

Does Air Pollution Increase Death and Disease, and Reduce Life Expectancy?

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Periodically we are flooded with reports of air pollution episodes in various developing countries, accompanied by claims of air pollution's staggering death toll and associated reductions in life spans. On June 22, 2022, CBS News¹ based on the 2022 update to an annual University of Chicago Air Quality Life Index (AQLI) report,² reported that air pollution was "slashing 10 years of life expectancy in Delhi, the world's most polluted city." It also noted:

"About 44% of the global pollution [as characterized by PM2.5] since 2013 has come from India, according to the research by EPIC (Energy Policy Institute at the University of Chicago). The country has witnessed a huge spike in air pollution over the last few decades due to rapid industrialization and a heavy reliance on fossil fuels. The number of vehicles on the country's roads has increased about four-fold, the report notes. India is trying hard to switch to cleaner fuels, but experts have told CBS News that it's not going to be easy to quit the national coal habit.

"The study ranked Bangladesh as the world's most polluted country overall, followed by India, Nepal, and Pakistan. People living in Bangladesh's capital Dhaka are losing nearly nine years of their lives to air pollution, while the national average stands at 6.9 years, according to the research."

The 2022 update then goes on to state that PM2.5 is the greatest risk for human health and far outweighs other risks including smoking, unsafe water and poor sanitation:

"Measured in terms of life expectancy, the AQLI shows that ambient particulate pollution is consistently the world's greatest risk to human health. While particulate pollution is set to reduce global average life expectancy by 2.2 years, first-hand cigarette smoke, for instance, reduces global life expectancy by about 1.9 years. Alcohol use reduces life expectancy by 8 months; unsafe water and

¹ <https://www.cbsnews.com/news/air-pollution-india-delhi-life-expectancy-down-10-years-most-polluted-city-epic-study/>. Visited March 14, 2023.

² Greenstone M, Hasenkopf C, Lee K. [Annual Update. Air Quality Life Index. 2022.](#)

sanitation, 7 months; HIV/AIDS, 4 months; malaria, 3 months; and conflict and terrorism, just 9 days.”

In this paper I will examine whether life expectancies in the countries identified above (India, Bangladesh, Pakistan, Nepal and China, which for many in the world has been synonymous with air pollution since late 1990s) are inversely correlated with population exposure to annual PM2.5 over the post-1990 period. This will also help shed light on the claim that PM2.5 is the world’s greatest health risk.

Note that the death toll estimated from air pollution is based on epidemiological/statistical models rather than on actual dead bodies.

High PM2.5 in each of these countries is due to high consumption of fossil fuels from industrialization, accompanied by the proliferation of fossil fuel driven transportation. Initially, these pollution sources had only rudimentary pollution controls, but the worsening air quality compelled authorities to impose control measures. Consequently, as we will see, in each of these countries the deterioration of air quality seems to have been halted and is now improving. Thus, each country provides us with a natural experiment which allows us to verify whether life expectancy, in fact, declines as population exposure to PM2.5 increases and then increases as PM2.5 decreases.

Trends in Population Exposure to PM2.5 and Life Expectancy

The five panels in the following figure show trends for the above identified Asian countries from 1990 through 2017 in (1) mean annual population exposure to ambient PM2.5, (2) life expectancy (LE), and (3) GDP per capita (GDPpc, a surrogate for both income and economic well-being which can have major effect on life expectancy). The figure starts in 1990 since population-weighted PM2.5 exposures are not available prior to that.

Annual PM2.5 exposure is taken from the 2022 update to the University of Chicago report which provides estimates of the population-weighted exposure to PM2.5 for each country while LE and GDPpc are taken from the World Development Bank’s online databank.³

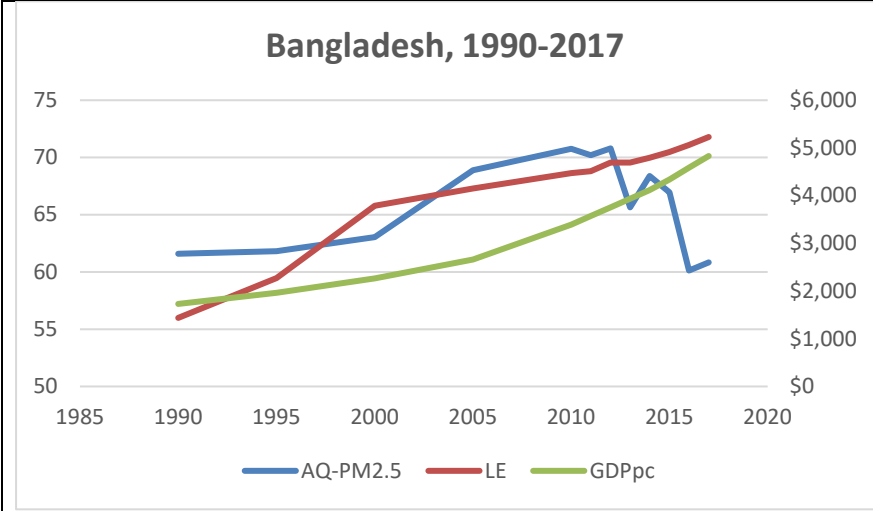
Each panel shows that:

³ <https://databank.worldbank.org/source/world-development-indicators>. Visited March 15, 2023.

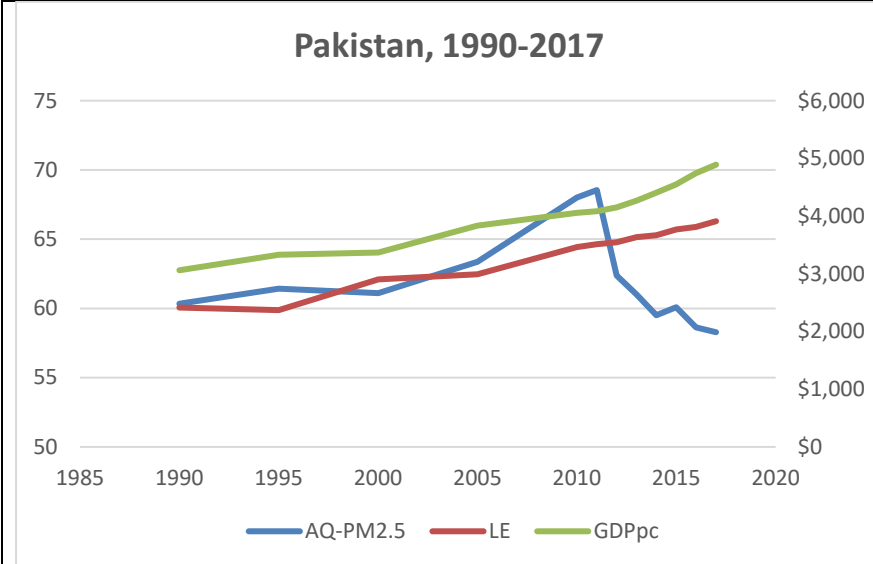
- Life expectancy has improved more or less continuously in each country, at least from 1990 onward regardless of whether PM2.5 exposures went up or down.
- Life expectancy correlates far better with GDPpc than PM2.5 exposure.
- The ups and downs in PM2.5 exposures are not visible in the LE data.

Thus, it's not evident that PM2.5 shortens lifespans. But if it does, its effects are more than overwhelmed by increases in life expectancy enabled directly or indirectly by economic growth (which is enabled by fossil fuel consumption) and associated technological advances and improved access to public health measures and medical care (that is, economic growth and technological change).

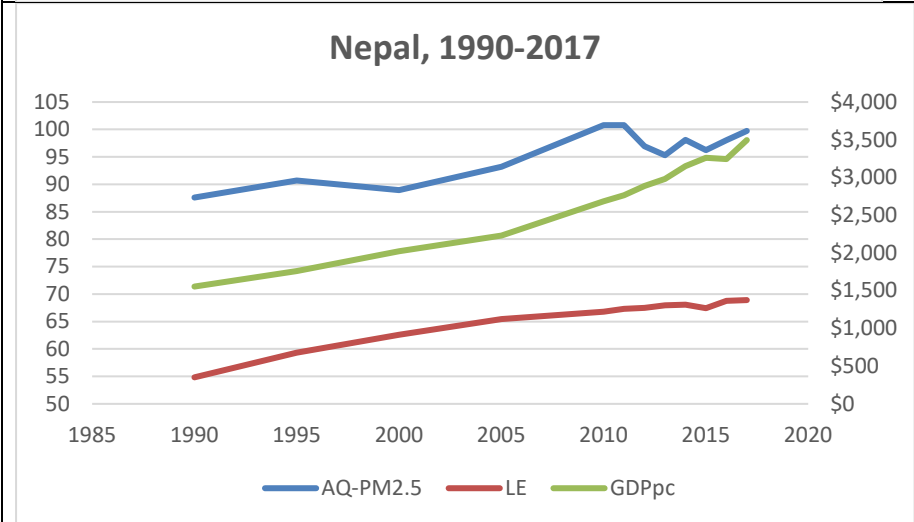
<p style="text-align: center;">China, 1990-2017</p> <p style="text-align: center;"> — AQ-PM2.5 — LE — GDPpc </p>	<ol style="list-style-type: none"> 1. Despite an increase of 16.2% in PM2.5 exposure from 2000 through 2011, LE increased 5.6%. 2. GDPpc increased 180% over the same period. 3. The variations in PM2.5 exposure are not evident in the LE data.
<p style="text-align: center;">India, 1990-2017</p> <p style="text-align: center;"> — AQ-PM2.5 — LE — GDPpc </p>	<ol style="list-style-type: none"> 1. Despite an increase of 16.2% in PM2.5 exposure from 2000 through 2011, LE increased 7.5%. 2. GDPpc increased 70.1% over the same period. 3. The variations in PM2.5 exposure are not evident in the LE data.



1. Despite an increase of 12.3% in PM2.5 exposure from 2000 through 2012, LE increased 5.7%.
2. GDPpc increased 65.7% over the same period.
3. The variations in PM2.5 exposure are not evident in the LE data.



1. Despite an increase of 12.2% in PM2.5 exposure from 2000 through 2011, LE increased 4.1%.
2. GDPpc increased 21.2% over the same period.
3. The variations in PM2.5 exposure are not evident in the LE data.



1. Despite an increase of 13.3% in PM2.5 exposure from 2000 through 2011, LE increased 7.5%.
2. GDPpc increased 36.8% over the same period.
3. The variations in PM2.5 exposure are not evident in the LE data.

Individually and collectively the above figures are inconsistent with the claim that exposure to PM2.5 is the greatest health risk in the world. The estimated relationship between such exposure and mortality is unreliable and should not be used to develop public policies.

So why the discrepancy between claims that PM2.5 (or air pollution more generally) reduces life expectancy and the reality that life expectancy has actually increased and continues to increase in some of the most polluted countries of the world whether population exposure to PM2.5 increases or not?

A couple of reasons, which are not mutually exclusive, come to mind:

- The cumulative direct and indirect effects of economic development (and fossil fuel use) on life expectancy not only outweigh the effects of PM2.5, they also enable populations to reduce PM2.5 once more significant health threats are reduced.⁴
- Life expectancy is based on data on real births and real deaths, whereas the mortality effects of PM2.5 are based on “statistical” deaths or, to use a term currently in vogue, “fake” deaths.⁵ As Steve Milloy is fond of asking, “Where are the bodies?”⁶

In today’s world, one could argue that claims of air pollution shortening life expectancy are fake news premised on fake deaths.

Trends in Death Rate and the Burdens of Disease

It is sometimes argued that looking at absolute number of deaths may be misleading because we may be trading off reductions in deaths for increases in disease and disability. On the other hand, declines in the absolute number of deaths without

⁴ Goklany IM. Have increases in population, affluence and technology worsened human and environmental well-being. *The Electronic Journal of Sustainable Development*. 2009;1(3):1

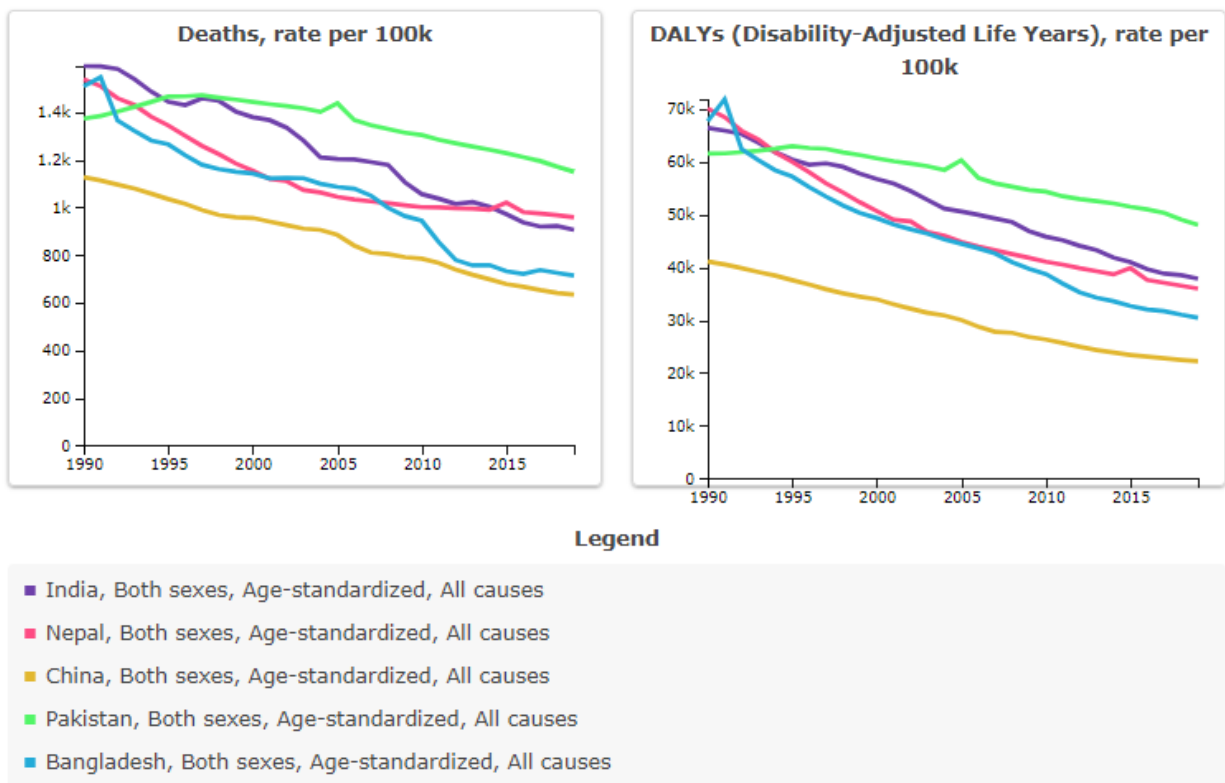
⁵ Estimates of deaths from air pollutants are based on epidemiological studies. However, these studies have several shortcomings. They include the fact that it is inappropriate to use outdoor monitors fixed in space to represent population exposure to PM2.5 (because most people move around, spend a substantial period of time indoors, and indoor and outdoor air quality may not always be the same for a variety of reasons). Steve Milloy has an extensive [critique of a recent epidemiological air pollution study](#) that illustrates many of these shortcomings.

⁶ Milloy S. [Claim: PM2.5 killed 1.22 million Chinese in 2013 — So where are the bodies?](#)

accounting for changes in population and its age structure of the population may mask the full extent of the improvement in the population's health condition over time.

To address these two concerns, the following two figures, based on estimates by the **Institute for Health Metrics and Evaluation's (IHME's) 1999 Global Burden of Disease (GBD) study**,⁷ display trends in the age-adjusted rates of death and the burden of disease from 1990 through 2019 for each of the five countries examined above.⁸ Note that these figures are consistent with the panel results shown previously.

The burden of disease is calculated using *disability-adjusted life year (DALY)*. It includes the potential years of life lost (YLL) due to premature death from a disease (or condition) as well as the years spent living with that disease or condition weighted by the severity of the disease [YLD]. Thus, $DALY = YLL + YLD$.



⁷ IHME (2022). Global Burden of Disease 2019 (GBD) Results Tool. Institute for Health Metrics and Evaluation. Available at <http://ghdx.healthdata.org/gbd-results-tool>.

⁸ IHME Global Burden of Disease 2019 (GBD) Results Tool. Available at Global Burden of Disease 2019 (GBD) Results Tool. Available at <http://ghdx.healthdata.org/gbd-results-tool>, downloaded March 18, 2023.

The figures on rates of death and burden of disease show that both rates have improved more or less continuously in each country at least from 1990 onward regardless of whether PM2.5 exposures went up or down. Comparing these two figures with the previous panels, the decline in these rates seem to correlate far better with GDPpc than PM2.5 exposure. Notably, the wiggles in PM2.5 exposures (shown in the previous panels) are not visible in the death and disease rates for the most part except, possibly, for the slight bumps for Pakistan in 2005, Bangladesh in 1991 and Nepal in 2015. Each of these bumps are associated with major natural disasters. The 2005 Pakistan bump can be ascribed to the (moment) magnitude 7.6 earthquake (followed by nearly 1,000 aftershocks in excess of 4.0) near Muzaffarabad which killed an estimated 86,000-87,400, which is slightly more than 6% of total deaths in Pakistan in 2004 or 2006.

Similarly, the 1991 spike for Bangladesh was due to a cyclone that claimed 139,000 lives, and the 2015 spike for Nepal was due to a 7.8 (moment) magnitude earthquake.

To summarize:

- Death and disease (and their rates) for each of the five most polluted countries (as identified by exposure to PM2.5) seem substantially more sensitive to economic development than PM2.5 exposure.
- The cumulative direct and indirect effects of economic development (and fossil fuel use) on life expectancy not only outweigh the effects of PM2.5, they would also enable populations to reduce PM2.5 once more significant health threats are reduced.⁹

Finally, the foregoing suggests that any analysis of the impacts of PM2.5 based on currently available dose-response functions between PM2.5 and human mortality and morbidity (which indicate high sensitivity to PM2.5) may result in misleading conclusions.

⁹ Goklany IM. Have increases in population, affluence and technology worsened human and environmental well-being. *The Electronic Journal of Sustainable Development*. 2009;1(3):1