Ekta Chaudhary. **Association of Ambient PM_(2.5) Exposure and its composition with Anemia Prevalence Amongst the Women of Reproductive Age in India.**

Background. Anemia, characterized by low red blood cell count and often accompanied by diminished hemoglobin levels, is highly prevalent in India. Ambient fine particulate matter (PM_(2.5)) exposure has been identified as a potential risk factor for anemia. However, such evidence is confined only to the developed countries. In this work, we examined the association of ambient PM_(2.5) exposure with anemia prevalence among women of reproductive age (WRA; 15-49 years) in India. We further explored the role of PM_(2.5) composition in modulating such association to understand the differential toxicity impact.

Methods. We used data from the fourth National Family Health Survey (NFHS-4), where hemoglobin concentration was used to identify anemia prevalence across 640 Indian districts. Hemoglobin content, adjusted for the altitude effect, below 12 g/dL (for WRA) is considered anemic. Satellite-based PM_(2.5) exposure dataset was used since the ground-based measurements are inadequate in India and do not cover more than 45% districts. This national database (at 1-km resolution) was generated by converting MODIS-MAIAC aerosol optical depth to surface PM_(2.5) using a dynamic scaling factor from MERRA-2 reanalysis data, and validated against existing ground-based reference-monitors. We also used black carbon (BC), organic carbon (OC), sulfate, dust, and sea-salt mass concentrations from MERRA-2 to examine toxicity issue.
We matched the survey cluster exposure using geocode information and used chronic exposure (2007-2016) as the exposure metric. In India, 51.5% of females are found anemic. A linear mixed model was used to examine the association between the anemia prevalence and PM_(2.5) exposure, adjusted for the risk factors: daily iron intake (from National Sample Survey, NSSO-68), BMI, smoking, cooking fuel, wealth index, and residence (urban/rural).

Results. At district-level, for every 10 Âµg/m^3 increase in ambient PM_(2.5) exposure, the average anemia prevalence increased by 7.23% (95% CI:6.82, 7.63) and average hemoglobin decreased by 0.057 g/dL (95% CI:0.060, 0.054). At the individual-level, for every 10 Âµg/m^3 increase in ambient PM_(2.5) exposure, average hemoglobin decreased by 0.044 g/dL (95% CI:0.047, 0.041). At ecological level, for each inter-quartile range (IQR) of BC (IQR=1.71 Âµg/m3), anemia prevalence increased by 17.7%. For the corresponding increase in sulfate (IQR=7.93 Âµg/m^3), OC (IQR=11.36 Âµg/m^3), and dust (IQR=10.06 Âµg/m^3), anemia prevalence increased by 16.7%, 15.6%, and 7.67%, respectively. Increased sea-salt exposure (IQR=0.90 Âµg/m^3) did not show any significant increase in anemia prevalence.

Conclusions. We established that the chronic exposure of ambient PM_(2.5) could be linked to anemia in the Indian WRA population, with the impact almost four times higher than the impact on children (<5 years) (reported recently). In terms of composition, the impact is comparable for BC, OC, and sulfate (three major anthropogenic species), and much higher than the natural components (dust and sea-salt). Our results imply large health benefits of meeting the National Clean Air Program target of reducing PM_(2.5) exposure by at least 30%. Additional research is recommended to understand the underlying biological mechanism and its response to differential toxicity.