

Moradi, Mahsa et al.

Article — Published Version

Particulate Matter Pollution Remains a Threat for Cardiovascular Health: Findings From the Global Burden of Disease 2019

Journal of the American Heart Association

Provided in Cooperation with:

Kiel Institute for the World Economy – Leibniz Center for Research on Global Economic Challenges

Suggested Citation: Moradi, Mahsa et al. (2023) : Particulate Matter Pollution Remains a Threat for Cardiovascular Health: Findings From the Global Burden of Disease 2019, Journal of the American Heart Association, ISSN 2047-9980, American Heart Association, New York, NY, Vol. 12, Iss. 16, pp. --, <https://doi.org/10.1161/JAHA.123.029375> , <https://www.ahajournals.org/doi/full/10.1161/JAHA.123.029375>

This Version is available at:

<https://hdl.handle.net/10419/274668>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.
















If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



<https://creativecommons.org/licenses/by-nc-nd/4.0/>

ORIGINAL RESEARCH

Particulate Matter Pollution Remains a Threat for Cardiovascular Health: Findings From the Global Burden of Disease 2019

Mahsa Moradi , PhD*; Amir Hossein Behnoush , MD, MPH*; Mohsen Abbasi-Kangevari , MD, MPH; Sahar Saeedi Moghaddam , MSc; Zahra Soleimani , PhD; Zahra Esfahani , MSc; Mohammadreza Naderian , MD; Mohammad-Reza Malekpour , MD; Nazila Rezaei , MD; Mohammad Keykhaei , MD, MPH; Shaghayegh Khanmohammadi , MD, MPH; Hamed Tavolinejad , MD; Negar Rezaei , MD, PhD; Bagher Larijani , MD; Farshad Farzadfar , MD, MPH, MHS, DSc

BACKGROUND: Particulate matter (PM) pollution is a significant risk factor for cardiovascular diseases, causing substantial disease burden and deaths worldwide. This study aimed to investigate the global burden of cardiovascular diseases attributed to PM from 1990 to 2019.

METHODS AND RESULTS: We used the GBD (Global Burden of Disease) study 2019 to investigate disability-adjusted life-years (DALYs), years of life lost (YLLs), years lived with disability (YLDs), and deaths attributed to PM as well as its subgroups. It was shown that all burden measures' age-standardized rates for PM were in the same decreasing trend, with the highest decline recorded for deaths (−36.7%). However, the all-age DALYs increased by 31%, reaching 8.9million in 2019, to which YLLs contributed the most (8.2million [95% uncertainty interval, 7.3 million–9.2 million]). Men had higher deaths, DALYs, and YLLs despite lower years lived with disability in 2019 compared with women. There was an 8.1% increase in the age-standardized rate of DALYs for ambient PM; however, household air pollution from solid fuels decreased by 65.4% in the assessed period. Although higher in men, the low and high sociodemographic index regions had the highest and lowest attributed YLLs/YLDs ratio for PM pollution in 2019, respectively.

CONCLUSIONS: Although the total age-standardized rate of DALYs for PM-attributed cardiovascular diseases diminished from 1990 to 2019, the global burden of PM on cardiovascular diseases has increased. The differences between men and women and between regions have clinical and policy implications in global health planning toward more exact funding and resource allocation, in addition to addressing inequity in health care access.

Key Words: air pollution ■ cardiovascular diseases ■ global burden of disease ■ particulate matter ■ sociodemographic index

Environmental pollution is among the most significant reversible causes of premature death and disability worldwide.¹ Among environmental risk factors, air pollution, particularly particulate matter (PM) pollution, is a leading contributor to the global burden of disease (GBD) associated with increased morbidity

and mortality.^{1–3} After hypertension, smoking, and high fasting plasma glucose, air pollution is the fourth most important risk factor considering all-cause death rates, whereas it is the second most important risk factor for global disability-adjusted life-years (DALYs).⁴ Moreover, 91% of the world's population lives in places where the

Correspondence to: Farshad Farzadfar, MD, MPH, DSc, Non-Communicable Diseases Research Center, Endocrinology and Metabolism Population Sciences Institute, Tehran University of Medical Sciences, No. 10, Al-e-Ahmad and Chamran Highway intersection, Tehran, Iran. Email: f-farzadfar@tums.ac.ir

*Drs Moradi and Behnoush contributed equally as joint first authors.

This article was sent to Mahasin S. Mujahid, PhD, MS, Associate Editor, for review by expert referees, editorial decision, and final disposition.

Supplemental Material is available at <https://www.ahajournals.org/doi/suppl/10.1161/JAHA.123.029375>

For Sources of Funding and Disclosures, see page 16.

© 2023 The Authors. Published on behalf of the American Heart Association, Inc., by Wiley. This is an open access article under the terms of the [Creative Commons Attribution-NonCommercial-NoDerivs](https://creativecommons.org/licenses/by-nc-nd/4.0/) License, which permits use and distribution in any medium, provided the original work is properly cited, the use is non-commercial and no modifications or adaptations are made.

JAHA is available at: www.ahajournals.org/journal/jaha

CLINICAL PERSPECTIVE

What Is New?

- Age-standardized rate of the cardiovascular disease burden attributable to particulate matter pollution had a decreasing trend from 1990 to 2019; also, all-age disability-adjusted life-years (DALYs) increased by 31% from 1990 to 2019, in which men contributed more.
- The age-standardized rate of DALYs for ambient particulate matter as a subtype of particulate matter increased from 1990 to 2019, whereas during the same period, there was a two-thirds decrease in this index for household air pollution from solid fuels.
- The differences in the burden of cardiovascular diseases attributable to particulate matter pollution among regions and between sexes can guide policy making to reduce the negative impacts of this environmental issue.

What Are the Clinical Implications?

- The findings of the current study showed that although there was a decrease in age-standardized rate of all burden measures, the all-age numbers for them increased.
- These differences highlight the inequity in access to health care in different global burden of disease regions and countries. Sex differences, including higher years of life lost (YLLs), deaths, and DALYs in men, can have clinical and policy implications.
- The higher YLLs/years lived with disability ratio in low and low-middle sociodemographic index regions can lead to better air pollution control strategies.

Nonstandard Abbreviations and Acronyms

ASR	age-standardized rate
GBD	global burden of disease
HAP	household air pollution
IHD	ischemic heart disease
PM	particulate matter
SDI	sociodemographic index
UI	uncertainty interval
YLLs	years of life lost

air quality index exceeds the limits of the World Health Organization guidelines.⁵

As one of the well-established outcomes of air pollution, cardiovascular diseases (CVDs) contribute to about one-third of global deaths.⁶ For CVDs, ambient

PM pollution and household air pollution (HAP) from solid fuels are 2 major risk factors.^{4,7,8} PM is classified into 3 main categories based on its aerodynamic diameter: coarse (PM₁₀, 2.5–10 μm), fine (PM_{2.5}, <2.5 μm), and ultrafine (PM_{0.1}, <0.1 μm) PM.^{5,7} PM₁₀ and PM_{2.5} are the most common pollutants responsible for hospitalization and mortality.⁷

PM_{2.5} is the most influential environmental risk factor contributing to global CVD mortality and disability.^{1,5} The CVD burden continues its decades-long increase in almost all countries other than high-income countries.⁴ Although PM pollution-attributed deaths caused by CVDs have decreased in several regions, it is still a significant concern, especially in low-income countries.⁹ Notably, climate change has already affected air quality; for instance, an increase of up to 112% was reported in mean annual PM_{2.5} concentration from 2000 to 2020.¹⁰

Thus, there is an urgent need for more extensive investigations and studies toward understanding the trends, spatial and temporal changes, and their relationship with policies and strategies on global, regional, and national scales. The GBD studies are systematic approaches evaluating global changes in health situations.¹¹ In this way, DALY is a complementary tool to assess health impacts (morbidity and mortality) that might be attributed to environmental risk factors (eg, PM pollution).¹² To compare the overall health and life expectancy of different populations, DALY is applied, taking into account the years of life lost (YLLs) and years lived with disability (YLDs).¹²

In this study, the global burden of CVD attributed to PM pollution and its subcategories was investigated using GBD data retrieved from the Institute for Health Metrics and Evaluation from 1990 to 2019. For this purpose, YLLs, YLDs, DALYs, and deaths were considered in 204 countries, 21 GBD regions, and socio-demographic index (SDI) quintiles.

METHODS

The data underlying this article were derived from sources in public domain: Institute for Health Metrics and Evaluation, at <http://ghdx.healthdata.org/gbd-results-tool>.

Overview

The study was based on the Guidelines for Accurate and Transparent Health Estimates Reporting.¹³ As GBD 2019 study only assessed PM-attributed burden in 2 of the 11 CVDs (ischemic heart disease [IHD] and stroke), we only used the *International Classification of Diseases (ICD-10)* codes for these 2 for mapping. The GBD 2019 study could provide all estimates along with their uncertainty intervals (UIs) for all regions in all years

in between, even in case of sparse or missing data. The data obtained were age-standardized rate (ASR) and all-age number of deaths, DALYs, YLLs, and YLDs attributed to ambient PM and HAP from solid fuels for all 204 countries, 21 GBD regions, and SDI quintiles by age groups and sex from 1990 to 2019.

Data Source

Data on the global burden of CVDs attributed to PM pollution were obtained from the GBD Results tool on the Institute for Health Metrics and Evaluation (<http://ghdx.healthdata.org/gbd-results-tool>) website in addition to GBD studies.¹⁴ The systematic evaluation of 369 diseases and injuries along with 87 risk factors in 204 countries and territories from 1990 to 2019 is available on the website.¹⁴

Detailed description of methods for estimation of CVD burden attributed to PM has been explained by GBD studies.^{4,15} Total PM, composed of ambient PM pollution and HAP from solid fuels data, was incorporated from various sources, such as satellite observations of aerosols, the atmosphere, chemical transport model simulations, population estimates, and land-use data (<http://ghdx.healthdata.org/gbd-2019/data-input-sources>). Ambient PM exposures were assessed using satellite, ground-level monitoring, and chemical transport models in grids that were subsequently transformed into national exposures by estimated population weights.^{16,17} HAP from solid fuels was also defined as the PM from wood, drug, agricultural residues, coal, and charcoal used for cooking and heating, which were estimated from observational surveys and census reporting.^{18,19}

CVD Burden

Estimation of mortality was done by using vital registration data coded to the *ICD-10* system or household mortality surveys known as verbal autopsy (IHD death: I20–I25.9¹⁴; and stroke death: G45–G46.8, I60–I63.9, I65–I66.9, I67.0–I67.3, I67.5–I67.6, I68.1–I68.2, and I69.0–I69.3¹⁴). Statistical methods were used to increase the comparability of mortality data sources. They include the reclassification of codes that are non-specific or unspecified, noise reduction algorithms, and Bayesian geospatial regression software (the Cause of Death Ensemble model) that used location-specific covariates to create smoothed time trends for 204 countries and territories by borrowing strength over age, space, and time. Selected covariates for Cause of Death Ensemble model of CVD included cholesterol (total, mean per capita) (+1 direction), smoking prevalence (+1 direction), systolic blood pressure (mmHg) (+1 direction), mean body mass index (+1 direction), elevation >1500m (proportion) (–1 direction),

fasting plasma glucose (mmol/L) (+1 direction), outdoor pollution (PM_{2.5}) (+1 direction), indoor air pollution (all fuel types) (+1 direction), health care access and quality index (–1 direction), lag distributed income per capita (–1 direction), summary exposure value for ω-3 fatty acids (+1 direction), fruits (+1 direction), vegetables (+1 direction), nuts and seeds (+1 direction), polyunsaturated fatty acids adjusted (percentage) (+1 direction), pulses/legumes (kcal/capita, unadjusted) (–1 direction), alcohol (liters per capita) (+1 direction), and trans fatty acid (+1 direction).

For incidence and prevalence of disease data, they were produced by a broad range of population-representative data sources identified through literature review and with study collaborations, including scientific reports of cohorts and registries, population surveys, microdata from registry and cohort studies, and health system administrative data (*ICD-10* codes: IHD new cases: I20–I21.6, I21.9–I25.9, and Z82.4–Z82.49²⁰; stroke new cases: G45–G46.8, I60–I62, I62.9–I64, I64.1, I65–I69.998, and Z82.3²⁰). Epidemiologic state-transition disease modeling software, DisMod-MR, and Bayesian meta-regression software, MR-BRT, which adjusted for study-level differences in measurement methods and case definitions, were used for the production of consistent disease estimates.⁴

PM-Attributed CVD Burden

Population-representative survey and surveillance data and geospatial Gaussian process regression models that borrowed strength across time and geography were used to estimate risk factor exposures.⁴ The attributable burden was defined by the reduction in the current CVD burden if population exposure was altered to a counterfactual distribution of PM. Estimating attributable burden followed the 6 key steps of comparative risk assessment framework,⁴ comprehensively described in the GBD articles^{21,22} and composed of the following: (1) including the risk-outcome pairs into the analysis; (2) estimating relative risk as a function of exposure based on published systematic reviews and meta-regression; (3) using spatiotemporal Gaussian process regression, DisMod-MR 2.1, a Bayesian meta-regression method, or alternative methods to estimate exposure levels; (4) computing the theoretical minimum risk exposure level as the counterfactual level of exposure based on the published trials or cohort studies; (5) calculating the population-attributable fractions and computing attributable burden (deaths, YLLs, YLDs, or DALYs) by the relevant outcome quantity; and (6) considering the mediating effects of various risk factors on each other to determine the attributed burden of a combination of risk factors.¹⁵ The final estimates of attributable burden include uncertainty in each step of the analysis.

Statistical Analysis

Standard epidemiologic measures, such as YLLs, YLDs, deaths, and DALYs, were considered caused by CVD burden attributable to PM, ambient PM, and HAP from solid fuels pollution risk factors. YLLs were calculated as the number of cause-specific deaths multiplied by a loss function that demonstrates the years lost for death calculated from the year at which death occurs. YLDs were also calculated as the number of years of healthy life lost attributable to disability or ill health. DALYs were obtained by the sum of YLLs based on maximum observed life expectancy, and YLDs based on standardized disability weights. Disability weights are scored on a scale of 0 to 1, where 0 is the state of full health, and 1 is regarded as dead. DALY is a summary measure quantifying all burdens of the disease, as it could take into account the effect of a disease with high morbidity and disability but low mortality and vice versa, resulting in the fact that each 1 year of DALY is regarded as 1 year of full health loss.²³ In summary, 1 DALY represents the loss of the equivalent of 1 year of full health. All mentioned measures were reported as the metrics of ASR per 100 000 or number with percentage change along with 95% UIs. In addition, the age group, sex, year, and location of all of them were extracted for stratification. The ASR was calculated through standardization to the global age structure; also, when comparing populations from different locations or a sample population over time, this standardization was considered to be necessary.²⁴ The 1000 draw-level estimates for each parameter were used for the calculation of UIs for each parameter, and 95% UIs were defined by the 25th and 975th values of the ordered 1000 times. YLLs/YLDs ratio was used as an epidemiologically meaningful combination of fatal and nonfatal estimates of CVDs.²⁵ This ratio can reflect the quality of health care provided in a region and poorer health quality, and living less than life expectancy in a certain region would lead to a higher YLLs/YLDs ratio.²⁶ In addition, the relation between development status reflected as SDI and YLLs/YLDs ratio was considered. SDI is the geometric mean of 0 to 1 index of total fertility rate for those aged <25 years, mean education for those aged ≥15 years, and lag distributed income per capita.^{27,28} The range of each SDI class is as follows: low SDI (<0.455), low-middle-SDI (0.455–0.608), middle SDI (0.608–0.690), high-middle-SDI (0.690–0.805), and high SDI (>0.805). The considered age category of CVD burden attributed to PM pollution was ≥25 years, by 5-year intervals. Graphs and world maps were designed to illustrate the distribution in addition to the changes in global and national CVD burden attributable to PM pollution. All statistical analyses were performed by R version 4.0.4 (R Core Team [2020]; R: a language and environment

for statistical computing; R Foundation for Statistical Computing, Vienna, Austria) and STATA software version 14.0 (Stata Corp).

Funding Source Role

There was no role of the funder in any of the study design, data collection, data analysis, data interpretation, or drafting of the manuscript. All the responsibility for the decision of the manuscript was on the corresponding author, who had full access to the study data.

Ethical Approval and Consent to Participate

No individual data were reported in this article, and the information is based on aggregated preexisting online data. All the data included in this study are publicly available on the GBD Compare tool (<https://gbd.healthdata.org/gbd-compare>). Therefore, the need for ethical approval was waived in this study. Also, as there are no individual data reported in this study, participant consent was waived.

RESULTS

Overview

Generally, in 2019, there were 3.5 million (95% UI, 3.1 million–4.0 million) deaths from CVDs attributed to PM, among which male individuals contributed 56.5%. For ASR of death also, 44 (95% UI, 38.9–49.4) deaths were reported per 100 000. Moreover, 8.9 million (95% UI, 7.9 million–9.9 million) DALYs were reported globally, among which men had a 40.6% contribution. Two subtypes of PM, ambient PM and HAP from solid fuels, had 2.5 million (95% UI, 2.0 million–2.9 million) and 1.1 million (95% UI, 0.7 million–1.5 million) CVD-attributed deaths, respectively. All-age numbers, ASRs, and crude rates of all burden measures for PM-attributed CVDs are shown in the [Table](#) and [Table S1](#).

Time Trends

Between 1990 and 2019, total deaths and DALYs attributable to PM pollution increased by about one-third. Although the all-age deaths increase from 2.6 million (95% UI, 2.3 million–2.9 million) in 1990 to 3.5 million (95% UI, 3.1 million–4.0 million) in 2019, a particularly higher increase was observed in men, 43.0% (95% UI, 25.3%–61.5%), compared with 28.2% (95% UI, 10.7%–48.0%) in women. The same increasing pattern was witnessed for DALYs, 6.8 million (95% UI, 6.1 million–7.5 million) in 1990 to 8.9 million (95% UI, 7.9 million–9.9 million) in 2019, and YLLs with an increase of 6.4 million (95% UI, 5.7 million–7.1 million) to 8.2 million (95% UI, 7.3 million–9.2 million). Noteworthy, there

Downloaded from <http://ahajournals.org> by on August 27, 2023

Table. Global Deaths, DALYs, YLLs, and YLDs Attributed to PM Pollution, Ambient PM Pollution, and HAP From Solid Fuels as Well as Their Percentage Change in 1990 and 2019

Risk factor	Measure	Metric	Year						% Change (1990–2019)		
			1990			2019			Both	Women	Men
			Both	Women	Men	Both	Women	Men			
PM pollution	Deaths	All ages number	2 603 804 (2 300 561 to 2 915 564)	1 203 761 (1 039 837 to 1 376 813)	1 400 043 (1 241 999 to 1 575 559)	3 545 160 (3 137 781 to 3 976 173)	1 543 201 (1 333 656 to 1 763 297)	2 001 960 (1 753 199 to 2 271 312)	36.2 (21.5 to 50.9)	28.2 (10.7 to 48)	43 (25.3 to 61.5)
		Age-standardized rate (per 100 000)	69.6 (61 to 78.5)	58.7 (50.5 to 67.5)	82.3 (72.4 to 92.8)	44 (38.9 to 49.4)	35.3 (30.5 to 40.3)	53.9 (47.2 to 61)	-36.7 (-43.9 to -29.7)	-40 (-48.2 to -30.4)	-34.5 (-42.6 to -26.1)
	DALYs	All ages number	67 790 619 (60 959 740 to 74 819 202)	29 190 335 (25 742 141 to 32 783 923)	38 600 284 (34 543 605 to 43 067 696)	88 829 330 (79 223 226 to 98 903 007)	36 087 855 (31 588 047 to 40 794 508)	52 741 476 (46 314 197 to 59 640 614)	31 (17.7 to 43.8)	23.6 (7.9 to 40.5)	36.6 (20.5 to 53.8)
YLLs	Deaths	Age-standardized rate (per 100 000)	1654.5 (1479.5 to 1832.4)	1354.6 (1190 to 1525.2)	1979.1 (1766.9 to 2213)	1073.4 (957 to 1195.1)	832.2 (728 to 940.7)	1329.6 (1168.7 to 1501.2)	-35.1 (-41.7 to -28.7)	-38.6 (-46.4 to -30.1)	-32.8 (-40.8 to -24.2)
		All ages number	64 164 633 (57 439 726 to 70 973 581)	27 159 409 (23 967 395 to 30 573 942)	37 005 224 (33 063 210 to 41 400 859)	82 553 097 (73 415 294 to 92 216 298)	32 614 773 (28 298 533 to 36 948 524)	49 938 324 (43 751 562 to 56 690 230)	28.7 (14.7 to 41.8)	20.1 (3.8 to 37.9)	34.9 (18.5 to 52.5)
	Age-standardized rate (per 100 000)	1567.9 (1396.7 to 1739.9)	1262.2 (1111.9 to 1421.2)	1898.9 (1683.3 to 2126.8)	997.7 (888.1 to 1114.4)	751.7 (652.7 to 851.7)	1259.3 (1104.9 to 1428.6)	-36.4 (-43.3 to -29.8)	-40.4 (-48.6 to -31.6)	-33.7 (-41.9 to -24.8)	
YLDs	All ages number	All ages number	3625 986 (2 570 349 to 4 703 291)	2 030 926 (1 431 701 to 2 634 272)	1 595 060 (1 135 662 to 2 080 989)	6 276 234 (4 436 840 to 8 057 647)	3 473 082 (2 446 729 to 4 473 936)	2 803 152 (1 981 673 to 3 647 258)	73.1 (62.3 to 83.6)	71 (59.6 to 81.9)	75.7 (64.9 to 86.4)
		Age-standardized rate (per 100 000)	86.6 (61.7 to 112)	92.4 (65 to 119.9)	80.2 (57.1 to 104.4)	75.7 (53.5 to 97.3)	80.5 (56.7 to 103.4)	70.3 (49.8 to 91.2)	-12.6 (-18.3 to -7.1)	-12.8 (-18.6 to -7.1)	-12.3 (-17.9 to -6.6)

(Continued)

Table 1. Continued

Risk factor	Measure	Metric	Year						% Change (1990–2019)		
			1990			2019			Both	Women	Men
			Both	Women	Men	Both	Women	Men			
Ambient PM pollution	Deaths	All ages number	1 115 610 (608 073 to 1 442 890)	492 053 (354 661 to 635 609)	623 556 (447 044 to 813 718)	2 475 395 (2 051 050 to 2 871 325)	1 013 791 (818 745 to 1 213 729)	1 461 604 (1 205 993 to 1 699 215)	121.9 (82.1 to 181.2)	106 (67.1 to 165.5)	134.4 (88.3 to 199.1)
		Age-standardized rate (per 100 000)	30.8 (22.3 to 39.7)	24.6 (17.7 to 31.8)	37.9 (27.1 to 48.9)	30.9 (25.5 to 35.8)	23.2 (18.7 to 27.7)	39.6 (32.7 to 46)	0.3 (-17.5 to 26.4)	-5.9 (-23.6 to 20.8)	4.6 (-15 to 33.3)
	DALYs	All ages number	27 446 836 (19 940 175 to 36 011 834)	10 794 529 (7 727 342 to 14 305 912)	16 652 306 (11 972 642 to 21 998 876)	60 910 841 (50 072 397 to 70 319 156)	22 991 746 (18 718 211 to 27 367 407)	37 919 096 (30 830 629 to 44 189 976)	121.9 (81.1 to 179.8)	113 (71.7 to 171.8)	127.7 (82.3 to 188.6)
YLLs	All ages number	Age-standardized rate (per 100 000)	681.8 (494.7 to 888.9)	507.9 (361.4 to 671.6)	869.4 (628.6 to 1133.9)	737.2 (606.9 to 850.9)	529.5 (430.5 to 630)	959.3 (782.4 to 1116.6)	8.1 (-11.8 to 35.9)	4.3 (-15.5 to 33)	10.3 (-11.7 to 40.3)
		All ages number	25 944 709 (18 811 580 to 34 041 510)	9 990 386 (7 163 161 to 13 247 322)	15 954 322 (11 438 414 to 21 002 311)	56 390 311 (46 518 089 to 65 184 378)	20 580 537 (16 698 127 to 24 536 471)	35 809 774 (29 049 805 to 41 869 928)	117.3 (77.4 to 174.3)	106 (65.2 to 163.7)	124.5 (79.5 to 185.9)
	Age-standardized rate (per 100 000)	645.4 (468.4 to 839.2)	471 (337.6 to 617.5)	833.6 (602.4 to 1095.2)	682.6 (564.2 to 788.6)	473.7 (384.2 to 564.6)	906.3 (739 to 1057.6)	5.8 (-13.6 to 32.9)	0.6 (-19.1 to 29.1)	8.7 (-13.2 to 38.5)	
YLLs	All ages number	Age-standardized rate (per 100 000)	36.5 (23.3 to 51.8)	36.9 (23.6 to 52.4)	35.8 (23.2 to 51.7)	54.6 (37.7 to 72)	55.8 (38.2 to 74.2)	53 (37 to 70)	49.6 (22.6 to 89.4)	51.1 (23.8 to 90)	48.2 (20.8 to 88.8)
		All ages number	1 502 127 (961 406 to 2 129 990)	804 143 (513 989 to 1 147 521)	697 984 (447 194 to 1 012 476)	4 520 530 (3 122 702 to 5 974 867)	2 411 209 (1 652 850 to 3 200 747)	2 109 322 (1 466 269 to 2 783 605)	200.9 (146.4 to 282.1)	199.8 (145.2 to 277.7)	202.2 (145.5 to 287.7)

(Continued)

Table 1. Continued

Risk factor	Measure	Metric	Year																	
			1990						2019						% Change (1990–2019)					
			Both	Women	Men	Both	Women	Men	Both	Women	Men	Both	Women	Men						
HAP from solid fuels	Deaths	All ages number	1 488 194 (1 149 450 to 1 846 032)	711 708 (552 090 to 887 272)	776 486 (579 884 to 989 242)	1 069 765 (729 005 to 1 472 897)	529 410 (367 957 to 712 873)	540 356 (346 910 to 794 331)	-28.1 (-44.9 to -10)	-25.6 (-43 to -7.3)	-30.4 (-48.8 to -9.5)	-66.1 (-74 to -57.3)	-64.5 (-72.7 to -55.9)	-67.9 (-76.2 to -58.3)						
		Age-standardized rate (per 100 000)	38.9 (29.8 to 48.3)	34.1 (26.4 to 42.7)	44.4 (33 to 56.8)	13.2 (9 to 18.2)	12.1 (8.4 to 16.3)	14.3 (9.1 to 21)												
DALYs		All ages number	40 343 783 (31 387 072 to 49 416 444)	18 395 805 (14 502 325 to 22 523 839)	21 947 978 (16 536 990 to 27 760 940)	27 918 489 (19 321 973 to 38 425 697)	13 096 109 (9 282 200 to 17 291 759)	148 223 380 (9 607 917 to 21 470 777)	-30.8 (-46.3 to -14.2)	-28.8 (-44.8 to -12.5)	-32.5 (-49.8 to -12.6)	-65.4 (-73.3 to -57.1)	-64.2 (-72.3 to -56.2)	-66.6 (-75.3 to -56.9)						
		Age-standardized rate (per 100 000)	972.7 (756.1 to 1192.7)	846.7 (666.2 to 1036.4)	1109.7 (830.6 to 1408.9)	336.2 (232.2 to 462.4)	302.7 (214.7 to 398.9)	370.2 (239.5 to 537.2)												
YLLs		All ages number	38 219 924 (29 729 706 to 46 733 952)	17 169 023 (13 521 525 to 20 946 778)	21 050 902 (15 794 641 to 26 626 506)	26 162 786 (18 096 937 to 35 754 130)	12 034 236 (8 516 187 to 15 976 718)	14 128 550 (9 170 002 to 20 484 455)	-31.5 (-46.8 to -15)	-29.9 (-45.7 to -13.9)	-32.9 (-50.1 to -13)	-65.8 (-73.5 to -57.7)	-64.9 (-72.8 to -57)	-66.9 (-75.5 to -57.1)						
		Age-standardized rate (per 100 000)	922.5 (716.4 to 1133)	791.3 (622.3 to 966.7)	1065.3 (798.2 to 1353.5)	315.1 (217.5 to 431)	278 (196.8 to 368.5)	353 (228.9 to 512.5)												
YLDs		All ages number	2 123 859 (1 427 927 to 2 867 354)	1 226 783 (833 704 to 1 642 711)	897 076 (588 240 to 1 246 211)	1 755 703 (1 075 876 to 2 629 849)	1 061 873 (659 264 to 1 546 036)	693 830 (398 671 to 1 091 987)	-17.3 (-37.9 to 4.6)	-13.4 (-34.8 to 9.7)	-22.7 (-43 to 0.6)	-57.9 (-68.3 to -46.7)	-55.4 (-66.3 to -43.5)	-61.1 (-71.4 to -49.4)						
		Age-standardized rate (per 100 000)	50.2 (33.9 to 67.7)	55.4 (37.7 to 74.2)	44.4 (29.1 to 61.8)	21.1 (12.9 to 31.7)	24.7 (15.4 to 35.9)	17.3 (9.9 to 27.2)												

Data in parenthesis are 95% uncertainty intervals. DALY indicates disability-adjusted life-year; HAP, household air pollution; PM, particulate matter; YLLs, years lived with disability; and YLDs, years of life lost.

was a 73.1% (95% UI, 62.3%–83.6%) increase in YLDs, which was almost similar in both sexes. In terms of the ASR for each of the measures, a similar decrease of \approx 35% was observed for deaths, DALYs, and YLLs. However, age-standardized YLDs of CVDs attributable to PM pollution decreased less dramatically (12.6% [95% UI, 7.1%–18.3%]) (Table).

From 1990 to 2019, deaths related to ambient PM pollution increased by 121.9% (95% UI, 82.1%–181.2%). Also, DALYs and YLLs had more than doubled in this period. YLDs increase was also \approx 200.9% (95% UI, 146.4%–282.1%), with nearly the same increase among women and men. Despite this increase in all measures, there was a more moderate increase in the ASRs, being 0.3%, 8.1%, 5.8%, and 49.6% for deaths, DALYs, YLLs, and YLDs, respectively (Table).

All crude numbers and ASRs attributed to HAP from solid fuels decreased from 1990 to 2019. These include a change in death from 1.5 million (95% UI, 1.1 million–1.8 million) to 1.1 million (95% UI, 0.7 million–1.5 million) with an ASR decrease of 66.1% (95% UI, 57.3%–74.0%) (Table).

The risk-time trend figures for PM pollution attributed to CVD burden imply that YLLs, deaths, and DALYs for PM pollution, especially HAP from solid fuels, ASR had decreasing trends for men and women from 1990 to 2019 (Figure 1). In the case of ambient PM, the 3 measures mentioned above had marginal fluctuations, whereas YLDs had an increasing trend from 1990 to 2019. For PM, ambient PM, and especially HAP from solid fuels, higher YLDs were allocated to the women, in contrast with the other 3 measures.

For PM pollution, ASR for all the studied measures had declining trends, particularly for YLLs, deaths, and DALYs; however, for the all-ages numbers, the measures had increasing trends from 1990 to 2019 (Figure S1). For ambient PM pollution, rates of YLLs, deaths, and DALYs had almost steady-state trends from 1990 to 2019. However, YLDs had an increasing trend from 1990 to 2019. The number of attributed all ages for all 4 measures had an increasing trend from 1990 to 2019. On the contrary, for HAP from solid fuels, decreasing trends were observed for all the considered measures.

Burden Among GBD Regions

PM Pollution

Changes in the ranking of deaths ASR from 1990 to 2019 for both sexes in 21 GBD regions were considered (Figure 2). North Africa and the Middle East exhibited the highest ranking in 1990, whereas it substantially decreased to the seventh rank in 2019. In the case of DALYs, the first rank was allocated to Oceania from 1990 to 2019. ASR of DALYs in North Africa and

the Middle East decreased by 36.5% from 2586.5 (95% UI, 2255.2–2951.5) to 1641.8 (95% UI, 1377.9–1925.6) per 100 000, and their rank decreased from the second to the sixth within the category. ASRs of deaths and DALYs for all GBD regions were declining; however, some areas, such as Southern and Central Asia, Eastern, Southern, and Western sub-Saharan Africa, the Caribbean, Central Latin America, and high-income Asia Pacific regions, increased ranking among the considered regions.

PM Pollution Subtypes

For ambient PM, death and DALY ASRs of women and men exhibited similar rankings for the studied regions. For men, the highest ASR of deaths (87.9; 95% UI, 48.9–128.5 per 100 000) was allocated to Central Europe in 1990, whereas it remarkably moved down to the seventh position with 39 (95% UI, 31.4–47.2) in 2019 (Figure S2). In 2019, Central Asia exhibited the highest ranking (103.3 ASR of deaths per 100 000; 95% UI, 74.3–135.2) among the considered regions climbing from the fourth position to the first. North Africa and Middle East and East Asia underwent a marginal increase in ranking from the third and fifth positions in 1990 to the second and third places, respectively. North Africa and the Middle East had the highest ranking, with deaths of 55.45 per 100 000 (95% UI, 43.1–68.1) in 1990. Although the total death rate increased by 1.5% to 56.3 per 100 000 (95% UI, 46.6–65.8), its ranking decreased to the second position in 2019. Similar to the corresponding data for men, Central Asia reached the first position for ambient PM-attributed deaths caused by CVD for women in 2019, with 63.3 deaths per 100 000 (95% UI, 44.7–83.7). Central, East, and Southeast Asia had increasing trends from 1990 to 2019.

For HAP from solid fuels, Oceania has been on top since 1990, with a death ASR change of 101.1 (95% UI, 78.6–129.2) to 85.04 (95% UI, 62.4–110.0) in 2019. Central, Eastern, and Western sub-Saharan Africa have changed their positions between the second and the fourth positions; however, Western sub-Saharan Africa has had a steady-state trend (Figure S2).

Burden Among GBD Countries

The country-level burden of PM pollution on CVDs was investigated. From 1990 to 2019, CVD's ASR of DALYs attributed to PM pollution decreased in most countries (Figure 3). In 2019, Solomon Islands, Vanuatu, and Afghanistan had the highest PM pollution-attributed CVD ASR of DALYs of 7171.4 (95% UI, 5684.0–8759.2), 4345.2 (95% UI, 3289.2–5798.7), and 3961.3 (95% UI, 3046.3–5042.0) with percentage

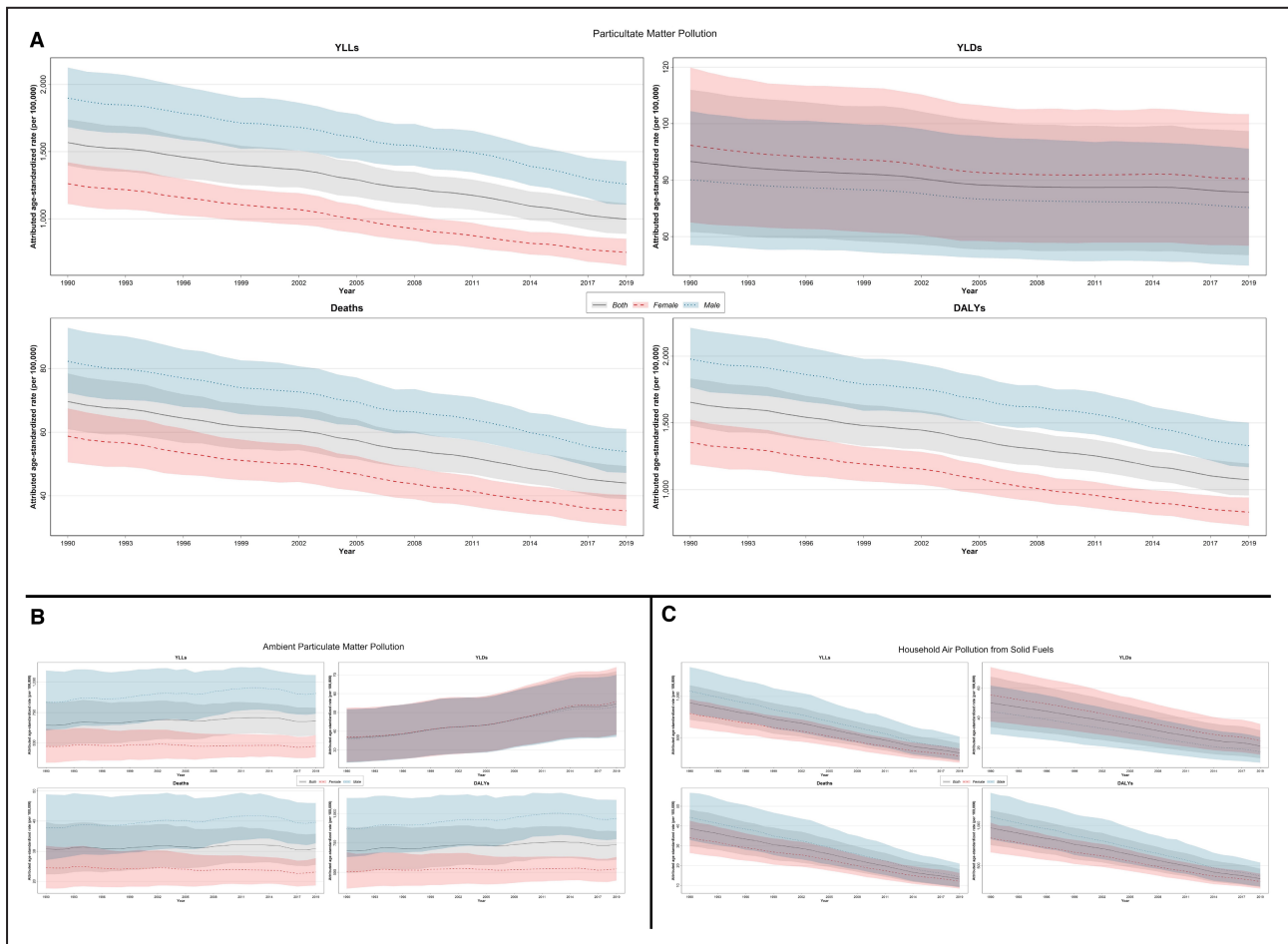


Figure 1. Global time trend of age-standardized rate for YLLs, YLDs, deaths, and DALYs caused by cardiovascular disease attributed to PM pollution (A), ambient PM pollution (B), and household air pollution from solid fuels (C) by sex from 1990 to 2019. DALY indicates disability-adjusted life-year; PM, particulate matter; YLDs, years lived with disability; and YLLs, years of life lost.

changes of -7.1% , -0.03% , and 35.8% from 1990 to 2019, respectively.

Determinants of CVD Attributable to PM Pollution

Sex and Age

The burden measures exhibited a higher attributed rate for men than women. In the case of YLDs, the attributed rate was almost unchanged between 1990 and 2019, and it was higher for women than for men. For the ambient PM, higher attributed rates of YLLs, DALYs, and deaths were depicted for men, whereas the attributed rate for YLDs was more for women, and it increased in 2019 compared with 1990 (Figure 4). In 2019, for PM pollution, the highest YLLs and DALY rates were both observed in the age range of 80 to 84 years; however, the highest YLDs were at the age of 75 to 79 years for both men and women. In the case of ambient PM and HAP from solid fuels, the highest rates for both YLLs and DALYs were in the age ranges

of 85 to 89 and 75 to 79 years, respectively. The HAP from solid fuels attributed rates of YLLs, YLDs, deaths, and DALYs caused by CVD significantly decreased from 1990 to 2019. Similar to the results obtained for PM and ambient PM, the attributed YLDs were notably higher for women versus men. In contrast to the attributed YLDs rate for the ambient PM, this measure remarkably decreased from 1990 to 2019 for both men and women.

The PM-attributed CVD age-standardized YLLs/YLDs ratio for both men and women remarkably changed from 1990 to 2019 (Figure 5). The YLLs/YLDs ratio for both sexes was 18.1 in 1990, decreasing to 13.2 in 2019 (Table). Also, for men and women, YLLs/YLDs ratio decreased from 23.7 and 13.7 in 1990 to 17.9 and 9.3 in 2019, respectively. Significantly higher YLLs/YLDs ratios were observed for men than women.

The ASR of deaths per 100000 attributed to ambient PM pollution was investigated for each sex, and in the case of women, it was generally less than that for men. The global deaths for women slightly decreased

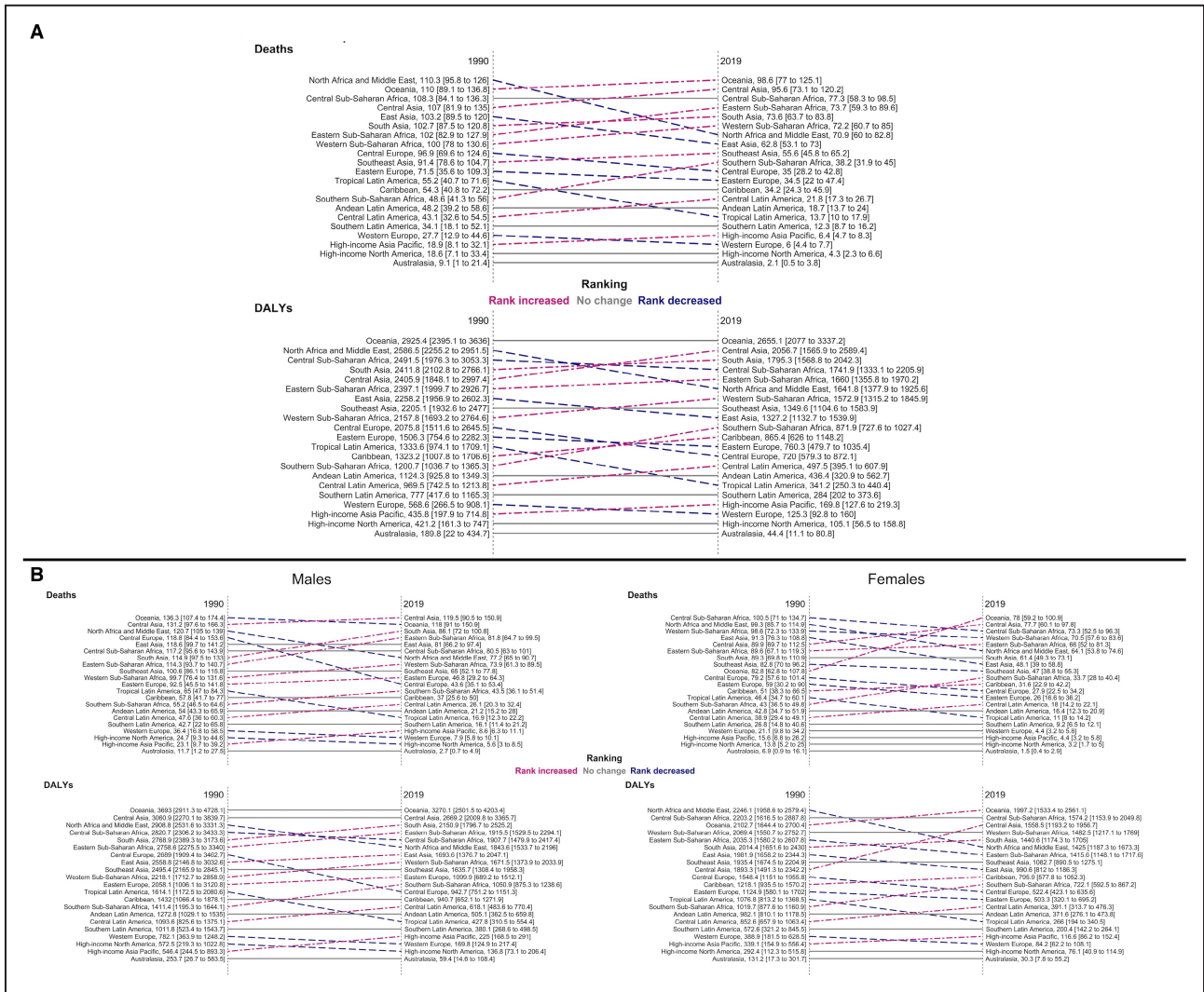


Figure 2. Ranking of 21 global burden of disease regions (1990–2019) for age-standardized rate of deaths and DALYs attributed to PM pollution, both sexes (A); and deaths and DALYs attributed to PM pollution for men versus women (B). DALY indicates disability-adjusted life-year; and PM, particulate matter.

from 24.6 (95% UI, 17.7–31.8) in 1990 to 23.2 (95% UI, 18.7–27.7) in 2019. HAP from solid fuels had higher death ASR for men compared with women, whereas both decreased from 1990 to 2019, with a percentage change of –67.9% (95% UI, –76.2% to –58.3%) and –64.5% (95% UI, –72.7% to –55.9%) for men and women, respectively.

Sociodemographic Index

In the third ranking, PM pollution was a significant risk factor for the global attributed burden of DALYs ASR caused by CVDs for both sexes in 2019 (Figure S3). The low, low-middle, and middle SDI quintiles had the second ranking in 2019, whereas high-middle and high SDI quintiles had the sixth and eighth rankings, respectively. In terms of deaths, although being the fourth globally, these were second for low and low-middle, third for middle, sixth for high-middle, and 10th for high SDI countries (Figure S3).

The low-middle SDI region had the highest burden of YLLs/YLDs ratio caused by CVD attributed to PM pollution for both men and women in 1990 and 2019 (Figure 6 and Table S2). As previously mentioned, YLLs/YLDs ratio was higher for men than women; and for women, the low SDI region had slightly higher values of YLLs/YLDs ratio in 2019, with a decrease compared with 1990.

IHD and Stroke Global Burden

Stroke and IHD were investigated separately for all measures. Similar to total trend of CVDs attributed to PM, all measures, including deaths, DALYs, YLLs, and YLDs, for IHD attributed to PM pollution showed decreasing trends in terms of ASR, with percentage changes of –30.3%, –28.5%, –28.9%, and –12.4%, respectively. However, all-ages number for all of them increased from 1990 to 2019 (46.2%, 44.1%, 43.3%, and 81.3%,

Downloaded from http://ahajournals.org by on August 27, 2023

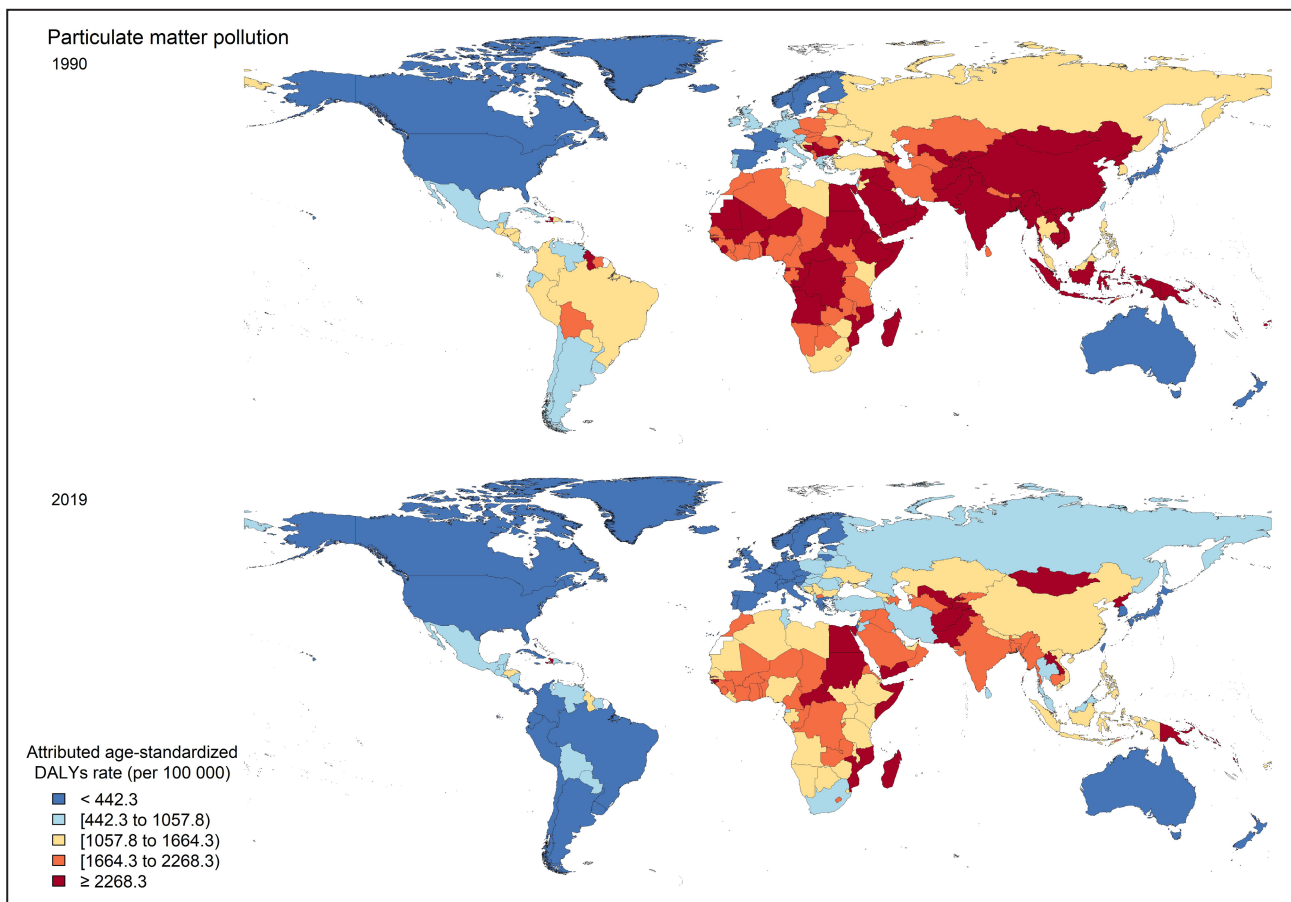


Figure 3. Global age-standardized DALY rate (per 100000) caused by cardiovascular disease attributed to particulate matter pollution for both sexes in 1990 and 2019.

DALY indicates disability-adjusted life-year.

respectively). This increase was mostly attributable to increase in ambient PM pollution, whereas ASR and all-age numbers of HAP from solid fuels decreased for all the measures during the investigated period (Table S3).

In terms of stroke burden, DALYs increased from 36.3 million (95% UI, 32.4 million–40.3 million) in 1990 to 43.5 million (95% UI, 38.4 million–48.7 million) in 2019. Conversely, ASR of DALYs decreased from 888.0 (95% UI, 789.9–989.8) to 525.6 (95% UI, 463.9–589.9) per 100000. Ambient PM pollution and HAP from solid fuels had similar trends to the whole CVD group burden, with moderate DALY increase of 9.0% (95% UI, –14.3% to 43.3%) in ambient PM pollution ASR and decrease of –68.8% (95% UI, –76.2% to –60.7%) in HAP from solid fuels (Table S3).

DISCUSSION

Globally, all-age deaths, DALYs, YLLs, and YLDs of CVDs attributable to PM increased from 1990 to 2019; however, the ASR for all of them showed a downward trend. This opposite trend can be partially explained

by aging and population growth. Men had a higher attributable rate for deaths, DALYs, and YLLs but not for YLDs. All burden measures and their ASR for ambient PM have also increased, whereas there was an inverse trend for HAP from solid fuels. In 2019, the highest CVD death rate was for the ages of 85 to 89 years, whereas this was 80 to 84 years for DALYs. This ranking was significantly different for SDI quintiles, with its highest ranking in low and low-middle SDI quintiles in 2019.

PM pollution is the most important environmental risk factor for global CVD mortality and disability. The epidemiologic studies conducted in Europe, Canada, and the United States suggest an association between exposure to fine PM pollution and mortality attributable to CVD.²⁹⁻³¹ The underlying mechanisms by which PM can affect the cardiovascular system are broad and elusive to determine; however, inflammation, oxidative stress, metabolic dysfunction, atherosclerosis, hypertension, and autonomic dysfunction are suggested to play a role in this regard.³²

Several factors contribute to PM, ambient PM, and HAP from solid fuels, which, in turn, may result in CVD burden. In the African region, HAP from solid

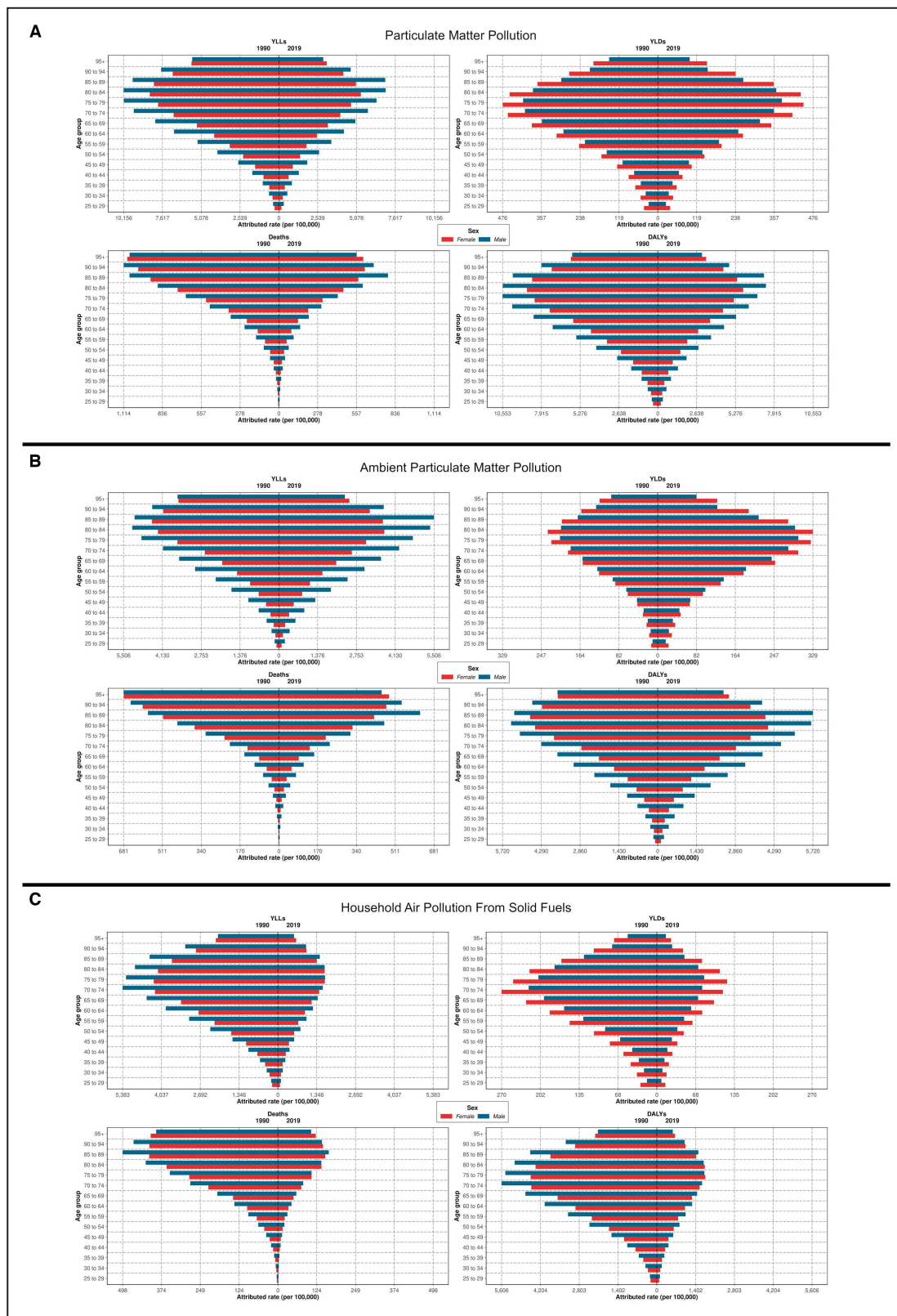


Figure 4. Global YLLs, YLDs, deaths, and DALYs caused by cardiovascular disease attributed to PM pollution (A), ambient PM pollution (B), and household air pollution from solid fuels (C) for both sexes, men and women, in 1990 and 2019. DALY indicates disability-adjusted life-year; PM, particulate matter; YLDs, years lived with disability; and YLLs, years of life lost.

Downloaded from <http://ahajournals.org> by on August 27, 2023

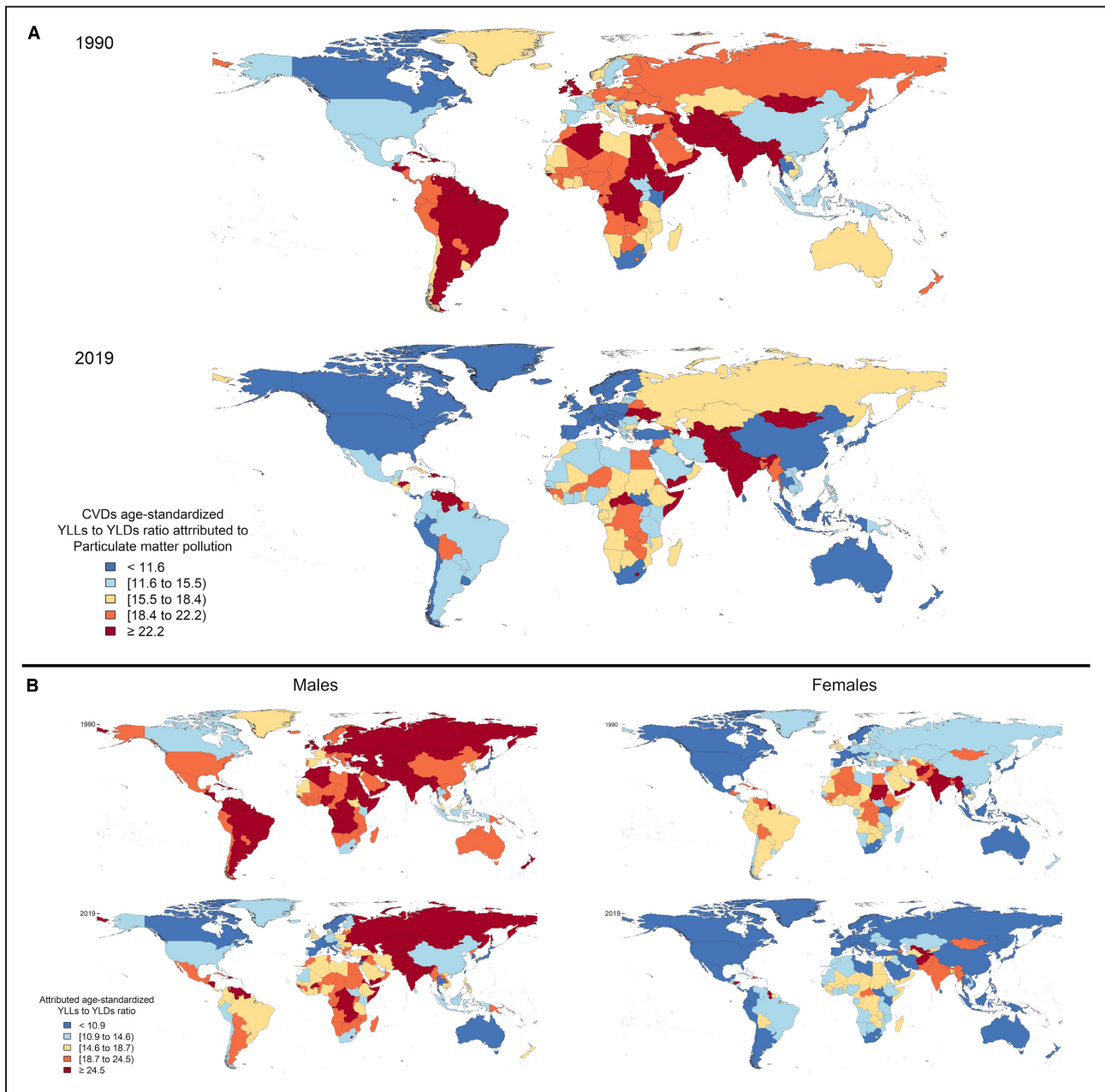


Figure 5. Global age-standardized YLLs/YLDs ratio of cardiovascular disease attributed to particulate matter pollution for both sexes (A) and men vs women (B) in 1990 and 2019.

YLDs indicates years lived with disability; and YLLs, years of life lost.

fuels was an influential risk factor for CVD, ranking third for the attributed YLLs caused by CVD. This is hypothesized to be related to biomass consumption as a primary source of domestic energy and coal burning for heating, cooking, and lighting. This consumption has been estimated to be as much as 80% in Africa.^{33,34} Likewise, it has been well established that indoor cooking is significantly harmful, especially in the absence of proper ventilation, which is common in African countries.³⁵ HAP affects ≈2.45 billion people in low- and middle-income countries. Additionally, 2.8

to 4.3 million premature deaths are attributed to HAP annually, equivalent to 7.7% of the global mortality.^{36,37}

The ASR of YLDs increased for men and women, with higher ambient PM and HAP from solid fuel levels. In our study, YLLs, deaths, and DALYs were higher for men, whereas higher YLDs were noticed for women. Sex disparities related to CVD can have clinical and policy implications in global health planning toward more exact funding and resource allocation.³⁸ It has been suggested that women might be more susceptible to PM-induced health effects. The Women's

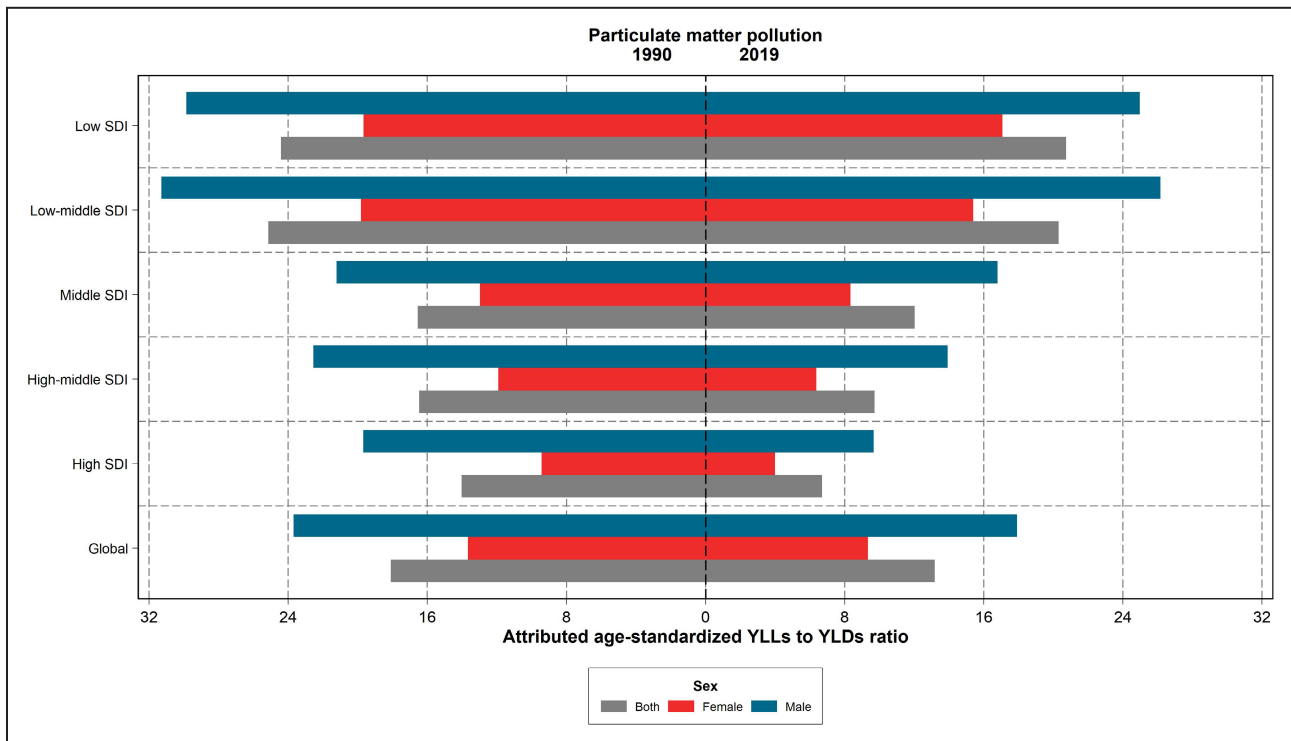


Figure 6. Age-standardized YLLs/YLDs ratio of cardiovascular disease attributed to particulate matter pollution for both sexes, men and women, within the 5 SDI locations in 1990 and 2019.

SDI indicates sociodemographic index; YLDs, years lived with disability; and YLLs, years of life lost.

Health Initiative Observational Study found that with each $10\text{-}\mu\text{g}/\text{cm}^3$ increase in $\text{PM}_{2.5}$, fatal cardiovascular events in women increased by 76%.³⁰ Also, according to the NHS (Nurses' Health Study), the same increase in $\text{PM}_{2.5}$ concentration could lead to an increase of 43% in fatal coronary heart disease.³⁹ This could be attributed to exposure disparities that increase the risk for women. For instance, the use of biomass fuels for cooking in sub-Saharan Africa and South Asia disproportionately exposes high levels of indoor air pollution.⁴⁰ In most of the regions, YLLs/YLDs ratio decreased. YLLs/YLDs ratio was generally higher for men than women, especially in the Russian Federation and African countries. In addition, it has been found that the IHD burden attributed to PM pollution is higher in men than women because of the higher all-cause mortality rates in men.⁴¹ On the basis of the results investigated in this current study, it was also endorsed that PM pollution has brought about higher YLLs for men and higher YLDs for women caused by CVD from 1990 to 2019. Policies should be designed to address these sex differences with the aim of reducing men's exposure to ambient air pollution and women's exposure to HAP from solid fuels. A great burden of HAP exposure has been suggested to be among women of childbearing age and children aged <5 years because of their disproportionate time spent in the house.⁴²

These interventions include the ones that improve access and take-up to cleaner fuels (such as refined biomass, ethanol, liquefied petroleum gas, solar fuels, and electricity), structural interventions, such as improved cookstoves and inbuilt stoves, fuel policy, and behavioral interventions.⁴³

Air pollution and its cardiovascular effects are becoming an emergency in communities in recent years. It has been suggested that short-term $\text{PM}_{2.5}$ can increase cardiovascular events by 1% to 3%, whereas longer exposure can lead to an $\approx 10\%$ increase.¹ The *Lancet* commission on pollution and health has prepared the "pollutome" framework as a subset of "exposome," which is defined by the total influences of pollution on human health.⁴⁰ The health effects of air pollution on all-cause mortality and cardiovascular mortality are only the tip of the iceberg, whereas the remaining complications, such as diabetes, nonfatal myocardial infarction, and heart failure with emerging evidence, should not be neglected. IHD and stroke were assessed as subcategories of CVDs for which the same trend was observed. The effect of PM pollution on IHD was attributed to several complications of atherosclerosis, including plaque vulnerability, thrombosis, and acute ischemic events.⁴⁴ In terms of stroke burden, a study by Zhang et al reported the association of $\text{PM}_{2.5}$ with both ischemic and hemorrhagic

stroke, whereas the case for PM₁₀ was only significant with ischemic stroke, which, stratifying by age and sex, could not affect this result.⁴⁵ Future projections of air pollution's effect on premature mortality have shown that although future PM_{2.5} will be reduced in most regions, the increase in population may lead to higher mortality attributed to PM.⁴⁶ All of these highlight the importance of pollution control all over the world.

Having the first ranking among the 21 GBD regions, North Africa and the Middle East exhibited the highest PM-attributed ASR of deaths in 1990. In this region, the highest disease burden attributable to air pollution was from the PM pollution.⁴⁷ Moreover, it has been reported that countries in North Africa and the Middle East had a high burden of IHD attributable to PM_{2.5}.⁴¹ Nevertheless, in 2019, its rank dramatically decreased from first to seventh. These countries are rich in terms of fossil fuels, and thereby, the main source of climate change is the energy sector; however, it seems hard to address this problem in preventive programs because energy is needed for the development of these countries.⁴⁸ Oceania held the first position for DALYs from 1990 to 2019. Indeed, in some low- and middle-income countries, particularly in Asia, Oceania, and Africa, there have been concerns about notable exposure to PM_{2.5}-attributed DALYs caused by IHD.⁴¹ Preventive measures with a special focus on PM_{2.5} are highly warranted to further reduce the attributable burden in these countries.

On the contrary, death and DALY rates underwent declining rankings in Europe, probably because of less exposure to PM through promoting air pollution control measures and technologies along with higher-quality and access to health care facilities and services. According to the literature, population aging has increased the total number of deaths and DALYs caused by IHD attributed to PM pollution in Europe, whereas in Asia and Africa, population growth has played this role since 1990.⁴¹ In Western Europe, the ranking of deaths caused by CVD attributed to ambient PM substantially decreased among the 21 GBD regions. In 2019, Central Asia exhibited the first ranking for ambient PM, for both men and women. Africa and Oceania also had increasing rankings from 1990 to 2019. Deaths per 100 000 were generally less for women than men. From 1990 to 2019, the ASR of HAP from solid fuels-attributable stroke burden decreased in most countries.⁴¹ Oceania has been on top of the death rate caused by CVD attributed to HAP from solid fuels.

Investigating at the country level, Afghanistan had the highest PM pollution-attributed DALYs ASR in 1990 and 2019, although its DALYs number decreased. The ASR of DALYs attributable to CVD attributed to PM pollution was the highest in South Asia, Central Asia, South-East Asia, North Africa and Middle East, and East-sub-Saharan Africa in 1990. In 2019, the CVD

ASR of DALYs attributed to PM pollution decreased in most regions. The highest levels were allocated to some parts of South Asia, Central Asia, and Eastern sub-Saharan Africa. These differences in ASR of DALYs around the globe supposedly indicate differences or inequity in access to health care and primary and secondary prevention strategies, especially in low- and middle-income countries.^{4,49}

More importantly, the share of older people is supposed to double in the mentioned regions between 2019 and 2050.^{4,50} Indeed, these global patterns present significant findings for clinical practice and public health policy development. Likewise, it has been well established that long-term exposure to PM, especially PM_{2.5}, is associated with an increased risk of CVD in adults aged 35 to 70 years.⁹ In this way, attention should be paid to promoting air pollution control systems and, more importantly, preventive policies and measures related to decreasing PM emissions.

The YLLs/YLDs ratio in high SDI, high-middle SDI, and middle SDI was lower than that in low SDI and low-middle SDI in both 1990 and 2019, but this difference was widened in 2019. The YLLs/YLDs ratio was higher in low and low-middle SDI than in global SDI. This global difference can be attributed to opposing trends in low and low-middle SDI countries and high and high-middle SDI countries. It can show the inequities in access to health care systems and air pollution control strategies. Widespread use of statins and low doses of aspirin have supposedly led to a lower burden of IHD in high SDI countries.⁴¹ Likewise, air pollution prevention and control strategies have resulted in less exposure to PM in high SDI countries.^{41,51} These results show that low-middle and low SDI countries cry out for urgent planning and implementation of preventive and control strategies to increase the access and quality of the health care system and enhance air pollution control with the main focus on PM control.

Strengths and Limitations

The present study provides the policy makers and stakeholders at national and international levels with valuable information about the burden of CVDs attributed to PM. However, there are several limitations to address. First, the data for some countries may be from samples not representative of the whole population of the region. Second, PM composition may vary over time and place,⁵² which can affect the spatial homogeneity assumption in these studies. Third, cause-specific mortalities from different countries are heterogeneous,⁵³⁻⁵⁵ affecting the GBD study results. Third, the GBD 2019 study only assessed IHD and stroke among CVDs in association with the PM that, although contributing to most CVDs, may have

an impact on our results and further consideration of other CVDs in future GBD studies may be helpful in this regard. Fourth, our findings from the GBD study 2019 showed an association between PM pollution and cardiovascular health, and no causal relationship can be deduced from these findings. Fifth, inherent limitations of GBD studies should be taken into consideration, the most important of which is the fact that data presented here are only estimates from the models, which may not necessarily represent true numbers. Finally, especially in low- and middle-income countries, there may be limited access to clinical care and a lack of effective case-finding methods, resulting in low-quality epidemiologic data sets.

CONCLUSIONS

Despite a decrease in ASR of deaths, DALYs, YLLs, and YLDs of CVD attributed to PM pollution from 1990 to 2019, the all-age numbers for them increased, primarily attributable to aging in higher SDI countries and population growth in lower SDI ones. The differences in ASR of DALYs around the globe supposedly indicated differences or inequity in access to health care and primary and secondary prevention strategies. It is worth considering that YLLs, deaths, and DALYs were higher for men, whereas higher YLDs were noticed for women, which can have clinical and policy implications in global health planning toward more exact funding and resource allocation. The YLLs/YLDs ratio was higher in low and low-middle SDI than global SDI. This global difference can show the inequities in access to health care systems and air pollution control strategies. Air pollution prevention and control strategies have resulted in less exposure to PM in many countries. These results showed that low-middle and low SDI countries cry out for urgent planning and implementation of preventive and control strategies to increase the access and quality of the health care system and enhance air pollution control with the main focus on PM control.

ARTICLE INFORMATION

Received January 5, 2023; accepted May 31, 2023.

Affiliations

Non-Communicable Diseases Research Center, Endocrinology and Metabolism Population Sciences Institute, Tehran University of Medical Sciences, Tehran, Iran (M.M., A.H.B., M.A., S.S.M., Z.S., Z.E., M.N., M.-R.M., N.R., M.K., S.K., H.T., N.R., F.F.); National Elites Foundation, Tehran, Iran (M.M.); Department of Environmental Health Engineering, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran (M.M.); Kiel Institute for the World Economy, Kiel, Germany (S.S.M.); Department of Biostatistics, University of Social Welfare and Rehabilitation Sciences, Tehran, Iran (Z.E.); Department of Cardiovascular Medicine, Mayo Clinic, Rochester, MN (M.N.); Tehran Heart Center, Cardiovascular Diseases Research Institute, Tehran University of Medical Sciences, Tehran, Iran (M.N.); Feinberg Cardiovascular and Renal Research Institute, Northwestern University, School of Medicine, Chicago, IL (M.K.); and Endocrinology and Metabolism Research Center,

Endocrinology and Metabolism Clinical Sciences Institute, Tehran University of Medical Sciences, Tehran, Iran (B.L., F.F.).

Acknowledgments

The authors would like to express their profound gratitude to the Institute for Health Metrics and Evaluation and all the staff of the Non-Communicable Diseases Research Center (NCDRC) of Tehran University of Medical Sciences (Tehran, Iran). This study was a part of the postdoctoral project funded by "Iran's National Elites Foundation," performed at the NCDRC in 2021. Author contributions: Study concept and design: Dr Farzadfar; acquisition of data: S. Saeedi Moghaddam, Dr Moradi, Dr Behnoush, and Dr Abbasi-Kangevari; analysis and interpretation of data: S. Saeedi Moghaddam, Dr Soleimnai, Z. Esfahani, Dr Naderian, Dr Moradi, Dr Behnoush, Dr Abbasi-Kangevari, Dr Malekpour, Dr Nazila Rezaei, and Dr Keykhaei; drafting of the manuscript: Dr Moradi and Dr Behnoush; critical revision of the manuscript for important intellectual content: S. Saeedi Moghaddam, Dr Moradi, Dr Behnoush, Dr Abbasi-Kangevari, Dr Negar Rezaei, Dr Malekpour, Dr Keykhaei, Dr Naderian, Dr Nazila Rezaei, Dr Khanmohammadi, Dr Larijani, and Dr Farzadfar; statistical analysis: S. Saeedi Moghaddam, Dr Moradi, Z. Esfahani, Dr Khanmohammadi, and Dr Behnoush; administrative, technical, or material support: Dr Negar Rezaei, Dr Farzadfar, Dr Larijani, and Dr Nazila Rezaei; study supervision: Dr Farzadfar. All authors read and approved the manuscript before submission.

Sources of Funding

None.

Disclosures

None.

Supplemental Material

Data S1

REFERENCES

- Rajagopalan S, Al-Kindi SG, Brook RD. Air pollution and cardiovascular disease: JACC state-of-the-art review. *J Am Coll Cardiol*. 2018;72:2054–2070. doi: 10.1016/j.jacc.2018.07.099
- Cohen AJ, Ross Anderson H, Ostro B, Pandey KD, Krzyzanowski M, Künzli N, Gutschmidt K, Pope A, Romieu I, Samet JM, et al. The global burden of disease due to outdoor air pollution. *J Toxic Environ Health A*. 2005;68:1301–1307. doi: 10.1080/15287390590936166
- Burney P, Amaral AFS. Air pollution and chronic airway disease: is the evidence always clear? *Lancet*. 2019;394:2198–2200. doi: 10.1016/S0140-6736(19)32537-1
- Roth GA, Mensah GA, Johnson CO, Addolorato G, Ammirati E, Baddour LM, Barengo NC, Beaton AZ, Benjamin EJ, Benziger CP, et al. Global burden of cardiovascular diseases and risk factors, 1990–2019: update from the GBD 2019 study. *J Am Coll Cardiol*. 2020;76:2982–3021. doi: 10.1016/j.jacc.2020.11.010
- Du J, Yang J, Wang L, Wu X, Cao W, Sun S. A comparative study of the disease burden attributable to PM_{2.5} in China, Japan and South Korea from 1990 to 2017. *Ecotoxicol Environ Saf*. 2021;209:111856. doi: 10.1016/j.ecoenv.2020.111856
- Yang B-Y, Guo Y, Morawska L, Bloom MS, Markevych I, Heinrich J, Dharmage SC, Knibbs LD, Lin S, Yim SH-L, et al. Ambient PM₁ air pollution and cardiovascular disease prevalence: insights from the 33 communities Chinese health study. *Environ Int*. 2019;123:310–317. doi: 10.1016/j.envint.2018.12.012
- Franklin BA, Brook R, Arden Pope C III. Air pollution and cardiovascular disease. *Curr Probl Cardiol*. 2015;40:207–238. doi: 10.1016/j.cpcardiol.2015.01.003
- Borsi SH, Khanjani N, Nejad HY, Riahi A, Sekhavatpour Z, Raji H, Dastoorpoor M. Air pollution and hospital admissions due to deep vein thrombosis (DVT) in Ahvaz. *Iran Heliyon*. 2020;6:e04814. doi: 10.1016/j.heliyon.2020.e04814
- Hystad P, Larkin A, Rangarajan S, AlHabib KF, Avezum Á, Calik KBT, Chifamba J, Dans A, Diaz R, du Plessis JL, et al. Associations of outdoor fine particulate air pollution and cardiovascular disease in 157 436 individuals from 21 high-income, middle-income, and low-income countries (PURE): a prospective cohort study. *Lancet Planet Health*. 2020;4:e235–e245. doi: 10.1016/S2542-5196(20)30103-0

10. Li S, Shafi S, Zou B, Liu J, Xiong Y, Muhammad B. PM_{2.5} concentration exposure over the belt and road region from 2000 to 2020. *Int J Environ Res Public Health*. 2022;19:2852. doi: 10.3390/ijerph19052852
11. Roth GA, Mensah GA, Fuster V. The global burden of cardiovascular diseases and risks: a compass for global action. *J Am Coll Cardiol*. 2020;76:2980–2981. doi: 10.1016/j.jacc.2020.11.021
12. Rovira J, Domingo JL, Schuhmacher M. Air quality, health impacts and burden of disease due to air pollution (PM10, PM2.5, NO2 and O3): application of AirQ+ model to the camp de Tarragona County (Catalonia, Spain). *Sci Total Environ*. 2020;703:135538. doi: 10.1016/j.scitotenv.2019.135538
13. Stevens GA, Alkema L, Black RE, Boerma JT, Collins GS, Ezzati M, Grove JT, Hogan DR, Hogan MC, Horton R, et al. Guidelines for accurate and transparent health estimates reporting: the GATHER statement. *Lancet*. 2016;388:e19–e23. doi: 10.1016/S0140-6736(16)30388-9
14. Vos T, Lim SS, Abbafati C, Abbas KM, Abbasi M, Abbasifard M, Abbasi-Kangevari M, Abbastabar H, Abd-Allah F, Abdelalim A, et al. Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019: a systematic analysis for the global burden of disease study 2019. *Lancet*. 2020;396:1204–1222. doi: 10.1016/S0140-6736(20)30925-9
15. Murray CJL, Aravkin AY, Zheng P, Abbafati C, Abbas KM, Abbasi-Kangevari M, Abd-Allah F, Abdelalim A, Abdollahi M, Abdollahpour I, et al. Global burden of 87 risk factors in 204 countries and territories, 1990–2019: a systematic analysis for the global burden of disease study 2019. *Lancet*. 2020;396:1223–1249. doi: 10.1016/S0140-6736(20)30752-2
16. Ostro B, Spadaro JV, Gummy S, Mudu P, Awe Y, Forastiere F, Peters A. Assessing the recent estimates of the global burden of disease for ambient air pollution: methodological changes and implications for low- and middle-income countries. *Environ Res*. 2018;166:713–725. doi: 10.1016/j.envres.2018.03.001
17. The impact of air pollution on deaths. Disease burden, and life expectancy across the states of India: the global burden of disease study 2017. *Lancet Planet Health*. 2019;3:e26–e39.
18. Bennett FB, Wozniak SS, Causey K, Burkart K, Brauer M. Estimating disease burden attributable to household air pollution: new methods within the global burden of disease study. *Lancet Glob Health*. 2021;9:S18. doi: 10.1016/S2214-109X(21)00126-1
19. Bu X, Xie Z, Liu J, Wei L, Wang X, Chen M, Ren H. Global PM2.5-attributable health burden from 1990 To 2017: estimates from the global burden of disease study 2017. *Environ Res*. 2021;197:111123. doi: 10.1016/j.envres.2021.111123
20. Network GBoDC. Global Burden of Disease Study 2019 (GBD 2019) Cause List Mapped to ICD Codes. In: (IHME) IfHMaE, editor. Seattle, United States of America 2020.
21. Murray CJ, Lopez AD. Global mortality, disability, and the contribution of risk factors: global burden of disease study. *Lancet*. 1997;349:1436–1442. doi: 10.1016/S0140-6736(96)07495-8
22. Murray CJ, Ezzati M, Lopez AD, Rodgers A, Vander HS. Comparative quantification of health risks: conceptual framework and methodological issues. *Popul Health Metrics*. 2003;1:1–20. doi: 10.1186/1478-7954-1-1
23. Fitzmaurice C, Allen C, Barber RM, Barregard L, Bhutta ZA, Brenner H, Dicker DJ, Chimed-Orchir O, Dandona R, Dandona L, et al. Global, regional, and National Cancer Incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 32 cancer groups, 1990 to 2015: a systematic analysis for the global burden of disease study. *JAMA Oncol*. 2017;3:524–548. doi: 10.1001/jamaoncol.2016.5688
24. Liu Z, Jiang Y, Yuan H, Fang Q, Cai N, Suo C, Jin L, Zhang T, Chen X. The trends in incidence of primary liver cancer caused by specific etiologies: results from the global burden of disease study 2016 and implications for liver cancer prevention. *J Hepatol*. 2019;70:674–683. doi: 10.1016/j.jhep.2018.12.001
25. Aminorroaya A, Ghasemi E, Shabani M, Rezaei N, Mohammadi E, Fattahi N, Farzadfar F. Global, regional, and national quality of care and burden of ischemic heart disease, 1990 To 2017: results from the GBD study 2017. *Eur Heart J*. 2020;41:ehaa946-3560. doi: 10.1093/ehjci/ehaa946.3560
26. Abbasi-Kangevari M, Ahmadi N, Fattahi N, Rezaei N, Malekpour MR, Ghamari SH, Moghaddam SS, Azadnajafabad S, Esfahani Z, Kolahi AA, et al. Quality of care of peptic ulcer disease worldwide: a systematic analysis for the global burden of disease study 1990-2019. *PLoS One*. 2022;17:e0271284. doi: 10.1371/journal.pone.0271284
27. Forouzanfar MH, Afshin A, Alexander LT, Anderson HR, Bhutta ZA, Biryukov S, Brauer M, Burnett R, Cercy K, Charlson FJ, et al. Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990–2015: a systematic analysis for the global burden of disease study 2015. *Lancet*. 2016;388:1659–1724. doi: 10.1016/S0140-6736(16)31679-8
28. Pishgar F, Haj-Mirzaian A, Ebrahimi H, Saeedi Moghaddam S, Mohajer B, Nowroozi MR, Ayati M, Farzadfar F, Fitzmaurice C, Amini E. Global, regional and national burden of testicular cancer, 1990–2016: results from the global burden of disease study 2016. *BJU Int*. 2019;124:386–394. doi: 10.1111/bju.14771
29. Crouse DL, Peters PA, van Donkelaar A, Goldberg MS, Villeneuve PJ, Brion O, Khan S, Atari DO, Jerrett M, Pope CA III. Risk of nonaccidental and cardiovascular mortality in relation to long-term exposure to low concentrations of fine particulate matter: a Canadian national-level cohort study. *Environ Health Perspect*. 2012;120:708–714. doi: 10.1289/ehp.1104049
30. Miller MR, Newby DE. Air pollution and cardiovascular disease: car sick. *Cardiovasc Res*. 2020;116:279–294. doi: 10.1093/cvr/cvz228
31. Pinault LL, Weichenthal S, Crouse DL, Brauer M, Erickson A, van Donkelaar A, Martin RV, Hystad P, Chen H, Finès P. Associations between fine particulate matter and mortality in the 2001 Canadian census health and environment cohort. *Environ Res*. 2017;159:406–415. doi: 10.1016/j.envres.2017.08.037
32. Aryal A, Harmon AC, Dugas TR. Particulate matter air pollutants and cardiovascular disease: strategies for intervention. *Pharmacol Ther*. 2021;223:107890. doi: 10.1016/j.pharmthera.2021.107890
33. Hailu AD, Kumsa DK. Ethiopia renewable energy potentials and current state. *Aims Energy*. 2021;9:1–14. doi: 10.3934/energy.2021001
34. Stecher K, Brosowski A, Thrän D. Biomass potential in Africa. International Renewable Energy Agency (IRENA). 2013:1–43.
35. Ali MU, Yu Y, Yousaf B, Munir MAM, Ullah S, Zheng C, Kuang X, Wong MH. Health impacts of indoor air pollution from household solid fuel on children and women. *J Hazard Mater*. 2021;416:126127. doi: 10.1016/j.jhazmat.2021.126127
36. Rosário Filho NA, Urrutia-Pereira M, D'Amato G, Cecchi L, Ansotegui IJ, Galán C, Pomés A, Murrieta-Aguttes M, Caraballo L, Rouadi P, et al. Air pollution and indoor settings. *World Allergy Organ J*. 2021;14:14. doi: 10.1016/j.waojou.2020.100499
37. Milanzi EB, Nkoka O, Kanje V, Ntenda PAM. Air pollution and non-communicable diseases in sub-Saharan Africa. *Sci Afr*. 2021;11:e00702. doi: 10.1016/j.sciaf.2021.e00702
38. Barker-Collo S, Bennett DA, Krishnamurthi RV, Parmar P, Feigin VL, Naghavi M, Forouzanfar MH, Johnson CO, Nguyen G, Mensah GA, et al. Sex differences in stroke incidence, prevalence, mortality and disability-adjusted life years: results from the global burden of disease study 2013. *Neuroepidemiology*. 2015;45:203–214. doi: 10.1159/000441103
39. Puett RC, Schwartz J, Hart JE, Yanosky JD, Speizer FE, Suh H, Paciorek CJ, Neas LM, Laden F. Chronic particulate exposure, mortality, and coronary heart disease in the nurses' health study. *Am J Epidemiol*. 2008;168:1161–1168. doi: 10.1093/aje/kwn232
40. Landrigan PJ, Fuller R, Acosta NJ, Adeyi O, Arnold R, Baldé AB, Bertollini R, Bose-O'Reilly S, Boufford JL, Breyse PN. The lancet commission on pollution and health. *Lancet*. 2018;391:462–512. doi: 10.1016/S0140-6736(17)32345-0
41. Wang L, Wu X, Du J, Cao W, Sun S. Global burden of ischemic heart disease attributable to ambient PM2.5 pollution from 1990 to 2017. *Chemosphere*. 2021;263:128134. doi: 10.1016/j.chemosphere.2020.128134
42. Okello G, Devereux G, Semple S. Women and girls in resource poor countries experience much greater exposure to household air pollutants than men: results from Uganda and Ethiopia. *Environ Int*. 2018;119:429–437. doi: 10.1016/j.envint.2018.07.002
43. Woolley KE, Dickinson-Craig E, Bartington SE, Oludotun T, Kirenga B, Mariga ST, Kabera T, Coombe A, Pope FD, Singh A, et al. Effectiveness of interventions to reduce household air pollution from solid biomass fuels and improve maternal and child health outcomes in low- and middle-income countries: a systematic review protocol. *Syst Rev*. 2021;10:33. doi: 10.1186/s13643-021-01590-z
44. Pope CA III, Muhlestein JB, May HT, Renlund DG, Anderson JL, Horne BD. Ischemic heart disease events triggered by short-term exposure to fine particulate air pollution. *Circulation*. 2006;114:2443–2448. doi: 10.1161/CIRCULATIONAHA.106.636977
45. Zhang R, Liu G, Jiang Y, Li G, Pan Y, Wang Y, Wei Z, Wang J, Wang Y. Acute effects of particulate air pollution on ischemic stroke and

- hemorrhagic stroke mortality. *Front Neurol*. 2018;9:827. doi: [10.3389/fneur.2018.00827](https://doi.org/10.3389/fneur.2018.00827)
46. Silva RA, West JJ, Lamarque JF, Shindell DT, Collins WJ, Dalsoren S, Faluvegi G, Folberth G, Horowitz LW, Nagashima T, et al. The effect of future ambient air pollution on human premature mortality to 2100 using output from the ACCMIP model ensemble. *Atmos Chem Phys*. 2016;16:9847–9862. doi: [10.5194/acp-16-9847-2016](https://doi.org/10.5194/acp-16-9847-2016)
 47. Abbasi-Kangevari M, Malekpour M-R, Masinaei M, Moghaddam SS, Ghamari S-H, Abbasi-Kangevari Z, Rezaei N, Rezaei N, Mokdad AH, Naghavi M, et al. Effect of air pollution on disease burden, mortality, and life expectancy in North Africa and the Middle East: a systematic analysis for the global burden of disease study 2019. *Lancet Planetary Health*. 2023;7:e358–e369. doi: [10.1016/S2542-5196\(23\)00053-0](https://doi.org/10.1016/S2542-5196(23)00053-0)
 48. Abbass RA, Kumar P, El-Gendy A. An overview of monitoring and reduction strategies for health and climate change related emissions in the Middle East and North Africa region. *Atmos Environ*. 2018;175:33–43. doi: [10.1016/j.atmosenv.2017.11.061](https://doi.org/10.1016/j.atmosenv.2017.11.061)
 49. Stanaway JD, Afshin A, Gakidou E, Lim SS, Abate D, Abate KH, Abbafati C, Abbasi N, Abbastabar H, Abd-Allah F, et al. Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks for 195 countries and territories, 1990–2017: a systematic analysis for the global burden of disease study 2017. *Lancet*. 2018;392:1923–1994. doi: [10.1016/S0140-6736\(18\)32225-6](https://doi.org/10.1016/S0140-6736(18)32225-6)
 50. United Nations. World Population Ageing 2019: highlights (ST/ESA/SER.A/430). Department of Economic and Social Affairs, Population Division. 2019.
 51. Cohen AJ, Brauer M, Burnett R, Anderson HR, Frostad J, Estep K, Balakrishnan K, Brunekreef B, Dandona L, Dandona R, et al. Estimates and 25-year trends of the global burden of disease attributable to ambient air pollution: an analysis of data from the global burden of diseases study 2015. *Lancet*. 2017;389:1907–1918. doi: [10.1016/S0140-6736\(17\)30505-6](https://doi.org/10.1016/S0140-6736(17)30505-6)
 52. Krall JR, Mulholland JA, Russell AG, Balachandran S, Winquist A, Tolbert PE, Waller LA, Sarnat SE. Associations between source-specific fine particulate matter and emergency department visits for respiratory disease in four US cities. *Environ Health Perspect*. 2017;125:97–103. doi: [10.1289/EHP271](https://doi.org/10.1289/EHP271)
 53. Achilleos S, Kioumourtzoglou M-A, Wu C-D, Schwartz JD, Koutrakis P, Papatheodorou SI. Acute effects of fine particulate matter constituents on mortality: a systematic review and meta-regression analysis. *Environ Int*. 2017;109:89–100. doi: [10.1016/j.envint.2017.09.010](https://doi.org/10.1016/j.envint.2017.09.010)
 54. Chung Y, Dominici F, Wang Y, Coull BA, Bell ML. Associations between long-term exposure to chemical constituents of fine particulate matter (PM_{2.5}) and mortality in Medicare enrollees in the eastern United States. *Environ Health Perspect*. 2015;123:467–474. doi: [10.1289/ehp.1307549](https://doi.org/10.1289/ehp.1307549)
 55. Crouse DL, Pinault L, Balram A, Brauer M, Burnett RT, Martin RV, van Donkelaar A, Villeneuve PJ, Weichenthal S. Complex relationships between greenness, air pollution, and mortality in a population-based Canadian cohort. *Environ Int*. 2019;128:292–300. doi: [10.1016/j.envint.2019.04.047](https://doi.org/10.1016/j.envint.2019.04.047)

SUPPLEMENTAL MATERIAL

Table S1. Crude rates of YLLs, YLDs, deaths and DALYs attributed to CVD attributed to PM pollution, ambient PM pollution, and HAP from solid fuels from 1990 to 2019; YLLs: years lived with disability, YLDs: years lived with disability, DALYs: disability-adjusted life years, CVD: cardiovascular disease, PM: particulate matter.

Cause	Location	Risk factor	Measure	Year						% Change (1990 to 2019)		
				1990			2019			Both	Female	Male
				Both	Female	Male	Both	Female	Male			
Cardiovascular diseases	Global	Particulate matter pollution	Deaths	48.7 (43 to 54.5)	45.3 (39.1 to 51.8)	52 (46.1 to 58.5)	45.8 (40.6 to 51.4)	40 (34.6 to 45.7)	51.6 (45.2 to 58.5)	-5.9 (-16 to 4.3)	-11.7 (-23.8 to 1.9)	-0.7 (-13 to 12.1)
			DALYs	1267.2 (1139.5 to 1398.5)	1099 (969.2 to 1234.3)	1433 (1282.4 to 1598.8)	1148 (1023.9 to 1278.2)	935.8 (819.1 to 1057.8)	1359 (1193.4 to 1536.7)	-9.4 (-18.6 to -0.6)	-14.9 (-25.7 to -3.3)	-5.2 (-16.4 to 6.7)
			YLLs	1199.4 (1073.7 to 1326.6)	1022.5 (902.4 to 1151.1)	1373.7 (1227.4 to 1536.9)	1066.9 (948.8 to 1191.8)	845.7 (733.7 to 958.1)	1286.7 (1127.3 to 1460.7)	-11 (-20.7 to -2)	-17.3 (-28.5 to -5)	-6.3 (-17.8 to 5.9)
			YLDs	67.8 (48 to 87.9)	76.5 (53.9 to 99.2)	59.2 (42.2 to 77.3)	81.1 (57.3 to 104.1)	90.1 (63.4 to 116)	72.2 (51.1 to 94)	19.7 (12.2 to 26.9)	17.8 (10 to 25.3)	22 (14.5 to 29.4)
		Ambient particulate matter pollution	Deaths	20.9 (15.1 to 27)	18.5 (13.4 to 23.9)	23.1 (16.6 to 30.2)	32 (26.5 to 37.1)	26.3 (21.2 to 31.5)	37.7 (31.1 to 43.8)	53.4 (25.9 to 94.4)	41.9 (15.1 to 82.8)	62.7 (30.7 to 107.6)
			DALYs	513 (372.7 to 673.1)	406.4 (290.9 to 538.6)	618.2 (444.5 to 816.7)	787.2 (647.1 to 908.8)	596.2 (485.4 to 709.6)	977.1 (794.4 to 1138.6)	53.4 (25.2 to 93.4)	46.7 (18.3 to 87.2)	58.1 (26.5 to 100.3)
			YLLs	485 (351.6 to 636.3)	376.1 (269.7 to 498.8)	592.3 (424.6 to 779.7)	728.8 (601.2 to 842.5)	533.7 (433 to 636.2)	922.7 (748.5 to 1078.9)	50.3 (22.7 to 89.7)	41.9 (13.8 to 81.6)	55.8 (24.6 to 98.4)
			YLDs	28.1 (18 to 39.8)	30.3 (19.4 to 43.2)	25.9 (16.6 to 37.6)	58.4 (40.4 to 77.2)	62.5 (42.9 to 83)	54.4 (37.8 to 71.7)	108.1 (70.3 to 164.2)	106.5 (68.9 to 160.1)	109.8 (70.4 to 169.1)
		Household air pollution from solid fuels	Deaths	27.8 (21.5 to 34.5)	26.8 (20.8 to 33.4)	28.8 (21.5 to 36.7)	13.8 (9.4 to 19)	13.7 (9.5 to 18.5)	13.9 (8.9 to 20.5)	-50.3 (-61.9 to -37.8)	-48.8 (-60.8 to -36.1)	-51.7 (-64.4 to -37.2)
			DALYs	754.1 (586.7 to 923.7)	692.6 (546 to 848)	814.8 (613.9 to 1030.6)	360.8 (249.7 to 496.6)	339.6 (240.7 to 448.4)	381.9 (247.6 to 553.2)	-52.2 (-62.9 to -40.7)	-51 (-62 to -39.8)	-53.1 (-65.2 to -39.3)
			YLLs	714.4 (555.7 to 873.6)	646.4 (509.1 to 788.6)	781.5 (586.3 to 988.5)	338.1 (233.9 to 462.1)	312.1 (220.8 to 414.3)	364 (236.3 to 527.8)	-52.7 (-63.2 to -41.3)	-51.7 (-62.6 to -40.7)	-53.4 (-65.3 to -39.6)
			YLDs	39.7 (26.7 to 53.6)	46.2 (31.4 to 61.8)	33.3 (21.8 to 46.3)	22.7 (13.9 to 34)	27.5 (17.1 to 40.1)	17.9 (10.3 to 28.1)	-42.8 (-57.1 to -27.7)	-40.4 (-55.1 to -24.5)	-46.3 (-60.4 to -30.2)
	High SDI	Particulate matter pollution	Deaths	32.4 (20.9 to 45)	30.5 (19.4 to 42.7)	34.4 (22.5 to 47.7)	14.5 (10.9 to 18.5)	12.4 (9 to 16.2)	16.6 (12.6 to 20.9)	-55.3 (-68.2 to -37)	-59.4 (-71.2 to -42.1)	-51.8 (-65.3 to -32.5)
			DALYs	695.6 (466.5 to 942.4)	570.7 (383.7 to 776.1)	824.3 (554.4 to 1118.8)	320.6 (247.6 to 400.4)	238.8 (180.6 to 303)	402.7 (313.8 to 502.1)	-53.9 (-66.3 to -36.5)	-58.2 (-69.5 to -41.7)	-51.1 (-63.8 to -32.6)
			YLLs	649.6 (435.4 to 884.9)	518.9 (345.6 to 707.1)	784.3 (528 to 1063.9)	279.5 (216.1 to 349.9)	194.6 (146.1 to 247.8)	364.8 (282 to 455.4)	-57 (-68.6 to -40.4)	-62.5 (-72.8 to -47.8)	-53.5 (-65.6 to -35.6)

Cause	Location	Risk factor	Measure	Year						% Change (1990 to 2019)			
				1990			2019			Both	Female	Male	
				Both	Female	Male	Both	Female	Male				
			YLDs	46 (28.4 to 66.7)	51.8 (32.1 to 75)	40 (24.9 to 58.1)	41.1 (26.8 to 56.6)	44.2 (29 to 61.4)	37.9 (25.1 to 52.8)	-10.7 (-33.8 to 21.8)	-14.7 (-37.4 to 16.4)	-5.3 (-28.9 to 29.8)	
		Ambient particulate matter pollution	Deaths	30.9 (19.6 to 43.4)	28.9 (18.1 to 41.2)	33 (21.3 to 46)	14.4 (10.8 to 18.4)	12.3 (8.9 to 16.1)	16.5 (12.5 to 20.8)	-53.5 (-67.3 to -32.7)	-57.6 (-70.4 to -38.3)	-50 (-64.3 to -28.3)	
			DALYs	658.4 (430.5 to 906.1)	535.6 (345.3 to 738.2)	785 (517.9 to 1079.8)	318.4 (245.5 to 398.5)	236.7 (178.7 to 300.5)	400.5 (311.4 to 499.6)	-51.6 (-65 to -31.8)	-55.8 (-68.3 to -37.5)	-49 (-62.6 to -28.1)	
			YLLs	615.3 (403.7 to 849.4)	487.3 (315.2 to 677.2)	747.2 (493.2 to 1029.6)	277.7 (213.9 to 347.4)	192.9 (145 to 245.4)	362.8 (280.4 to 453.1)	-54.9 (-67.2 to -36.2)	-60.4 (-71.7 to -43.5)	-51.4 (-64.5 to -31)	
			YLDs	43.1 (26.4 to 63)	48.3 (29.2 to 70.5)	37.7 (23 to 55.2)	40.7 (26.7 to 56.2)	43.8 (28.8 to 60.7)	37.7 (25 to 52.6)	-5.5 (-30.7 to 32.9)	-9.4 (-34.2 to 28.4)	-0.1 (-25.5 to 40.6)	
		Household air pollution from solid fuels	Deaths	1.5 (0.8 to 2.5)	1.5 (0.9 to 2.5)	1.5 (0.8 to 2.5)	0.1 (0 to 0.2)	0.1 (0 to 0.3)	0.1 (0 to 0.2)	-93.3 (-97.3 to -87.8)	-92.9 (-97.1 to -87.4)	-93.6 (-97.5 to -88)	
			DALYs	37.2 (20.6 to 60.1)	35.1 (20.4 to 55.2)	39.3 (20.8 to 67.3)	2.2 (0.6 to 5.3)	2.1 (0.6 to 5.3)	2.2 (0.6 to 5.7)	-94.2 (-97.7 to -89.2)	-94.1 (-97.6 to -89.1)	-94.4 (-97.8 to -89.1)	
			YLLs	34.3 (18.9 to 55.8)	31.6 (18.3 to 49)	37.1 (19.4 to 63.1)	1.8 (0.5 to 4.5)	1.6 (0.5 to 4.1)	2 (0.5 to 5.1)	-94.7 (-97.9 to -90.1)	-94.8 (-97.9 to -90.3)	-94.6 (-97.9 to -89.6)	
			YLDs	2.9 (1.5 to 4.8)	3.5 (1.8 to 5.8)	2.3 (1.1 to 4.1)	0.3 (0.1 to 0.8)	0.4 (0.1 to 1.2)	0.2 (0.1 to 0.6)	-88.5 (-95.2 to -79.1)	-87.4 (-94.6 to -77.6)	-90.2 (-96.1 to -81.7)	
	High-middle SDI	Particulate matter pollution	Deaths	61.9 (51.1 to 73)	60 (48.3 to 72.6)	63.9 (53.2 to 74.5)	51.1 (43.2 to 59.4)	45.5 (37.1 to 54.1)	56.8 (47.5 to 66.9)	-17.4 (-29.5 to -3.4)	-24.3 (-37.7 to -7)	-11 (-25.5 to 5.7)	
				DALYs	1495.3 (1260.8 to 1735)	1298 (1067.3 to 1537.2)	1694.8 (1416.4 to 1971.2)	1144 (974.2 to 1315.4)	911 (759.5 to 1072.6)	1377.5 (1146.7 to 1617)	-23.5 (-34.3 to -11.2)	-29.8 (-41 to -15.5)	-18.7 (-32.2 to -3.5)
				YLLs	1407.5 (1178.7 to 1633.8)	1196.7 (978.7 to 1421)	1620.6 (1353.2 to 1890.3)	1037.3 (879.5 to 1200.9)	791.5 (651.8 to 933.9)	1283.6 (1062.4 to 1516.8)	-26.3 (-37.4 to -14)	-33.9 (-45.1 to -19.1)	-20.8 (-34.4 to -5.5)
				YLDs	87.9 (61.7 to 116.1)	101.3 (70.6 to 134.3)	74.2 (52.2 to 97.8)	106.7 (74.8 to 140)	119.4 (83.9 to 156.7)	93.8 (65.8 to 123.8)	21.4 (8.9 to 35.7)	17.9 (4.6 to 32.9)	26.4 (14.8 to 39.8)
			Ambient particulate matter pollution	Deaths	38.8 (27.5 to 49.6)	36.5 (25 to 48.2)	41.1 (29.8 to 51.8)	46.2 (38.4 to 53.9)	40.2 (32.6 to 48.4)	52.1 (43 to 61.2)	18.9 (-5.3 to 55.9)	10 (-16.7 to 51.4)	26.7 (-0.7 to 67.7)
				DALYs	918 (654.9 to 1174.2)	754.7 (519.8 to 989.9)	1083.2 (783.4 to 1372.1)	1033 (862.7 to 1190.7)	803.1 (658.7 to 952.9)	1263.4 (1045.5 to 1477.2)	12.5 (-10.3 to 46.9)	6.4 (-18 to 45.7)	16.6 (-8.3 to 54)

Cause	Location	Risk factor	Measure	Year						% Change (1990 to 2019)			
				1990			2019			Both	Female	Male	
				Both	Female	Male	Both	Female	Male				
			YLLs	867.3 (617.4 to 1111.4)	697.7 (480 to 914.8)	1038.7 (753.8 to 1309.9)	937.6 (786.9 to 1089.4)	698.1 (569.8 to 839.2)	1177.6 (964.4 to 1385.8)	8.1 (-13.8 to 41.3)	0.1 (-23.2 to 37.2)	13.4 (-11 to 50.6)	
			YLDs	50.8 (31.9 to 71.6)	56.9 (35.2 to 81.4)	44.5 (27.8 to 63.3)	95.4 (66.4 to 125.8)	105 (72.7 to 139.1)	85.8 (60 to 113.1)	87.9 (51.3 to 146.5)	84.4 (45.6 to 149.1)	92.7 (55.1 to 153.5)	
		Household air pollution from solid fuels	Deaths	23.1 (15.9 to 31.7)	23.5 (16.3 to 31.6)	22.7 (14.4 to 32.8)	5 (2.1 to 9.6)	5.3 (2.2 to 9.9)	4.7 (1.8 to 9.5)	-78.4 (-88.9 to -65.5)	-77.6 (-88.2 to -64.7)	-79.2 (-90 to -65.9)	
			DALYs	577.3 (400.7 to 789.1)	543.4 (384.7 to 712.4)	611.6 (387.5 to 870.3)	111 (46.5 to 215)	107.8 (47.2 to 200.5)	114.1 (44 to 227)	-80.8 (-90.1 to -69.4)	-80.2 (-89.6 to -68.6)	-81.3 (-91.1 to -69.4)	
			YLLs	540.2 (373.3 to 735.7)	499 (351.2 to 659.1)	581.9 (367.1 to 829.9)	99.7 (41.2 to 192.9)	93.4 (39.8 to 175.2)	106.1 (40.3 to 212.1)	-81.5 (-90.5 to -70.5)	-81.3 (-90.3 to -70.2)	-81.8 (-91.3 to -69.9)	
			YLDs	37.1 (23 to 52.8)	44.4 (28 to 62.4)	29.7 (17.5 to 44.3)	11.3 (4.7 to 21.8)	14.5 (6.1 to 27.7)	8 (3.1 to 16.7)	-69.6 (-84.5 to -50)	-67.4 (-82.9 to -46.9)	-72.9 (-86.9 to -54.1)	
	Middle SDI	Particulate matter pollution	Deaths	49.2 (44.2 to 55.1)	46.4 (40.8 to 53)	51.9 (45.8 to 58.6)	56.5 (49.3 to 64)	48.2 (41 to 55.6)	64.8 (55.6 to 74.4)	14.9 (0.4 to 29.9)	3.9 (-13.4 to 22.3)	24.7 (6.2 to 44.5)	
				DALYs	1333.9 (1204.2 to 1473.8)	1191 (1056.9 to 1344.1)	1472 (1306.3 to 1654.2)	1406 (1233.7 to 1583.8)	1123 (974.9 to 1283.1)	1685.5 (1447.2 to 1924.3)	5.4 (-7.1 to 18.2)	-5.7 (-19.1 to 9.5)	14.5 (-1.9 to 32.1)
				YLLs	1254.8 (1134.2 to 1397.3)	1101.4 (973 to 1243.9)	1403.1 (1244.9 to 1581.6)	1296.6 (1132.2 to 1468.6)	1000.3 (857.2 to 1150.6)	1589 (1357.9 to 1827.9)	3.3 (-9.6 to 16.8)	-9.2 (-23.1 to 7.2)	13.3 (-3.9 to 31.7)
				YLDs	79.1 (56.1 to 101.5)	89.6 (63.2 to 115.3)	68.9 (49.3 to 88.4)	109.5 (77.4 to 141.8)	122.6 (86.4 to 158.7)	96.4 (68.2 to 126.4)	38.4 (29.9 to 45.9)	36.8 (28.6 to 44.7)	40 (30.9 to 48.7)
			Ambient particulate matter pollution	Deaths	17.7 (11.5 to 24.9)	14.4 (9.4 to 20.8)	21 (13.5 to 29.6)	44.8 (37.7 to 51.5)	36.4 (29.7 to 43.6)	53.1 (44.1 to 61.5)	152.5 (82.6 to 263.1)	152.6 (77.2 to 267.9)	153.3 (83.7 to 270)
				DALYs	486.6 (320.6 to 682.2)	373.1 (240.8 to 540.5)	596.4 (384.1 to 839.8)	1116.9 (943.6 to 1275.7)	850.4 (704.5 to 1006.1)	1380.1 (1153.7 to 1593.8)	129.5 (67.6 to 230)	127.9 (60.7 to 232)	131.4 (68.4 to 237.4)
				YLLs	460.8 (301.7 to 649.7)	347.1 (224.7 to 504.4)	570.7 (368.1 to 801.9)	1033.1 (872.9 to 1185.8)	760.1 (624.3 to 903.3)	1302.6 (1079.8 to 1510.7)	124.2 (63.6 to 220.6)	118.9 (54.1 to 220.9)	128.2 (65.5 to 233.1)
				YLDs	25.8 (14.5 to 40.1)	25.9 (14.8 to 40.2)	25.7 (14.5 to 40)	83.9 (57.8 to 111.1)	90.3 (61.4 to 119.9)	77.5 (53.4 to 101.5)	225 (136.3 to 376.7)	248.3 (151.8 to 415.4)	201.8 (117.5 to 351.2)
		Household air	Deaths	31.5 (23.3 to 39.3)	32 (24.4 to 39.8)	31 (21.9 to 40.5)	11.7 (6.3 to 18.9)	11.8 (6.5 to 18)	11.7 (5.7 to 20.1)	-62.7 (-78.5 to -44.8)	-63.2 (-78.3 to -45.4)	-62.3 (-79.9 to -41.6)	

Cause	Location	Risk factor	Measure	Year						% Change (1990 to 2019)			
				1990			2019			Both	Female	Male	
				Both	Female	Male	Both	Female	Male				
		pollution from solid fuels	DALYs	847.2 (635.4 to 1054.8)	817.9 (632.3 to 1015)	875.6 (623.2 to 1138.8)	289.1 (158.1 to 465.7)	272.6 (154 to 414.1)	305.3 (148.5 to 523.7)	-65.9 (-80.3 to -49.5)	-66.7 (-80.2 to -50.8)	-65.1 (-81 to -46)	
			YLLs	793.9 (595.6 to 987.8)	754.2 (579.4 to 935)	832.4 (589.5 to 1090.1)	263.5 (142.9 to 424.6)	240.3 (133.6 to 367.6)	286.4 (141 to 492.8)	-66.8 (-80.9 to -51)	-68.1 (-81.3 to -52.9)	-65.6 (-81.3 to -46.8)	
			YLDs	53.3 (35.3 to 72.6)	63.7 (42.9 to 85.7)	43.2 (28.1 to 61.1)	25.6 (13.2 to 42.6)	32.3 (17.4 to 51.7)	18.9 (8.8 to 34.8)	-52 (-71.6 to -30.4)	-49.2 (-69.4 to -26.9)	-56.2 (-75.4 to -33.4)	
			Deaths	48.6 (42.6 to 55.8)	42.9 (36.2 to 50.7)	54 (47.5 to 61.6)	53 (46.7 to 59.4)	46.7 (39.5 to 54)	59.2 (51.5 to 67.5)	9 (-6.1 to 23.2)	8.7 (-10 to 29.9)	9.6 (-5.6 to 26.1)	
	Low-middle SDI	Particulate matter pollution	DALYs	1369.7 (1217.6 to 1547)	1170.3 (1010.1 to 1351.1)	1561.3 (1385 to 1770.1)	1416.4 (1256.9 to 1583.9)	1183.6 (1013.3 to 1361.3)	1646.9 (1425.8 to 1878.9)	3.4 (-9.4 to 16.4)	1.1 (-15.2 to 18.7)	5.5 (-8.6 to 21.4)	
				YLLs	1315.6 (1167.2 to 1487.4)	1111 (958.1 to 1284.9)	1512.1 (1337.5 to 1716.9)	1348.7 (1190.6 to 1510.9)	1109.1 (940.2 to 1284.9)	1585.8 (1367 to 1817.6)	2.5 (-10.8 to 15.9)	-0.2 (-17 to 18.2)	4.9 (-9.5 to 21.2)
				YLDs	54.2 (38.9 to 70.2)	59.3 (42.1 to 76.9)	49.3 (35.3 to 64.1)	67.7 (48.5 to 86.7)	74.5 (53.1 to 95.3)	61.1 (43.8 to 79)	25 (17.2 to 31.3)	25.6 (16.9 to 32.4)	24 (16.5 to 30)
				Deaths	7.7 (3.6 to 13.7)	5.5 (2.6 to 9.9)	9.8 (4.3 to 17.7)	27.5 (19.6 to 34.6)	21.5 (15.2 to 28.1)	33.5 (23.2 to 42.3)	258.5 (123.9 to 568.6)	290.2 (135.9 to 611.9)	243.2 (109.7 to 557.7)
			Ambient particulate matter pollution	DALYs	216.9 (99.5 to 393.6)	149.4 (70 to 272.1)	281.8 (122.5 to 514.8)	738.6 (521.2 to 931.9)	545.5 (383.1 to 710)	929.8 (644.5 to 1181)	240.5 (110 to 543.6)	265.2 (118.4 to 578.6)	229.9 (99.9 to 538.5)
				YLLs	208.5 (94.7 to 378.6)	141.5 (66.3 to 256.2)	272.8 (118.4 to 499.8)	704.8 (496.8 to 887)	511.6 (356.6 to 670.8)	896.1 (620.3 to 1137.3)	238.1 (107.9 to 537.8)	261.5 (116 to 572.9)	228.5 (99.1 to 536.6)
				YLDs	8.4 (3.6 to 15.7)	7.8 (3.4 to 14.5)	9 (3.8 to 16.9)	33.8 (21.9 to 47)	33.9 (22.1 to 48.1)	33.7 (21.8 to 46.6)	300.3 (151.5 to 628.2)	332.3 (171.4 to 678.4)	273.5 (135.6 to 595.8)
				Deaths	40.9 (31.9 to 50.9)	37.4 (29.4 to 47.1)	44.3 (33.9 to 55.4)	25.5 (17.5 to 34.2)	25.2 (17.8 to 33.5)	25.7 (16.5 to 36.4)	-37.8 (-53.5 to -21.8)	-32.7 (-49.4 to -14.7)	-41.9 (-58.7 to -23)
		Household air pollution from solid fuels	DALYs	1152.8 (907.7 to 1406.6)	1020.9 (821.1 to 1249.1)	1279.5 (986.1 to 1579.6)	677.8 (469 to 906.9)	638.1 (455 to 836.4)	717.1 (459.8 to 1010.9)	-41.2 (-56 to -26.3)	-37.5 (-52.4 to -21.7)	-44 (-60.3 to -26.1)	
			YLLs	1107.1 (876.7 to 1352.2)	969.5 (779 to 1187.1)	1239.3 (952 to 1529.9)	643.8 (442.7 to 864.3)	597.5 (424.5 to 787.1)	689.7 (437.5 to 972.5)	-41.8 (-56.8 to -26.7)	-38.4 (-53.5 to -22.2)	-44.3 (-60.7 to -26.4)	
			YLDs	45.7 (31.1 to 61.6)	51.5 (35.3 to 68.9)	40.2 (27 to 54.8)	34 (21.7 to 48.4)	40.6 (26.6 to 56.4)	27.4 (16.1 to 40.6)	-25.7 (-41.9 to -9.3)	-21.1 (-36.8 to -5.1)	-31.9 (-50 to -13.5)	
			Deaths	40.9 (31.9 to 50.9)	37.4 (29.4 to 47.1)	44.3 (33.9 to 55.4)	25.5 (17.5 to 34.2)	25.2 (17.8 to 33.5)	25.7 (16.5 to 36.4)	-37.8 (-53.5 to -21.8)	-32.7 (-49.4 to -14.7)	-41.9 (-58.7 to -23)	

Cause	Location	Risk factor	Measure	Year						% Change (1990 to 2019)		
				1990			2019			Both	Female	Male
				Both	Female	Male	Both	Female	Male			
Ischemic heart disease	Low SDI	Particulate matter pollution	Deaths	43.5 (36.6 to 53.2)	38.3 (29.4 to 49.7)	48.7 (41 to 58.2)	33.3 (28.7 to 38.4)	30.4 (25.6 to 35.7)	36.2 (30.5 to 42.1)	-23.5 (-34.6 to -12.1)	-20.6 (-34.9 to -4.2)	-25.7 (-37 to -10.6)
			DALYs	1224 (1046.4 to 1463.9)	1054.3 (846.8 to 1316.8)	1390.7 (1183.8 to 1630.6)	929.2 (806.3 to 1063.2)	813.7 (696 to 943.1)	1043.9 (885.5 to 1212.8)	-24.1 (-34.4 to -13.4)	-22.8 (-35.7 to -8.7)	-24.9 (-36.1 to -10.4)
			YLLs	1173.7 (1002.2 to 1408.2)	999.6 (795.3 to 1256.8)	1344.7 (1137.4 to 1581.4)	883.7 (759.4 to 1018.6)	764.2 (649.6 to 890.7)	1002.4 (843.1 to 1167.7)	-24.7 (-35.2 to -13.8)	-23.5 (-36.6 to -8.6)	-25.5 (-37.1 to -10.5)
			YLDs	50.3 (35.6 to 65.8)	54.7 (38.5 to 71.7)	46 (32.7 to 60.3)	45.5 (32.6 to 58)	49.5 (35.4 to 62.6)	41.5 (29.7 to 53.2)	-9.6 (-16.6 to -4.2)	-9.6 (-17.1 to -3.9)	-9.8 (-16.6 to -4.7)
		Ambient particulate matter pollution	Deaths	4.4 (1.6 to 9.2)	2.9 (1 to 6.4)	5.8 (2 to 12)	9.7 (6.1 to 14.1)	7.3 (4.6 to 10.8)	12.1 (7.3 to 17.4)	122.6 (39.7 to 344.8)	149.1 (49.1 to 400.7)	109.7 (29.8 to 335.2)
			DALYs	124.4 (44.4 to 261.2)	82.5 (28.4 to 181.8)	165.6 (58.6 to 347.1)	273.5 (168.4 to 397.6)	199.1 (121.8 to 299.3)	347.4 (209.8 to 502.2)	119.9 (36.8 to 348.3)	141.4 (42.2 to 389.7)	109.8 (28.2 to 334)
			YLLs	119.7 (42.2 to 252.6)	78.3 (26.9 to 172.6)	160.3 (56.7 to 334.8)	261.5 (161.4 to 378.3)	187.7 (115.5 to 279.3)	334.8 (201.9 to 484.8)	118.5 (35.9 to 344.5)	139.6 (40.7 to 388.6)	108.8 (27.2 to 333.1)
			YLDs	4.7 (1.6 to 10.6)	4.2 (1.4 to 9.6)	5.2 (1.8 to 11.7)	12 (6.7 to 18.9)	11.4 (6.4 to 18.2)	12.6 (6.8 to 19.7)	155.2 (61.1 to 397.8)	173.6 (70.3 to 447.8)	141 (53 to 365.1)
		Household air pollution from solid fuels	Deaths	39.2 (29.6 to 50.6)	35.3 (25.4 to 47.4)	43 (31.7 to 54.9)	23.6 (17.7 to 30.1)	23.1 (17.2 to 29.3)	24.1 (17.5 to 31.7)	-39.8 (-49.1 to -30.1)	-34.7 (-46.9 to -20.8)	-43.8 (-53.7 to -30.9)
			DALYs	1099.6 (844.3 to 1392.1)	971.8 (733 to 1272.8)	1225.1 (918.5 to 1550.3)	655.7 (497.6 to 821.5)	614.6 (467.6 to 768.9)	696.5 (508.4 to 902.1)	-40.4 (-49 to -30.6)	-36.8 (-47.3 to -24.7)	-43.1 (-53.2 to -30.1)
			YLLs	1054 (801.9 to 1328.9)	921.3 (690.6 to 1208.2)	1184.4 (884.3 to 1501.7)	622.2 (470.5 to 790.6)	576.5 (438.4 to 728)	667.6 (485.4 to 869.9)	-41 (-49.7 to -31)	-37.4 (-48.3 to -25)	-43.6 (-53.8 to -30.3)
			YLDs	45.6 (31 to 61.6)	50.5 (34.5 to 67.9)	40.8 (27.3 to 55.6)	33.4 (22.9 to 44.6)	38 (26.2 to 50.6)	28.9 (19.2 to 39.5)	-26.7 (-33.4 to -19.9)	-24.8 (-31.4 to -17.7)	-29.1 (-36.5 to -21.6)
	Global	Particulate matter pollution	Deaths	22.9 (19.6 to 26.3)	19.6 (16.6 to 23)	26.1 (22.5 to 30)	23.8 (20.8 to 26.9)	19.8 (16.7 to 22.9)	27.8 (24 to 31.9)	4 (-9.2 to 17.2)	0.7 (-13.7 to 16.2)	6.6 (-7.4 to 21)
			DALYs	588.4 (514.3 to 664.4)	448.8 (386.3 to 515.4)	726.1 (629 to 825.7)	586.2 (512.4 to 662.1)	432.8 (370.3 to 493.9)	738.6 (637.9 to 847.3)	-0.4 (-12.4 to 11.1)	-3.6 (-17.9 to 10.5)	1.7 (-11.1 to 15.3)
			YLLs	575.5 (502.6 to 651.1)	437.2 (375.6 to 502.3)	711.9 (616.2 to 810.6)	570 (497.1 to 646.4)	418.2 (357.8 to 480.2)	720.9 (623.3 to 827)	-1 (-13.1 to 10.7)	-4.4 (-18.9 to 10)	1.3 (-11.8 to 14.9)

Cause	Location	Risk factor	Measure	Year						% Change (1990 to 2019)		
				1990			2019			Both	Female	Male
				Both	Female	Male	Both	Female	Male			
			YLDs	12.9 (8.3 to 18.7)	11.5 (7.5 to 16.8)	14.2 (9.2 to 20.7)	16.1 (10.4 to 23.5)	14.6 (9.5 to 21.1)	17.6 (11.3 to 25.5)	25.4 (15.9 to 34.3)	26.9 (16.5 to 36.8)	24.2 (15.3 to 32.6)
		Ambient particulate matter pollution	Deaths	11.4 (8.4 to 14.4)	9.4 (6.8 to 12)	13.3 (9.9 to 16.8)	17.2 (14 to 20.1)	13.6 (10.9 to 16.4)	20.8 (16.8 to 24.4)	51.6 (25.5 to 87.2)	44.2 (17.8 to 83.1)	57 (29.1 to 95.5)
			DALYs	272.7 (201.8 to 347.8)	191.1 (139.6 to 245)	353.2 (258.6 to 453.1)	415.8 (336.3 to 487.4)	287.2 (232.1 to 343)	543.6 (439.1 to 642.2)	52.5 (26.5 to 87.5)	50.3 (23.3 to 86.6)	53.9 (25.9 to 91.1)
			YLLs	267 (198.6 to 339.6)	186.3 (136.3 to 239.1)	346.7 (254.3 to 443.8)	403.8 (328.5 to 474.4)	276.7 (223.2 to 330.4)	530.1 (427.2 to 627.6)	51.2 (25.4 to 86.1)	48.5 (21.6 to 84.6)	52.9 (25.1 to 89.4)
			YLDs	5.7 (3.4 to 8.7)	4.8 (2.8 to 7.4)	6.5 (3.9 to 10.1)	12 (7.6 to 17.9)	10.5 (6.6 to 15.7)	13.5 (8.6 to 20.2)	111.9 (74 to 167.7)	119.2 (78.2 to 180.3)	106.8 (68.8 to 163.8)
		Household air pollution from solid fuels	Deaths	11.5 (8.8 to 14.8)	10.2 (7.7 to 13.1)	12.9 (9.4 to 16.7)	6.6 (4.5 to 9.2)	6.2 (4.3 to 8.6)	7 (4.5 to 10.4)	-42.8 (-55.8 to -28)	-39.4 (-53.9 to -23.7)	-45.4 (-59.2 to -29.6)
			DALYs	315.7 (242.9 to 399)	257.7 (200 to 325.3)	372.9 (276.1 to 481.8)	170.3 (117 to 235.9)	145.6 (101.2 to 194.1)	195 (126.4 to 284)	-46 (-58.1 to -32.7)	-43.5 (-56.6 to -29.7)	-47.7 (-60.9 to -32.7)
			YLLs	308.5 (237.7 to 391.3)	251 (194.7 to 315.3)	365.2 (270.6 to 472.5)	166.2 (114.1 to 230.7)	141.5 (98.5 to 189)	190.8 (123.8 to 277.1)	-46.1 (-58.1 to -32.8)	-43.6 (-56.8 to -29.7)	-47.7 (-60.9 to -32.8)
			YLDs	7.2 (4.3 to 10.9)	6.7 (4 to 10.1)	7.7 (4.5 to 11.6)	4.1 (2.3 to 6.6)	4.1 (2.2 to 6.6)	4.2 (2.2 to 6.9)	-42.8 (-57.4 to -26)	-39.3 (-55.2 to -21.5)	-45.9 (-59.7 to -29.6)
Stroke		Particulate matter pollution	Deaths	25.8 (22.6 to 29.1)	25.7 (22.1 to 29.6)	25.9 (22.8 to 29.4)	22 (19.4 to 24.8)	20.2 (17.4 to 23.4)	23.8 (20.6 to 27.1)	-14.6 (-24.7 to -4.1)	-21.2 (-32.8 to -7.3)	-8.2 (-21.5 to 5.9)
			DALYs	678.8 (605.5 to 754.2)	650.2 (569.2 to 738.5)	706.9 (628.3 to 797.9)	561.9 (495.8 to 629.7)	503 (438.8 to 574.9)	620.4 (539.7 to 704.5)	-17.2 (-26.2 to -8.2)	-22.6 (-32.8 to -11.2)	-12.2 (-24.6 to 0.1)
			YLLs	623.9 (555.7 to 697)	585.3 (512.2 to 665.4)	661.9 (585 to 753.3)	496.9 (440.1 to 557.1)	427.5 (370.7 to 490.5)	565.8 (489.9 to 645.1)	-20.4 (-29.6 to -10.8)	-27 (-37.2 to -14.8)	-14.5 (-27.7 to -1.4)
			YLDs	54.9 (38.8 to 71.5)	64.9 (46 to 84.1)	45 (31.8 to 58.6)	65 (45.3 to 83.9)	75.5 (52.4 to 98)	54.6 (38.4 to 70.8)	18.3 (10.8 to 25.9)	16.2 (8.5 to 23.8)	21.3 (13.8 to 28.7)
		Ambient particulate matter pollution	Deaths	9.5 (6.5 to 12.8)	9.1 (6.3 to 12.3)	9.9 (6.7 to 13.4)	14.8 (12.2 to 17.3)	12.7 (10.1 to 15.3)	16.9 (13.8 to 20)	55.6 (22.1 to 106.1)	39.5 (9.1 to 85.1)	70.4 (28.7 to 134.4)
			DALYs	240.3 (163.8 to 327.2)	215.3 (147.9 to 295.9)	265 (177.1 to 363.1)	371.4 (302.1 to 432.2)	309 (248.2 to 371.2)	433.4 (351.6 to 512)	54.5 (21.1 to 104.2)	43.5 (11.7 to 90.6)	63.6 (24.8 to 125)

Cause	Location	Risk factor	Measure	Year						% Change (1990 to 2019)		
				1990			2019			Both	Female	Male
				Both	Female	Male	Both	Female	Male			
			YLLs	217.9 (147 to 296.8)	189.8 (130.7 to 263.1)	245.6 (163.1 to 338.3)	325 (264.9 to 380.4)	257 (206.5 to 312)	392.6 (316 to 466.8)	49.1 (15.9 to 98.2)	35.4 (4.5 to 81.8)	59.8 (20.6 to 121.9)
			YLDs	22.4 (14.1 to 32.1)	25.5 (16.1 to 36.2)	19.4 (12 to 28.1)	46.4 (31.7 to 61.4)	52 (35.4 to 69.5)	40.9 (28 to 53.9)	107.1 (69.6 to 163.9)	104.1 (67.1 to 157.8)	110.8 (69.9 to 171.7)
		Household air pollution from solid fuels	Deaths	16.3 (12.5 to 20.2)	16.6 (12.8 to 20.6)	16 (11.8 to 20.5)	7.2 (4.9 to 9.9)	7.5 (5.3 to 10.2)	6.9 (4.4 to 10.1)	-55.6 (-66.4 to -43.5)	-54.5 (-65.3 to -42.4)	-56.8 (-69.1 to -42.8)
			DALYs	438.4 (339.4 to 536.6)	434.9 (340.7 to 531.6)	441.9 (329.9 to 561.3)	190.5 (131 to 260.2)	194 (139.2 to 256.4)	187 (120.4 to 271.5)	-56.6 (-66.8 to -45.5)	-55.4 (-65.3 to -44.5)	-57.7 (-69.4 to -44.3)
			YLLs	405.9 (313.9 to 500)	395.4 (309.9 to 485.3)	416.3 (309.6 to 530.9)	171.9 (117.9 to 233.7)	170.6 (121.2 to 224.7)	173.2 (112.5 to 249.9)	-57.7 (-67.6 to -46.7)	-56.9 (-66.6 to -46.1)	-58.4 (-69.8 to -45)
			YLDs	32.5 (22 to 44.3)	39.5 (26.9 to 52.7)	25.6 (16.9 to 35.6)	18.6 (11.5 to 27.7)	23.5 (14.7 to 34.7)	13.7 (7.9 to 21.8)	-42.8 (-57.1 to -27.8)	-40.6 (-55.2 to -25)	-46.4 (-60.8 to -30.2)

Data in parenthesis are 95% uncertainty intervals; DALYs: Disability-Adjusted Life Years; YLLs: Years of Life Lost; YLDs: Years Lived with Disability

Table S2. Data related to YLLs, YLDs, deaths and DALYs attributed to CVD attributed to PM pollution, ambient PM pollution and HAP from solid fuels within 5 SDI locations in 1990 and 2019; YLLs: years lived with disability, YLDs: years lived with disability, DALYs: disability-adjusted life years, CVD: cardiovascular disease, PM: particulate matter.

Location	Risk factor	Measure	Metric	Year						% Change (1990 to 2019)		
				1990			2019			Both	Female	Male
				Both	Female	Male	Both	Female	Male			
High SDI	Particulate matter pollution	Deaths	All ages number	266429 (172025 to 369794)	127031 (81096 to 178105)	139398 (91025 to 193072)	146730 (110221 to 187237)	62813 (45663 to 82285)	83917 (63730 to 105566)	-44.9 (-60.8 to -22.3)	-50.6 (-65 to -29.5)	-39.8 (-56.7 to -15.6)
			Age-standardized rate (per 100,000)	25.4 (16.5 to 35.2)	19.5 (12.7 to 27.1)	32.9 (21.4 to 45.6)	7.6 (5.8 to 9.6)	5.3 (3.9 to 6.8)	10.2 (7.8 to 12.8)	-70 (-78.3 to -57.8)	-72.8 (-80.7 to -61.6)	-69.1 (-77.6 to -56.5)
		DALYs	All ages number	5718004 (3834478 to 7746606)	2380795 (1600789 to 3237485)	3337209 (2244471 to 4529480)	3248745 (2508770 to 4057119)	1212152 (916785 to 1538456)	2036593 (1586671 to 2539192)	-43.2 (-58.5 to -21.7)	-49.1 (-62.9 to -29.1)	-39 (-54.8 to -15.8)
			Age-standardized rate (per 100,000)	560.4 (378.1 to 758.5)	399.3 (272.6 to 539.1)	747.8 (501.2 to 1017)	198.4 (154.2 to 246.6)	132.1 (101.4 to 165.9)	267 (209 to 331)	-64.6 (-73.7 to -51.2)	-66.9 (-75.8 to -54.4)	-64.3 (-73.5 to -50.6)
		YLLs	All ages number	5339847 (3578762 to 7274029)	2164685 (1441591 to 2949727)	3175162 (2137458 to 4307280)	2832565 (2189873 to 3546213)	987747 (741576 to 1258091)	1844818 (1426086 to 2302790)	-47 (-61.3 to -26.6)	-54.4 (-66.9 to -36.5)	-41.9 (-57.1 to -19.6)
			Age-standardized rate (per 100,000)	523.1 (352.7 to 711.1)	361 (246.2 to 488.6)	711.7 (477.1 to 968.2)	172.7 (134.2 to 215.4)	105.6 (80.5 to 133)	242 (188.1 to 301)	-67 (-75.6 to -54.2)	-70.7 (-78.5 to -59.3)	-66 (-74.8 to -52.9)
	YLDs	All ages number	378156 (233850 to 548093)	216110 (133709 to 312928)	162047 (100645 to 235120)	416180 (272033 to 573975)	224405 (147458 to 311744)	191775 (126862 to 267240)	10.1 (-18.4 to 50.1)	3.8 (-23.9 to 41.6)	18.3 (-11.1 to 62.2)	
		Age-standardized rate (per 100,000)	37.3 (23.2 to 53.9)	38.3 (23.8 to 55.7)	36.2 (22.4 to 52.4)	25.8 (16.9 to 35.1)	26.5 (17.4 to 36.1)	25 (16.4 to 34.4)	-30.9 (-48.4 to -5.8)	-30.9 (-48.5 to -6.1)	-30.8 (-47.8 to -4.8)	
	Ambient particulate matter pollution	Deaths	All ages number	254187 (161478 to 356863)	120687 (75453 to 172057)	133500 (86101 to 186235)	145714 (109252 to 186322)	62267 (45187 to 81847)	83447 (63269 to 104936)	-42.7 (-59.6 to -17.1)	-48.4 (-64 to -25)	-37.5 (-55.4 to -10.4)
			Age-standardized rate (per 100,000)	24.2 (15.4 to 33.9)	18.5 (11.7 to 26.2)	31.6 (20.2 to 44.1)	7.6 (5.8 to 9.5)	5.3 (3.8 to 6.8)	10.1 (7.7 to 12.7)	-68.8 (-77.6 to -55.1)	-71.6 (-79.9 to -58.6)	-67.9 (-77 to -53.9)
		DALYs	All ages number	5412150 (3538703 to 7448081)	2234232 (1440618 to 3079685)	3177918 (2096517 to 4371505)	3226942 (2488359 to 4038534)	1201590 (907435 to 1525699)	2025352 (1574886 to 2526601)	-40.4 (-56.8 to -15.9)	-46.2 (-61.4 to -24)	-36.3 (-53.3 to -10.1)
			Age-standardized rate (per 100,000)	529.9 (348.5 to 724.5)	372.9 (244 to 509.7)	712.6 (468.9 to 979.8)	197.1 (153 to 245.7)	131 (100.2 to 164.5)	265.6 (208 to 329.7)	-62.8 (-72.8 to -47.5)	-64.9 (-74.6 to -50.5)	-62.7 (-72.6 to -47.1)
YLLs		All ages number	5057783 (3318688 to 6982151)	2032690 (1314780 to 2825200)	3025093 (1996748 to 4168227)	2814120 (2168107 to 3520631)	979420 (735932 to 1245938)	1834700 (1418111 to 2291163)	-44.4 (-59.5 to -21.3)	-51.8 (-65.6 to -31.2)	-39.4 (-55.6 to -13.9)	
		Age-standardized rate (per 100,000)	495 (326.6 to 681)	337.4 (221.1 to 463.2)	678.5 (447.1 to 934.7)	171.6 (133.3 to 213.7)	104.8 (79.9 to 131.5)	240.7 (186.9 to 299)	-65.3 (-74.5 to -50.8)	-68.9 (-77.5 to -55.9)	-64.5 (-74 to -49.4)	

Location	Risk factor	Measure	Metric	Year						% Change (1990 to 2019)			
				1990			2019			Both	Female	Male	
				Both	Female	Male	Both	Female	Male				
	Household air pollution from solid fuels	YLDs	All ages number	354367 (216798 to 517673)	201542 (122017 to 293996)	152825 (93157 to 223510)	412822 (270191 to 569180)	222170 (146014 to 308375)	190652 (126211 to 265752)	16.5 (-14.6 to 63.9)	10.2 (-20 to 56.3)	24.8 (-6.9 to 75.7)	
			Age-standardized rate (per 100,000)	34.9 (21.3 to 51)	35.6 (21.6 to 52.1)	34.1 (20.8 to 49.8)	25.6 (16.7 to 34.9)	26.2 (17.2 to 35.8)	24.9 (16.4 to 34)	-26.7 (-45.8 to 3.2)	-26.3 (-45.9 to 4.1)	-27.1 (-45.4 to 2.6)	
		Deaths	All ages number	12242 (6778 to 20146)	6344 (3666 to 10239)	5898 (3052 to 10077)	1016 (286 to 2499)	547 (151 to 1340)	470 (120 to 1204)	-91.7 (-96.6 to -85)	-91.4 (-96.4 to -84.6)	-92 (-96.9 to -85.1)	
			Age-standardized rate (per 100,000)	1.2 (0.7 to 1.9)	1 (0.6 to 1.6)	1.3 (0.7 to 2.3)	0.1 (0 to 0.1)	0 (0 to 0.1)	0.1 (0 to 0.1)	-95.6 (-98.2 to -92.1)	-95.6 (-98.2 to -91.9)	-95.8 (-98.4 to -92.1)	
	DALYs	All ages number	305854 (169000 to 493718)	146563 (84941 to 230120)	159291 (84118 to 272322)	21803 (5993 to 53377)	10562 (2993 to 26769)	11241 (2891 to 28731)	-92.9 (-97.1 to -86.7)	-92.8 (-97.1 to -86.7)	-92.9 (-97.3 to -86.4)		
		Age-standardized rate (per 100,000)	30.6 (16.9 to 49.1)	26.3 (15.4 to 41.1)	35.2 (18.6 to 60.3)	1.3 (0.4 to 3.2)	1.1 (0.3 to 2.8)	1.5 (0.4 to 3.7)	-95.8 (-98.3 to -92)	-95.8 (-98.3 to -92.1)	-95.9 (-98.4 to -92.1)		
	YLLs	All ages number	282065 (155574 to 458800)	131995 (76166 to 204546)	150070 (78559 to 255566)	18445 (5163 to 45666)	8327 (2330 to 20599)	10118 (2611 to 25576)	-93.5 (-97.4 to -87.8)	-93.7 (-97.5 to -88.2)	-93.3 (-97.4 to -87)		
		Age-standardized rate (per 100,000)	28.2 (15.7 to 45.6)	23.6 (13.7 to 36.3)	33.2 (17.4 to 56.8)	1.1 (0.3 to 2.7)	0.8 (0.2 to 2.1)	1.3 (0.3 to 3.3)	-96.2 (-98.5 to -92.7)	-96.4 (-98.6 to -93.2)	-96.1 (-98.5 to -92.4)		
	YLDs	All ages number	23790 (12241 to 39814)	14568 (7613 to 24198)	9222 (4452 to 16631)	3358 (943 to 8511)	2235 (637 to 5863)	1123 (284 to 3006)	-85.9 (-94.1 to -74.3)	-84.7 (-93.4 to -72.7)	-87.8 (-95.1 to -77.2)		
		Age-standardized rate (per 100,000)	2.4 (1.2 to 4)	2.7 (1.4 to 4.5)	2 (1 to 3.7)	0.2 (0.1 to 0.5)	0.3 (0.1 to 0.7)	0.1 (0 to 0.4)	-91.4 (-96.4 to -84.3)	-90.3 (-95.8 to -82.6)	-92.8 (-97.1 to -86.6)		
	High-middle SDI	Particulate matter pollution	Deaths	All ages number	712572 (587585 to 839395)	347134 (279633 to 420040)	365438 (304501 to 426395)	731590 (618534 to 849902)	325467 (265847 to 387397)	406123 (339033 to 477803)	2.7 (-12.3 to 20.1)	-6.2 (-22.9 to 15.1)	11.1 (-7 to 32)
				Age-standardized rate (per 100,000)	72.2 (59.1 to 85.6)	60.1 (48.4 to 72.7)	87.6 (72.8 to 102.1)	36.5 (30.8 to 42.3)	27.8 (22.7 to 33)	47 (39.2 to 55)	-49.5 (-57 to -40.8)	-53.7 (-61.9 to -43)	-46.4 (-55.1 to -36.3)
DALYs			All ages number	17202870 (14504831 to 19960463)	7507449 (6172841 to 8890543)	9695421 (8102695 to 11276841)	16363726 (13935616 to 18815768)	6521480 (5437466 to 7678615)	9842246 (8193101 to 11553897)	-4.9 (-18.3 to 10.4)	-13.1 (-26.9 to 4.6)	1.5 (-15.3 to 20.5)	
			Age-standardized rate (per 100,000)	1603.2 (1342.6 to 1866.4)	1253.6 (1030.5 to 1486.3)	2009.1 (1684.8 to 2339.2)	814.9 (695.7 to 938.2)	586.9 (489.2 to 688.8)	1067.9 (893 to 1253.2)	-49.2 (-56.4 to -41)	-53.2 (-60.6 to -43.7)	-46.8 (-55.6 to -37)	

Location	Risk factor	Measure	Metric	Year						% Change (1990 to 2019)		
				1990			2019			Both	Female	Male
				Both	Female	Male	Both	Female	Male			
		YLLs	All ages number	16192162 (13559610 to 18796101)	6921431 (5660438 to 8218323)	9270731 (7741249 to 10813507)	14838105 (12579841 to 17177832)	5666362 (4666558 to 6686033)	9171742 (7591124 to 10837640)	-8.4 (-22.1 to 6.9)	-18.1 (-32.1 to 0.2)	-1.1 (-18 to 18)
			Age-standardized rate (per 100,000)	1511.5 (1266 to 1760.9)	1156.6 (948.8 to 1371.8)	1923.8 (1605.9 to 2245.7)	738.8 (627.1 to 853.8)	507.2 (417.6 to 597.4)	996.3 (827.7 to 1174.5)	-51.1 (-58.4 to -43)	-56.2 (-63.6 to -46.2)	-48.2 (-56.9 to -38.2)
		YLDs	All ages number	1010708 (709604 to 1335214)	586018 (408518 to 776677)	424690 (298429 to 559581)	1525621 (1070598 to 2003178)	855117 (600734 to 1121687)	670504 (469925 to 884238)	50.9 (35.4 to 68.8)	45.9 (29.4 to 64.5)	57.9 (43.3 to 74.6)
			Age-standardized rate (per 100,000)	91.7 (64.5 to 121.8)	97 (68.3 to 128.1)	85.3 (60.1 to 112.2)	76 (53.2 to 99.7)	79.7 (55.9 to 104.3)	71.6 (50.2 to 94.1)	-17.1 (-25.5 to -7.5)	-17.8 (-26.8 to -7.6)	-16.1 (-23.8 to -7.2)
	Ambient particulate matter pollution	Deaths	All ages number	446652 (316900 to 570386)	211323 (144390 to 278567)	235330 (170284 to 296551)	660132 (549540 to 770732)	287768 (233124 to 346376)	372364 (307454 to 436920)	47.8 (17.7 to 93.9)	36.2 (3.1 to 87.4)	58.2 (24 to 109.5)
			Age-standardized rate (per 100,000)	45.7 (32.5 to 58.5)	36.8 (25.3 to 48.5)	56.9 (41.4 to 71.8)	32.9 (27.4 to 38.5)	24.6 (19.9 to 29.5)	43.1 (35.8 to 50.3)	-27.9 (-42.9 to -5)	-33.2 (-48.9 to -8.2)	-24.3 (-40.3 to 0)
		DALYs	All ages number	10561493 (7533996 to 13508486)	4364747 (3006457 to 5725524)	6196746 (4481640 to 7849169)	14776312 (12339655 to 17032130)	5749429 (4715712 to 6821563)	9026883 (7470359 to 10554883)	39.9 (11.6 to 82.6)	31.7 (1.5 to 80.4)	45.7 (14.6 to 92.4)
			Age-standardized rate (per 100,000)	988.1 (707.7 to 1265.5)	729 (501.4 to 954.5)	1287.9 (938.1 to 1624.3)	736 (614.4 to 847.4)	517.4 (423.8 to 613.6)	979.6 (814.7 to 1144.5)	-25.5 (-40.5 to -2.4)	-29 (-45 to -2.9)	-23.9 (-39.9 to 0.3)
		YLLs	All ages number	9977523 (7102284 to 12785721)	4035519 (2775999 to 5291129)	5942004 (4312504 to 7493562)	13411800 (11255587 to 15582943)	4997964 (4079165 to 6007575)	8413836 (6890422 to 9901717)	34.4 (7.2 to 75.6)	23.8 (-4.9 to 69.8)	41.6 (11.1 to 88.1)
			Age-standardized rate (per 100,000)	935 (669.5 to 1199.5)	674.6 (464.3 to 884.3)	1236.4 (902.7 to 1551.3)	668 (561 to 774.9)	447.4 (365.5 to 536.4)	914.1 (751 to 1073.6)	-28.6 (-43 to -6.5)	-33.7 (-49 to -9)	-26.1 (-42 to -2.3)
		YLDs	All ages number	583970 (366967 to 824096)	329228 (203463 to 471056)	254742 (158806 to 362029)	1364512 (950429 to 1800115)	751465 (520788 to 996113)	613047 (428668 to 808044)	133.7 (88.2 to 206.5)	128.3 (80.2 to 208.3)	140.7 (93.8 to 216.6)
			Age-standardized rate (per 100,000)	53.1 (33.5 to 74.7)	54.4 (33.6 to 77.6)	51.5 (32.6 to 72.9)	68 (47.3 to 89.3)	70.1 (48.7 to 92.4)	65.5 (45.9 to 86.2)	28 (2.9 to 68.8)	28.8 (1.9 to 73.3)	27.3 (2.6 to 66.6)

Location	Risk factor	Measure	Metric	Year						% Change (1990 to 2019)		
				1990			2019			Both	Female	Male
				Both	Female	Male	Both	Female	Male			
	Household air pollution from solid fuels	Deaths	All ages number	265919 (182584 to 365192)	135811 (94316 to 182562)	130108 (82233 to 187690)	71458 (29601 to 137985)	37699 (15809 to 70827)	33759 (12721 to 67976)	-73.1 (-86.1 to -57.1)	-72.2 (-85.4 to -56.4)	-74.1 (-87.5 to -57.4)
			Age-standardized rate (per 100,000)	26.6 (18.2 to 36.8)	23.3 (16.1 to 31.4)	30.7 (19.5 to 44.4)	3.6 (1.5 to 6.9)	3.2 (1.4 to 6.1)	3.9 (1.5 to 7.8)	-86.6 (-93.1 to -78.9)	-86.2 (-92.7 to -78.4)	-87.4 (-93.9 to -79.4)
		DALYs	All ages number	6641377 (4610333 to 9077809)	3142702 (2224860 to 4120008)	3498676 (2216576 to 4978458)	1587414 (665185 to 3075558)	772051 (337962 to 1435601)	815363 (314283 to 1621831)	-76.1 (-87.7 to -61.9)	-75.4 (-87.2 to -61.1)	-76.7 (-88.8 to -61.8)
			Age-standardized rate (per 100,000)	615.1 (426.7 to 841.4)	524.6 (370.9 to 688.5)	721.3 (459.5 to 1032.7)	78.8 (33.1 to 152.7)	69.4 (30.4 to 129.1)	88.3 (33.9 to 175.7)	-87.2 (-93.4 to -79.7)	-86.8 (-93.1 to -79)	-87.8 (-94.1 to -79.9)
		YLLs	All ages number	6214639 (4294612 to 8464011)	2885912 (2031011 to 3811721)	3328727 (2100221 to 4747796)	1426304 (589303 to 2759453)	668399 (284586 to 1254198)	757906 (288143 to 1515615)	-77 (-88.2 to -63.3)	-76.8 (-88 to -63.2)	-77.2 (-89.1 to -62.4)
			Age-standardized rate (per 100,000)	576.5 (396.9 to 786.8)	482.1 (339.1 to 637.7)	687.4 (437.5 to 984.9)	70.8 (29.3 to 137)	59.8 (25.5 to 112.1)	82.2 (31.2 to 164.3)	-87.7 (-93.6 to -80.5)	-87.6 (-93.6 to -80.4)	-88 (-94.3 to -80.4)
		YLDs	All ages number	426739 (264385 to 607760)	256790 (161750 to 361003)	169948 (100116 to 253497)	161109 (67300 to 312390)	103652 (43952 to 198494)	57457 (21830 to 119303)	-62.2 (-80.8 to -37.8)	-59.6 (-78.9 to -34.3)	-66.2 (-83.6 to -42.7)
			Age-standardized rate (per 100,000)	38.6 (24 to 55.1)	42.6 (26.8 to 59.8)	33.8 (20.1 to 50.6)	8 (3.4 to 15.6)	9.6 (4.1 to 18.4)	6.1 (2.3 to 12.7)	-79.3 (-89.4 to -65.7)	-77.4 (-88.2 to -63.5)	-82 (-91.3 to -69.4)
Middle SDI	Particulate matter pollution	Deaths	All ages number	844765 (759409 to 946100)	391358 (344025 to 447260)	453407 (400044 to 511671)	1354599 (1181813 to 1534840)	573708 (488078 to 661935)	780890 (670689 to 897669)	60.4 (40.2 to 81.3)	46.6 (22.1 to 72.5)	72.2 (46.7 to 99.7)
			Age-standardized rate (per 100,000)	93.4 (83.1 to 104.8)	84.1 (73.4 to 96.3)	103 (91.2 to 116.5)	59.3 (51.6 to 67.1)	47.8 (40.7 to 55.4)	72 (61.9 to 82.4)	-36.5 (-44.6 to -28.1)	-43.1 (-52.5 to -33.4)	-30 (-40.2 to -19.2)
		DALYs	All ages number	22899126 (20673360 to 25300708)	10051102 (8919625 to 11343047)	12848024 (11401783 to 14438669)	33695971 (29566117 to 37957406)	13371018 (11608351 to 15277899)	20324952 (17451733 to 23204506)	47.1 (29.7 to 65)	33 (14.2 to 54.6)	58.2 (35.5 to 82.5)
			Age-standardized rate (per 100,000)	2126.6 (1913.4 to 2354.6)	1862.7 (1651 to 2099.4)	2389.2 (2115.2 to 2678.1)	1334.5 (1171.2 to 1503.4)	1031.6 (896.4 to 1177.7)	1654.7 (1422.8 to 1884.9)	-37.2 (-44.5 to -29.5)	-44.6 (-52.7 to -35.7)	-30.7 (-40.7 to -20.2)
		YLLs	All ages number	21541424 (19471920 to 23987558)	9294600 (8211355 to 10497389)	12246824 (10866104 to 13804867)	31072689 (27134245 to 35196777)	11910659 (10206011 to 13700524)	19162030 (16375182 to 22042506)	44.2 (26.2 to 63)	28.1 (8.5 to 51.3)	56.5 (32.7 to 82)

Location	Risk factor	Measure	Metric	Year						% Change (1990 to 2019)		
				1990			2019			Both	Female	Male
				Both	Female	Male	Both	Female	Male			
			Age-standardized rate (per 100,000)	2005.5 (1802.1 to 2235.7)	1729.4 (1521.2 to 1958.3)	2281.7 (2015.4 to 2574.4)	1232.1 (1076.5 to 1392.2)	921 (787.1 to 1058.4)	1561.8 (1336.5 to 1790.8)	-38.6 (-46.1 to -30.5)	-46.7 (-55.2 to -37.2)	-31.6 (-42 to -20.7)
		YLDs	All ages number	1357702 (963207 to 1741933)	756502 (533599 to 973245)	601200 (430642 to 771650)	2623281 (1855336 to 3397278)	1460359 (1029231 to 1890072)	1162922 (822437 to 1523656)	93.2 (81.3 to 103.7)	93 (81.5 to 104.2)	93.4 (80.9 to 105.4)
			Age-standardized rate (per 100,000)	121.1 (86.5 to 155.9)	133.3 (94 to 171.3)	107.5 (77 to 139)	102.4 (72.2 to 132.3)	110.6 (78.1 to 143.3)	93 (65.8 to 121.8)	-15.5 (-20.6 to -11)	-17 (-22.2 to -12.2)	-13.5 (-19 to -8.2)
	Ambient particulate matter pollution	Deaths	All ages number	304556 (197657 to 428158)	121665 (79278 to 175606)	182891 (117503 to 257988)	1073673 (903950 to 1234177)	433660 (353427 to 518945)	640013 (532119 to 741336)	252.5 (154.9 to 406.8)	256.4 (150 to 419)	249.9 (153.8 to 411.2)
Age-standardized rate (per 100,000)			33.3 (21.7 to 46.7)	26 (17 to 37.5)	41.6 (26.8 to 58.2)	46.9 (39.4 to 54.1)	36.1 (29.4 to 43.1)	59.1 (49 to 68.3)	40.7 (2 to 101.2)	38.7 (-2 to 100.8)	42 (3.8 to 105.5)	
DALYs		All ages number	8354228 (5503238 to 11712029)	3148430 (2032467 to 4561215)	5205798 (3352387 to 7330185)	26767988 (22614856 to 30573384)	10125092 (8388126 to 11979795)	16642896 (13912225 to 19219920)	220.4 (133.9 to 360.6)	221.6 (126.8 to 368.4)	219.7 (132.6 to 366.1)	
		Age-standardized rate (per 100,000)	768 (503.1 to 1079.1)	579.7 (374.4 to 847)	964.3 (616.5 to 1352.3)	1058.6 (895.5 to 1208.4)	780.4 (644.4 to 920.1)	1355.3 (1132.6 to 1562.4)	37.8 (0.1 to 97.7)	34.6 (-4.8 to 96.5)	40.6 (2.4 to 104.1)	
YLLs		All ages number	7911273 (5179880 to 11153037)	2929661 (1895954 to 4256796)	4981612 (3212743 to 6999470)	24758080 (20918700 to 28419560)	9049891 (7432885 to 10755761)	15708189 (13021345 to 18217603)	212.9 (128.4 to 347.6)	208.9 (117.4 to 352.8)	215.3 (128.7 to 360.2)	
		Age-standardized rate (per 100,000)	728.7 (474.4 to 1020.8)	541.3 (351.9 to 779.7)	924 (596.1 to 1298.1)	980.2 (829.9 to 1127.2)	699 (574.9 to 831.4)	1280.5 (1066.3 to 1481.3)	34.5 (-2.2 to 92.2)	29.1 (-9 to 88.8)	38.6 (1.1 to 102)	
YLDs		All ages number	442955 (249327 to 687748)	218769 (124791 to 339672)	224186 (126670 to 349000)	2009908 (1384389 to 2661645)	1075201 (731128 to 1427033)	934707 (643605 to 1224331)	353.7 (229.9 to 565.4)	391.5 (255.3 to 627.1)	316.9 (200.6 to 523.4)	
		Age-standardized rate (per 100,000)	39.3 (22.2 to 61.3)	38.3 (21.9 to 59.8)	40.3 (23 to 63.2)	78.4 (54 to 103.3)	81.4 (55.4 to 108.1)	74.9 (51.6 to 98.1)	99.5 (45.5 to 192.2)	112.4 (52.9 to 216.3)	85.9 (33.9 to 178)	
	Household air pollution	Deaths	All ages number	540210 (400554 to 675182)	269693 (205763 to 336127)	270516 (191451 to 353402)	280926 (152025 to 453913)	140048 (77456 to 214674)	140878 (68910 to 242031)	-48 (-69.9 to -22.9)	-48.1 (-69.4 to -23)	-47.9 (-72.2 to -19.3)

Location	Risk factor	Measure	Metric	Year						% Change (1990 to 2019)				
				1990			2019			Both	Female	Male		
				Both	Female	Male	Both	Female	Male					
	from solid fuels		Age-standardized rate (per 100,000)	60.1 (44.4 to 75.1)	58.1 (44 to 72.7)	61.4 (43 to 80.4)	12.4 (6.7 to 20.1)	11.7 (6.5 to 18.1)	13 (6.3 to 22.2)	-79.3 (-88 to -69.5)	-79.8 (-88.1 to -70.1)	-78.9 (-88.7 to -67.3)		
		DALYs	All ages number	14544898 (10907896 to 18109094)	6902672 (5336159 to 8565780)	7642226 (5439424 to 9939713)	6927983 (3789892 to 11161646)	3245926 (1833095 to 4930607)	3682057 (1791113 to 6314947)	-52.4 (-72.5 to -29.5)	-53 (-72 to -30.6)	-51.8 (-73.8 to -25.4)		
			Age-standardized rate (per 100,000)	1358.6 (1017.7 to 1692.2)	1283 (986.2 to 1593.3)	1425 (1012.9 to 1850.7)	275.9 (150.9 to 443.8)	251.2 (141.9 to 381.1)	299.4 (145.3 to 513.8)	-79.7 (-88.2 to -70.1)	-80.4 (-88.3 to -71.2)	-79 (-88.6 to -67.6)		
		YLLs	All ages number	13630151 (10225495 to 16958391)	6364939 (4889653 to 7890612)	7265212 (5145343 to 9515027)	6314610 (3424924 to 10176758)	2860768 (1590579 to 4376692)	3453842 (1700173 to 5943126)	-53.7 (-73.3 to -31.6)	-55.1 (-73.6 to -33.6)	-52.5 (-74.2 to -26.5)		
			Age-standardized rate (per 100,000)	1276.8 (952.7 to 1593.2)	1188.1 (906.4 to 1475.8)	1357.7 (962.7 to 1775.5)	251.9 (136.5 to 405.9)	222 (122.8 to 341.2)	281.3 (138 to 483)	-80.3 (-88.6 to -70.8)	-81.3 (-89 to -72.5)	-79.3 (-88.8 to -68.1)		
		YLDs	All ages number	914747 (606387 to 1247210)	537733 (362298 to 723288)	377014 (245444 to 533389)	613374 (316041 to 1020619)	385158 (206874 to 615837)	228215 (106482 to 419885)	-32.9 (-60.3 to -2.8)	-28.4 (-56.8 to 3.2)	-39.5 (-66.1 to -8)		
			Age-standardized rate (per 100,000)	81.8 (54.5 to 111.7)	94.9 (63.6 to 127.5)	67.3 (43.9 to 95.2)	23.9 (12.4 to 40)	29.2 (15.7 to 46.6)	18.1 (8.4 to 33.3)	-70.7 (-82.6 to -57.6)	-69.3 (-81.5 to -55.7)	-73 (-84.9 to -59.1)		
		Low-middle SDI	Particulate matter pollution	Deaths	All ages number	548818 (481728 to 630736)	237550 (200218 to 280360)	311268 (273645 to 354765)	934438 (824221 to 1047250)	409471 (346871 to 474274)	524968 (456635 to 598290)	70.3 (46.6 to 92.3)	72.4 (42.7 to 105.9)	68.7 (45.2 to 93.9)
				Age-standardized rate (per 100,000)	101.6 (87.8 to 118.8)	90.8 (75.5 to 109.7)	112 (97.7 to 128.3)	72.3 (63.9 to 81.4)	61.3 (52.1 to 70.9)	84.2 (73.3 to 95.5)	-28.8 (-39.3 to -19)	-32.5 (-44.8 to -18)	-24.8 (-35.8 to -13.1)	
				DALYs	All ages number	15473225 (13754506 to 17475278)	6477146 (5590599 to 7477779)	8996079 (7980195 to 10199174)	24985190 (22171697 to 27938886)	10385757 (8891894 to 11945175)	14599433 (12639732 to 16656198)	61.5 (41.5 to 81.7)	60.3 (34.5 to 88.1)	62.3 (40.6 to 86.7)
	Age-standardized rate (per 100,000)	2405.1 (2124.7 to 2740.8)		2080.1 (1769.7 to 2429.1)	2715.3 (2391.3 to 3079.3)	1739.2 (1546.1 to 1946)	1420.8 (1219.7 to 1630.2)	2072.2 (1797.2 to 2357.9)	-27.7 (-37.4 to -18.6)	-31.7 (-43.3 to -19.5)	-23.7 (-34 to -12.3)			
	YLLs	All ages number		14861237 (13185621 to 16802370)	6148947 (5302980 to 7111216)	8712290 (7706440 to 9892657)	23790187 (21001139 to 26652872)	9732316 (8249883 to 11274646)	14057871 (12117719 to 16112444)	60.1 (39.3 to 81)	58.3 (31.6 to 87.4)	61.4 (39.2 to 86.5)		

Location	Risk factor	Measure	Metric	Year						% Change (1990 to 2019)		
				1990			2019			Both	Female	Male
				Both	Female	Male	Both	Female	Male			
			Age-standardized rate (per 100,000)	2313.1 (2040.2 to 2633.8)	1980.2 (1679.7 to 2318.8)	2631.2 (2310.1 to 2991.6)	1657.5 (1463.7 to 1857.4)	1334.2 (1129.8 to 1544)	1995.9 (1727.3 to 2280.3)	-28.3 (-38.3 to -19)	-32.6 (-44.5 to -19.9)	-24.1 (-34.7 to -12.5)
		YLDs	All ages number	611988 (439456 to 792961)	328199 (233034 to 425496)	283789 (203386 to 369430)	1195002 (855476 to 1529200)	653441 (465901 to 836074)	541562 (388310 to 700082)	95.3 (83 to 105)	99.1 (85.3 to 110)	90.8 (79.3 to 100)
			Age-standardized rate (per 100,000)	92 (65.8 to 119)	99.9 (70.9 to 129.3)	84.1 (60.1 to 109.9)	81.6 (58.4 to 105)	86.6 (61.8 to 110.8)	76.3 (54.6 to 98.5)	-11.3 (-17.9 to -6.3)	-13.3 (-20.3 to -8)	-9.3 (-15.4 to -4.4)
	Ambient particulate matter pollution	Deaths	All ages number	86688 (40399 to 155036)	30465 (14594 to 54687)	56223 (24842 to 101753)	485315 (345662 to 609833)	188463 (133604 to 246419)	296852 (205670 to 374988)	459.8 (249.7 to 944.1)	518.6 (274.1 to 1028.7)	428 (222.6 to 912)
			Age-standardized rate (per 100,000)	16.1 (7.6 to 28.5)	11.8 (5.8 to 21.1)	20.3 (9.3 to 36.5)	37.5 (27 to 47)	28.2 (20 to 36.8)	47.7 (33 to 60.1)	133.3 (46.6 to 319.1)	139.3 (45.9 to 326.8)	134.3 (44.5 to 340)
		DALYs	All ages number	2450432 (1123452 to 4446849)	826601 (387595 to 1505703)	1623830 (705576 to 2966121)	13029044 (9194242 to 16439229)	4786446 (3362134 to 6230090)	8242598 (5713331 to 10469471)	431.7 (227.9 to 905)	479.1 (246.2 to 976)	407.6 (207.5 to 882.4)
				Age-standardized rate (per 100,000)	380.4 (176.7 to 684.4)	266.8 (126.2 to 483.6)	490.9 (216.8 to 891.6)	905.2 (639.9 to 1141.4)	654.6 (460.9 to 853.4)	1170.4 (813 to 1484.8)	138 (47.7 to 345.1)	145.4 (48.1 to 349.8)
		YLLs	All ages number	2355083 (1069504 to 4277184)	783238 (367035 to 1418231)	1571846 (682004 to 2879776)	12433111 (8762865 to 15646573)	4489200 (3129029 to 5886521)	7943912 (5498417 to 10081674)	427.9 (224.6 to 896)	473.2 (242.5 to 966.9)	405.4 (206.3 to 879.4)
				Age-standardized rate (per 100,000)	366 (169.5 to 657.7)	253.6 (120.2 to 455.9)	475.5 (208.8 to 867.5)	864.5 (608.9 to 1087.7)	615.1 (430 to 807.7)	1128.3 (783.5 to 1428.3)	136.2 (46.2 to 342.3)	142.6 (45.5 to 345.1)
		YLDs	All ages number	95348 (40746 to 177520)	43363 (19032 to 80496)	51985 (21921 to 97544)	595933 (386005 to 828811)	297247 (193865 to 422013)	298687 (192901 to 413422)	525 (292.7 to 1037.1)	585.5 (330.2 to 1134.2)	474.6 (262.5 to 970.5)
				Age-standardized rate (per 100,000)	14.3 (6.2 to 25.9)	13.2 (5.9 to 24.4)	15.4 (6.5 to 28.7)	40.7 (26.5 to 56.9)	39.4 (25.7 to 55.9)	42.2 (27.2 to 58.1)	184.2 (80 to 410.7)	198.2 (88.7 to 429.4)
	Household air pollution from solid fuels	Deaths	All ages number	462130 (360498 to 574770)	207085 (162613 to 260882)	255045 (195333 to 319338)	449123 (308680 to 602647)	221008 (156215 to 293596)	228115 (146312 to 323095)	-2.8 (-27.3 to 22.1)	6.7 (-19.8 to 35.3)	-10.6 (-36.4 to 18.5)
				Age-standardized rate (per 100,000)	85.5 (66 to 108)	79 (60.6 to 101.8)	91.6 (69.3 to 116.5)	34.8 (24 to 46.9)	33.1 (23.2 to 44)	36.5 (23.4 to 51.8)	-59.3 (-69.6 to -48.5)	-58.1 (-68.5 to -46.2)

Location	Risk factor	Measure	Metric	Year						% Change (1990 to 2019)				
				1990			2019			Both	Female	Male		
				Both	Female	Male	Both	Female	Male					
		DALYs	All ages number	13022793 (10254317 to 15890074)	5650545 (4544321 to 6913194)	7372249 (5681553 to 9101223)	11956145 (8272894 to 15998176)	5599311 (3992743 to 7339042)	6356835 (4076435 to 8961068)	-8.2 (-31.3 to 15.1)	-0.9 (-24.5 to 24.2)	-13.8 (-38.9 to 13.7)		
			Age-standardized rate (per 100,000)	2024.7 (1586.2 to 2510)	1813.3 (1431.9 to 2247.8)	2224.4 (1712.1 to 2766.5)	834 (576.7 to 1113.9)	766.3 (546.4 to 1006.3)	901.8 (578.1 to 1273.8)	-58.8 (-69.1 to -48.4)	-57.7 (-67.9 to -46.8)	-59.5 (-71.1 to -46.3)		
		YLLs	All ages number	12506154 (9903277 to 15275559)	5365709 (4311616 to 6569978)	7140445 (5485274 to 8814893)	11357076 (7810002 to 15246679)	5243117 (3725167 to 6907056)	6113960 (3878330 to 8621384)	-9.2 (-32.5 to 14.4)	-2.3 (-26.3 to 23.4)	-14.4 (-39.6 to 13.3)		
			Age-standardized rate (per 100,000)	1947.1 (1525.2 to 2401.3)	1726.6 (1371.1 to 2150.6)	2155.7 (1652 to 2677.5)	793.1 (544.4 to 1062.4)	719 (511.4 to 951.6)	867.7 (552.6 to 1226.7)	-59.3 (-69.7 to -49)	-58.4 (-68.6 to -47.3)	-59.8 (-71.5 to -46.6)		
		YLDs	All ages number	516640 (351125 to 695724)	284836 (195622 to 381161)	231804 (155598 to 315506)	599069 (381999 to 853014)	356194 (233266 to 494996)	242875 (143095 to 359502)	16 (-9.3 to 41.6)	25.1 (0.2 to 50.4)	4.8 (-23 to 33.1)		
			Age-standardized rate (per 100,000)	77.6 (52.4 to 104.5)	86.7 (59.2 to 116.8)	68.7 (45.8 to 93.7)	40.9 (25.9 to 58.2)	47.2 (30.9 to 65.5)	34.1 (20.1 to 51)	-47.3 (-59.2 to -35.4)	-45.5 (-56.6 to -34.3)	-50.3 (-63.3 to -37.2)		
		Low SDI	Particulate matter pollution	Deaths	All ages number	229995 (193287 to 280985)	100128 (77041 to 130182)	129867 (109193 to 155170)	376041 (323880 to 432975)	170954 (144006 to 200833)	205087 (172604 to 238275)	63.5 (39.9 to 87.8)	70.7 (39.8 to 105.8)	57.9 (34 to 90.1)
					Age-standardized rate (per 100,000)	110 (89.6 to 138.3)	99.7 (74.4 to 133.4)	119.6 (99.7 to 147.7)	79.5 (68.4 to 92.6)	72.3 (60.6 to 85.8)	86.9 (72.8 to 100.9)	-27.7 (-39 to -16.1)	-27.5 (-42 to -10.9)	-27.3 (-38.5 to -12)
DALYs	All ages number			6464411 (5526210 to 7731486)	2759546 (2216446 to 3446622)	3704864 (3153664 to 4343901)	10487426 (9100712 to 11999808)	4577138 (3914983 to 5304798)	5910288 (5013378 to 6866488)	62.2 (40.2 to 85)	65.9 (38.3 to 96.3)	59.5 (35.8 to 90.5)		
	Age-standardized rate (per 100,000)			2559.6 (2157.8 to 3098.2)	2257.1 (1775.3 to 2877.6)	2846 (2413.2 to 3367.4)	1862 (1613.4 to 2136.2)	1639.2 (1391.3 to 1907.1)	2087.2 (1766.4 to 2416.7)	-27.3 (-37.2 to -16.7)	-27.4 (-39.9 to -13)	-26.7 (-37.3 to -12.2)		
YLLs	All ages number			6198630 (5293026 to 7437088)	2616338 (2081734 to 3289542)	3582292 (3030078 to 4212806)	9974101 (8571540 to 11496143)	4298894 (3654119 to 5010149)	5675206 (4773142 to 6611370)	60.9 (38.4 to 84.3)	64.3 (36.2 to 96.5)	58.4 (33.8 to 90.1)		
	Age-standardized rate (per 100,000)			2458.9 (2076.1 to 2978.5)	2147.9 (1671.8 to 2760.4)	2753.8 (2323.9 to 3269.2)	1776.3 (1531.9 to 2046.7)	1548.5 (1305.8 to 1809.3)	2006.8 (1688.7 to 2332.9)	-27.8 (-38.2 to -17)	-27.9 (-40.9 to -12.9)	-27.1 (-38 to -12.2)		

Location	Risk factor	Measure	Metric	Year						% Change (1990 to 2019)			
				1990			2019			Both	Female	Male	
				Both	Female	Male	Both	Female	Male				
	YLDs	All ages number		265780 (188171 to 347353)	143208 (100830 to 187680)	122572 (87106 to 160761)	513325 (367727 to 654621)	278244 (199251 to 352032)	235081 (168305 to 301379)	93.1 (78.2 to 104.8)	94.3 (78.1 to 106.5)	91.8 (77.3 to 102.6)	
				100.7 (71 to 132.6)	109.2 (76.8 to 144.1)	92.2 (64.9 to 121.6)	85.6 (61.2 to 109.4)	90.7 (65 to 115.6)	80.4 (57.4 to 103.9)	-15 (-22.2 to -9.1)	-16.9 (-24.5 to -10.9)	-12.9 (-20.2 to -7.3)	
	Ambient particulate matter pollution	Deaths	All ages number		23051 (8256 to 48790)	7706 (2740 to 16859)	15345 (5460 to 31868)	109646 (68429 to 159434)	41250 (25828 to 60864)	68396 (41555 to 98721)	375.7 (198.6 to 850.5)	435.3 (220.4 to 976)	345.7 (175.8 to 824.8)
					10.8 (4 to 22.4)	7.5 (2.7 to 16.2)	14 (5.1 to 28.8)	22.8 (14.4 to 33)	17.2 (10.9 to 25.4)	28.9 (17.9 to 41.3)	112 (32.4 to 314.3)	128.4 (37.6 to 348.7)	106 (29.3 to 324.2)
	DALYs	All ages number		657020 (234711 to 1379522)	215947 (74406 to 475902)	441072 (156058 to 924591)	3087062 (1900859 to 4487796)	1120137 (685169 to 1683469)	1966926 (1187705 to 2843380)	369.9 (192.4 to 858.1)	418.7 (205.6 to 952.4)	345.9 (172.4 to 822.4)	
				256.7 (92.7 to 540)	174.3 (61.5 to 383)	336.7 (120.7 to 702.3)	543.3 (338 to 792.6)	397.6 (245.5 to 589.8)	693.7 (419.5 to 1000.9)	111.7 (32.9 to 325.3)	128.1 (36.4 to 355.5)	106.1 (27.4 to 325.4)	
	YLLs	All ages number		632109 (222705 to 1334262)	204998 (70395 to 451885)	427111 (150927 to 891989)	2951191 (1821845 to 4269995)	1055763 (649839 to 1571324)	1895428 (1143088 to 2744734)	366.9 (190.4 to 849.8)	415 (202.3 to 950.1)	343.8 (170.4 to 820.4)	
				247.4 (87.9 to 523)	166 (59.5 to 364.8)	326.3 (116.1 to 678.1)	520.7 (322.1 to 760.7)	376.7 (234 to 557)	669.2 (404.1 to 967.3)	110.5 (32 to 324.2)	126.9 (34.9 to 356.9)	105.1 (26.6 to 324.9)	
	YLDs	All ages number		24910 (8679 to 56054)	10949 (3777 to 25068)	13961 (4719 to 31151)	135871 (75830 to 213345)	64374 (36207 to 102219)	71498 (38222 to 111513)	445.4 (244.2 to 963.9)	487.9 (266.1 to 1077.2)	412.1 (225.3 to 888.5)	
				9.3 (3.3 to 20.7)	8.2 (2.9 to 18.7)	10.4 (3.6 to 23.1)	22.6 (12.8 to 35.3)	20.9 (11.9 to 32.8)	24.5 (13.2 to 38.2)	142.7 (53.5 to 363)	153.9 (58 to 395.3)	135.4 (50.4 to 352)	
	Household air pollution from solid fuels	Deaths	All ages number		206944 (156112 to 267135)	92422 (66467 to 124179)	114523 (84371 to 146354)	266395 (200036 to 340209)	129704 (96890 to 165009)	136691 (98943 to 179350)	28.7 (8.8 to 49.5)	40.3 (14.1 to 70.2)	19.4 (-1.5 to 46.8)
					99.2 (72.6 to 132.1)	92.2 (64.2 to 128.4)	105.6 (76.4 to 139.3)	56.7 (42.1 to 73.1)	55.1 (40.6 to 70.9)	58 (41.7 to 76.5)	-42.9 (-52.3 to -33.7)	-40.3 (-52 to -26.6)	-45 (-54.4 to -32.4)
		DALYs	All ages number	5807391 (4459274 to 7352442)	2543599 (1918607 to 3331412)	3263792 (2446963 to 4130082)	7400363 (5616219 to 9272081)	3457001 (2630161 to 4325254)	3943362 (2878579 to 5107095)	27.4 (9 to 48.3)	35.9 (13.3 to 61.8)	20.8 (-0.5 to 48.6)	

Location	Risk factor	Measure	Metric	Year						% Change (1990 to 2019)		
				1990			2019			Both	Female	Male
				Both	Female	Male	Both	Female	Male			
			Age-standardized rate (per 100,000)	2303 (1747.3 to 2952.4)	2082.8 (1530.9 to 2751.8)	2509.3 (1861 to 3200.5)	1318.6 (997.4 to 1672.3)	1241.7 (938.3 to 1566.4)	1393.5 (1017.1 to 1810.8)	-42.7 (-51.3 to -33.8)	-40.4 (-50.7 to -28.7)	-44.5 (-54.1 to -32.2)
		YLLs	All ages number	5566521 (4235051 to 7018709)	2411340 (1807521 to 3162323)	3155181 (2355844 to 4000649)	7022910 (5310929 to 8923395)	3243131 (2466163 to 4095260)	3779779 (2748137 to 4924874)	26.2 (7.5 to 47.5)	34.5 (11.1 to 61.2)	19.8 (-1.9 to 48.1)
			Age-standardized rate (per 100,000)	2211.6 (1673.4 to 2848.4)	1981.9 (1444.2 to 2630.4)	2427.5 (1793.5 to 3094.7)	1255.6 (945.5 to 1599.7)	1171.8 (881.4 to 1478.9)	1337.6 (970.6 to 1746.1)	-43.2 (-51.8 to -34.2)	-40.9 (-51.6 to -28.8)	-44.9 (-54.6 to -32.4)
		YLDs	All ages number	240870 (163706 to 325443)	132259 (90342 to 177842)	108611 (72826 to 148031)	377454 (258786 to 503652)	213870 (147646 to 284450)	163583 (108514 to 223731)	56.7 (42.3 to 71.2)	61.7 (47.3 to 76.8)	50.6 (35 to 66.7)
			Age-standardized rate (per 100,000)	91.4 (62.4 to 124.3)	101 (68.8 to 138)	81.8 (54.8 to 113.2)	63 (43.2 to 84.4)	69.8 (48.4 to 92.9)	55.9 (37.2 to 77)	-31 (-37.8 to -24.2)	-30.8 (-37.5 to -24)	-31.7 (-39.1 to -24.1)

Data in parenthesis are 95% uncertainty intervals; DALYs: Disability-Adjusted Life Years; YLLs: Years of Life Lost; YLDs: Years Lived with Disability

Table S3. Global deaths, DALYs, YLLs and YLDs attributed to PM pollution, Ambient PM pollution and HAP from solid fuels by CVD cause as well as their percent change in 1990 and 2019; ASR: age-standardized rate, YLLs: years lived with disability, YLDs: years lived with disability, DALYs: disability-adjusted life years, CVD: cardiovascular disease, PM: particulate matter.

Cause	Risk factor	Measure	Metric	Year						% Change (1990 to 2019)		
				1990			2019			Both	Female	Male
				Both	Female	Male	Both	Female	Male			
Ischemic heart disease	Particulate matter pollution	Deaths	All ages number	1225184 (1046644 to 1405597)	521826 (441819 to 609835)	703357 (606352 to 807958)	1843217 (1605729 to 2080472)	763120 (644913 to 881342)	1080097 (932621 to 1238248)	50.4 (31.3 to 69.5)	46.2 (25.3 to 68.7)	53.6 (33.4 to 74.4)
			Age-standardized rate (per 100,000)	32.8 (27.9 to 38.0)	25.7 (21.7 to 30.1)	41.1 (35.1 to 47.4)	22.9 (19.9 to 25.9)	17.4 (14.7 to 20.1)	29.0 (25.0 to 33.1)	-30.3 (-39.1 to -21.0)	-32.1 (-41.7 to -21.3)	-29.5 (-38.7 to -20.1)
		DALYs	All ages number	31477742 (27514284 to 35546060)	11919605 (10259551 to 13690689)	19558138 (16942612 to 22242785)	45354420 (39644690 to 51231554)	16689791 (14281043 to 19047172)	28664628 (24757992 to 32883656)	44.1 (26.6 to 60.7)	40.0 (19.2 to 60.4)	46.6 (28.0 to 66.1)
			Age-standardized rate (per 100,000)	766.5 (663.7 to 869.4)	555.0 (476.9 to 638.9)	992.9 (858.6 to 1,134.7)	547.8 (479.0 to 618.8)	385.0 (330.0 to 439.3)	719.5 (622.6 to 823.3)	-28.5 (-37.2 to -20.1)	-30.6 (-40.8 to -20.4)	-27.5 (-36.9 to -17.9)
		YLLs	All ages number	30789259 (26889201 to 34833279)	11613778 (9975956 to 13342798)	19175481 (16600125 to 21836871)	44106187 (38464075 to 50012926)	16126476 (13799373 to 18517305)	27979711 (24189416 to 32096456)	43.3 (25.6 to 60.0)	38.9 (17.8 to 59.7)	45.9 (27.1 to 65.6)
			Age-standardized rate (per 100,000)	749.3 (648.6 to 851.4)	540.7 (462.6 to 621.6)	972.4 (840.1 to 1,112.4)	532.7 (465.5 to 603.4)	372.1 (318.3 to 427.5)	702.0 (607.3 to 806.7)	-28.9 (-37.7 to -20.4)	-31.2 (-41.5 to -20.8)	-27.8 (-37.1 to -18.1)
	YLDs	All ages number	688484 (443634 to 1002488)	305827 (199144 to 447035)	382657 (247810 to 558431)	1248232 (808065 to 1814531)	563315 (366328 to 813246)	684917 (436803 to 990972)	81.3 (67.6 to 94.2)	84.2 (69.2 to 98.6)	79.0 (66.1 to 91.1)	
		Age-standardized rate (per 100,000)	17.2 (11.1 to 24.9)	14.3 (9.4 to 21.0)	20.5 (13.2 to 30.0)	15.1 (9.8 to 21.9)	12.9 (8.4 to 18.7)	17.4 (11.2 to 25.2)	-12.4 (-19.3 to -5.9)	-9.8 (-17.2 to -2.6)	-15.1 (-21.8 to -8.9)	
	Ambient particulate matter pollution	Deaths	All ages number	607576 (450158 to 769644)	250493 (180651 to 319239)	357084 (265381 to 452738)	1332043 (1086918 to 1557229)	524564 (420780 to 631284)	807479 (652574 to 947228)	119.2 (81.6 to 170.7)	109.4 (71.1 to 165.9)	126.1 (86.0 to 181.6)
			Age-standardized rate (per 100,000)	16.8 (12.3 to 21.3)	12.7 (9.1 to 16.1)	21.6 (15.9 to 27.5)	16.6 (13.6 to 19.4)	12.0 (9.6 to 14.4)	21.8 (17.7 to 25.6)	-1.2 (-18.1 to 22.0)	-5.3 (-22.6 to 20.0)	0.9 (-17.1 to 25.7)
		DALYs	All ages number	14589882 (10795925 to 18608473)	5075634 (3707182 to 6506461)	9514248 (6965213 to 12205486)	32174350 (26024800 to 37713769)	11076103 (8949796 to 13227339)	21098247 (17042274 to 24925316)	120.5 (82.9 to 171.2)	118.2 (79.0 to 170.9)	121.8 (81.4 to 175.3)
			Age-standardized rate (per 100,000)	362.5 (269.0 to 459.8)	240.4 (175.8 to 308.7)	493.4 (364.5 to 627.8)	389.2 (315.6 to 455.8)	255.2 (206.2 to 304.8)	531.2 (430.5 to 625.2)	7.4 (-11.2 to 31.9)	6.1 (-12.9 to 32.5)	7.7 (-11.6 to 33.4)
YLLs		All ages number	14286499 (10623562 to 18169598)	4948033 (3621294 to 6349449)	9338466 (6850180 to 11954786)	31244478 (25419964 to 36707291)	10669924 (8609112 to 12741796)	20574554 (16579274 to 24355992)	118.7 (81.4 to 169.1)	115.6 (76.6 to 168.0)	120.3 (80.2 to 172.9)	
		Age-standardized rate (per 100,000)	354.8 (264.1 to 450.2)	234.4 (171.5 to 300.7)	483.8 (356.9 to 614.7)	377.9 (307.4 to 442.9)	245.8 (198.4 to 293.5)	517.9 (418.2 to 611.5)	6.5 (-11.9 to 30.8)	4.9 (-14.1 to 31.1)	7.0 (-12.1 to 32.7)	

Cause	Risk factor	Measure	Metric	Year						% Change (1990 to 2019)			
				1990			2019			Both	Female	Male	
				Both	Female	Male	Both	Female	Male				
		YLDs	All ages number	303383 (181302 to 465555)	127601 (75024 to 197841)	175782 (104472 to 272572)	929872 (591036 to 1381407)	406179 (255690 to 604176)	523692 (332882 to 785783)	206.5 (151.6 to 287.2)	218.3 (158.7 to 307.0)	197.9 (143.2 to 280.0)	
			Age-standardized rate (per 100,000)	7.7 (4.7 to 11.8)	6.0 (3.6 to 9.3)	9.6 (5.8 to 14.9)	11.2 (7.1 to 16.7)	9.3 (5.9 to 13.9)	13.3 (8.6 to 19.8)	46.0 (19.4 to 84.8)	54.4 (25.4 to 96.7)	38.7 (13.9 to 76.2)	
		Household air pollution from solid fuels	Deaths	All ages number	617607 (471852 to 790195)	271334 (204779 to 348852)	346274 (254553 to 450332)	511174 (348356 to 714580)	238556 (164032 to 330502)	272618 (175101 to 401886)	-17.2 (-36.1 to 4.2)	-12.1 (-33.0 to 10.7)	-21.3 (-41.2 to 1.4)
				Age-standardized rate (per 100,000)	16.0 (12.2 to 20.5)	13.0 (9.8 to 16.8)	19.5 (14.2 to 25.3)	6.3 (4.3 to 8.8)	5.5 (3.8 to 7.6)	7.2 (4.6 to 10.6)	-60.7 (-69.5 to -50.7)	-58.1 (-68.0 to -47.4)	-63.2 (-72.4 to -52.6)
		DALYs	All ages number	16887860 (12993917 to 21344578)	6843970 (5311692 to 8640128)	10043890 (7437659 to 12979526)	13180070 (9051398 to 18251784)	5613688 (3901927 to 7484370)	7566382 (4905811 to 11020754)	-22.0 (-39.4 to -2.7)	-18.0 (-37.1 to 2.1)	-24.7 (-43.6 to -3.1)	
			Age-standardized rate (per 100,000)	404.0 (310.5 to 508.3)	314.6 (243.8 to 397.7)	499.5 (367.7 to 646.3)	158.7 (108.9 to 219.7)	129.8 (90.3 to 173.0)	188.3 (121.8 to 274.5)	-60.7 (-69.4 to -51.1)	-58.7 (-68.2 to -48.6)	-62.3 (-71.7 to -51.7)	
		YLLs	All ages number	16502760 (12718594 to 20934210)	6665745 (5172736 to 8375408)	9837015 (7289841 to 12727953)	12861709 (8826065 to 17853420)	5456552 (3798478 to 7287895)	7405157 (4802887 to 10753506)	-22.1 (-39.4 to -2.9)	-18.1 (-37.2 to 2.1)	-24.7 (-43.7 to -3.2)	
			Age-standardized rate (per 100,000)	394.5 (304.3 to 498.1)	306.3 (237.9 to 385.9)	488.6 (360.8 to 634.1)	154.8 (106.2 to 214.5)	126.2 (88.0 to 168.6)	184.2 (119.2 to 268.2)	-60.8 (-69.4 to -51.2)	-58.8 (-68.3 to -48.5)	-62.3 (-71.7 to -51.7)	
		YLDs	All ages number	385101 (231511 to 584502)	178225 (106588 to 267930)	206875 (120182 to 312953)	318361 (175687 to 513670)	157136 (85421 to 252681)	161225 (85189 to 266010)	-17.3 (-38.4 to 7.0)	-11.8 (-35.0 to 14.0)	-22.1 (-41.9 to 1.4)	
			Age-standardized rate (per 100,000)	9.5 (5.7 to 14.2)	8.3 (5.0 to 12.4)	10.9 (6.4 to 16.4)	3.8 (2.1 to 6.2)	3.6 (2.0 to 5.8)	4.1 (2.2 to 6.7)	-59.6 (-69.8 to -47.8)	-56.5 (-67.7 to -43.8)	-62.6 (-72.0 to -51.3)	
	Stroke	Particulate matter pollution	Deaths	All ages number	1378620 (1210663 to 1557058)	681935 (586263 to 786292)	696685 (613760 to 793241)	1701943 (1498447 to 1917895)	780080 (671813 to 901537)	921863 (798049 to 1052863)	23.5 (8.9 to 38.6)	14.4 (-2.5 to 34.6)	32.3 (13.1 to 52.5)
				Age-standardized rate (per 100,000)	36.8 (32.1 to 41.6)	33.1 (28.3 to 38.2)	41.2 (36.1 to 47.0)	21.1 (18.6 to 23.9)	17.8 (15.4 to 20.6)	24.9 (21.6 to 28.5)	-42.5 (-49.6 to -35.2)	-46.1 (-54.0 to -36.4)	-39.5 (-48.3 to -30.2)
DALYs			All ages number	36312877 (32393296 to 40347183)	17270730 (15117278 to 19616421)	19042146 (16924404 to 21494213)	43474911 (38364312 to 48722881)	19398064 (16922830 to 22170013)	24076847 (20947202 to 27340210)	19.7 (6.7 to 32.8)	12.3 (-2.4 to 28.9)	26.4 (8.6 to 44.2)	
			Age-standardized rate (per 100,000)	888.0 (789.9 to 989.8)	799.6 (698.7 to 908.1)	986.2 (876.2 to 1,114.3)	525.6 (463.9 to 589.9)	447.2 (390.4 to 511.1)	610.1 (529.9 to 692.9)	-40.8 (-47.4 to -34.3)	-44.1 (-51.3 to -35.8)	-38.1 (-46.8 to -29.3)	

Cause	Risk factor	Measure	Metric	Year						% Change (1990 to 2019)		
				1990			2019			Both	Female	Male
				Both	Female	Male	Both	Female	Male			
Ambient particulate matter pollution	Deaths	All ages number	33375374 (29726748 to 37286595)	15545631 (13603606 to 17674887)	17829743 (15757627 to 20293110)	38446909 (34049904 to 43105162)	16488297 (14297698 to 18916577)	21958613 (19013110 to 25037157)	15.2 (1.8 to 29.0)	6.1 (-8.8 to 23.6)	23.2 (4.2 to 42.0)	
		Age-standardized rate (per 100,000)	818.5 (729.6 to 916.9)	721.6 (629.4 to 821.6)	926.5 (817.5 to 1,054.3)	465.0 (411.5 to 521.2)	379.7 (329.2 to 435.7)	557.2 (483.3 to 634.9)	-43.2 (-49.9 to -36.3)	-47.4 (-54.9 to -38.6)	-39.9 (-48.8 to -30.7)	
	YLDs	All ages number	2937502 (2074626 to 3826673)	1725099 (1222365 to 2234107)	1212403 (856636 to 1578105)	5028001 (3507984 to 6494182)	2909767 (2021877 to 3780864)	2118235 (1489060 to 2748683)	71.2 (60.3 to 82.1)	68.7 (57.5 to 79.8)	74.7 (64.0 to 85.5)	
		Age-standardized rate (per 100,000)	69.4 (49.0 to 90.2)	78.0 (55.2 to 101.1)	59.6 (42.2 to 77.5)	60.6 (42.3 to 78.4)	67.6 (47.0 to 87.8)	52.9 (37.3 to 68.7)	-12.7 (-18.4 to -6.9)	-13.4 (-19.2 to -7.6)	-11.3 (-16.9 to -5.6)	
	DALYs	All ages number	508033 (350059 to 684235)	241560 (168633 to 326083)	266473 (179424 to 361724)	1143352 (945530 to 1336394)	489227 (390724 to 590728)	654125 (534294 to 777204)	125.1 (76.5 to 198.1)	102.5 (58.4 to 168.8)	145.5 (85.4 to 237.7)	
			Age-standardized rate (per 100,000)	14.0 (9.6 to 18.6)	12.0 (8.3 to 16.1)	16.3 (11.1 to 21.9)	14.3 (11.8 to 16.6)	11.2 (8.9 to 13.5)	17.8 (14.6 to 21.2)	2.2 (-19.5 to 34.8)	-6.6 (-27.0 to 23.5)	9.6 (-16.4 to 49.4)
		All ages number	12856953 (8763700 to 17506435)	5718895 (3927950 to 7860047)	7138058 (4770971 to 9781816)	28736491 (23372268 to 33440293)	11915642 (9570573 to 14314048)	16820849 (13644195 to 19871089)	123.5 (75.1 to 195.4)	108.4 (62.2 to 176.8)	135.7 (79.9 to 224.1)	
			Age-standardized rate (per 100,000)	319.3 (219.5 to 433.5)	267.5 (185.1 to 366.3)	376.0 (254.0 to 511.4)	348.1 (283.3 to 404.4)	274.3 (220.6 to 329.4)	428.1 (348.7 to 505.8)	9.0 (-14.3 to 43.3)	2.6 (-20.0 to 35.6)	13.9 (-12.7 to 56.0)
		All ages number	11658209 (7866503 to 15879882)	5042354 (3470904 to 6987046)	6615856 (4392681 to 9112538)	25145833 (20500083 to 29433743)	9910613 (7965442 to 12034110)	15235220 (12265514 to 18117801)	115.7 (67.7 to 186.7)	96.5 (51.7 to 163.9)	130.3 (73.8 to 219.6)	
			Age-standardized rate (per 100,000)	290.6 (197.6 to 394.3)	236.6 (162.6 to 327.0)	349.8 (234.4 to 476.2)	304.7 (248.2 to 357.0)	227.9 (183.2 to 276.4)	388.4 (313.7 to 461.5)	4.9 (-18.2 to 39.3)	-3.7 (-25.7 to 29.5)	11.0 (-16.0 to 53.2)
		All ages number	1198744 (756639 to 1717257)	676542 (428213 to 962377)	522202 (323553 to 756009)	3590659 (2454868 to 4754059)	2005029 (1364329 to 2682043)	1585629 (1088365 to 2093285)	199.5 (145.3 to 281.7)	196.4 (142.6 to 274.3)	203.6 (144.8 to 291.5)	
			Age-standardized rate (per 100,000)	28.8 (18.2 to 40.7)	30.9 (19.6 to 43.9)	26.2 (16.3 to 37.8)	43.3 (29.6 to 57.4)	46.5 (31.7 to 62.1)	39.7 (27.3 to 52.4)	50.6 (22.9 to 90.6)	50.5 (23.2 to 89.2)	51.8 (22.8 to 94.5)
Household air pollution from solid fuels	Deaths	All ages number	870587 (667242 to 1079202)	440375 (339855 to 547735)	430212 (317082 to 553173)	558591 (380841 to 769150)	290853 (203861 to 391675)	267738 (170503 to 390535)	-35.8 (-51.4 to -18.3)	-34.0 (-49.6 to -16.3)	-37.8 (-55.5 to -17.5)	
		Age-standardized rate (per 100,000)	22.8 (17.5 to 28.5)	21.1 (16.3 to 26.4)	24.9 (18.4 to 32.2)	6.9 (4.7 to 9.5)	6.7 (4.7 to 9.0)	7.1 (4.5 to 10.4)	-69.8 (-77.2 to -61.5)	-68.5 (-76.0 to -60.1)	-71.5 (-79.7 to -62.3)	

Cause	Risk factor	Measure	Metric	Year						% Change (1990 to 2019)		
				1990			2019			Both	Female	Male
				Both	Female	Male	Both	Female	Male			
	DALYs	All ages number		23455923 (18155376 to 28707224)	11551835 (9048955 to 14120476)	11904088 (8887744 to 15120605)	14738419 (10132652 to 20130763)	7482421 (5367983 to 9887987)	7255998 (4674469 to 10537049)	-37.2 (-52.0 to -21.1)	-35.2 (-49.6 to -19.5)	-39.0 (-55.8 to -19.7)
			Age-standardized rate (per 100,000)	568.6 (438.6 to 699.3)	532.1 (416.0 to 650.5)	610.2 (455.8 to 777.0)	177.5 (122.1 to 242.8)	172.9 (124.1 to 228.3)	182.0 (117.2 to 264.0)	-68.8 (-76.2 to -60.7)	-67.5 (-74.8 to -59.7)	-70.2 (-78.5 to -60.8)
		YLLs	All ages number	21717165 (16795279 to 26747317)	10503278 (8231221 to 12890569)	11213887 (8339128 to 14302071)	13301077 (9124838 to 18084726)	6577684 (4675127 to 8665674)	6723393 (4364833 to 9698592)	-38.8 (-53.2 to -22.9)	-37.4 (-51.5 to -21.7)	-40.0 (-56.5 to -20.8)
			Age-standardized rate (per 100,000)	528.0 (407.2 to 651.1)	485.0 (379.3 to 592.8)	576.7 (427.0 to 737.4)	160.2 (109.8 to 218.2)	151.8 (107.9 to 199.7)	168.8 (109.3 to 243.5)	-69.7 (-76.9 to -61.9)	-68.7 (-75.7 to -60.9)	-70.7 (-78.8 to -61.5)
	YLDs	All ages number	1738758 (1175325 to 2369965)	1048557 (714029 to 1400167)	690201 (454050 to 958437)	1437343 (889434 to 2141799)	904737 (568076 to 1337055)	532605 (305567 to 844171)	-17.3 (-38.0 to 4.5)	-13.7 (-34.9 to 8.9)	-22.8 (-43.6 to 0.6)	
		Age-standardized rate (per 100,000)	40.7 (27.6 to 55.3)	47.2 (32.0 to 63.3)	33.5 (22.1 to 46.8)	17.3 (10.7 to 25.7)	21.1 (13.3 to 31.1)	13.2 (7.6 to 21.0)	-57.5 (-68.0 to -46.1)	-55.3 (-66.1 to -43.6)	-60.6 (-71.2 to -48.8)	

Data in parenthesis are 95% uncertainty intervals; DALYs: Disability-Adjusted Life Years; YLLs: Years of Life Lost; YLDs: Years Lived with Disability

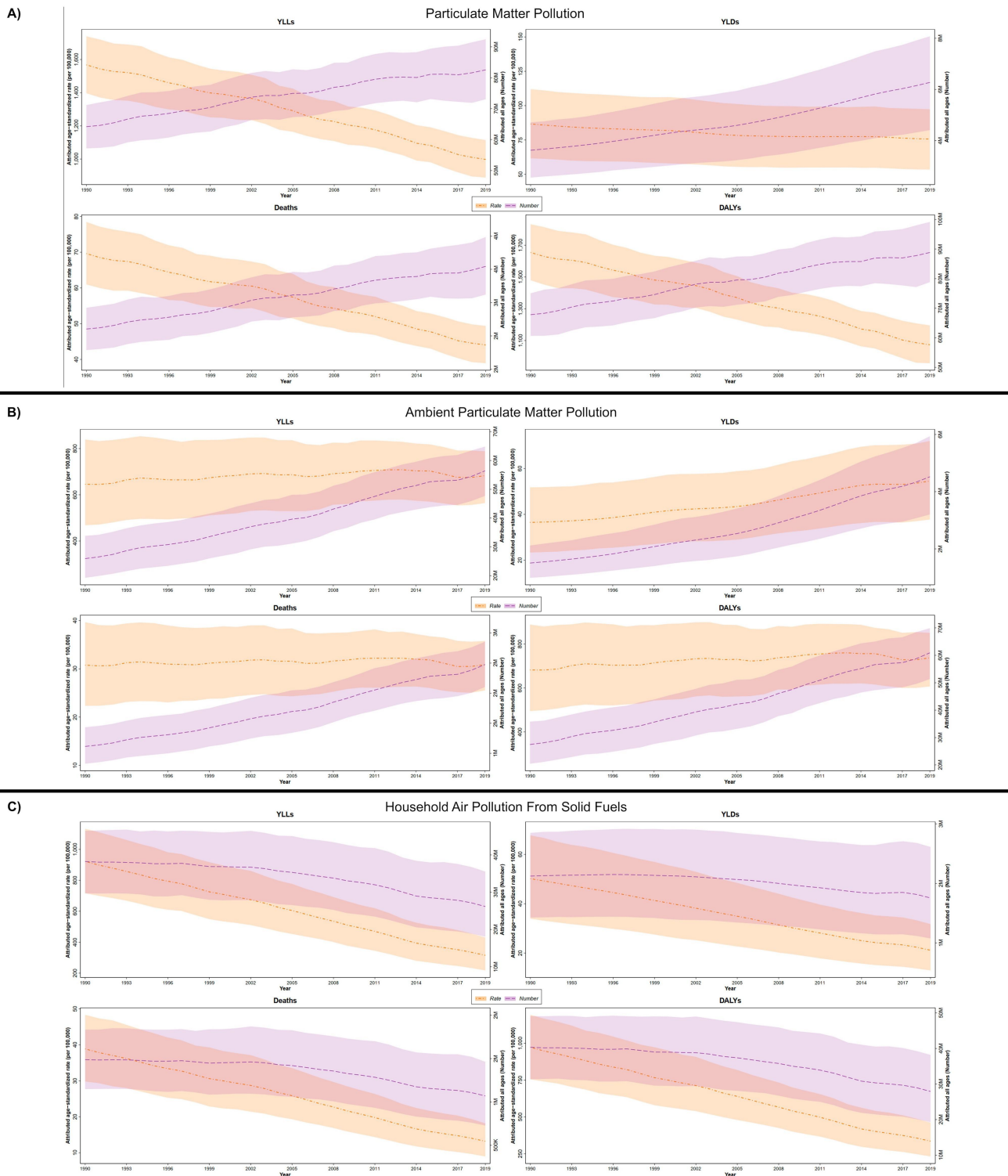


Figure S1. Time trend of ASR vs. all-ages number of YLLs, YLDs, deaths, and DALYs caused by CVD attributed to (a) PM pollution, (b) Ambient PM pollution, and (c) HAP from solid fuels by sex from 1990 to 2019; ASR: age-standardized rate, YLLs: years lived with disability, YLDs: years lived with disability, DALYs: disability-adjusted life years, CVD: cardiovascular disease, PM: particulate matter, HAP: household air pollution.

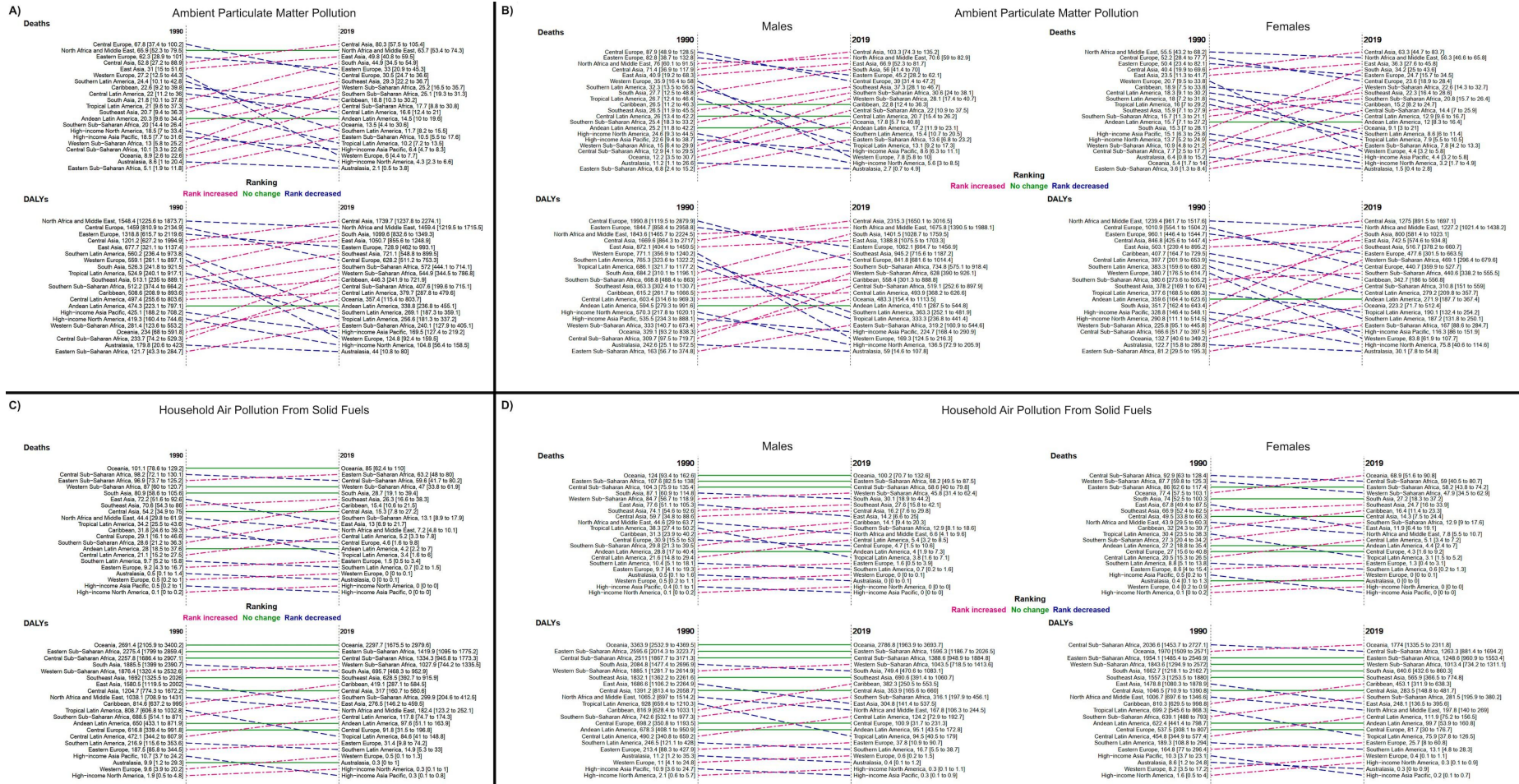


Figure S2. Ranking of 21 GBD regions (1990 to 2019) for ASR of (a) deaths and DALYs attributed to ambient PM, both sexes; (b) deaths and DALYs attributed to ambient PM pollution for men vs women; (c) deaths and DALYs attributed to HAP from solid fuels pollution, both sexes; (d) deaths and DALYs attributed to HAP from solid fuels pollution for men vs women; ASR: age-standardized rate, YLLs: years lived with disability, YLDs: years lived with disability, DALYs: disability-adjusted life years, CVD: cardiovascular disease, PM: particulate matter, HAP: household air pollution.

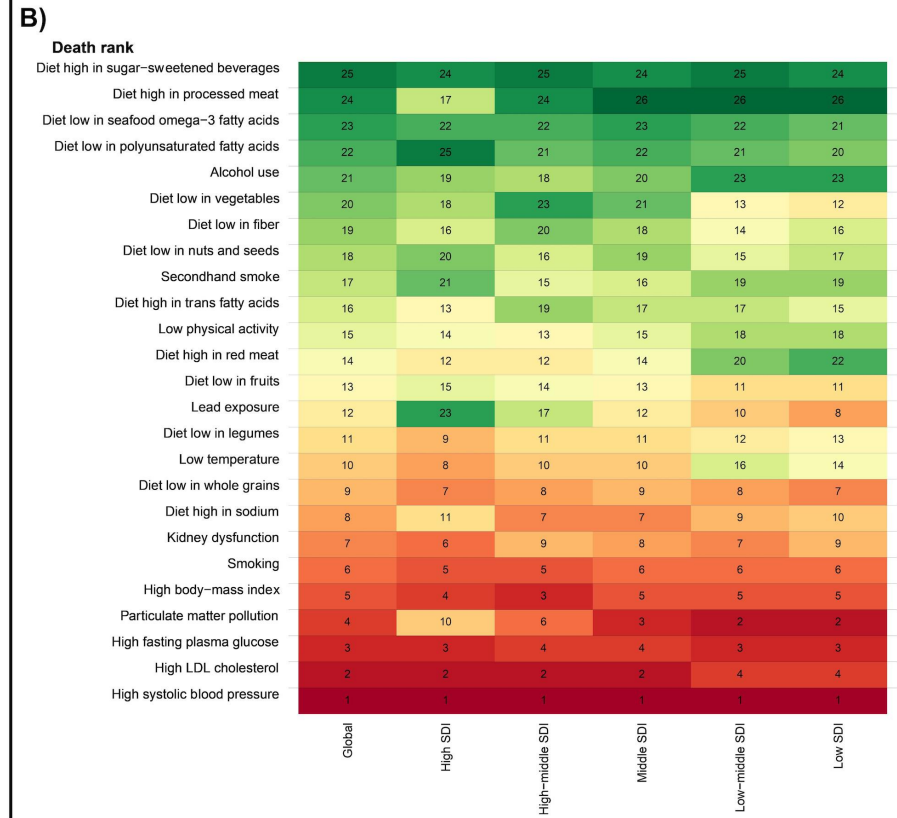
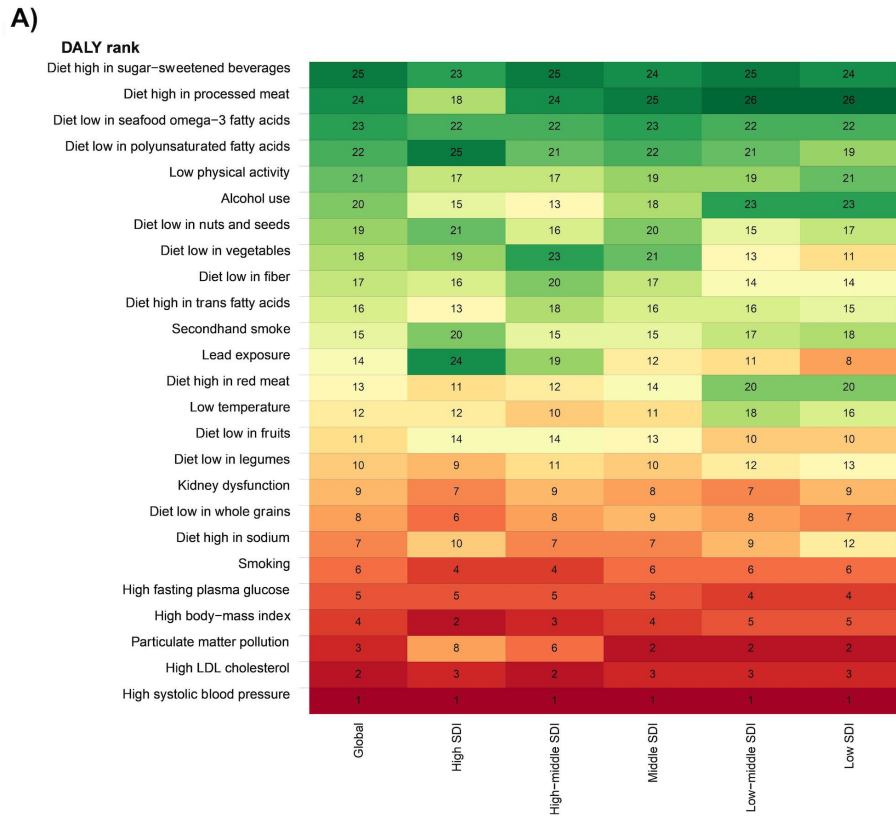


Figure S3. Comparison of CVD risk factors in different SDI regions in 2019 in terms of (a) DALYs, (b) Deaths; DALYs: disability-adjusted life years, CVD: cardiovascular disease, SDI: sociodemographic index.