Published in final edited form as:

Paediatr Perinat Epidemiol. 2017 September ; 31(5): 435–437. doi:10.1111/ppe.12390.

Air Pollution – Who Is at Risk?

Pauline Mendola

Division of Intramural Population Health Research, Eunice Kennedy Shriver National Institute of Child Health and Human Development, Bethesda, MD

In this issue of *Paediatric and Perinatal Epidemiology*, Basu and colleagues¹ add to a growing literature suggesting that fine particles in ambient air (particulate matter ≤ 2.5 microns, $PM_{2.5}$) increase preterm birth risk. The authors conducted an impressive array of analyses to estimate effects in California by region, maternal race and age, and indicators of social status such as maternal education and area-level poverty. $PM_{2.5}$ is commonly studied and often associated with adverse health outcomes. However, we rarely see such a comprehensive suite of $PM_{2.5}$ constituents as presented by Dr. Basu. It is an interesting approach to the question and has the potential to address a key issue – whether health effects are due to particle size/ mass (these small particles go deep into the lung and can go directly into circulation) or due to the compounds that form the particles and/or are adsorbed on the particles which themselves can be directly toxic or dissolve into circulation where they might cause systemic effects. Challenging this opportunity to shed more light on the question, here we see a differential response by region. If the particles or compounds themselves are biologically implicated in preterm birth, they ought to behave similarly in different areas of the state. However, for most compounds, the effects are greater in Northern California although the preterm birth rates are similar and the exposures are generally similar, perhaps slightly higher, in Southern California. The authors attempt to explain this regional difference based on variation in the underlying populations, but those differences do not resolve this question. There may be other factors associated with region, agricultural practices, for example, that could be explored further.

Other uncertainties arise from the use of birth certificates to identify births within 10 km of a monitor and monitor data that is typically sparse. Compounds detectable for at least 30% of monitoring days and with data for 75% of gestational weeks were used. $PM_{2.5}$ tends to be a regional pollutant with broad dispersion, which mitigates some of the concern related to the non-specific geographical linkage, but concentrations will vary due to point sources (traffic, industrial combustion, etc.) as well as with atmospheric conditions including precipitation and wind characteristics. The authors did control for apparent temperature and season, but are limited to monitor data in proximity to zip-code centroids for the population of interest. This is a common issue for population-based studies of air quality – we assume that the measurement error is not related to the outcome and that error will make ‘real’ effects harder to discover. Despite these concerns, the paper provides strong evidence that $PM_{2.5}$ increases preterm birth risk by 16% per interquartile range and the largest increases occur with chronic

Correspondence: Pauline Mendola, Division of Intramural Population Health Research, Eunice Kennedy Shriver National Institute of Child Health and Human Development, Bethesda, MD, USA, pauline.mendola@nih.gov.

exposure to ammonium, nitrate, bromine, elemental carbon, and zinc, compounds that are also typically related to PM_{2.5} total mass. Negative associations were observed with chlorine, sodium, sodium ions, and vanadium but the observed levels of these compounds were quite low. The authors also acknowledge the role of shared sources, another challenge in sorting out the ‘bad actors’ from other correlated compounds or the effects of complex mixtures.

Essentially, this is a classic application of population-based ‘shoe-leather’ epidemiology – using data collected for another purpose and doing a careful job of assembling information on both the exposure and outcome sides of the equation as the foundation for detailed modelling of risk. We keep doing these studies, despite their limitations, in order to estimate risks in the general population rather than smaller, better characterized, but nonrepresentative samples. Both types of studies are needed to confirm the relationship, but it is challenging to conduct smaller studies of preterm birth. The effect estimates tend to be small (as we expect in the United States where air pollution is relatively low compared with many other countries), so we need large numbers of events and, to some extent, those large numbers also help overcome the noise of nondifferential measurement error. The results of this study are generally consistent with the limited literature on PM_{2.5} constituents and preterm birth risk. The detailed subgroup analyses showing greater risk for Black and Asian women, older mothers, those with some college and among births from 32 to 34 weeks of gestational age are a substantive contribution to this developing body of knowledge. If the risks observed here are subject to non-differential misclassification of exposure, the effects may be even stronger. If the effects are indeed linear, the risks will also be higher in areas with greater PM_{2.5} concentrations.

What is striking to me is the relative lack of attention given to the risks experienced by pregnant women, their infants, and by extension, their families compared with other at-risk groups. A recent article in the *New England Journal of Medicine* describes the increased mortality associated with PM_{2.5} in the Medicare population² with an accompanying editorial entitled ‘Air pollution still kills’.³ Mortality was increased 7% in association with annual average exposure increases of 10 µg/m³, and the effects were even stronger (13% increase) under the current National Ambient Air Quality standard of 12 µg/m³. Medicare beneficiaries are nearly all over age 65 and risks were highest if individuals were male, poor (eligible for Medicaid) or Black. Against a backdrop of strong evidence for acute air pollution effects on cardiovascular⁴ and pulmonary⁵ hospitalizations and mortality, this chronic effect in the elderly is strong and perhaps not surprising. If we take Dr. Basu’s paper a step further and consider preterm birth in this broader context, it is a leading cause of infant mortality nationwide⁶ and in California,⁷ second only to congenital malformations and more than two times the rate of Sudden Infant Death Syndrome. In addition to the research that suggests some congenital malformations are also associated with air pollution, ^{8,9} mortality associated with preterm birth is really just the tip of the iceberg since preterm birth often has life-long health consequences, medical and social costs for the affected infant, mothers, families, and ultimately the society. If we imagine that these well-conducted studies are correct and improving air quality could prevent premature death and morbidity, epidemiologists have a role in making this clear to decision makers. Berger and colleagues

write ‘Do we really want to breathe air that kills us?’³ but our related question might be ‘Do we really want to breathe air that kills our children?’.

Bottom line – everyone breathes. The effects of even small increases in mortality or preterm birth associated with modest levels of particles in ambient air have a large population health impact. Too many American families and families around the globe experience premature adult deaths in addition to deaths and disability among preterm infants from this preventable, modifiable exposure. We have known for a long time that poor air quality causes premature deaths in the elderly and adults with chronic disease. It is time to consider pregnant women and their infants as a vulnerable population and reduce exposures to prevent increased premature birth morbidity and mortality associated with common air pollutants.

Acknowledgments

About the author

Pauline Mendola is an Investigator at the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development at the National Institutes of Health. Her research has focused on environmental factors that influence reproductive health, particularly pregnancy and birth outcomes. Currently, she leads the Air Quality and Reproductive Health study and the B-WELL-Mom study, a clinical study measuring lung function, inflammation and immune markers over the course of pregnancy in women with and without asthma. This work was supported by the Intramural Research Program of *Eunice Kennedy Shriver* Institute for Child Health and Human Development but the opinions expressed are those of the author.

References

1. Basu RP, Pearson D, Ebisu K, Malig B. Association between PM_{2.5} and PM_{2.5} constituents and preterm delivery in California, 2000–2006. *Paediatric and Perinatal Epidemiology* 2017; 31:424–434. [PubMed: 28732119]
2. Di Q, Wang Y, Zanobetti A, Wang Y, Koutrakis P, Choirat C, et al. Air pollution and mortality in the medicare population. *New England Journal of Medicine* 2017; 376:2513–2522. [PubMed: 28657878]
3. Berger RE, Ramaswami R, Solomon CG, Drazen JM. Air pollution still kills. *New England Journal of Medicine* 2017; 376:2591–2592. [PubMed: 28657876]
4. Du Y, Xu X, Chu M, Guo Y, Wang J. Air particulate matter and cardiovascular disease: the epidemiological, biomedical and clinical evidence. *Journal of Thoracic Disease* 2016; 8:E8–E19. [PubMed: 26904258]
5. Song Q, Christiani DC, Xiaorong Wang, Ren J. The global contribution of outdoor air pollution to the incidence, prevalence, mortality and hospital admission for chronic obstructive pulmonary disease: a systematic review and meta-analysis. *International Journal of Environmental Research and Public Health* 2014; 11:11822–11832. [PubMed: 25405599]
6. Xu J, Murphy SL, Kochanek KD, Arias E. Mortality in the United States, 2015. *NCHS Data Brief* 2016; 267:1–8.
7. Kidsdata.org. Infant Mortality in California. www.kidsdata.org/topic/54/infant-mortality/summary [last accessed July 3, 2017].
8. Chen EK, Zmirou-Navier D, Padilla C, Deguen S. Effects of air pollution on the risk of congenital anomalies: a systematic review and meta-analysis. *International Journal of Environmental Research and Public Health* 2014; 11:7642–7668. [PubMed: 25089772]
9. Padula AM, Yang W, Carmichael SL, Tager IB, Lurmann F, Hammond SK, et al. Air Pollution, neighbourhood socioeconomic factors, and neural tube defects in the San Joaquin Valley of California. *Paediatric and Perinatal Epidemiology* 2015; 29:536–545. [PubMed: 26443985]