GBD 2017 State-Level Burden of Disease from Air Pollution in India: Findings and Future Research Needs

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On Behalf of the India State-Level Disease Burden Initiative

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INDIAN COUNCIL OF MEDICAL RESEARCH

IHME

India State-Level Disease Burden Initiative Air Pollution Collaborators

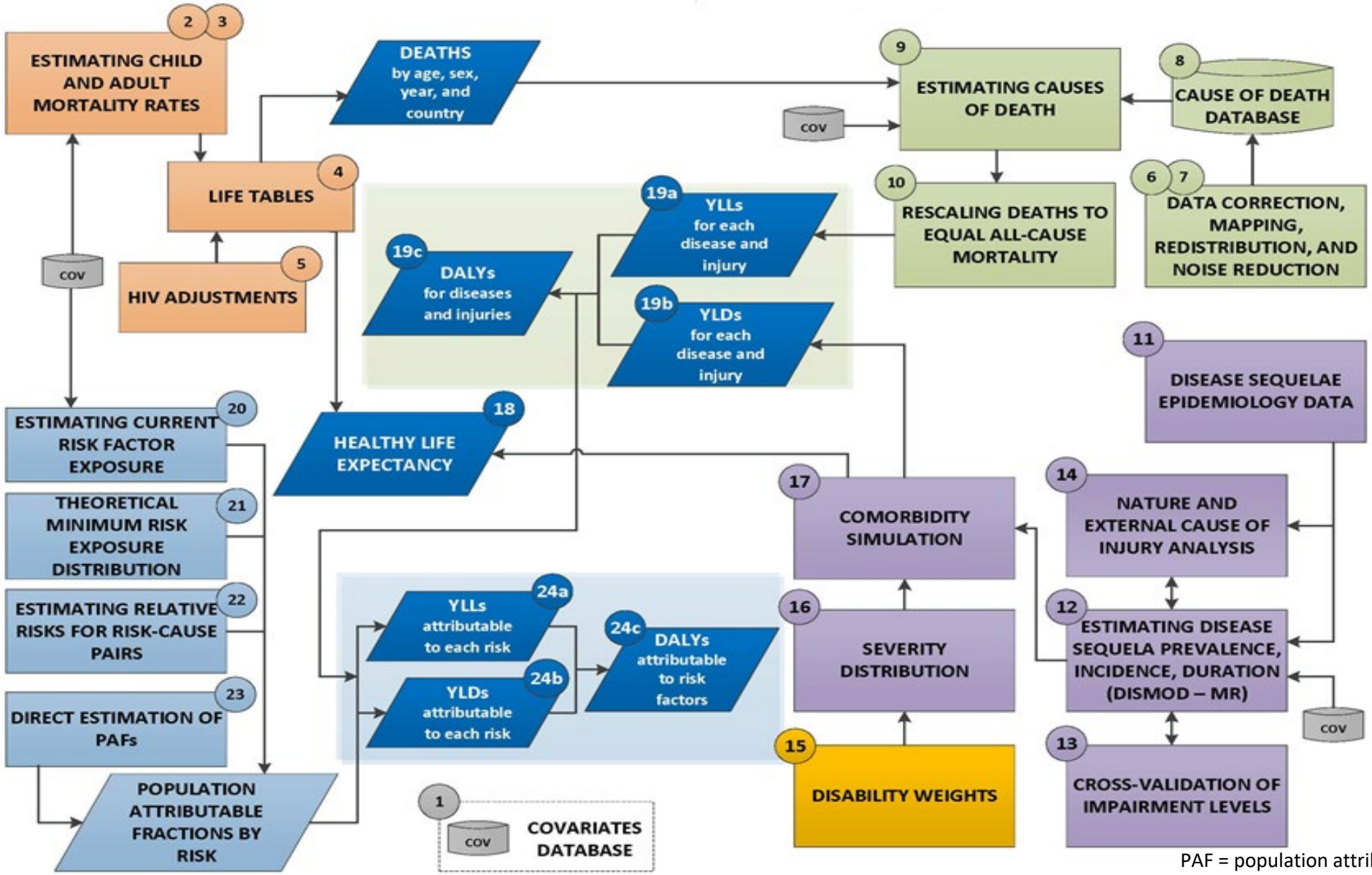
76 collaborators

Sri Ramachandra Institute of Higher Education and Research, Chennai; Indian Institute of Technology, New Delhi; Indian Institute of Technology, Kanpur; Indian Institute of Tropical Meteorology, Ministry of Earth Sciences, Government of India, Pune; Indian Council of Medical Research, New Delhi; National Institute of Occupational Health, ICMR, Ahmedabad; National Institute for Research in Environmental Health, ICMR, Bhopal; Ministry of Environment, Forest and Climate Change, Government of India, New Delhi; National Centre for Disease Control, Ministry of Health and Family Welfare, Government of India, New Delhi; Directorate General of Health Services, Ministry of Health and Family Welfare, Government of India, New Delhi; All India Institute of Medical Sciences, New Delhi; Postgraduate Institute of Medical Education and Research, Chandigarh; Sree Chitra Tirunal Institute for Medical Sciences and Technology, Trivandrum; Asthma Bhawan, Jaipur; Chest Research Foundation, Pune; CSIR-Institute of Genomics and Integrative Biology, New Delhi; Sher-i-Kashmir Institute of Medical Sciences, Srinagar; Christian Medical College, Ludhiana; Christian Medical College, Vellore; St. John's Medical College, Bengaluru; JSS Medical College, Mysuru; Government Medical College, Trivandrum; King George Medical University, Lucknow; National Allergy Asthma Bronchitis Institute, Kolkata; Rajasthan University of Health Sciences, Jaipur; Madras Diabetes Research Foundation, Chennai; Institute of Postgraduate Medical Education and Research, Kolkata; University of British Columbia, Vancouver; Health Effects Institute, Boston; Institute for Health Metrics and Evaluation, University of Washington, Seattle; Public Health Foundation of India, Gurugram

India State-Level Disease Burden Initiative

- Launched in October 2015 as joint effort of the Indian Council of Medical Research (ICMR), the Public Health Foundation of India (PHFI) and the Institute for Health Metrics and Evaluation (IHME), in collaboration with the Ministry of Health and Family Welfare
- Extensive engagement with about 300 experts from over 100 institutions across India and with policy makers for this work
- Produce disaggregated disease burden trends by age groups, sexes, rural-urban populations for each state
- Identify major data gaps that could be addressed over time
- Build systems and capacity for producing robust sub-national disease burden estimates on a regular basis
- Estimations in collaboration with and as part of the Global Burden of Disease (GBD) Study

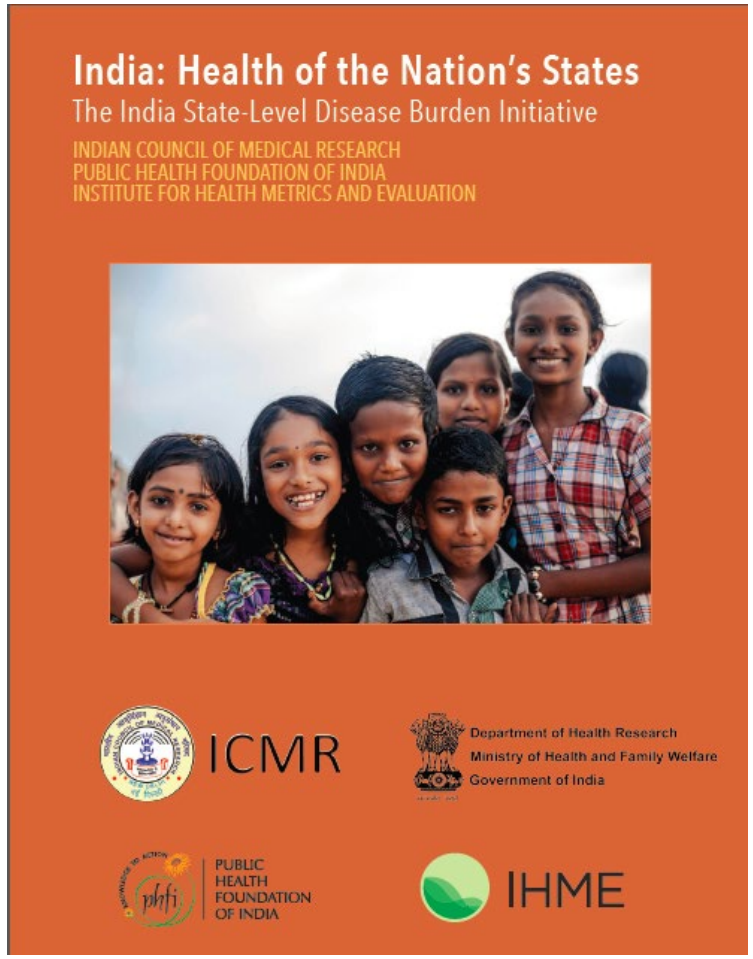
Methods: GBD Data and Model Flow Chart



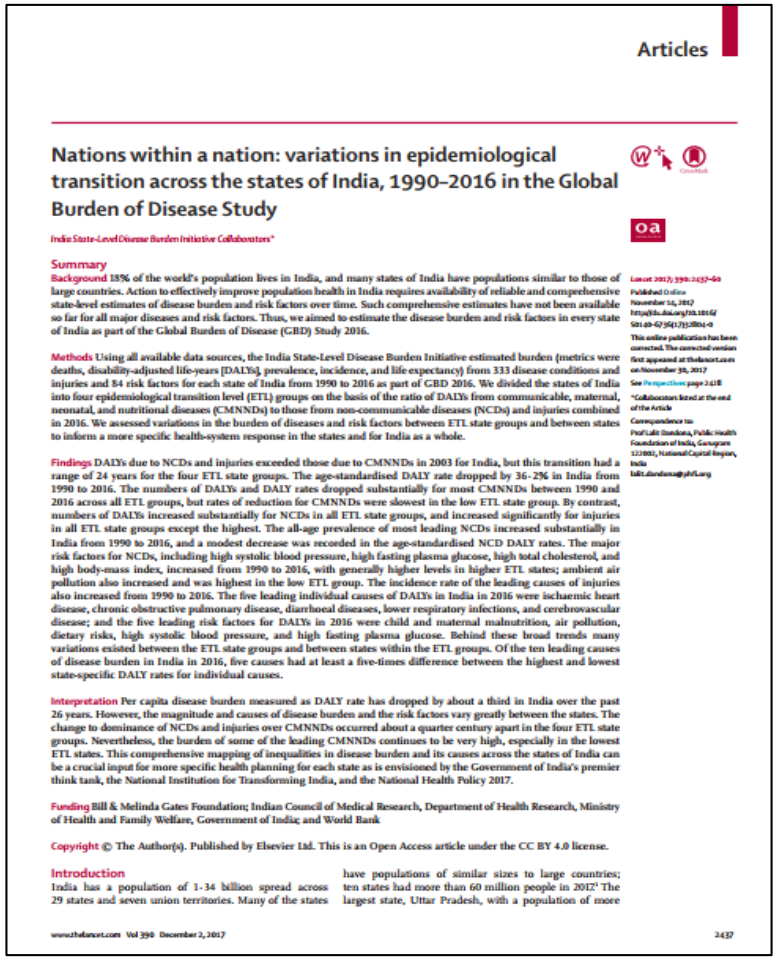
Methods developed and refined over 25 years

PAF = population attributable fraction
DALY = disability-adjusted life years
YLL = years of life lost due to premature mortality
YLD = years lived with disability

Initial Published Materials



Report:
http://www.healthdata.org/policy-report/india-health-nation%E2%80%99s-states

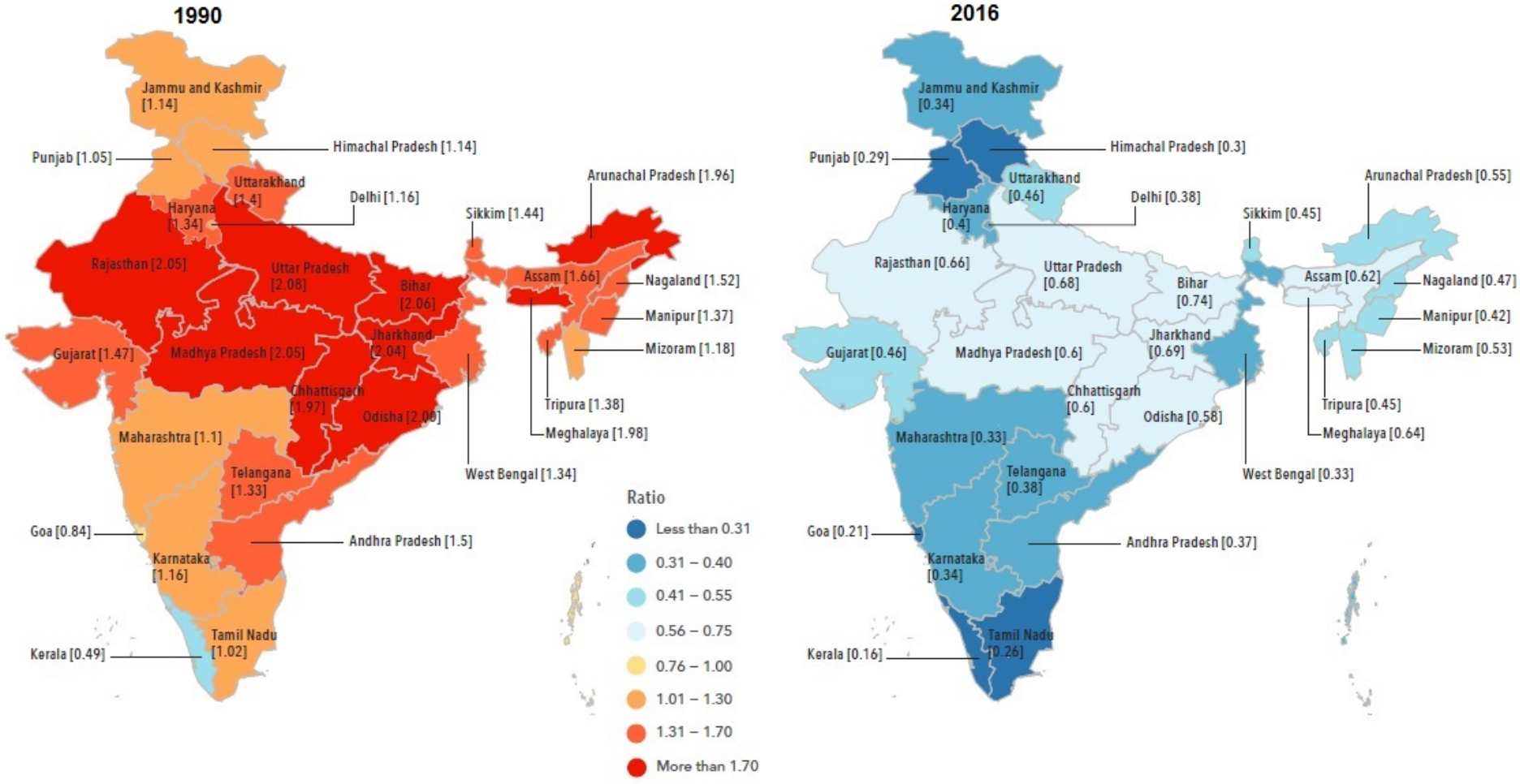


Lancet Paper:
www.thelancet.com/journals/lancet/article/PIIS0140-6736(17)32804-0/fulltext

Findings Released by Vice-President and Health Minister of India in Nov 2017

Epidemiological Transition Across the States of India

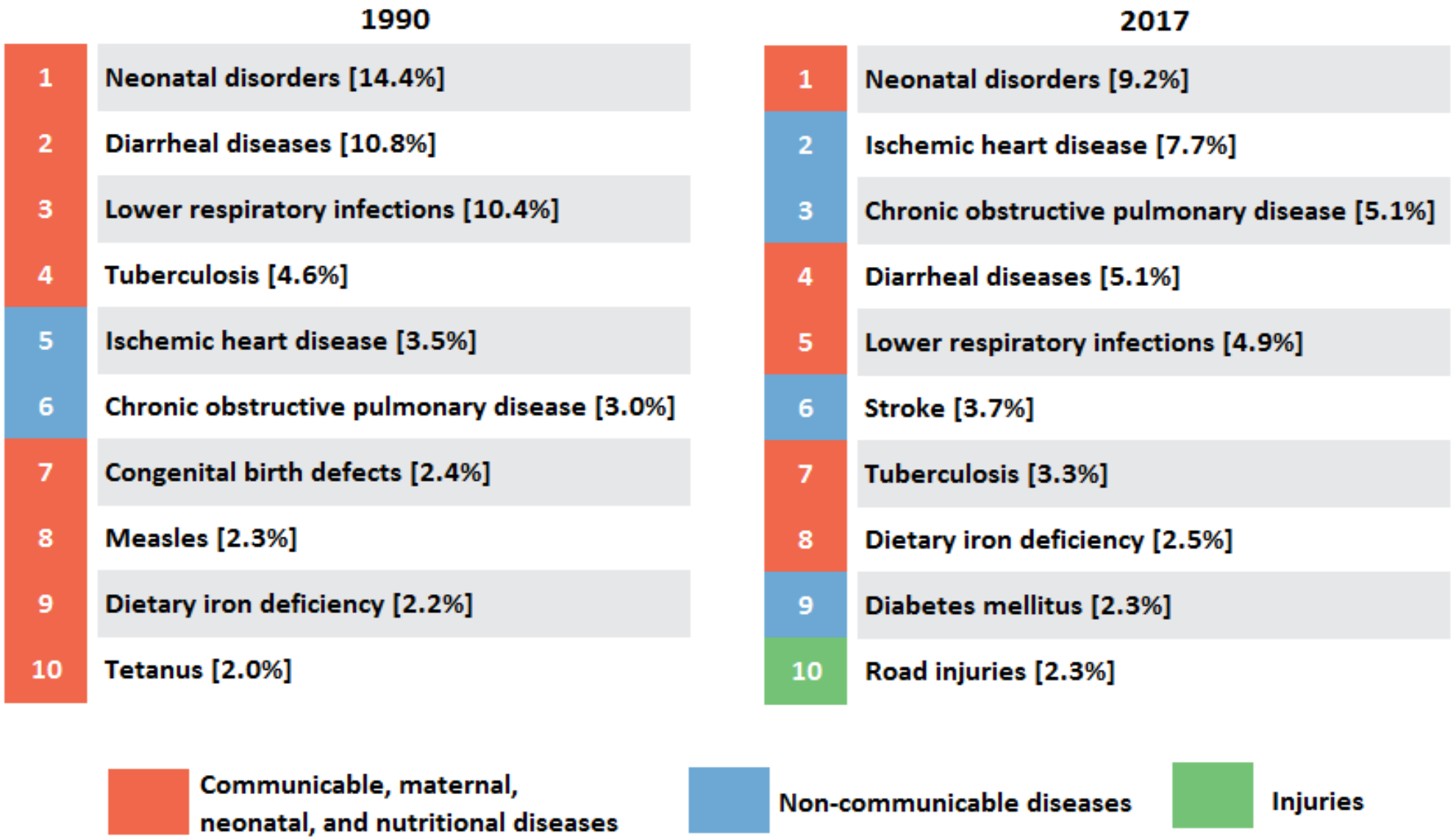
Infectious and related diseases cause less than half of the disease burden in every state now



This transition occurred in some states 30 years ago and in others only in the past few years

Lancet 2017; 390: 2437–2460

Leading Individual Causes of DALYs in India



https://vizhub.healthdata.org/gbd-compare/

DALYs = disability-adjusted life years

DALYs Attributable to Risk Factors in India

	1990		2017
1	Child and maternal malnutrition [36.4%]	1	Child and maternal malnutrition [17.3%]
2	Unsafe water and sanitation [11.5%]	2	Dietary risks [9.0%]
3	Air pollution [9.0%]	3	Air pollution [8.0%]
4	Tobacco use [5.2%]	4	High systolic blood pressure [7.9%]
5	Dietary risks [4.5%]	5	Tobacco use [6.5%]
6	High systolic blood pressure [3.6%]	6	High fasting plasma glucose [6.0%]
7	Alcohol use [2.2%]	7	Unsafe water and sanitation [5.1%]
8	High fasting plasma glucose [2.2%]	8	Alcohol use [4.5%]
9	Occupational risks [1.9%]	9	High body-mass index [3.9%]
10	High LDL cholesterol [1.7%]	10	High LDL cholesterol [3.9%]

Behavioural risks

Environmental/occupational risks

Metabolic risks

https://vizhub.healthdata.org/gbd-compare/

DALYs = disability-adjusted life years

Estimation of Air Pollution Exposure in GBD 2017

- Outdoor air pollution
  - Annual average $PM_{2.5}$ concentration
  - Satellite-based aerosol optical depth data calibrated with ground-level $PM_{2.5}$ data
  - Data from 369 ground monitoring sites in India
- Household air pollution
  - Proportion of population using solid cooking fuels converted into $PM_{2.5}$ exposure
  - Major data sources included national surveys such as NFHS, DLHS and NSSO, Census of India, and other epidemiological studies
- Ambient ozone pollution
  - Mean of daily maximum 8-hour average concentration
  - GBD 2017 used new database of global surface ozone observations

Lancet Planetary Health 2019; 3: e26-e39 – Epub 6 Dec 2018

GBD = Global Burden of Disease
$PM_{2.5}$ = fine particulate matter
NFHS = National Family Health Survey
DLHS = District Level Household Survey
NSSO = National Sample Survey Office

Disease Burden and Deaths Attributable to Air Pollution

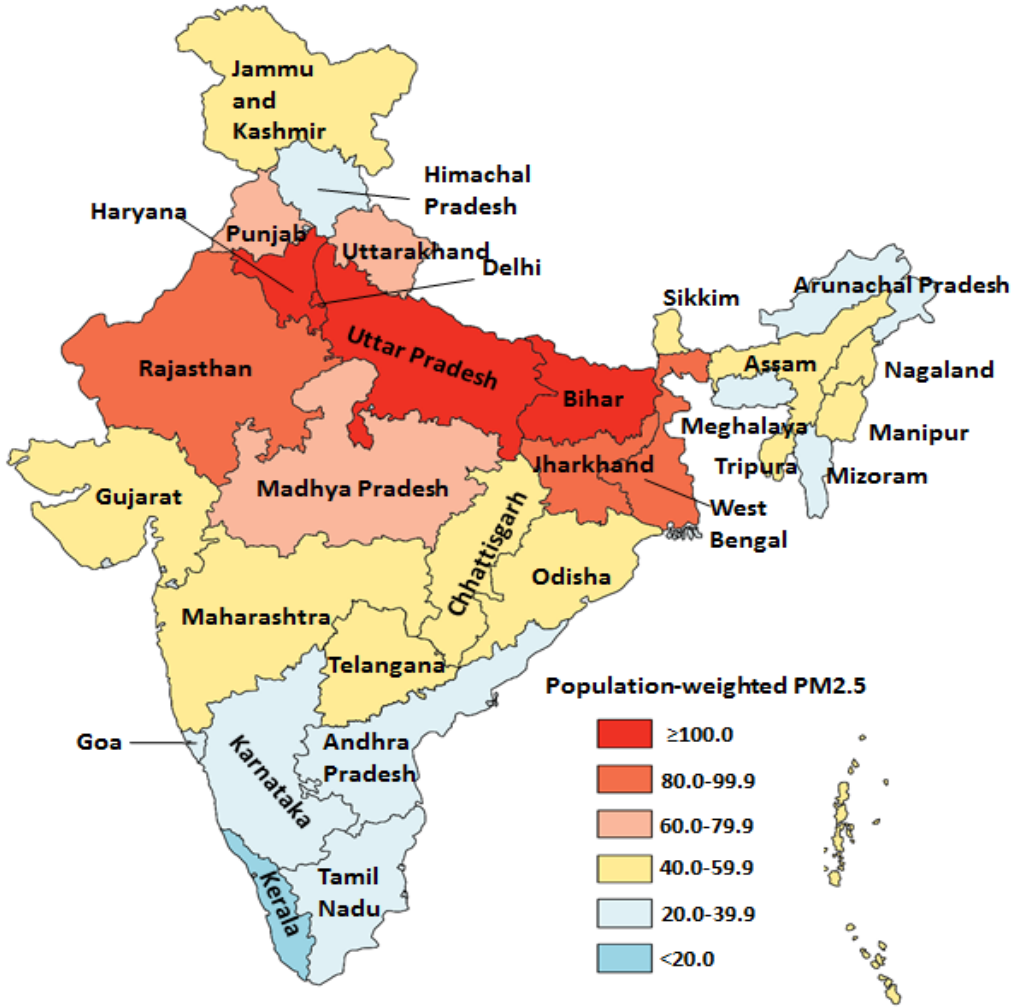
- Assessed risk-outcome pairs that had strong evidence for a biologically plausible association between exposure and disease outcomes
- Estimated relative risk of lower respiratory infections, chronic obstructive pulmonary disease, ischaemic heart disease, stroke, lung cancer, and diabetes for $PM_{2.5}$ exposure (60 studies)
- Estimated relative risk of cataract for household air pollution exposure
- Based on above, deaths and DALYs attributable to air pollution estimated
- GBD 2017 estimated mutually exclusive disease burden for outdoor particulate matter pollution and household air pollution

Lancet Planetary Health 2019; 3: e26-e39 – Epub 6 Dec 2018

GBD = Global Burden of Disease
DALYs = disability-adjusted life years
$PM_{2.5}$ = fine particulate matter

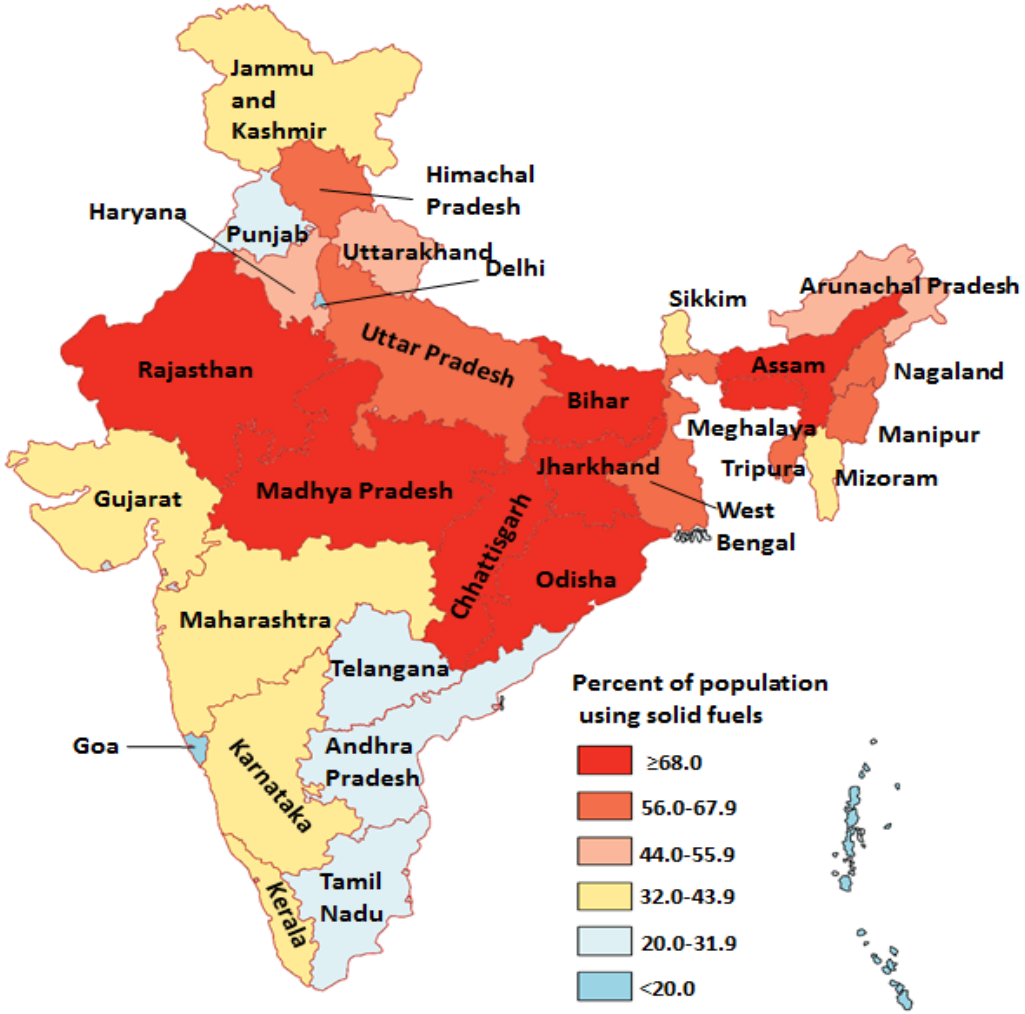
Air Pollution Exposure in the States of India: 2017

Population-weighted particulate matter $PM_{2.5}$



India mean: 90 µg/m³

Proportion of population using solid fuels



India mean: 55.5%

Lancet Planetary Health 2019; 3: e26-e39 – Epub 6 Dec 2018

$PM_{2.5}$ = fine particulate matter

Deaths and DALYs Attributable to Air Pollution in India: 2017

12.5% of all deaths attributable to air pollution in India

Total deaths attributable to air pollution:

1.24 million (95% uncertainty interval 1.09 to 1.39 million)

673,000 from outdoor particulate air pollution

482,000 from household air pollution

India had 18% of the global population in 2017

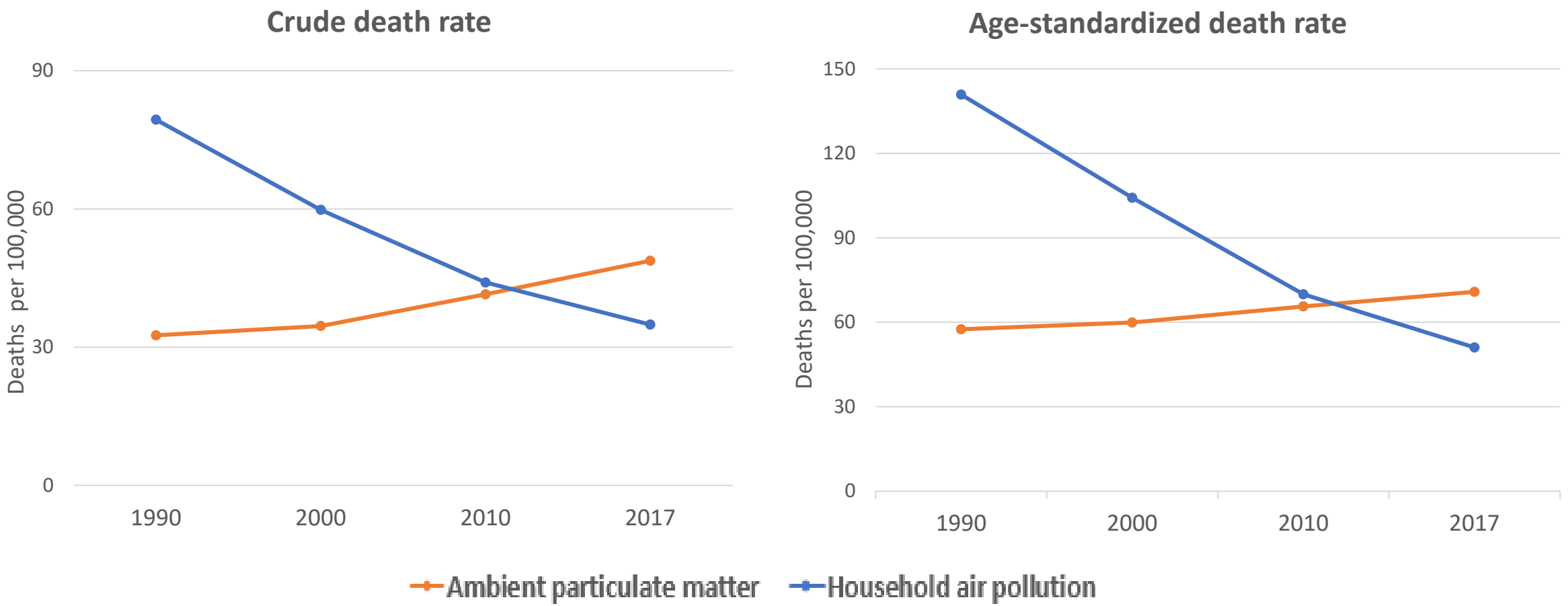
India suffered 26% of the global DALYs attributable to air pollution

Lancet Planetary Health 2019; 3: e26-e39 – Epub 6 Dec 2018

DALYs = disability-adjusted life years

Air Pollution Death Rate in India: 1990-2017

Ambient versus Household



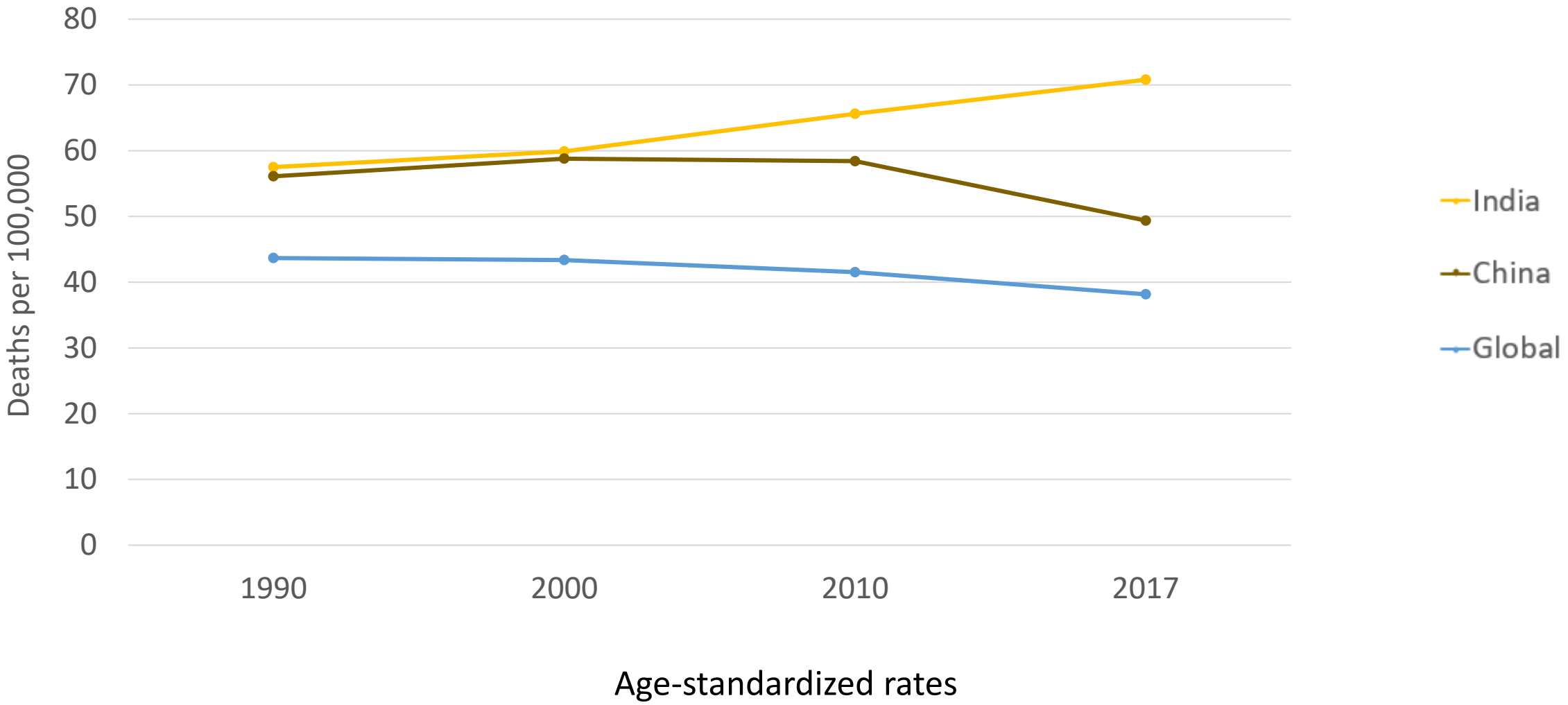
1990-2017
Ambient: 50% increase
Household: 56% decrease

1990-2017
Ambient: 22% increase
Household: 64% decrease

https://vizhub.healthdata.org/gbd-compare/

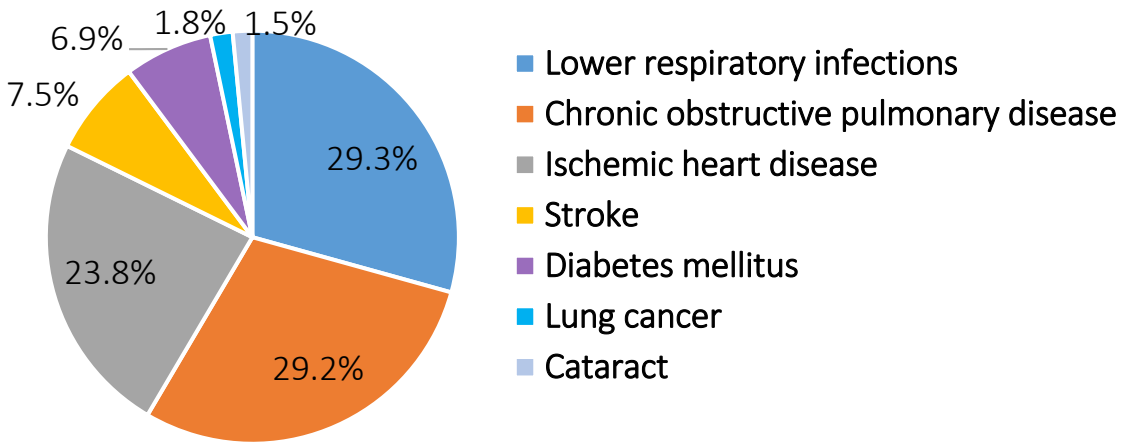
Ambient Particulate Matter Death Rate Comparison: 1990-2017

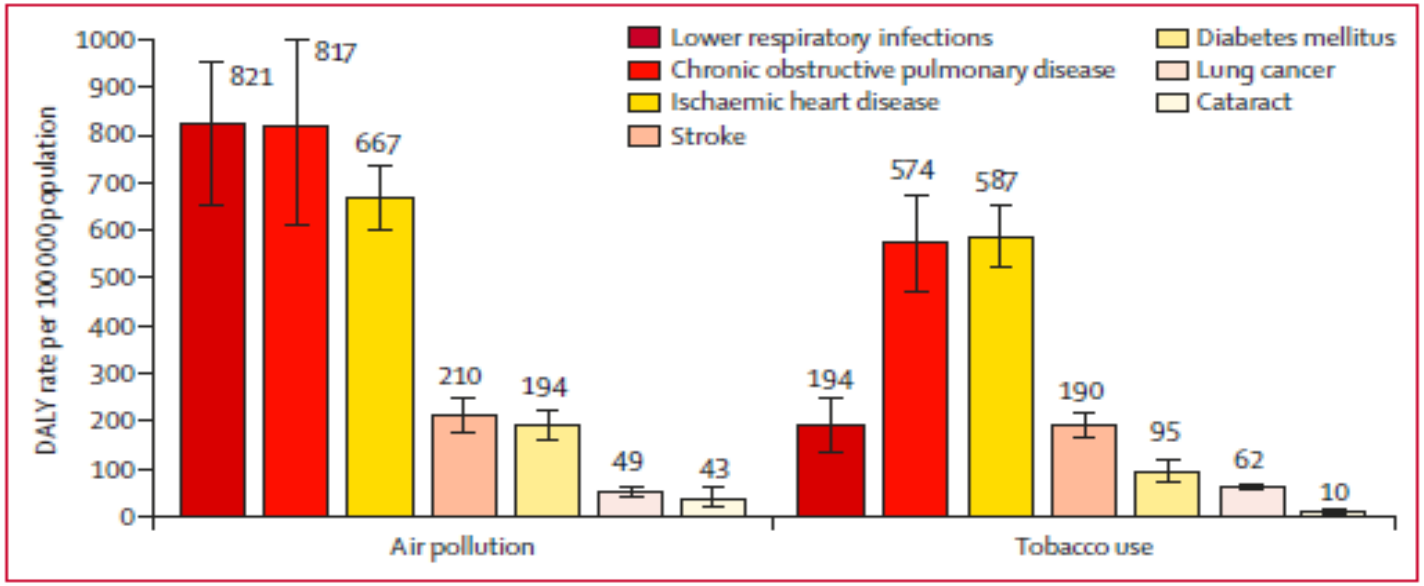
India, China, Global



https://vizhub.healthdata.org/gbd-compare/

DALYs Attributable to Air Pollution by Cause in India: 2017





DALY rates attributable to air pollution and tobacco use in India, 2017

Error bars represent 95% uncertainty intervals. DALY = disability-adjusted life-year.

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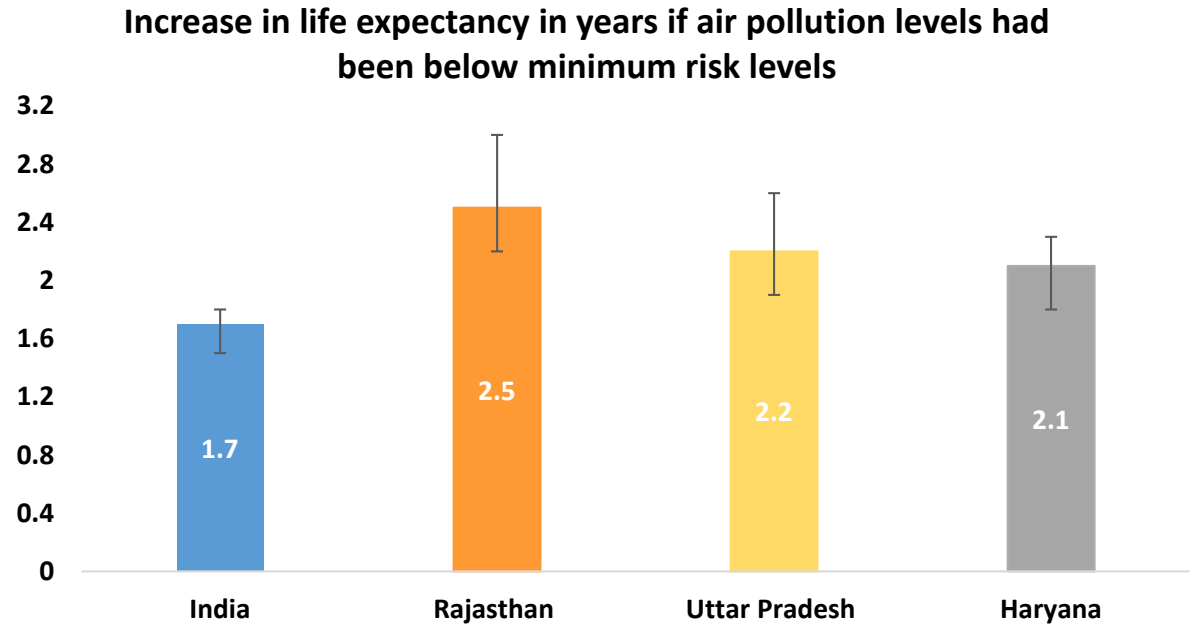
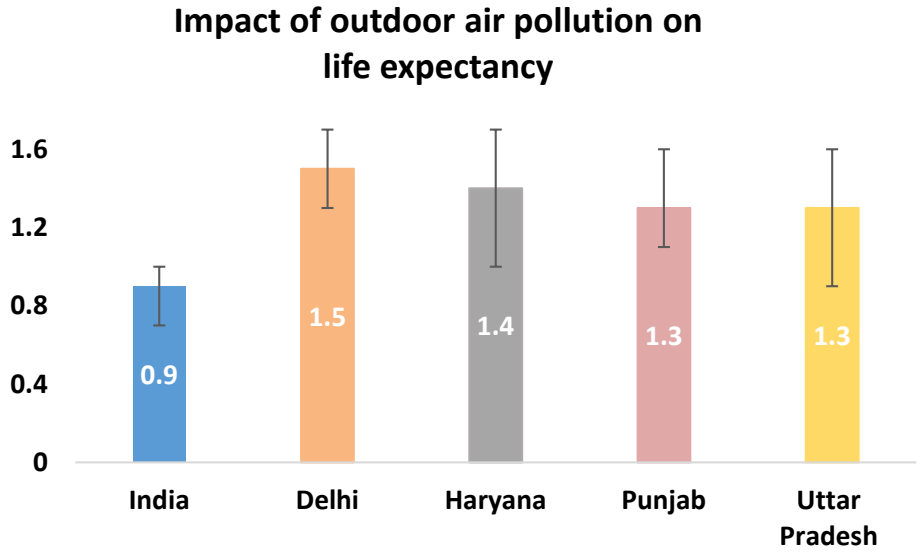
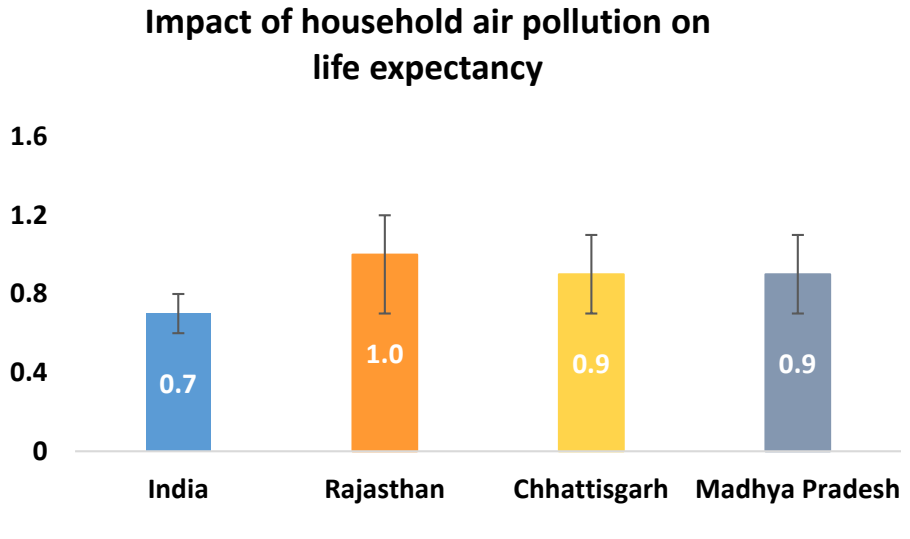
Impact of Air Pollution on Life Expectancy in India







Lancet Planetary Health 2019; 3: e26-e39 – Epub 6 Dec 2018

The impact of air pollution on deaths, disease burden, and life expectancy across the states of India: the Global Burden of Disease Study 2017

*India State-Level Disease Burden Initiative Air Pollution Collaborators**

Summary

Background Air pollution is a major planetary health risk, with India estimated to have some of the worst levels globally. To inform action at subnational levels in India, we estimated the exposure to air pollution and its impact on deaths, disease burden, and life expectancy in every state of India in 2017.

Methods We estimated exposure to air pollution, including ambient particulate matter pollution, defined as the annual average gridded concentration of $PM_{2.5}$, and household air pollution, defined as percentage of households using solid cooking fuels and the corresponding exposure to $PM_{2.5}$, across the states of India using accessible data from multiple sources as part of the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2017. The states were categorised into three Socio-demographic Index (SDI) levels as calculated by GBD 2017 on the basis of lag-distributed per-capita income, mean education in people aged 15 years or older, and total fertility rate in people younger than 25 years. We estimated deaths and disability-adjusted life-years (DALYs) attributable to air pollution exposure, on the basis of exposure–response relationships from the published literature, as assessed in GBD 2017; the proportion of total global air pollution DALYs in India; and what the life expectancy would have been in each state of India if air pollution levels had been less than the minimum level causing health loss.

Findings The annual population-weighted mean exposure to ambient particulate matter $PM_{2.5}$ in India was 89·9 μg/m³ (95% uncertainty interval [UI] 67·0–112·0) in 2017. Most states, and 76·8% of the population of India, were exposed to annual population-weighted mean $PM_{2.5}$ greater than 40 μg/m³, which is the limit recommended by the National Ambient Air Quality Standards in India. Delhi had the highest annual population-weighted mean $PM_{2.5}$ in 2017, followed by Uttar Pradesh, Bihar, and Haryana in north India, all with mean values greater than 125 μg/m³. The proportion of population using solid fuels in India was 55·5% (54·8–56·2) in 2017, which exceeded 75% in the low SDI states of Bihar, Jharkhand, and Odisha. 1·24 million (1·09–1·39) deaths in India in 2017, which were 12·5% of the total deaths, were attributable to air pollution, including 0·67 million (0·55–0·79) from ambient particulate matter pollution and 0·48 million (0·39–0·58) from household air pollution. Of these deaths attributable to air pollution, 51·4% were in people younger than 70 years. India contributed 18·1% of the global population but had 26·2% of the global air pollution DALYs in 2017. The ambient particulate matter pollution DALY rate was highest in the north Indian states of Uttar Pradesh, Haryana, Delhi, Punjab, and Rajasthan, spread across the three SDI state groups, and the household air pollution DALY rate was highest in the low SDI states of Chhattisgarh, Rajasthan, Madhya Pradesh, and Assam in north and northeast India. We estimated that if the air pollution level in India were less than the minimum causing health loss, the average life expectancy in 2017 would have been higher by 1·7 years (1·6–1·9), with this increase exceeding 2 years in the north Indian states of Rajasthan, Uttar Pradesh, and Haryana.

Interpretation India has disproportionately high mortality and disease burden due to air pollution. This burden is generally highest in the low SDI states of north India. Reducing the substantial avoidable deaths and disease burden from this major environmental risk is dependent on rapid deployment of effective multisectoral policies throughout India that are commensurate with the magnitude of air pollution in each state.

Funding Bill & Melinda Gates Foundation; and Indian Council of Medical Research, Department of Health Research, Ministry of Health and Family Welfare, Government of India.

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See Comment page e2

*Collaborators listed at the end of the Articles
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Introduction

Air pollution contributes substantially to premature mortality and disease burden globally, with a greater impact in low-income and middle-income countries than in high-income countries.[1,2] India has one of the highest exposure levels to air pollution globally.[1] The major components of air pollution are ambient particulate matter pollution, household air pollution, and to a smaller extent ozone in the troposphere, the lowest layer of atmosphere. In India, the major sources of ambient particulate matter pollution are coal burning for thermal power production, industry emissions, construction activity and brick kilns, transport

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Epub 6 Dec 2018
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Media Coverage of Air Pollution Findings Reported in December 2018

The Washington Post

Participants run during a half-marathon organised by the Indian National Security Guard on a smoggy morning in New Delhi in November. (Reuters/Altaf Hussain)

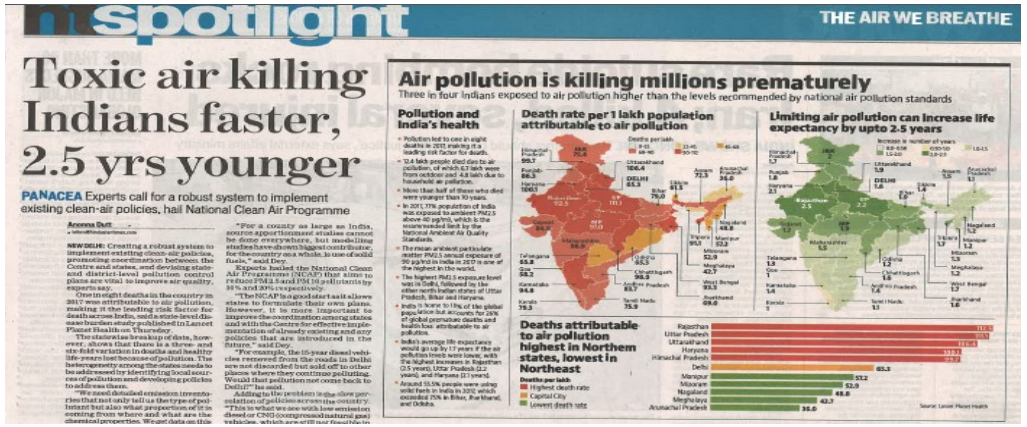
Bad air kills more than a million Indians a year, study says

By Joanna Slater December 7

NEW DELHI — At least 1 in 8 deaths in India can be attributed to air pollution, according to a new nationwide study that serves as the latest grim addition to research on the long-term health effects of the country's bad air.

More people died last year in India because of air pollution than from tobacco use, according to the study published Thursday in the journal Lancet Planetary Health.

The fact that pollution is behind 1 in 8 deaths is "remarkable," said Lalit Dandona, director of the India State Level Disease Burden Initiative, which conducted the study. "We've always thought of it as high, but to see it like that is quite a massive impact on health."



mint spotlight

THE AIR WE BREATHE

Toxic air killing Indians faster, 2.5 yrs younger

PANACEA Experts call for a robust system to implement existing clean-air policies, hail National Clean Air Programme

Aroosa Butt

NEW DELHI: Creating a robust system to implement existing clean-air policies, promoting coordination between the Centre and states, and devising state- and district-level pollution control plans are vital to improve air quality, experts say.

One in eight deaths in the country in 2017 was attributable to air pollution, making it the leading risk factor for death across India, said a state-level disease burden study published in Lancet Planet Health on Thursday.

The state-wise breakup of data, however, shows that there is a three- and six-fold variation in deaths and healthy life-years lost because of pollution. The heterogeneity among the states needs to be addressed by identifying local sources of pollution and developing policies to address them.

"We need detailed emission inventories that not only tell us the type of pollutant but also what proportion of it is coming from where and what are the chemical properties. We get data on this for a country as large as India, source apportionment studies cannot be done everywhere, but inside-Ding studies have shown biggest contributor for the country as a whole, in case of solid fuels, is coal. Dey.

"India launched the National Clean Air Programme (NCAP) that aims to reduce PM2.5 and PM 10 pollutants by 30% and 20% respectively.

"The NCAP is a good start as it allows states to formulate their own plans. However, it is more important to improve the coordination among states and with the Centre for effective implementation of already existing and any policies that are introduced in the future," said Dey.

"For example, the 15-year diesel vehicles removed from the roads in Delhi are not discarded but sold off to other places where they continue polluting. Would that pollution not come back to Delhi?" he said.

Adding to the problem is the slow penetration of policies across the country. "This is what we see with low-emission diesel or CNG (compressed natural gas) vehicles, which are still not fossil fuels to

Air pollution is killing millions prematurely

Three in four Indians exposed to air pollution higher than the levels recommended by national air pollution standards

Pollution and India's health

- Pollution led to one in eight deaths in 2017, making it a leading risk factor for death.
- 12.4 lakh people died due to air pollution, of which 67 lakh were from outdoor and 4.8 lakh due to household air pollution.
- More than half of those who died were younger than 70 years.
- In 2017, 77% population of India was exposed to ambient PM2.5 above 40 µg/m3, which is the recommended limit by the National Ambient Air Quality Standards.
- The mean ambient particulate matter PM2.5 annual exposure of 90 µg/m3 in India in 2017 is one of the highest in the world.
- The highest PM2.5 exposure level was in Delhi, followed by the other north Indian states of Uttar Pradesh, Bihar and Haryana.
- India is home to 18% of the global population but accounts for 26% of global premature deaths and healthy life lost attributable to air pollution.
- India's average life expectancy would go up by 1.7 years if the air pollution levels were lower, with the highest increases in Rajasthan (2.5 years), Uttar Pradesh (2.2 years), and Haryana (2.1 years).
- Around 15.5% people were using solid fuels in India in 2012 which exceeded 70% in Bihar, Jharkhand, and Odisha.

Death rate per 1 lakh population attributable to air pollution

Limiting air pollution can increase life expectancy by upto 2.5 years

Deaths attributable to air pollution highest in Northern states, lowest in Northeast

Deaths per lakh
Highest death rate
Capital City
Lowest death rate

Source: Lancet Planet Health

hindustantimes

7 December 2018
Front Page

Air pollution causes 1 in 8 deaths in India: Report

'More Hazardous To Public Health Than Smoking'

Sushrut.Dey@timesgroup.com

New Delhi: One in every eight deaths in India is attributable to air pollution, which now contributes to a bigger disease burden than smoking.

In fact, the average life expectancy in India would have been 1.7 years higher if the air pollution level was less than the minimum level, show the first comprehensive estimates of deaths, disease burden and life expectancy reduction associated with air pollution in each state of India, released by the Indian Council of Medical Research on Thursday. Around 77% of India's population is exposed to outdoor air pollution levels above the National Ambient Air Quality Standards safe limit, the report says. States in east and north India had some of the highest levels of ambient particulate matter and household air pollution, especially Bihar, UP, Rajasthan and Jharkhand. Delhi, Haryana and Punjab had some of the highest ambient particulate matter pollution exposure.

▶Related report, P 12

WORST HIT COUNTRIES

Nepal 99.7
Niger 94.1
Qatar 93.5
India 90.5
Saudi Arabia 90.0

WORST AFFECTED STATES

Delhi 339
UP 174.9
Bihar 169.4
Haryana 135.6
Rajasthan 131

Population-weighted annual mean PM2.5 ug/m3

THE TIMES OF INDIA

8 December 2018
Front Page

Air pollution linked to 12.4L deaths in India in '17: Report

Sushrut.Dey@timesgroup.com

New Delhi: In 2017, air pollution accounted for 12.4 lakh deaths in India, which included 6.7 lakh deaths due to outdoor particulate matter air pollution and 4.8 lakh deaths due to household air pollution, an ICMR report said. Over half of the deaths due to air pollution were in persons less than 70 years of age, the report said. With 18% of the global population, India suffered 26% of premature mortality and health loss attributable to air pollution globally.

The report, published in the Lancet Planetary Health, assumes significance as it follows several such reports by the World Health Organisation, which has already detailed the major health risks posed by foul air in the country.

A special report released by WHO on Wednesday at COP 24 said India can get massive health gains — up to $60 trillion by pursuing global warming limit of 1.5°C. The UN agency had recently also linked air pollution with increasing child mortality. In 2017, India witnessed 1.33 lakh premature deaths of children due to air pollution, highest in the world in the category of children under five years of age.

The India State-Level Disease Burden, conducted jointly by ICMR along with Public Health Foundation of India (PHFI) and Institute for Health Metrics and Evaluation (IHME) in collaboration with the health ministry, shows a marked variation between states, with 13 times difference for ambient particulate matter pollution and 45 times difference for household air pollution.

Full report on www.toi.com

1 in 8 deaths in India due to air deadlier than cigarettes

STUDY In 2017, it led to 1.24 mn fatalities – 12.5% of the total deaths

hindustantimes the air we breathe

Sanchita Sharma

NEW DELHI: It's official: Air pollution in India is more injurious to health — and more deadly — than smoking. Lung infections, chronic obstructive lung disease, heart attacks, stroke, diabetes, and lung cancer from air pollution cause more early deaths than smoking, according to most comprehensive estimates of deaths, disease burden and life expectancy associated with air pollution across each state in India.

One in eight deaths was attributable to air pollution in 2017, making it a leading cause of death in India, according to a study titled 'The impact of air pollution on deaths, disease burden, and life expectancy across the states of India: the global burden of disease study 2017'.

The study, which provides the "India-centric" data that environment minister Dr Harsh Vardhan and other policymakers have been vocally seeking over the past year, was published in The Lancet Planetary Health.

Though most people associate air pollution with lung disease, 38% of the burden from air pollution is in the form of heart disease and diabetes, according to the study. In 2017, air pollution led to 1.34 million deaths in India, which accounts for 12.5% of the total deaths.

"Living in India is like being a chronic smoker. A substantial 8% of the total disease burden and 11% of premature deaths in people younger than 70 years are attributed to air pollution," said senior author Prof Lalit Dandona, director of the India State-Level Disease Burden Initiative, which led the study.

No state across the country had an annual mean particulate matter 2.5 (PM2.5 micrometres are particles one-400th of a millimetre) lower than the World Health Organization (WHO)-recommended level of 10 µg/m³.

CONTINUED ON P 8

THE GREATER ENEMY

Report shows air pollution is a bigger trigger than tobacco for many diseases that significantly hit life expectancy

DALY* rate per 100,000 population

Air pollution
Tobacco use

*Disability Adjusted Life Years (DALY) is a sum of years of life lost due to premature death and a weighted measure of years lived with disability

821 194 Lower respiratory infections
817 536 COPD
667 580 Ischaemic heart disease
256 190 Stroke
194 95 Diabetes mellitus
49 62 Lung cancer
43 10 Cataract

Source: Lancet Planet Health

ROOT CAUSE: Pollution is linked to heart disease, stroke, chronic obstructive pulmonary disease, and lung cancer

MILLIONS CHOKING: In 2017, 77% of India's population was exposed to PM2.5 above 40µg/m3 the safe limit

CAPITAL CURSE: Delhi had the highest annual mean PM2.5, followed by UP, Bihar and Haryana — all above 125 µg/m3

About 50 news reports including front page and editorials

What Causes Air Pollution in India?

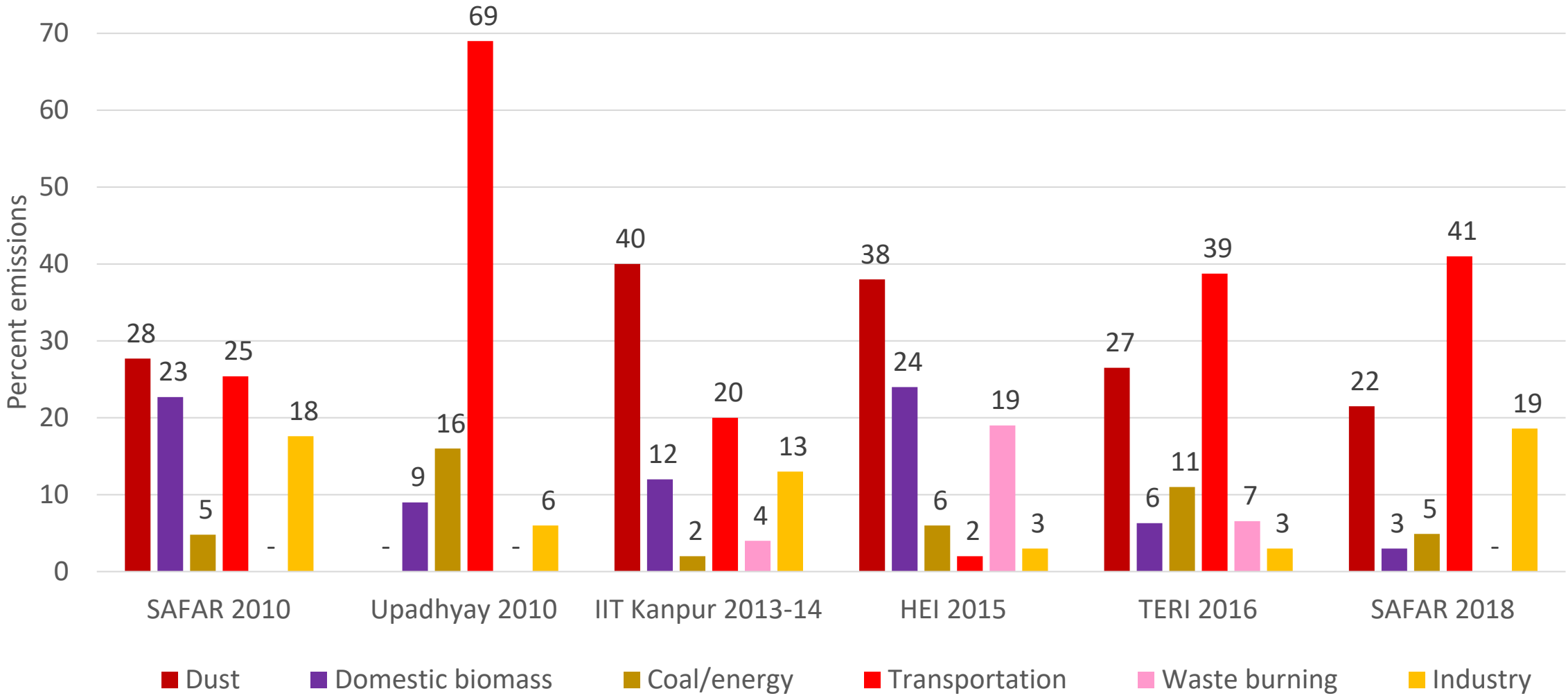









Particulate Matter Emission Sources in Delhi



Results shown for six different studies

Policy and Action for Air Pollution Control

- National Air Quality Index launched by the Prime Minister of India in 2015
- National scheme launched in 2016 to increase clean cooking fuel use with the aim to reach 80 million households
- India pledged in 2016 to increase electricity generation from renewable sources as part of the Paris Agreement
- National Clean Air Programme launched in 2018
- Target set by the National Clean Air Programme in early 2019 for 20-30% reduction in air pollution in 102 cities across India

Visibly higher attention to air pollution in public and policy discussions over the past year

Evidence for the Impact of Air Pollution on Disease Burden in India

- Short-term exposure effects of outdoor particulate matter on acute diseases and on all-cause mortality are similar in India and other countries
- Recent cohort study in China, which included exposure at levels comparable to those observed in India, shows similar cause-specific mortality as in the more developed countries
- Some cohort studies have been initiated in India, select early findings from which are consistent with meta-analyses estimates from elsewhere
- Reasonable for now to use disease attribution data from worldwide long-term exposure cohort studies to estimate disease burden attributable to air pollution in India

Air Pollution Evidence Gaps in India

- Limited ground monitoring of air pollution, especially in less developed states and rural areas
    - National Pollution Control Board has announced plans to increase ground monitoring sites
- No comprehensive long-term cohort studies to assess the health impact of air pollution
    - Tamil Nadu Study (TAPHE) – low birth weight, respiratory diseases
    - Hyderabad Study (CHAI) – cardiovascular arterial thickening
    - Delhi-Chennai Study (CARRS) – cardio-respiratory diseases
- Divergent estimates of contributors to ambient air pollution
- No significant policy or intervention research related to air pollution

Air Pollution Research in India

- Few air pollution research groups
  - Chennai – Sri Ramachandra University
  - Delhi – Public Health Foundation of India (PHFI), Indian Institute of Technology – Delhi (IITD)
  - Mumbai – Indian Institute of Technology - Mumbai (IITM)
  - Kanpur – Indian Institute of Technology - Kanpur (IITK)
  - Chandigarh – Post Graduate Institute of Medical Education & Research, Chandigarh (PGIMER)
  - Pune – Chest Research Foundation (CRF), System of Air Quality and Weather Forecasting And Research (SAFAR)
- Limited resources for air pollution research
  - India – Indian Council of Medical Research (ICMR), Department of Biotechnology (DBT), Department of Science & Technology (DST), Ministry of External Affairs (MoE)
  - International – National Institutes of Health (NIH), World Health Organization (WHO), Medical Research Council (MRC), Health Effects Institute (HEI)

Various sporadic research outputs but few established programs of air pollution research

Strengthening Evidence for Air Pollution Control in India

- Establish comprehensive long-term cohort studies to assess the health impact of air pollution
  - Ideally nationwide representation, or at least cover diverse parts of the country
  - Tag with existing large scale data collection efforts – pros and cons
  - Challenges with starting fresh cohorts
  - Include all-cause mortality, cause-specific mortality, morbidity, possibly biomarkers
- Establish collaborative efforts to standardize estimation of the contribution of various sources to ambient air pollution
  - Emission inventory assessment methods
  - Simulation modelling methods
- Plan strategic policy and intervention research
  - Assess through research how policy engagement can be enhanced
  - Efficient impact assessment of recent and new air pollution control programs
  - Develop research to assess the impact of specific interventions