POLLUTION AND WOMEN'S HEALTH

Particulates and anaemia in India

Anaemia remains an intransigent global health problem that increases the risk of morbidity and mortality for women and children, and nowhere more so than in India. Now, a study links particulate air pollution exposure with anaemia in women of reproductive age.

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Ambient air pollution causes substantial morbidity and mortality globally, and exposure to it is associated with an expanding litany of adverse health outcomes, including cardiovascular and respiratory disease, diabetes and low birth weight[1]. To that list, we may now also add anaemia, which has substantial and far-reaching consequences, including poor maternal health and perinatal outcomes for women and implications for productive work[2,3]. The burden of anaemia in India is particularly pronounced — approximately 54% of women aged 15–49 are thought to be anaemic[4]. Writing in *Nature Sustainability*, Ekta Chaudhary and colleagues present population-level evidence that air pollution — specifically particulate pollution — is associated with anaemia among women of reproductive age and, critically, that meeting India's national air quality guidelines would substantially reduce the prevalence of anaemia in this vulnerable population[5].

Anaemia is characterized by decreased levels of haemoglobin, reducing the blood's oxygen-carrying capacity. Anaemia has many causes, including nutritional deficiencies, infectious disease and inflammatory processes. Air pollution is known to induce inflammation. Given the high and heterogeneous levels of ambient air pollution across India (Fig. 1), an exploration of the relationship between particulate pollution levels and anaemia prevalence has been warranted for some time. It is now possible, thanks to a growing wealth of relevant data, including: spatially and temporally resolved pollution estimates; data on other sources of exposure, including tobacco and biomass smoke; and nationally representative data on anaemia prevalence and known associated factors, such as education level and obesity.

To date, there is limited evidence linking ambient particulate pollution exposure with anaemia, especially among women of reproductive age. Of note, much of the existing evidence — whether for children[6,7], pregnant women[8] or the elderly[9,10] — indicates a substantial association between exposure and anaemia. While many such studies are from low- and middle-income settings[6,7,10], only one is from India[6]; it focuses on anaemia in children and, like the others, finds a significant association.

Fig. 1 | Air pollution, here above New Delhi, is associated with anaemia in Indian women of reproductive age. Chaudhary and colleagues[5] use multiple data sources to provide evidence of a linkage between anaemia and particulate air pollution and suggest that reducing air pollution could help to decrease the intransigent and high anaemia prevalence among women of reproductive age in India. Credit: Sondeep Shankar/Alamy Stock Photo

Given the high prevalence of anaemia among women of reproductive age in India, Chaudhary and colleagues built upon the previous literature to comprehensively explore the relationship between particulate pollution exposure and anaemia. They estimated the impacts of spatiotemporally matched long-term particulate air pollution exposure (assessed in two ways) and anaemia status among more than 640,000 respondents to the National Family Health Survey (2016), a population-weighted representative sample of the Indian population. Their primary exposure metric used satellite-based particle pollution data to estimate exposure for a ten-year period preceding the National Family Health Survey. They also investigated specific components of particle pollution — such as sulfate, black carbon, soil dust and sea salt, among others — using a separate data product to see whether any had an especially pronounced effect on anaemia prevalence. They then tied these pollutants to potential sources of emissions to identify associated economic sectors to target for control measures. Finally, they estimated the relationship between exposure and anaemia and created so-called 'exposure–response' curves that allow estimation of health benefits under different policy-relevant scenarios. Their bottom-line message is consistent and relatively robust across their various methods, indicating substantial reductions in anaemia prevalence of approximately 6–7% per 10 μg per m^3

decrease in exposure. They found that specific components of particulate pollution were more strongly associated with anaemia prevalence and that action to meet the Indian annual average air quality standard for particulate pollution would reduce the prevalence of anaemia to 39.5%.

There are, of course, questions that remain. Replication in other contexts where similar data exist — for instance, in China or Peru, where studies have been performed with children and older adults, respectively — would provide additional evidence of the strength and robustness of this relationship across contexts. Furthermore, evaluating the robustness of findings when also considering variation in diets and past or ongoing infections could help to alleviate concerns that unaccounted-for factors explain the results in the current analysis. Finally, considering the impacts of activities to reduce anaemia that target multiple risk factors — like insufficient iron intake[11] and air pollution — may provide a path forward.

There is no shortage of reasons to act to reduce air pollution levels in India and beyond. For many years, policymakers in India have sought more evidence generated in India to motivate that action and, in recent years, that desire has increasingly been fulfilled. Owing partially to the growth of this high-quality Indian evidence base, the National Clean Air Programme was launched in 2019 to reduce air pollution exposures across the country. The work of Chaudhary and colleagues contributes more high-quality evidence and adds anaemia reduction as yet another health outcome that justifies acting now to reduce the large burden of air pollution exposure and related disease currently experienced across the Indian sub-continent. ❐

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Competing interests

The authors declare no competing interests.