Coal and dirty development in China & India leads to 1.6 million extra air pollution deaths a year

- Greenpeace India, 2nd December 2016

- *Air pollution generally reduces as a country's GDP increases. But China and India have particularly bad air pollution despite recent economic growth.*
- *1.6 million more people in China and India are killed by air pollution each year than would be typical, based on other large middle-income countries.*
- *The death rate from air pollution in China is around three times higher than the average of high-income countries like the US, Japan and Germany.*
- *Air pollution death rates have fallen in China and India since 1990, but are still worse than in most similar countries. In India rates have not improved since 2010.*
- *Continued widespread use of coal is a major reason for the high air pollution death rates in both countries.*
- *Further coal-powered development will create health and economic risks for India and China.*

Millions around the world are dying from polluted air, but as countries get richer they usually clean up their air

Air pollution kills nearly 6.5 million people globally each year, according to data released in October 2016.[1] As well as early deaths, air pollution causes ill-health and economic loss, including $225 billion in lost income.[2] It is among the top causes of premature death worldwide, causing only slightly fewer deaths than tobacco smoking.

In general, a country that is richer has a lower air pollution death rate. But the picture is complicated, with several factors affecting how air pollution death rates change as a country's economy grows. As countries become richer they generally develop less polluting industries, require polluting sectors to use cleaner technologies and shift to cleaner fuels for domestic cooking and heating. They generally improve healthcare, which saves lives. But increasing economic activity brings more opportunities to produce pollution. While there is a complex relationship between urbanisation and economic growth, increased urbanisation can also expose more people to pollution.[3]

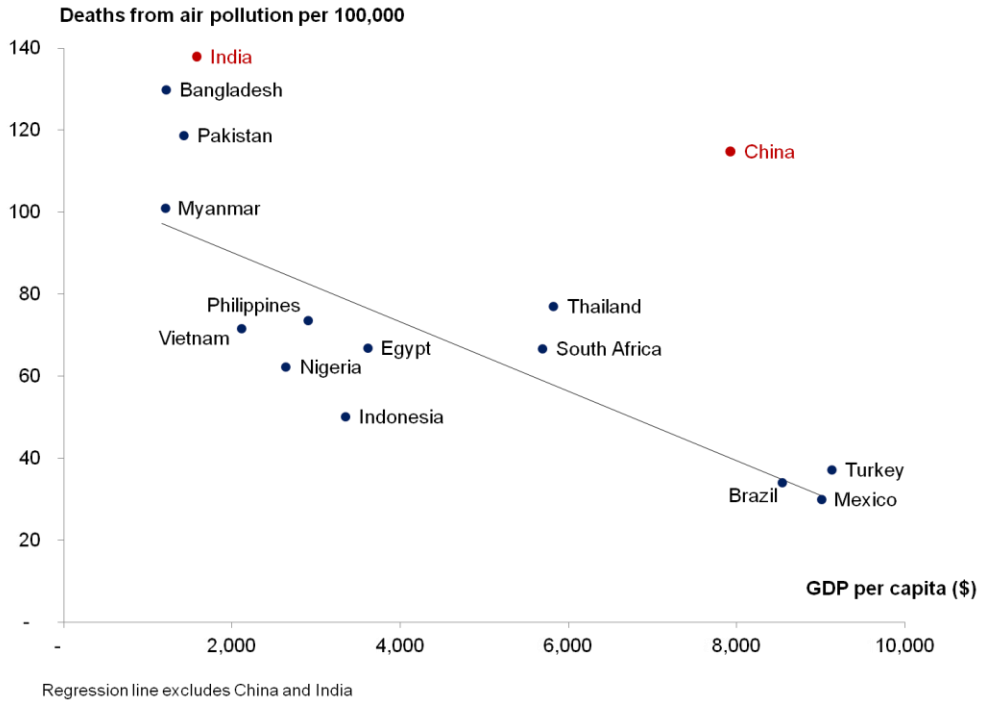
As a result some countries have higher death rates than others that have a similar income level. Of the 10 countries with the highest air-pollution death rates globally, half are middle-income countries, including India.[4]

[1] http://ghdx.healthdata.org/gbd-2015
[2] http://www.worldbank.org/en/news/press-release/2016/09/08/air-pollution-deaths-cost-global-economy-225-billion
[3] http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4123908/
[4] See appendix

Amongst middle income countries, China and India stand out because of surprisingly high death rates

While rich countries generally have lower air pollution death rates than poor countries, variations in geography and economy can override this relationship when comparing countries with relatively small differences in income. Middle-income countries are a diverse group and between these countries there is little evidence that those with higher GDP per capita have lower air pollution death rates than their poorer middle-income peers.[5] Around 20% are small island states (such as Cape Verde, Fiji and Grenada) and cannot support large industry; many of the others are small or medium-sized countries (such as Honduras, Lebanon and Lesotho) which generally develop in different ways compared with large economies;[6] others are former Soviet republics (such as Georgia, Kazakhstan and Moldova) whose economies shrank after the collapse of the USSR, and which had often inherited heavily-polluting industries that had suffered from long-term underinvestment.

Excluding these small island states and other small and medium-sized countries and former Soviet republics leaves a set of 15 countries, including China and India that in 2015 were middle income and had populations above 50 million.[7] A comparison of these countries demonstrates a strong negative correlation between GDP per capita[8] and air pollution death rates. But China and India break the pattern with much higher air pollution death rates than would be expected given their GDP per capita:



[5] See appendix

[6] https://dash.harvard.edu/bitstream/handle/1/4551794/alesina_size.pdf?sequence=2

[7] Iran is excluded as the World Bank does not provide 2015 data for per capita income; calculating the value from other sources would be inconsistent with the approach used for the other countries.

[8] http://data.worldbank.org/indicator/NY.GDP.PCAP.CD

China and India are excluded from the regression so that the death rates in those countries can be compared with the typical rate in the other countries. For the remaining 13 large middle-income countries, the r-squared value of the correlation between GDP per capita and the death rate from air pollution is 0.65, meaning nearly two-thirds of the difference between these countries in air pollution death rates can be explained by differences in GDP per capita. While the other large South Asian countries, Bangladesh and Pakistan, are also partly outliers from the overall trend, they are included in the regression.

1.6 million people die each year in China and India because of worse than average air pollution

Using this comparison it is possible to estimate how many more air pollution deaths there are each year in China and India than there would be if the death rate in those countries was typical of other large middle-income countries. 3.4 million people died as a result of air pollution in 2015 combined, out of the 6.5 million that died globally.

The expected air pollution death rate of a large middle-income country can be calculated according to the formula provided by the regression analysis in the above graph:

Air pollution death rate per 100,000 people = (-0.0084 x GDP per capita) + 107.29

This can be used to estimate the air pollution death rate in China and India that might be expected if the rate in those countries was similar to the rate in comparable countries, taking into account their GDP per capita:

Country	**China**	**India**
GDP per capita (2015)	$7925	$1582
Actual air pollution death rate	115	138
Expected air pollution death rate	41	94

This expected air pollution death rate can also be used to estimate the difference between the number of actual deaths from air pollution and the number of expected deaths:

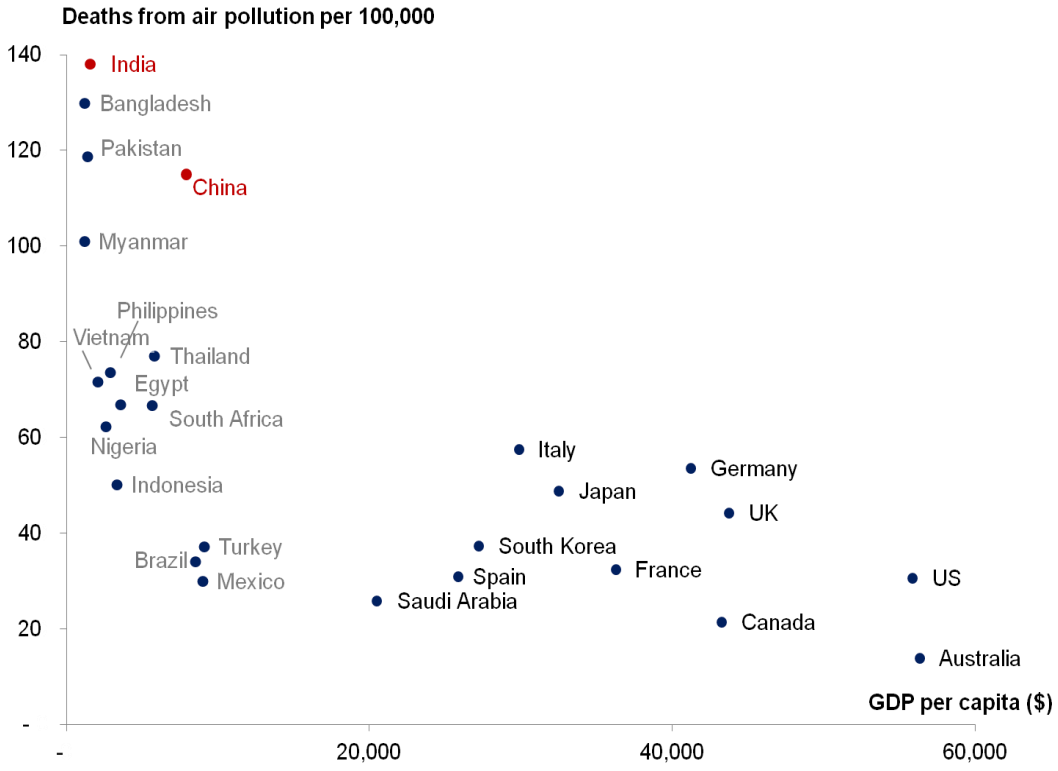
Country	**China**	**India**
Population (2015)	1,371,220,000	1,311,050,527
Actual air pollution deaths per year	1,587,840	1,809,053
Expected air pollution deaths per year	558,253	1,232,469
Excess deaths per year	1,029,587	576,584

This suggests that there are over 1 million more deaths a year in China and nearly 600,000 more deaths a year in India than there would be if the air pollution death rate in both countries was the average of other large middle-income countries with their level of GDP per capita.

While no country follows a typical pathway in its development, it is apparent that the air pollution death rates in China and India are significantly higher than rates in comparable countries with similar levels of GDP per capita. This suggests that these countries have prioritised pursuing economic growth over addressing the harms caused by air pollution to a greater extent than other large middle-income countries. Other comparable countries have reached levels of GDP per capita that are similar to those of China and India, without doing so at the cost of such high air pollution death rates.

Air pollution deaths in China and India are three to four times higher than in high-income countries

A comparison with large high-income countries[9], such as the US, Japan, Germany, France and the UK, also shows that air pollution death rates in China and India are particularly high. The average air pollution mortality in these countries is 36 per 100,000.[10]



The air pollution death rate in China is more than three times greater than the rate in these high-income countries. As shown in the table above, according to its GDP per capita, China could be

[9] High-income countries with populations of at least 20 million in 2015: this threshold was used to provide enough countries for a meaningful comparison.
[10] See appendix.

expected to have a death rate of around 41 per 100,000. So it has already reached a level of income where its air pollution death rate could be expected to be similar to that in rich countries.

In India, the air pollution death rate is nearly four times greater than the rate in high-income countries. According to its GDP per capita, the expected death rate in India is 94 per 100,000. So, unlike China, it has not yet reached an income level where its air pollution death rate could be expected to be similar to that in rich countries. But it both cases, the comparison with high-income countries reflects the potential for significant improvements in air pollution death rates.

The air pollution death rate in China and India has been worse than in most comparable countries since at least 1990

Although air pollution death rates have fallen modestly in both China and India in recent years, they have remained worse than in nearly all comparable countries since at least 1990.[11]

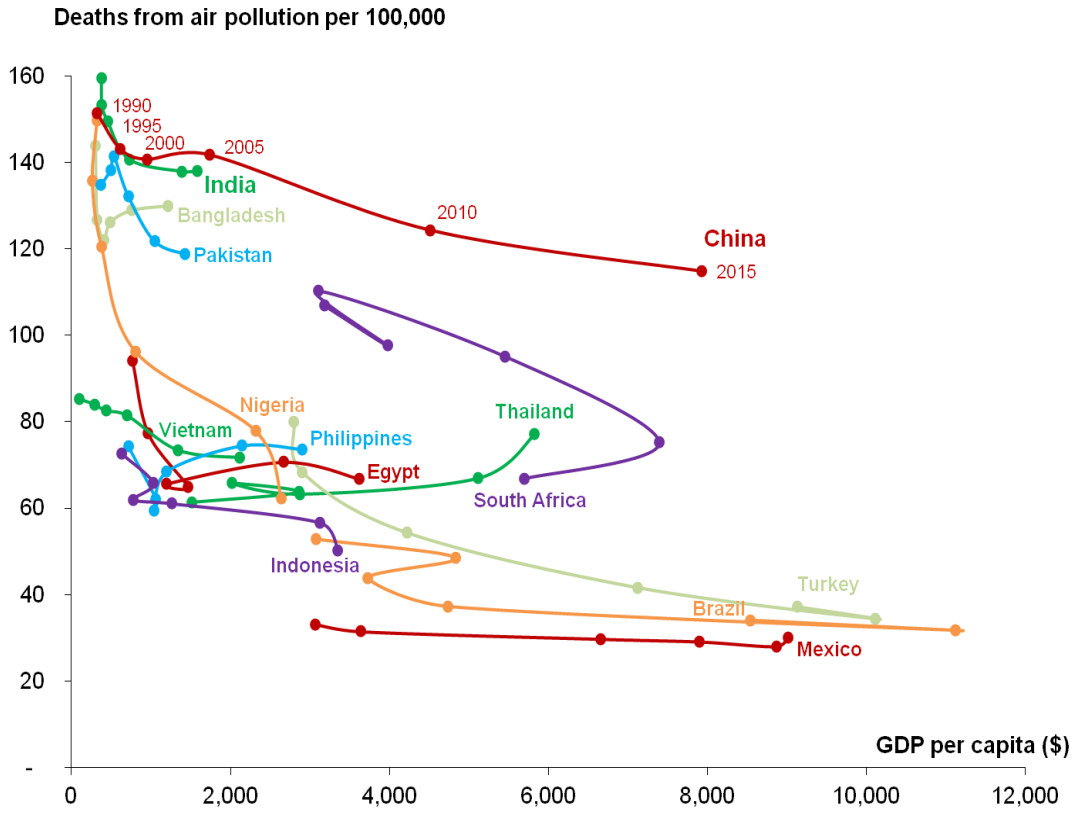
In India the air pollution death rate has improved more slowly than in most comparable countries. Between 1990 and 2015 the rate fell by 14%, compared with 28% among the other countries that, in 1990, had death rates of above 100 per 100,000. Since 2005 there has been very little improvement in India's air pollution death rate: it has fallen only from 141 to 138 per 100,000.

In China, the air pollution death rate has improved at about the average rate of the comparable countries, falling by 24% since 1990, compared with 22% among the other countries. Most of this improvement has come since 2005, which was also the period of fastest improvement in GDP per capita. But the rate in China remains much higher than it is in other large countries with similar income levels. It is more than three times that of Brazil, Turkey and Mexico, which all have a GDP per capita that is only slightly higher than China's.

China is unique, out of the selected countries, in both having had a GDP per capita of below $800 in 1990 and having increased its GDP per capita by more than $7000 over the period. It may be that this rapid growth, from a low base, came at the expense of the health of China's population. But pollution may now be restricting China's growth: it has been estimated that particulate matter pollution in 2010 caused damages worth between 9.7% and 13.2% of China's GDP.[12]

[11] Myanmar is excluded from the analysis from this point onwards, as there is insufficient data from before 2015.

[12] https://www.unilever.com/Images/better-growth-better-climate-new-climate-economy-global-report-september-2014_tcm244-425167_en.pdf, p35



The remainder of this report examines the causes of the relatively high rates of air pollution mortality in China and India.

While other factors are important, exposure to pollutants is the main cause of the high mortality rate in China and India

Exposure to high levels of air pollutants is not the only reason why countries have high air pollution death rates. The extent to which higher exposure to air pollution leads to a higher air pollution death rate is influenced by other factors, including the proportion of elderly people in a country, the underlying health of the population and the quality of healthcare facilities. This is reflected in the fact that, of the 10 countries with the highest rates of air pollution mortality none is among the 10 countries with the highest exposure to outdoor air pollution.[13] This is not to say that exposure to air pollution does not, all else being equal, increase the air pollution mortality rate: these mortality rates are partly calculated from data on exposure to air pollutants. But it demonstrates that other factors are also important for explaining differences in air pollution mortality rates.

This is significant because it could, in principle, indicate that the reason China and India have relatively high rates of air pollution mortality may not be because their populations are exposed to high levels of pollutants. The difference might be due to other factors, such as contrasting levels of vulnerability of their populations or differences in the adequacy of healthcare facilities.

[13] See appendix

But - as with the relationship between GDP per capita and air pollution mortality - there is a strong relationship between exposure to air pollutants and air pollution mortality when comparing countries that are otherwise relatively similar. For example, among the large middle-income countries compared above, 72% of the difference in air pollution mortality can be explained by differences in exposure to outdoor particulate matter.[14]

This indicates that the high air pollution death rates in China and India appear to be largely explained by the extent to which their populations are exposed to air pollutants, rather than by other factors such as the vulnerability of the population or the adequacy of healthcare. This therefore raises the question of why the populations of China and India are exposed to such high levels of pollutants, and what can be done to address the problem.

Indoor air pollution is being reduced, leaving continuing use of fossil fuels, particularly coal, as a major reason for the high pollution death rate in China and India

Over the past 25 years, nearly all countries that are now large and middle-income have increased GDP per capita and reduced air pollution death rates, to varying degrees. China and India have both done this, but their air pollution death rates remain higher than those of most comparable countries, particularly when taking into account their income levels.

In both China and India, indoor air pollution deaths are falling and the rate is now lower than the outdoor air pollution death rate. In China, between 2005 and 2015 the indoor air pollution death rate fell from 70 to 43 per 100,000. Likewise, in India over the same period the rate fell from 86 to 74 per 100,000. But in both countries, the deaths from outdoor air pollution are not falling so quickly, or at all. In China, between 2005 and 2015 the death rate from outdoor particulate matter pollution fell more slowly, from 87 to 80 per 100,000. In India, the rate increased over the same period, from 78 to 83 per 100,000. So while indoor air pollution is becoming less of a problem in both countries, outdoor air pollution is not being addressed so effectively.

Coal use is a major reason for the high air pollution death rates in both countries. This includes indoor air pollution, which is partly caused by domestic coal burning.[15] China is responsible for around half of global coal consumption, making it the country with the second-highest per capita consumption.[16] It is continuing to build two coal power stations a week, which is reducing demand for less polluting sources of power, even though much of the additional coal capacity is not needed.[17] It has been estimated that particulate matter generated by coal use kills 670,000 people a year in China:[18] this represents around 40% of all the deaths linked to both indoor and outdoor air pollution in the country.

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[14] See appendix

[15] http://www.un.org.vn/en/unicef-agencypresscenter2-89/4240-pollution-300-million-children-breathing-toxic-air-unicef.html

[16] www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html

[17] http://energydesk.greenpeace.org/2016/07/13/china-keeps-building-coal-plants-despite-new-overcapacity-policy/

[18] http://www.nrdc.cn/coalcap/index.php/English/project_content/id/508

In India coal consumption doubled between 2005 and 2014, and this has been a cause of the worsening of the air pollution death rate over this time.[19] One reason coal power stations in India cause particularly large amounts of air pollution is that there are only limited controls on their emissions.[20] A study of 2011-12 data estimated that up to 115,000 people a year are killed in India from air pollution from coal-fired power stations alone.[21] This excludes the effect of pollution from coal burning in homes and industry, so the total number of deaths in India from air pollution due to coal use is greater.

Both countries are now taking steps to replace coal power with clean energy. India has a target of 350GW of renewable capacity by 2030[22] and had 82GW of renewable power capacity in 2015.[23] China's target of hydro, wind and solar power capacity is 650GW by 2020;[24] it had 520GW of capacity in 2015.

A new approach to energy policy in India and China can cut air pollution death rates by replacing coal, and reduce the economic risks of further coal-powered development

This growth in renewables has the potential to accelerate the transition away from coal - and so to cut air pollution - but it increases the risk that recent and planned investments in coal will become stranded. Already, coal power stations in India are being used to only 56% of their capacity, and in China to below 47%. With renewable power increasing and coal being seen as less attractive, investments in new coal-fired capacity may not be able to meet the required rate of return.[25] A 2015 study found that $179 billion of unneeded fossil fuel investments in China to 2025 are at risk of becoming stranded, and nearly $38 billion in India.[26]

The economic growth in China and India, particularly since 2000, has lifted vast numbers of people out of poverty. But both countries' growth has failed to address a health crisis that costs millions of lives. The air pollution death rate in India has worsened as the country has become richer, while in China it has improved only relatively slowly and the gap with other countries has widened. Improvements in indoor air pollution have masked slow progress - or worsening - of outdoor air pollution. As a result the air pollution death rate in both countries remains higher than it is in similar countries - and far worse than in richer countries. A new approach is now needed. If these economies make sensible decisions about investment in their energy infrastructure, they can make significant improvements to air quality, cut air pollution related mortality, and protect themselves from the financial risks of stranded assets. Unless significant measures are taken to reduce pollution, millions will continue to die from unsafe air.

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19 http://www.greenpeace.org/india/Global/india/cleanairnation/Reports/Out%20of%20Sight.pdf
20 http://energydesk.greenpeace.org/2016/05/23/satellite-data-india-coal-power-plants-air-pollution-crisis/
21 http://www.greenpeace.org/india/Global/india/report/Coal_Kills.pdf
22 http://ieefa.org/wp-content/uploads/2016/11/2016-Year-in-Review.pdf
23 http://www.irena.org/DocumentDownloads/Publications/IRENA_RE_Capacity_Statistics_2016.pdf
24 http://news.xinhuanet.com/english/china/2014-11/19/c_133801014.htm
25 http://ieefa.org/wp-content/uploads/2016/11/2016-Year-in-Review.pdf
26 http://www.carbontracker.org/wp-content/uploads/2015/11/CAR3817_Synthesis_Report_24.11.15_WEB2.pdf

Way Forward:

- Set a deadline for meeting the national air quality standards e.g. 5-year interim targets for reducing pollution levels in each state and city that doesn't currently comply.
- Create a regional action plan covering the extremely highly polluted areas from Punjab to West Bengal, addressing all major air pollution emitting sectors.
- Set targets for reducing interstate pollution, including compliance plan for meeting the new thermal power plant emission standards, 2015, as soon as possible.
- Regularly monitor power sector progress in complying with the new emission standards, including reporting on timeline for ordering and installing pollution control devices.
- Update the regulatory framework for enforcing power plant emission standards, including substantial automatic fines for every violation of emission limits.
- Make it mandatory for the industries and thermal power plants to display real time air emission data available on public platforms.
- Make public transport more reliable and safe so that people can shift from polluting individual private vehicles to public transport.
- Implementing stricter norms for vehicles and upgrading to more efficient and stricter emission norms emission.

Appendix: supplementary data

Data sources used in this appendix
Air pollution mortality: http://ghdx.healthdata.org/gbd-2015
Exposure to particulate matter: http://pubs.acs.org/doi/suppl/10.1021/acs.est.5b03709

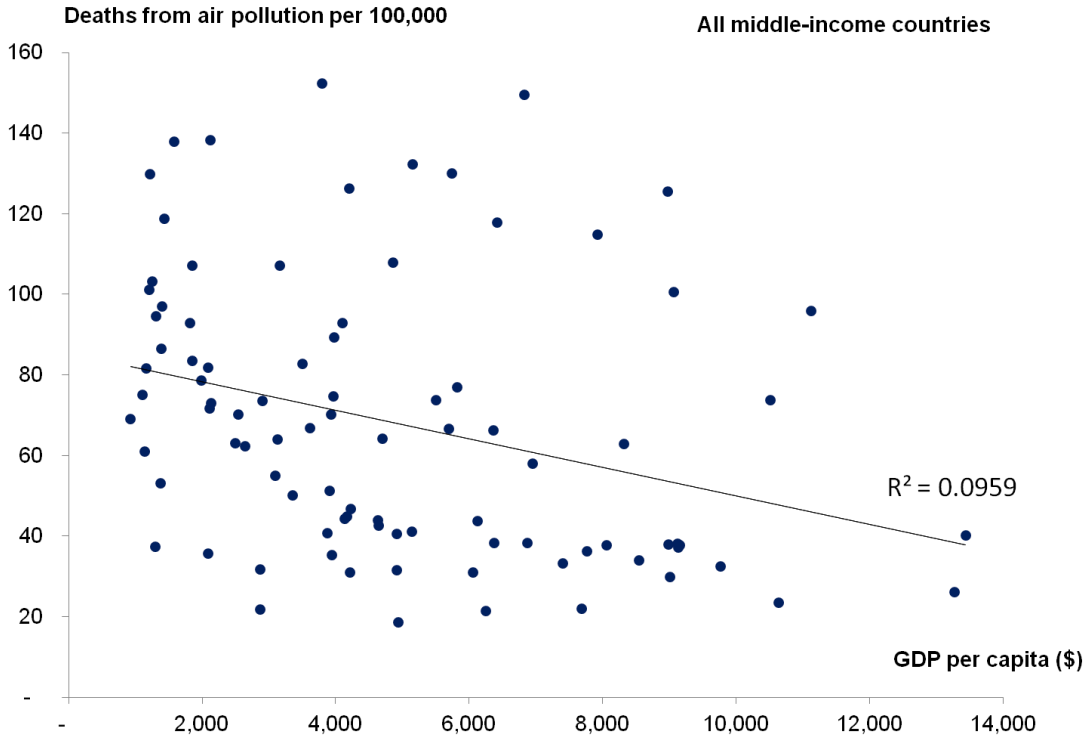
Air pollution death rates and income level
"Of the 10 countries with the highest air-pollution death rates globally, half are middle-income countries, including India"

Country	Income classification (2015)[27]	Deaths from air pollution per 100,000 (2015)
Central African Republic	Lower	199
Afghanistan	Lower	165
Georgia	Upper-middle	152
Bulgaria	Upper-middle	150
North Korea	Lower	148
Somalia	Lower	142
Guinea-Bissau	Lower	141
Ukraine	Lower-middle	138
India	Lower-middle	138
Lesotho	Lower-middle	134

[27] siteresources.worldbank.org/DATASTATISTICS/Resources/OGHIST.xls

Air pollution death rates in middle-income countries

“There is little evidence that the air pollution death rate is, on average, lower in wealthier middle-income countries than it is in poorer middle-income countries”



Air pollution death rates in high-income countries
“The average air pollution mortality in these countries is 36 per 100,000”

Among countries at a high level of economic development, there is little correlation between GDP per capita and air pollution mortality (r-squared=0.09) so an average of air pollution mortality is an appropriate measure for comparison. Poland is excluded as, like post-Soviet economies, it has a legacy of heavily polluting industry that is unusual for a country of its level of development.

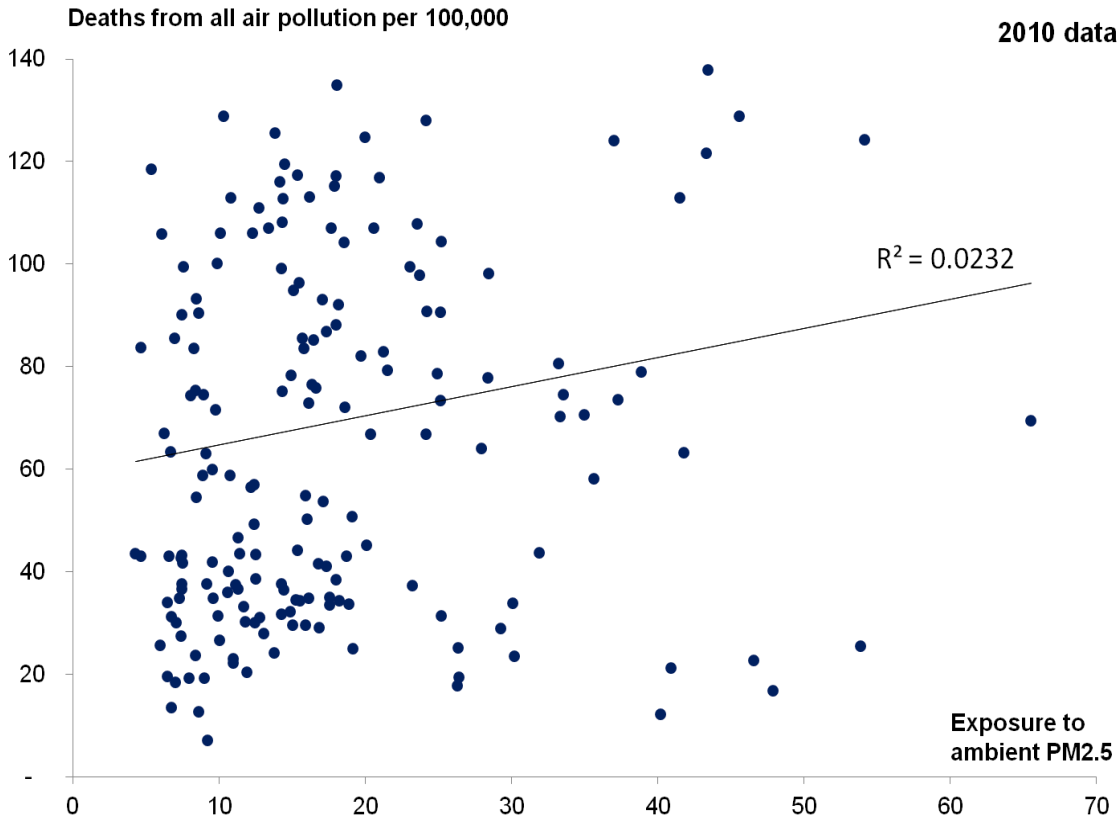
Air pollution death rates and exposure to pollutants

"Of the 10 countries that had the highest rates of air pollution mortality in 2010, none was among the 10 countries with the highest average exposure to outdoor particulate matter pollution."

Country	Deaths from air pollution per 100,000 (2010)	Ranking of exposure to outdoor particulate matter pollution (2010) (1=highest in world, 187=lowest)
Central African Republic	203	61
Afghanistan	187	47
Georgia	169	75
Somalia	159	150
Guinea-Bissau	155	25
Chad	150	24
Bulgaria	150	76
Lesotho	149	135
North Korea	143	43
Ukraine	140	88

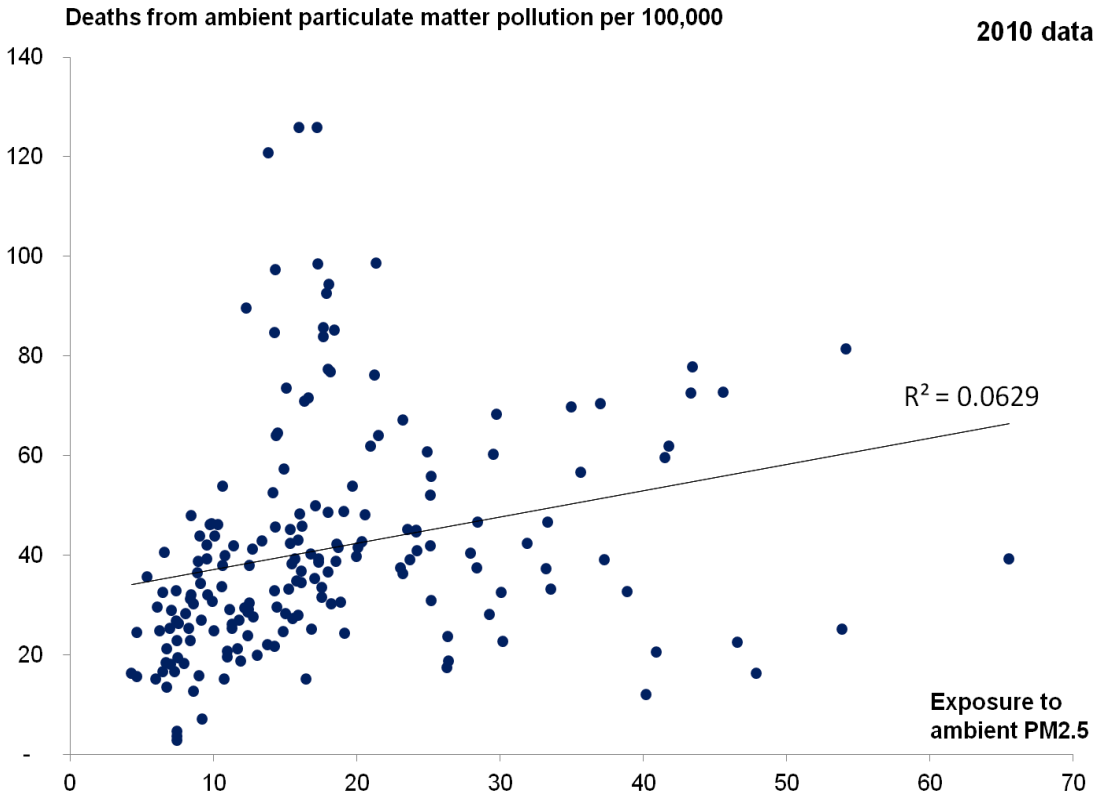
2010 is the most recent year for which data is available on both exposure to air pollution and air pollution mortality in the 2015 GBD.

Indeed, when the data from every country is compared, there is almost no correlation between exposure to outdoor air pollutants and the air pollution mortality rate:



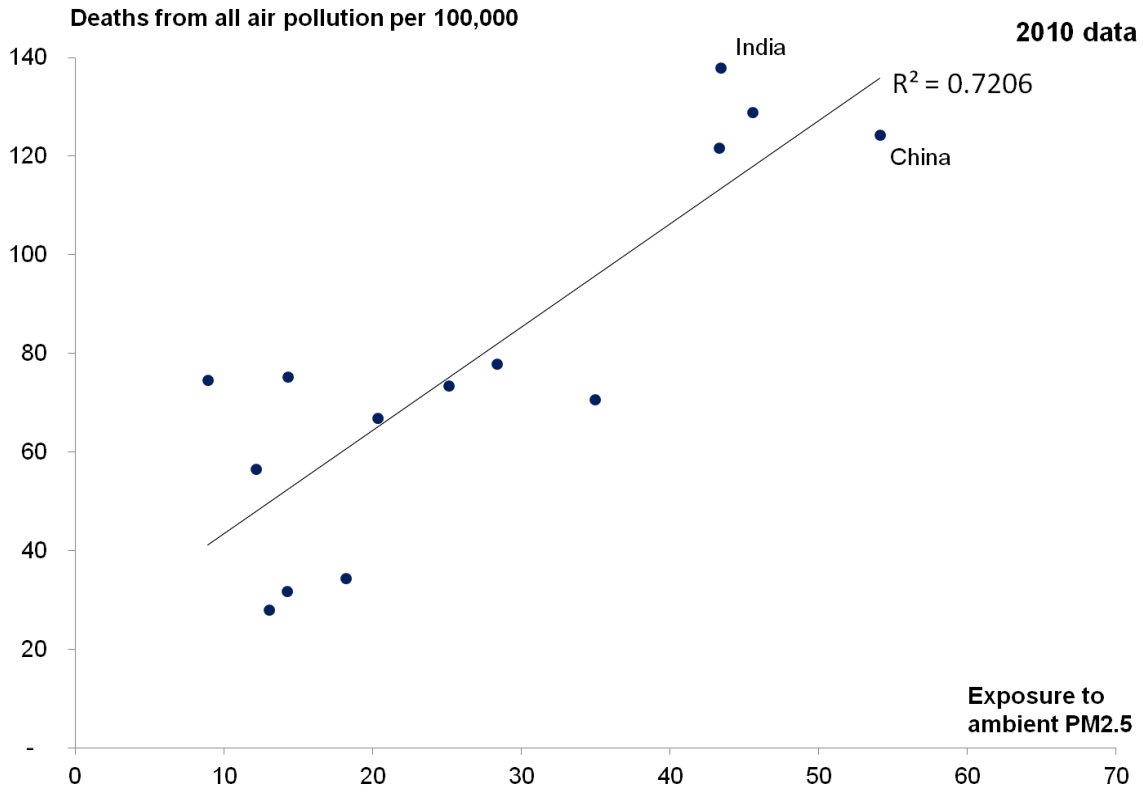
This is not because indoor air pollution is included in the mortality rate but excluded from the exposure data: there is also very little correlation, at the global level, between exposure to outdoor air pollutants and the mortality rate from outdoor particulate matter

There is also very little correlation, at the global level, between exposure to outdoor air pollutants and the mortality rate from outdoor pollutants only

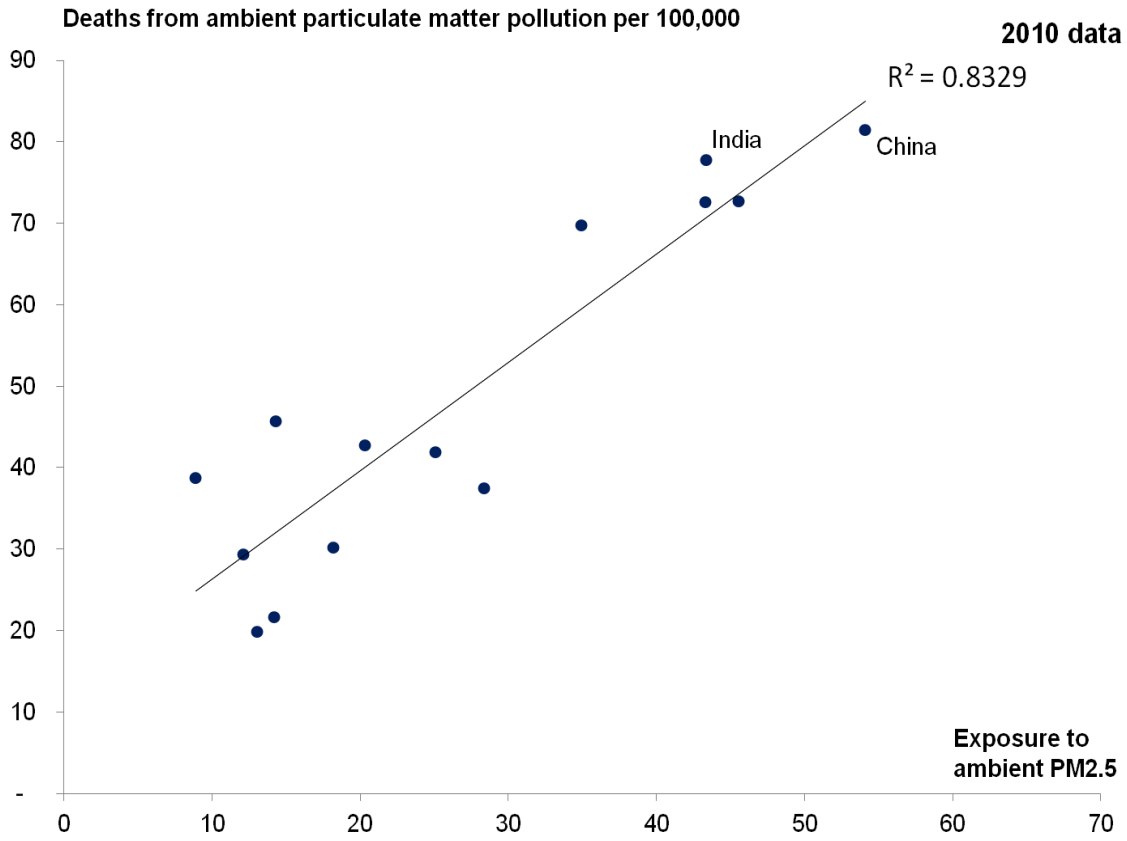

Deaths from ambient particulate matter pollution per 100,000
2010 data
140
120
100
80
60
40
20
-
0
10
20
30
40
50
60
70
R² = 0.0629
Exposure to ambient PM2.5

Air pollution death rates and exposure to pollutants in middle-income countries

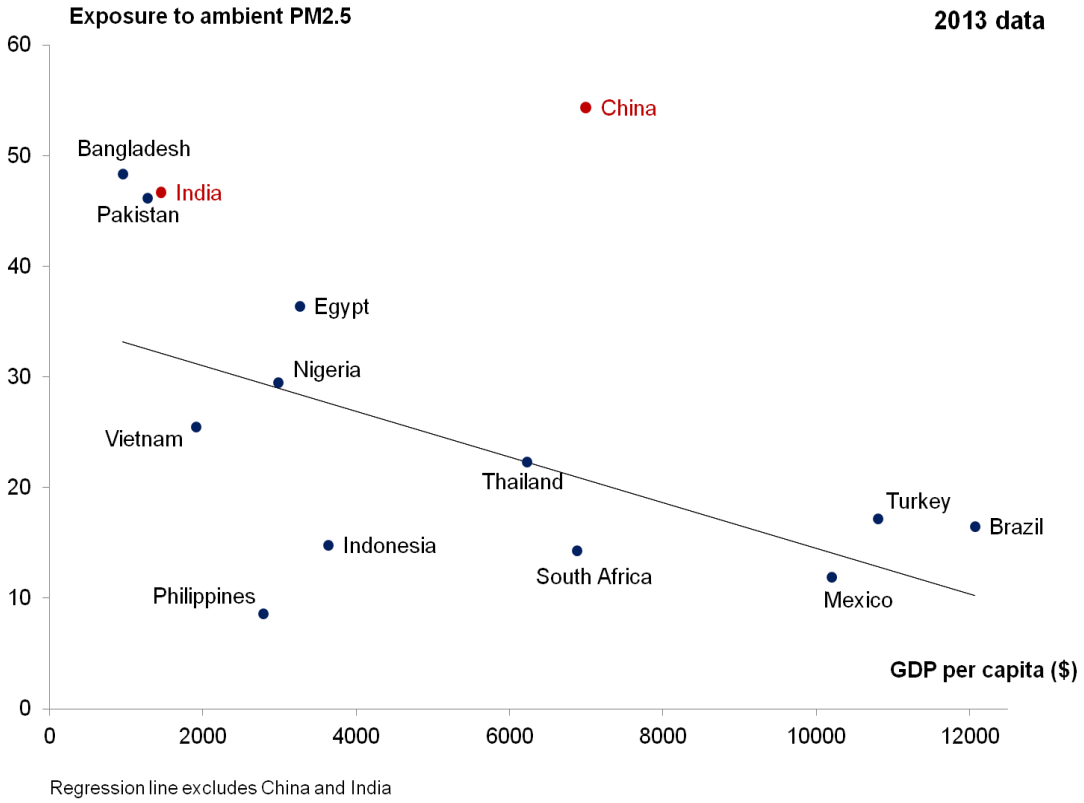
"among the 14 large middle-income countries compared above, 72% of the difference between the countries in air pollution mortality can be explained by differences in exposure to outdoor air pollutants"



When looking only at mortality from outdoor particulate matter pollution, the level of exposure to outdoor air pollutants explains 83% of the difference between these countries



Given this, it is perhaps not surprising that India and, particularly, China are again unusual among the comparable countries in having high levels of exposure to air pollutants, relative to their GDP per capita - although the correlation between these variables is less strong (r-squared=0.37, p=0.036):



Regression line excludes China and India