (#)**
Austria	32 300	362	8 500	95	4 900	55
Belgium	47 200	409	12 600	109	3 000	26
Bulgaria	99 800	1 443	20 300	294	4 400	63
Croatia	37 200	921	3 700	91	3 400	83
Cyprus	6 700	536	2 600	206	1 000	82
Czechia	86 300	822	9 500	90	6 000	57
Denmark	13 000	223	460	8	1 500	25
Estonia	1 100	84	100	7	380	28
Finland	1 700	31	330	6	1 100	20
France	214 200	327	52 700	81	26 600	41
Germany	333 000	400	98 900	119	36 000	43
Greece	98 000	918	20 800	195	11 400	107
Hungary	112 400	1 155	18 400	189	9 200	94
Ireland	5 500	110	800	16	850	17
Italy	415 400	701	100 300	169	46 700	79
Latvia	14 300	755	1 300	69	750	40

	$PM_{2.5}$		NO_2		O_3	
Country	**YLL (#)**	**YLL/10^5 inhab. (#)**	**YLL (#)**	**YLL/10^5 inhab. (#)**	**YLL (#)**	**YLL/10^5 inhab. (#)**
Lithuania	21 800	779	2 000	73	1 300	48
Luxembourg	890	140	420	66	140	22
Malta	2 200	426	110	21	350	68
Netherlands	59 000	338	18 300	105	4 700	27
Poland	519 000	1 372	45 700	121	21 900	58
Portugal	20 700	211	5 400	55	4 600	47
Romania	213 300	1 111	52 800	275	11 500	60
Slovakia	57 900	1 060	4 200	76	3 700	68
Slovenia	11 500	543	1 600	74	1 400	67
Spain	153 600	340	49 700	110	25 400	56
Sweden	5 900	57	370	4	2 100	20
Albania	37 000	1 308	3 100	109	3 600	127
Andorra	210	272	110	138	20	31
Bosnia and Herzegovina	80 600	2 107	5 000	130	4 200	109
Iceland	10	4	10	2	60	16
Kosovo	26 200	1 459	2 900	163	1 900	104
Liechtenstein	90	233	40	95	20	49
Monaco	130	345	60	164	30	84
Montenegro	9 600	1 549	490	79	740	119
North Macedonia	43 800	2 115	3 500	169	1 800	88
Norway	4 100	76	900	17	810	15
San Marino	190	537	30	75	20	66
Serbia	133 200	1 938	14 600	212	6 800	99
Switzerland	17 700	204	6 100	71	3 600	42
Türkiye (TR)			171 500	205	41 300	49
EU27	2 584 000	584	532 000	120	234 000	53
EEA32 (no TR)	2 606 000	570				
EEA32			710 000	131	280 000	52

	$PM_{2.5}$		NO_2		O_3	
Country	**YLL (#)**	**YLL/10^5 inhab. (#)**	**YLL (#)**	**YLL/10^5 inhab. (#)**	**YLL (#)**	**YLL/10^5 inhab. (#)**
All countries (no TR)	2 936 000	618				
All countries			740 000	132	299 000	54

Notes: YLLs are rounded for every country, to the nearest hundred if the number is above 1,000 and to the nearest ten if the number is below 1,000; for country aggregates, the rounding is done after summing the original YLL per country to the nearest thousand; YLL/100,000 inhabitants are based on the original unrounded YLL and total population and are rounded to the next integer.

3.1 Sensitivity analysis

This section aims to indicate how sensitive the estimation of mortality indicators is to changes in the counterfactual concentration and CRF.

Assuming a constant slope of the CRF (β) and varying the counterfactual concentration implies that the results will vary. For example, if the estimations assume a lower counterfactual concentration, the estimation of mortality will be higher, i.e., a lower counterfactual level implies that more of the population will be at risk since the exposure will include a larger range of concentration levels.

We have recalculated the mortality indicators for the sensitivity analysis, assuming the CRF and counterfactual concentrations described in Table 2.2. Table 3.3 shows the AD for the aggregated areas, and Figure 3.4 (PM2.5), Figure 3.5 (NO2), and Figure 3.6 (O3) are the results for individual countries in terms of the number of YLL per 100000 inhabitants.

Table 3.3: Results of the sensitivity analysis on the counterfactual concentrations in terms of attributed deaths

Scenario	Area	$PM_{2.5}$	NO_2	O_3
Baseline	EU27	253 000	52 000	22 000
	EEA32	255 000	66 000	25 000
	All countries	293 000	69 000	27 000
Sensitivity 1	EU27	343 000	9 000	108 000
	EEA32	347 000	16 000	119 000
	All countries	391 000	16 000	127 000
Sensitivity 2	EU27	432 000	142 000	-
	EEA32	438 000	165 000	-
	All countries	487 000	175 000	-

Notes: The values are rounded to the nearest hundred if the number is above 1,000 and to the nearest ten if the number is below 1,000.

The sensitivity analysis shows that changing the established counterfactual concentrations can produce different results. The increase in deaths due to exposure to $PM_{2.5}$ by reducing the counterfactual concentration in half (sensitivity 1) and to zero (sensitivity 2) is, on average, 35 % and 69 %, respectively. In the case of NO_2, the number of deaths decreases by a factor of 2.6, on average, by doubling the counterfactual concentration (sensitivity 1) and increases by a factor of 4.7 when reducing this value to zero (sensitivity 2). The number of deaths related to exposure to O_3 increases when applying SOMO10 as a metric to evaluate short-term exposure (sensitivity 1). Figure 3.1, Figure 3.2, and Figure 3.3 show the estimated number of YLL per 100000 inhabitants based on the baseline and the sensitivity scenarios for aggregated areas and individual countries. As expected, the burden of disease will increase when the counterfactual concentrations are reduced, as more grid cells within country boundaries will have exposure levels that are considered harmful to human health. For example, for countries with very high concentration levels of $PM_{2.5}$, higher than the counterfactual concentration, such as North Macedonia, decreasing the counterfactual concentration does not impact the final estimation as much as a country, such as Finland, that has recurrently low levels of $PM_{2.5}$, typically lower than the current counterfactual concentration.

Figure 3.1: YLL per 100 inhabitants related to long-term exposure to PM2.5 estimated based on the baseline and sensitivity scenarios

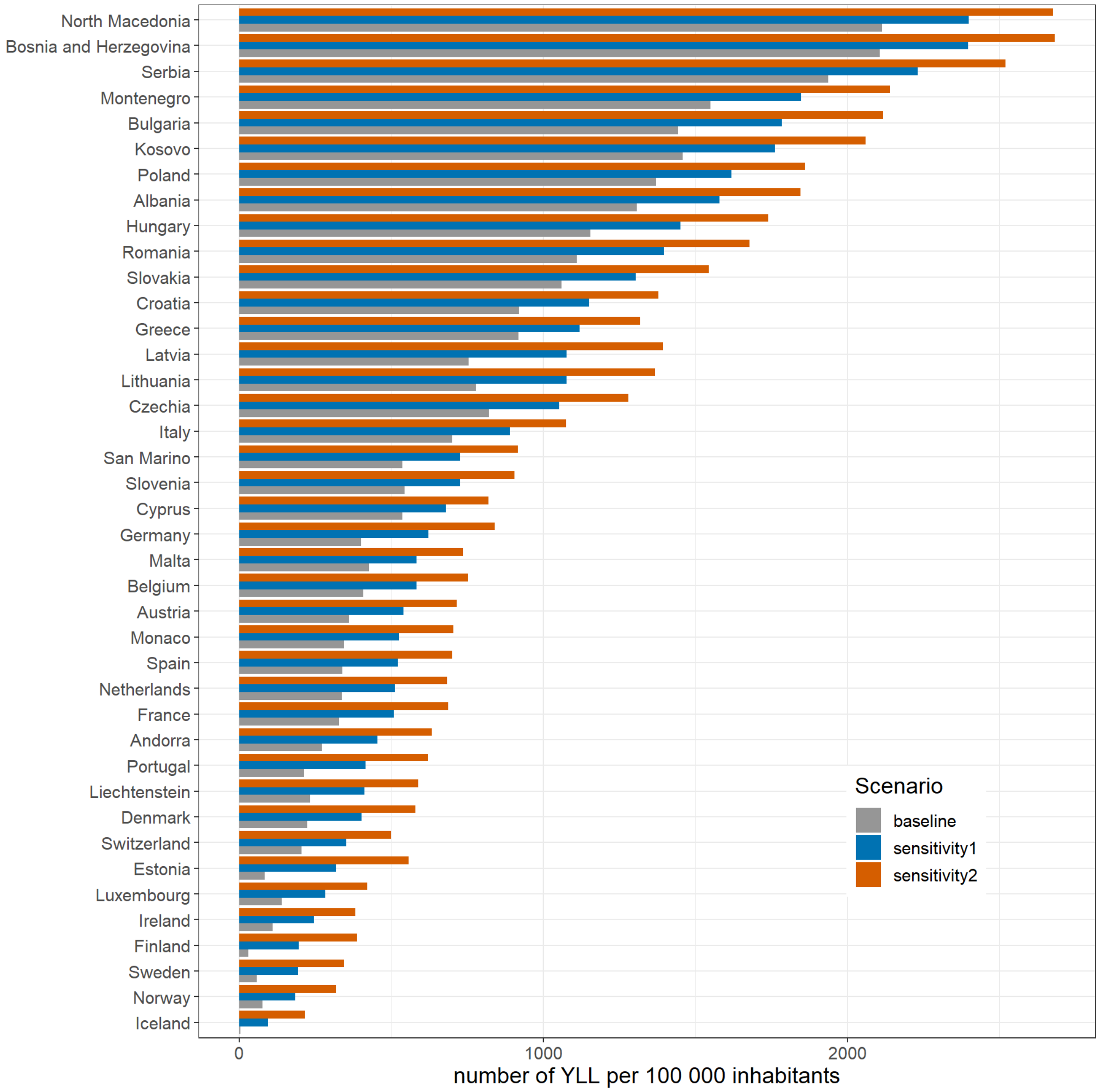


Figure 3.2: YLL per 100 inhabitants related to long-term exposure to NO2 estimated based on the baseline and sensitivity scenarios

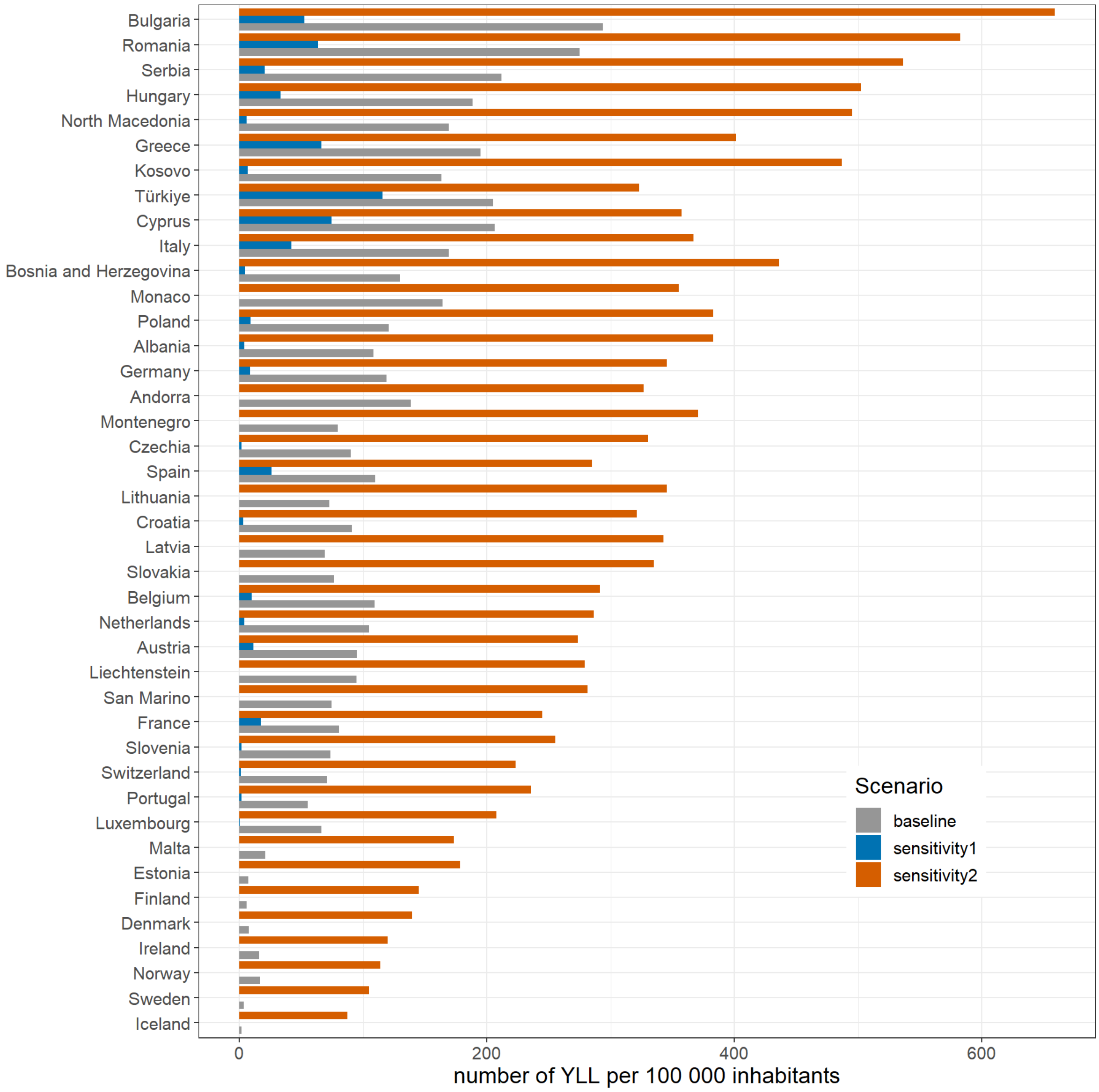
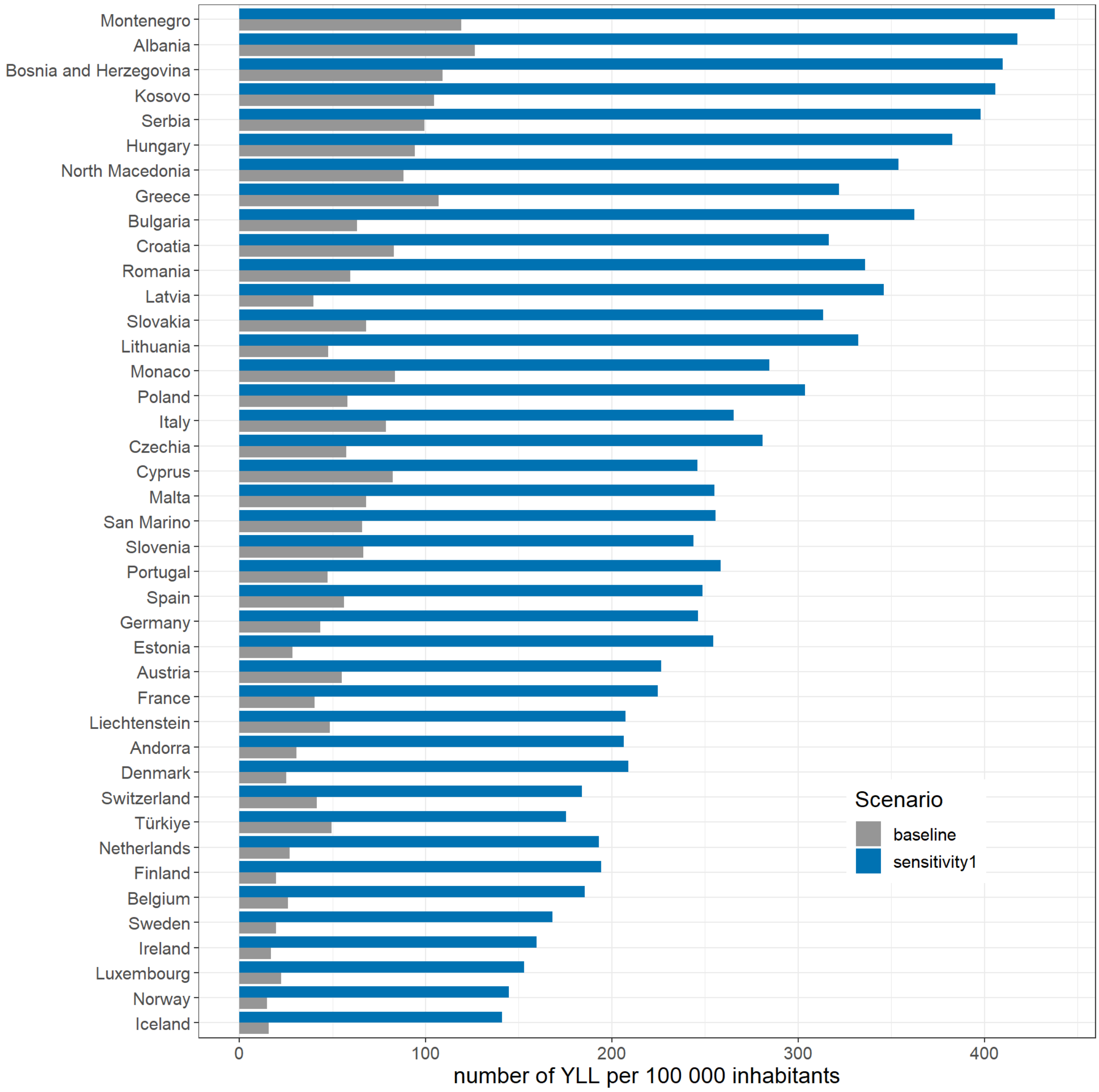


Figure 3.3: YLL per 100 inhabitants related to long-term exposure to O3 estimated based on the baseline and sensitivity scenarios



Another sensitivity analysis was performed based on changing the CRF values to the lower and upper ends of the 95% CI and assuming the counterfactual concentration constant, i.e., the same value as the baseline assumption for the individual pollutants. The changes in the final values are depicted in Figure 3.4, Figure 3.5, and Figure 3.6. These Figures show the impact on the estimation of the YLL per 100 000 inhabitants, where the estimation using the average CRF value is represented by the bars and the estimations based on the lower and upper end of the 95 % CI by the error bars. This variation is similar in proportional terms, independently of the chosen mortality indicator. On an aggregated level, the change in CRF results in 548 ± 103 and 163 ± 96 YLL per 100 000 inhabitants for all countries and 581 ± 108 and 149 ± 88 YLL per 100 000 inhabitants for EU27 when the population is long-term exposed to $PM_{2.5}$ and NO_2 concentration levels, respectively. For short-term exposure to O_3 concentration levels, the change in CRF is 54 ± 12 YLL per 100 000 inhabitants for all countries and 53 ± 11 YLL per 100 000 inhabitants for EU27.

Figure 3.4: All-cause mortality due to long-term exposure to PM2.5 (YLL per 100 000 inhabitants) estimated based on the average CRF (bars) and on the lower and upper 95% CI (error bars)

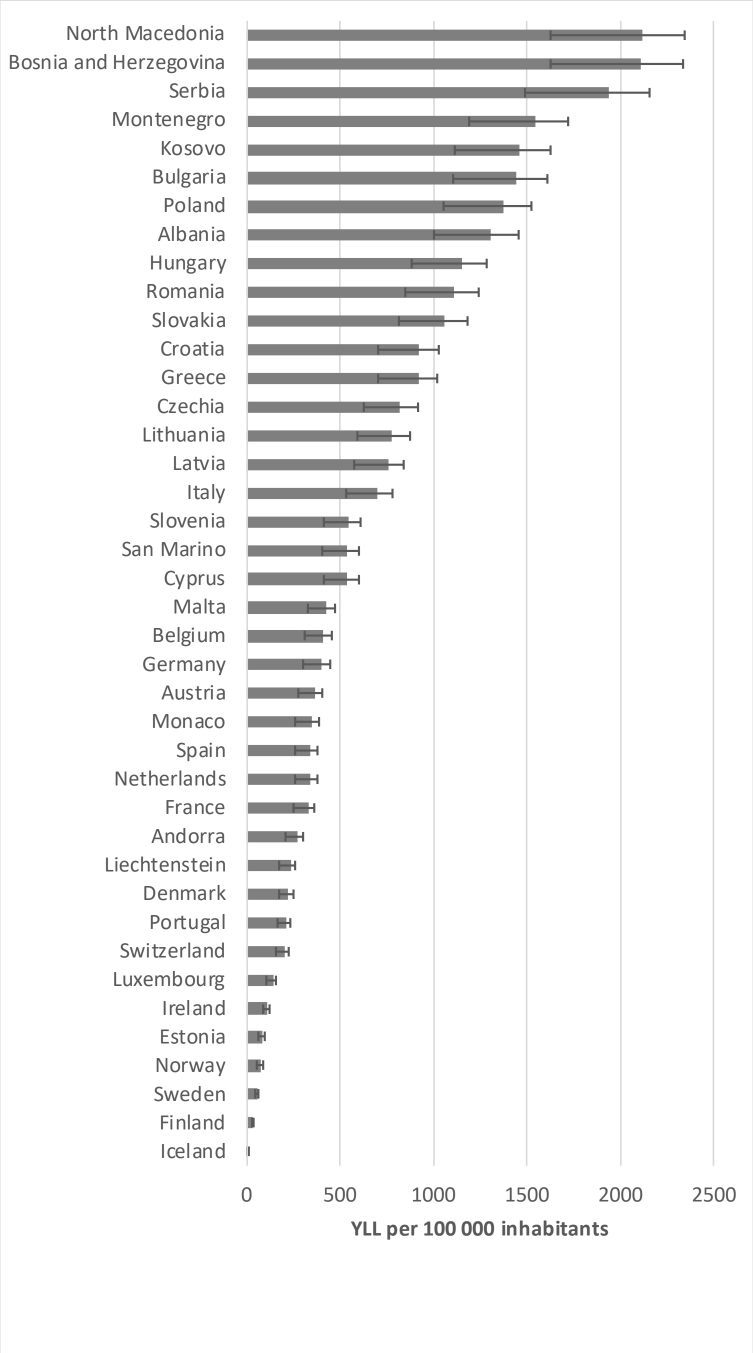


Figure 3.5: All-cause mortality due to long-term exposure to NO2 (YLL per 100 000 inhabitants) estimated based on the average CRF (bars) and on the lower and upper 95% CI (error bars)

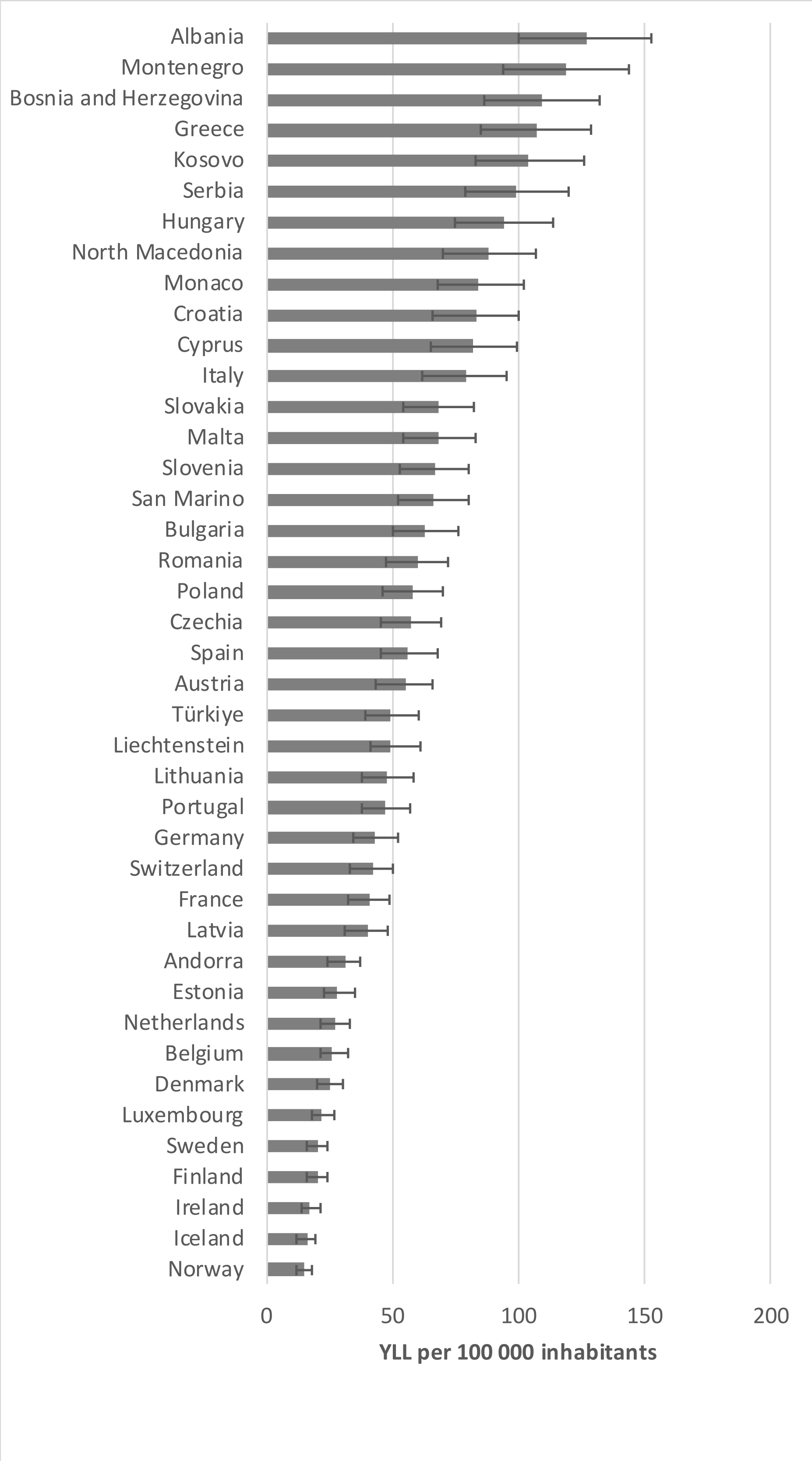
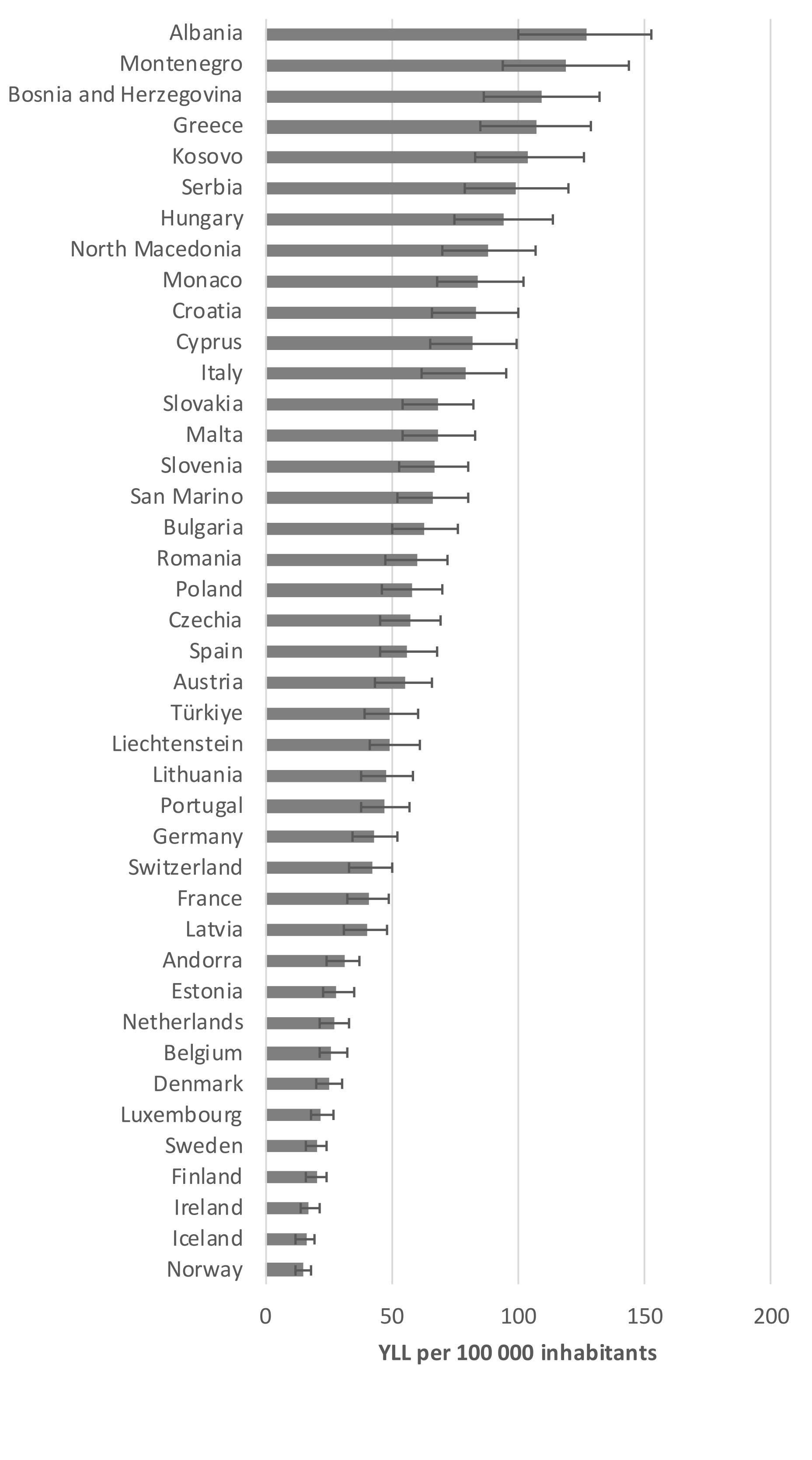


Figure 3.6: All-cause mortality due to short-term exposure to O3 (YLL per 100 000 inhabitants) estimated based on the average CRF (bars) and on the lower and upper 95% CI (error bars)



4 Combining cause-specific mortality and morbidity outcomes

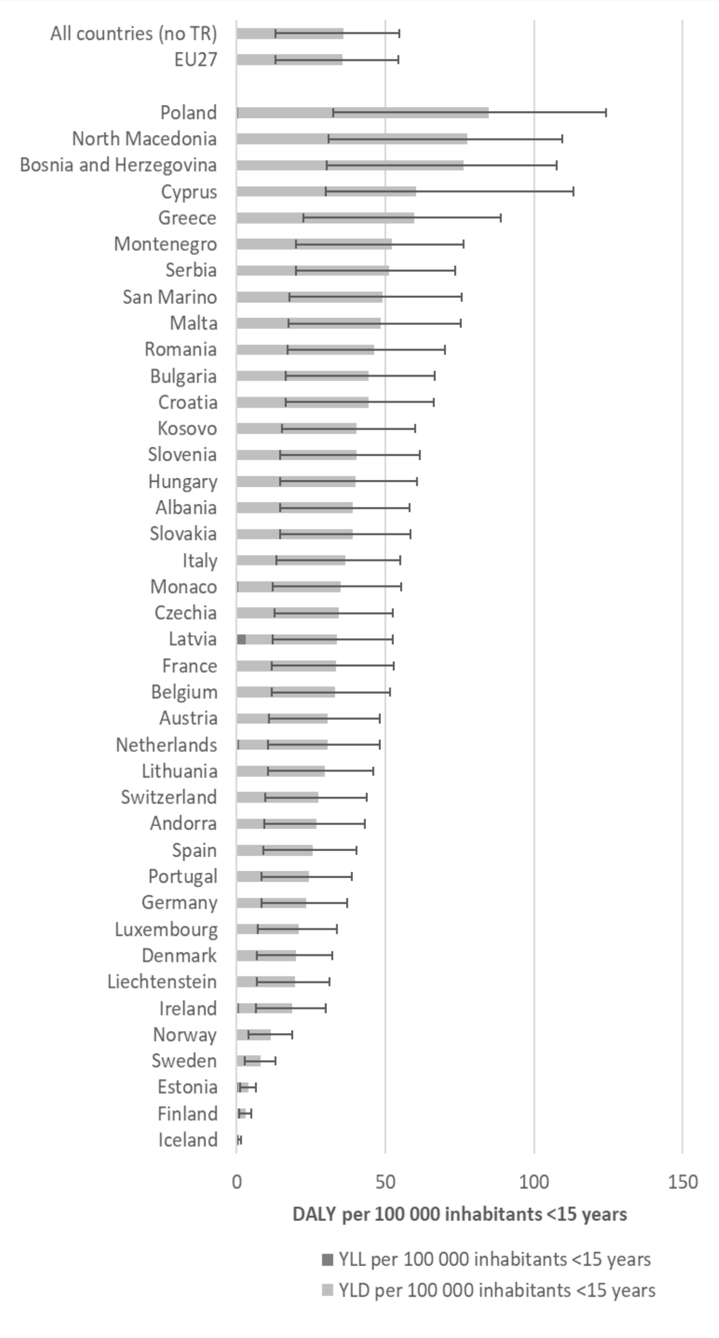
The following section presents the results of the cause-specific EBD analyses for the reference year 2021 based on the indicators AD, YLL, YLD, DALY, and attributable cases for hospital admissions. The 95 % CI, which only takes into account the uncertainty of the CRF, is also given in each case. For a better country comparison, the values are also presented as a rate per 100 000 inhabitants at risk.

4.1 $PM_{2.5}$

4.1.1 Asthma in children younger than 15 years of age

For asthma, the evidence base only allowed an estimate of the burden of disease for the population of children aged less than 15 years. The burden was mostly related to the morbidity effects because deaths due to asthma in these age groups are very unlikely. Taking all countries together, less than 10 AD or less than 1 AD per 100 000 inhabitants younger than 15 years were calculated. This resulted in 182 (95 % CI 66-280) YLL or less than 1 YLL per 100 000 inhabitants younger than 15 years (**Table A2.1** and **Table A2.2**). Apart from four countries, the YLL share of DALY corresponded to a maximum of about 1 % (range 0-13 %). Overall, 25 932 DALY related to asthma were attributable to $PM_{2.5}$. The 95 % CI ranged from 9 514 to 39 615. The highest total burden was estimated for Poland, France, and Italy: 4 973, 3 999 and 2 791 DALY, respectively. San Marino, Monaco, Liechtenstein, and Iceland had the lowest total burden, with less than 10 DALY in each country. The highest DALY rates were observed for Poland, North Macedonia, and Bosnia and Herzegovina, with 84.9, 77.5 and 76.2 DALY per 100 000 population in the age groups younger than 15 years of age. The lowest rates were observed for Estonia, Finland and Iceland, with 4, 3.1 and 1 DALY per 100 000 persons aged under 15 years, respectively (see Figure 4.1 and **Table A2.4**). Latvia, as a country with a relatively small population, had a higher mortality due to asthma than countries with a comparable population. This feature becomes most obvious when considering the rates per 100 000 inhabitants, showing a larger share of YLL in the country ranking.

Figure 4.1: Asthma-related disease burden due to PM2.5 (YLL, YLD and DALY per 100 000 inhabitants < 15 years) estimated based on the average CRF (bars) and the lower and upper 95% CI (error bars)

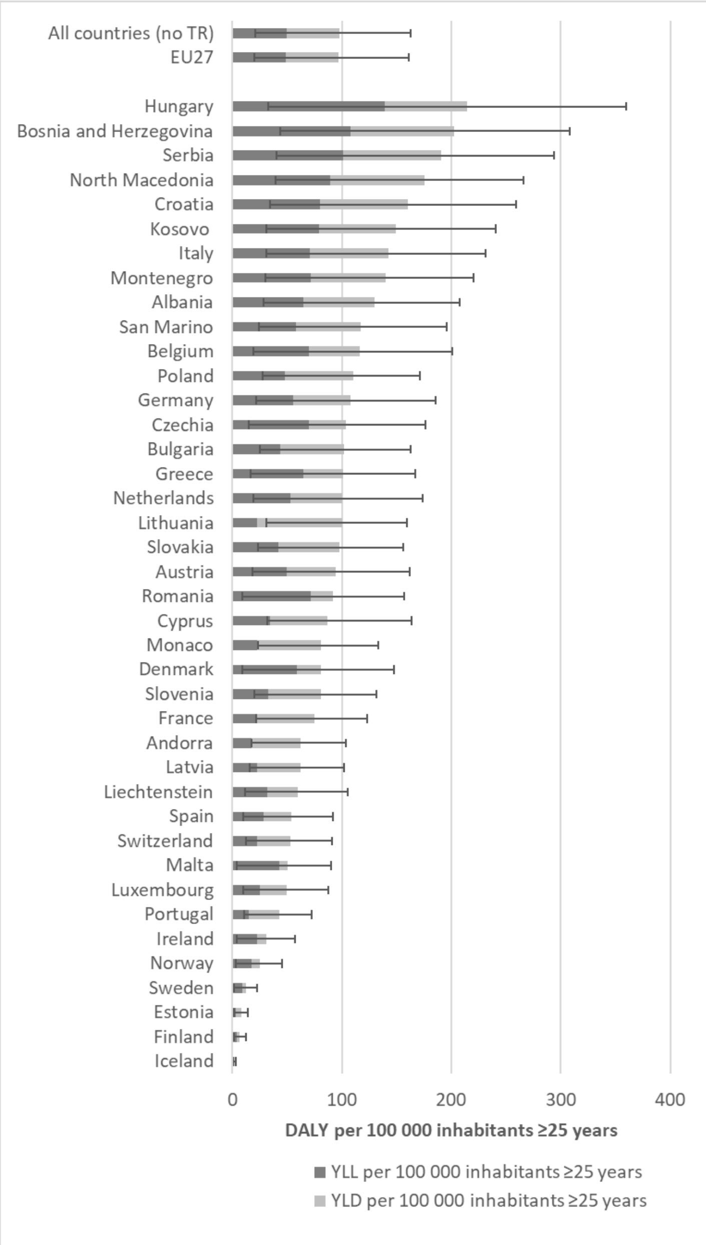


4.1.2 Chronic obstructive pulmonary diseases in adults aged 25 years or older

Regarding COPD related to $PM_{2.5}$, 19 233 (95 % CI 347-34 672) AD or 5.4 (95 % CI less than 1-9.7) AD per 100 000 inhabitants aged 25 years or older were calculated for all European countries. This resulted in 175 639 (95 % CI 3 159-317 863) YLL or 49.3 (95 % CI less than 1-89.2) YLL per 100 000 inhabitants (see **Table A2.5** and **Table A2.6**). On average, the YLL share was about 51 % (range 22-85 %). With respect to DALY, the overall burden of COPD due to $PM_{2.5}$ in the selected European countries was estimated at 349 097 with a 95 % CI ranging from 72 938 to 579 245 DALY. The total numbers indicate the highest burden in Germany, Italy and France, with 68 295, 65 153 and 35 609 DALY, respectively. The lowest total burden was estimated for Monaco, Liechtenstein and Iceland, with 22, 18 and 5 DALY, respectively.

Figure 4.2 and **Table A2.8** present the DALY rates per 100 000 inhabitants aged 25 years or older, including the 95 % CI. The rates indicate the highest burden for Hungary, Bosnia and Herzegovina, and Serbia, with 207.5, 196.8 and 185 DALY per 100 000 persons, respectively. The lowest rates were observed for Estonia, Finland, and Iceland, with 6.6, 5.8, and 2.6 DALY per 100 000 persons.

Figure 4.2: COPD-related disease burden due to PM2.5 (YLL, YLD and DALY per 100 000 inhabitants ≥ 25 years) estimated based on the average CRF (bars) and the lower and upper 95% CI (error bars)

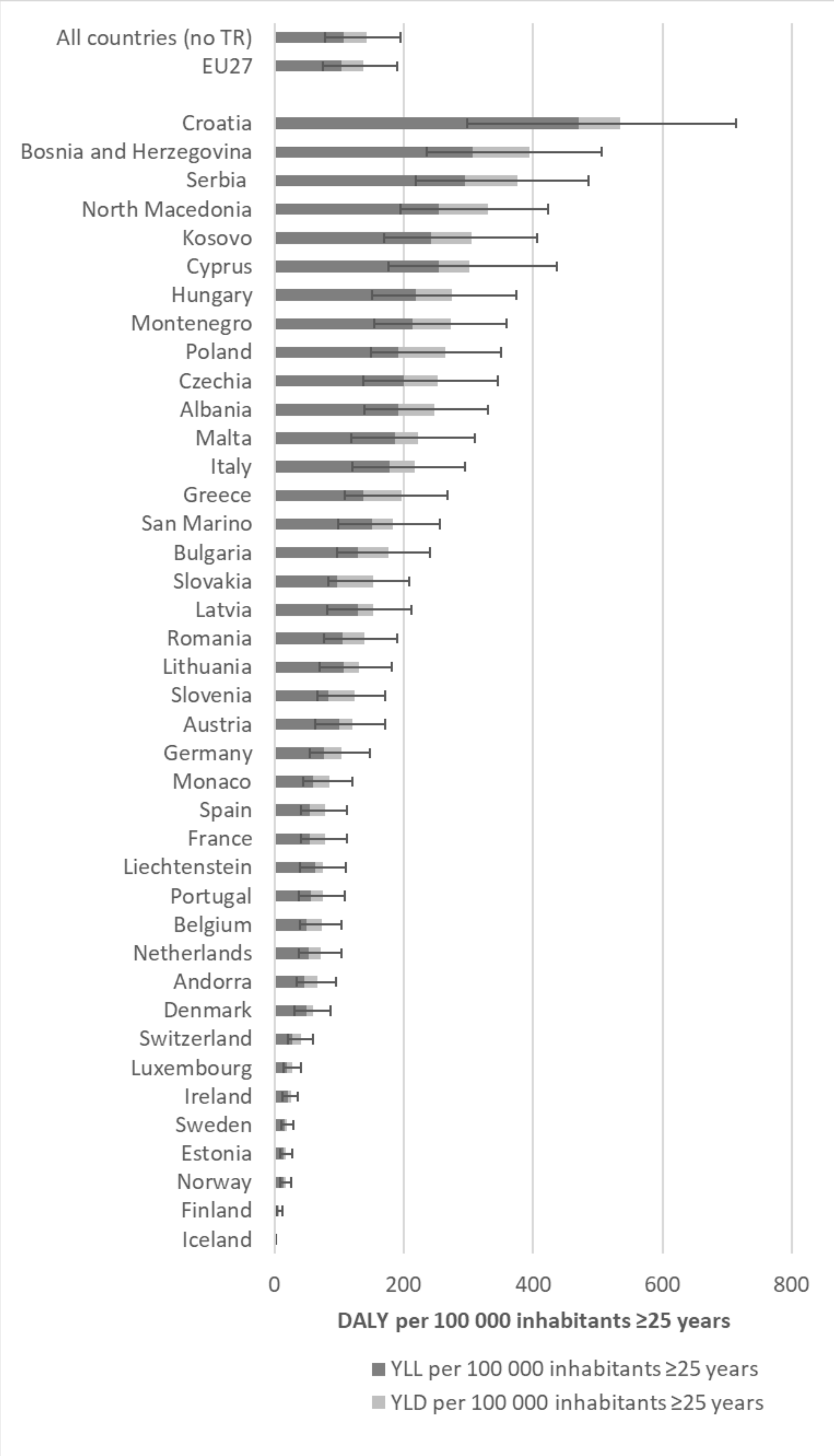


4.1.3 *Diabetes mellitus in adults aged 25 years or older*

For DM related to $PM_{2.5}$, the overall number of AD for all countries considered was 42 671 (95 % CI 23 673-57 504) or 12.0 (95 % CI 6.6-16.1) AD per 100 000 inhabitants aged 25 years or older. The total number of YLL was 383 887 (95 % CI 212 880-517 518). The corresponding rate amounted to 107.7 (95 % CI 59.7-145.2) YLL per 100 000 inhabitants aged 25 years or older (**Table A2.9** and **Table A2.10**). With an average of about 76 % for all countries, YLL clearly accounted for the largest share of DALY (range 63-88 %). With respect to DALY, the total burden was estimated at 505 256 (95 % CI: 275 898-693 419). The highest total burden was estimated for Italy, Poland and Germany, with 99 620, 74 518 and 65 410 DALY, respectively. The lowest total burden was identified for Monaco, Liechtenstein and Iceland, with 23, 22 and less than 10 DALY, respectively. Taking into account the population size, the highest DALY rates were estimated for Croatia, Bosnia and Herzegovina, and Serbia, with 533.8, 395.1 and 375.5 DALY per 100 000 inhabitants aged 25 years or older, respectively (Figure 4.3 and **Table A2.12**). The lowest rates were observed for Norway, Finland, and Iceland, with 18.0, 8.0 and 1.2 DALY per 100 000 inhabitants aged 25 years or older.

Overall, it should be noted that the input data on health (prevalence, deaths) and DW refer to diabetes type 1 and 2 (ICD10 E10-14). However, this is not consistent with the CRF on morbidity and mortality. In contrast to mortality, the odds ratio for morbidity only refers to T2DM, which accounts for the largest proportion of diabetes cases.

Figure 4.3: DM-related disease burden due to PM2.5 (YLL, YLD and DALY per 100 000 inhabitants ≥ 25 years) estimated based on the average CRF (bars) and on the lower and upper 95% CI (error bars)

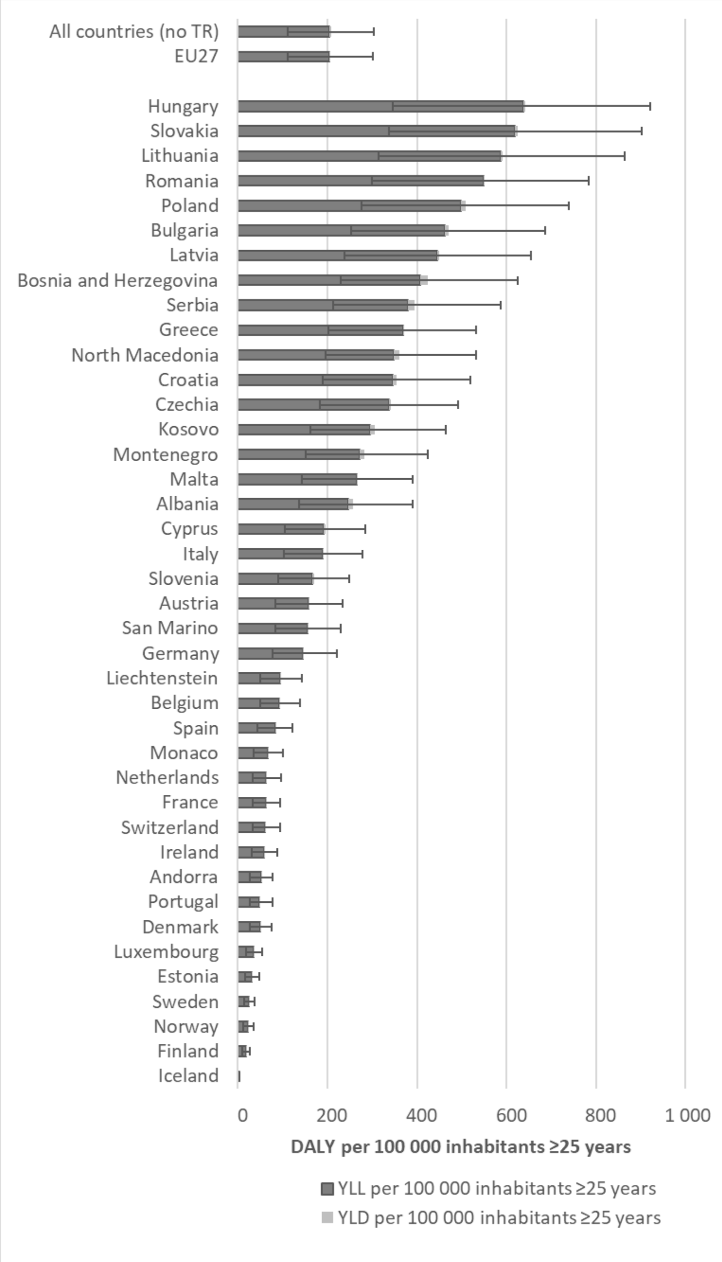


4.1.4 Ischemic heart diseases in adults aged 25 years or older

A total of 86 586 (95 % CI 47 104-122 398) AD were calculated for IHD related to $PM_{2.5}$ in all selected European countries. The corresponding rate per 100 000 inhabitants aged 25 years or older was 24.3 (95 % CI 13.2-34.3) AD. This translates into 730 454 (95 % CI 397 058-1 033 370) YLL or 205.0 (95 % CI 111.4-290.0) YLL per 100 000 inhabitants 25 years or older (**Tables A2.13** and **Table A2.14**). With an average YLL share of 98 % (range 96-99 %) of DALY, almost the entire burden of disease was attributed to mortality. Total DALY were estimated at 741 383 with a 95 % CI from 397 058 to 1 081 865 DALY. Poland, Germany and Italy had the highest total burden, with 143 664, 93 258 and 88 125 DALY, respectively. The lowest total burden was estimated for Liechtenstein and Andorra with 28 DALYs each, followed by Monaco and Iceland, with 18 and less than 10 DALY, respectively (Figure 4.4). The highest DALY rates were identified for Hungary, Slovakia and Lithuania, with 642.4, 625.9 and 591.6 DALY per 100 000 inhabitants aged 25 years or older. Norway, Finland, and Iceland showed the lowest rates, with 23.0, 17.8 and 2.3 DALY per 100 000 inhabitants 25 years or older (**Table A2.16**).

Overall, it should be noted that the selected CRF for the association between $PM_{2.5}$ and IHD morbidity was non-significant as the lower bound of the 95 % CI of the HR was less than one. Accordingly, for the YLD results, the lower bound of the 95 % CI was set to zero. Therefore, the results are to be regarded with caution, even if the share of YLD is only very small in this case.

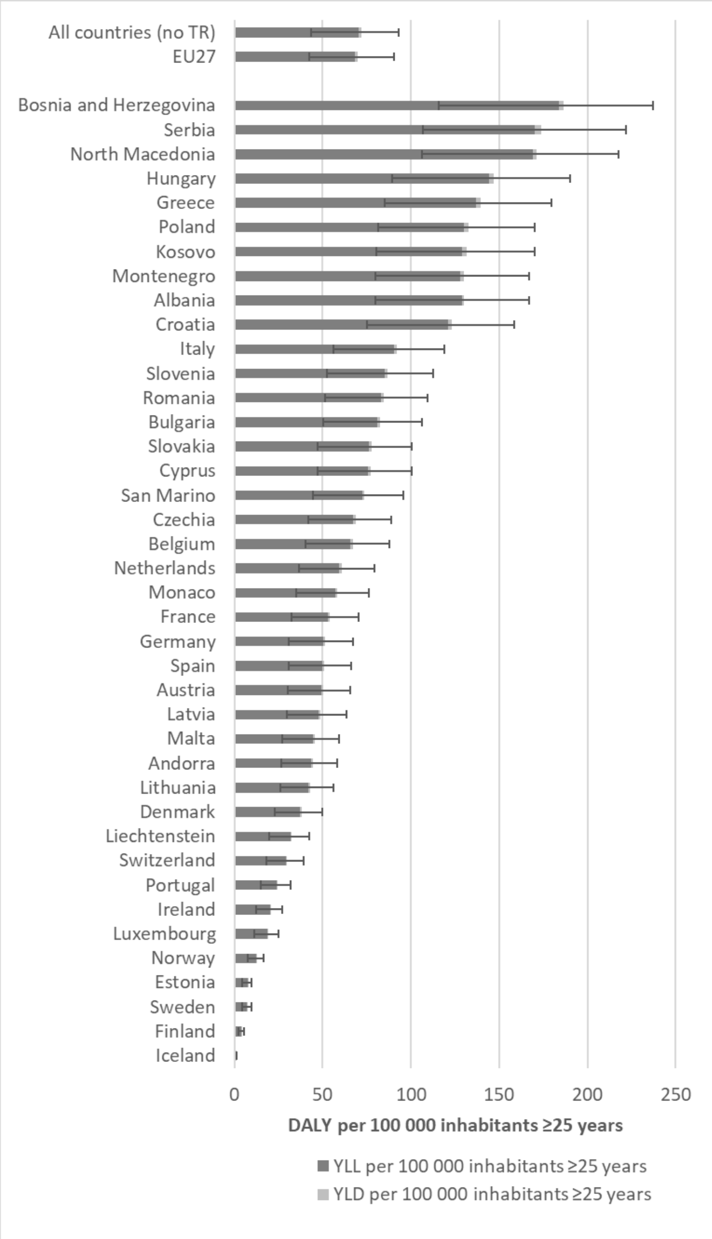
Figure 4.4: IHD-related disease burden due to PM2.5 (YLL, YLD and DALY per 100 000 inhabitants ≥ 25 years) estimated based on the average CRF (bars) and on the lower and upper 95% CI (error bars)



4.1.5 Lung cancer in adults aged 25 years or older

The overall burden of disease resulting from LC due to $PM_{2.5}$ in all selected European countries was estimated at 18 334 (95 % CI 11 185-23 620) AD with rates per 100 000 inhabitants aged 25 years or older of 5.1 (95 % CI 3.1-6.6) AD. Corresponding YLL figures amounted to 250 933 (95 % CI 152 979-323 457) or 70.4 (95 % CI 42.9-90.8) YLL per 100 000 inhabitants aged 25 years or older (**Table A2.17** and **Table A2.18**). The disease burden resulting from LC was strongly driven by the mortality effects with a mean YLL share of 98 % (range 97-99 %) of DALY (see Figure 4.5). Overall, DALY were estimated at 255 829 with the 95 % CI spanning from 155 068 to 331 174 DALY for all countries. The highest total burden was identified for Italy, Poland, and Germany, with 42 106, 37 446 and 32 553 DALY, respectively. The lowest total DALY were estimated for Monaco, Liechtenstein, and Iceland, with 16, 10 and less than 10 DALY, respectively. We found the highest DALY rates per 100 000 inhabitants aged 25 years or older for Bosnia and Herzegovina, Serbia, and North Macedonia, with 186.4, 173.7 and 171.2 DALY per 100 000, respectively. Sweden, with 7.2, Finland, with 3.9, and Iceland, with less than 1 DALY per 100 000 inhabitants aged 25 years or older, showed the lowest rates (**Table A2.20**).

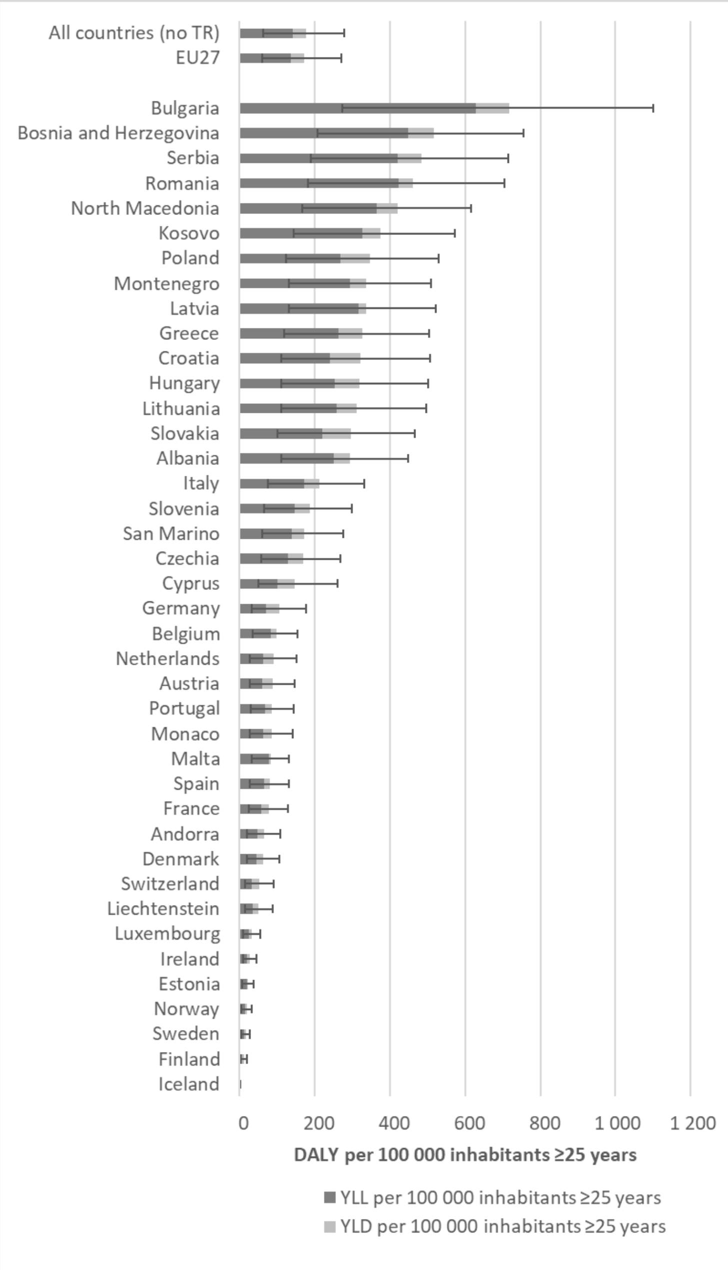
Figure 4.5: LC-related disease burden due to PM2.5 (YLL, YLD and DALY per 100 000 inhabitants ≥ 25 years) estimated based on the average CRF (bars) and the lower and upper 95% CI (error bars)



4.1.6 Stroke in adults aged 25 years or older

In 2021, the overall AD for stroke related to $PM_{2.5}$ for all countries considered was estimated at 64 171 (95 % CI 25 859-96 408) with a rate per 100 000 inhabitants aged 25 years or older of 18.0 (95 % CI 7.5-27.1) AD. Total YLL amounted to 505 337 (95 % CI 211 398-759 602) or 141.8 (95 % CI 59.3-213.2) YLL per 100 000 inhabitants aged 25 years or older (**Table A2.21** and **Table A2.22**). Mortality (YLL) also accounts for the largest share of the burden of disease in stroke, averaging 90 % (range 64-94 %) of DALY (see Figure 4.6). Overall, 571 390 DALY related to stroke due to $PM_{2.5}$ were estimated for 2021. The 95 % CI spans from 201 917 to 902 611 DALY. Poland, Italy, and Germany present the highest total DALY with 97 957, 97 529 and 66 905 DALY. The lowest total DALY was observed for Monaco, Liechtenstein, and Iceland, with 23, 15 and less than 10 DALY, respectively. Normalising for population size, the highest rates were estimated for Bulgaria, Bosnia and Herzegovina and Serbia, with 716.2, 516.4 and 59.2 DALY per 100 000 inhabitants aged 25 years or older. With 17.2, 11.9 and 1.4 DALY per 100 000 inhabitants aged 25 years or older, the lowest rates were observed for Sweden, Finland, and Iceland (**Table A2.24**).

Figure 4.6: Stroke-related disease burden due to PM2.5 (YLL, YLD and DALY per 100 000 inhabitants ≥ 25 years) estimated based on the average CRF (bars) and on the lower and upper 95% CI (error bars)



4.2 NO_2

4.2.1 Asthma in adults aged 15 years or older

For asthma effects attributable to NO_2, the CRF only applies to the population aged 15 years or older. A total of 788 (95 % CI 504-1 062) AD were calculated for all selected European countries. Corresponding rates were less than 1 AD per 100 000 inhabitants aged 15 years or older. The total number of YLL was estimated at 8 330 (95 % CI 5 328-11 224) or 1.8 (95 % CI 1.1-2.4) YLL per 100 000 inhabitants aged 15 years or older (**Table A2.25** and **Table A2.26**). YLL contributed, on average, only 9 % (range 1-24 %) to DALY (see Figure 4.7). The total burden for this age group was estimated at 115 425 DALY for the selected countries, with a 95 % CI ranging from 73 811 to 155 331 DALY. Türkiye, Germany, and Italy contributed the highest total burden with 49 947, 17 011 and 10 996 DALY, respectively. The lowest total burden was observed for Estonia, with 10 DALY, and Liechtenstein and San Marino had less than 10 DALY in each country. The highest DALY rates were estimated for Türkiye, Monaco, and Andorra, with 77.4, 38 and 33.3 DALY per 100 000 inhabitants aged 15 years or older. The lowest rates were observed for Finland, Sweden, and Estonia, averaging at rates of 2.1, 1.7 and less than 1 DALY per 100 000 inhabitants (**Table A2.28**).

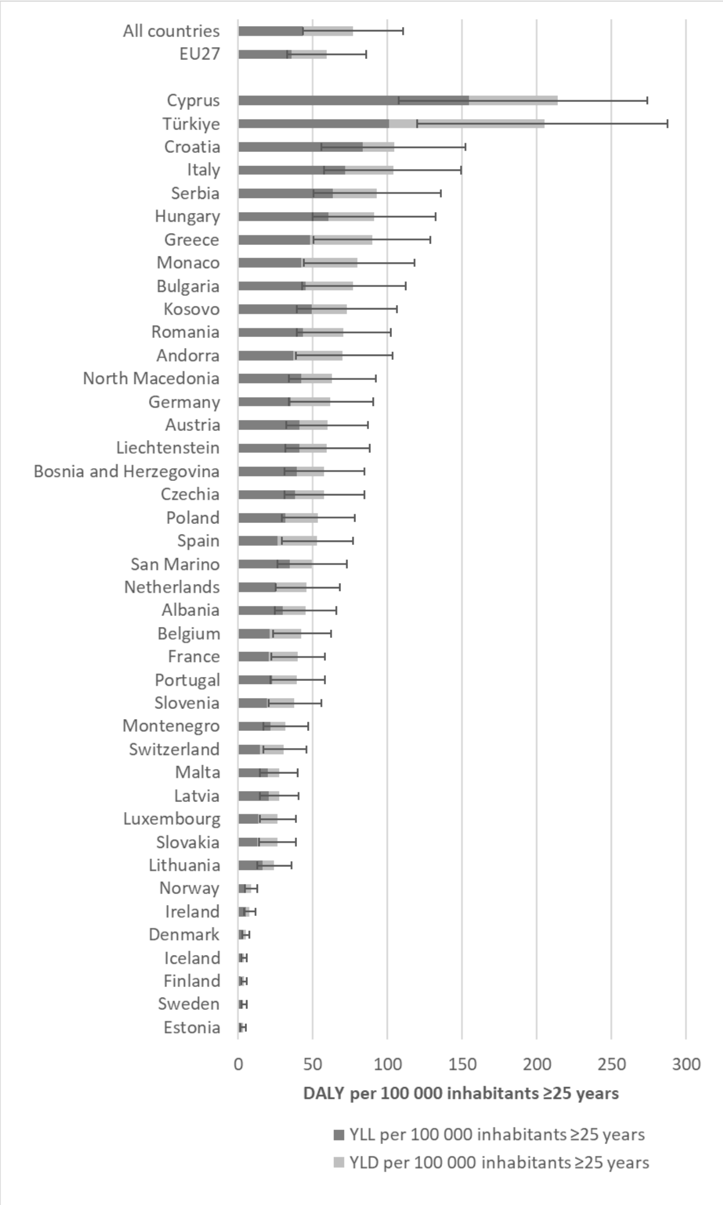
Figure 4.7: Asthma-related disease burden due to NO2 (YLL, YLD and DALY per 100 000 inhabitants ≥ 15 years) estimated based on the average CRF (bars) and the lower and upper 95% CI (error bars)

4.2.2 Diabetes mellitus in adults aged 25 years or older

In 2021, the overall AD for all European countries considered was estimated at 18 227 (95 % CI 9 782-25 499) with an AD rate per 100 000 inhabitants aged 25 years or older of 4.5 (95 % CI 2.4-6.2). The total number of YLL was 178 478 (95 % CI 96 236-248 673). The corresponding rate amounted to 43.7 (95 % CI 23.6-60.9) YLL per 100 000 inhabitants aged 25 years or older (**Table A2.29** and **Table A2.30**). The share of YLL in DALYs was 60 % on average (range 43-80%) (see Figure 4.8).

The total DM burden for the respective countries was estimated at 314 574 DALY, with the 95 % CI spanning from 177 035 to 451 956 DALY. The highest total burden was estimated for Türkiye, Italy, and Germany with 105 834, 47 711 and 39 032 DALY, respectively. The lowest burden was identified for Liechtenstein, San Marino, and Iceland, with 17, 13 and 10 DALY, respectively. Considering the age structure of the populations, the highest DALY rates were estimated for Cyprus, Türkiye, and Croatia, with 214.2, 204.9 and 104.4 DALY per 100 000 inhabitants aged 25 years or older, respectively. The lowest rates were found for Finland, Sweden, and Estonia, with 3.9, 3.8 and 3.7 DALY per 100 000 inhabitants aged 25 years or older (**Table A2.32**).

Figure 4.8: Diabetes mellitus-related disease burden due to NO2 (YLL, YLD and DALY per 100 000 inhabitants ≥ 25 years) estimated based on the average CRF (bars) and on the lower and upper 95% CI (error bars)

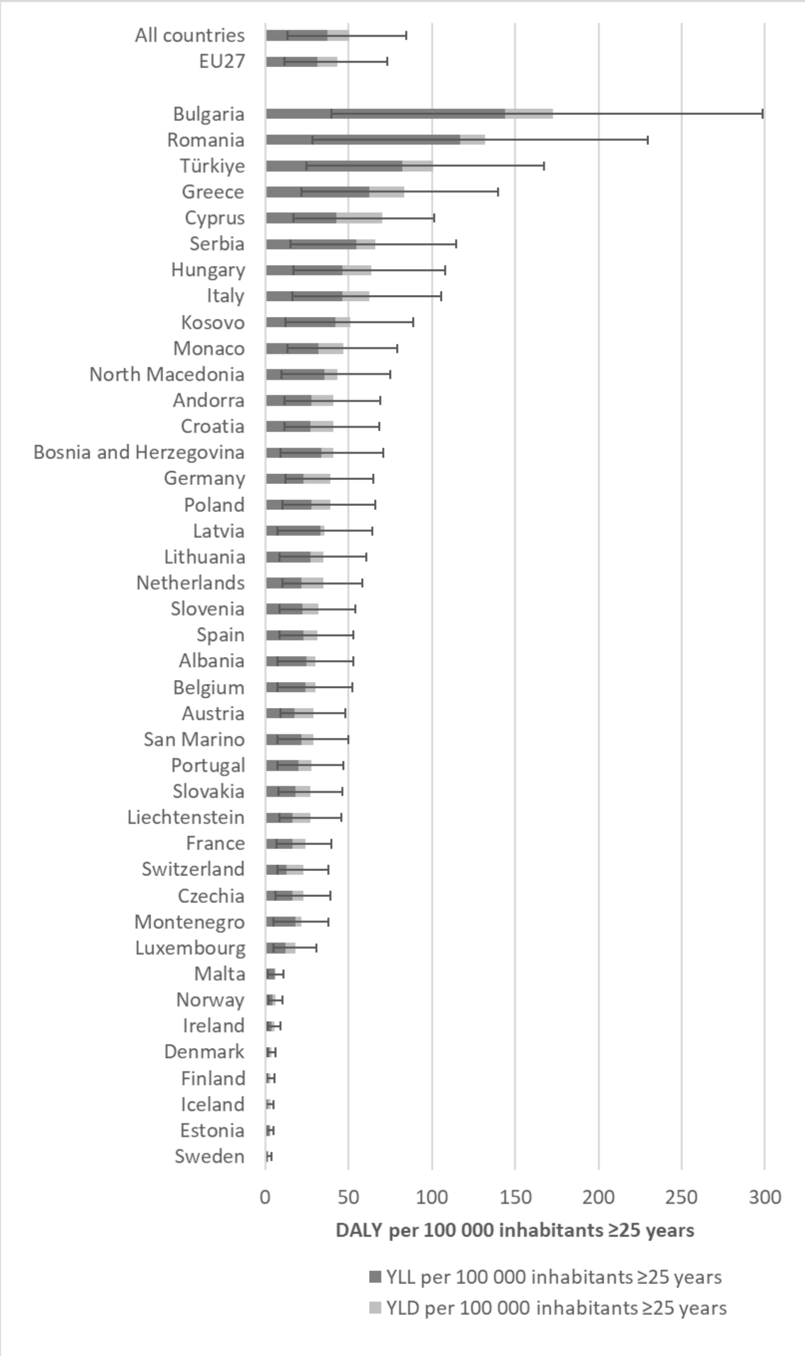


4.2.3 Stroke in adults aged 25 years or older

In 2021, the overall AD for stroke related to NO_2 were estimated at 17 937 (95 % CI 3 110 - 31 761) for all European countries considered. Adjusting for population size (per 100 000 inhabitants 25 years or older), the rate amounted to 4.4 (95 % CI less than 1.0 - 7.8) AD. Corresponding total YLL were calculated at 153 181 (95 % CI 26 624-270 623) or 37.5 (95 % CI 6.5-66.3) YLL per 100 000 inhabitants aged 25 years or older (**Table A2.33** and **Table A2.34**). Here, too, the share of YLL in DALY is significantly higher than the YLD, averaging 72 % (range 54-92 %) (see Figure 4.9).

Regarding DALY figures, the overall burden of stroke resulting from NO_2 exposure in the selected countries was estimated at 204 723 DALY. The 95 % CI spans from 53 575 to 344 547 DALY. The highest total burden was estimated for Türkiye, Italy, and Germany with 52 131, 28 694 and 24 755 DALY, respectively. With less than 10 DALY each, San Marino, Liechtenstein, and Iceland showed the lowest observed burden. Bulgaria, Romania, and Türkiye were identified to have the highest DALY rates with 172.8, 132.1 and 100.9 DALY per 100 000 inhabitants aged 25 years or older, respectively. The lowest rates were observed for Iceland, Estonia, and Sweden, with 2.9, 2.8 and 2.0 DALY per 100 000 inhabitants aged 25 years or older (Table A2.36).

Figure 4.9: Stroke-related disease burden due to NO2 (YLL, YLD and DALY per 100 000 inhabitants ≥ 25 years) estimated based on the average CRF (bars) and the lower and upper 95% CI (error bars)



4.3 Ozone

4.3.1 Hospital admissions for respiratory diseases in adults aged 65 years or older

Due to the lack of a suitable CRF, the disease burden due to O_3 (SOMO35) was only calculated for "hospital admissions for respiratory diseases" in the older segment of the population (aged 65 years and older). We identified 15 986 attributable hospital admissions in the selected European countries. The 95 % CI ranged between 2 543 and 30 156 cases. The highest number of cases were found for Italy, Germany, and Spain, with 2 894, 2 266 and 2 084 attributable hospital admissions, respectively. The lowest number of cases was identified for Liechtenstein, Monaco, Iceland, and Andorra, with less than 10 cases each. Considering rates per 100 000 inhabitants aged 65 years or older, San Marino, Greece, and Malta presented with the highest rates of 51.6, 36.7 and 32.1 attributable hospital admissions. With 5.5, 5.4, and 4.4 attributable hospital admissions per 100 000 inhabitants aged 65 years or older, Estonia, Latvia, and Iceland had the lowest rates (**Table A2.37**).

4.4 Summary of results for Europe

Figure 4.10 and Figure 4.11 summarise the results for the different burden of disease indicators (cause-specific total AD, YLL, YLD, and DALY) for $PM_{2.5}$ and NO_2, respectively, differentiated by health outcomes. The numbers refer to all countries considered. When comparing the figures, note the different range of values on the Y-axis. It should also be noted that different age groups were considered in some of the estimates.

The results for Europe in 2021 show that the total burden of disease attributable to $PM_{2.5}$ was considerably higher than the one related to NO_2 (2 510 442 and 634 721 DALY, respectively). For both air pollutants, $PM_{2.5}$ and NO_2 the contribution of mortality (YLL) to the overall DALY was higher, with 82 and 54 %, respectively, than the morbidity contribution. In any case, not considering morbidity would lead to a substantial underestimation of the disease burden. For $PM_{2.5}$, IHD contributed most to the total DALY (741 383; 95 % CI 397 058-1 081 865), and for NO_2 it was DM (314 574; 95 % CI 177 035-451 956). Asthma accounted for the smallest share in each case ($PM_{2.5}$: 25 932; 95 % CI 9 514-39 615 DALY; NO_2: 115 425; 73 868-155 450 DALY). No corresponding indicators were calculated for O_3.

Figure 4.10: Burden of disease indicators for PM2.5 (all countries) differentiated by outcomes. The total is estimated based on the average CRF (bars) and the lower and upper 95% CI (error bars)

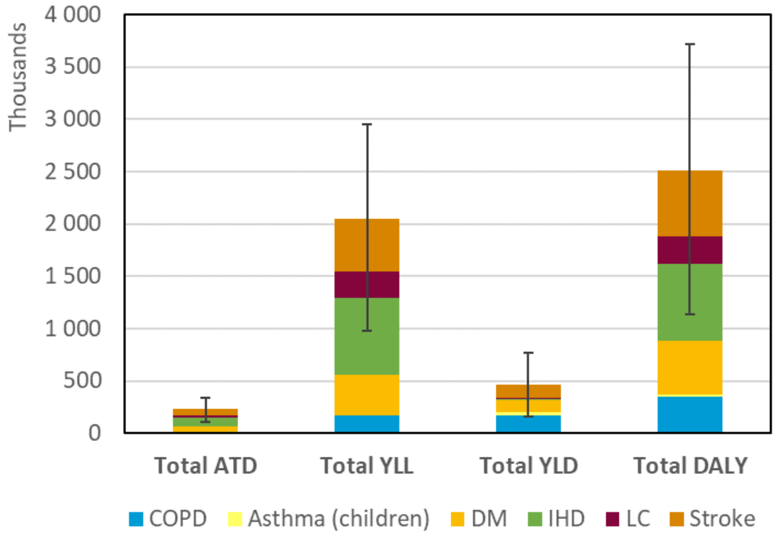
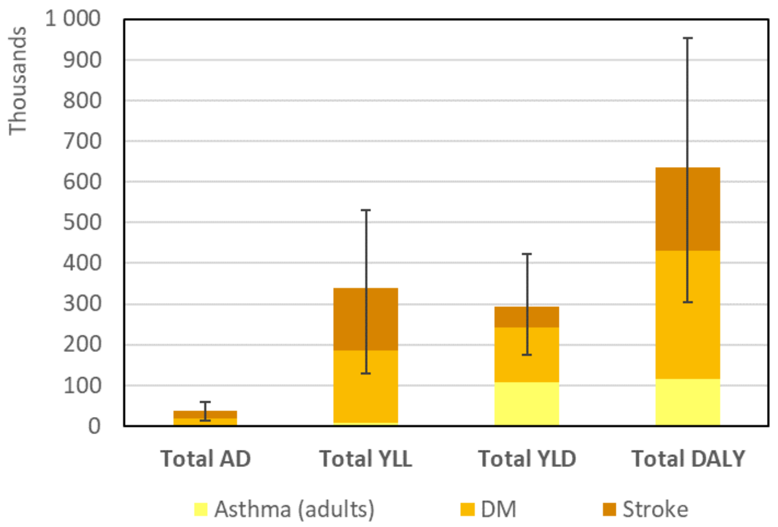


Figure 4.11: Burden of disease indicators for NO2 (all countries) differentiated by outcomes. The total is estimated based on the average CRF (bars) and the lower and upper 95% CI (error bars)



5 All-cause mortality versus cause-specific mortality – rational and a comparison of the results

The mortality associated burden of disease due to air pollution can be estimated using mortality data and a CRF for all-cause natural mortality or cause-specific mortality. Both approaches have their advantages and limitations and can be used to answer specific policy questions. When using the all-cause mortality approach, the relevant CRFs from environmental epidemiological studies are based on the association between the concentration of an air pollutant and the occurrence of all natural deaths. Injury and unspecified deaths are excluded from the analyses. Thus, the effect measures resulting from such analyses cannot be differentiated by health outcome. This hampers tailored prevention and intervention measures to focus on specific vulnerable groups suffering from diseases such as asthma or COPD. The advantage of the all-cause mortality approach is a) that the data from mortality statistics are readily available and of high quality for most European countries, b) the effect measures are based on bigger-sized samples because no stratification by outcome is included in the analyses, and c) they probably include additional health outcomes that were not yet identified to be associated with certain air pollutants.

The last point is, however, also a major point of criticism, because this approach also includes deaths which have a not negligible probability to be not associated with air pollution. These include diseases caused by an infectious agent, e.g. hepatitis or other infectious diseases such as influenza, which considerably adds to mortality in Europe (GBD 2019 Risk Factors Collaborators, 2020). Here, we know that the influenza virus is the causative agent. Assuming that a share of the influenza deaths would be related to air pollution is critical because air pollution might add to a person's vulnerability to influenza. Still, without the causative agent, this disease and probably the resulting death case would not have occurred. Epidemiological studies using all-cause mortality as an outcome include this large spectrum of diseases and thus the resulting effect measures can be biased by not considering the cause-specific associations that might vary widely. Since all-cause mortality analyses cannot be stratified by the relevant death causes, the impact on the effect measures cannot be eliminated in the statistical analyses. Another limitation of the all-cause mortality approach is that when using a summary measure of population health, such as the DALY, there is no equivalent information for all-cause natural mortality concerning the morbidity, i.e., all-cause prevalence. This hampers the addition of morbidity to the mortality effects. To be able to combine the mortality and morbidity components in a DALY estimate, it is thus necessary to use the cause-specific approach. This approach uses cause-specific mortality data (cause of death data from vital registration systems) and CRF. A cause-specific CRF is based on environmental epidemiological studies that assess the association between air pollution exposure and specific outcomes, such as LC or COPD.

The advantage of cause-specific approach is that: a) one can differentiate between health outcomes, which can help to focus specific prevention measures targeted to vulnerable groups; b) the CRF are tailored to specific outcomes, which allows more specific effect estimates; and c) the approach enables the quantification of the comprehensive disease burden using the DALY as the summary measure. However, the approach is limited to the fact that it only considers health outcomes that have shown a strong evidence base for the association between air pollutants and that health outcome. Thus, potentially relevant outcomes not studied to that extent today, compared to established risk-outcome pairs, could be missed, leading to an underestimation of the disease burden. The cause-specific estimates in the report thus rather represent conservative results. It should be kept in mind that both approaches have their specific purposes. The all-cause natural mortality approach helps to get an overview of the overall potential impact of air pollutants on health. The data is mostly available for all European countries and the results can be generated more easily. Also, most of the data is based on continuously updated registries. The cause-specific approach comes with higher resource demands. In addition, some data sources (e.g. the EHIS-survey) are not routinely (yearly) updated, leading to a higher demand for gap-filling techniques, which may introduce higher uncertainties in the estimates. Nonetheless, the cause-specific approach allows for a focus on specific diseases. Also, it has the advantage of including the morbidity component and estimating the DALY as a summary measure of population health.

The overall comparison of both approaches presented in this report shows that with 293 000 deaths attributable to $PM_{2.5}$, the all-cause mortality approach resulted in a higher burden as compared to 230 999 AD when all cause-specific estimates for the six health outcomes are aggregated to the overall burden for the 40 countries considered. Comparing the YLL, using the all-cause mortality approach also results in a higher overall disease burden with 2 936 000 compared to 2 046 431 YLL for the six cause-specific outcomes. With a rate of 618 YLL per 100 000 inhabitants, a higher rate was estimated with the all-cause mortality approach, compared to a rate of about 574 YLL per 100 000 inhabitants for the cause-specific approach.

For NO_2, using the all-cause mortality approach yielded 69 000 AD, which is almost twice as high as the cause-specific estimate with 36 952 AD across all 41 countries. Comparing the YLL, the all-cause mortality approach resulted in 740 000 YLL or a rate of 132 per 100 000 inhabitants. In the cause-specific approach, the burden of disease was much lower, with 339 989 YLL and a rate of about 83 YLL per 100 000.

The results of the cause-specific analyses also showed the importance of including the morbidity component. Taking the example of $PM_{2.5}$ it was still obvious that the mortality component contributes most to the DALY, especially when considering diseases such as IHD and lung cancer. For both outcomes, on average only 2 % of the DALY resulted from the impacts of morbidity. Other diseases such as DM, COPD or stroke have a higher contribution of morbidity to the burden of disease. The strongest contribution was observed for COPD, with about 50 % of DALY being due to YLD. Further, the shares of morbidity are still relevant, with about 24 % for DM and with about 20 % for stroke. Finally, childhood asthma represents a disease where almost 100 % of the DALYs is due to YLD.

Leaving out the morbidity impacts due to $PM_{2.5}$ would result in an underestimation of the overall disease burden by 464 011 years which are lost due to living in a state of reduced health. With further increases of chronic diseases in Europe, which is to be expected due to the anticipated future increase of non-communicable diseases, the relevance of diseases with livelong disabilities will become more prominent. Thus, using the DALY as a summary measure of population health in future assessments is a necessary prerequisite to allow a comprehensive assessment of the air pollutant impacts on the health of the European population.

In both approaches and for all pollutants, we used the same exposure (concentration) data, however, in the cause-specific approach the calculation for this report could not be performed on the 1x1 km² grid as done in the all-cause mortality approach. The burden of disease estimation was performed at the country level using age and sex specific cause of death data as the basis. This introduces a relevant difference between the two approaches. The baseline data differ in the sense that in the all-cause mortality approach the number of deaths, which is the starting point when attributing deaths to a risk factor, is higher than the sum of the deaths resulting from six outcomes for $PM_{2.5}$ or the three considered outcomes for NO_2. Another source of difference is the use of the life expectancy. In the all-cause mortality approach 1-year age groups were used. However, in the cause-specific approach abridged life expectancy values for 5-year age groups were used. The abridged life expectancy values are generally based on the single age classes but were combined to 5-year age groups using interpolation techniques.

The quantitative comparison of the impact of the CRF is not feasible due to the fact that each of the six health outcomes for $PM_{2.5}$ has a different CRF, hampering comparison of the resulting overall burden from both approaches. A general commonality is the linear shape of the CRF with increasing concentrations. This holds for both, $PM_{2.5}$ and NO_2.

The counterfactual concentration plays an important role in the size of the disease burden. The counterfactual concentrations were aligned between both approaches and thus do not contribute to the observed differences. For both approaches, the guideline levels provided in the 2021 AQG by the WHO (WHO, 2021) were used as counterfactual concentrations for $PM_{2.5}$ and NO_2, and WHO (2013) for O_3.

6 Conclusions and further work

The environmental burden of disease assessments presented in this report builds on the work presented in previous Eionet and EEA reports and briefings on HRA, expanding its scope. The previous expansion of the EBD assessments made the burden of disease estimations more complete by assessing both all-cause mortality and cause-specific morbidity. This Eionet report adds to the previous assessments by estimating cause-specific mortality, aligned to cause-specific morbidity, to assess the overall impact of selected air pollutants on human health. These results are focused on the DALY indicator, but we also included AD, YLL, YLD, and attributable cases for comparison with the all-cause mortality analyses. Using a comprehensive and comparable indicator for the combined effects of mortality and morbidity for European countries is a major step forward in the assessments of the EEA-ETC HE on the burden of disease related to exposure to major harmful air pollutants in Europe: $PM_{2.5}$, NO_2, and O_3. Additionally, such indicators allow the comparison of the burden due to various environmental risk factors with other risk factors or diseases.

The all-cause mortality burden of disease associated with exposure to air pollution across Europe in 2021 remained high, especially in central and south-eastern European countries. The largest mortality from long-term exposure is attributed to $PM_{2.5}$, followed by NO_2. The assessment for O_3 is only related to short-term exposure (acute). The exposure to concentration levels above the 2021 WHO AQ guideline levels in 2021 resulted in 293 000 AD related to $PM_{2.5}$ exposure (excluding Türkiye), and 69 000 AD due to NO_2 across the countries included in the assessment. For the same 41 countries, 27 000 AD were due to short-term exposure to O_3. For EU27, AD in 2021 are 253 000, 52 000 and 22 000, respectively. When considering both AD and the age at which they occur (and scalled by population), the number of YLL (and YLL per 100 000 inhabitants) for the 41 (40 for $PM_{2.5}$) European countries is 2 936 000 (618), 740 000 (132) and 299 000 (54) due to exposure to $PM_{2.5}$, NO_2, and O_3, respectively. For EU27, YLL (YLL per 100 000 inhabitants) are 2 584 000 (584), 532 000 (120), 234 000 (53), respectively.

The cause-specific approach allows combining the mortality and morbidity associated burden of disease into the summary measure DALY. Comparing the impact of $PM_{2.5}$ and NO_2 on the population health of the European population, $PM_{2.5}$ is clearly the pollutant with the strongest effect, contributing 2 510 442 DALY across the 40 countries or 2 294 842 DALY in the EU27. The burden attributable to NO_2 was considerably lower, with 634 721 DALY and 403 788 DALY for all 41 countries and in the EU27, respectively. This was caused, in part, by the fact that six diseases were considered for $PM_{2.5}$, while only three were taken into account for NO_2. Looking at the single disease entities, ischemic heart disease contributed most to the overall burden of $PM_{2.5,}$ with 741 383 DALY across the 40 countries and 688 979 DALY in the EU27. The lowest burden was related to asthma (children), with 25 932 and 23 969 DALY in all 40 countries and the EU27, respectively. For NO_2, the highest disease burden was associated with diabetes mellitus (all 41 countries: 314 574 DALY; EU27: 197 031 DALY) and the lowest with asthma (adults) (all 41 countries: 115 425 DALY; EU27: 62 460 DALY). No corresponding indicators were calculated for O_3, yet short-term exposure to O_3 was associated with 15 986 attributable hospital admissions in the 41 selected European countries. When comparing the results, it is important to note that different age groups (i.e. children, adults, and elderly) were considered in the estimates, following the concentration-response functions.

The results of the underlying EBD assessment clearly show that air pollution is still an important risk factor for the health of the European population. Concerted actions are needed to reduce the European population's exposure to further reduce the disease burden.

Forward-thinking, this work paves the way to keep expanding the assessment to consider further health outcomes with a lower evidence level (suggestive or moderate evidence) based on the latest epidemiological studies and keep updating the baseline assumptions of the studies (CRFs and DWs). The work described in this report also points to the need to improve the gap-filling process to cover as many European countries as possible and make the process as consistent as possible, especially between all-cause and cause-specific analyses. It also highlights that aligning the methodology for estimating cause-specific mortality/morbidity with all-cause mortality is crucial for consistency and, eventually, allowing the EBD to be estimated at different NUTS levels.

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List of abbreviations

Abbreviation	Name	Reference
AD	Attributable death	
AQG	Air quality guidelines	
CAMS	Copernicus Atmosphere Monitoring Service	
CI	Confidence interval	
COPD	Chronic obstructive pulmonary disease	
CRF	Concentration-response function	
DALY	Disability-adjusted life year	
DM	Diabetes mellitus	
DW	Disability weight	
EBD	Environmental burden of disease	
EEA	European Environment Agency	www.eea.europa.eu
ELAPSE	Effects of low-level air pollution: a study in Europe	www.elapseproject.eu
EHIS	European Health Interview Survey	
ETC/ATNI	European Topic Centre on Air pollution, Transport, Noise and Industrial pollution	
ETC HE	European Topic Centre on Human Health and the Environment	
EU	European Union	www.european-union.europa.eu
GBD	Global burden of disease	
HR	Hazard ratio	
HRAPIE	Health risks of air pollution in Europe	https://iris.who.int/handle/10665/153692?show=full
IARC	International Agency for Research on Cancer	
ICD	International classification of diseases	
IHD	Ischemic heart disease	
LC	Lung cancer	
m^3	Cubic meter	
N/A	Not Available	
NO_2	Nitrogen dioxide	
O_3	Ozone	
OR	Odds ratio	
PAF	Population attributable fraction	

Abbreviation	Name	Reference
$PM_{2.5}$	Fine particulate matter (diameter below 2.5 µm)	
ppb	Parts per billion	
RR	Relative risk	
SOMO35	Annual sum of daily maximum running 8-h average concentrations above 35 ppb	
SOMO10	Annual sum of daily maximum running 8-h average concentrations above 10 ppb	
T2DM	Type 2 diabetes mellitus	
WHO	World Health Organization	www.who.int
YLL	Year of life lost due to death	
YLD	Year lived with disability	
µg	Microgram	
µm	Micrometer	

Annex 1 Methodology

A.1.1 Estimation of health outcomes related to air pollution

All-cause (natural) mortality

For European ambient air pollution levels, the relative risk (RR_C) in a population whose exposure is estimated by an average concentration C can be described as a log-linear function relating concentrations and mortality (Ostro, 2004; WHO, 2013), as specified below:

$$\boldsymbol{RR_C} = \mathbf{exp}\,[\,\boldsymbol{\beta}\ (\boldsymbol{C} - \boldsymbol{C_0})\,] \qquad \text{(A1.1)}$$

where, C is the concentration level the population is exposed to, C_0 is the counterfactual concentration, and β is based on the concentration-response function (CRF) estimated by epidemiological studies. The CRF depends on the pollutant and health outcome to be estimated. C_0 can either be the background concentration (i.e., the level that would exist without any human-made pollution), a concentration below which no health effects are expected, or a counterfactual concentration level. β can be estimated as follows:

$$\boldsymbol{\beta} = \frac{\ln(\boldsymbol{CRF})}{\boldsymbol{UC}} \qquad \text{(A1.2)}$$

where *UC* is the unit of concentration.

According to (WHO, 2019a), the population attributable fraction (PAF) can be used as a metric to assess the contribution of a risk factor to a disease or a death. The PAF can be defined as the share of the total burden of disease in a population that is identified as being due to a certain risk factor. This share may be zero if the risk factor (causative exposure) was eliminated or at least lower when the exposure is reduced to a less harmful level, also called the counterfactual concentration. Assuming that the population is exposed to a single concentration level over the assessed period, the PAF can be calculated based on the relative risk as follows:

$$\boldsymbol{PAF} = \frac{\boldsymbol{RR_C} - \mathbf{1}}{\boldsymbol{RR_C}} \qquad \text{(A1.3)}$$

Finally, a health indicator attributable to air pollution is estimated by:

$$\boldsymbol{health\ indicator} = \boldsymbol{PAF} \cdot \boldsymbol{MR} \cdot \boldsymbol{Pop} \qquad \text{(A1.4)}$$

Where *MR* is the baseline incidence of the health effect expected for the population amount *Pop.* When assessing all-cause mortality, the term PAF indicates the proportional reduction in population death that would occur if exposure to a risk factor were reduced to an alternative ideal exposure scenario.

Mortality measures the number of deaths in a particular population due to a specific or non-discriminated cause. An attributable death is defined as a death, which is statistically attributable to the exposure towards a risk factor, e.g. $PM_{2.5}$. The attribution is based on the evidence from studies for the causal link between a risk factor and the health outcome leading to death. This health outcome is estimated as follows:

$$\boldsymbol{AD} = \boldsymbol{PAF} \sum_{a,s} \boldsymbol{CDR_{a,s}} * \boldsymbol{Pop_{a,s}} \qquad \text{(A1.5)}$$

where AD is the number of attributable deaths, $CDR_{a,s}$ is the natural mortality rate by sex (s) and age (a) in a particular population due to a specific cause, and $Pop_{a,s}$ is the population fraction stratified by age and sex.

YLL measures the years lost due to death before reaching a specifically selected life expectancy value. YLL takes into account the life expectancy at the moment of death and is greater for deaths at a younger age and lower for deaths at an older age (Murray and Lopez, 1996). It gives, therefore, more nuanced information than the AD alone. YLL is determined by relating CDR with life expectancy:

$$\boldsymbol{YLL = PAF\ \sum_{a,s} CDR_{a,s} * Pop_{a,s} * LE_{a,s}} \qquad \text{(A1.6)}$$

where $LE_{a,s}$ is the average time a person is expected to live, based on the year of birth, sex (s) and age (a).

For this environmental burden of disease (EBD) indicator, Equations (A.1.1) to (A.1.6) are applied to every single grid cell of the concentration maps (C in A1.1). Error! Reference source not found. d escribes the CRFs and C_0 used in this report. The health outcomes are then aggregated to country-level or larger areas, e.g., EU27.

Cause-specific mortality and morbidity

The methodology for calculating cause-specific EBD indicators (YLL, years lived with disability (YLD), disability-adjusted life years (DALY), AD, attributable cases) is described in the following. The approach for calculating the morbidity indicators is also presented in the ETC HE report (2022b).

For the calculation of the outcome (o) specific baseline (b) YLL ($YLL_{b,o}$, overall disease burden before attribution to the selected air pollutants), the number of deaths (M) per sex and age group of a cause-specific health outcome (o) (M_o) were multiplied by the sex and age specific remaining life expectancy (RLE) at the age of death (Equation A1.7):

$$\boldsymbol{YLL_{b,o} = M_o * RLE} \qquad \text{(A1.7)}$$

For the calculation of the outcome specific baseline YLD ($YLD_{b,o}$) the sex and age group specific prevalence of a disease (P_o) was multiplied by the outcome specific disability weight (DW_o[1]) (Equation A1.8). The DW_o represent the severity of a health outcome on a scale ranging from zero to one.Generally, prevalence data should be used for the same population group regarding age and sex as was considered to derive the CRF.

$$\boldsymbol{YLD_{b,o} = P_o * DW_o} \qquad \text{(A1.8)}$$

As within the methodology for all-cause (natural) mortality, the PAF is required to calculate the proportion of the burden of disease due to a certain risk factor (e.g. $PM_{2.5}$). For the estimation of the PAF, a CRF is needed and was derived by the same formulas as used for all-cause mortality (see equations A1.1 and A1.2). However, the equation for calculating the PAF was slightly different, as the all-cause mortality calculations were based on grid cells and thus differed in the individual calculation steps from the cause-specific EBD indicators.

For the cause-specific estimates, the PAF_{Mort} was calculated using the equation A1.9 for the mortality indicators YLL and AD and the PAF_{Morb} using the equation A1.10 for the morbidity indicator YLD. The procedure for estimating attributable cases is explained in the ozone-specific calculation steps below.

$$\boldsymbol{PAF_{Mort} = \frac{1}{Pop_t}\sum Pop_c * \left(\frac{RR_{c,Mort} - 1}{RR_{c,Mort}}\right)} \qquad \text{(A1.9)}$$

$$\boldsymbol{PAF_{Morb} = \frac{1}{Pop_t}\sum Pop_c * \left(\frac{RR_{c,Morb} - 1}{RR_{c,Morb}}\right)} \qquad \text{(A1.10)}$$

[1] The outcome specific DW were derived from data of the Global Burden of Disease 2019 study, accessible via: https://vizhub.healthdata.org/gbd-results/

where Pop_c is the population exposed to a specific pollutant concentration, Pop_t the total population of the considered age group and $RR_{c,\ Mort}$ or $RR_{c,\ Morb}$ the mortality or morbidity specific relative risk of the population at a certain concentration level.

Lastly, to estimate outcome specific YLL and YLD attributable to a specific risk factor ($YLL_{a,\ o}$, $YLD_{a,\ o}$), the outcome specific baseline YLL and YLD were multiplied by the respective PAF (Equation A1.11 and A1.12).

$$YLL_{a,o} = YLL_{b,o} * PAF_{Mort} \qquad (A1.11)$$

$$YLD_{a,o} = YLD_{b,o} * PAF_{Morb} \qquad (A1.12)$$

DALY is a commonly used EBD indicator, which counts population-based losses of healthy life years resulting from a disease or attributable to a certain risk factor. It equals the sum of YLL and YLD. To provide a final estimate of the attributable burden, outcome specific attributable YLD and YLL were therefore summed up and formed the outcome specific attributable DALY (Equation A1.13):

$$DALY_{a,o} = YLL_{a,o} + YLD_{a,o} \qquad (A1.13)$$

In addition, the calculation of cause-specific AD (AD_o) was performed, multiplying the disease specific number of deaths (M_o) by the according PAF (equation A1.14). In this way, all-cause mortality results on YLL and AD can be compared to the cause-specific ones.

$$AD_o = M_o * PAF_{Mort} \qquad (A1.14)$$

Ozone-specific calculation processes

The provided O_3 concentrations (SOMO35) represented an annual sum, yet daily mean values were required for the EBD calculation in this assessment. Therefore, the SOMO35 concentrations were divided by 365 days ($C_{daily\ mean}$) as described below:

$$C_{daily\ mean} = \frac{SOMO35\ (annual\ sum)}{365} \qquad (A1.15)$$

The SOMO35 is then used as *C* in Eq. A1.1 for both all-cause and cause-specific mortality.

In the case of the risk-outcome pair hospital admissions for respiratory diseases and O_3, only attributable hospital admission cases were calculated, not YLD, as no eligible CRF was identified (see also Section 2.2.3**Error! Reference source not found.**). Therefore, further methodological steps were n eeded. First, a linear function y was derived. It described the increase in hospitalisations as a function of the specific daily mean SOMO35 concentrations. For this, the increase rate in hospital admissions was divided by the unit increase of the daily mean SOMO35 concentration (UC) multiplied by the specific daily mean SOMO35 concentration ($C_{daily\ mean}$):

$$y = \frac{increase\ rate\ in\ hospital\ admissions}{UC} * C_{daily\ mean} \qquad (A1.16)$$

Lastly, attributable hospital admission cases could be calculated using the following equation (A1.17) by multiplying y with data on total hospital admissions or rather hospital discharges (P_o) and the specific exposed population (Pop_c):

$$Attributable\ cases = y * Pop_c * \sum P_o \qquad (A1.17)$$

A.1.2 Input data and preparatory steps

Ambient air concentrations

Concentration maps with annual statistics of the relevant pollutant metrics are produced on a 1x1 km^2 grid resolution for most of Europe (the whole Europe apart from Belarus, Moldova, Ukraine, and European parts of Russia and Kazakhstan; in the case of $PM_{2.5}$ Türkiye is also excluded due to the lack of enough background stations to produce the maps). The annual statistics are estimated using a mapping method, 'Regression – Interpolation – Merging Mapping' (RIMM) which performs a linear regression model followed by kriging of its residuals (ETC HE, 2023 and references herein). The mapping method combines the monitoring data from rural and urban background stations for $PM_{2.5}$, O_3, and NO_2 with results from chemical transport models and other supplementary data, such as altitude, meteorology, and population density. Urban traffic station data was also included for NO_2 and $PM_{2.5}$, to account for hotspots, since traffic is the most important source of NO_2 and an important source of PM. Lastly, the rural and urban background (and for NO_2 and $PM_{2.5}$ also urban traffic) map layers are merged into the final map and used as input data for the EBD assessment. Note that all the data supporting the RIMM refers to the year estimated.

The ETC HE Report (ETC HE, 2023) includes the analysis of the latest maps available, including the associated uncertainties.

Population

Gridded population data is used for estimating the all-cause mortality EBD, as the health outcomes result from collocating concentration levels and populating density. Thus, the higher the population density, the higher the population will be at risk if concentrations are above the counterfactual concentrations. We use population density maps (gridded) based on the GEOSTAT 2011 dataset (Eurostat, 2014), the European population distribution in 2011. It is mapped on the same grid resolution as the ambient air concentrations presented above facilitating the health outcomes estimation per grid-cell. The GEOSTAT 2011 population data was scaled with the total population data available country-wise from Eurostat (Eurostat, 2023a) to make it consistent with the estimated year. The data reflects the total population on the 31st of December of the indicated year reported by the National Statistical Offices. This data has been available yearly since 1960 for all countries across Europe. The scaling of the population (scaled pop_i) was done by applying the following:

$$scaled\ pop_i = pop_i \times \frac{pop_{c\_Eurostat}}{pop_c} \qquad \text{(A1.8)}$$

where pop_i is the population in the i^{th} grid cell for country *c* in the GEOSTAT 2011 population density map, pop_c is the total population for country *c* calculated based on the GEOSTAT 2011 population density map, and $pop_{c\_Eurostat}$ is the total population reported to Eurostat for country *c* for the estimated year.

Since the concentration maps do not include overseas territories, population data for those territories need to be excluded from the original Eurostat data. Moreover, the GEOSTAT 2011 Cyprus population data includes Greek and Turkish Cypriots. The Eurostat data includes only Greek Cypriots, requiring the addition of the Turkish Cypriot population. These corrections mentioned above are done by applying additional scaling factors for France, Portugal, Spain, and Cyprus:

$$scaled\ pop_i = pop_i \times \frac{pop_{c\_Eurostat}}{pop_c} \times \frac{pop_{c2015}}{pop_{c\_Eurostat2015}} \text{ (A1.3)}$$

where pop_{c2015} is the total population for country *c* calculated based on the GEOSTAT 2011 population density map scaled for year 2015 and $pop_{c\_Eurostat2015}$ is the total population reported to

Eurostat for country *c* for the year 2015 (Eurostat, 2023a). Year 2015 was arbitrary selected as reference for performing the spatial scaling of population numbers due to computationally demanding task of re-scaling the whole population density map for every single year (ETC/ACM, 2017). Plus, the ratios should remain fairly similar over the time. Countries lacking data for total polutaion for 2021 are described in Table A.1.1.

Table A1.1: Countries lacking population data and the selected gap filling proxies for all-cause mortality

Data set	Country	Data used for gap filling	Year of data used for gap filling	Country of data used for gap filling
Total population	AD, MC	Total population	2021	FR
Total population	AL, BA, XK	Total population	2021	RS
Total population	SM	Total population	2021	IT

The population distribution by age groups is required to estimate how many people have died per age group. Eurostat (2023b) provides data with a 1-year age interval, from 'less than a year' to 99 years old, for almost all countries assessed. Gap filling of missing information was necessary for several countries, years and age groups. In case of all-cause mortality, it was done by using relative age distribution numbers (that is, the percentage of the population in each age group) from the same proxies as shown in Table A1.1: Serbia for other West Balkan countries, Italy for San Marino, France for Andorra and Monaco, and by applying average relative age distribution numbers from data available in 2005 – 2020 period for all remaining countries missing information for a specific age group.

Tables A1.2 show the countries lacking population data and the selected gap filling proxies for cause-specific mortality and morbidity. The proxies of cause-specific mortality and morbidity are aligned as much as possible to the all-cause mortality, but the former require different stratification of the data than all-cause mortality.

Table A1.2: Countries lacking population data and the selected gap filling proxies for cause-specific mortality and morbidity

Data set	Country	Data used for gap filling	Year of data used for gap filling	Country of data used for gap filling
Total population	AD	Total population	2020	AD
Total population	BA	Total population	2019	BA
Total population	MC	Total population	2019	MC
Population (stratified by sex and age)	AD, MC	Age distribution	2021	FR
Population (stratified by sex and age)	AL (≥ 85 years)	Age distribution	2021	RS (≥ 85 years)
Population (stratified by sex and age)	BA, XK	Age distribution	2021	RS
Population (stratified by sex and age)	SM	Age distribution	2021	IT

Note: The population ≥ 85 years of age was calculated from the difference between the total population and the population < 85 years.

Demographic and health data

Data on the cause of death, number of natural deaths, and life expectancy are needed to calculate the health outcomes. Eurostat data on causes of death (Eurostat, 2023c) is available since 2011 for 5-year interval, from ‘less than 1 year’ to '80 years or over'. It is compiled based on the ICD10 Mortality Tabulation List, the latest tabulation existing for mortality data. According to the description of the concentration-response functions (see Error! Reference source not found.), only natural deaths should b e considered. Therefore, causes of death due to injury or poisoning (V01-Y89), unknown and unspecified causes (R00-R99), and total deaths due to all causes are excluded before calculations.

Estimating the number of natural deaths with a 1-year interval is based on interpolation using the ratio between all-natural deaths and all (natural + external) causes of death (5-year interval) and Eurostat data on the total number of deaths (Eurostat, 2022d) given with a 1-year interval. After this operation, mortality data is aligned with life expectancy data, available from the Eurostat database (Eurostat, 2022e) on a 1-year interval, by age and sex, from 0 to 85+ years old, since 1960. Life expectancies are extrapolated for ages above 85, using regression on life expectancy data for age groups 79 – 85, to reflect all age groups available for mortality data (up to 95+).

Gap filling was done for countries where the data described above is unavailable in the Eurostat datasets. Data on causes of death are available from 2011 onwards and that year is used as proxy for years 2005 - 2010. Afterwards, gap filling is performed for missing data on external causes of deaths using average of number of deaths due to external causes from previous 5 years. Then, missing numbers of deaths due to natural causes are gap-filled by subtracting the number of deaths due to external causes from the totals.

Data on the number of deaths and life expectancy are available for most countries since 2005. Nevertheless, for cases where data is unavailable, gap filling is performed using relative age distribution numbers of mortality (mortality ratios, or the number of deaths per population in each age group) and YLL ratios, following similar methodology as described for population numbers. Original data is used where possible, i.e., if the original life expectancy numbers exist, they are used for calculating YLL ratios, even if mortality ratios have to be gap-filled.

Tables with the logic of gap filling of demographic data (Data set vs EBD assessment year vs proxy country) is available from the EEA upon request for the all-cause mortality estimations.

As for population, the proxies of cause-specific mortality and morbidity are aligned as much as possible to the all-cause mortality, but the former require different stratification of the data than all-cause mortality. Tables A1.3 and A1.4 show the gap-filling proxies for countries lacking life expectancy and other health data and the selected gap filling proxies for cause-specific mortality and morbidity.

Table A1.3: Countries lacking life expectancy data and the selected gap filling proxies for cause-specific mortality and morbidity

Data set	Country	Data used for gap filling	Year of data used for gap filling	Country of data used for gap filling
Life expectancy	AD, MC	YLL rates	2021	FR
Life expectancy	BA, XK	YLL rates	2021	RS
Life expectancy	LI	YLL rates	2021	AT
Life expectancy	SM	YLL rates	2021	IT
Life expectancy	TR	Life expectancy	2019	TR

Table A1.4: Countries lacking health data and the according gap filling proxies for cause-specific mortality and morbidity

Data set	Country	Data used for gap filling	Year of data used for gap filling	Country of data used for gap filling
Asthma (children)				
Mortality	AL, BA, ME, MK, XK	Mortality rate	2021	RS
Mortality	BE, FR, GR, HR, IE, IT, LV, NO, PT, RO, SE	Mortality rate	2020	BE, FR, GR, HR, IE, IT, LV, NO, PT, RO, SE
Mortality	AD, MC	Mortality rate	2020	FR
Mortality	CY	Mortality rate	2020	GR
Mortality	DK, IS	Mortality rate	2019	DK
Mortality	EE	Mortality rate	2020	LV
Mortality	LU	Mortality rate	2019	LU
Mortality	SM, MT	Mortality rate	2020	IT
Mortality	SI	Mortality rate	2020	SK
Mortality	TR	Mortality rate	2019	TR
Prevalence	LI	Prevalence rate	2019	AT
Prevalence	RS	Prevalence rate	2019	RS+XK
Prevalence	XK	Prevalence rate	2019	RS+XK
Asthma (adults), COPD, DM, IHD, Stroke				
Mortality	BE, DK, EE, FR, GR, HR, IE, IS, IT, MT, NO, PT, RO, SE, SI	Mortality rate	2020	BE, DK, EE, FR, GR, HR, IE, IS, IT, MT, NO, PT, RO, SE, SI
Mortality	AL, BA, ME, MK, XK	Mortality rate	2021	RS
Mortality	AD, MC	Mortality rate	2020	FR
Mortality	SM	Mortality rate	2020	IT
Mortality	TR	Mortality rate	2019	TR
Only for asthma (adults): Mortality (15-24 years)	IS, LU, MT	Mortality rate (15-24 years)	--	According to GBD 2019 study or mortality rates in following age groups, data was set to 0
Prevalence	AL, BA, ME, MK, XK	Prevalence rate	2019	RS
Prevalence	CH	Prevalence rate	2019	AT
Prevalence	LI	Prevalence rate	2019	AT
Prevalence	SM	Prevalence rate	2019	IT
LC				
Mortality	AL, BA, XK	Mortality rate	2020	RS
Mortality	AD, MC	Mortality rate	2020	FR

Data set	Country	Data used for gap filling	Year of data used for gap filling	Country of data used for gap filling
Mortality	SM	Mortality rate	2020	IT
Prevalence	AD, MC	Prevalence rate	2020	FR
Prevalence	LI	Prevalence rate	2020	AT
Prevalence	SM	Prevalence rate	2020	IT
Prevalence	RS	Prevalence rate	2020	RS+XK
Prevalence	XK	Prevalence rate	2020	RS+XK
Hospital admissions due to respiratory diseases				
Prevalence	AL, BA, ME, MK, XK	Prevalence rate	2019	RS
Prevalence	AD, MC	Prevalence rate	2019	FR
Prevalence	MT	Prevalence rate	2019	IT
Prevalence	LI	Prevalence rate	2019	AT
Prevalence	BU	Prevalence rate	2019	RO
Prevalence	DK	Prevalence rate	2019	NO
Prevalence	EE	Prevalence rate	2019	LV
Prevalence	FI	Prevalence rate	2019	SE
Prevalence	GR	Prevalence rate	2019	RO
Prevalence	LU	Prevalence rate	2019	DE
Prevalence	TR	Prevalence rate	2019	RO

Annex 2 Results for the cause-specific analyses

$PM_{2.5}$ (long-term effects) and asthma (children < 15 years)

Table A2.1: Asthma disease burden (AD) due to $PM_{2.5}$ for children < 15 years for 41 European countries (individual and total countries) and the EU27 in 2021

	PAF (95 % CI: low, high)			AD ([a]) (95 % CI: low, high)			AD/10^5 inhabitants < 15 years (95 % CI: low, high)		
Country	mean	low	high	mean	low	high	mean	low	high
Austria	0.13	0.05	0.21	0	0	0	0.0	0.0	0.0
Belgium	0.16	0.06	0.24	0	0	0	0.0	0.0	0.0
Bulgaria	0.26	0.10	0.38	0	0	0	0.0	0.0	0.0
Croatia	0.24	0.09	0.36	0	0	0	0.0	0.0	0.0
Cyprus	0.23	0.09	0.35	0	0	0	0.0	0.0	0.0
Czechia	0.22	0.08	0.33	0	0	0	0.0	0.0	0.0
Denmark	0.09	0.03	0.14	0	0	0	0.0	0.0	0.0
Estonia	0.03	0.01	0.04	< 1	< 1	< 1	< 1.0	< 1.0	< 1.0
Finland	0.01	0.00	0.02	0	0	0	0.0	0.0	0.0
France	0.12	0.04	0.19	< 10	< 1	< 10	< 1.0	< 1.0	< 1.0
Germany	0.12	0.04	0.19	< 1	< 1	< 1	< 1.0	< 1.0	< 1.0
Greece	0.27	0.10	0.40	0	0	0	0.0	0.0	0.0
Hungary	0.24	0.09	0.36	0	0	0	0.0	0.0	0.0
Ireland	0.06	0.02	0.09	< 1	< 1	< 1	< 1.0	< 1.0	< 1.0
Italy	0.23	0.08	0.34	< 1	< 1	< 1	< 1.0	< 1.0	< 1.0
Latvia	0.15	0.06	0.24	< 1	< 1	< 1	< 1.0	< 1.0	< 1.0
Lithuania	0.17	0.06	0.27	0	0	0	0.0	0.0	0.0
Luxembourg	0.07	0.03	0.12	0	0	0	0.0	0.0	0.0
Malta	0.18	0.06	0.28	< 1	< 1	< 1	< 1.0	< 1.0	< 1.0
Netherlands	0.13	0.05	0.20	< 1	< 1	< 1	< 1.0	< 1.0	< 1.0
Poland	0.00	0.00	0.00	< 10	< 1	< 10	< 1.0	< 1.0	< 1.0
Portugal	0.00	0.00	0.00	0	0	0	0.0	0.0	0.0
Romania	0.00	0.00	0.00	< 1	< 1	< 1	< 1.0	< 1.0	< 1.0
Slovakia	0.00	0.00	0.00	0	0	0	0.0	0.0	0.0
Slovenia	0.00	0.00	0.00	0	0	0	0.0	0.0	0.0
Spain	0.12	0.04	0.20	< 1	< 1	< 1	< 1.0	< 1.0	< 1.0
Sweden	0.00	0.00	0.00	0	0	0	0.0	0.0	0.0
Albania	0.28	0.11	0.42	0	0	0	0.0	0.0	0.0
Andorra	0.10	0.03	0.16	< 1	< 1	< 1	< 1.0	< 1.0	< 1.0
Bosnia & Herzegovina	0.38	0.15	0.54	0	0	0	0.0	0.0	0.0
Iceland	0.00	0.00	0.01	0	0	0	0.0	0.0	0.0
Kosovo	0.00	0.00	0.00	0	0	0	0.0	0.0	0.0
Liechtenstein	0.08	0.03	0.14	0	0	0	0.0	0.0	0.0
Monaco	0.13	0.05	0.21	< 1	< 1	< 1	< 1.0	< 1.0	< 1.0
Montenegro	0.30	0.11	0.43	0	0	0	0.0	0.0	0.0
North Macedonia	0.39	0.16	0.56	0	0	0	0.0	0.0	0.0
Norway	0.00	0.00	0.00	0	0	0	0.0	0.0	0.0
San Marino	0.00	0.00	0.00	< 1	< 1	< 1	< 1.0	< 1.0	< 1.0
Serbia	0.00	0.00	0.00	0	0	0	0.0	0.0	0.0
Switzerland	0.09	0.03	0.15	0	0	0	0.0	0.0	0.0
Türkiye (TR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EU27	-	-	-	< 10	< 10	< 10	< 1.0	< 1.0	< 1.0
All countries (no TR)	-	-	-	< 10	< 10	< 10	< 1.0	< 1.0	< 1.0

([a]) Total and national data are rounded

Table A2.2: Asthma disease burden (YLL) due to $PM_{2.5}$ for children < 15 years for 41 European countries (individual and total countries) and the EU27 in 2021

	PAF (95 % CI: low, high)			YLL ([a]) (95 % CI: low, high)			YLL/10^5 inhabitants < 15 years (95 % CI: low, high)		
Country	mean	low	high	mean	low	high	mean	low	high
Austria	0.13	0.05	0.21	0	0	0	0.0	0.0	0.0
Belgium	0.16	0.06	0.24	0	0	0	0.0	0.0	0.0
Bulgaria	0.26	0.10	0.38	0	0	0	0.0	0.0	0.0
Croatia	0.24	0.09	0.36	0	0	0	0.0	0.0	0.0
Cyprus	0.23	0.09	0.35	0	0	0	0.0	0.0	0.0
Czechia	0.22	0.08	0.33	0	0	0	0.0	0.0	0.0
Denmark	0.09	0.03	0.14	0	0	0	0.0	0.0	0.0
Estonia	0.03	0.01	0.04	< 10	< 1	< 10	< 1.0	< 1.0	< 1.0
Finland	0.01	0.00	0.02	0	0	0	0.0	0.0	0.0
France	0.12	0.04	0.19	53	19	84	< 1.0	< 1.0	< 1.0
Germany	0.12	0.04	0.19	9	3	14	< 1.0	< 1.0	< 1.0
Greece	0.27	0.10	0.40	0	0	0	0.0	0.0	0.0
Hungary	0.24	0.09	0.36	0	0	0	0.0	0.0	0.0
Ireland	0.06	0.02	0.09	< 10	< 10	13	< 1.0	< 1.0	1.3
Italy	0.23	0.08	0.34	15	< 10	23	< 1.0	< 1.0	< 1.0
Latvia	0.15	0.06	0.24	10	< 10	15	3.2	1.1	4.9
Lithuania	0.17	0.06	0.27	0	0	0	0.0	0.0	0.0
Luxembourg	0.07	0.03	0.12	0	0	0	0.0	0.0	0.0
Malta	0.18	0.06	0.28	< 1	< 1	< 1	< 1.0	< 1.0	< 1.0
Netherlands	0.13	0.05	0.20	21	< 10	33	< 1.0	< 1.0	1.2
Poland	0.32	0.12	0.46	42	16	62	< 1.0	< 1.0	1.1
Portugal	0.07	0.02	0.11	0	0	0	0.0	0.0	0.0
Romania	0.24	0.09	0.36	13	< 10	20	< 1.0	< 1.0	< 1.0
Slovakia	0.26	0.10	0.39	0	0	0	0.0	0.0	0.0
Slovenia	0.19	0.07	0.29	0	0	0	0.0	0.0	0.0
Spain	0.12	0.04	0.20	< 10	< 10	13	< 1.0	< 1.0	< 1.0
Sweden	0.03	0.01	0.04	0	0	0	0.0	0.0	0.0
Albania	0.28	0.11	0.42	0	0	0	0.0	0.0	0.0
Andorra	0.10	0.03	0.16	< 1	< 1	< 1	< 1.0	< 1.0	< 1.0
Bosnia and Herzegovina	0.38	0.15	0.54	0	0	0	0.0	0.0	0.0
Iceland	0.00	0.00	0.01	0	0	0	0.0	0.0	0.0
Kosovo	0.29	0.11	0.42	0	0	0	0.0	0.0	0.0
Liechtenstein	0.08	0.03	0.14	0	0	0	0.0	0.0	0.0
Monaco	0.13	0.05	0.21	< 1	< 1	< 1	< 1.0	< 1.0	< 1.0
Montenegro	0.30	0.11	0.43	0	0	0	0.0	0.0	0.0
North Macedonia	0.39	0.16	0.56	0	0	0	0.0	0.0	0.0
Norway	0.04	0.01	0.06	0	0	0	0.0	0.0	0.0
San Marino	0.19	0.07	0.29	< 1	< 1	< 1	< 1.0	< 1.0	< 1.0
Serbia	0.36	0.14	0.52	0	0	0	0.0	0.0	0.0
Switzerland	0.09	0.03	0.15	0	0	0	0.0	0.0	0.0
Türkiye (TR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EU27	-	-	-	182	66	280	< 1.0	< 1.0	< 1.0
All countries (no TR)	-	-	-	182	66	280	< 1.0	< 1.0	< 1.0

([a]) Total and national data are rounded

Table A2.3: Asthma disease burden (YLD) due to $PM_{2.5}$ for children < 15 years for 41 European countries (individual and total countries) and the EU27 in 2021

	PAF (95 % CI: low, high)			YLD ([a]) (95 % CI: low, high)			$YLD/10^5$ inhabitants < 15 years (95 % CI: low, high)		
Country	mean	low	high	mean	low	high	mean	low	high
Austria	0.13	0.05	0.21	395	140	618	30.7	10.9	48.1
Belgium	0.16	0.06	0.24	642	229	1 002	33.1	11.8	51.7
Bulgaria	0.26	0.10	0.38	443	165	665	44.4	16.5	66.6
Croatia	0.24	0.09	0.36	256	96	383	44.3	16.6	66.3
Cyprus	0.23	0.09	0.35	87	43	163	60.3	30.0	113.2
Czechia	0.22	0.08	0.33	594	219	902	34.5	12.7	52.5
Denmark	0.09	0.03	0.14	191	66	306	20.1	7.0	32.2
Estonia	0.03	0.01	0.04	< 10	< 10	12	3.5	1.2	5.7
Finland	0.01	0.00	0.02	27	< 10	44	3.1	1.1	5.1
France	0.12	0.04	0.19	3 945	1 394	6 218	33.0	11.7	52.0
Germany	0.12	0.04	0.19	2 689	948	4 246	23.4	8.3	37.0
Greece	0.27	0.10	0.40	901	338	1 343	59.6	22.4	88.9
Hungary	0.24	0.09	0.36	568	210	860	40.1	14.8	60.7
Ireland	0.06	0.02	0.09	179	62	287	17.9	6.2	28.7
Italy	0.23	0.08	0.34	2 776	1 031	4 181	36.3	13.5	54.8
Latvia	0.15	0.06	0.24	93	34	144	30.7	11.1	47.6
Lithuania	0.17	0.06	0.27	125	45	194	29.6	10.6	46.0
Luxembourg	0.07	0.03	0.12	21	< 10	34	21.0	7.3	33.8
Malta	0.18	0.06	0.28	34	12	52	48.5	17.4	75.3
Netherlands	0.13	0.05	0.20	808	285	1 275	29.8	10.5	47.0
Poland	0.32	0.12	0.46	4 931	1 893	7 208	84.2	32.3	123.1
Portugal	0.07	0.02	0.11	336	117	538	24.3	8.5	38.9
Romania	0.24	0.09	0.36	1 391	515	2 100	46.0	17.0	69.4
Slovakia	0.26	0.10	0.39	338	126	507	38.9	14.5	58.3
Slovenia	0.19	0.07	0.29	128	47	196	40.3	14.7	61.7
Spain	0.12	0.04	0.20	1 732	614	2 721	25.6	9.1	40.2
Sweden	0.03	0.01	0.04	150	52	242	8.2	2.8	13.2
Albania	0.28	0.11	0.42	183	69	271	39.2	14.8	58.1
Andorra	0.10	0.03	0.16	< 10	< 10	< 10	26.7	9.3	42.5
Bosnia and Herzegovina	0.38	0.15	0.54	380	152	537	76.2	30.5	107.7
Iceland	0.00	0.00	0.01	< 10	< 1	< 10	1.0	< 1.0	1.6
Kosovo	0.29	0.11	0.42	104	39	154	40.5	15.2	60.2
Liechtenstein	0.08	0.03	0.14	< 10	< 10	< 10	19.6	6.8	31.4
Monaco	0.13	0.05	0.21	< 10	< 10	< 10	34.5	12.2	54.5
Montenegro	0.30	0.11	0.43	58	22	85	52.1	20.0	76.4
North Macedonia	0.39	0.16	0.56	258	103	365	77.5	30.9	109.6
Norway	0.04	0.01	0.06	107	37	173	11.7	4.0	18.8
San Marino	0.19	0.07	0.29	< 10	< 10	< 10	48.8	17.6	75.5
Serbia	0.36	0.14	0.52	503	198	722	51.4	20.2	73.7
Switzerland	0.09	0.03	0.15	358	125	570	27.4	9.6	43.7
Türkiye (TR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EU27	-	-	-	23 787	8 699	36 441	35.3	12.9	54.1
All countries (no TR)	-	-	-	25 750	9 448	39 335	35.6	13.1	54.4

([a]) Total and national data are rounded

Table A2.4: Asthma disease burden (DALY) attributable to $PM_{2.5}$ for children < 15 years for 41 European countries (individual and total countries) and the EU27 in 2021

Country	DALY ([a]) (95 % CI: low, high) mean	low	high	DALY/10^5 inhabitants < 15 years (95 % CI: low, high) mean	low	high
Austria	395	140	618	30.7	10.9	48.1
Belgium	642	229	1 002	33.1	11.8	51.7
Bulgaria	443	165	665	44.4	16.5	66.6
Croatia	256	96	383	44.3	16.6	66.3
Cyprus	87	43	163	60.3	30.0	113.2
Czechia	594	219	902	34.5	12.7	52.5
Denmark	191	66	306	20.1	7.0	32.2
Estonia	< 10	< 10	14	4.0	1.4	6.6
Finland	27	< 10	44	3.1	1.1	5.1
France	3 999	1 413	6 302	33.4	11.8	52.7
Germany	2 698	951	4 260	23.5	8.3	37.1
Greece	901	338	1 343	59.6	22.4	88.9
Hungary	568	210	860	40.1	14.8	60.7
Ireland	187	65	300	18.7	6.5	30.0
Italy	2 791	1 036	4 205	36.5	13.6	55.1
Latvia	103	37	159	33.9	12.2	52.6
Lithuania	125	45	194	29.6	10.6	46.0
Luxembourg	21	< 10	34	21.0	7.3	33.8
Malta	34	12	52	48.6	17.5	75.5
Netherlands	829	292	1 308	30.6	10.8	48.2
Poland	4 973	1 909	7 270	84.9	32.6	124.1
Portugal	336	117	538	24.3	8.5	38.9
Romania	1 405	520	2 121	46.4	17.2	70.1
Slovakia	338	126	507	38.9	14.5	58.3
Slovenia	128	47	196	40.3	14.7	61.7
Spain	1 741	617	2 734	25.8	9.1	40.4
Sweden	150	52	242	8.2	2.8	13.2
Albania	183	69	271	39.2	14.8	58.1
Andorra	< 10	< 10	< 10	27.0	9.4	43.1
Bosnia and Herzegovina	380	152	537	76.2	30.5	107.7
Iceland	< 10	< 1	< 10	1.0	< 1.0	1.6
Kosovo	104	39	154	40.5	15.2	60.2
Liechtenstein	< 10	< 1	< 10	19.6	6.8	31.4
Monaco	< 10	< 10	< 10	35.0	12.3	55.3
Montenegro	58	22	85	52.1	20.0	76.4
North Macedonia	258	103	365	77.5	30.9	109.6
Norway	107	37	173	11.7	4.0	18.8
San Marino	< 10	< 10	< 10	49.0	17.7	75.8
Serbia	503	198	722	51.4	20.2	73.7
Switzerland	358	125	570	27.4	9.6	43.7
Türkiye (TR)	N/A	N/A	N/A	N/A	N/A	N/A
EU27	23 969	8 765	36 721	35.6	13.0	54.5
All countries (no TR)	25 932	9 514	39 615	35.9	13.2	54.8

([a]) Total and national data are rounded

$PM_{2.5}$ (long-term effects) and chronic obstructive pulmonary disease (adults ≥ 25 years)

Indicators calculation spreadsheet PM25_COPD_2021.xlsx is available ….

Table A2.5: COPD disease burden (AD) due to PM2.5 for adults ≥ 25 years for 41 European countries (individual and total countries) and the EU27 in 2021

	PAF (95 % CI: low, high)			AD ([a]) (95 % CI: low, high)			AD/10^5 inhabitants ≥ 25 years (95 % CI: low, high)		
Country	mean	low	high	mean	low	high	mean	low	high
Austria	0.11	0.00	0.21	314	< 10	586	4.7	< 1.0	8.7
Belgium	0.13	0.00	0.24	511	< 10	949	6.2	< 1.0	11.4
Bulgaria	0.22	0.00	0.39	290	< 10	512	5.5	< 1.0	9.7
Croatia	0.20	0.00	0.36	332	< 10	584	11.0	< 1.0	19.3
Cyprus	0.20	0.00	0.35	27	< 1	49	4.3	< 1.0	7.6
Czechia	0.19	0.00	0.34	571	10	1 023	7.1	< 1.0	12.8
Denmark	0.07	0.00	0.14	248	< 10	475	5.9	< 1.0	11.4
Estonia	0.02	0.00	0.04	< 10	< 1	< 10	< 1.0	< 1.0	< 1.0
Finland	0.01	0.00	0.02	13	< 1	25	< 1.0	< 1.0	< 1.0
France	0.10	0.00	0.19	963	17	1 809	2.0	< 1.0	3.8
Germany	0.10	0.00	0.19	3 184	55	5 994	5.0	< 1.0	9.5
Greece	0.23	0.00	0.40	707	13	1 237	8.8	< 1.0	15.4
Hungary	0.20	0.00	0.36	948	17	1 691	13.0	< 1.0	23.1
Ireland	0.05	0.00	0.09	72	< 10	139	2.1	< 1.0	4.1
Italy	0.19	0.00	0.34	4 606	85	8 166	10.1	< 1.0	17.8
Latvia	0.13	0.00	0.24	32	< 1	59	2.3	< 1.0	4.2
Lithuania	0.15	0.00	0.27	54	< 1	99	2.6	< 1.0	4.7
Luxembourg	0.06	0.00	0.12	10	< 1	18	2.1	< 1.0	4.0
Malta	0.15	0.00	0.28	15	< 1	28	3.8	< 1.0	7.1
Netherlands	0.11	0.00	0.21	614	11	1 156	4.9	< 1.0	9.2
Poland	0.27	0.01	0.47	1 401	27	2 390	5.0	< 1.0	8.5
Portugal	0.06	0.00	0.11	151	< 10	289	1.9	< 1.0	3.7
Romania	0.20	0.00	0.36	1 123	21	1 996	7.9	< 1.0	14.1
Slovakia	0.22	0.00	0.39	157	< 10	277	3.9	< 1.0	6.8
Slovenia	0.16	0.00	0.29	59	< 10	106	3.7	< 1.0	6.7
Spain	0.10	0.00	0.20	1 100	19	2 056	3.1	< 1.0	5.7
Sweden	0.02	0.00	0.04	68	< 10	131	< 1.0	< 1.0	1.8
Albania	0.24	0.00	0.42	153	< 10	266	7.8	< 1.0	13.6
Andorra	0.08	0.00	0.16	< 1	< 1	< 10	1.7	< 1.0	3.2
Bosnia and Herzegovina	0.33	0.01	0.54	349	< 10	569	13.2	< 1.0	21.6
Iceland	0.00	0.00	0.01	< 1	< 1	< 1	< 1.0	< 1.0	< 1.0
Kosovo	0.24	0.00	0.43	131	< 10	229	9.7	< 1.0	16.9
Liechtenstein	0.07	0.00	0.14	< 1	< 1	< 1	1.5	< 1.0	2.8
Monaco	0.11	0.00	0.21	< 1	< 1	< 10	2.2	< 1.0	4.1
Montenegro	0.25	0.00	0.43	36	< 1	61	8.3	< 1.0	14.2
North Macedonia	0.34	0.01	0.56	147	< 10	240	9.8	< 1.0	16.1
Norway	0.03	0.00	0.06	65	< 10	126	1.7	< 1.0	3.3
San Marino	0.16	0.00	0.29	< 10	< 1	< 10	8.2	< 1.0	15.1
Serbia	0.31	0.01	0.52	643	13	1 070	12.4	< 1.0	20.7
Switzerland	0.08	0.00	0.15	131	< 10	248	2.0	< 1.0	3.8
Türkiye (TR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EU27	-	-	-	17 574	315	31 853	5.3	< 1.0	9.6
All countries (no TR)	-	-	-	19 233	347	34 672	5.4	< 1.0	9.7

([a]) Total and national data are rounded

Table A2.6: COPD disease burden (YLL) due to $PM_{2.5}$ for adults ≥ 25 years for 41 European countries (individual and total countries) and the EU27 in 2021

Country	PAF (95 % CI: low, high) mean	low	high	YLL ([a]) (95 % CI: low, high) mean	low	high	YLL/10^5 inhabitants ≥ 25 years (95 % CI: low, high) mean	low	high
Austria	0.11	0.00	0.21	3 342	58	6 230	49.8	< 1.0	92.9
Belgium	0.13	0.00	0.24	5 819	102	10 801	70.1	1.2	130.1
Bulgaria	0.22	0.00	0.39	2 308	43	4 072	43.6	< 1.0	76.9
Croatia	0.20	0.00	0.36	2 423	45	4 260	79.9	1.5	140.5
Cyprus	0.20	0.00	0.35	220	< 10	392	34.2	< 1.0	61.0
Czechia	0.19	0.00	0.34	5 567	101	9 971	69.5	1.3	124.4
Denmark	0.07	0.00	0.14	2 474	42	4 745	59.3	1.0	113.7
Estonia	0.02	0.00	0.04	34	< 1	66	3.5	< 1.0	6.7
Finland	0.01	0.00	0.02	143	< 10	282	3.5	< 1.0	6.9
France	0.10	0.00	0.19	9 838	170	18 480	20.7	< 1.0	38.8
Germany	0.10	0.00	0.19	34 833	599	65 584	55.1	< 1.0	103.7
Greece	0.23	0.00	0.40	5 240	98	9 166	65.0	1.2	113.8
Hungary	0.20	0.00	0.36	10 182	185	18 161	139.4	2.5	248.7
Ireland	0.05	0.00	0.09	749	13	1 443	22.2	< 1.0	42.8
Italy	0.19	0.00	0.34	32 427	596	57 491	70.8	1.3	125.6
Latvia	0.13	0.00	0.24	321	< 10	590	22.6	< 1.0	41.6
Lithuania	0.15	0.00	0.27	465	< 10	858	22.2	< 1.0	41.0
Luxembourg	0.06	0.00	0.12	116	< 10	224	25.1	< 1.0	48.4
Malta	0.15	0.00	0.28	168	< 10	309	42.5	< 1.0	78.2
Netherlands	0.11	0.00	0.21	6 647	114	12 509	52.7	< 1.0	99.1
Poland	0.27	0.01	0.47	13 557	260	23 124	48.0	< 1.0	81.9
Portugal	0.06	0.00	0.11	1 188	20	2 271	15.2	< 1.0	29.1
Romania	0.20	0.00	0.36	10 133	185	18 014	71.7	1.3	127.4
Slovakia	0.22	0.00	0.39	1 708	32	3 008	42.3	< 1.0	74.4
Slovenia	0.16	0.00	0.29	517	< 10	937	32.4	< 1.0	58.8
Spain	0.10	0.00	0.20	10 318	179	19 297	28.8	< 1.0	53.9
Sweden	0.02	0.00	0.04	670	11	1 296	9.1	< 1.0	17.5
Albania	0.24	0.00	0.42	1 269	24	2 204	64.9	1.2	112.8
Andorra	0.08	0.00	0.16	< 10	< 1	18	17.2	< 1.0	32.7
Bosnia and Herzegovina	0.33	0.01	0.54	2 842	57	4 641	108.0	2.2	176.3
Iceland	0.00	0.00	0.01	< 10	< 1	< 10	< 1.0	< 1.0	1.8
Kosovo	0.24	0.00	0.43	1 070	20	1 866	79.0	1.5	137.7
Liechtenstein	0.07	0.00	0.14	< 10	< 1	18	31.5	< 1.0	60.3
Monaco	0.11	0.00	0.21	< 10	< 1	11	22.4	< 1.0	42.1
Montenegro	0.25	0.00	0.43	310	6	530	71.7	1.4	122.7
North Macedonia	0.34	0.01	0.56	1 330	27	2 174	89.1	1.8	145.7
Norway	0.03	0.00	0.06	669	11	1 291	17.5	< 1.0	33.8
San Marino	0.16	0.00	0.29	16	< 1	29	57.9	1.0	106.2
Serbia	0.31	0.01	0.52	5 240	103	8 722	101.2	2.0	168.4
Switzerland	0.08	0.00	0.15	1 459	25	2 774	22.6	< 1.0	42.9
Türkiye (TR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EU27	-	-	-	161 407	2 885	293 581	48.5	< 1.0	88.3
All countries (no TR)	-	-	-	175 639	3 159	317 863	49.3	< 1.0	89.2

([a]) Total and national data are rounded

Table A2.7: COPD disease burden (YLD) due to $PM_{2.5}$ for adults ≥ 25 years for 41 European countries (individual and total countries) and the EU27 in 2021

Country	PAF (95 % CI: low, high)			YLD ([a]) (95 % CI: low, high)			YLD/10^5 inhabitants ≥ 25 years (95 % CI: low, high)		
	mean	low	high	mean	low	high	mean	low	high
Austria	0.14	0.06	0.22	2 996	1 175	4 609	44.7	17.5	68.7
Belgium	0.16	0.06	0.25	3 822	1 504	5 858	46.0	18.1	70.5
Bulgaria	0.27	0.11	0.40	3 083	1 267	4 541	58.2	23.9	85.7
Croatia	0.25	0.10	0.37	2 442	1 007	3 587	80.5	33.2	118.3
Cyprus	0.25	0.10	0.37	335	201	660	52.2	31.3	102.8
Czechia	0.23	0.09	0.35	2 767	1 123	4 126	34.5	14.0	51.5
Denmark	0.09	0.03	0.14	900	345	1 416	21.6	8.3	33.9
Estonia	0.03	0.01	0.04	45	17	72	4.6	1.7	7.3
Finland	0.01	0.01	0.02	133	50	213	3.3	1.2	5.2
France	0.13	0.05	0.20	25 852	10 072	40 008	54.3	21.2	84.0
Germany	0.13	0.05	0.20	33 462	13 011	51 879	52.9	20.6	82.0
Greece	0.28	0.12	0.42	2 925	1 211	4 281	36.3	15.0	53.1
Hungary	0.25	0.10	0.38	5 447	2 217	8 092	74.6	30.4	110.8
Ireland	0.06	0.02	0.09	308	118	487	9.1	3.5	14.4
Italy	0.24	0.10	0.35	32 726	13 402	48 400	71.5	29.3	105.7
Latvia	0.16	0.06	0.25	564	224	857	39.8	15.8	60.5
Lithuania	0.18	0.07	0.28	1 627	644	2 480	77.7	30.7	118.4
Luxembourg	0.08	0.03	0.12	114	44	180	24.7	9.4	39.1
Malta	0.19	0.07	0.29	30	12	46	7.7	3.0	11.7
Netherlands	0.14	0.05	0.21	6 049	2 353	9 375	47.9	18.6	74.3
Poland	0.33	0.14	0.48	17 562	7 435	25 198	62.2	26.3	89.2
Portugal	0.07	0.03	0.12	2 160	829	3 390	27.6	10.6	43.4
Romania	0.25	0.10	0.37	2 804	1 145	4 155	19.8	8.1	29.4
Slovakia	0.28	0.11	0.41	2 250	926	3 309	55.6	22.9	81.8
Slovenia	0.20	0.08	0.30	767	308	1 154	48.1	19.3	72.4
Spain	0.13	0.05	0.20	8 805	3 443	13 580	24.6	9.6	37.9
Sweden	0.03	0.01	0.05	241	92	382	3.3	1.2	5.2
Albania	0.30	0.12	0.43	1 270	529	1 848	65.0	27.1	94.5
Andorra	0.11	0.04	0.17	25	10	39	45.3	17.4	70.9
Bosnia and Herzegovina	0.40	0.18	0.56	2 492	1 098	3 458	94.7	41.7	131.4
Iceland	0.00	0.00	0.01	< 10	< 10	< 10	1.0	< 1.0	1.6
Kosovo	0.30	0.12	0.44	957	397	1 397	70.6	29.3	103.1
Liechtenstein	0.09	0.03	0.14	< 10	< 10	13	28.4	10.9	44.7
Monaco	0.14	0.05	0.21	16	< 10	25	58.8	22.8	91.2
Montenegro	0.31	0.13	0.45	294	124	423	68.0	28.7	97.9
North Macedonia	0.41	0.18	0.57	1 290	567	1 792	86.5	38.0	120.1
Norway	0.04	0.01	0.06	271	103	428	7.1	2.7	11.2
San Marino	0.20	0.08	0.30	16	< 10	24	59.0	23.5	89.6
Serbia	0.38	0.16	0.53	4 621	2 000	6 506	89.2	38.6	125.6
Switzerland	0.10	0.04	0.15	1 979	763	3 093	30.6	11.8	47.8
Türkiye (TR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EU27	-	-	-	160 217	64 171	242 333	48.2	19.3	72.9
All countries (no TR)	-	-	-	173 459	69 779	261 381	48.7	19.6	73.4

([a]) Total and national data are rounded

Table A2.8: COPD disease burden (DALY) due to $PM_{2.5}$ for adults ≥ 25 years for 41 European countries (individual and total countries) and the EU27 in 2021

	DALY ([a]) (95 % CI: low, high)			DALY/10^5 inhabitants ≥ 25 years (95 % CI: low, high)		
Country	mean	low	high	mean	low	high
Austria	6 338	1 233	10 839	94.5	18.4	161.7
Belgium	9 641	1 605	16 659	116.1	19.3	200.6
Bulgaria	5 392	1 310	8 614	101.8	24.7	162.6
Croatia	4 865	1 052	7 847	160.4	34.7	258.7
Cyprus	555	205	1 052	86.4	32.0	163.8
Czechia	8 334	1 224	14 097	104.0	15.3	175.9
Denmark	3 374	386	6 160	80.8	9.3	147.6
Estonia	79	18	138	8.0	1.8	14.0
Finland	276	52	495	6.8	1.3	12.2
France	35 690	10 241	58 488	75.0	21.5	122.8
Germany	68 295	13 610	117 463	108.0	21.5	185.7
Greece	8 165	1 308	13 447	101.3	16.2	166.9
Hungary	15 629	2 402	26 253	214.0	32.9	359.5
Ireland	1 058	130	1 930	31.3	3.9	57.2
Italy	65 153	13 997	105 891	142.3	30.6	231.3
Latvia	884	229	1 447	62.4	16.2	102.1
Lithuania	2 092	652	3 338	99.9	31.1	159.4
Luxembourg	230	45	404	49.9	9.9	87.5
Malta	198	15	355	50.1	3.8	90.0
Netherlands	12 696	2 467	21 884	100.6	19.5	173.3
Poland	31 119	7 695	48 322	110.2	27.2	171.1
Portugal	3 348	850	5 660	42.8	10.9	72.4
Romania	12 937	1 330	22 169	91.5	9.4	156.8
Slovakia	3 958	958	6 317	97.9	23.7	156.2
Slovenia	1 284	317	2 091	80.6	19.9	131.2
Spain	19 123	3 622	32 877	53.4	10.1	91.8
Sweden	911	103	1 678	12.3	1.4	22.7
Albania	2 540	553	4 052	129.9	28.3	207.3
Andorra	34	10	57	62.4	17.7	103.7
Bosnia and Herzegovina	5 334	1 156	8 099	202.7	43.9	307.7
Iceland	< 10	< 10	< 10	1.9	< 1.0	3.4
Kosovo	2 027	417	3 263	149.6	30.8	240.8
Liechtenstein	18	< 10	31	59.9	11.4	105.0
Monaco	22	< 10	36	81.1	23.2	133.3
Montenegro	603	130	952	139.7	30.1	220.5
North Macedonia	2 620	594	3 967	175.6	39.8	265.8
Norway	940	115	1 720	24.6	3.0	45.1
San Marino	31	< 10	53	117.0	24.5	195.9
Serbia	9 861	2 103	15 228	190.4	40.6	294.0
Switzerland	3 437	788	5 867	53.2	12.2	90.7
Türkiye (TR)	N/A	N/A	N/A	N/A	N/A	N/A
EU27	321 624	67 056	535 914	96.7	20.2	161.1
All countries (no TR)	349 097	72 938	579 245	98.0	20.5	162.6

([a]) Total and national data are rounded

PM$_{2.5}$ (long-term effects) and diabetes mellitus disease (adults ≥ 25 years)

Table A2.9: DM disease burden (AD) due to PM$_{2.5}$ for adults ≥ 25 years for 41 European countries (individual and total countries) and the EU27 in 2021

	PAF (95 % CI: low, high)			AD ([a]) (95 % CI: low, high)			AD/10^5 inhabitants ≥ 25 years (95 % CI: low, high)		
Country	mean	low	high	mean	low	high	mean	low	high
Austria	0.23	0.12	0.33	766	405	1 075	11.4	6.0	16.0
Belgium	0.27	0.14	0.37	407	216	568	4.9	2.6	6.8
Bulgaria	0.42	0.24	0.56	742	418	984	14.0	7.9	18.6
Croatia	0.39	0.22	0.52	1 861	1 051	2 463	61.4	34.7	81.2
Cyprus	0.39	0.22	0.52	191	106	256	29.7	16.5	39.9
Czechia	0.37	0.20	0.50	1 875	1 037	2 527	23.4	12.9	31.5
Denmark	0.15	0.08	0.22	196	100	284	4.7	2.4	6.8
Estonia	0.05	0.02	0.07	16	< 10	23	1.6	< 1.0	2.3
Finland	0.02	0.01	0.03	15	< 10	23	< 1.0	< 1.0	0.6
France	0.21	0.11	0.30	2 609	1 367	3 692	5.5	2.9	7.8
Germany	0.21	0.11	0.30	5 518	2 884	7 826	8.7	4.6	12.4
Greece	0.44	0.25	0.58	1 060	602	1 395	13.2	7.5	17.3
Hungary	0.40	0.22	0.53	1 615	897	2 164	22.1	12.3	29.6
Ireland	0.10	0.05	0.15	66	33	96	1.9	< 1.0	2.8
Italy	0.37	0.21	0.50	9 635	5 389	12 870	21.0	11.8	28.1
Latvia	0.26	0.14	0.36	192	103	265	13.5	7.3	18.7
Lithuania	0.29	0.16	0.41	209	112	290	10.0	5.3	13.8
Luxembourg	0.13	0.07	0.19	< 10	< 10	14	2.0	1.0	3.0
Malta	0.30	0.16	0.42	76	40	105	19.1	10.2	26.5
Netherlands	0.23	0.12	0.32	646	338	915	5.1	2.7	7.2
Poland	0.50	0.29	0.65	5 447	3 182	7 001	19.3	11.3	24.8
Portugal	0.12	0.06	0.18	525	270	758	6.7	3.5	9.7
Romania	0.39	0.22	0.53	1 549	864	2 070	10.9	6.1	14.6
Slovakia	0.43	0.24	0.57	349	197	462	8.6	4.9	11.4
Slovenia	0.32	0.17	0.43	144	79	197	9.1	4.9	12.3
Spain	0.22	0.11	0.30	2 324	1 224	3 273	6.5	3.4	9.1
Sweden	0.05	0.03	0.07	117	59	170	1.6	0.8	2.3
Albania	0.46	0.26	0.60	466	267	609	23.8	13.7	31.1
Andorra	0.18	0.09	0.26	< 10	< 10	< 10	4.6	2.4	6.7
Bosnia and Herzegovina	0.58	0.36	0.72	995	610	1 231	37.8	23.2	46.8
Iceland	0.01	0.00	0.01	< 1	< 1	< 1	< 1.0	< 1.0	< 1.0
Kosovo	0.46	0.26	0.61	406	231	532	29.9	17.1	39.2
Liechtenstein	0.15	0.08	0.22	< 1	< 1	< 1	1.0	< 1.0	1.5
Monaco	0.23	0.12	0.32	< 10	< 1	< 10	5.9	3.1	8.4
Montenegro	0.47	0.27	0.61	108	63	139	24.9	14.5	32.1
North Macedonia	0.60	0.37	0.74	419	257	519	28.1	17.2	34.8
Norway	0.07	0.03	0.10	52	26	75	1.4	< 1.0	2.0
San Marino	0.32	0.17	0.44	< 10	< 10	< 10	17.9	9.7	24.7
Serbia	0.56	0.34	0.70	1 877	1 127	2 358	36.2	21.8	45.5
Switzerland	0.17	0.09	0.24	182	94	261	2.8	1.5	4.0
Türkiye (TR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EU27	-	-	-	38 157	20 993	51 766	11.5	6.3	15.6
All countries (no TR)	-	-	-	42 671	23 673	57 504	12.0	6.6	16.1

([a]) Total and national data are rounded

Table A2.10: DM disease burden (YLL) due to $PM_{2.5}$ for adults ≥ 25 years for 41 European countries (individual and total countries) and the EU27 in 2021

Country	PAF (95 % CI: low, high) mean	low	high	YLL ([a]) (95 % CI: low, high) mean	low	high	YLL/10^5 inhabitants ≥ 25 years (95 % CI: low, high) mean	low	high
Austria	0.23	0.12	0.33	6 686	3 534	9 386	99.7	52.7	140.0
Belgium	0.27	0.14	0.37	4 156	2 208	5 804	50.0	26.6	69.9
Bulgaria	0.42	0.24	0.56	6 837	3 847	9 070	129.1	72.6	171.2
Croatia	0.39	0.22	0.52	14 283	8 067	18 904	471.0	266.0	623.3
Cyprus	0.39	0.22	0.52	1 633	906	2 191	254.3	141.2	341.3
Czechia	0.37	0.20	0.50	16 059	8 880	21 640	200.4	110.8	270.0
Denmark	0.15	0.08	0.22	2 047	1 048	2 962	49.0	25.1	71.0
Estonia	0.05	0.02	0.07	142	71	210	14.4	7.3	21.3
Finland	0.02	0.01	0.03	204	101	303	5.0	2.5	7.5
France	0.21	0.11	0.30	26 239	13 750	37 132	55.1	28.9	78.0
Germany	0.21	0.11	0.30	48 672	25 440	69 035	77.0	40.2	109.1
Greece	0.44	0.25	0.58	11 074	6 289	14 572	137.5	78.1	180.9
Hungary	0.40	0.22	0.53	15 925	8 850	21 348	218.1	121.2	292.3
Ireland	0.10	0.05	0.15	676	344	983	20.0	10.2	29.1
Italy	0.37	0.21	0.50	81 129	45 376	108 362	177.2	99.1	236.7
Latvia	0.26	0.14	0.36	1 836	986	2 540	129.6	69.6	179.3
Lithuania	0.29	0.16	0.41	2 227	1 192	3 089	106.3	56.9	147.5
Luxembourg	0.13	0.07	0.19	91	47	133	19.8	10.1	28.8
Malta	0.30	0.16	0.42	738	396	1 023	187.0	100.2	259.1
Netherlands	0.23	0.12	0.32	6 622	3 463	9 385	52.5	27.4	74.3
Poland	0.50	0.29	0.65	53 883	31 478	69 252	190.8	111.4	245.2
Portugal	0.12	0.06	0.18	4 447	2 284	6 413	56.9	29.2	82.1
Romania	0.39	0.22	0.53	14 914	8 318	19 940	105.5	58.8	141.0
Slovakia	0.43	0.24	0.57	3 944	2 224	5 222	97.6	55.0	129.2
Slovenia	0.32	0.17	0.43	1 336	729	1 823	83.9	45.8	114.4
Spain	0.22	0.11	0.30	19 484	10 261	27 448	54.4	28.7	76.7
Sweden	0.05	0.03	0.07	1 152	584	1 684	15.6	7.9	22.8
Albania	0.46	0.26	0.60	3 758	2 153	4 910	192.3	110.1	251.2
Andorra	0.18	0.09	0.26	25	13	37	46.6	24.0	67.1
Bosnia and Herzegovina	0.58	0.36	0.72	8 074	4 950	9 994	306.8	188.1	379.7
Iceland	0.01	0.00	0.01	< 10	< 10	< 10	< 1.0	< 1.0	1.3
Kosovo	0.46	0.26	0.61	3 292	1 877	4 315	242.9	138.5	318.4
Liechtenstein	0.15	0.08	0.22	18	< 10	26	62.6	32.1	90.5
Monaco	0.23	0.12	0.32	16	< 10	23	59.8	31.3	84.8
Montenegro	0.47	0.27	0.61	921	536	1 190	213.4	124.2	275.4
North Macedonia	0.60	0.37	0.74	3 786	2 318	4 686	253.7	155.3	314.0
Norway	0.07	0.03	0.10	527	268	767	13.8	7.0	20.1
San Marino	0.32	0.17	0.44	41	22	56	151.0	81.3	208.2
Serbia	0.56	0.34	0.70	15 231	9 145	19 140	294.1	176.6	369.6
Switzerland	0.17	0.09	0.24	1 756	907	2 519	27.2	14.0	39.0
Türkiye (TR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EU27	-	-	-	346 438	190 672	469 853	104.2	57.3	141.3
All countries (no TR)	-	-	-	383 887	212 880	517 518	107.7	59.7	145.2

([a]) Total and national data are rounded

Table A2.11: DM disease burden (YLD) due to $PM_{2.5}$ for adults ≥ 25 years for 41 European countries (individual and total countries) and the EU27 in 2021

	PAF (95 % CI: low, high)			YLD ([a]) (95 % CI: low, high)			YLD/10^5 inhabitants ≥ 25 years (95 % CI: low, high)		
Country	mean	low	high	mean	low	high	mean	low	high
Austria	0.04	0.02	0.05	1 405	724	2 047	20.9	10.8	30.5
Belgium	0.04	0.02	0.06	1 958	1 009	2 852	23.6	12.2	34.3
Bulgaria	0.07	0.04	0.11	2 524	1 312	3 645	47.6	24.8	68.8
Croatia	0.07	0.04	0.10	1 906	992	2 751	62.8	32.7	90.7
Cyprus	0.07	0.03	0.10	308	222	607	47.9	34.6	94.6
Czechia	0.06	0.03	0.09	4 194	2 175	6 073	52.3	27.1	75.8
Denmark	0.02	0.01	0.03	465	238	681	11.1	5.7	16.3
Estonia	0.01	0.00	0.01	37	19	54	3.8	1.9	5.5
Finland	0.00	0.00	0.00	121	62	178	3.0	1.5	4.4
France	0.03	0.02	0.05	11 010	5 664	16 066	23.1	11.9	33.7
Germany	0.03	0.02	0.05	16 738	8 608	24 435	26.5	13.6	38.6
Greece	0.08	0.04	0.11	4 809	2 505	6 937	59.7	31.1	86.1
Hungary	0.07	0.04	0.10	4 135	2 146	5 984	56.6	29.4	81.9
Ireland	0.02	0.01	0.02	172	88	253	5.1	2.6	7.5
Italy	0.07	0.03	0.09	18 491	9 610	26 724	40.4	21.0	58.4
Latvia	0.04	0.02	0.06	318	164	462	22.5	11.6	32.6
Lithuania	0.05	0.02	0.07	492	254	716	23.5	12.1	34.2
Luxembourg	0.02	0.01	0.03	39	20	57	8.4	4.3	12.3
Malta	0.05	0.03	0.07	139	72	202	35.1	18.1	51.1
Netherlands	0.04	0.02	0.05	2 503	1 287	3 654	19.8	10.2	28.9
Poland	0.10	0.05	0.14	20 635	10 798	29 631	73.1	38.2	104.9
Portugal	0.02	0.01	0.03	1 404	720	2 054	18.0	9.2	26.3
Romania	0.07	0.04	0.10	4 719	2 451	6 825	33.4	17.3	48.3
Slovakia	0.08	0.04	0.11	2 211	1 150	3 192	54.7	28.4	79.0
Slovenia	0.05	0.03	0.08	633	327	918	39.7	20.5	57.6
Spain	0.03	0.02	0.05	8 758	4 509	12 770	24.5	12.6	35.7
Sweden	0.01	0.00	0.01	316	162	464	4.3	2.2	6.3
Albania	0.08	0.04	0.12	1 061	553	1 528	54.3	28.3	78.2
Andorra	0.03	0.01	0.04	10	< 10	15	19.0	9.7	27.8
Bosnia and Herzegovina	0.12	0.06	0.17	2 325	1 227	3 312	88.4	46.6	125.9
Iceland	0.00	0.00	0.00	< 1	< 1	< 10	< 1.0	< 1.0	< 1.0
Kosovo	0.08	0.04	0.12	830	432	1 196	61.2	31.9	88.3
Liechtenstein	0.02	0.01	0.03	< 10	< 10	< 10	13.0	6.7	19.1
Monaco	0.04	0.02	0.05	< 10	< 10	10	25.0	12.8	36.4
Montenegro	0.09	0.05	0.13	252	132	362	58.4	30.6	83.9
North Macedonia	0.12	0.07	0.18	1 141	602	1 625	76.4	40.3	108.9
Norway	0.01	0.01	0.01	162	83	237	4.2	2.2	6.2
San Marino	0.05	0.03	0.08	< 10	< 10	13	32.2	16.6	46.8
Serbia	0.11	0.06	0.16	4 216	2 216	6 028	81.4	42.8	116.4
Switzerland	0.03	0.01	0.04	912	468	1 334	14.1	7.2	20.6
Türkiye (TR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EU27	-	-	-	110 440	57 288	160 234	33.2	17.2	48.2
All countries (no TR)	-	-	-	121 369	63 018	175 901	34.1	17.7	49.4

([a]) Total and national data are rounded

Table A2.12: DM disease burden (DALY) due to $PM_{2.5}$ for adults ≥ 25 years for 41 European countries (individual and total countries) and the EU27 in 2021

	DALY ([a]) (95 % CI: low, high)			DALY/10^5 inhabitants ≥ 25 years (95 % CI: low, high)		
Country	mean	low	high	mean	low	high
Austria	8 091	4 257	11 433	120.7	63.5	170.5
Belgium	6 114	3 217	8 657	73.6	38.7	104.2
Bulgaria	9 361	5 159	12 715	176.7	97.4	240.0
Croatia	16 189	9 059	21 654	533.8	298.7	714.0
Cyprus	1 940	1 129	2 799	302.2	175.8	435.9
Czechia	20 253	11 055	27 713	252.7	138.0	345.8
Denmark	2 512	1 286	3 642	60.2	30.8	87.3
Estonia	179	90	264	18.2	9.2	26.8
Finland	325	163	481	8.0	4.0	11.8
France	37 249	19 414	53 199	78.2	40.8	111.7
Germany	65 410	34 047	93 470	103.4	53.8	147.8
Greece	15 883	8 794	21 509	197.1	109.1	267.0
Hungary	20 060	10 996	27 332	274.7	150.6	374.2
Ireland	848	433	1 235	25.1	12.8	36.6
Italy	99 620	54 986	135 086	217.6	120.1	295.0
Latvia	2 154	1 150	3 003	152.0	81.2	212.0
Lithuania	2 719	1 446	3 805	129.8	69.0	181.7
Luxembourg	130	66	190	28.2	14.4	41.2
Malta	877	467	1 225	222.2	118.3	310.3
Netherlands	9 125	4 750	13 039	72.3	37.6	103.3
Poland	74 518	42 275	98 883	263.8	149.7	350.1
Portugal	5 850	3 004	8 467	74.9	38.4	108.3
Romania	19 633	10 769	26 765	138.8	76.1	189.2
Slovakia	6 155	3 374	8 414	152.2	83.5	208.1
Slovenia	1 969	1 057	2 741	123.6	66.3	172.0
Spain	28 242	14 770	40 218	78.9	41.2	112.3
Sweden	1 469	746	2 148	19.9	10.1	29.1
Albania	4 819	2 706	6 438	246.6	138.4	329.4
Andorra	36	18	52	65.6	33.8	94.8
Bosnia and Herzegovina	10 399	6 178	13 306	395.1	234.7	505.6
Iceland	< 10	< 10	< 10	1.2	< 1.0	1.8
Kosovo	4 122	2 309	5 511	304.1	170.4	406.6
Liechtenstein	22	11	32	75.6	38.8	109.5
Monaco	23	12	33	84.8	44.1	121.3
Montenegro	1 174	668	1 552	271.8	154.7	359.4
North Macedonia	4 927	2 919	6 312	330.1	195.6	423.0
Norway	688	351	1 004	18.0	9.2	26.3
San Marino	49	26	69	183.2	97.9	254.9
Serbia	19 448	11 361	25 168	375.5	219.4	486.0
Switzerland	2 668	1 376	3 853	41.3	21.3	59.6
Türkiye (TR)	N/A	N/A	N/A	N/A	N/A	N/A
EU27	456 878	247 961	630 087	137.4	74.5	189.4
All countries (no TR)	505 256	275 898	693 419	141.8	77.4	194.6

([a]) Total and national data are rounded

PM$_{2.5}$ (long-term effects) and ischemic heart disease (adults ≥ 25 years)

Indicators calculation spreadsheet PM25_IHD_2021.xlsx is available ....

Table A2.13: IHD disease burden (AD) due to PM$_{2.5}$ for adults ≥ 25 years for 41 European countries (individual and total countries) and the EU27 in 2021

	PAF (95 % CI: low, high)			AD ([a]) (95 % CI: low, high)			AD/10^5 inhabitants ≥ 25 years (95 % CI: low, high)		
Country	mean	low	high	mean	low	high	mean	low	high
Austria	0.10	0.05	0.14	1 235	658	1 782	18.4	9.8	26.6
Belgium	0.11	0.06	0.16	708	378	1 019	8.5	4.5	12.3
Bulgaria	0.19	0.10	0.27	3 069	1 675	4 322	57.9	31.6	81.6
Croatia	0.18	0.10	0.25	1 384	757	1 946	45.7	25.0	64.2
Cyprus	0.17	0.09	0.24	98	53	139	15.3	8.3	21.6
Czechia	0.16	0.09	0.23	3 589	1 946	5 088	44.8	24.3	63.5
Denmark	0.06	0.03	0.09	211	111	308	5.1	2.7	7.4
Estonia	0.02	0.01	0.03	39	21	58	4.0	2.1	5.9
Finland	0.01	0.00	0.01	80	41	117	2.0	1.0	2.9
France	0.09	0.05	0.13	2 759	1 464	3 992	5.8	3.1	8.4
Germany	0.09	0.05	0.13	10 685	5 666	15 477	16.9	9.0	24.5
Greece	0.20	0.11	0.28	2 837	1 555	3 981	35.2	19.3	49.4
Hungary	0.18	0.10	0.25	5 686	3 088	8 047	77.9	42.3	110.2
Ireland	0.04	0.02	0.06	177	93	259	5.2	2.8	7.7
Italy	0.17	0.09	0.24	10 799	5 885	15 237	23.6	12.9	33.3
Latvia	0.11	0.06	0.16	800	429	1 146	56.5	30.3	80.9
Lithuania	0.13	0.07	0.18	1 753	938	2 516	83.7	44.8	120.1
Luxembourg	0.05	0.03	0.08	14	< 10	20	3.0	1.6	4.3
Malta	0.13	0.07	0.19	95	51	136	24.0	12.8	34.4
Netherlands	0.09	0.05	0.14	765	406	1 108	6.1	3.2	8.8
Poland	0.24	0.13	0.33	17 494	9 702	24 272	61.9	34.3	85.9
Portugal	0.05	0.03	0.07	354	186	516	4.5	2.4	6.6
Romania	0.18	0.10	0.25	9 837	5 352	13 900	69.6	37.8	98.3
Slovakia	0.20	0.11	0.27	3 121	1 705	4 392	77.2	42.2	108.6
Slovenia	0.14	0.08	0.20	253	136	360	15.9	8.6	22.6
Spain	0.09	0.05	0.13	2 610	1 388	3 770	7.3	3.9	10.5
Sweden	0.02	0.01	0.03	195	102	286	2.6	1.4	3.9
Albania	0.21	0.12	0.30	559	308	782	28.6	15.7	40.0
Andorra	0.07	0.04	0.11	< 10	< 10	< 10	4.8	2.5	7.0
Bosnia and Herzegovina	0.29	0.17	0.40	1 299	736	1 767	49.4	28.0	67.2
Iceland	0.00	0.00	0.00	< 1	< 1	< 1	< 1.0	< 1.0	< 1.0
Kosovo	0.21	0.12	0.30	484	266	678	35.7	19.6	50.1
Liechtenstein	0.06	0.03	0.09	< 10	< 1	< 10	5.4	2.9	7.9
Monaco	0.09	0.05	0.14	< 10	< 1	< 10	6.3	3.3	9.1
Montenegro	0.22	0.12	0.31	133	74	185	30.8	17.1	42.8
North Macedonia	0.30	0.17	0.41	545	309	742	36.5	20.7	49.7
Norway	0.03	0.01	0.04	86	45	127	2.3	1.2	3.3
San Marino	0.14	0.07	0.20	< 10	< 10	< 10	19.2	10.3	27.5
Serbia	0.27	0.15	0.38	2 388	1 340	3 277	46.1	25.9	63.3
Switzerland	0.07	0.04	0.10	432	228	629	6.7	3.5	9.7
Türkiye (TR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EU27	-	-	-	80 647	43 792	114 194	24.2	13.2	34.3
All countries (no TR)	-	-	-	86 586	47 104	122 398	24.3	13.2	34.3

([a]) Total and national data are rounded

Table A2.14: IHD disease burden (YLL) due to $PM_{2.5}$ for adults ≥ 25 years for 41 European countries (individual and total countries) and the EU27 in 2021

	PAF (95 % CI: low, high)			YLL ([a]) (95 % CI: low, high)			YLL/10^5 inhabitants ≥ 25 years (95 % CI: low, high)		
Country	mean	low	high	mean	low	high	mean	low	high
Austria	0.10	0.05	0.14	10 517	5 601	15 170	156.9	83.5	226.2
Belgium	0.11	0.06	0.16	7 709	4 113	11 099	92.8	49.5	133.6
Bulgaria	0.19	0.10	0.27	24 444	13 343	34 425	461.5	251.9	649.9
Croatia	0.18	0.10	0.25	10 498	5 742	14 759	346.2	189.3	486.7
Cyprus	0.17	0.09	0.24	1 236	671	1 750	192.5	104.5	272.5
Czechia	0.16	0.09	0.23	27 094	14 690	38 410	338.1	183.3	479.3
Denmark	0.06	0.03	0.09	2 062	1 085	3 010	49.4	26.0	72.1
Estonia	0.02	0.01	0.03	311	162	457	31.6	16.5	46.4
Finland	0.01	0.00	0.01	713	371	1 052	17.5	9.1	25.9
France	0.09	0.05	0.13	29 292	15 549	42 385	61.5	32.7	89.0
Germany	0.09	0.05	0.13	91 851	48 705	133 041	145.2	77.0	210.3
Greece	0.20	0.11	0.28	29 659	16 252	41 617	368.1	201.7	516.6
Hungary	0.18	0.10	0.25	46 625	25 320	65 983	638.4	346.7	903.5
Ireland	0.04	0.02	0.06	1 969	1 034	2 879	58.3	30.6	85.3
Italy	0.17	0.09	0.24	87 129	47 480	122 938	190.3	103.7	268.5
Latvia	0.11	0.06	0.16	6 305	3 379	9 038	445.1	238.5	638.0
Lithuania	0.13	0.07	0.18	12 298	6 581	17 655	587.2	314.2	842.9
Luxembourg	0.05	0.03	0.08	164	86	240	35.5	18.6	51.9
Malta	0.13	0.07	0.19	1 051	562	1 508	266.1	142.4	381.9
Netherlands	0.09	0.05	0.14	7 850	4 163	11 368	62.2	33.0	90.0
Poland	0.24	0.13	0.33	140 442	77 885	194 854	497.2	275.7	689.8
Portugal	0.05	0.03	0.07	3 809	2 007	5 553	48.7	25.7	71.0
Romania	0.18	0.10	0.25	77 650	42 242	109 719	549.1	298.7	775.8
Slovakia	0.20	0.11	0.27	25 011	13 664	35 193	618.6	338.0	870.5
Slovenia	0.14	0.08	0.20	2 656	1 433	3 784	166.7	89.9	237.5
Spain	0.09	0.05	0.13	29 812	15 856	43 056	83.3	44.3	120.2
Sweden	0.02	0.01	0.03	1 841	965	2 697	24.9	13.1	36.5
Albania	0.21	0.12	0.30	4 833	2 658	6 759	247.3	136.0	345.8
Andorra	0.07	0.04	0.11	28	15	41	51.0	26.9	74.2
Bosnia and Herzegovina	0.29	0.17	0.40	10 704	6 066	14 559	406.7	230.5	553.2
Iceland	0.00	0.00	0.00	< 10	< 10	< 10	2.3	1.2	3.4
Kosovo	0.21	0.12	0.30	3 988	2 188	5 588	294.2	161.4	412.3
Liechtenstein	0.06	0.03	0.09	28	15	41	95.0	50.0	138.7
Monaco	0.09	0.05	0.14	18	10	26	66.5	35.3	96.4
Montenegro	0.22	0.12	0.31	1 176	651	1 634	272.3	150.9	378.3
North Macedonia	0.30	0.17	0.41	5 186	2 935	7 060	347.5	196.7	473.1
Norway	0.03	0.01	0.04	869	456	1 272	22.8	12.0	33.3
San Marino	0.14	0.07	0.20	42	22	60	154.8	83.0	221.7
Serbia	0.27	0.15	0.38	19 669	11 035	26 993	379.8	213.1	521.2
Switzerland	0.07	0.04	0.10	3 914	2 066	5 694	60.5	32.0	88.1
Türkiye (TR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EU27	-	-	-	679 995	368 939	963 638	204.4	110.9	289.7
All countries (no TR)	-	-	-	730 454	397 058	1 033 370	205.0	111.4	290.0

([a]) Total and national data are rounded

Table A2.15: IHD disease burden (YLD) due to $PM_{2.5}$ for adults ≥ 25 years for 41 European countries (individual and total countries) and the EU27 in 2021

	PAF (95 % CI: low, high)			YLD ([a]) (95 % CI: low, high)			YLD/10^5 inhabitants ≥ 25 years (95 % CI: low, high)		
Country	mean	low	high	mean	low	high	mean	low	high
Austria	0.02	0.00	0.09	120	0	553	1.8	0.0	8.2
Belgium	0.02	0.00	0.10	73	0	335	< 1.0	0.0	4.0
Bulgaria	0.04	0.00	0.17	432	0	1 920	8.2	0.0	36.2
Croatia	0.04	0.00	0.16	224	0	995	7.4	0.0	32.8
Cyprus	0.04	0.00	0.16	14	0	81	2.2	0.0	12.6
Czechia	0.03	0.00	0.15	225	0	1 012	2.8	0.0	12.6
Denmark	0.01	0.00	0.06	19	0	87	< 1.0	0.0	2.1
Estonia	0.00	0.00	0.02	< 10	0	23	< 1.0	0.0	2.3
Finland	0.00	0.00	0.01	11	0	53	< 1.0	0.0	1.3
France	0.02	0.00	0.08	497	0	2 302	1.0	0.0	4.8
Germany	0.02	0.00	0.08	1 407	0	6 534	2.2	0.0	10.3
Greece	0.04	0.00	0.18	287	0	1 270	3.6	0.0	15.8
Hungary	0.04	0.00	0.16	292	0	1 306	4.0	0.0	17.9
Ireland	0.01	0.00	0.04	16	0	75	< 1.0	0.0	2.2
Italy	0.03	0.00	0.15	996	0	4 438	2.2	0.0	9.7
Latvia	0.02	0.00	0.10	54	0	245	3.8	0.0	17.3
Lithuania	0.02	0.00	0.11	93	0	426	4.4	0.0	20.3
Luxembourg	0.01	0.00	0.05	< 10	0	10	< 1.0	0.0	2.2
Malta	0.03	0.00	0.12	< 10	0	32	1.8	0.0	8.2
Netherlands	0.02	0.00	0.09	183	0	849	1.4	0.0	6.7
Poland	0.05	0.00	0.22	3 222	0	13 978	11.4	0.0	49.5
Portugal	0.01	0.00	0.05	95	0	445	1.2	0.0	5.7
Romania	0.04	0.00	0.16	229	0	1 024	1.6	0.0	7.2
Slovakia	0.04	0.00	0.18	294	0	1 304	7.3	0.0	32.2
Slovenia	0.03	0.00	0.13	43	0	193	2.7	0.0	12.1
Spain	0.02	0.00	0.08	134	0	619	< 1.0	0.0	1.7
Sweden	0.00	0.00	0.02	11	0	51	< 1.0	0.0	< 1.0
Albania	0.04	0.00	0.19	194	0	853	9.9	0.0	43.7
Andorra	0.01	0.00	0.07	0	0	2	0.9	0.0	4.0
Bosnia and Herzegovina	0.06	0.00	0.27	447	0	1 874	17.0	0.0	71.2
Iceland	0.00	0.00	0.00	< 1	0	< 1	< 1.0	0.0	< 1.0
Kosovo	0.04	0.00	0.19	157	0	694	11.6	0.0	51.2
Liechtenstein	0.01	0.00	0.06	< 1	0	1	1.1	0.0	4.9
Monaco	0.02	0.00	0.09	< 1	0	1	1.1	0.0	5.2
Montenegro	0.05	0.00	0.20	46	0	200	10.7	0.0	46.4
North Macedonia	0.07	0.00	0.28	207	0	869	13.8	0.0	58.2
Norway	0.01	0.00	0.02	< 10	0	36	< 1.0	0.0	< 1.0
San Marino	0.03	0.00	0.12	< 1	0	2	1.7	0.0	7.9
Serbia	0.06	0.00	0.25	806	0	3 436	15.6	0.0	66.4
Switzerland	0.01	0.00	0.06	78	0	363	1.2	0.0	5.6
Türkiye (TR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EU27	-	-	-	8 985	0	40 162	2.7	0.0	12.1
All countries (no TR)	-	-	-	10 929	0	48 494	3.1	0.0	13.6

([a]) Total and national data are rounded

Table A2.16: IHD disease burden (DALY) due to $PM_{2.5}$ for adults ≥ 25 years for 41 European countries (individual and total countries) and the EU27 in 2021

	DALY ([a]) (95 % CI: low, high)			DALY/10^5 inhabitants ≥ 25 years (95 % CI: low, high)		
Country	mean	low	high	mean	low	high
Austria	10 637	5 601	15 723	158.6	83.5	234.5
Belgium	7 782	4 113	11 434	93.7	49.5	137.7
Bulgaria	24 876	13 343	36 345	469.6	251.9	686.2
Croatia	10 723	5 742	15 754	353.6	189.3	519.5
Cyprus	1 250	671	1 830	194.7	104.5	285.1
Czechia	27 320	14 690	39 422	340.9	183.3	491.9
Denmark	2 080	1 085	3 097	49.8	26.0	74.2
Estonia	316	162	480	32.1	16.5	48.7
Finland	724	371	1 105	17.8	9.1	27.2
France	29 788	15 549	44 687	62.6	32.7	93.9
Germany	93 258	48 705	139 575	147.4	77.0	220.7
Greece	29 947	16 252	42 887	371.7	201.7	532.3
Hungary	46 916	25 320	67 289	642.4	346.7	921.4
Ireland	1 985	1 034	2 954	58.8	30.6	87.5
Italy	88 125	47 480	127 376	192.5	103.7	278.2
Latvia	6 359	3 379	9 283	448.9	238.5	655.3
Lithuania	12 391	6 581	18 081	591.6	314.2	863.3
Luxembourg	166	86	250	36.0	18.6	54.1
Malta	1 058	562	1 540	267.9	142.4	390.1
Netherlands	8 032	4 163	12 217	63.6	33.0	96.8
Poland	143 664	77 885	208 832	508.6	275.7	739.3
Portugal	3 904	2 007	5 997	49.9	25.7	76.7
Romania	77 879	42 242	110 743	550.7	298.7	783.1
Slovakia	25 304	13 664	36 497	625.9	338.0	902.7
Slovenia	2 699	1 433	3 977	169.3	89.9	249.6
Spain	29 946	15 856	43 675	83.6	44.3	122.0
Sweden	1 851	965	2 748	25.1	13.1	37.2
Albania	5 027	2 658	7 612	257.2	136.0	389.5
Andorra	28	15	43	51.8	26.9	78.2
Bosnia and Herzegovina	11 151	6 066	16 432	423.7	230.5	624.4
Iceland	< 10	< 10	< 10	2.3	1.2	3.6
Kosovo	4 145	2 188	6 281	305.8	161.4	463.5
Liechtenstein	28	15	42	96.1	50.0	143.6
Monaco	18	10	27	67.6	35.3	101.6
Montenegro	1 222	651	1 834	283.0	150.9	424.7
North Macedonia	5 392	2 935	7 929	361.4	196.7	531.3
Norway	877	456	1 308	23.0	12.0	34.3
San Marino	42	22	62	156.5	83.0	229.6
Serbia	20 475	11 035	30 429	395.4	213.1	587.6
Switzerland	3 991	2 066	6 056	61.7	32.0	93.7
Türkiye (TR)	N/A	N/A	N/A	N/A	N/A	N/A
EU27	688 979	368 939	1 003 799	207.1	110.9	301.8
All countries (no TR)	741 383	397 058	1 081 865	208.1	111.4	303.6

([a]) Total and national data are rounded

PM2.5 (long-term effects) and lung cancer (adults ≥ 25 years)

Table A2.17: LC disease burden (AD) due to $PM_{2.5}$ for adults ≥ 25 years for 41 European countries (individual and total countries) and the EU27 in 2021

	PAF (95 % CI: low, high)			AD ([a]) (95 % CI: low, high)			AD/10^5 inhabitants ≥ 25 years (95 % CI: low, high)		
Country	mean	low	high	mean	low	high	mean	low	high
Austria	0.05	0.03	0.07	222	134	288	3.3	2.0	4.3
Belgium	0.06	0.04	0.08	363	220	470	4.4	2.6	5.7
Bulgaria	0.11	0.07	0.14	371	227	477	7.0	4.3	9.0
Croatia	0.10	0.06	0.13	288	177	370	9.5	5.8	12.2
Cyprus	0.10	0.06	0.13	32	19	41	4.9	3.0	6.3
Czechia	0.09	0.06	0.12	451	275	581	5.6	3.4	7.3
Denmark	0.03	0.02	0.04	117	70	152	2.8	1.7	3.6
Estonia	0.01	0.01	0.01	< 10	< 10	< 10	< 1.0	< 1.0	< 1.0
Finland	0.00	0.00	0.01	11	< 10	15	< 1.0	< 1.0	< 1.0
France	0.05	0.03	0.06	1 516	916	1 969	3.2	1.9	4.1
Germany	0.05	0.03	0.06	2 201	1 329	2 859	3.5	2.1	4.5
Greece	0.11	0.07	0.15	808	495	1 037	10.0	6.1	12.9
Hungary	0.10	0.06	0.13	821	501	1 058	11.2	6.9	14.5
Ireland	0.02	0.01	0.03	45	27	59	1.3	< 1.0	1.7
Italy	0.09	0.06	0.12	3 080	1 883	3 962	6.7	4.1	8.7
Latvia	0.06	0.04	0.08	58	35	75	4.1	2.5	5.3
Lithuania	0.07	0.04	0.09	76	46	98	3.6	2.2	4.7
Luxembourg	0.03	0.02	0.04	< 10	< 10	< 10	1.3	< 1.0	1.7
Malta	0.07	0.04	0.09	13	< 10	17	3.3	2.0	4.2
Netherlands	0.05	0.03	0.07	524	316	681	4.2	2.5	5.4
Poland	0.14	0.08	0.18	2 867	1 767	3 666	10.2	6.3	13.0
Portugal	0.03	0.02	0.04	121	73	158	1.6	< 1.0	2.0
Romania	0.10	0.06	0.13	937	572	1 206	6.6	4.0	8.5
Slovakia	0.11	0.07	0.14	261	160	335	6.4	3.9	8.3
Slovenia	0.08	0.05	0.10	96	58	123	6.0	3.7	7.7
Spain	0.05	0.03	0.06	1 122	678	1 455	3.1	1.9	4.1
Sweden	0.01	0.01	0.01	39	23	51	< 1.0	< 1.0	< 1.0
Albania	0.12	0.07	0.15	192	118	246	9.8	6.0	12.6
Andorra	0.04	0.02	0.05	1	< 1	< 10	2.6	1.6	3.4
Bosnia and Herzegovina	0.17	0.11	0.22	405	252	514	15.4	9.6	19.5
Iceland	0.00	0.00	0.00	< 1	< 1	< 1	< 1.0	< 1.0	< 1.0
Kosovo	0.12	0.07	0.16	146	90	188	10.8	6.6	13.9
Liechtenstein	0.03	0.02	0.04	< 1	< 1	< 1	< 1.0	< 1.0	< 1.0
Monaco	0.05	0.03	0.07	< 1	< 1	< 10	3.4	2.1	4.5
Montenegro	0.13	0.08	0.16	44	27	56	10.2	6.3	13.0
North Macedonia	0.18	0.11	0.22	197	123	251	13.2	8.2	16.8
Norway	0.01	0.01	0.02	33	20	43	< 1.0	< 1.0	1.1
San Marino	0.08	0.05	0.10	< 10	< 1	< 10	5.4	3.3	7.0
Serbia	0.16	0.10	0.20	737	457	939	14.2	8.8	18.1
Switzerland	0.04	0.02	0.05	122	73	159	1.9	1.1	2.5
Türkiye (TR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EU27	-	-	-	16 453	10 023	21 220	4.9	3.0	6.4
All countries (no TR)	-	-	-	18 334	11 185	23 620	5.1	3.1	6.6

([a]) Total and national data are rounded

Table A2.18: LC disease burden (YLL) due to $PM_{2.5}$ for adults ≥ 25 years for 41 European countries (individual and total countries) and the EU27 in 2021

	PAF (95 % CI: low, high)			YLL([a]) (95 % CI: low, high)			YLL/10^5 inhabitants ≥ 25 years (95 % CI: low, high)		
Country	mean	low	high	mean	low	high	mean	low	high
Austria	0.05	0.03	0.07	3 315	2 005	4 299	49.4	29.9	64.1
Belgium	0.06	0.04	0.08	5 468	3 309	7 086	65.8	39.8	85.3
Bulgaria	0.11	0.07	0.14	4 279	2 617	5 502	80.8	49.4	103.9
Croatia	0.10	0.06	0.13	3 672	2 248	4 717	121.1	74.1	155.5
Cyprus	0.10	0.06	0.13	485	296	625	75.6	46.1	97.3
Czechia	0.09	0.06	0.12	5 382	3 281	6 935	67.2	40.9	86.5
Denmark	0.03	0.02	0.04	1 551	933	2 020	37.2	22.4	48.4
Estonia	0.01	0.01	0.01	72	43	94	7.3	4.4	9.5
Finland	0.00	0.00	0.01	157	94	205	3.9	2.3	5.0
France	0.05	0.03	0.06	25 204	15 219	32 721	52.9	32.0	68.7
Germany	0.05	0.03	0.06	31 877	19 239	41 400	50.4	30.4	65.5
Greece	0.11	0.07	0.15	11 043	6 767	14 179	137.1	84.0	176.0
Hungary	0.10	0.06	0.13	10 544	6 434	13 581	144.4	88.1	186.0
Ireland	0.02	0.01	0.03	673	405	877	20.0	12.0	26.0
Italy	0.09	0.06	0.12	41 333	25 264	53 171	90.3	55.2	116.1
Latvia	0.06	0.04	0.08	677	411	877	47.8	29.0	61.9
Lithuania	0.07	0.04	0.09	881	534	1 141	42.1	25.5	54.5
Luxembourg	0.03	0.02	0.04	86	52	112	18.7	11.2	24.3
Malta	0.07	0.04	0.09	175	106	227	44.4	26.9	57.4
Netherlands	0.05	0.03	0.07	7 506	4 531	9 748	59.5	35.9	77.2
Poland	0.14	0.08	0.18	36 667	22 594	46 880	129.8	80.0	166.0
Portugal	0.03	0.02	0.04	1 882	1 133	2 450	24.1	14.5	31.4
Romania	0.10	0.06	0.13	11 759	7 181	15 136	83.1	50.8	107.0
Slovakia	0.11	0.07	0.14	3 078	1 883	3 956	76.1	46.6	97.8
Slovenia	0.08	0.05	0.10	1 360	827	1 755	85.3	51.9	110.1
Spain	0.05	0.03	0.06	17 877	10 805	23 194	49.9	30.2	64.8
Sweden	0.01	0.01	0.01	524	314	683	7.1	4.3	9.2
Albania	0.12	0.07	0.15	2 518	1 546	3 229	128.8	79.1	165.2
Andorra	0.04	0.02	0.05	24	14	31	43.6	26.2	56.7
Bosnia and Herzegovina	0.17	0.11	0.22	4 835	3 010	6 135	183.7	114.4	233.1
Iceland	0.00	0.00	0.00	< 10	< 10	< 10	< 1.0	< 1.0	1.1
Kosovo	0.12	0.07	0.16	1 746	1 071	2 241	128.9	79.0	165.4
Liechtenstein	0.03	0.02	0.04	< 10	< 10	12	32.0	19.3	41.7
Monaco	0.05	0.03	0.07	15	< 10	20	57.2	34.5	74.3
Montenegro	0.13	0.08	0.16	552	340	706	127.9	78.8	163.6
North Macedonia	0.18	0.11	0.22	2 523	1 570	3 203	169.1	105.2	214.6
Norway	0.01	0.01	0.02	469	282	612	12.3	7.4	16.0
San Marino	0.08	0.05	0.10	19	12	25	72.3	43.9	93.6
Serbia	0.16	0.10	0.20	8 800	5 452	11 206	169.9	105.3	216.4
Switzerland	0.04	0.02	0.05	1 892	1 139	2 460	29.3	17.6	38.1
Türkiye (TR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EU27	-	-	-	227 526	138 527	293 573	68.4	41.6	88.3
All countries (no TR)	-	-	-	250 933	152 979	323 457	70.4	42.9	90.8

([a]) Total and national data are rounded

Table A2.19: LC disease burden (YLD) due to $PM_{2.5}$ for adults ≥ 25 years for 41 European countries (individual and total countries) and the EU27 in 2021

Country	PAF (95 % CI: low, high)			YLD ([a]) (95 % CI: low, high)			YLD/10^5 inhabitants ≥ 25 years (95 % CI: low, high)		
	mean	low	high	mean	low	high	mean	low	high
Austria	0.11	0.05	0.18	60	25	98	< 1.0	< 1.0	1.5
Belgium	0.13	0.05	0.21	127	53	205	1.5	< 1.0	2.5
Bulgaria	0.22	0.09	0.34	85	36	132	1.6	< 1.0	2.5
Croatia	0.20	0.09	0.32	61	26	94	2.0	< 1.0	3.1
Cyprus	0.20	0.08	0.31	11	< 10	20	1.7	< 1.0	3.1
Czechia	0.19	0.08	0.29	123	53	194	1.5	< 1.0	2.4
Denmark	0.07	0.03	0.12	38	15	62	< 1.0	< 1.0	1.5
Estonia	0.02	0.01	0.04	< 10	< 1	< 10	< 1.0	< 1.0	0.3
Finland	0.01	0.00	0.02	< 10	< 10	< 10	< 1.0	< 1.0	0.1
France	0.10	0.04	0.16	479	198	778	1.0	< 1.0	1.6
Germany	0.10	0.04	0.17	676	280	1 101	1.1	< 1.0	1.7
Greece	0.23	0.10	0.35	197	85	305	2.4	1.1	3.8
Hungary	0.20	0.09	0.32	197	84	309	2.7	1.2	4.2
Ireland	0.05	0.02	0.08	16	< 10	27	< 1.0	< 1.0	< 1.0
Italy	0.19	0.08	0.30	773	332	1 206	1.7	< 1.0	2.6
Latvia	0.13	0.05	0.21	14	< 10	23	1.0	< 1.0	1.6
Lithuania	0.14	0.06	0.23	20	< 10	33	< 1.0	< 1.0	1.6
Luxembourg	0.06	0.02	0.10	< 10	< 1	< 10	< 1.0	< 1.0	< 1.0
Malta	0.15	0.06	0.24	< 10	< 10	< 10	< 1.0	< 1.0	1.6
Netherlands	0.11	0.04	0.18	152	63	248	1.2	< 1.0	2.0
Poland	0.27	0.12	0.41	779	344	1 184	2.8	1.2	4.2
Portugal	0.06	0.02	0.10	30	12	49	< 1.0	< 1.0	< 1.0
Romania	0.20	0.09	0.32	219	94	342	1.5	< 1.0	2.4
Slovakia	0.22	0.10	0.35	71	31	110	1.8	< 1.0	2.7
Slovenia	0.16	0.07	0.25	24	10	37	1.5	< 1.0	2.3
Spain	0.10	0.04	0.17	300	125	486	< 1.0	< 1.0	1.4
Sweden	0.02	0.01	0.04	11	< 10	18	< 1.0	< 1.0	< 1.0
Albania	0.24	0.11	0.37	23	10	36	1.2	< 1.0	1.8
Andorra	0.08	0.03	0.14	< 1	< 1	< 1	< 1.0	< 1.0	1.4
Bosnia and Herzegovina	0.33	0.15	0.49	71	32	105	2.7	1.2	4.0
Iceland	0.00	0.00	0.00	< 1	< 1	< 1	< 1.0	< 1.0	< 1.0
Kosovo	0.24	0.11	0.37	40	17	62	2.9	1.3	4.5
Liechtenstein	0.07	0.03	0.12	< 1	< 1	< 1	< 1.0	< 1.0	< 1.0
Monaco	0.11	0.04	0.18	< 1	< 1	< 1	1.1	< 1.0	1.8
Montenegro	0.25	0.11	0.38	10	< 1	15	2.3	1.0	3.5
North Macedonia	0.34	0.15	0.50	32	15	48	2.2	< 1.0	3.2
Norway	0.03	0.01	0.05	11	< 10	18	< 1.0	< 1.0	< 1.0
San Marino	0.16	0.07	0.25	< 1	< 1	< 1	1.4	< 1.0	2.2
Serbia	0.31	0.14	0.46	196	88	292	3.8	1.7	5.6
Switzerland	0.08	0.03	0.13	37	15	61	< 1.0	< 1.0	< 1.0
Türkiye (TR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EU27	-	-	-	4 475	1 902	7 079	1.3	< 1.0	2.1
All countries (no TR)	-	-	-	4 897	2 089	7 717	1.4	< 1.0	2.2

([a]) Total and national data are rounded

Table A2.20: LC disease burden (DALY) due to $PM_{2.5}$ for adults ≥ 25 years for 41 European countries (individual and total countries) and the EU27 in 2021

Country	DALY ([a]) (95 % CI: low, high) mean	low	high	DALY/10^5 inhabitants ≥ 25 years (95 % CI: low, high) mean	low	high
Austria	3 376	2 030	4 397	50.3	30.3	65.6
Belgium	5 595	3 362	7 292	67.4	40.5	87.8
Bulgaria	4 364	2 654	5 633	82.4	50.1	106.4
Croatia	3 732	2 274	4 811	123.1	75.0	158.7
Cyprus	496	302	645	77.3	47.0	100.4
Czechia	5 505	3 334	7 129	68.7	41.6	89.0
Denmark	1 589	948	2 082	38.1	22.7	49.9
Estonia	74	44	97	7.5	4.4	9.8
Finland	160	95	210	3.9	2.3	5.2
France	25 682	15 417	33 499	53.9	32.4	70.4
Germany	32 553	19 519	42 501	51.5	30.9	67.2
Greece	11 241	6 852	14 484	139.5	85.1	179.8
Hungary	10 741	6 518	13 889	147.1	89.2	190.2
Ireland	690	411	904	20.4	12.2	26.8
Italy	42 106	25 597	54 378	92.0	55.9	118.8
Latvia	692	417	900	48.8	29.4	63.5
Lithuania	902	543	1 174	43.1	25.9	56.1
Luxembourg	88	53	116	19.1	11.4	25.1
Malta	179	108	233	45.3	27.3	59.0
Netherlands	7 658	4 593	9 996	60.7	36.4	79.2
Poland	37 446	22 938	48 064	132.6	81.2	170.2
Portugal	1 912	1 145	2 499	24.5	14.6	32.0
Romania	11 977	7 275	15 478	84.7	51.4	109.4
Slovakia	3 149	1 914	4 066	77.9	47.3	100.6
Slovenia	1 383	837	1 793	86.8	52.5	112.5
Spain	18 177	10 929	23 680	50.8	30.5	66.1
Sweden	535	319	701	7.2	4.3	9.5
Albania	2 542	1 556	3 265	130.0	79.6	167.1
Andorra	24	15	32	44.4	26.6	58.1
Bosnia and Herzegovina	4 906	3 043	6 240	186.4	115.6	237.1
Iceland	< 10	< 10	< 10	< 1.0	< 1.0	1.2
Kosovo	1 786	1 088	2 303	131.8	80.3	169.9
Liechtenstein	< 10	< 10	12	32.6	19.5	42.6
Monaco	16	< 10	20	58.3	34.9	76.0
Montenegro	562	345	722	130.2	79.8	167.1
North Macedonia	2 555	1 584	3 251	171.2	106.2	217.8
Norway	480	286	630	12.6	7.5	16.5
San Marino	20	12	26	73.7	44.5	95.8
Serbia	8 996	5 540	11 498	173.7	107.0	222.0
Switzerland	1 929	1 155	2 522	29.8	17.9	39.0
Türkiye (TR)	N/A	N/A	N/A	N/A	N/A	N/A
EU27	232 001	140 429	300 652	69.7	42.2	90.4
All countries (no TR)	255 829	155 068	331 174	71.8	43.5	92.9

([a]) Total and national data are rounded

PM$_{2.5}$ (long-term effects) and stroke (adults ≥ 25 years)

Indicators calculation spreadsheet PM25_Strike_2021.xlsx is available ….

Table A2.21: Stroke disease burden (AD) due to PM$_{2.5}$ for adults ≥ 25 years for 41 European countries (individual and total countries) and the EU27 in 2021

	PAF (95 % CI: low, high)			AD ([a]) (95 % CI: low, high)			AD/10^5 inhabitants ≥ 25 years (95 % CI: low, high)		
Country	mean	low	high	mean	low	high	mean	low	high
Austria	0.11	0.04	0.17	508	206	786	7.6	3.1	11.7
Belgium	0.13	0.05	0.20	760	309	1 172	9.1	3.7	14.1
Bulgaria	0.21	0.09	0.32	5 007	2 105	7 486	94.5	39.7	141.3
Croatia	0.20	0.08	0.30	1 008	425	1 504	33.3	14.0	49.6
Cyprus	0.20	0.08	0.29	70	29	105	10.9	4.5	16.4
Czechia	0.18	0.08	0.28	1 316	548	1 986	16.4	6.8	24.8
Denmark	0.07	0.03	0.11	217	86	341	5.2	2.1	8.2
Estonia	0.02	0.01	0.03	23	< 10	37	2.3	< 1.0	3.7
Finland	0.01	0.00	0.02	41	16	65	1.0	< 1.0	1.6
France	0.10	0.04	0.15	3 123	1 261	4 852	6.6	2.6	10.2
Germany	0.10	0.04	0.16	5 312	2 141	8 265	8.4	3.4	13.1
Greece	0.23	0.10	0.34	2 989	1 263	4 445	37.1	15.7	55.2
Hungary	0.20	0.08	0.30	2 153	898	3 241	29.5	12.3	44.4
Ireland	0.05	0.02	0.07	74	29	117	2.2	< 1.0	3.5
Italy	0.19	0.08	0.28	10 952	4 592	16 420	23.9	10.0	35.9
Latvia	0.13	0.05	0.19	672	275	1 030	47.4	19.4	72.7
Lithuania	0.14	0.06	0.22	743	303	1 141	35.5	14.5	54.5
Luxembourg	0.06	0.02	0.09	13	< 10	20	2.8	1.1	4.4
Malta	0.15	0.06	0.23	32	13	49	8.0	3.3	12.3
Netherlands	0.11	0.04	0.17	962	388	1 496	7.6	3.1	11.8
Poland	0.27	0.12	0.39	8 451	3 634	12 373	29.9	12.9	43.8
Portugal	0.06	0.02	0.09	676	270	1 061	8.6	3.5	13.6
Romania	0.20	0.08	0.30	8 190	3 425	12 301	57.9	24.2	87.0
Slovakia	0.22	0.09	0.33	1 050	442	1 569	26.0	10.9	38.8
Slovenia	0.16	0.06	0.24	312	129	474	19.6	8.1	29.7
Spain	0.10	0.04	0.16	2 550	1 032	3 951	7.1	2.9	11.0
Sweden	0.02	0.01	0.04	118	47	187	1.6	< 1.0	2.5
Albania	0.24	0.10	0.35	664	282	983	34.0	14.4	50.3
Andorra	0.08	0.03	0.13	< 10	< 10	< 10	5.4	2.2	8.5
Bosnia and Herzegovina	0.33	0.15	0.47	1 570	696	2 236	59.6	26.5	85.0
Iceland	0.00	0.00	0.00	< 1	< 1	< 1	< 1.0	< 1.0	< 1.0
Kosovo	0.24	0.10	0.36	590	250	876	43.5	18.4	64.6
Liechtenstein	0.07	0.03	0.11	< 1	< 1	< 1	1.2	< 1.0	1.9
Monaco	0.11	0.04	0.17	< 10	< 1	< 10	7.1	2.9	11.0
Montenegro	0.25	0.11	0.37	159	68	233	36.7	15.8	53.9
North Macedonia	0.34	0.15	0.48	638	282	909	42.7	18.9	60.9
Norway	0.03	0.01	0.05	67	27	106	1.8	< 1.0	2.8
San Marino	0.15	0.06	0.24	< 10	< 10	< 10	19.5	8.0	29.9
Serbia	0.31	0.13	0.44	2 892	1 265	4 170	55.8	24.4	80.5
Switzerland	0.08	0.03	0.12	259	104	405	4.0	1.6	6.3
Türkiye (TR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EU27	-	-	-	57 322	23 881	86 472	17.2	7.2	26.0
All countries (no TR)	-	-	-	64 171	26 859	96 408	18.0	7.5	27.1

([a]) Total and national data are rounded

Table A2.22: Stroke disease burden (YLL) due to $PM_{2.5}$ for adults ≥ 25 years for 41 European countries (individual and total countries) and the EU27 in 2021

Country	PAF (95 % CI: low, high) mean	low	high	YLL ([a]) (95 % CI: low, high) mean	low	high	YLL/10^5 inhabitants ≥ 25 years (95 % CI: low, high) mean	low	high
Austria	0.11	0.04	0.17	4 021	1 631	6 219	60.0	24.3	92.7
Belgium	0.13	0.05	0.20	6 953	2 828	10 725	83.7	34.0	129.1
Bulgaria	0.21	0.09	0.32	33 277	13 986	49 748	628.2	264.0	939.2
Croatia	0.20	0.08	0.30	7 293	3 074	10 878	240.5	101.4	358.7
Cyprus	0.20	0.08	0.29	656	274	988	102.2	42.6	153.9
Czechia	0.18	0.08	0.28	10 470	4 357	15 799	130.6	54.4	197.1
Denmark	0.07	0.03	0.11	1 942	774	3 055	46.5	18.5	73.2
Estonia	0.02	0.01	0.03	199	79	317	20.2	8.0	32.2
Finland	0.01	0.00	0.02	360	141	575	8.9	3.5	14.1
France	0.10	0.04	0.15	28 267	11 411	43 914	59.4	24.0	92.2
Germany	0.10	0.04	0.16	44 913	18 103	69 874	71.0	28.6	110.5
Greece	0.23	0.10	0.34	21 275	8 992	31 642	264.1	111.6	392.8
Hungary	0.20	0.08	0.30	18 442	7 694	27 759	252.5	105.3	380.1
Ireland	0.05	0.02	0.07	727	289	1 146	21.5	8.6	34.0
Italy	0.19	0.08	0.28	78 480	32 904	117 663	171.4	71.9	257.0
Latvia	0.13	0.05	0.19	4 500	1 842	6 899	317.7	130.0	487.0
Lithuania	0.14	0.06	0.22	5 404	2 207	8 300	258.0	105.4	396.3
Luxembourg	0.06	0.02	0.09	118	47	186	25.6	10.2	40.4
Malta	0.15	0.06	0.23	308	126	473	78.0	31.9	119.8
Netherlands	0.11	0.04	0.17	8 086	3 260	12 577	64.1	25.8	99.6
Poland	0.27	0.12	0.39	76 247	32 787	111 630	269.9	116.1	395.2
Portugal	0.06	0.02	0.09	5 411	2 160	8 496	69.2	27.6	108.7
Romania	0.20	0.08	0.30	59 930	25 064	90 015	423.8	177.2	636.5
Slovakia	0.22	0.09	0.33	8 892	3 742	13 277	219.9	92.5	328.4
Slovenia	0.16	0.06	0.24	2 346	969	3 565	147.2	60.8	223.7
Spain	0.10	0.04	0.16	23 276	9 422	36 064	65.0	26.3	100.7
Sweden	0.02	0.01	0.04	999	396	1 580	13.5	5.4	21.4
Albania	0.24	0.10	0.35	4 932	2 095	7 300	252.3	107.2	373.5
Andorra	0.08	0.03	0.13	27	11	42	49.3	19.7	77.3
Bosnia and Herzegovina	0.33	0.15	0.47	11 813	5 240	16 826	448.9	199.1	639.3
Iceland	0.00	0.00	0.00	< 10	< 1	< 10	< 1.0	< 1.0	1.5
Kosovo	0.24	0.10	0.36	4 441	1 880	6 593	327.7	138.8	486.5
Liechtenstein	0.07	0.03	0.11	10	< 10	16	35.4	14.1	55.6
Monaco	0.11	0.04	0.17	17	< 10	27	64.2	25.9	99.9
Montenegro	0.25	0.11	0.37	1 267	544	1 858	293.3	125.9	430.2
North Macedonia	0.34	0.15	0.48	5 456	2 416	7 780	365.6	161.9	521.3
Norway	0.03	0.01	0.05	574	228	906	15.0	6.0	23.7
San Marino	0.15	0.06	0.24	38	15	58	140.1	57.4	214.5
Serbia	0.31	0.13	0.44	21 767	9 518	31 386	420.3	183.8	606.1
Switzerland	0.08	0.03	0.12	2 200	881	3 444	34.0	13.6	53.3
Türkiye (TR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EU27	-	-	-	452 793	188 558	683 363	136.1	56.7	205.4
All countries (no TR)	-	-	-	505 337	211 398	759 602	141.8	59.3	213.2

([a]) Total and national data are rounded

Table A2.23: Stroke disease burden (YLD) due to $PM_{2.5}$ for adults ≥ 25 years for 41 European countries (individual and total countries) and the EU27 in 2021

	PAF (95 % CI: low, high)			YLD ([a]) (95 % CI: low, high)			YLD/10^5 inhabitants ≥ 25 years (95 % CI: low, high)		
Country	mean	low	high	mean	low	high	mean	low	high
Austria	0.09	0.01	0.17	1 911	209	3 627	28.5	3.1	54.1
Belgium	0.10	0.01	0.20	1 176	129	2 224	14.2	1.6	26.8
Bulgaria	0.17	0.02	0.32	4 661	533	8 462	88.0	10.1	159.8
Croatia	0.16	0.02	0.30	2 508	288	4 539	82.7	9.5	149.7
Cyprus	0.16	0.02	0.29	292	47	689	45.5	7.3	107.3
Czechia	0.15	0.02	0.27	3 086	349	5 671	38.5	4.3	70.8
Denmark	0.06	0.01	0.11	699	75	1 357	16.8	1.8	32.5
Estonia	0.02	0.00	0.03	33	< 10	65	3.4	< 1.0	6.6
Finland	0.01	0.00	0.02	124	13	246	3.1	< 1.0	6.1
France	0.08	0.01	0.15	9 445	1 029	18 032	19.8	2.2	37.9
Germany	0.08	0.01	0.15	21 992	2 391	42 066	34.8	3.8	66.5
Greece	0.18	0.02	0.33	5 030	579	9 069	62.4	7.2	112.6
Hungary	0.16	0.02	0.30	4 879	553	8 939	66.8	7.6	122.4
Ireland	0.04	0.00	0.07	198	21	385	5.9	< 1.0	11.4
Italy	0.15	0.02	0.28	19 048	2 171	34 707	41.6	4.7	75.8
Latvia	0.10	0.01	0.19	273	30	512	19.3	2.1	36.1
Lithuania	0.11	0.01	0.22	1 121	124	2 109	53.5	5.9	100.7
Luxembourg	0.05	0.01	0.09	38	< 10	73	8.2	< 1.0	15.9
Malta	0.12	0.01	0.22	25	< 10	47	6.3	< 1.0	11.9
Netherlands	0.09	0.01	0.16	3 401	370	6 503	26.9	2.9	51.5
Poland	0.22	0.03	0.39	21 710	2 550	38 342	76.9	9.0	135.7
Portugal	0.05	0.00	0.09	1 408	151	2 725	18.0	1.9	34.9
Romania	0.16	0.02	0.29	5 380	611	9 827	38.0	4.3	69.5
Slovakia	0.18	0.02	0.32	3 091	354	5 602	76.4	8.7	138.6
Slovenia	0.13	0.01	0.24	658	74	1 221	41.3	4.6	76.6
Spain	0.08	0.01	0.16	6 136	671	11 673	17.1	1.9	32.6
Sweden	0.02	0.00	0.04	273	29	534	3.7	< 1.0	7.2
Albania	0.19	0.02	0.35	824	95	1 476	42.1	4.9	75.5
Andorra	0.07	0.01	0.13	< 10	< 1	17	16.4	1.8	31.7
Bosnia and Herzegovina	0.27	0.03	0.46	1 776	217	3 024	67.5	8.2	114.9
Iceland	0.00	0.00	0.00	< 10	< 1	< 10	< 1.0	< 1.0	1.0
Kosovo	0.19	0.02	0.35	658	76	1 183	48.5	5.6	87.3
Liechtenstein	0.06	0.01	0.11	< 10	< 1	< 10	16.6	1.8	32.2
Monaco	0.09	0.01	0.16	< 10	< 1	11	21.4	2.3	41.0
Montenegro	0.20	0.02	0.36	191	22	338	44.2	5.2	78.2
North Macedonia	0.28	0.03	0.47	830	101	1 416	55.6	6.8	94.9
Norway	0.02	0.03	0.05	197	21	385	5.2	< 1.0	10.1
San Marino	0.12	0.01	0.23	< 10	< 10	17	33.7	3.7	63.2
Serbia	0.25	0.03	0.44	3 258	390	5 639	62.9	7.5	108.9
Switzerland	0.06	0.01	0.12	1 248	135	2 406	19.3	2.1	37.2
Türkiye (TR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EU27	-	-	-	118 596	13 359	219 248	35.7	4.0	65.9
All countries (no TR)	-	-	-	127 608	14 420	235 172	35.8	4.0	66.0

([a]) Total and national data are rounded

Table A2.24: Stroke disease burden (DALY) due to $PM_{2.5}$ for adults ≥ 25 years for 41 European countries (individual and total countries) and the EU27 in 2021

	DALY ([a]) (95 % CI: low, high)			DALY/10^5 inhabitants ≥ 25 years (95 % CI: low, high)		
Country	mean	low	high	mean	low	high
Austria	5 933	1 840	9 846	88.5	27.4	146.8
Belgium	8 129	2 957	12 948	97.9	35.6	155.9
Bulgaria	37 938	14 519	58 210	716.2	274.1	1098.9
Croatia	9 801	3 361	15 416	323.2	110.8	508.3
Cyprus	948	320	1 677	147.6	49.9	261.2
Czechia	13 556	4 706	21 470	169.2	58.7	267.9
Denmark	2 641	849	4 412	63.3	20.3	105.7
Estonia	233	82	382	23.6	8.3	38.8
Finland	485	154	821	11.9	3.8	20.2
France	37 712	12 440	61 947	79.2	26.1	130.1
Germany	66 905	20 494	111 940	105.8	32.4	177.0
Greece	26 305	9 570	40 711	326.5	118.8	505.3
Hungary	23 321	8 246	36 697	319.3	112.9	502.5
Ireland	925	310	1 532	27.4	9.2	45.4
Italy	97 529	35 075	152 370	213.0	76.6	332.8
Latvia	4 773	1 872	7 411	336.9	132.2	523.1
Lithuania	6 524	2 330	10 409	311.5	111.3	497.0
Luxembourg	156	51	260	33.8	11.0	56.3
Malta	333	129	520	84.4	32.6	131.7
Netherlands	11 487	3 630	19 080	91.0	28.8	151.1
Poland	97 957	35 337	149 971	346.8	125.1	530.9
Portugal	6 819	2 312	11 221	87.2	29.6	143.6
Romania	65 310	25 676	99 843	461.8	181.5	706.0
Slovakia	11 982	4 095	18 879	296.4	101.3	466.9
Slovenia	3 004	1 043	4 786	188.5	65.4	300.3
Spain	29 412	10 093	47 737	82.1	28.2	133.3
Sweden	1 273	425	2 115	17.2	5.8	28.6
Albania	5 755	2 190	8 776	294.5	112.1	449.0
Andorra	36	12	59	65.7	21.5	109.0
Bosnia and Herzegovina	13 589	5 457	19 850	516.4	207.3	754.3
Iceland	< 10	< 10	< 10	1.4	< 1.0	2.5
Kosovo	5 099	1 956	7 775	376.2	144.3	573.7
Liechtenstein	15	< 10	26	52.0	15.9	87.8
Monaco	23	< 10	38	85.7	28.2	141.0
Montenegro	1 457	566	2 196	337.5	131.1	508.4
North Macedonia	6 286	2 517	9 196	421.2	168.6	616.2
Norway	771	249	1 291	20.2	6.5	33.8
San Marino	47	16	75	173.8	61.1	277.7
Serbia	25 025	9 908	37 025	483.2	191.3	714.9
Switzerland	3 448	1 016	5 850	53.3	15.7	90.5
Türkiye (TR)	N/A	N/A	N/A	N/A	N/A	N/A
EU27	571 390	201 917	902 611	171.8	60.7	271.4
All countries (no TR)	632 945	225 818	994 775	177.6	63.4	279.2

([a]) Total and national data are rounded

NO_2 (long-term effects) and asthma (adults ≥ 15 years)

Indicators calculation spreadsheet NO2_Asthma_adults_2021.xlsx is available ....

Table A2.25: Asthma disease burden (AD) due to NO_2 for adults ≥ 15 years for 41 European countries (individual and total countries) and the EU27 in 2021

	PAF (95 % CI: low, high)			AD ([a]) (95 % CI: low, high)			AD/10^5 inhabitants ≥ 15 years (95 % CI: low, high)		
Country	mean	low	high	mean	low	high	mean	low	high
Austria	0.07	0.05	0.10	< 10	< 10	< 10	0.1	0.0	0.1
Belgium	0.09	0.05	0.12	< 10	< 10	11	0.1	0.1	0.1
Bulgaria	0.11	0.07	0.15	< 10	< 10	< 10	0.1	0.0	0.1
Croatia	0.05	0.03	0.07	< 10	< 10	< 10	0.2	0.1	0.2
Cyprus	0.18	0.12	0.24	< 10	< 10	< 10	0.6	0.4	0.8
Czechia	0.05	0.03	0.07	12	< 10	17	0.1	0.1	0.2
Denmark	0.01	0.00	0.01	< 1	< 1	< 1	0.0	0.0	0.0
Estonia	0.01	0.00	0.01	< 1	< 1	< 1	0.0	0.0	0.0
Finland	0.01	0.00	0.01	< 1	< 1	< 1	0.0	0.0	0.0
France	0.06	0.04	0.08	44	28	59	0.1	0.0	0.1
Germany	0.07	0.05	0.10	77	48	106	0.1	0.1	0.1
Greece	0.12	0.08	0.16	< 10	< 10	< 10	0.0	0.0	0.0
Hungary	0.08	0.05	0.11	14	< 10	20	0.2	0.1	0.2
Ireland	0.02	0.01	0.03	< 10	< 1	< 10	0.0	0.0	0.0
Italy	0.11	0.07	0.16	59	37	80	0.1	0.1	0.2
Latvia	0.03	0.02	0.04	< 1	< 1	< 10	0.1	0.0	0.1
Lithuania	0.03	0.02	0.05	< 10	< 1	< 10	0.1	0.0	0.1
Luxembourg	0.07	0.04	0.09	< 1	< 1	< 1	0.1	0.0	0.1
Malta	0.02	0.02	0.03	< 1	< 1	< 1	0.1	0.0	0.1
Netherlands	0.08	0.05	0.11	12	< 10	17	0.1	0.1	0.1
Poland	0.06	0.04	0.09	39	24	54	0.1	0.1	0.2
Portugal	0.04	0.02	0.05	< 10	< 10	< 10	0.1	0.0	0.1
Romania	0.12	0.08	0.17	34	22	47	0.2	0.1	0.3
Slovakia	0.04	0.03	0.06	< 10	< 10	< 10	0.0	0.0	0.1
Slovenia	0.06	0.03	0.08	< 1	< 1	< 10	0.0	0.0	0.1
Spain	0.08	0.05	0.11	64	41	88	0.2	0.1	0.2
Sweden	0.01	0.00	0.01	< 1	< 1	< 10	0.0	0.0	0.0
Albania	0.05	0.03	0.07	< 10	< 10	< 10	0.2	0.1	0.3
Andorra	0.11	0.07	0.15	< 1	< 1	< 1	0.1	0.1	0.2
Bosnia and Herzegovina	0.06	0.04	0.08	< 10	< 10	12	0.3	0.2	0.4
Iceland	0.01	0.01	0.01	< 1	< 1	< 1	0.0	0.0	0.0
Kosovo	0.07	0.04	0.10	< 10	< 10	< 10	0.4	0.2	0.5
Liechtenstein	0.07	0.05	0.10	0	0	0	0.0	0.0	0.0
Monaco	0.12	0.08	0.17	< 1	< 1	< 1	0.2	0.1	0.2
Montenegro	0.04	0.02	0.05	< 1	< 1	< 10	0.1	0.1	0.2
North Macedonia	0.07	0.05	0.10	< 10	< 10	< 10	0.3	0.2	0.4
Norway	0.02	0.01	0.03	< 10	< 1	< 10	0.0	0.0	0.0
San Marino	0.05	0.03	0.08	< 1	< 1	< 1	0.1	0.0	0.1
Serbia	0.09	0.06	0.13	27	17	38	0.5	0.3	0.6
Switzerland	0.07	0.04	0.09	< 10	< 10	< 10	0.0	0.0	0.1
Türkiye	0.21	0.14	0.28	330	217	434	0.5	0.3	0.7
EU27	-	-	-	401	252	549	0.1	0.1	0.1
All countries	-	-	-	788	504	1 062	0.2	0.1	0.2

([a]) Total and national data are rounded

Table A2.26: Asthma disease burden (YLL) due to NO_2 for adults ≥ 15 years for 41 European countries (individual and total countries) and the EU27 in 2021

Country	PAF (95 % CI: low, high) mean	low	high	YLL ([a]) (95 % CI: low, high) mean	low	high	YLL/10[5] inhabitants ≥ 15 years (95 % CI: low, high) mean	low	high
Austria	0.07	0.05	0.10	65	41	89	< 1.0	< 1.0	1.2
Belgium	0.09	0.05	0.12	108	67	149	1.1	0.7	1.5
Bulgaria	0.11	0.07	0.15	27	17	37	< 1.0	< 1.0	< 1.0
Croatia	0.05	0.03	0.07	45	28	63	1.3	< 1.0	1.8
Cyprus	0.18	0.12	0.24	33	21	45	4.4	2.8	5.9
Czechia	0.05	0.03	0.07	131	81	182	1.5	< 1.0	2.0
Denmark	0.01	0.00	0.01	< 10	< 10	< 10	< 1.0	< 1.0	< 1.0
Estonia	0.01	0.00	0.01	< 1	< 1	< 1	< 1.0	< 1.0	< 1.0
Finland	0.01	0.00	0.01	< 10	< 10	< 10	< 1.0	< 1.0	< 1.0
France	0.06	0.04	0.08	568	359	775	1.0	< 1.0	1.4
Germany	0.07	0.05	0.10	964	602	1 329	1.3	< 1.0	1.9
Greece	0.12	0.08	0.16	19	12	26	< 1.0	< 1.0	< 1.0
Hungary	0.08	0.05	0.11	176	110	241	2.1	1.3	2.9
Ireland	0.02	0.01	0.03	11	< 10	15	< 1.0	< 1.0	< 1.0
Italy	0.11	0.07	0.16	610	386	830	1.2	0.7	1.6
Latvia	0.03	0.02	0.04	< 10	< 10	11	< 1.0	< 1.0	< 1.0
Lithuania	0.03	0.02	0.05	11	< 10	15	< 1.0	< 1.0	< 1.0
Luxembourg	0.07	0.04	0.09	< 10	< 10	< 10	1.1	< 1.0	1.6
Malta	0.02	0.02	0.03	< 10	< 10	< 10	< 1.0	< 1.0	< 1.0
Netherlands	0.08	0.05	0.11	128	80	177	< 1.0	< 1.0	1.2
Poland	0.06	0.04	0.09	393	245	542	1.2	< 1.0	1.7
Portugal	0.04	0.02	0.05	57	35	79	< 1.0	< 1.0	< 1.0
Romania	0.12	0.08	0.17	293	186	400	1.8	1.1	2.5
Slovakia	0.04	0.03	0.06	22	14	31	< 1.0	< 1.0	< 1.0
Slovenia	0.06	0.03	0.08	< 10	< 10	< 10	< 1.0	< 1.0	< 1.0
Spain	0.08	0.05	0.11	609	384	832	1.5	< 1.0	2.0
Sweden	0.01	0.00	0.01	< 10	< 10	< 10	< 1.0	< 1.0	< 1.0
Albania	0.05	0.03	0.07	40	25	56	1.7	1.1	2.4
Andorra	0.11	0.07	0.15	< 10	< 10	< 10	1.8	1.1	2.5
Bosnia and Herzegovina	0.06	0.04	0.08	71	44	98	2.4	1.5	3.3
Iceland	0.01	0.01	0.01	< 10	< 1	< 10	< 1.0	< 1.0	< 1.0
Kosovo	0.07	0.04	0.10	46	29	64	3.0	1.9	4.1
Liechtenstein	0.07	0.05	0.10	< 1	< 1	< 1	< 1.0	< 1.0	1.2
Monaco	0.12	0.08	0.17	< 1	< 1	< 1	2.1	1.3	2.8
Montenegro	0.04	0.02	0.05	< 10	< 10	< 10	1.3	< 1.0	1.8
North Macedonia	0.07	0.05	0.10	43	27	60	2.5	1.6	3.5
Norway	0.02	0.01	0.03	14	< 10	20	< 1.0	< 1.0	< 1.0
San Marino	0.05	0.03	0.08	< 1	< 1	< 1	< 1.0	< 1.0	< 1.0
Serbia	0.09	0.06	0.13	225	141	310	3.8	2.4	5.3
Switzerland	0.07	0.04	0.09	29	18	40	< 1.0	< 1.0	< 1.0
Türkiye	0.21	0.14	0.28	3 543	2 323	4 655	5.5	3.6	7.2
EU27	-	-	-	4 309	2 707	5 910	1.1	< 1.0	1.6
All countries	-	-	-	8 330	5 328	11 224	1.8	1.1	2.4

([a]) Total and national data are rounded

Table A2.27: Asthma disease burden (YLD) due to NO_2 for adults ≥ 15 years for 41 European countries (individual and total countries) and the EU27 in 2021

	PAF (95 % CI: low, high)			YLD ([a]) (95 % CI: low, high)			YLD/10^5 inhabitants ≥ 15 years (95 % CI: low, high)		
Country	mean	low	high	mean	low	high	mean	low	high
Austria	0.07	0.05	0.10	901	564	1 240	11.8	7.4	16.2
Belgium	0.09	0.05	0.12	1 808	1 129	2 495	18.8	11.7	25.9
Bulgaria	0.11	0.07	0.15	551	347	755	9.3	5.9	12.8
Croatia	0.05	0.03	0.07	312	194	432	9.0	5.6	12.5
Cyprus	0.18	0.12	0.24	211	77	166	28.0	10.2	22.0
Czechia	0.05	0.03	0.07	828	514	1 148	9.2	5.7	12.8
Denmark	0.01	0.00	0.01	109	67	152	2.2	1.4	3.1
Estonia	0.01	0.00	0.01	< 10	< 10	13	< 1.0	< 1.0	1.2
Finland	0.01	0.00	0.01	97	60	136	2.1	1.3	2.9
France	0.06	0.04	0.08	9 970	6 302	13 589	17.9	11.3	24.4
Germany	0.07	0.05	0.10	16 047	10 029	22 123	22.4	14.0	30.9
Greece	0.12	0.08	0.16	1 353	863	1 827	14.8	9.4	19.9
Hungary	0.08	0.05	0.11	1 299	815	1 783	15.6	9.8	21.4
Ireland	0.02	0.01	0.03	216	134	300	5.4	3.3	7.5
Italy	0.11	0.07	0.16	10 386	6 572	14 136	20.1	12.7	27.4
Latvia	0.03	0.02	0.04	69	43	97	4.4	2.7	6.1
Lithuania	0.03	0.02	0.05	88	54	122	3.7	2.3	5.1
Luxembourg	0.07	0.04	0.09	82	51	114	15.4	9.6	21.4
Malta	0.02	0.02	0.03	25	15	34	5.6	3.5	7.7
Netherlands	0.08	0.05	0.11	2 989	1 860	4 139	20.2	12.6	28.0
Poland	0.06	0.04	0.09	3 143	1 963	4 336	9.8	6.1	13.6
Portugal	0.04	0.02	0.05	794	494	1 101	8.9	5.5	12.3
Romania	0.12	0.08	0.17	1 092	690	1 487	6.8	4.3	9.2
Slovakia	0.04	0.03	0.06	297	184	414	6.5	4.0	9.0
Slovenia	0.06	0.03	0.08	185	115	256	10.3	6.4	14.3
Spain	0.08	0.05	0.11	5 154	3 252	7 038	12.7	8.0	17.3
Sweden	0.01	0.00	0.01	136	84	191	1.6	< 1.0	2.2
Albania	0.05	0.03	0.07	160	100	222	6.8	4.2	9.4
Andorra	0.11	0.07	0.15	20	12	28	31.5	19.6	43.6
Bosnia and Herzegovina	0.06	0.04	0.08	229	142	317	7.6	4.8	10.6
Iceland	0.01	0.01	0.01	12	< 10	16	4.0	2.5	5.5
Kosovo	0.07	0.04	0.10	148	92	206	9.6	6.0	13.3
Liechtenstein	0.07	0.05	0.10	< 10	< 10	< 10	12.0	7.4	16.7
Monaco	0.12	0.08	0.17	11	< 10	16	36.0	22.4	49.7
Montenegro	0.04	0.02	0.05	23	14	32	4.5	2.8	6.3
North Macedonia	0.07	0.05	0.10	162	101	224	9.3	5.8	12.9
Norway	0.02	0.01	0.03	258	160	359	5.8	3.6	8.0
San Marino	0.05	0.03	0.08	< 10	< 10	< 10	9.5	5.9	13.3
Serbia	0.09	0.06	0.13	726	454	1 001	12.3	7.7	17.0
Switzerland	0.07	0.04	0.09	782	487	1 084	10.6	6.6	14.7
Türkiye	0.21	0.14	0.28	46 404	30 423	60 969	71.9	47.1	94.5
EU27	-	-	-	58 151	36 478	79 624	15.3	9.6	21.0
All countries	-	-	-	107 095	68 483	144 107	22.7	14.5	30.5

([a]) Total and national data are rounded

Table A2.28: Asthma disease burden (DALY) due to NO_2 for adults ≥ 15 years for 41 European countries (individual and total countries) and the EU27 in 2021

	DALY ([a]) (95 % CI: low, high)			DALY/10^5 inhabitants ≥ 15 years (95 % CI: low, high)		
Country	mean	low	high	mean	low	high
Austria	965	604	1 329	12.6	7.9	17.4
Belgium	1 916	1 197	2 644	19.9	12.4	27.5
Bulgaria	578	364	792	9.8	6.1	13.4
Croatia	358	223	495	10.3	6.4	14.3
Cyprus	244	98	210	32.4	13.0	27.9
Czechia	959	595	1 330	10.7	6.6	14.8
Denmark	115	71	160	2.3	1.4	3.3
Estonia	10	< 10	14	< 1.0	< 1.0	1.3
Finland	100	62	140	2.1	1.3	3.0
France	10 538	6 661	14 364	18.9	12.0	25.8
Germany	17 011	10 631	23 452	23.7	14.8	32.7
Greece	1 372	875	1 853	15.0	9.5	20.2
Hungary	1 475	926	2 024	17.7	11.1	24.3
Ireland	226	140	315	5.7	3.5	7.9
Italy	10 996	6 958	14 966	21.3	13.5	29.0
Latvia	78	48	109	4.9	3.0	6.8
Lithuania	99	61	137	4.2	2.6	5.8
Luxembourg	88	55	122	16.5	10.3	22.9
Malta	27	17	38	6.1	3.8	8.4
Netherlands	3 117	1 939	4 316	21.1	13.1	29.2
Poland	3 536	2 208	4 878	11.1	6.9	15.3
Portugal	851	529	1 179	9.5	5.9	13.2
Romania	1 385	876	1 887	8.6	5.4	11.7
Slovakia	319	198	445	7.0	4.3	9.7
Slovenia	190	118	264	10.6	6.6	14.7
Spain	5 764	3 636	7 870	14.2	8.9	19.4
Sweden	143	88	200	1.7	1.0	2.3
Albania	201	125	277	8.5	5.3	11.7
Andorra	21	13	29	33.3	20.7	46.1
Bosnia and Herzegovina	300	187	416	10.0	6.2	13.9
Iceland	12	< 10	17	4.1	2.6	5.7
Kosovo	195	121	269	12.6	7.8	17.5
Liechtenstein	< 10	< 10	< 10	12.8	7.9	17.9
Monaco	12	< 10	17	38.0	23.7	52.6
Montenegro	29	18	41	5.8	3.6	8.1
North Macedonia	206	128	284	11.8	7.4	16.4
Norway	272	169	379	6.1	3.8	8.5
San Marino	< 10	< 10	< 10	10.1	6.3	14.1
Serbia	951	595	1 311	16.1	10.1	22.2
Switzerland	811	505	1 123	11.0	6.9	15.3
Türkiye	49 947	32 746	65 624	77.4	50.7	101.7
EU27	62 460	39 185	85 533	16.4	10.3	22.5
All countries	115 425	73 811	155 331	24.5	15.6	32.9

([a]) Total and national data are rounded

NO_2 (long-term effects) and diabetes mellitus (adults ≥ 25 years)

Indicators calculation spreadsheet NO2_DM_2021.xlsx is available ….

Table A2.29: DM disease burden (AD) due to NO_2 for adults ≥ 25 years for 41 European countries (individual and total countries) and the EU27 in 2021

	PAF (95 % CI: low, high)			AD ([a]) (95 % CI: low, high)			AD/10^5 inhabitants ≥ 25 years (95 % CI: low, high)		
Country	mean	low	high	mean	low	high	mean	low	high
Austria	0.10	0.05	0.14	317	166	453	4.7	2.5	6.8
Belgium	0.11	0.06	0.16	172	90	247	2.1	1.1	3.0
Bulgaria	0.15	0.08	0.21	259	137	367	4.9	2.6	6.9
Croatia	0.07	0.04	0.10	330	171	475	10.9	5.7	15.7
Cyprus	0.24	0.13	0.33	116	63	161	18.1	9.8	25.0
Czechia	0.07	0.04	0.10	358	185	518	4.5	2.3	6.5
Denmark	0.01	0.01	0.02	14	< 10	20	< 1.0	< 1.0	< 1.0
Estonia	0.01	0.00	0.01	< 10	< 10	< 10	< 1.0	< 1.0	< 1.0
Finland	0.01	0.00	0.01	< 10	< 10	< 10	< 1.0	< 1.0	< 1.0
France	0.08	0.04	0.11	980	522	1 379	2.1	1.1	2.9
Germany	0.10	0.05	0.14	2 534	1 325	3 628	4.0	2.1	5.7
Greece	0.15	0.08	0.21	373	202	517	4.6	2.5	6.4
Hungary	0.11	0.06	0.16	446	235	634	6.1	3.2	8.7
Ireland	0.03	0.01	0.04	17	< 10	24	< 1.0	< 1.0	< 1.0
Italy	0.15	0.08	0.21	3 903	2 084	5 478	8.5	4.6	12.0
Latvia	0.04	0.02	0.06	30	15	44	2.1	1.1	3.1
Lithuania	0.05	0.02	0.07	33	17	48	1.6	0.8	2.3
Luxembourg	0.09	0.05	0.13	< 10	< 10	< 10	1.4	< 1.0	2.0
Malta	0.03	0.02	0.05	< 10	< 10	11	2.0	1.1	2.9
Netherlands	0.11	0.06	0.16	313	163	452	2.5	1.3	3.6
Poland	0.08	0.04	0.12	904	472	1 296	3.2	1.7	4.6
Portugal	0.05	0.03	0.07	214	111	309	2.7	1.4	3.9
Romania	0.16	0.09	0.23	637	340	896	4.5	2.4	6.3
Slovakia	0.06	0.03	0.08	46	24	67	1.1	< 1.0	1.7
Slovenia	0.07	0.04	0.11	33	17	48	2.1	1.1	3.0
Spain	0.11	0.06	0.15	1 138	604	1 605	3.2	1.7	4.5
Sweden	0.01	0.00	0.01	18	< 10	26	< 1.0	< 1.0	< 1.0
Albania	0.07	0.04	0.10	72	37	104	3.7	1.9	5.3
Andorra	0.14	0.07	0.20	< 10	< 10	< 10	3.7	1.9	5.3
Bosnia and Herzegovina	0.07	0.04	0.11	128	66	184	4.9	2.5	7.0
Iceland	0.01	0.01	0.02	< 1	< 1	< 1	< 1.0	< 1.0	< 1.0
Kosovo	0.09	0.05	0.14	83	43	119	6.1	3.2	8.8
Liechtenstein	0.10	0.05	0.14	< 1	< 1	< 1	< 1.0	< 1.0	< 1.0
Monaco	0.16	0.08	0.23	< 10	< 1	< 10	4.2	2.2	6.0
Montenegro	0.05	0.02	0.07	11	6	16	2.5	1.3	3.7
North Macedonia	0.10	0.05	0.14	70	36	100	4.7	2.4	6.7
Norway	0.03	0.01	0.04	20	10	29	< 1.0	< 1.0	< 1.0
San Marino	0.07	0.04	0.11	< 10	< 1	< 10	4.1	2.1	6.0
Serbia	0.12	0.06	0.17	404	211	577	7.8	4.1	11.1
Switzerland	0.09	0.05	0.13	97	50	139	1.5	0.8	2.2
Türkiye	0.27	0.15	0.36	4 130	2 340	5 500	8.0	4.5	10.6
EU27	-	-	-	13 209	6 979	18 723	4.0	2.1	5.6
All countries	-	-	-	18 227	9 782	25 499	4.5	2.4	6.2

([a]) Total and national data are rounded

Table A2.30: DM disease burden (YLL) due to NO_2 for adults ≥ 25 years for 41 European countries (individual and total countries) and the EU27 in 2021

Country	PAF (95 % CI: low, high) mean	low	high	YLL ([a]) (95 % CI: low, high) mean	low	high	YLL/10^5 inhabitants ≥ 25 years (95 % CI: low, high) mean	low	high
Austria	0.10	0.05	0.14	2 769	1 452	3 953	41.3	21.6	59.0
Belgium	0.11	0.06	0.16	1 757	917	2 518	21.2	11.0	30.3
Bulgaria	0.15	0.08	0.21	2 386	1 262	3 378	45.0	23.8	63.8
Croatia	0.07	0.04	0.10	2 533	1 316	3 648	83.5	43.4	120.3
Cyprus	0.24	0.13	0.33	992	537	1 374	154.5	83.6	214.0
Czechia	0.07	0.04	0.10	3 070	1 587	4 439	38.3	19.8	55.4
Denmark	0.01	0.01	0.02	145	74	211	3.5	1.8	5.1
Estonia	0.01	0.00	0.01	23	12	34	2.3	1.2	3.4
Finland	0.01	0.00	0.01	68	35	100	1.7	< 1.0	2.5
France	0.08	0.04	0.11	9 859	5 253	13 875	20.7	11.0	29.1
Germany	0.10	0.05	0.14	22 356	11 686	32 003	35.3	18.5	50.6
Greece	0.15	0.08	0.21	3 894	2 107	5 402	48.3	26.2	67.0
Hungary	0.11	0.06	0.16	4 402	2 318	6 258	60.3	31.7	85.7
Ireland	0.03	0.01	0.04	170	88	246	5.0	2.6	7.3
Italy	0.15	0.08	0.21	32 862	17 547	46 123	71.8	38.3	100.7
Latvia	0.04	0.02	0.06	288	147	420	20.3	10.4	29.6
Lithuania	0.05	0.02	0.07	350	180	508	16.7	8.6	24.3
Luxembourg	0.09	0.05	0.13	62	32	90	13.5	7.0	19.5
Malta	0.03	0.02	0.05	78	41	112	19.8	10.3	28.4
Netherlands	0.11	0.06	0.16	3 215	1 668	4 633	25.5	13.2	36.7
Poland	0.08	0.04	0.12	8 944	4 669	12 818	31.7	16.5	45.4
Portugal	0.05	0.03	0.07	1 810	938	2 612	23.2	12.0	33.4
Romania	0.16	0.09	0.23	6 139	3 274	8 628	43.4	23.2	61.0
Slovakia	0.06	0.03	0.08	519	266	755	12.8	6.6	18.7
Slovenia	0.07	0.04	0.11	310	160	447	19.4	10.1	28.0
Spain	0.11	0.06	0.15	9 543	5 069	13 460	26.7	14.2	37.6
Sweden	0.01	0.00	0.01	174	89	255	2.4	1.2	3.5
Albania	0.07	0.04	0.10	581	302	836	29.7	15.4	42.8
Andorra	0.14	0.07	0.20	20	10	29	36.9	19.1	53.3
Bosnia and Herzegovina	0.07	0.04	0.11	1 038	538	1 497	39.4	20.4	56.9
Iceland	0.01	0.01	0.02	< 10	< 10	< 10	2.0	1.0	2.9
Kosovo	0.09	0.05	0.14	673	349	969	49.6	25.7	71.5
Liechtenstein	0.10	0.05	0.14	12	< 10	18	41.0	21.0	59.9
Monaco	0.16	0.08	0.23	11	< 10	16	42.1	21.9	60.4
Montenegro	0.05	0.02	0.07	93	48	136	21.5	11.0	31.5
North Macedonia	0.10	0.05	0.14	629	327	906	42.2	21.9	60.7
Norway	0.03	0.01	0.04	201	104	291	5.3	2.7	7.6
San Marino	0.07	0.04	0.11	< 10	< 10	14	34.7	17.9	50.3
Serbia	0.12	0.06	0.17	3 276	1 714	4 684	63.3	33.1	90.4
Switzerland	0.09	0.05	0.13	931	483	1 342	14.4	7.5	20.8
Türkiye	0.27	0.15	0.36	52 280	29 620	69 626	101.2	57.3	134.8
EU27	-	-	-	118 719	62 722	168 301	35.7	18.9	50.6
All countries	-	-	-	178 478	96 236	248 673	43.7	23.6	60.9

([a]) Total and national data are rounded

Table A2.31: DM disease burden (YLD) due to NO_2 for adults ≥ 25 years for 41 European countries (individual and total countries) and the EU27 in 2021

Country	PAF (95 % CI: low, high) mean	low	high	YLD ([a]) (95 % CI: low, high) mean	low	high	YLD/10^5 inhabitants ≥ 25 years (95 % CI: low, high) mean	low	high
Austria	0.03	0.02	0.05	1 242	731	1 881	18.5	10.9	28.1
Belgium	0.04	0.02	0.06	1 742	1 024	2 642	21.0	12.3	31.8
Bulgaria	0.05	0.03	0.08	1 707	1 006	2 576	32.2	19.0	48.6
Croatia	0.02	0.01	0.04	635	372	964	20.9	12.3	31.8
Cyprus	0.08	0.05	0.13	383	152	385	59.6	23.7	60.0
Czechia	0.02	0.01	0.04	1 552	909	2 362	19.4	11.3	29.5
Denmark	0.00	0.00	0.01	72	42	109	1.7	1.0	2.6
Estonia	0.00	0.00	0.00	13	< 10	20	1.3	0.8	2.0
Finland	0.00	0.00	0.00	92	54	141	2.3	1.3	3.5
France	0.03	0.02	0.04	9 171	5 420	13 801	19.3	11.4	29.0
Germany	0.03	0.02	0.05	16 675	9 801	25 273	26.4	15.5	40.0
Greece	0.05	0.03	0.08	3 328	1 976	4 982	41.3	24.5	61.8
Hungary	0.04	0.02	0.06	2 252	1 327	3 404	30.8	18.2	46.6
Ireland	0.01	0.00	0.01	97	57	147	2.9	1.7	4.4
Italy	0.05	0.03	0.08	14 849	8 780	22 333	32.4	19.2	48.8
Latvia	0.01	0.01	0.02	100	58	153	7.1	4.1	10.8
Lithuania	0.02	0.01	0.02	157	92	240	7.5	4.4	11.4
Luxembourg	0.03	0.02	0.05	59	35	90	12.8	7.5	19.5
Malta	0.01	0.01	0.02	30	18	46	7.7	4.5	11.7
Netherlands	0.04	0.02	0.06	2 607	1 529	3 962	20.6	12.1	31.4
Poland	0.03	0.02	0.04	6 098	3 583	9 247	21.6	12.7	32.7
Portugal	0.02	0.01	0.03	1 262	740	1 918	16.1	9.5	24.5
Romania	0.06	0.03	0.08	3 868	2 287	5 820	27.4	16.2	41.2
Slovakia	0.02	0.01	0.03	539	315	822	13.3	7.8	20.3
Slovenia	0.02	0.01	0.04	291	171	443	18.3	10.7	27.8
Spain	0.04	0.02	0.06	9 384	5 540	14 142	26.2	15.5	39.5
Sweden	0.00	0.00	0.00	106	62	162	1.4	0.8	2.2
Albania	0.02	0.01	0.04	300	176	456	15.4	9.0	23.4
Andorra	0.05	0.03	0.07	18	11	27	33.0	19.4	50.3
Bosnia and Herzegovina	0.03	0.01	0.04	482	283	733	18.3	10.7	27.9
Iceland	0.00	0.00	0.01	< 10	< 10	< 10	2.0	1.2	3.1
Kosovo	0.03	0.02	0.05	313	183	476	23.1	13.5	35.1
Liechtenstein	0.03	0.02	0.05	< 10	< 10	< 10	18.6	10.9	28.4
Monaco	0.05	0.03	0.08	10	< 10	16	38.0	22.3	57.6
Montenegro	0.02	0.01	0.02	44	26	68	10.3	6.0	15.7
North Macedonia	0.03	0.02	0.05	308	181	468	20.6	12.1	31.3
Norway	0.01	0.00	0.01	138	81	210	3.6	2.1	5.5
San Marino	0.02	0.01	0.04	< 10	< 10	< 10	14.9	8.7	22.7
Serbia	0.04	0.02	0.06	1 542	906	2 336	29.8	17.5	45.1
Switzerland	0.03	0.02	0.04	1 059	621	1 609	16.4	9.6	24.9
Türkiye	0.10	0.06	0.15	53 554	32 231	78 796	103.7	62.4	152.6
EU27	-	-	-	78 312	46 086	118 067	23.5	13.9	35.5
All countries	-	-	-	136 096	80 799	203 283	33.4	19.8	49.8

([a]) Total and national data are rounded

Table A2.32: DM disease burden (DALY) due to NO_2 for adults ≥ 25 years for 41 European countries (individual and total countries) and the EU27 in 2021

	DALY ([a]) (95 % CI: low, high)			DALY/10^5 inhabitants ≥ 25 years (95 % CI: low, high)		
Country	mean	low	high	mean	low	high
Austria	4 012	2 182	5 834	59.8	32.5	87.0
Belgium	3 499	1 941	5 160	42.1	23.4	62.1
Bulgaria	4 093	2 268	5 955	77.3	42.8	112.4
Croatia	3 167	1 688	4 611	104.4	55.7	152.1
Cyprus	1 375	689	1 760	214.2	107.3	274.0
Czechia	4 622	2 496	6 801	57.7	31.1	84.9
Denmark	216	116	321	5.2	2.8	7.7
Estonia	36	19	54	3.7	1.9	5.5
Finland	160	88	241	3.9	2.2	5.9
France	19 030	10 673	27 677	40.0	22.4	58.1
Germany	39 032	21 487	57 276	61.7	34.0	90.6
Greece	7 223	4 083	10 383	89.7	50.7	128.9
Hungary	6 654	3 645	9 662	91.1	49.9	132.3
Ireland	266	144	393	7.9	4.3	11.7
Italy	47 711	26 326	68 457	104.2	57.5	149.5
Latvia	388	206	573	27.4	14.5	40.4
Lithuania	507	272	748	24.2	13.0	35.7
Luxembourg	121	67	180	26.3	14.5	38.9
Malta	108	59	158	27.5	14.8	40.0
Netherlands	5 822	3 197	8 594	46.1	25.3	68.1
Poland	15 042	8 252	22 065	53.3	29.2	78.1
Portugal	3 072	1 678	4 530	39.3	21.5	58.0
Romania	10 008	5 561	14 448	70.8	39.3	102.2
Slovakia	1 057	581	1 577	26.2	14.4	39.0
Slovenia	601	331	890	37.7	20.8	55.8
Spain	18 928	10 609	27 602	52.9	29.6	77.1
Sweden	281	151	417	3.8	2.0	5.7
Albania	881	478	1 292	45.1	24.5	66.1
Andorra	38	21	57	70.0	38.5	103.6
Bosnia and Herzegovina	1 520	821	2 230	57.8	31.2	84.7
Iceland	10	< 10	15	4.1	2.2	6.0
Kosovo	986	532	1 445	72.7	39.3	106.6
Liechtenstein	17	< 10	26	59.7	31.9	88.3
Monaco	22	12	32	80.1	44.2	118.1
Montenegro	137	73	204	31.8	17.0	47.1
North Macedonia	937	508	1 374	62.8	34.0	92.1
Norway	339	185	501	8.9	4.8	13.1
San Marino	13	< 10	20	49.6	26.6	73.1
Serbia	4 818	2 621	7 020	93.0	50.6	135.5
Switzerland	1 990	1 104	2 951	30.8	17.1	45.6
Türkiye	105 834	61 851	148 422	204.9	119.7	287.3
EU27	197 031	108 808	286 368	59.2	32.7	86.1
All countries	314 574	177 035	451 956	77.1	43.4	110.8

([a]) Total and national data are rounded

NO_2 (long-term effects) and stroke (adults ≥ 25 years)

Indicators calculation spreadsheet NO2_Stroke_2021.xlsx is available ….

Table A2.33: Stroke disease burden (AD) due to NO_2 for adults ≥ 25 years for 41 European countries (individual and total countries) and the EU27 in 2021

	PAF (95 % CI: low, high)			AD ([a]) (95 % CI: low, high)			AD/10^5 inhabitants ≥ 25 years (95 % CI: low, high)		
Country	mean	low	high	mean	low	high	mean	low	high
Austria	0.03	0.01	0.06	146	25	262	2.2	< 1.0	3.9
Belgium	0.04	0.01	0.07	221	38	397	2.7	< 1.0	4.8
Bulgaria	0.05	0.01	0.09	1 147	197	2 048	21.7	3.7	38.7
Croatia	0.02	0.00	0.04	114	19	206	3.8	< 1.0	6.8
Cyprus	0.08	0.01	0.14	29	< 10	52	4.6	< 1.0	8.0
Czechia	0.02	0.00	0.04	163	28	295	2.0	< 1.0	3.7
Denmark	0.00	0.00	0.01	11	< 10	19	< 1.0	< 1.0	< 1.0
Estonia	0.00	0.00	0.00	< 10	< 1	< 10	< 1.0	< 1.0	< 1.0
Finland	0.00	0.00	0.00	< 10	< 10	18	< 1.0	< 1.0	< 1.0
France	0.03	0.00	0.05	843	146	1 498	1.8	< 1.0	3.1
Germany	0.03	0.01	0.06	1 711	292	3 073	2.7	< 1.0	4.9
Greece	0.05	0.01	0.09	706	123	1 244	8.8	1.5	15.4
Hungary	0.04	0.01	0.07	394	68	705	5.4	0.9	9.6
Ireland	0.01	0.00	0.01	13	< 10	24	< 1.0	< 1.0	< 1.0
Italy	0.05	0.01	0.09	2 972	514	5 277	6.5	1.1	11.5
Latvia	0.01	0.00	0.02	70	12	126	4.9	< 1.0	8.9
Lithuania	0.01	0.00	0.03	78	13	141	3.7	< 1.0	6.7
Luxembourg	0.03	0.00	0.05	< 10	< 10	11	1.3	< 1.0	2.4
Malta	0.01	0.00	0.02	< 10	< 1	< 10	< 1.0	< 1.0	1.0
Netherlands	0.04	0.01	0.06	324	55	584	2.6	< 1.0	4.6
Poland	0.03	0.00	0.05	868	148	1 560	3.1	< 1.0	5.5
Portugal	0.02	0.00	0.03	194	33	350	2.5	< 1.0	4.5
Romania	0.05	0.01	0.10	2 262	391	4 019	16.0	2.8	28.4
Slovakia	0.02	0.00	0.03	87	15	157	2.1	< 1.0	3.9
Slovenia	0.02	0.00	0.04	48	< 10	86	3.0	< 1.0	5.4
Spain	0.04	0.01	0.06	888	153	1 581	2.5	< 1.0	4.4
Sweden	0.00	0.00	0.00	13	< 10	23	< 1.0	< 1.0	< 1.0
Albania	0.02	0.00	0.04	64	11	116	3.3	< 1.0	5.9
Andorra	0.05	0.01	0.08	< 10	< 1	< 10	3.0	< 1.0	5.5
Bosnia and Herzegovina	0.02	0.00	0.04	117	20	211	4.4	< 1.0	8.0
Iceland	0.00	0.00	0.01	< 1	< 1	< 1	< 1.0	< 1.0	< 1.0
Kosovo	0.03	0.01	0.06	76	13	137	5.6	< 1.0	10.1
Liechtenstein	0.03	0.01	0.06	< 1	< 1	< 1	< 1.0	< 1.0	1.0
Monaco	0.05	0.01	0.09	< 1	< 1	< 10	3.5	< 1.0	6.3
Montenegro	0.02	0.00	0.03	10	< 10	18	2.2	< 1.0	4.1
North Macedonia	0.03	0.01	0.06	62	11	111	4.1	< 1.0	7.5
Norway	0.01	0.00	0.01	18	< 10	33	< 1.0	< 1.0	< 1.0
San Marino	0.02	0.00	0.04	< 1	< 1	< 10	3.0	< 1.0	5.4
Serbia	0.04	0.01	0.07	375	64	672	7.2	1.2	13.0
Switzerland	0.03	0.00	0.05	96	16	174	1.5	< 1.0	2.7
Türkiye	0.10	0.02	0.17	3 793	679	6 516	7.3	1.3	12.6
EU27	-	-	-	13 321	2 291	23 765	4.0	< 1.0	7.1
All countries	-	-	-	17 937	3 110	31 761	4.4	< 1.0	7.8

([a]) Total and national data are rounded

Table A2.34: Stroke disease burden (YLL) due to NO_2 for adults ≥ 25 years for 41 European countries (individual and total countries) and the EU27 in 2021

Country	PAF (95 % CI: low, high) mean	low	high	YLL ([a]) (95 % CI: low, high) mean	low	high	YLL/10^5 inhabitants ≥ 25 years (95 % CI: low, high) mean	low	high
Austria	0.03	0.01	0.06	1 158	198	2 077	17.3	3.0	31.0
Belgium	0.04	0.01	0.07	2 020	345	3 631	24.3	4.2	43.7
Bulgaria	0.05	0.01	0.09	7 625	1 310	13 612	143.9	24.7	257.0
Croatia	0.02	0.00	0.04	825	140	1 487	27.2	4.6	49.0
Cyprus	0.08	0.01	0.14	274	48	484	42.7	7.4	75.4
Czechia	0.02	0.00	0.04	1 298	220	2 345	16.2	2.7	29.3
Denmark	0.00	0.00	0.01	95	16	173	2.3	< 1.0	4.2
Estonia	0.00	0.00	0.00	22	< 10	41	2.3	< 1.0	4.1
Finland	0.00	0.00	0.00	86	14	157	2.1	< 1.0	3.9
France	0.03	0.00	0.05	7 627	1 317	13 554	16.0	2.8	28.5
Germany	0.03	0.01	0.06	14 464	2 470	25 977	22.9	3.9	41.1
Greece	0.05	0.01	0.09	5 022	875	8 851	62.3	10.9	109.9
Hungary	0.04	0.01	0.07	3 375	579	6 037	46.2	7.9	82.7
Ireland	0.01	0.00	0.01	130	22	234	3.8	< 1.0	6.9
Italy	0.05	0.01	0.09	21 298	3 681	37 816	46.5	8.0	82.6
Latvia	0.01	0.00	0.02	466	79	846	32.9	5.5	59.7
Lithuania	0.01	0.00	0.03	566	96	1 026	27.0	4.6	49.0
Luxembourg	0.03	0.00	0.05	57	< 10	103	12.4	2.1	22.3
Malta	0.01	0.00	0.02	22	< 10	40	5.6	< 1.0	10.1
Netherlands	0.04	0.01	0.06	2 722	463	4 910	21.6	3.7	38.9
Poland	0.03	0.00	0.05	7 830	1 336	14 074	27.7	4.7	49.8
Portugal	0.02	0.00	0.03	1 555	264	2 807	19.9	3.4	35.9
Romania	0.05	0.01	0.10	16 555	2 860	29 411	117.1	20.2	208.0
Slovakia	0.02	0.00	0.03	735	124	1 333	18.2	3.1	33.0
Slovenia	0.02	0.00	0.04	359	61	648	22.5	3.8	40.6
Spain	0.04	0.01	0.06	8 104	1 396	14 431	22.6	3.9	40.3
Sweden	0.00	0.00	0.00	106	18	193	1.4	< 1.0	2.6
Albania	0.02	0.00	0.04	479	82	863	24.5	4.2	44.2
Andorra	0.05	0.01	0.08	15	< 10	27	27.5	4.7	49.6
Bosnia and Herzegovina	0.02	0.00	0.04	881	150	1 590	33.5	5.7	60.4
Iceland	0.00	0.00	0.01	< 10	< 1	< 10	1.6	< 1.0	2.8
Kosovo	0.03	0.01	0.06	572	97	1 032	42.2	7.2	76.1
Liechtenstein	0.03	0.01	0.06	< 10	< 1	< 10	16.1	2.7	29.3
Monaco	0.05	0.01	0.09	< 10	< 10	15	31.6	5.4	56.8
Montenegro	0.02	0.00	0.03	77	13	140	17.9	3.0	32.5
North Macedonia	0.03	0.01	0.06	529	90	953	35.4	6.0	63.9
Norway	0.01	0.00	0.01	156	26	281	4.1	< 1.0	7.4
San Marino	0.02	0.00	0.04	< 10	< 1	10	21.4	3.6	38.7
Serbia	0.04	0.01	0.07	2 819	482	5 060	54.4	9.3	97.7
Switzerland	0.03	0.00	0.05	819	139	1 478	12.7	2.2	22.9
Türkiye	0.10	0.02	0.17	42 414	7 589	72 861	82.1	14.7	141.1
EU27	-	-	-	104 397	17 950	186 297	31.4	5.4	56.0
All countries	-	-	-	153 181	26 624	270 623	37.5	6.5	66.3

([a]) Total and national data are rounded

Table A2.35: Stroke disease burden (YLD) due to NO_2 for adults ≥ 25 years for 41 European countries (individual and total countries) and the EU27 in 2021

Country	PAF (95 % CI: low, high) mean	low	high	YLD ([a]) (95 % CI: low, high) mean	low	high	YLD/10^5 inhabitants ≥ 25 years (95 % CI: low, high) mean	low	high
Austria	0.04	0.02	0.05	798	414	1 153	11.9	6.2	17.2
Belgium	0.04	0.02	0.06	495	257	717	6.0	3.1	8.6
Bulgaria	0.06	0.03	0.08	1 528	796	2 203	28.9	15.0	41.6
Croatia	0.03	0.01	0.04	406	210	589	13.4	6.9	19.4
Cyprus	0.09	0.05	0.14	175	61	166	27.2	9.4	25.9
Czechia	0.03	0.01	0.04	551	285	800	6.9	3.6	10.0
Denmark	0.00	0.00	0.01	50	26	73	1.2	< 1.0	1.8
Estonia	0.00	0.00	0.00	< 10	< 10	< 10	< 1.0	< 1.0	< 1.0
Finland	0.00	0.00	0.00	44	22	64	1.1	< 1.0	1.6
France	0.03	0.02	0.04	3 693	1 931	5 308	7.8	4.1	11.1
Germany	0.04	0.02	0.05	10 291	5 341	14 894	16.3	8.4	23.5
Greece	0.06	0.03	0.09	1 691	889	2 418	21.0	11.0	30.0
Hungary	0.04	0.02	0.06	1 282	667	1 850	17.5	9.1	25.3
Ireland	0.01	0.00	0.01	52	27	75	1.5	< 1.0	2.2
Italy	0.06	0.03	0.09	7 396	3 869	10 623	16.2	8.5	23.2
Latvia	0.02	0.01	0.02	41	21	60	2.9	1.5	4.2
Lithuania	0.02	0.01	0.03	170	88	248	8.1	4.2	11.8
Luxembourg	0.03	0.02	0.05	27	14	39	5.8	3.0	8.4
Malta	0.01	0.01	0.02	< 10	< 10	< 10	< 1.0	< 1.0	< 1.0
Netherlands	0.04	0.02	0.06	1 665	862	2 416	13.2	6.8	19.1
Poland	0.03	0.02	0.05	3 171	1 645	4 591	11.2	5.8	16.3
Portugal	0.02	0.01	0.03	590	305	857	7.6	3.9	11.0
Romania	0.06	0.03	0.09	2 128	1 113	3 058	15.0	7.9	21.6
Slovakia	0.02	0.01	0.03	367	189	534	9.1	4.7	13.2
Slovenia	0.03	0.01	0.04	145	75	211	9.1	4.7	13.2
Spain	0.04	0.02	0.06	3 094	1 616	4 453	8.6	4.5	12.4
Sweden	0.00	0.00	0.00	43	22	62	< 1.0	< 1.0	< 1.0
Albania	0.03	0.01	0.04	114	59	166	5.8	3.0	8.5
Andorra	0.05	0.03	0.08	< 10	< 10	11	13.3	6.9	19.4
Bosnia and Herzegovina	0.03	0.01	0.04	187	97	271	7.1	3.7	10.3
Iceland	0.01	0.00	0.01	< 10	< 10	< 10	1.3	< 1.0	1.9
Kosovo	0.04	0.02	0.05	121	63	176	8.9	4.6	13.0
Liechtenstein	0.04	0.02	0.05	< 10	< 10	< 10	11.1	5.7	16.1
Monaco	0.06	0.03	0.09	< 10	< 10	< 10	15.3	7.9	22.2
Montenegro	0.02	0.01	0.03	17	9	24	3.8	2.0	5.6
North Macedonia	0.04	0.02	0.05	113	59	165	7.6	3.9	11.0
Norway	0.01	0.00	0.01	78	40	114	2.1	1.6	3.0
San Marino	0.03	0.01	0.04	< 10	< 10	< 10	7.5	3.9	10.8
Serbia	0.05	0.02	0.07	596	310	863	11.5	6.0	16.7
Switzerland	0.03	0.02	0.05	677	351	983	10.5	5.4	15.2
Türkiye	0.12	0.06	0.16	9 717	5 204	13 660	18.8	10.1	26.4
EU27	-	-	-	39 900	20 750	57 473	12.0	6.2	17.3
All countries	-	-	-	51 542	26 950	73 923	12.6	6.6	18.1

([a]) Total and national data are rounded

Table A2.36: Stroke disease burden (DALY) due to NO_2 for adults ≥ 25 years for 41 European countries (individual and total countries) and the EU27 in 2021

	DALY ([a]) (95 % CI: low, high)			DALY/10^5 inhabitants ≥ 25 years (95 % CI: low, high)		
Country	mean	low	high	mean	low	high
Austria	1 955	612	3 230	29.2	9.1	48.2
Belgium	2 515	601	4 347	30.3	7.2	52.3
Bulgaria	9 153	2 107	15 815	172.8	39.8	298.6
Croatia	1 231	351	2 076	40.6	11.6	68.5
Cyprus	449	108	650	70.0	16.9	101.2
Czechia	1 849	505	3 145	23.1	6.3	39.2
Denmark	146	42	247	3.5	1.0	5.9
Estonia	28	< 10	49	2.8	< 1.0	5.0
Finland	130	37	221	3.2	< 1.0	5.4
France	11 320	3 248	18 862	23.8	6.8	39.6
Germany	24 755	7 812	40 871	39.1	12.4	64.6
Greece	6 713	1 764	11 269	83.3	21.9	139.9
Hungary	4 656	1 246	7 887	63.8	17.1	108.0
Ireland	181	49	309	5.4	1.4	9.2
Italy	28 694	7 550	48 439	62.7	16.5	105.8
Latvia	507	100	906	35.8	7.0	63.9
Lithuania	736	184	1 273	35.1	8.8	60.8
Luxembourg	84	23	142	18.1	5.1	30.7
Malta	25	< 10	44	6.3	1.3	11.0
Netherlands	4 387	1 325	7 326	34.8	10.5	58.0
Poland	11 001	2 981	18 665	38.9	10.6	66.1
Portugal	2 146	570	3 664	27.5	7.3	46.9
Romania	18 683	3 973	32 469	132.1	28.1	229.6
Slovakia	1 101	313	1 866	27.2	7.7	46.2
Slovenia	504	136	859	31.6	8.5	53.9
Spain	11 199	3 012	18 884	31.3	8.4	52.7
Sweden	149	40	256	2.0	< 1.0	3.5
Albania	593	141	1 029	30.4	7.2	52.6
Andorra	22	< 10	38	40.8	11.6	69.0
Bosnia and Herzegovina	1 068	246	1 861	40.6	9.4	70.7
Iceland	< 10	< 10	12	2.9	< 1.0	4.7
Kosovo	693	160	1 207	51.1	11.8	89.1
Liechtenstein	< 10	< 10	13	27.2	8.4	45.4
Monaco	13	< 10	21	46.9	13.3	79.0
Montenegro	94	22	164	21.7	5.0	38.1
North Macedonia	642	149	1 118	43.1	10.0	74.9
Norway	234	67	395	6.1	1.7	10.4
San Marino	< 10	< 10	13	28.9	7.5	49.6
Serbia	3 415	791	5 923	65.9	15.3	114.4
Switzerland	1 497	490	2 461	23.2	7.6	38.1
Türkiye	52 131	12 793	86 521	100.9	24.8	167.5
EU27	144 297	38 700	243 770	43.4	11.6	73.3
All countries	204 723	53 575	344 547	50.2	13.1	84.4

([a]) Total and national data are rounded

O_3 (short-term effects) and hospital admissions for respiratory diseases (adults ≥ 65 years)

Indicators calculation spreadsheet O3_HospAdmRespDisease_2021.xlsx is available ….

Table A2.37: Hospital admissions for respiratory diseases (attributable cases) due to O_3 for adults ≥ 65 years for 41 European countries (individual and total countries) and the EU27 in 2021

	Attributable cases ([a]) (95 % CI: low, high)			Attributable cases/10^5 inhabitants ≥ 65 years (95 % CI: low, high)		
Country	mean	low	high	mean	low	high
Austria	389	62	734	22.7	3.6	42.7
Belgium	189	30	356	8.5	1.3	16.0
Bulgaria	183	29	345	12.2	1.9	22.9
Croatia	101	16	191	11.7	1.9	22.1
Cyprus	31	< 10	58	20.7	3.3	39.1
Czechia	256	41	482	11.9	1.9	22.4
Denmark	128	20	242	10.9	1.7	20.5
Estonia	15	< 10	28	5.5	< 1.0	10.5
Finland	75	12	141	5.9	< 1.0	11.2
France	1 528	243	2 883	10.9	1.7	20.6
Germany	2 266	360	4 274	12.4	2.0	23.4
Greece	883	140	1 666	36.7	5.8	69.2
Hungary	314	50	592	15.9	2.5	29.9
Ireland	89	14	167	12.0	1.9	22.7
Italy	2 894	460	5 459	20.8	3.3	39.2
Latvia	21	< 10	40	5.4	< 1.0	10.2
Lithuania	47	< 10	88	8.4	1.3	15.8
Luxembourg	< 10	< 10	17	9.6	1.5	18.2
Malta	31	< 10	59	32.1	5.1	60.5
Netherlands	192	31	363	5.6	< 1.0	10.5
Poland	582	93	1 098	8.2	1.3	15.5
Portugal	251	40	474	10.9	1.7	20.5
Romania	503	80	949	13.6	2.2	25.6
Slovakia	128	20	242	13.8	2.2	26.0
Slovenia	90	14	170	20.7	3.3	39.1
Spain	2 084	332	3 932	22.2	3.5	42.0
Sweden	160	25	302	7.7	1.2	14.5
Albania	67	11	127	15.6	2.5	29.5
Andorra	< 10	< 1	< 10	8.2	1.3	15.4
Bosnia and Herzegovina	87	14	163	11.7	1.9	22.0
Iceland	< 10	< 1	< 10	4.4	< 1.0	8.4
Kosovo	43	< 10	80	11.2	1. 8	21.0
Liechtenstein	< 10	< 1	< 10	20.1	3.2	37.9
Monaco	< 10	< 1	< 10	22.7	3.6	42.8
Montenegro	13	< 10	24	12.8	2.0	24.1
North Macedonia	30	< 10	56	9.8	1.6	18.4
Norway	84	13	158	8.7	1.4	16.4
San Marino	< 10	< 1	< 10	51.6	8.2	97.3
Serbia	156	25	294	10.7	1.7	20.1
Switzerland	213	34	401	13.1	2.1	24.6
Türkiye	1 844	293	3 479	23.2	3.7	43.7
EU27	13 440	2 138	25 352	14.4	2.3	27.2
All countries	15 986	2 543	30 156	14.9	2.4	28.1

([a]) Total and national data are rounded

Annex 3 Glossary

Currently used term	Glossary term	Description
Health Risk Assessment	Environmental Burden of Disease Assessment (EBD)	The Environmental Burden of Disease concept is an evolution of the Comparative Risk Assessment (CRA) and allows to estimate the share of the disease burden (deaths, years of life lost due to death, healthy years lost due to disability or disability-adjusted life years) that can be attributed to the exposure towards an environmental risk factor (e.g. the exposure of a population to certain $PM_{2.5}$ concentrations). In general, the Comparative Risk Assessment methodology, as introduced in the Global Burden of Disease Study, allows to be used for all kinds of risk factors such as behavioral, metabolic or occupational risks. Explanation for changing the terminology: A Health Risk Assessment (HRA) describes a complex assessment process of e.g. the effects of chemical hazards on health as for example described in the WHO "Human Health Risk Assessment Toolkit: Chemical Hazards https://www.who.int/publications/i/item/9789240035720. It is generally not wrong to use the term HRA for the assessments presented in the previous EEA Air Quality in Europe reports. Using the term EBD is however more accurate, helps to connect to other assessments and also leads to a more streamlined terminology in this field.
	Population Attributable Fraction (PAF)	The share of the total burden of disease in a population that is attributable to a certain risk factor. This share may be zero if the risk factor was eliminated or at least lower when the exposure is reduced to a less harmful level also called the counterfactual value in the EBD approach.
	Counterfactual exposure	In the estimation of the environmental burden of disease, a counterfactual exposure describes an alternative hypothetical exposure compared to the one currently observed in a population. The hypothetical exposure is mostly associated with a lower risk and often with a "no-risk" defined as a Relative Risk of 1. Synonyms are also counterfactual value or counterfactual concentration. In the EEA assessments the guideline values as presented by the WHO in the 2021 Air Quality Guidelines are used as counterfactual concentrations for $PM_{2.5}$ and NO_2.
Premature death	Attributable Death	An attributable death is defined as a death which is statistically attributable to the exposure towards a risk factor, e.g. $PM_{2.5}$. The attribution is based on the evidence from studies for the causal link between a risk factor and the health outcome leading to death. Explanation for changing the terminology: Previously, the EEA Air Quality Reports have used the term "premature death" for the deaths which are attributable to one of the three air pollutants ($PM_{2.5}$, NO_2, O_3). Methodologically, a

Currently used term	Glossary term	Description
		premature death is defined as a death occurring before a person has reached an expected or normatively set life expectancy. When using the concept of remaining life expectancy, as it is done in the EEA analyses, every death is premature, even if occurring at ages over 95 years.
	Disability-Adjusted Life Year (DALY)	The Disability-Adjusted Life Year is an indicator of the burden of disease and counts losses of healthy life years resulting from a disease or attributable to a certain risk factor. The DALY combines the population-based mortality (YLL) and morbidity (YLD) effects and is a widely used summary measure of population health. It is used to compare the population health impacts of diseases, injuries and risk factors.
	Years lived with Disability (YLD)	The morbidity component of the DALY that measures years of healthy life lost due to living in a state of reduced overall health.
	Years of Life Lost (YLL)	The mortality component of the DALY that measures the years lost due to death before reaching a predefined life expectancy value.
	Remaining Life Expectancy	The statistically remaining number of years to live at an exact age (for instance, the age of death).
	Disability	Disability is understood as any reduction from the state of full health due to a disease or injury.
	Disability Weight	The disability weight is a weighting factor representing the severity of a disease or an injury on a scale from 0 (full health) to 1 (most severe health state equivalent to death).
	Incidence	Incidence represents the number of individuals developing a disease or experiencing a certain health event during a particular time period (e.g. day, week, month)
	Prevalence	Prevalence represents the total number of individuals in a certain population having a disease or health outcome. Prevalence can either be described as a point prevalence or period prevalence. Point prevalence, refers to the number of existing cases at a specific time point (e.g. mid-year prevalence). Period prevalence refers to the number of existing cases over a range of time (e.g. days, weeks, months).
	Incidence-based DALY approach	In the incidence-based DALY approach, the incidence of a disease is used to estimate the YLD-component. Here, the number of incident cases is multiplied by the disability weight and the duration of a health state.
	Prevalence-based DALY approach	In the prevalence-based DALY approach the prevalence of a disease is used to estimate the YLD-component. Compared to the incidence-based DALY approach, the number of prevalent cases is multiplied only by the disability weight, as a duration of one year is assumed for each prevalent case. The use of the prevalence-based approach is currently recommended by the Global Burden of Disease Study protocol and is followed in the ETC/EEA analyses.

Currently used term	Glossary term	Description
	Effect measure such as Hazard Ratio or Relative Risk	Effect measures in the field of epidemiology are used to quantify the strength of the association between exposures and outcomes. For example, Hazard Ratios (HR) or Relative Risk (RR) are used in cohort studies and quantify the risk of an outcome after exposure, comparing an exposed against a non- or lower- exposed group. A value of 1, for both a HR or RR, would mean no additional risk, a value of 1.08 would mean an increase of risk (e.g. risk of death) in the exposed group by 8% as compared to a non- or lower exposed group. For the estimation of the population attributable fraction (PAF), an effect measure, e.g. Relative Risk (RR), is needed. The basis of such an effect estimate are epidemiological studies. Such observational studies record the exposure to a risk factor and the onset of health outcomes after a certain time of follow-up.
	Confounding	Confounding describes a factor (i.e. independent variable) in a study that is associated with both the exposure and the outcome. In an analysis this can lead to skewed results regarding the true relationship between an exposure and the outcome. Generally, when using effect estimates from epidemiological studies it is recommended to use the effect measures that are adjusted for confounding.
	Concentration-Response Function (CRF)	The Concentration-Response Function (CRF) is the mathematical representation of the association between a risk factor (e.g. $PM_{2.5}$ concentration) and a health outcome (e.g. lung cancer). The simplest relationship is a linear regression, but many studies have shown a supralinear relationship between air pollution and the risk for health outcomes. A CRF describes the change of an effect measure (e.g. HR, RR) associated with the change of e.g. the concentration of a certain air pollutant in the air.
	All-cause mortality vs. cause-specific mortality	EBD mortality estimates for air pollutants can be calculated on the basis of all-cause natural mortality and cause-specific mortality. For the all-cause mortality approach, the effect measures from epidemiological studies are combined with data on the overall non-accidental natural mortality in a population. For the cause-specific approach, only effect estimates for single diseases, showing a clear causal relationship with the risk factor, are combined with the relevant health data. Both approaches have their strengths and limitations. The all-cause mortality approach includes diseases that are probably not causally related to air pollutants, which might result in an overestimation of the disease burden. On the other hand, in the cause-specific approach risk-outcome-pairs can be missed out, probably leading to an underestimation of the disease burden.

Annex 4 Country ISO2 code

Country Name	Country ISO2 code
Austria	AT
Albania	AL
Andorra	AD
Belgium	BE
Bosnia and Herzegovina	BA
Bulgaria	BG
Croatia	HR
Cyprus	CY
Czechia	CZ
Denmark	DK
Estonia	EE
Finland	FI
France	FR
Germany	DE
Greece	GR
Hungary	HU
Iceland	IS
Ireland	IE
Italy	IT
Kosovo	XK
Latvia	LV
Liechtenstein	LI
Lithuania	LT
Luxembourg	LU
Malta	MT
Monaco	MC
Montenegro	ME
Netherlands	NL
North Macedonia	MK
Norway	NO
Poland	PL
Portugal	PT
Romania	RO
San Marino	SM
Serbia	RS
Slovakia	SK
Slovenia	SI
Spain	ES
Sweden	SE
Switzerland	CH
Türkiye	TR

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