Outdoor Air Pollution and the Burden of Childhood Asthma across Europe

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Supplementary Material - Datasets and Methods

Census data

The total population count at the 1 km x 1 km grid cell unit was extracted from the GEOSTAT 2011 population grid (V2.0.1) database (Eurostat EFGS, 2011). This database was a joint initiative between Eurostat and European Forum for Geography and Statistics (EFGS), which contains national population grid information for European countries. The GEOSTAT database did not specifically include childhood population counts. To calculate the childhood population count in each grid, which was our population of interest, the percentage of people aged 1 to 14 years old was extracted from the NUTS 3 dataset (Nomenclature of Territorial Units for Statistics, Eurostat, European Commission, version 2010) at the regional scale, which are the smallest available regions for statistical purposes. The NUTS classification is a hierarchical system for dividing the economic territory of the European Union for different purposes. NUTS 3 level contains 1,566 regions within European countries and represents the regional unit for socio-economic statistics. We multiplied the percentage of people aged 1 to 14 from each region by the total population count, as extracted from the GEOSTAT population grid database, to calculate the childhood population count at the 1 km x 1 km grid cell scale. Unfortunately, at the 1 km x 1 km scale of our analysis, we had no source of data on childhood population count from age 0 to 18 years old. The older childhood group (>14 to 18 years old) was mixed with adults (15-29), and as such we performed our analysis exclusively for the age group 1 to 14 years old. We also stratified our analysis by age and present results for young children under 5 years old and children aged 5-14 years old.

Exposure assessment model and data

Childhood exposures to NO_2, $PM_{2.5}$ and BC were assessed at the 1 km x 1 km scale using a validated LUR model, which is described next. LUR modeling is an increasingly popular empirical air pollution modeling technique which uses predictor variables such as land-use, geographic, road and traffic characteristics to explain spatial variations of measured air pollution concentrations at multiple sites across the study area [25].

The set of LUR models we use comes from work reported in de Hoogh, Chen [24], where the authors modeled NO_2, $PM_{2.5}$ and BC annual mean 2010 exposures at the 100 m x 100 m grid cell scale. The LUR models were developed on the full monitoring data set (100%) and a robust validation was performed by developing five hold-out-validation models (on 80% of sites) and comparing the measured concentrations against the predictions at the five (20% each) hold-out samples. Another difference with the original founding LUR models reported in previous work by de Hoogh, Gulliver [45] was the additional step in the $PM_{2.5}$ model's development to explain the residual spatial variation at urban and rural background sites only, using ordinary kriging.

For NO_2, the final model adopted included the following predictor variables: chemical transport model estimates, all roads (50, 300 and 2000m), major roads (100m), natural area (400m), ports (700m) and residential area (300m). The adjusted R^2 of this model equaled 0.59 whilst the hold-out-validation R^2 equaled 0.58. *For $PM_{2.5}$*, the final model adopted included the following predictor variables: satellite and chemical transport model estimates, all roads (100m), natural area (50m), ports (800m), residential area (200m) and altitude and additional ordinary kriging was applied to the residuals. The adjusted R^2 of this model equaled 0.72 (0.62 before kriging) whilst the hold-out-validation R^2 equaled 0.66 (0.59 before kriging). *For BC*, the final model adopted included the following predictor variables: satellite and chemical transport model estimates, length of major roads within 100m, all roads (50 and 700m), residential area (3000m), urban green (1000m) and latitude.

The adjusted R^2 of this model equaled 0.54 whilst the hold-out-validation R^2 equaled 0.51. Full detail on these models' development and performance/validation can be found in de Hoogh, Chen [24]. All three models were used to estimate NO_2, $PM_{2.5}$ exposures (in µg/m^3), and BC (in 10^{-5} m^{-1}), at the 100 m x 100 m grid cell scale, across the 18 countries in our study area (section 2.1).

Matching of census and exposure data

To match the childhood population data with the exposure estimates, the NO_2, $PM_{2.5}$ and BC exposure estimates from the LUR model (section 2.3) were averaged up from the 100 m x 100 m grid cell to the 1 km x 1 km grid cell, as this was the finest scale at which census population data was available. Therefore, for each 1 km x 1 km grid cell across our study area, an average exposure estimate was calculated, based on all the 100 m x 100 m grid cells contained within each 1 km x 1 km grid cell. This average exposure estimate was then assigned to all children who lived within that 1 km x 1 km grid cell. There were 1,540,386 1 km x 1 km grid cells across the 18 included countries which had complete data, and which we included in our analysis. The exposure and population characteristics in these 1 km x 1 km grid cells are shown in Table S1, below.

Table S1 Population and exposure characteristics at the 1 km x 1 km grid cells across the 18 selected countries

Population characteristics		
Number of total 1 km x 1 km grid cells across the 18 selected countries (with complete population and air pollution data)	1,540,386	
Total number of children in all included 1 km x 1 km grid cells (1 – 14y.o.)	63,4 M	
Average number of children in all included 1 km x 1 km grid cells (1 – 14 y.o.)	43	
Minimum number of children in any included 1 km x 1 km grid cell (1 – 14 y.o.)	1	
Maximum number of children in any included 1 km x 1 km grid cell (1 – 14 y.o.)	8,141	
Exposure characteristics		
NO_2 (µg/m^3)	Mean (sd)	11.8 (6.7)
	Minimum	1.4
	25th percentile	7.0
	Median	10.6
	75th percentile	15.4
	Maximum	70.0
$PM_{2.5}$ (µg/m^3)	Mean (sd)	11.6 (4.6)
	Minimum	2.0
	25th percentile	8.2
	Median	12.1
	75th percentile	14.5
	Maximum	41.1
BC (10^{-5} m^{-1})	Mean (sd)	1.0 (0.5)
	Minimum	0.003
	25th percentile	0.7
	Median	1.2
	75th percentile	1.4
	Maximum	3.7

Abbreviations: NO_2: Nitrogen Dioxide; $PM_{2.5}$: Particulate Matter equal or less than 2.5 micrometers in diameter; BC: $PM_{2.5}$ absorbance/ black carbon; km: kilometers; y.o.: years old; sd: standard deviation

Baseline childhood asthma incidence rates

Incidence rates were extracted at the country level for the year 2016, which, at the time of this analysis, was the latest and theoretically the best available assessment as more input data became available in recent years. The GBD data uses public and official health data records reported from health surveys and clinical records. Between year 2010 (the year of the air pollution exposure assessment) and year 2016 (the year of the asthma incidence rates assessment), the average childhood asthma incidence rate across the 18 included countries decreased by 2% (Global Burden of Disease Collaborative Network, 2016). Additional information can be found at GHDx (http://ghdx.healthdata.org/gbd-results-tool).

Incidence rates in the age group 1-4 and 5-14 years old, were directly provided by the GBD, and no further analysis was required to establish the baseline asthma incidence rates used in the age-stratified analyses. For the wider age group 1-14 years old, the GBD did not directly provide the incidence rate for this specific group. Instead, we estimated the number of cases in the 1-4 and 5-14 years old age groups and summed these cases to represent the burden in the age group 1-14 years old.

Table S2 Baseline childhood asthma incidence rates by country, source: (Global Burden of Disease Collaborative Network, 2016)

Country	**Childhood asthma incidence rate 1-4 years old Year 2016 (cases per 100,000 person-years)**
Austria	1592
Belgium	1488
Denmark	2017
Finland	1776
France	1730
Germany	1244
Greece	1554
Hungary	1570
Ireland	2293
Italy	1128
Lithuania	1681
Netherlands	1459
Norway	2780
Portugal	2487
Spain	1382
Sweden	2160
Switzerland	1766
United Kingdom	2820
Country	**Childhood asthma incidence rate 5-14 years old Year 2016 (cases per 100,000 person-years)**
Austria	514
Belgium	479
Denmark	676
Finland	569
France	583
Germany	470
Greece	514
Hungary	598
Ireland	677

Italy	513
Lithuania	722
Netherlands	464
Norway	821
Portugal	744
Spain	447
Sweden	809
Switzerland	561
United Kingdom	823

Estimation of the impact of exposure reduction scenarios

We assessed the impacts of two plausible scenarios on the burden of incident childhood asthma:

1. Where in exceedance, the reduction of air pollution levels to comply with the World Health Organization (WHO) air quality guideline values [28]. This scenario was applicable to two of the three studied pollutants, as BC has no air quality guideline value:
    a. **NO_2 reduced to 40 µg/m^3** (annual average), where in exceedance;
    b. **$PM_{2.5}$ reduced to 10 µg/m^3** (annual average), where in exceedance.
2. Where in exceedance, the reduction of air pollution levels to meet the minimum air pollution levels recorded across any of the 41 studies synthesized in the underlying systematic review from which we sourced our exposure-response functions [6]:
    a. **NO_2 reduced to 1.5 µg/m^3** (annual average) as recorded in Oftedal, Nystad [46], where in exceedance;
    b. **$PM_{2.5}$ reduced to 0.4 µg/m^3** (annual average) as recorded in Fuertes, Standl [47], where in exceedance.
    c. **BC reduced to 0.4 x 10^{-5}m^{-1}** (annual average) as recorded in Gehring, Wijga [48], where in exceedance;

Estimation of population attributable fraction and attributable number of cases

Using the exposure-response functions shown in section 2.5.2, the risk estimates for asthma development in association with the three investigated pollutants were scaled to the difference in exposure level between the two counterfactual scenarios (section 2.5.3) and the reference scenario (current exposure as estimated from the LUR model). Each analysis was undertaken for each pollutant separately and at the 1 km x 1 km grid cell. To scale the risk estimate from the exposure-response functions' concentration unit to the exposure difference between the reference and the two counterfactual scenarios, standard methods were used [30], where:

$$RR_{exposure\_difference} = e^{\left(\left(\frac{\ln RR}{E_{RR\_unit}}\right)\times E_{exposure\_difference}\right)}$$

Where *RR* is the relative risk obtained from the exposure-response function for each pollutant (section 2.5.2.);

E_{RR_unit} is the exposure unit that corresponds to the RR obtained from the exposure-response function for each pollutant (section 2.5.2.);

$E_{exposure\_difference}$ is the difference in the exposure level between the counterfactual scenario (section 2.5.3.) and the reference scenario (current exposure);

$RR_{exposure\_difference}$ is the scaled relative risk that corresponds to the difference in exposure level between the counterfactual (section 2.5.3.) and reference (current exposure) scenarios.

Next, the population attributable fraction (PAF) was calculated, also for each 1 km x 1 km grid cell, pollutant and scenario. The PAF is an epidemiological measure that is widely used in BoD and health impact assessments to identify the fraction of all cases of a particular health outcome in a population that is attributable to a specific exposure [49]. As such, it defines the proportional reduction in morbidity that would occur if the specific exposure, to outdoor air pollution in this case, was reduced to the counterfactual exposure scenario(s):

$$PAF = \frac{\sum_{i=1}^{n} P\,(RR_{exposure\_difference} - 1)}{\sum_{i=1}^{n} P\left(RR_{exposure\ difference} - 1\right) + 1}$$

Where P is the proportion of the exposed population (100% assumed);

$RR_{exposure\_difference}$ is the previously scaled RR that corresponds to the difference in the exposure level between the counterfactual scenario (section 2.5.3.) and the reference scenario (current exposure);

n is the number of exposure levels (1 in this case).

Finally, the number of incident childhood asthma cases attributable to the excess exposure compared to the counterfactual exposure scenarios was calculated as follows, separately for each cell, pollutant and scenario:

$$Attributable\ number\ of\ asthma\ cases = PAF * expected\ asthma\ cases\ due\ to\ all\ causes$$

Where:

$$Expected\ asthma\ cases\ due\ to\ all\ causes = childhood\ population * baseline\ childhood\ asthma\ incidence\ rate$$

The confidence intervals around the central values were estimated using the confidence intervals around the exposure-response functions, as provided by the underlying meta-analysis (Khreis et al. 2017). Confidence intervals were estimated for each cell, pollutant and scenario, and then added to estimate the total country values, as done for the central estimate.

Supplementary Material – Results

Table S3: summary statistics for exposures in each of the 18 included countries

	NO_2 (µg/m^3)					$PM_{2.5}$ (µg/m^3)					BC ($10^{-5\ m-1}$)				
Country	Mean	sd	min	max	median	mean	sd	min	max	median	mean	sd	min	max	median
Austria	13.86	4.98	2.34	44	13.62	14.72	3.86	2.05	41.1	15.14	1.42	0.2	0.75	2.84	1.42
Belgium	21.5	5.72	7.6	56.36	21.47	16.42	2.32	8.52	22.29	17.05	1.48	0.23	0.98	2.97	1.46
Denmark	10.33	3.35	3.68	42.76	9.69	10.61	1.25	5.87	19.13	10.57	0.67	0.16	0.15	2.3	0.66
Finland	4.6	3.02	1.4	36.66	3.86	4.53	1.53	2.05	31.74	4.37	0.1	0.14	0	1.67	0.05
France	11.34	4.58	1.4	58.42	10.51	13.17	2.26	2.05	28.01	13.32	1.21	0.18	0.81	3.39	1.18
Germany	16.53	5.01	3.7	50.99	15.65	14.33	2.15	2.76	23.46	14.28	1.24	0.22	0.65	2.74	1.23
Greece	8.6	5.39	1.4	60.89	7.6	14.14	3.03	3.13	23.26	14.27	1.64	0.19	1.28	3.48	1.62
Hungary	11.52	3.74	3.57	39.39	10.69	18.4	1.37	11.58	23.75	18.42	1.47	0.13	1.19	2.66	1.44
Ireland	6.48	2.64	1.4	37.71	6.37	7.12	1.11	2.38	13.16	7.32	0.43	0.11	0.14	1.92	0.43
Italy	14.49	7.23	1.4	63.96	12.74	15.34	5.24	2.05	31.15	14.01	1.56	0.24	0.82	3.33	1.51
Lithuania	7.17	2.11	2.1	28.29	6.97	11.9	1.59	6.98	17.29	11.91	0.73	0.12	0.48	1.89	0.73
Netherlands	21.19	6.06	7.27	51.99	20.84	15.37	1.6	8.22	22.35	15.53	1.24	0.23	0.67	2.75	1.22
Norway	5.37	3.84	1.4	39.2	4.3	4.6	2.06	2.05	12.98	4.19	0.14	0.17	0	1.81	0.08
Portugal	9.98	4.98	1.61	45.47	8.68	8.36	1.98	2.05	15.75	8.38	1.41	0.18	1.06	3.11	1.38
Spain	11.45	6.5	1.4	69.98	9.81	9.28	2.78	2.05	19.8	9.24	1.45	0.26	0.99	3.74	1.4
Sweden	5.14	3.58	1.4	41.18	4.24	5.37	2.2	2.05	21.06	5.24	0.29	0.22	0	1.86	0.29
Switzerland	13.47	5.57	1.78	47.29	13.22	12.55	3.05	2.05	25.34	13.02	1.33	0.22	0.83	2.7	1.32
United Kingdom	15.37	7.04	1.4	55.45	14.74	9.99	2.34	2.05	18.32	10.47	0.8	0.32	0	2.46	0.81

Abbreviations: NO_2: Nitrogen Dioxide; $PM_{2.5}$: Particulate Matter equal or less than 2.5 micrometers in diameter; BC: $PM_{2.5}$ absorbance/ black carbon

Table S4: burden of disease results with WHO air quality guidelines scenario – young children between 1 and 4 years old

Country	Children population assessed (#)	NO_2 – WHO guideline value*				$PM_{2.5}$ – WHO guideline value**			
		Percentage of total cases attributable to the exposure scenario (%)	Attributable expected cases	LCI	UCI	Percentage of total cases attributable to the exposure scenario (%)	Attributable expected cases	LCI	UCI
Austria	332,715	0.09	5	2	6	19.66	1,041	383	1,584
Belgium	510,857	0.72	55	23	75	21.31	1,620	591	2,476
Denmark	236,198	0.01	0.24	0.10	0.33	5.81	277	96	444
Finland	234,472	0.00	0.00	0.00	0.00	0.19	8	3	13
France	3,106,577	0.62	336	140	457	16.67	8,959	3,249	13,789
Germany	2,870,930	0.10	35	15	48	16.11	5,750	2,066	8,920
Greece	369,993	0.81	46	19	63	18.32	1,053	382	1,619
Hungary	358,812	0.00	0.00	0.00	0.00	24.61	1,387	512	2,097
Ireland	275,872	0.00	0.00	0.00	0.00	0.46	29	10	47
Italy	2,084,242	0.56	131	55	178	20.84	4,898	1,834	7,333
Lithuania	117,734	0.00	0.00	0.00	0.00	10.79	214	75	337
Netherlands	704,472	0.42	43	18	59	18.01	1,851	667	2,863
Norway	245,074	0.00	0.00	0.00	0.00	0.83	56	19	92
Portugal	340,041	0.08	6	3	9	4.39	371	129	597
Spain	1,764,634	1.60	391	166	527	7.85	1,915	673	3,035
Sweden	472,059	0.00	0.05	0.02	0.06	1.10	112	39	180
Switzerland	345,719	0.02	1.3	0.5	1.8	14.17	865	309	1,349
United Kingdom	3,158,411	0.27	238	99	325	6.81	6,066	2,112	9,693
Total	17,528,813	0.42	1,288	540	1,750	11.77	36,471	13,147	56,465

* NO_2 reduced to 40 µg/m^3 (annual average), where in exceedance

** $PM_{2.5}$ reduced to 10 µg/m^3 (annual average), where in exceedance

Abbreviations: NO_2: Nitrogen Dioxide; $PM_{2.5}$: Particulate Matter equal or less than 2.5 micrometers in diameter; WHO: World Health Organization; LCI: Lower Confidence Interval; UCI: Upper Confidence Interval

Table S5: burden of disease results with WHO air quality guidelines scenario – children between 5 and 14 years old

Country	Children population assessed (#)	NO_2 – WHO guideline value*				$PM_{2.5}$ – WHO guideline value**			
		Percentage of total cases attributable to the exposure scenario (%)	Attributable expected cases	LCI	UCI	Percentage of total cases attributable to the exposure scenario (%)	Attributable expected cases	LCI	UCI
Austria	833,019	0.11	5	2	6	24.32	1,041	383	1,584
Belgium	1,277,143	0.72	44	18	60	21.31	1,304	476	1,993
Denmark	663,511	0.01	0.23	0.09	0.31	5.81	261	90	418
Finland	606,154	0.00	0.00	0.00	0.00	0.19	6	2	10
France	8,127,540	0.62	296	124	403	16.67	7,902	2,865	12,162
Germany	7,588,220	0.10	35	15	48	5.79	2,065	8,916	8,920
Greece	1,043,113	0.81	43	18	59	18.32	983	357	1,511
Hungary	960,739	0.00	0.00	0.00	0.00	24.61	1,414	522	2,138
Ireland	690,175	0.00	0.00	0.00	0.00	0.46	21	7	35
Italy	5,706,853	0.56	163	69	222	20.84	6,103	2,285	9,137
Lithuania	273,196	0.00	0.00	0.00	0.00	10.79	213	75	336
Netherlands	1,920,765	0.42	37	15	51	18.01	1,605	578	2,484
Norway	628,416	0.00	0.00	0.00	0.00	0.83	43	15	69
Portugal	1,048,336	0.08	6	2	8	4.39	342	119	550
Spain	4,815,022	1.60	345	146	465	7.85	1,688	593	2,676
Sweden	1,156,855	0.00	0.04	0.02	0.06	1.10	103	36	165
Switzerland	827,086	0.02	0.98	0.40	1.35	14.17	657	235	1,025
United Kingdom	7,747,461	0.27	170	71	233	6.81	4,343	1,512	6,940
Total	45,913,606	0.43	1,146	480	1,557	11.16	30,095	19,065	52,152

* NO_2 reduced to 40 µg/m^3 (annual average), where in exceedance

** $PM_{2.5}$ reduced to 10 µg/m^3 (annual average), where in exceedance

Abbreviations: NO_2: Nitrogen Dioxide; $PM_{2.5}$: Particulate Matter equal or less than 2.5 micrometers in diameter; WHO: World Health Organization; LCI: Lower Confidence Interval; UCI: Upper Confidence Interval

Table S6: burden of disease results with minimum air pollution levels scenario – young children between 1 and 4 years old

Country	Children population assessed (#)	NO_2*				$PM_{2.5}$**				BC***			
		Percentage of total cases attributable to the exposure scenario (%)	Attributable expected cases	LCI	UCI	Percentage of total cases attributable to the exposure scenario (%)	Attributable expected cases	LCI	UCI	Percentage of total cases attributable to the exposure scenario (%)	Attributable expected cases	LCI	UCI
Austria	332,715	23	1,194	528	1,569	39	2,076	824	2,949	19	1,008	415	1,590
Belgium	510,857	29	2,178	981	2,830	41	3,098	1,230	4,392	19	1,466	603	2,315
Denmark	236,198	19	908	397	1,202	29	1,380	519	2,052	9	420	167	685
Finland	234,472	14	589	253	787	18	753	272	1,162	3	119	47	197
France	3,106,577	23	12,157	5,408	15,922	37	19,999	7,839	28,697	18	9,522	3,911	15,059
Germany	2,870,930	24	8,451	3,738	11,102	37	13,147	5,129	18,932	16	5,617	2,281	8,990
Greece	369,993	22	1,246	560	1,623	38	2,208	869	3,156	23	1,321	552	2,050
Hungary	358,812	18	1,001	434	1,331	43	2,436	979	3,420	18	1,000	408	1,590
Ireland	275,872	14	863	371	1,154	22	1,365	498	2,086	5	321	127	527
Italy	2,084,242	24	5,574	2,484	7,291	40	9,479	3,802	13,358	20	4,817	1,990	7,567
Lithuania	117,734	14	276	118	370	33	649	249	950	9	183	73	300
Netherlands	704,472	29	3,028	1,366	3,929	38	3,932	1,542	5,636	16	1,676	682	2,677
Norway	245,074	15	990	428	1,319	19	1,322	481	2,025	3	212	84	350
Portugal	340,041	21	1,749	770	2,305	27	2,282	853	3,415	19	1,619	666	2,557
Spain	1,764,634	25	6,035	2,719	7,846	30	7,317	2,774	10,808	21	5,166	2,142	8,083
Sweden	472,059	16	1,582	685	2,107	20	2,038	743	3,119	5	465	184	768
Switzerland	345,719	22	1,316	579	1,736	35	2,150	833	3,114	17	1,054	430	1,677
United Kingdom	3,158,411	26	23,361	10,447	30,486	29	26,163	9,871	38,803	13	11,153	4,499	17,981
Total	17,528,813	23	72,497	32,265	94,910	33	101,792	39,307	148,074	15	47,139	19,262	74,962

* NO_2 reduced to 1.5 µg/m^3 (annual average) as recorded in Oftedal et al, (2009), where in exceedance

** $PM_{2.5}$ reduced to 0.4 µg/m^3 (annual average) as recorded in Fuertes et al, (2013), where in exceedance

*** BC reduced to 0.4 x $10^{-5}m^{-1}$ (annual average) as recorded in Gehring et al, (2015), where in exceedance

Abbreviations: NO_2: Nitrogen Dioxide; $PM_{2.5}$: Particulate Matter equal or less than 2.5 micrometers in diameter; BC: $PM_{2.5}$ absorbance/ black carbon**;** WHO: World Health Organization; LCI: Lower Confidence Interval; UCI: Upper Confidence Interval

Table S7: burden of disease results with minimum air pollution levels scenario – children between 5 and 14 years old

Country	Children population assessed (#)	NO_2*				$PM_{2.5}$**				BC***			
		Percentage of total cases attributable to the exposure scenario (%)	Attributable expected cases	LCI	UCI	Percentage of total cases attributable to the exposure scenario (%)	Attributable expected cases	LCI	UCI	Percentage of total cases attributable to the exposure scenario (%)	Attributable expected cases	LCI	UCI
Austria	833,019	23	965	427	1,268	39	1,679	666	2,384	19	815	336	1,286
Belgium	1,277,143	29	1,753	789	2,278	41	2,493	990	3,535	19	1,180	485	1,863
Denmark	663,511	19	855	374	1,132	29	1,300	489	1,933	9	395	158	646
Finland	606,154	14	488	210	653	18	624	225	964	3	99	39	163
France	8,127,540	23	10,723	4,770	14,044	37	17,639	6,914	25,311	18	8,399	3,450	13,282
Germany	7,588,220	24	8,447	3,736	11,097	37	13,140	5,127	18,922	16	5,614	2,280	8,985
Greece	1,043,113	22	1,163	522	1,515	38	2,060	811	2,945	23	1,232	515	1,913
Hungary	960,739	18	1,020	442	1,357	43	2,484	998	3,487	18	1,019	416	1,622
Ireland	690,175	14	637	274	852	22	1,008	368	1,541	5	237	94	389
Italy	5,706,853	24	6,945	3,095	9,085	40	11,811	4,737	16,645	20	6,002	2,480	9,429
Lithuania	273,196	14	275	117	369	33	647	248	947	9	183	73	299
Netherlands	1,920,765	29	2,627	1,185	3,408	38	3,411	1,338	4,889	16	1,454	591	2,322
Norway	628,416	15	750	324	1,000	19	1,001	365	1,534	3	161	64	265
Portugal	1,048,336	21	1,613	710	2,125	27	2,105	787	3,149	19	1,493	614	2,358
Spain	4,815,022	25	5,321	2,398	6,919	30	6,452	2,446	9,531	21	4,555	1,889	7,128
Sweden	1,156,855	16	1,453	629	1,934	20	1,871	682	2,863	5	427	169	705
Switzerland	827,086	22	1,000	440	1,319	35	1,633	633	2,366	17	801	327	1,274
United Kingdom	7,747,461	26	16,727	7,480	21,828	29	18,732	7,068	27,783	13	7,986	3,221	12,874
Total	45,913,606	23	62,761	27,923	82,183	33	90,091	34,891	130,728	16	42,052	17,200	66,802

* NO_2 reduced to 1.5 µg/m^3 (annual average) as recorded in Oftedal et al, (2009), where in exceedance

** $PM_{2.5}$ reduced to 0.4 µg/m^3 (annual average) as recorded in Fuertes et al, (2013), where in exceedance

*** BC reduced to 0.4 x 10^{-5}m^{-1} (annual average) as recorded in Gehring et al, (2015), where in exceedance

Abbreviations: NO_2: Nitrogen Dioxide; $PM_{2.5}$: Particulate Matter equal or less than 2.5 micrometers in diameter; BC: $PM_{2.5}$ absorbance/ black carbon**;** WHO: World Health Organization; LCI: Lower Confidence Interval; UCI: Upper Confidence Interval

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