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Editorial

Global warming and adverse pregnancy outcomes – the need for research and intervention

Farid Midhet Mahmood

Bahria University Health Sciences Campus, Karachi, Pakistan

Address for correspondence:
Farid Midhet Mahmood, Bahria University Health Sciences Campus, Sailor Street, DHA-II, Karachi, Pakistan.
E-mail: FaridMidhet.bumdc@bahria.edu.pk

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Global warming poses one of the most significant threats to life on our planet. While its effects are far-reaching, pregnant women and their unborn children are particularly vulnerable. Rising temperatures, extreme weather events, and air pollution associated with climate change directly impact maternal health, leading to adverse outcomes for both mothers and infants. As we grapple with this urgent crisis, it is imperative that we recognize the intersection of climate change and maternal health and take decisive action to protect the well-being of our most vulnerable populations.

Research on global warming has a checkered history. Svante August Arrhenius (1859–1927), a Swedish scientist and Nobel laureate (1903), was the first to quantify the contribution of carbon dioxide (CO_2) to the greenhouse effect and long-term variations in the climate.[1] However, it was not until the middle of the 20th century that global warming began to register as a threat to human survival on earth, when Keeling[2] and others reported an upward trend in atmospheric CO_2 levels. They linked this increase to fossil fuels burning and theorized that an overall increase in the greenhouse gases (GHGs)-including CO_2, methane, nitrous oxide, and ozone – leads to trapping of heat in the earth's atmosphere, thus increasing the surface temperature.

According to the Intergovernmental Panel on Climate Change,[3] since 1900, the global average temperature has increased by approximately 1.1–1.2°, largely driven by human activities, particularly the burning of fossil fuels and deforestation. The rate of global warming has been noticeable since the mid-20th century, with the most rapid increases occurring in recent decades. The emission of GHGs has also been linked to deforestation, industrial activities, livestock farming, waste landfills, and waste treatment processes. Note that all of these causes are anthropogenic and that each can be reduced, modified, managed, and/or replaced with environment-friendly options. Unfortunately, the global efforts to reduce GHG emissions to pre-industrial levels are consistently falling short of their targets.

Therefore, in the foreseeable future, environmental degradation is likely to increase, even if at a slower pace.[4] This means that global warming will worsen, which will have a disproportionately higher impact on developing countries. Most importantly, the rise in ambient temperature has various adverse effects on health, to which pregnant women and small children are more vulnerable. These include heat stress, the worsening impact of air pollution, and vector-borne diseases. Global warming can also trigger extreme weather events such as heavy rains and floods leading to internal displacement of population, and cause food and water shortages leading to malnutrition and waterborne diseases. All of the dire consequences of global warming primarily affect the poorer, rural populations of developing countries and have a disproportionately bigger impact on pregnant and lactating women and infants.

Extreme heat is recognized as a direct cause of adverse pregnancy outcomes, especially in poor and marginalized communities. Animal studies have established that heat exposure during pregnancy can be harmful in many different ways and there is evidence to suggest similar risks for human pregnancies. Unfortunately, lack of consistency in study design and exposure windows are the major drawbacks of research in this field. Most studies have been conducted in high-income countries, which limits our understanding of the impact on marginalized populations of developing countries. Research in these settings is essential because they face the greatest risks due to climate change. Second, studies often rely on associations rather than direct causal evidence. The effects of climate change can be both direct (e.g., heat stress) and indirect (e.g., extreme weather events), making it challenging to isolate the risk factors. Third, the findings vary across studies due to differences in study design, population characteristics, and climate contexts. Long-term data tracking maternal and child health outcomes under changing climate conditions are scarce, which hinders our ability to predict long-term consequences and makes the attribution of maternal and child deaths to climate-related hazards.

A scoping review which analyzed 84 studies primarily conducted in high-income countries,[5] highlighted some of the above weaknesses. The review found a strong association between heat and preterm birth, low birth weight, congenital

anomalies, and stillbirth. While some studies considered race/ethnicity and socioeconomic factors, the emphasis on these factors was not consistent. The use of precise temperature data helped overcome the limitations of regional heat wave definitions, but the inconsistency in study designs and exposure windows made it difficult to systematically evaluate the existing literature.

Despite the limitations, there is growing evidence of the impact of heat on pregnant women's health, pregnancy outcomes, and newborn survival. An important study in India found that working in extremely high temperatures doubled the pregnant women's risk of miscarriage, stillbirth, preterm delivery, and low birth weight.[6] Extreme heat and flooding have been linked to reproductive health problems such as anemia in pregnancy, gestational diabetes, pre-eclampsia, low birth weight, stillbirth, and preterm birth.[7] A multi-country retrospective study found between 5% and 13% increase in preterm births and hypertensive disease during pregnancy due to a rise in ambient temperatures in the second trimester of pregnancy.[8] A narrative review of 20 studies on heat and pregnancy outcomes found an association between heat and stillbirth risk.[9] Beyond physical health risks related to nutrition, water, and hygiene, exposure to climate hazards during and after pregnancy can also impact women's mental health.[10] Pregnant and postpartum women are also at a higher risk of experiencing post-traumatic disorder and depression after natural disasters and displacement. Flooding has been associated with poor nutrition and malaria, while extreme heat exposure can lead to dehydration, kidney failure, and heat stroke in pregnant women. Pregnant women require reliable access to pre-hospital transportation and medical care, which are disrupted during and after extreme weather events such as floods. At the same time, biological and behavioral changes during pregnancy make women more prone to water-borne diseases, which may affect pregnancy outcomes and newborn survival.

Preterm birth and stillbirth emerge as the most common adverse outcomes of exposure to heat in pregnancy. Indeed, a systematic review and meta-analysis estimated that, for every 1°C rise in ambient temperature during the last trimester of pregnancy, the odds of preterm birth increase by 5%, and during heatwaves, this risk may escalate to about 16%. These findings underscore the urgency of addressing climate-related risks to pregnant women and fetus.[11] The same study found that higher temperatures were also associated with reduced birth weight and the impact was particularly pronounced among women in lower socioeconomic groups and at age extremes. Infants born preterm and/or with low birth weight face heightened susceptibility to infections and other complications. Finally, heat may also impact newborn care and breastfeeding practices. Maternal psychological stress has been shown to have an effect on breastfeeding.[12] Heat may lead to both physical and psychological maternal stress, which in turn may cause disruption in breastfeeding.

As climate change is likely to continue and further deteriorate the environment, its impact on maternal and child health must be contained through mitigation strategies. Health-care providers, researchers, policymakers, and health managers must modify their roles and practices according to the emerging needs of the patients and populations. It is important to devise and implement mitigation strategies that are customized to each country and community's situation. This needs action at the highest levels of the government through evidence-based decision-making, which may include the following steps:

First, a comprehensive review of scientific literature and government policies is essential to evaluate the clinical practice protocols and nature-based solutions to mitigate the impacts of climate change on pregnant and lactating women and newborn babies. This may lead to policy recommendations for mitigation of heat risks to pregnant women and newborn children. For example, antenatal and postnatal care should be used to prepare the pregnant woman and her family to take precautionary measures for the safety and comfort of the mother and the newborn baby in hot weather and rainy season.

Second, the concerned government agencies should preempt heat waves, heavy rains, and floods and take steps to ensure the continuation of health-care services, especially for mothers and infants. Nature-based solutions to combat extreme heat may also be introduced to communities. These may include the planting of trees, insulation of residential structures, and use of solar energy, for which the government may provide financial and technical support to the communities. In addition, health-care providers – particularly community health workers – should be trained to provide guidance and support to pregnant women and their families in household-level heat mitigation strategies.

What mitigation strategies should be adopted to shelter pregnant women and their newborn babies from adverse impacts of heat and severe weather will depend upon the local situation and needs. This underscores the gnawing gap in intervention research. Intervention research is needed to investigate community and household-level impacts of climate change and to develop mitigation strategies specific to each country and community. This may include qualitative research to identify the cultural and social phenomena that may facilitate or hinder the implementation of heat mitigation strategies; and experimental research to develop the most effective interventions for patient education and clinical assessment of the biological impact of heat on pregnant women. Universities and other research bodies across the developing world must take on this challenge as soon as possible.

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