Received: 31 October 2020 | Revised: 2 February 2021 | Accepted: 9 February 2021

DOI: 10.1111/aogs.14124

COMMENTARY

Maternal and newborn health risks of climate change: A call for awareness and global action

Nathalie Roos[1] | Sari Kovats[2] | Shakoor Hajat[2] | Veronique Filippi[3] | Matthew Chersich[4] | Stanley Luchters[5,6,7] | Fiona Scorgie[4] | Britt Nakstad[8,9] | Olof Stephansson[1,10] | CHAMNHA Consortium*

[1]Department of Medicine, Solna, Clinical Epidemiology Division, Karolinska Institutet, Stockholm, Sweden

[2]Centre for Climate Change and Planetary Health, London School of Hygiene and Tropical Medicine, London, UK

[3]Department of Infectious Disease Epidemiology, London School of Hygiene and Tropical Medicine, London, UK

[4]School of Public Health, University of Witwatersrand, Johannesburg, South Africa

[5]Department of Population Health, Medical College, The Aga Khan University, Nairobi, Kenya

[6]Department of Public Health and Primary Care, Ghent University, Ghent, Belgium

[7]Department of Epidemiology and Preventive Medicine, Monash University, Melbourne, Australia

[8]Division of Child and Adolescent Health, Institute for Clinical Medicine, University of Oslo, Oslo, Norway

[9]Department of Pediatrics and Adolescent Health, University of Botswana, Gaborone, Botswana

[10]Division of Obstetrics and Gynecology, Department of Women's and Children's Health, Karolinska Institutet, Stockholm, Sweden

Correspondence
Nathalie Roos, Clinical Epidemiology Division, Department of Medicine, Solna, Karolinska Institutet, 171 76 Stockholm, Sweden.
Email: nathalie.roos@ki.se

Abstract

Climate change represents one of the largest global health threats of the 21st century with immediate and long-term consequences for the most vulnerable populations, especially in the poorest countries with the least capacity to adapt to climate change. Pregnant women and newborns are increasingly being recognized as vulnerable populations in the context of climate change. The effects can be direct or indirect through heat stress, extreme weather events and air pollution, potentially impacting both the immediate and long-term health of pregnant women and newborns through a broad range of mechanisms. In 2008, the World Health Organization passed a resolution during the 61st World Health Assembly, recognizing the need for research to identify strategies and health-system strengthening to mitigate the effects of climate change on health. Climate adaptation plans need to consider vulnerable populations such as pregnant women and neonates and a broad multisectoral approach to improve overall resilience of societies.

KEYWORDS
air pollution, climate change, extreme heat, heat wave, maternal health, neonatal health

*CHAMNHA collaboration Members are listed in Appendix 1.

This is an open access article under the terms of the Creative Commons Attribution-NonCommercial License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited and is not used for commercial purposes.
© 2021 The Authors. *Acta Obstetricia et Gynecologica Scandinavica* published by John Wiley & Sons Ltd on behalf of Nordic Federation of Societies of Obstetrics and Gynecology (NFOG).

1 | BACKGROUND

Every year, worldwide, it has been estimated that 2.0 million stillbirths, 2.5 million neonatal deaths and 295 000 maternal deaths take place.[1-3] Most of these occur in low-income countries and are preventable with timely lifesaving interventions during pregnancy and childbirth. In addition, in 2015, the numbers of maternal morbidity cases exceeded by far those of maternal deaths, with an estimated 25 million episodes of maternal morbidity from the five direct obstetric causes of maternal deaths alone (abortion, hemorrhage, hypertensive disorders, obstructed labor and sepsis).[4]

Climate change has been identified as the biggest global health threat of the 21st century, with immediate harm in early life and significant lifelong consequences, and major implications for generations to come.[5] Climate change has already resulted in more extreme weather events such as storms and floods, heat waves and droughts, and the frequency and severity of such events are expected to increase.[6] The world today is already 1.2°C warmer than during preindustrial times, and the last decade recorded the eight warmest years on record, with combustion of fossil fuels as the principal mechanism for global warming.

Low-income countries are particularly vulnerable to climate change because of poverty, poor sanitation, high prevalence of malnutrition, infections, non-communicable diseases, poor quality housing and weak non-resilient healthcare systems.

2 | MATERNAL AND NEWBORN HEALTH PHYSIOLOGY AND THE DIRECT IMPACT OF CLIMATE CHANGE AND AMBIENT TEMPERATURE EXTREMES

Climate change impacts maternal and perinatal health through several mechanisms. The pregnancy and neonatal periods are characterized by physiological and anatomical changes which decrease the ability to thermoregulate. In pregnant women, these changes include considerable augmented metabolism and internal heat production due to fetal growth, increased body mass index with increased fat deposition and consequently decreased body surface area to body mass. The main physiological mechanisms for maintaining heat balance during heat events are through radiation from the skin by vasodilation and/or sweating. When heat balance cannot be maintained, heat stress causes heat-shock proteins to be released, which may induce a cascade of biological and physiological reactions with detrimental effects for maternal and perinatal health, including the neonatal period. A large number of studies suggests an association between heat exposures and the risk of preterm birth, premature rupture of membranes, low birthweight and stillbirth.[7,8] Low birthweight infants have increased susceptibility to a series of complications, including infections.[9] In addition, dehydration from increased sweating as part of thermoregulation in pregnant women can trigger the onset of early labor and prolong duration of labor.[10]

Key message

Air pollution and climate change both have an immediate adverse effect on reproductive, maternal and perinatal health outcomes, with the devastating potential to affect the health of future generations to come.

Air pollution has also been shown to increase the risk of low birthweight infants and preterm birth.[8,11] In 2010, it was estimated that the number of air pollution-associated preterm births was 2.7 million, 18% of total preterm births globally.[11] Preterm birth represents 11% of all births globally and 35% of all neonatal deaths, and is hence the leading cause of neonatal death globally and a significant contributor to long-term ill-health.[2,16] Lack of access to clean energy is a significant cause of climate change and impacts on maternal and neonatal health.[6]

Stress, including heat stress, causes a rise in cortisol levels which may lead to decreased blood flow to the placenta due to diverting blood flow for other immediate action. This can consequently affect fetal growth as well as the likelihood of intrapartum complications due to decreased oxygen levels to the fetus.[12] Extreme heat may lead to elevated blood pressure and possible preeclampsia in pregnancy, one of the three main causes of maternal death globally. The evidence is, however, inconclusive as to whether the exacerbation of hypertensive conditions increases during heat waves or not, as heat exposure may cause vasodilation and lowering blood pressure.[13] While some evidence indicates that heat exposure in the first trimester increases risk for congenital anomalies, confirmatory data are required. Moreover, it is unknown whether rates of maternal mortality increase during heat waves, as it does in other groups with challenges to thermoregulation. Lastly, research has shown that extreme weather events increase the risk of postpartum depression and posttraumatic stress disorder, as well as the occurrence of preterm birth and low birthweight infants.[14,15]

3 | WHAT ARE THE INDIRECT MECHANISMS BY WHICH CLIMATE CHANGE CAN IMPACT MATERNAL AND NEONATAL HEALTH?

Good maternal health is crucial for successful birth and neonatal outcomes and requires screening, diagnosing and disease prevention of important conditions that may impact pregnancy. Threats to maternal and perinatal health include unmet nutritional needs, infections, heavy physical labor, and underlying chronic conditions like diabetes and overweight, which in turn may complicate pregnancy outcomes, further exacerbated by climate change.

The indirect impacts of climate change on the health of vulnerable populations interact through a broad range of mechanisms and may have far-reaching social, economic and health consequences. Heavy

16000412, 2021, 4, Downloaded from https://obgyn.onlinelibrary.wiley.com/doi/10.1111/aogs.14124 by Universitsbibliothek, Wiley Online Library on [29/03/2023]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

precipitation may lead to floods, resulting in damage to infrastructure and critical services, crop loss, population displacements and disrupted access to maternal and child health services. Shortage of safe water and sanitation may lead to an increase in diarrheal disease, gastrointestinal parasite infections and cholera outbreaks. Drought may lead to failed crops and livestock deaths, and consequently malnutrition and household poverty, further increasing the nutritional gap in low- and middle-income countries in women of reproductive age and neonates who are at greatest risk. Of increasing concern are new internal displacement patterns due to climate change and climate-related disasters. Competition over depleted natural resources can in turn spark conflict between communities. Other indirect consequences of climate change may be altered disease patterns and an increase in vector-borne diseases such as malaria, dengue and schistosomiasis, which are important complicating infections during pregnancy, malaria in particular. In addition, there are psychological consequences of climate change in conjunction with extreme weather events, eg common mental disorders such as anxiety and depression. Recently, it has been estimated that disruption of services due to the recent COVID-19 pandemic in low- and middle-income countries could result in additional maternal and under-five child deaths and it is reasonable to believe that extreme weather events causing disruption in services might have a similar effect on maternal and child mortality.[17]

The proportion of maternal and neonatal mortality and morbidity attributable to climate change has not been comprehensively estimated, which justifies additional research efforts, particularly in low- and middle-income countries.

4 | GLOBAL COMMITMENTS

The World Health Organization and its Member States passed a resolution on climate change and health during the 61st World Health Assembly in 2008, recognizing the need for increased health protection strategies, strengthening of health systems to mitigate the health effects of climate change, and strengthening research to identify health protective strategies.[18] This was followed by the commitment to the 17 Sustainable Development Goals by all United Nations Member States, to improve health and living conditions for the world's population by 2030, through a broad range of approaches to address issues of human rights, equity and health, including environmental aspects.[19] Unlike the Millennium Development Goals, these global commitments do not specifically mention pregnant women, the developing fetus and the neonate, who have increasingly been recognized as populations vulnerable to the effects of climate change and heat waves, with long-term impacts on current and future generations.[8,20,21]

5 | FUTURE STEPS

Women and neonates are among the most vulnerable groups across a range of social and cultural contexts.[6] Identifying pregnant women and neonates as a risk group during climate-related events such as heat extremes is becoming an emerging need for an adequate policy and public health response to mitigate the risk of heat on adverse pregnancy and neonatal outcomes.

Low-resource settings have poor resilience and adaptive capacity to climate change. Research is required to assess and quantify the differential impacts across settings of climate change and heat waves on maternal and perinatal health outcomes. This is particularly needed in low- and middle-income countries where the burden is likely to be the largest and likely to increase over time and in areas with the poorest resources to adapt. Research efforts therefore need to identify available, efficient and low-cost interventions to mitigate the health effects of climate change globally, with a particular focus on vulnerable populations, and in geographic regions where there is a paucity of data and where the burden of poor maternal and neonatal health outcomes is the highest, such as in Sub-Saharan Africa. Research on the impacts of climate change on maternal and neonatal health requires data of high quality, especially from the hardest hit low- and middle-income countries. Pooling of available data from large cohorts or trials, especially those stored in open access data repositories, may provide valuable opportunity for large-scale analyses across multiple low-income settings.

Pregnancy-related complications that can arise from extreme heat can be detected and treated with timely antenatal and intrapartum care. The World Health Organization has updated guidance on antenatal care and intrapartum care, with an increased number of antenatal care visits to a minimum of eight.[22] This approach has proven to reduce perinatal mortality and the timely detection of pregnancy-related complications so that adequate and timely treatment to prevent mortality and morbidity can be provided, with a focus on quality of care during childbirth.[23] This requires broad investments in primary healthcare and universal health coverage overall to increase health system resilience to both climate change and other global threats, as shown by the recent COVID-19 pandemic.

National adaptation plans describe the strategies and investments needed to adapt to climate change. Both climate and health planning should consider improving access to comprehensive family planning services and investing in education for girls and boys. Investments in sexual and reproductive health services will address the unmet need in family planning, which alone could prevent 54 million unintended pregnancies as well as 26 million fewer and often unsafe abortions, and prevent 79 000 maternal and 600 000 newborn deaths globally each year.[24] There is a need to improve geographic and financial access to antenatal and intrapartum care as well as service quality for strengthened health system resilience. This includes protecting healthcare workers, pregnant women and neonates during health facility visits and childbirth from heat stress. Health-promoting strategies and communication campaigns should also include education on the risks of heat stress and how to mitigate these risks. Delaying first time pregnancy to allow young girls to complete schooling and spacing of pregnancies has lifelong benefits for women, reducing maternal nutritional deficits such as anemia and allowing families with reduced resources to prosper. In addition, empowering women will have direct down-stream positive effects

16000412, 2021, 4, Downloaded from https://obgyn.onlinelibrary.wiley.com/doi/10.1111/aogs.14124 by Universitsbibliothek, Wiley Online Library on [29/03/2023]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

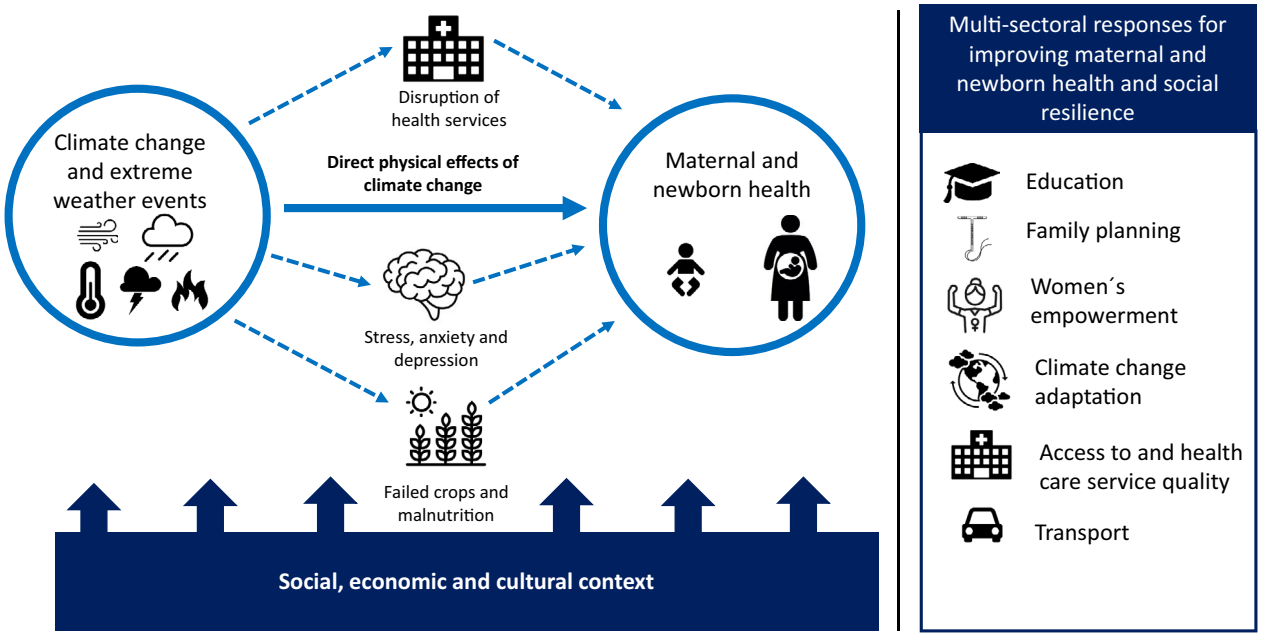

FIGURE 1 Framework for the direct and indirect effects of climate change on maternal and neonatal health and the multisectoral responses needed to strengthen resilience [Color figure can be viewed at wileyonlinelibrary.com]

on the resilience of societies, with highest gains in low-resource settings (Figure 1). These strategies will also support the achievement of the Sustainable Development Goals, nationally and globally.

With the effort to fill important knowledge gaps in terms of the impact of heat waves on the health of pregnant women and newborns, the CHAMNHA (Climate, Heat and Maternal and Neonatal Health in Africa) project aims to assess and quantify the impact of heat stress on health outcomes (including health-related behavior), to identify vulnerable populations and understand how heat is perceived as a health risk, among pregnant women and neonates. The project further aims to explore heat intervention strategies at the community and facility level in Burkina Faso and Kenya, and conduct a global review of policies and adaptation plans related to climate change, and maternal and newborn health.

The global health and climate change communities need to work together and galvanize efforts to raise awareness among policy makers regarding the consequences of climate change on the health of women and children, and on future generations to come. There is a need to improve availability of high-quality data on the impact of climate change on maternal and newborn health for understanding the global burden and its attribution, in particular in the poorest and least resilient societies who are, and will be, the most affected by climate change. Knowing the true burden will contribute to mobilizing efforts to design low-cost and efficient heat mitigation interventions and better heat adaptation planning for the future in the most affected and least resilient countries.

CONFLICT OF INTEREST

MFC and FS hold investments in the fossil fuel industry through their pension funds. The University of the Witwatersrand holds investments in the fossil fuel industry through their endowments and other financial reserves. The rest of the authors have stated explicitly that there are no conflicts of interest in connection with this article.

ORCID

Nathalie Roos https://orcid.org/0000-0001-9752-2355
Olof Stephansson https://orcid.org/0000-0003-1528-4563

REFERENCES

1. Trends in Maternal Mortality 2000 to 2017: Estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division. Geneva: World Health Organization; 2019.
2. UNICEF, World Bank Group and United Nations. Levels & trends in child mortality estimation, estimates developed by the UN inter-agency group for child mortality estimation. New York: United Nations Children's Fund; 2019.
3. UN Inter-Agency Group for Child Mortality Estimation (UN IGME). A Neglected Tragedy: The Global Burden of Stillbirths. New York: United Nations Children's Fund; 2020.
4. Graham W, Woodd S, Byass P, et al. Diversity and divergence: the dynamic burden of poor maternal health. *Lancet*. 2016;388:2164–2175.
5. Costello A, Abbas M, Allen A, et al. Managing the health effects of climate change: Lancet and University College London Institute for Global Health Commission. *Lancet*. 2009;373:1693–1733.
6. Watts N, Amann M, Arnell N, et al. The 2019 report of The Lancet Countdown on health and climate change: ensuring that the health of a child born today is not defined by a changing climate. *Lancet*. 2019;394:1836–1878.
7. Chersich MF, Pham MD, Areal A, et al. Associations between high temperatures in pregnancy and risk of preterm birth, low birth weight, and stillbirths: systematic review and meta-analysis. *BMJ*. 2020;371:m3811.
8. Bekkar B, Pacheco S, Basu R, DeNicola N. Association of air pollution and heat exposure with preterm birth, low birth weight,

16000412, 2021, 4, Downloaded from https://obgyn.onlinelibrary.wiley.com/doi/10.1111/aogs.14124 by Universitsbibliothek, Wiley Online Library on [29/03/2023]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

and stillbirth in the US: a systematic review. *JAMA Netw Open*. 2020;3:e208243.
9. McCormick MC. The contribution of low birth weight to infant mortality and childhood morbidity. *N Engl J Med*. 1985;312:82–90.
10. Hnat MD, Meadows JW, Brockman DE, Pitzer B, Lyall F, Myatt L. Heat shock protein-70 and 4-hydroxy-2-nonenal adducts in human placental villous tissue of normotensive, preeclamptic and intrauterine growth restricted pregnancies. *Am J Obstet Gynecol*. 2005;193:836–840.
11. Malley CS, Kuylenstierna JC, Vallack HW, Henze DK, Blencowe H, Ashmore MR. Preterm birth associated with maternal fine particulate matter exposure: a global, regional and national assessment. *Environ Int*. 2017;101:173–182.
12. Lajinian S, Hudson S, Applewhite L, Feldman J, Minkoff HL. An association between the heat-humidity index and preterm labor and delivery: a preliminary analysis. *Am J Public Health*. 1997;87:1205–1207.
13. Say L, Chou D, Gemmill A, et al. Global causes of maternal death: a WHO systematic analysis. *Lancet Glob Health*. 2014;2:e323–e333.
14. Harville EW, Tran T, Xiong X, Buekens P. Population changes, racial/ethnic disparities, and birth outcomes in Louisiana after Hurricane Katrina. *Disaster Med Public Health Prep*. 2010;4:S39–S45.
15. Harville EW, Xiong X, Pridjian G, Elkind-Hirsch K, Buekens P. Postpartum mental health after Hurricane Katrina: a cohort study. *BMC Pregnancy Childbirth*. 2009;9:21.
16. Blencowe H, Cousens S, Chou D, et al. Born too soon: the global epidemiology of 15 million preterm births. *Reprod Health*. 2013;10:S2.
17. Roberton T, Carter ED, Chou VB, et al. Early estimates of the indirect effects of the COVID-19 pandemic on maternal and child mortality in low-income and middle-income countries: a modelling study. *Lancet Glob Health*. 2020;8:e901–e908.
18. Climate change and health [press release]. Geneva: World Health Organization; 2008.
19. The UN sustainable development goals 2016–2030. New York: United Nations. https://sustainabledevelopment.un.org/#
20. Climate Crisis and Health Statement. London: FIGO Committee on Reproductive and Developmental Environmental Health; 2020.
21. Climate Change and Women's Health. Washington: American College of Obstetricians and Gynaecologists; 2018.
22. WHO. WHO Recommendations on Antenatal Care for a Positive Pregnancy Experience. Geneva: World Health Organization; 2016.
23. WHO. WHO Recommendations: Intrapartum Care for a Positive Childbirth Experience. Geneva: World Health Organization; 2018.
24. Singh S, Darroch JE. *Adding It Up: Costs and Benefits of Contraceptive Services – Estimates for 2012*. New York: Guttmacher Institute and United Nations Population Fund (UNFPA); 2012.

How to cite this article: Roos N, Kovats S, Hajat S, et al. Maternal and newborn health risks of climate change: A call for awareness and global action. *Acta Obstet Gynecol Scand*. 2021;100:566–570. https://doi.org/10.1111/aogs.14124

APPENDIX 1

CHAMNHA collaboration Members

Matthew Chersich, Jeremy Hess, Kadiatou Kadio, Seni Kouanda, Sari Kovats, Stanley Luchters, Adelaide Lusambili, John Marsham, Britt Nakstad, Anthony Ngugi, Nathalie Roos, Fiona Scorgie, Olof Stephansson, Caradee Y. Wright.

16000412, 2021, 4, Downloaded from https://obgyn.onlinelibrary.wiley.com/doi/10.1111/aogs.14124 by Universitsbibliothek, Wiley Online Library on [29/03/2023]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License