



A Clarion Warning About Pregnancy Outcomes and the Climate Crisis

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Without mitigating efforts, the climate crisis is anticipated to result in increasingly warmer global temperatures, more frequent and extreme weather events, changes in precipitation patterns, and rising sea levels. These adverse events are predicted to have devastating effects on global water and food supplies, economic sustainability, forced population and wildlife migrations, civil conflict, and physical and mental health-related illnesses.^{1,2} Human populations most affected include disadvantaged communities, indigenous peoples, persons with disabilities and preexisting or chronic medical conditions, older adults, pregnant women, the developing fetus, and children.³ Pregnant women are particularly at risk for health compromise by air pollution because of their altered cardiopulmonary physiology and by high temperatures since their ability to thermoregulate is compromised at all gestational ages.³ Understanding the impacts of climate change on human health broadly is critically important for the global population, and effects on pregnancy outcomes and on children are of major importance for the health and well-being of this and future generations. Indeed, the most recent *Lancet* Countdown has highlighted “ensuring that the health of a child born today is not defined by a changing climate.”²

Increasing evidence across the globe supports poor pregnancy outcomes in the setting of environmental exposures exacerbated by climate change, including the air pollutants ozone (O₃) and fine particulate matter less than 2.5 μm in diameter (PM_{2.5}) and extreme heat. These adverse outcomes include preterm birth (PTB), low birth weight (LBW), stillbirth (SB), infertility, and miscarriage.⁴ The systematic review by Bekkar et al⁵ focuses on studies involving more than 31 million births in the US—the largest study to date and with exclusive focus on the US population. Using the Arksey and O’Malley scoping review framework,⁶ they identified 1851 studies on US human participants between January 1, 2007, and April 30, 2019, of which 68 met inclusion criteria.⁵ Key findings were that exposures mainly in the third trimester (or averaged across gestation) to PM_{2.5}, O₃, and heat, alone or together, are associated with PTB (delivery at <37 weeks of gestation), LBW (<2500 g after ≥37 weeks of gestation), and SB in the vast majority of studies analyzed and were consistent across the country. Limited data were available for SB because of a lack of available data in health studies. Notably, there was a disproportional impact on vulnerable populations. The subpopulations at highest risk were women with asthma and minority women, especially black women across the US and Hispanic women in California. Additionally, increased risks for poor pregnancy outcomes were noted in some studies among women with low socioeconomic status and residential proximity to power plants and freeways.

These findings of Bekkar et al⁵ are remarkable because the studies included in their systematic review had varied study designs, different timing and duration of exposures during gestation, different associated comorbidities, heterogeneity of air pollution components, different methods to measure exposures, varied definitions of heat, and genetic variability among populations. Although some non-US studies have found similar results, the systematic review by Bekkar et al⁵ is the largest study to date investigating who is affected and the magnitude of these effects under different conditions. Notably, a minority of studies included in the systematic review found no associations between air pollutants and heat and pregnancy outcomes, likely due to study designs, population demographic characteristics, and seasonality of exposures.

The causes of PTB, LBW, and SB are multifactorial and heterogeneous, and environmental impact as a component of these complex disorders is a relatively new dimension in this paradigm. Preterm birth is a major risk factor for biobehavioral or neurodevelopmental disorders and other

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chronic morbidities.⁷ In the US, the highest rates of PTB (and LBW) occur among poor women, women of color, and those with comorbidities. These risk factors overlap with the risk of environmental exposures augmented by climate change, and whether there are additive and/or synergistic associations of these exposures with neonatal health outcomes, stratified by timing of delivery, is worthy of further investigation. In addition, tracking neonatal outcomes in the studies included in the article by Bekkar and colleagues⁵ could be highly informative, especially given the large maternal cohort evaluated.

As Bekkar et al have commented,⁵ mechanisms underlying the association of PM_{2.5} with PTB (eg, on placental function and eliciting maternal systemic inflammation) and with LBW (linked to altered maternal cardiac and pulmonary function and systemic and placental inflammation) support biologically plausible drivers of adverse pregnancy outcomes associated with climate change. Most of these underlying mechanisms are borne out by animal studies.⁵ Moreover, proof of principle has been demonstrated in a natural experiment in which retiring of coal and oil power plants resulted in a reduction in the PTB rate (from 7% to 5%) in women living within 5 km of the plants in California.⁸

It has been estimated that the number of PTBs associated with PM_{2.5} was 2.7 million, or 18% of the total PTBs globally.⁹ In the US, 3.32% of PTBs nationally (corresponding to 15 808 PTBs) were attributed to PM_{2.5}, with associated costs estimated at \$5.09 billion, of which \$760 million were spent for medical care.¹⁰ These financial costs are added to the personal cost of morbidities.

It is of utmost importance that pregnant women and their health care professionals are aware of increased risks for PTB, LBW, and SB, including environmental causes, with the goal to minimize these exposures if possible. Notably, direct control over climate is often beyond the control of an individual, and thus advocacy for regulations to minimize these exposures is essential. Professional societies are increasingly becoming active in this space. For example, in 2019 the International Federation of Gynecologists and Obstetricians, a consortium of 132 professional societies of obstetricians and gynecologists across the globe, established a Committee on Reproductive and Developmental Environmental Health.³ Its goals are to advocate for policies to prevent exposure to environmental insults, work to ensure a healthy food system for all, make environmental health part of health care, and champion environmental justice.³ The Committee has just issued a statement on Climate Crisis and Health⁴ to raise awareness among its members about these important issues. Moreover, the Medical Society Consortium on Climate Change and Health, composed of 600 000 clinical practitioners in the US, is dedicated to informing the public and policy makers about the impact of climate change on human health and benefits derived by reducing greenhouse gas emissions and other preventive measures.

Indeed, the time has come for us to come together to protect the health of all global citizens, especially women and children, from the consequences of climate change now and in the years ahead. There is just too much at stake to take an alternative path.

ARTICLE INFORMATION

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Conflict of Interest Disclosures: Dr Giudice is chair of the International Federation of Gynecologists and Obstetricians Committee on Reproductive and Developmental Environmental Health (2019-2022). She is also founder of the University of California, San Francisco, Program on Reproductive Health and the Environment.

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