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Volume 68, Number 3, May/June 2023

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Journal of Midwifery & Women's Health

The Official Journal of the American College of Nurse-Midwives

SPECIAL CONTINUING EDUCATION ISSUE

Effects of Climate and Environment on Perinatal and Reproductive Health Care

Journal of Midwifery & Women's Health

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Aims & Scope

The *Journal of Midwifery & Women's Health (JMWH)* is the official journal of the American College of Nurse-Midwives. Within a culture of inclusion and antiracism, *JMWH* advocates for health equity, access to quality care for all persons, and excellence in midwifery. Articles published in *JMWH* include new research and current knowledge across a broad range of clinical and interprofessional topics including perinatal care, sexual and reproductive health, gynecology, primary care, public health, health care policy, and global health. Implications for midwifery practice, policy, education, research, and workforce development in the United States are emphasized. International health articles with global perspectives and broad implications are welcomed. *JMWH* utilizes a double anonymous peer review process to ensure manuscripts meet the highest standards of scholarly work and welcomes submissions from midwives, collaborating health professionals, scientists, and others with an interest in the Journal's scope.

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THE JOURNAL OF MIDWIFERY & WOMEN'S HEALTH, (Print ISSN: 1526-9523; Online ISSN: 1542-2011), is published bimonthly on behalf of the American College of Nurse-Midwives by Wiley Subscription Services, Inc., a Wiley Company, 111 River St., Hoboken, NJ 07030-5774.

Periodical Postage Paid at Hoboken, NJ and additional offices.

Postmaster: Send all address changes to THE JOURNAL OF MIDWIFERY & WOMEN'S HEALTH, John Wiley & Sons Inc., C/O The Sheridan Press, PO Box 465, Hanover, PA 17331.

INFORMATION FOR SUBSCRIBERS: The *Journal of Midwifery & Women's Health* is published in six issues per year. Institutional subscription prices for 2023 are: Print & Online: US$866 (US), US$866 (Rest of World), €708 (Europe), £616 (UK). Prices are exclusive of tax. Asia-Pacific GST, Canadian GST/HST and European VAT will be applied at the appropriate rates. For more information on current tax rates, please go to https://onlinelibrary.wiley.com/library-info/products/price-lists/payment. The price includes online access to the current and all online backfiles for previous 5 years, where available. For other pricing options, including access information and terms and conditions, please visit https://onlinelibrary.wiley.com/library-info/products/price-lists. Terms of use can be found here: https://onlinelibrary.wiley.com/terms-and-conditions.

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PUBLISHER: The *Journal of Midwifery & Women's Health* is published by Wiley Periodicals Inc., 101 Station Landing, Suite 300, Medford, MA 02155.

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Journal of Midwifery & Women's Health

Volume 68
Number 3
May/June 2023

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THE JOURNAL OF MIDWIFERY & WOMEN'S HEALTH, (ISSN: 1526-9523 [print]; ISSN: 1542-2011 [online]), is published bimonthly on behalf of the American College of Nurse-Midwives by Wiley Subscription Services, Inc., a Wiley Company, 111 River St., Hoboken, NJ 07030-5774.


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Editorial

The Heat is On: Imperative for Midwifery Engagement in Climate Change

As the world continues to grapple with the devastating impacts of climate change, the effects on perinatal and newborn outcomes are becoming increasingly evident. Extreme heat events related to climate change are becoming more frequent and intense and are linked to a range of health problems during pregnancy and for newborns. This *Journal of Midwifery & Women's Health* (*JMWH*) theme issue on Climate and Environmental Effects on Perinatal and Reproductive Health aims to provide midwives and others with concrete information to help identify the health effects of climate change and provide suggestions to mitigate those effects, including proposing action to be taken individually and as a profession. It is imperative that midwives develop expertise in this area, educating ourselves, our patients, and our students, and amplifying the calls for immediate change. As highlighted in advance of the recent United Nations (UN) Conference of the Parties, or COP 27, the first of these important global climate meetings to focus on the nexus of climate change and human health, health must be at the center of climate change policy going forward.[1]

The UN Secretary General was recently quoted as stating "there is no Planet B: we must fix the world we have."[2(p 1)] Those of us involved in perinatal health, whether in policy, research, education, or clinical care, must understand the broad impacts of climate change on those we care for. Climate change related events are already affecting health outcomes. Midwifery is a necessary voice to help identify and implement new solutions through interprofessional engagement in improving health systems and in our individual provision of care every day.[3]

The UN International Panel on Climate Change (IPCC) reported that greenhouse gases have already caused 1.1°C (34°F) in global warming as well as "widespread adverse impacts and related losses and damages to nature and people"[4(p 17)] and that "vulnerable communities who have historically contributed the least to current climate change are disproportionately affected."[4 (p 6)] IPCC warned that steep cuts must be made quickly or harms will increase with fewer opportunities to adapt.[4] One direct impact of extreme heat on maternal health is the increased risk of dehydration and heat stroke in pregnancy. Pregnancy increases the body's need for water, and the body is physiologically sensitive to high temperatures during pregnancy. Heat exposure can lead to pregnancy complications, such as preterm labor and low birth weight. The number of stillbirths and premature births has been estimated to increase by approximately 5% for every 1°C increase in temperature according to a recent systematic review and meta-analysis.[5(p 8)]

In this *JMWH* issue, Baharav et al have provided a comprehensive state of the science review documenting the effects of extreme heat on newborns and pregnant people.[6] The authors summarize the negative impacts on perinatal morbidity and mortality in the United States and globally. Implications for practice are addressed and a number of resources are provided, along with specific recommendations for patients that can assist clinicians in their practice.[6] Atkin et al offer an educational case study, a composite of actual patient situations, to educate students on the risks faced by pregnant persons when exposed to high heat levels.[7] Midwifery faculty and others may freely use the case study in their education programs along with the list of readings provided.[7] Continuing with a practical approach to environment and health effects, Sanders and Davis use a clinical case study to highlight the impacts of climate change and air pollution on perinatal health.[8] Air quality is critical to human health, particularly in pregnancy. Respiratory physiologic changes during pregnancy are reviewed along with effects of air pollution as the authors provide clinical guidance for managing allergic rhinitis and asthma in pregnancy.

Although climate change affects everyone, the impacts on resource-constrained and marginalized communities are greater and must be better understood and addressed through concerted policy action. The role of midwives as part of humanitarian efforts in climate related disasters, especially when positioned within communities at the local level, is described in the article by Purno et al.[9] The response to flooding in Bangladesh provides an example of the importance of maintaining access to reproductive care in disasters. The lessons learned in this case may be helpful globally in other similar situations. Two commentaries call our attention and action to the effects of climate change on perinatal mental health and to the devastating effects plastics are causing to human and environmental health.[10,11] Two other articles examine outcomes of the COVID-19 pandemic and suggest how lessons learned in that situation may transfer to actions needed to reduce climate change and address impacts on health.[12,13] And finally, in a surprising reversal of direction, a framework of vulnerability to climate change is adapted in developing a new maternal adaptive capacity theory. This theory, proposed for use in future research, focuses on maternal strengths and how to remain well during pregnancy despite existing risks.[14]

Climate change is also exacerbating existing health inequities, particularly for persons in marginalized communities who are often more vulnerable to extreme heat.[15] This "environmental injustice" will likely make existing racial inequities worse,[15(p 459)] including for families with low-income, Indigenous and people of color, and those living in urban areas with limited access to green spaces. Additional barriers to accessing midwifery care during heat waves may exist in marginalized communities, which can further increase the risk of adverse perinatal and neonatal outcomes, including low birthweight, preterm birth, and stillbirth. Studies in

1526-9523/09/$36.00 doi:10.1111/jmwh.13517

the United States and globally have described the additional effects of excessive heat on pregnant farm and agricultural workers and the need to reduce heat exposure to reduce poor outcomes,[16] as well as the need to provide information for pregnant workers and health care professionals.[17] To address the impact of extreme heat and climate change on midwifery and perinatal health, it is crucial to take a comprehensive approach that addresses both the direct and indirect effects of rising temperatures. This includes investing in public health infrastructure, such as cooling centers and air conditioning in health care facilities, to provide relief during heat waves. It also requires accessible information on screening for at-risk populations and clinical guidance for midwives and other health care professionals on the front lines of caring for pregnant persons and their newborns. *JMWH* readers may appreciate a collection of articles in a recent issue of the *International Journal of Obstetrics and Gynecology*, Special Section: The Impact of Global Warming on Women's Health.[18]

Midwives have the power and the voice to advocate for change and to prevent, recognize, and address the impacts on pregnant persons and newborns, and across the span of reproductive and primary health care. Let us all commit together, as midwives, to take action, individually and collectively, to reduce climate threats and support the necessary adaptations to mitigate climate change related impacts on both midwives and our patients, starting now. Consistent with the recently updated *ACNM Position Statement on Climate Change and Maternal Fetal and Infant Health*,[19] midwives have a responsibility to engage in the future of perinatal and reproductive health through advocating locally and nationally, working to mitigate emissions at the local level, and sharing accurate information about the damaging effects of fossil fuels. We have no time to waste because the heat *is* on and "there is no Planet B."[2(p 1)]

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REFERENCES

1. Health must be front and centre in the COP27 climate change negotiations. World Health Organization website. Accessed April 20, 2023. https://www.who.int/news/item/06-11-2022-health-must-be-front-and-centre-in-the-cop27-climate-change-negotiations
2. Secretary General's remarks at the UN Biodiversity Conference - COP 15. United Nations website. Accessed April 20, 2023. https://www.un.org/sg/en/content/sg/speeches/2022-12-06/secretary-generals-remarks-the-un-biodiversity-conference-%E2%80%94-cop15
3. Wheeler S, Ateva E, Churchill R, et al. Short communication: the global health community needs to start planning for the impact of the climate crisis on maternal and newborn health. *J Clim Change Health*. 2022;6:100131.
4. Lee H, Romero J, eds. *Climate Change 2023: Synthesis Report. A Report of the Intergovernmental Panel on Climate Change. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Intergovernmental Panel on Climate Change; Forthcoming 2013.
5. 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.
6. Baharav Y, Nichols L, Wahal A, et al. The impact of extreme heat exposure on pregnant people and neonates: A state of the science review. *J Midwifery Womens Health*. 2023;69(3):324-332.
7. Atkin K, Bernhardt JM, Olayinka O, Simmonds K. Screening for heat-related illness in pregnant people: Sample case study for clinician education. *J Midwifery Womens Health*. 2023;68:364-370.
8. Sanders B, Davis M. Effects of air pollution on pregnancy and newborn health. *J Midwifery Womens Health*. 2023;68:383-390
9. Purno N, Biswas A, Anderson R, Hoque DE. Responding to humanitarian crises: midwifery care in Bangladesh. *J Midwifery Womens Health*. 2023;68:371-375.
10. O'Sullivan J. Plastics and health. *J Midwifery Womens Health*. 2023;68:315-319.
11. Potter T, Jonker TP. Mental health impacts of climate change for birthing people and the provider's role. *J Midwifery Womens Health*. 2023;68:320-323.
12. Collembeck J, Ibrahim BB, Scharer K, Brickley T, Julien T, Kennedy HP. Applying lessons learned from the COVID-19 pandemic to future threats to the maternity care system. *J Midwifery Womens Health*. 2023;68:333-339.
13. Ellis J, Ward K, Garrett K, et al. Changes to birth plans due to COVID-19: A survey of Utah midwives and doulas. *J Midwifery Womens Health*. 2023;68:353-363.
14. Mollard E, Cottrell C. Maternal adaptive capacity: a strengths-based theory to guide maternal health research. *J Midwifery Womens Health*. 2023;68:376-382.
15. Berberian AG, Gonzalez DJX, Cushing LJ. Racial disparities in climate change-related health effects in the United States. *Curr Environ Health Rep*. 2022;9(3):451-464.
16. Bonell A, Sonko B, Badjie J, et al. Environmental health stress on maternal physiology and fetal blood flow in pregnant subsistence farmers in The Gambia, west Africa: an observational cohort study. *Lancet*. 2022;6(12):e968-e976.
17. Flocks J, Vi Thien Mac V, Runkle J, Tovar-Aguilar JA, Economos J, McCauley MA. Female farmworkers' perceptions of heat-related illness and pregnancy health. *J Agromedicine*. 2013;18(4):350-358.
18. Special Section: The Impact of Global Warming on Women's Health. *Int J Obstet Gynecol*. 2023;160(2).
19. American College of Nurse-Midwives. *Climate Change and Maternal, Fetal and Infant Health; 2023*. American College of Nurse-Midwives; 2023. Accessed April 25, 2023. https://www.midwife.org/acnm/files/acnmlibrarydata/uploadfilename/000000000308/2023_ps-climate-change-and=maternal-fetal-and-infant-health.pdf


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Mental Health Impacts of Climate Change for Birthing People and the Provider's Role

Teddie Potter[1], PhD, RN, Terra Peterson Jonker[2], BA

INTRODUCTION

Exceptional care delivered by midwives and other birth professionals has significantly decreased global infant and maternal mortality rates in recent decades[1,2]; however, these positive gains are threatened by human disruptions of our Earth's natural systems. Destruction of our environment, including climate change, impact human physical and mental health as well as the health of all life on the planet.[3] It is important for health care professionals to recognize the potential impacts that environmental disruptions can have on women during pregnancy so that appropriate teaching and safety measures can be put in place. The mental health impacts of climate change may be particularly overlooked by health care providers who do not recognize the risks or know how to respond.[4] Birth professionals have an important role to play to ensure that mental health and well-being are emphasized in this increasingly climate-changed era.

CLIMATE CHANGE: AN URGENT HEALTH RISK

In 2008, NASA scientist James Hanson, and others, stated that 350 parts per million (ppm) of CO_2 is the level of greenhouse gasses that the planet can tolerate without a string of ever-worsening conditions and perhaps irreversible changes to the Earth's life support systems.[5] As of the writing of this article, the Earth's level of CO_2 is 420 ppm.[6] The 2019 *Lancet* Countdown Report[7(p 1837)] provides a dire warning if we fail to limit our CO_2 emissions:

The life of every child born today will be profoundly affected by climate change, with populations around the world increasingly facing extremes of weather, food, and water insecurity, changing patterns of infectious disease, and a less certain future. Without accelerated intervention, this new era will come to define the health of people at every stage of their lives.

More recently, United Nations (UN) General Secretary Antonio Guterres issued this ultimatum during his opening remarks at COP27, the 2022 UN Climate Change Conference.

We are in the fight of our lives. And we are losing. Greenhouse gas emissions keep growing. Global temperatures keep rising. And our planet is fast approaching tipping points that will make climate chaos irreversible. We are on a highway to climate hell with our foot still on the accelerator… Humanity has a choice: cooperate or perish. It is either a Climate Solidarity Pact – or a Collective Suicide Pact.[8]

Clearly these are sobering messages for everyone to hear, but the reality of the climate crisis will significantly impact people of childbearing age, as the perinatal population and their children are likely to experience the worst consequences of inaction.

RESEARCH TO INFORM PRACTICE

Climate change concerns are gaining momentum as the impacts to our physical and mental health become more defined, but there is a distinct clinical care and research gap around climate change and the mental health of the perinatal population. Barkin et al[9] have produced the most comprehensive summary of research related to climate change as an emerging threat to perinatal mental health; however, they acknowledge "In terms of the mental health effects of climate change, the child population has been a primary focus while the impacts on pregnant and postpartum women have exacted less attention."[9(p 2)]

A scoping review by Ma et al[10] found that 92 studies focused primarily on the traumatic impacts following exposure to a natural disaster but only 4 studies examined the climate change and mental health impacts for younger people. More recently, health care professionals are becoming informed about the ways that climate change can impact mental health and well-being. A review by Charlson et al[11] found that climate impacts such as wildfires, floods, heat, and droughts can prompt psychological distress, exacerbate mental health conditions, and increase the risk of suicide rates. The American Psychological Association and ecoAmerica[12] report that acute climate-related disasters may precipitate shock, posttraumatic stress disorder (PTSD), and strains on social relationships, including intimate partner violence, whereas long-term impacts of climate change include mental distress, insecurity, and heightened anxiety.

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1526-9523/09/$36.00 doi:10.1111/jmwh.13492

It is important for health care professionals to recognize the continuum of mental health symptoms that may impact pregnancy, postpartum, and early parenting. In addition to generalized mental health stressors that are exacerbated by climate change, eco-anxiety and solastalgia are 2 concepts that are becoming more prominent in the literature. Eco-anxiety is an accepted term that describes a rational fear and concern related to climate change. Eco-anxiety can be mild, or it can have a debilitating impact on activities of daily living. According to the 2020 report *Climate Change in the American Mind*,[13(p 10)] 27% of Americans are very worried about climate change, and 66% of Americans are somewhat worried. People may manifest eco-anxiety even if they have not directly experienced a climate disaster. Again, young people and pregnant individuals may find eco-anxiety enhanced as they consider the future their children are likely to experience.

Solastalgia is a term coined by Australian sustainability professor Glenn Albrecht. Solastalgia refers to the sense of loss and distress that is "produced by environmental change impacting on people while they are directly connected to their home environment."[14(p S95)] All people can experience this sense of grief and loss as climate change brings about obvious changes to the environment around us. Solastalgia can impact our sense of hope and our belief in a positive future. Therefore, it is important for birth professionals to know how to respond.

The perinatal population is more vulnerable to mental health concerns, with 10% to 20% of individuals being affected by perinatal or postpartum mood and anxiety disorders[15] Considering the unique mental health needs of the birth community, Canadian researchers Olson and Metz[16] report that climate change multiplies the vulnerability and threatens the resilience of at-risk populations, which ultimately contributes to adverse pregnancy outcomes and impaired child development. The authors highlight the urgent need to "intervene to reduce stress and increase resilience in pre-conceptual women and men, pregnant and postpartum women, and their young children."[16(p 1)]

Although we see some emerging research examining the effects of extreme weather events (EWEs) specifically on perinatal mental health, there remains a gap of knowledge about eco-anxiety and solastalgia and the impact that other slower shifts in climate change will have on overall mental health. For example, worsening exposure to prolonged heat or cold, poor air quality/wildfire smoke, and displacement due to rising oceans may not have the same traumatic or PTSD response as EWEs but may still impact perinatal mental health and well-being.[17]

The birthing body and mental health are deeply connected. Physical changes can impact the mental health of those giving birth, and vice versa. Poor mental health can also have adverse outcomes for neonatal health[18] and childhood development[19]; therefore, in addition to literature on the impacts of climate change on mental health and well-being, birth professionals must also be well versed in emerging literature on the physical risks that climate change poses during pregnancy and postpartum. It is especially important to recognize that even though everyone will experience adverse impacts of climate change, underresourced and marginalized communities are known to suffer "first and worst."[20] Birth professionals have an obligation to patients to be aware of the expanding impacts of climate change on mental health and well-being and an opportunity to advance research in this area.

CLIMATE CHANGE AND THE ROLE OF BIRTH PROFESSIONALS

Health care professionals are often tasked to allay anxieties about potential events that we know are statistically uncommon. We hold the evidence-based information of the lower risk of said concerns becoming reality and impart that knowledge with compassion and kindness to shift a patient's worry. With climate change, we may hold the same concerns as our clients, so one of the first things we need to do is educate and care for ourselves. We must work to find our seed of hope so we can pass it forward. Nurses Climate Challenge,[21] an initiative cosponsored by Health Care Without Harm and the Alliance of Nurses for Healthy Environments, provides many tools to assist health care workers to gain knowledge and a sense of fellowship in addressing climate change as a community. Clayton et al[12] provide a list of recommendations on what professionals can do to mitigate the impacts of climate change on mental health.

Birth professionals can also represent the needs and concerns of perinatal clients in policy dialogues related to climate change and support efforts to decarbonize the health sector. By joining other health care professionals in advocacy, climate mitigation efforts are strengthened.[22]

ASSESSMENT FOR ALTERATIONS IN MENTAL HEALTH AND WELL-BEING

As Barkin et al[9] so aptly state,

Our changing climate is highly relevant to clinicians including obstetric and pediatric providers who are tasked with evaluating women for perinatal depression and anxiety. As the effects of climate change continue to broaden geographically, more patients will be affected, requiring providers to screen for mental wellness and adjust their advisement and approaches with environmental factors in mind.[(p 4)]

This is where midwives, labor and delivery nurses, doulas, and other birth professionals will begin to play a big role.

Midwives hold the unique role of simultaneously being rooted in the medical world and being able to hold space for all that is present, including the anxieties and concerns raised by patients. One of the greatest tools that can be used by birth professionals to combat the rising tide of eco-anxiety and climate change related mental health concerns is compassionate listening and acknowledging that the fears held are a reality. Climate change and its impacts are becoming a necessary topic to address in scheduled prenatal care. Not only does this mean we need to adjust to providing resources on how to stay physically safe during EWEs or addressing how to know when there may be poor air quality days related to climate-precipitated wildfires, but we also need to discuss ways to mitigate the mental strains, anxiety, and stressors that accompany climate events. This will mean making mental health screenings more robust by incorporating questions related to climate change, continuing to build out programs where patients have further access to mental health care in pregnancy and

postpartum, and encouraging clients with eco-anxiety to join organizations where they feel they are making a difference.

CLIMATE CONVERSATIONS WITH BIRTHERS

The way that climate concerns manifest in patients varies greatly based on the population being served and the prevalent worries currently present in the community. Birth professionals may be engaged in discussions about the new realities of climate change: how to stay safe in extreme heat or air pollution, how to get to prenatal care or a birthplace during volatile storms or unexpected weather, and heightened anxiety around long-term climate change impacts for children. Whereas our current health system frequently focuses on the acute needs of a patient, the ongoing, long-term impacts of eco-anxiety, solastalgia, and climate change-related mental health crises will need to be addressed. The Substance Abuse and Mental Health Services Administration offers resources to help professionals strengthen their disaster behavioral health responses.[23]

Although some of the risks of climate change, such as EWEs and other disasters, have clear ways that midwives can assist, others, such as eco-anxiety and mental health strains, require a more nuanced approach. Acknowledging and holding space for eco-anxiety is the first step to mitigating it, but the impacts on families experiencing heightened anxiety can often far outweigh what birth professionals are able to support in day-to-day work. In the years to come, the need to address access to mental health therapy and building more comprehensive prenatal and postpartum care to monitor the well-being of patients will directly influence the way climate change related mental health concerns play out in the health of a family.

The antidote to eco-anxiety is to be informed, to find others who share your views and concerns, and to act. Social media and doom scrolling can augment anxiety, so it is important to seek knowledge from reputable sources. In the United States, one important, regularly updated resource for patients is the Climate Change and the Health of Pregnant, Breastfeeding, and Postpartum Women webpage on the Environmental Protection Agency's website.[17] The site offers specific action items for women to follow.

Some families may ask health care professionals for sociopolitical steps they can take to mitigate climate change. There are many local, national, and international organizations taking action to address climate change. Participation in these organizations provides a supportive community and a path for meaningful and impactful action. The organization Mothers Out Front addresses the unique concerns of birthing and parenting communities. Their actions are founded on the belief that

There is no more powerful force for change than women mobilizing to protect their children. We know that when we come together for climate, racial, and social justice to tell our stories and share our dreams for our children, we cannot fail.[24]

In conclusion, compassionate care, delivered by informed health care professionals, can aid in decreasing climate-related stress, potentially improving perinatal mental health and birth outcomes. Birth professionals have a unique opportunity and growing obligation to patients to provide education and support on the expanding impacts of climate change.

CONFLICT OF INTEREST

Neither author has conflicts of interest.

REFERENCES

1. World infant mortality rate 1950-2022. Macrotrends website. Updated 2022. Accessed September 30, 2022. https://www.macrotrends.net/countries/WLD/world/infant-mortality-rate.
2. Maternal mortality. UNICEF website. Published 2021. Accessed September 30, 2022. https://data.unicef.org/topic/maternal-health/maternal-mortality/
3. Planetary health. Planetary Health Alliance website. Accessed September 30. 2022. https://www.planetaryhealthalliance.org/planetary-health
4. Kircher M, Doheny B, Raab K, et al. Understanding the knowledge, attitudes, and practices of healthcare professionals toward climate change and health in Minnesota. *Challenges*. 2022;13(2):57. https://doi.org/10.3390/challe13020057
5. Hansen J, Sato M, Kharecha P, et al. Target atmospheric CO_2: where should humanity aim? *Open Atmos Sci J*. 2008;2:217-231. https://doi.org/10.2174/1874282300802010217
6. Daily CO_2. CO_2-earth website. Updated September 30, 2022. Accessed January 27, 2023. https://www.co2.earth/daily-co2
7. 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(10211):1836-1878. 10.1016/S0140-6736(19)32596-6
8. Guterres A. General Secretary's remarks to high-level opening of COP27. United Nations website. Accessed January 29, 2023. https://www.un.org/sg/en/content/sg/speeches/2022-11-07/secretary-generals-remarks-high-level-opening-of-cop27
9. Barkin JL, Philipsborn RP, Curry CL, et al. Climate change is an emerging threat to perinatal mental health. *J Am Psychiatr Nurses Assoc*. 2022;8:10783903221139831. https://doi.org/10.1177/10783903221139
10. Ma T, Moore J, Cleary A. Climate change impacts on the mental health and wellbeing of young people: a scoping review of risk and protective factors. *Soc Sci Med*. 2022;301:114888. https://doi.org/10.1016/j.socscimed.2022.114888
11. Charlson F, Ali S, Benmarhnia T, et al. Climate change and mental health: a scoping review. *J Environ Res Public Health*. 2021;18(4486):4486. https://doi.org/10.3390/ijerph18094486
12. Clayton S, Manning CM, Speiser M, Hill AN. *Mental Health and Our Changing Climate: Impacts, Inequities, responses*. American Psychological Association; ecoAmerica; 2021.
13. Leiserowitz A, Maibach E, Rosenthal S, et al. *Climate Change in the American Mind: December 2020*. Yale University; George Mason University; 2021.
14. Albrecht G, Sartore GM, Connor L, et al. Solastalgia: the distress caused by environmental change. *Australas Psychiatry*. 2007;15 Suppl 1:S95-S98. https://doi.org/10.1080/10398560701701288
15. Puspitasari AJ, Heredia D, Weber E, et al. Perinatal mood and anxiety disorder management in multicenter community practices: clinicians' training, current practices and perceived strategies to improve future implementation. *J Prim Care Community Health*. 2021;12:2150132721996888. https://doi.org/10.1177/2150132721996888
16. Olson DM., Metz GAS. Climate change is a major stressor causing poor pregnancy outcomes and child development. *F1000Res*. 2020;9. https://doi.org/10.12688/f1000research.27157.1
17. Climate change and the health of pregnant, breastfeeding, and postpartum women. US Environmental Protection Agency website. Updated December 2022. Accessed January 29, 2023.

https://www.epa.gov/climateimpacts/climate-change-and-health-pregnant-breastfeeding-and-postpartum-women
18. Bekkar, Pacheco S,Basu R, DeNicola N. Association of air pollution and heat exposure with preterm birth, low birth weight, and stillbirth in the US: a systematic review. *JAMA Netw Open*. 2020;3(6):e208243. https://doi.org/10.1001/jamanetworkopen.2020.8243
19. Van Den Bergh BRH, Van Den Heuvel MI, Lahti M, et al. Prenatal developmental origins of behavior and mental health: the influence of maternal stress in pregnancy. *Neurosci Biobehav Rev*. 2020;117:26-64
20. US Environmental Protection Agency. *Climate Change and Social Vulnerability in the United States*. US Environmental Protection Agency; 2021. Accessed January 29, 2023. https://www.epa.gov/system/files/documents/2021-09/climate-vulnerability_september-2021_508.pdf
21. Nurses Climate Challenge. Nurses Climate Challenge website. Updated 2022. Accessed January 29, 2023. https://nursesclimatechallenge.org/
22. Liu J, Potter T, Zahner S. Policy brief on climate change and mental health/well-being. *Nurs Outlook*. 2020;68(4):517-522.
23. Disaster behavioral health planners resource portal. Substance Abuse and Mental Health Services Administration website. Accessed January 29, 2023. https://www.samhsa.gov/dtac/disaster-planners
24. Who we are. Mothers Out Front website. Accessed January 29, 2023. https://www.mothersoutfront.org/who-we-are/


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The Impact of Extreme Heat Exposure on Pregnant People and Neonates: A State of the Science Review

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The relationship between heat exposure and perinatal morbidity and mortality is of increasing concern as global temperatures rise and extreme heat events become more frequent and intense. Heat exposure can lead to a multitude of harmful outcomes for pregnant individuals and neonates, including hospitalization and death. This state of the science review explored the evidence on the associations between heat exposure and negative health outcomes during pregnancy and the neonatal period. Findings suggest that improving health care provider and patient awareness of heat-related risks and implementing specific interventions could mitigate adverse outcomes. Furthermore, public health and other policy interventions are needed to increase thermal comfort and reduce societal exposure to extreme heat and related risks. Early warning systems, medical alerts, provider and patient education, and increased access to health care and thermal comfort may improve pregnancy and early life health outcomes. J Midwifery Womens Health 2023;68:324–332 © 2023 Adrienne Arsht – Rockefeller Foundation Resilience Center. *Journal of Midwifery & Women's Health* published by Wiley Periodicals LLC on behalf of American College of Nurse Midwives (ACNM).

Keywords: climate/environmental health, global health/international, health policy, newborn care, patient education, patient safety and risk management, pregnancy complications, public health

INTRODUCTION

Exposure to extreme heat is a growing global health concern. By 2070, it is estimated that, without migration, one-third of Earth's population will reside in areas with annual average temperatures greater than 84.2°F (29°C), currently only experienced in less than 1% of Earth.[1] Heat waves were the deadliest meteorological hazard over the past 30 years in the United States[2] and globally from 2015 to 2019.[3] Thus, researchers are increasingly studying the effects of heat exposure among vulnerable groups such as the elderly, pregnant people, infants and children, outdoor workers, heat-exposed indoor workers, and low-income and marginalized communities.[4,5] Heat exposure interacts with underlying health conditions including chronic obstructive pulmonary disease, asthma, cardiovascular events, and mental health disorders, particularly suicide risk.[6–8]

Identifying and categorizing the impacts of heat exposure is challenging, as there are no universally accepted definitions for *excessive heat*, *extreme heat*, *heat waves*, *extreme heat events* (EHEs), *heat exposure*, and *high ambient temperatures*.[9–11] The World Meteorological Organization (WMO) and World Health Organization (WHO) acknowledge that there is "no universally accepted definition" of heat waves, and that heat waves are "understood to be periods of unusually hot and dry or hot and humid weather that have a subtle onset and cessation, a duration of at least 2 to 3 days, usually with a discernible impact on human and natural systems."[9(p xi)] Heat exposure was defined by the literature in this review in a variety of ways, including multiday periods of elevated temperatures, experiencing temperatures over a certain threshold, incremental/quartile increases in average temperatures, and seasonal averages or abnormalities in temperature.

Extreme heat warnings are most frequently issued using temperature or apparent temperature thresholds.[9] However, thresholds vary greatly by region and within countries. Furthermore, specific heat thresholds are not always well correlated with adverse health effects.[12] In the United States, for example, the National Weather Service generally issues heat advisories based on the heat index, which combines heat and relative humidity.[12] Yet, the heat index currently accounts for only 2 meteorological variables, excluding the impact of other variables, such as several consecutive days of oppressive weather, which further contribute to poor health outcomes.[12]

Factors Influencing the Effects of Heat Exposure

Climatological and environmental factors such as humidity,[13] urban heat islands,[14] access to cooling, minimum nighttime temperatures, and access to shade mediate apparent temperature and the body's cooling ability.[9] Gender differences can

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1526-9523/09/$36.00 doi:10.1111/jmwh.13502

Quick Points

- Heat exposure is associated with many adverse health outcomes for pregnant people and newborns.
- Consistent global definitions and criteria for various heat conditions, such as excessive heat, extreme heat, heat waves, "high" ambient temperatures, and extreme heat events, are lacking.
- Policy, public health, and health care provider advocacy and action can increase access to interventions that improve patients' resilience to heat.

also influence vulnerability to extreme heat.[15] Lower socioeconomic status (SES) and historically marginalized communities are frequently exposed to higher temperatures,[16] with negative consequences for health and well-being. Additionally, factors such as acclimatization,[11] thermoregulation,[7] access to health care,[15] medications, and ability to self-care influence heat-related health outcomes.[14,17,18]

During pregnancy, normal physiologic changes, such as increased hormonal sensitivity and changes in circulation and blood volume, can reduce a pregnant individual's ability to regulate body temperature, increasing susceptibility to adverse heat-related health effects.[15,19] Heat exposure can cause elevations in maternal core body temperature and maternal pulse, which can lead to fetal heart rate tachycardia and trigger uterine contractions.[15] Pregnancy increases blood volume and hydration needs, increasing risks for dehydration.[19] The combination of dehydration and heat exposure further contributes to the incidence of preterm contractions[19] and can alter blood flow to the placenta, leading to more serious complications such as placental abruption[20] and fetal growth restriction.[4] Heat can cause the secretion of antidiuretic hormones and oxytocin, which can also trigger uterine activity.[15] Hyperthermia has well-documented teratogenic effects in clinical and animal studies, which may have implications for congenital birth defects, although the connection with ambient heat is less comprehensively understood.[21] More research is needed to identify critical windows of pregnancy and examine heat's relationship with pathophysiology. This state of the science review was therefore conducted to examine associations between heat exposure and negative health outcomes for pregnant people and neonates and synthesize recommendations for reducing heat-related mortality and morbidity.

HEAT-RELATED MORTALITY AND MORBIDITY

A literature search was conducted in Web of Science, Google Scholar, PubMed, and MEDLINE and supplemented by reference tracking, ancestry approach, and author tracking. To be included, articles had to address heat exposure and neonatal or maternal morbidity or mortality. English language systematic reviews with or without meta-analyses, cohort studies, case studies, ecological studies, time series studies, and case-control studies were included. Evidence for heat-related mortality and morbidity is presented through all-cause mortality, obstetric complications, and neonatal complications.

Negative heat-health outcomes for pregnant people included obstetric complications such as placental abruption,[20] gestational hypertension,[15,22] gestational diabetes mellitus (GDM),[23] cardiovascular events,[24] preterm birth (PTB),[5,11,13,17,24–34] miscarriage,[22,35–37] stillbirth,[5,10,13,18,25–27,37–40] and potential impacts on maternal mental health.[41] Neonatal complications included fetal distress,[42] neonatal intensive care unit (NICU) admissions,[43] fetal growth restriction or low birth weight,[4,13,25,26,29,44] congenital birth defects,[26,45–47] diarrheal disease,[48–50] vector-borne diseases (VBDs),[51–55] and sudden infant death syndrome (SIDS).[56]

All-Cause Mortality

Extreme heat increases mortality primarily by interacting with existing health conditions, such as cardiovascular, cerebrovascular, and respiratory diseases.[12] Few studies, however, have examined broad associations, instead exploring mortality by specific etiologies.[15] In a case-crossover analysis in the Catalonia region of Spain, researchers identified an association between extreme heat days (defined as days with maximum temperature above the 95th percentile) and an increased risk of neonatal mortality in the perinatal period (relative risk [RR], 1.53; 95% CI, 1.16-2.02).[57] The neonatal mortality causes most sensitive to extreme heat days included hemorrhagic and hematologic disorders and respiratory, cardiovascular, and digestive complications.[57] In the United States, where maternal mortality is the highest among industrialized countries, traditionally marginalized and low-income communities suffer greater heat-related morbidity and mortality.[15] Researchers have found that Black women were 3 to 4 times more likely than White women to experience maternal mortality linked to disproportionate exposure to heat and less access to thermally safe spaces.[15]

Obstetric Complications

Placental Abruption

Placental abruption is a medical emergency with high risk of mortality and morbidity for both the pregnant person and infant.[20] A case-crossover analysis in Canada found that a maximum weekly temperature of 86°F (30°C), compared with a maximum weekly temperature of 59°F (15°C), was associated with an increased risk of abruption in pregnancies at or close to term (odds ratio [OR], 1.12; 95% CI, 1.02-1.24).[20] This association was more pronounced in women who were nulliparous, under 35, or had low SES.[20] Kim et al also identified increased risk of hospitalization due to antepartum hemorrhage, the third leading cause of maternal mortality, with exposure to extreme heat.[15]

Gestational Hypertension and Preeclampsia

Several studies suggested exposure to EHEs and elevated ambient heat during pregnancy may increase the risk of developing gestational hypertension, including preeclampsia and eclampsia.[15,22,58–60] In a case-crossover analysis of pregnancy complications and EHEs in New York State, EHEs were associated with a 13% increase in emergency department visits for hypertensive pregnancy complications (OR, 1.13; 95% CI, 1.02-1.25).[22] Other researchers compared hospital discharge records and temperature variations for 2.24 million mothers in Arizona, New York, and Washington, finding that an additional day with an average temperature 3 SDs or more above the county's monthly mean temperature during pregnancy increased odds of hospitalization by 0.1 percentage points.[15] The authors noted that multiple pregnancy complications contributed to this increase, but gestational hypertension was one of the most frequent.[15]

A national cohort study in China identified that exposure to high weekly average ambient temperatures (above 95th percentile) during the first half of pregnancy increased the likelihood of gestational hypertension (OR, 1.16; 95% CI, 1.10-1.22).[58] Likewise, a cohort study conducted in Be'er Sheva, Israel found that an elevation of one interquartile range of the mean daily temperature averaged over each trimester, in the second or third trimester, was associated with an increased risk of developing preeclampsia (RR, 2.91; 95% CI, 1.98-4.28).[59] A meta-analysis across multiple climate and development contexts also noted an increased risk of developing preeclampsia in pregnancies with a warm season conception date (June, Northern hemisphere/December, Southern hemisphere pooled RR, 1.3; 95% CI, 0.78-2.27).[60] Although all reviewed studies found that seasonality and exposure to extreme temperatures was associated with gestational hypertension or preeclampsia, additional research is needed to clarify temperature ranges with adverse effects and gestational windows of greatest vulnerability.

Acclimatization, adaptation, and cooling access influenced the magnitude of heat's effects on hypertensive disorders in pregnancy. Hospitalizations in counties that were adapted to higher temperatures were not affected by an additional hot day.[15] In unadapted counties, however, an additional day of temperatures greater than 90°F (32.2°C) increased the likelihood of hospitalization by 5.1% ($P = .04$).[15] Shashar et al suggested that adaptation mitigated preeclampsia risk, positing that the higher risk of preeclampsia observed in local nomadic Bedouin populations compared with Jewish ethnicity patients may have been largely due to differences in heat stress coping mechanisms, housing, and cooling access.[59]

Gestational Diabetes

A systematic review of heat impacts on gestational diabetes, covering studies from Australia, Brazil, Canada, Greece, Italy, Israel, Spain, Sweden, Taiwan, and the United Kingdom, identified a consistent association between summer seasons, higher prevalence of GDM, and increased blood glucose levels.[23] GDM is associated with increased incidence of cesarean birth, PTB, preeclampsia, macrosomia, neonatal hypoglycemia, type 2 diabetes, and cardiovascular disease.[23] Studies focused on ambient temperature were also included in Preston et al's review, with several suggesting an association between high ambient temperature and increased blood glucose levels in pregnancy.[23] This finding has potential implications for the development and treatment of GDM.[23] Future research is needed to better understand the sensitivity windows and magnitude of this effect.

Cardiovascular Events

Cardiovascular events during pregnancy and birth, including heart attacks and strokes, account for 15% of pregnancy-related deaths.[24] Ha et al found in a US-based case-crossover study that a 1.8°F (1°C) increase during the warm season the week before birth was associated with a 7% (OR, 1.07; 95% CI, 3%-12%) increase in the risk of a cardiovascular event during labor.[24] Increased risks of cardiovascular events were more pronounced the closer the temperature increase was to the onset of labor.[24] This study also found that Black women were more susceptible to cardiovascular events than non-Hispanic White women at the same temperature increase.[24]

Preterm Birth

Heat exposure may elevate the risk of PTB, a leading cause of morbidity and mortality in neonates.[11,13,26,29–31] Researchers have suggested that heat exposure increases the likelihood of dehydration and the secretion of antidiuretic hormones and oxytocin, contributing to PTB.[19,27,28]

Ha et al examined heat exposure (temperatures >90th percentile) across 12 US states by gestational weeks of pregnancy, finding that heat exposure was correlated with a 6% to 21% increase in PTB risk at week 34 and weeks 36 to 38.[61] Additionally, a 5°F (2.8°C) increase in temperature the week before birth was associated with 12% to 16% higher risk of early PTB (<34 weeks) (OR, 1.16; CI, 1.12-1.19) and late PTB (34−36 weeks) (OR, 1.12; CI, 1.10-1.15).[61] In a systematic review, with studies mostly conducted in the United States, the European Union, and New Zealand, Chersich et al found that the likelihood of PTB rose 1.05 times with every 1.8°F (1°C) increase in temperature (OR, 1.05; 95% CI, 1.03-1.07).[5] Moreover, heat wave conditions increased the odds of PTB more substantially, by 1.16 times (OR, 1.16; 95% CI, 1.10-1.23).[5]

Likewise, evidence from multiple studies conducted in rural China, Korea, Taiwan, the United States, and across 14 low- and middle-income countries in Africa and Central and Southeast Asia supported this finding, suggesting that exposure to multiday periods of extreme heat had a stronger effect on PTB rates than exposure to mild or moderate elevations in temperature.[17,25,27,28,32–34]

Several researchers have examined the impact of heat exposure on PTB during specific gestational windows. Ha et al's study and Wang et al's time series study in Guangzhou, China both found that exposure to hot and cold temperature extremes in the first trimester of pregnancy increased risk of PTB.[10,61] Wang et al defined heat waves as greater than or equal to 2 days of temperatures higher than 91.4°F (33°C) or when temperatures exceeded the 75th, 90th, 95th, or 98th percentile.[10,61] Significant associations with PTB and heat exposure around conception were described by authors

conducting studies in China.[31,33] In a prospective cohort study, authors noted a significant association between PTB, ambient temperature, and extreme heat and cold days in the month of conception (OR, 1.17; 95% CI, 1.06-1.28).[31] Likewise, Zhou et al's survey in Henan, China found that exposure to extreme heat (>90th percentile) in the 2 to 3 weeks before conception increased the risks of PTB.[33]

Several studies identified population subgroups that were more susceptible to heat-related PTB. A cohort study in Seoul, South Korea found that the most significant and strongest effect of heat on PTB was in mothers who had low education levels and lived in low SES communities.[30] Other risk factors identified were higher pre-pregnancy BMI, extremes of maternal age, late or no prenatal care, and chronic diseases.[5,17] In a study of Korean birth data, researchers found that in the second trimester heat waves combined with high particulate matter (PM) 2.5 exposure (a metric for air pollution levels) had a stronger effect than either exposure alone.[32] The authors concluded that communities with poor air quality may be more susceptible to heat-related PTB.[32]

Miscarriage

Miscarriages affect approximately 20% of all pregnancies globally.[36] Several studies suggest a positive relationship between increasing temperature and increased risk of miscarriage.[22,35–37] For example, a case-control study in Nanjing, China found that increases in ambient temperatures higher than the median temperature of 62.6°F (17°C) gradually increased the risk of miscarriage.[36] The effect of extreme heat (91.4°F [33°C]) on the probability of miscarriage (2%-5% increase) was especially pronounced during summer and transitional months (OR, 2.07; 95% CI, 1.36-3.16).[36] A cross-sectional study of the Ghana Maternal Health Survey found that with each 1.8°F (1°C) increase in wet bulb globe temperature (WBGT) the risk of miscarriage rose by 12% to 15%.[37] However, these findings were not statistically significant.[37] A case-control study of miscarriage and heat effects in Guangdong, China found that the risk of miscarriage decreased in the high heat exposure group compared with the moderate heat exposure group.[35] Authors theorized that the decrease may be associated with increased adaptation, such as air conditioning use or reduced outdoor activity during high heat.[35]

Stillbirth

Asamoah et al suggested that each degree increase in maternal heat exposure (measured in WBGT) in warm regions was correlated with a 27% to 42% increase in likelihood of miscarriage or stillbirth (crude OR, 1.42; 95% CI, 1.00-2.03).[37] Other researchers in the United States found that incremental increases in temperature were associated with an increase in the risk and incidence of stillbirth.[39,40] Additionally, an average increase of 2.8°F (1°C) over the county 97.5th percentile temperature threshold was associated with a 10% increase in risk of stillbirth (OR, 1.1; CI, 1.04-1.17).[40]

Some studies suggest that the timing of exposure to temperature extremes affects risk of stillbirth. A cohort study in Brisbane, Australia found an increased risk of stillbirth with exposure to high ambient temperatures (measured in percentiles) during the second and third trimesters.[38] A second cohort study conducted in the same area found associations between heat wave exposure and increased risk of stillbirth in every month of pregnancy.[10] However, authors reported a stronger association during early pregnancy compared to late pregnancy.[10]

Multiple studies found that pregnancies of historically marginalized groups may be at greater risk of stillbirth.[18,27] For instance, a case-crossover study in Texas found that there was an elevated stillbirth risk in the summertime among Hispanic and non-Hispanic Black women but no elevated risk in non-Hispanic White women (Hispanic women: OR, 1.60; 95% CI, 1.19-2.15; non-Hispanic Black women: OR, 1.61; 95% CI, 1.12-2.30; non-Hispanic White women: OR, 0.90; 95% CI, 0.54-1.50).[18]

Maternal Mental Health

Some research has suggested that heat waves may contribute to increased risk of suicide and mental health-related admissions in the general population.[8] Although studies on the relationship between temperature and maternal mental health are limited, a cohort study in Shanghai, China found that extreme heat conditions may exacerbate emotional stress and life-event stress on the day of, and up to 2 days after, heat exposure (OR, 2.9; 95% CI, 2.1-4.2; $P < .001$).[41] Considering evidence of heat-related adverse effects on mental health in the general population, more research is needed on heat-related mental health impacts in pregnancy and postpartum.

Neonatal Complications

Fetal Distress and NICU Admissions

A time series analysis indicated a potential association between heat wave exposure (when the heat index exceeded locally or regionally defined thresholds for a heat advisory) during pregnancy and increased rates of perinatal fetal distress, meconium aspiration, and neonatal ventilator use.[42] Cil and Cameron noted that a heat wave during the third trimester was associated with a 3.5% increase in the fraction of births (1/1000) in which at least one of fetal distress, meconium aspiration, or neonatal ventilator use occurred.[42] Fetal distress increased by 2.1 cases per 1000 births ($P < .05$) with heat wave occurrence in the third trimester.[42]

Kakkad et al conducted a retrospective review of birth records and NICU admissions at Shardaben Chimanlal Lalbhai (SCL) Municipal General Hospital in Ahmedabad, India, identifying an association between heat and neonatal morbidity.[43] SCL Hospital primarily serves low-income patients and did not have air conditioning during the study period.[43] A strong relationship between heat and NICU admissions was observed after temperatures exceeded 107.6°F (42°C), above which every 1.8°F (1°C) increase was associated with a 43% increase in heat-related NICU admissions (95% CI, 9.2%-88%).[43] SCL Hospital moved the maternity ward to

a lower floor and saw a protective effect, with heat-related NICU admissions reduced by 64% (95% CI, 3%-89%).[43]

Fetal Growth Restriction and Low Birth Weight

Multiple studies suggested a strong association between heat exposure and fetal growth restriction or low birth weight.[4,13,25,26,29,44,62] An empirical cohort study in Bolivia, Colombia, and Peru found that a one SD increase relative to the municipality's long-term temperature mean was correlated with an average reduction in birth weight of 20 g and raised the probability of low birth weight by 0.7 percentage points.[44] Sun et al found that fetal growth restriction was associated with exposure to above-average temperatures during pregnancy.[4] However, an association between small for gestational age (SGA) and heat was less established. In a retrospective observational study of 29,597,735 births in 402 US counties, researchers found that high temperatures (>90th percentile) throughout the pregnancy were associated with a higher risk of SGA in term births (OR, 1.041; 95% CI, 1.029-1.054).[4] The risk was especially pronounced when temperatures were high during the second and third trimesters and in areas with historically cooler climates.[4] However, a study in southern Israel found that higher temperatures were associated with a lower risk of SGA.[63] Although ambient temperatures may affect SGA, more research is needed to understand the magnitude and direction of this association.

Congenital Birth Defects

Of congenital birth defects, research on congenital heart disease (CHD) was most frequently identified. A cohort study of live and stillbirths in the Tel Aviv region of Israel found that the risk for multiple CHDs increased with a 1-day increase in EHEs (OR, 1.13; 95% CI, 1.06-1.21).[46]

The US National Birth Defects Prevention Study (1999-2007) found that increased odds of ventricular septal defect were present only in offspring exposed to both high PM 2.5 levels and an EHE in utero (OR, 0.82; 95% CI, −0.39 to 2.17).[47] A follow-up study noted that regional differences in CHDs may be associated with ambient temperature variations, with the Southern United States experiencing more conotruncal CHD and the Northeast more atrial septal defects.[64] With projected increased heat exposure due to climate change, researchers suggest that CHD burden may increase.[64]

Teratogenic effects of increased maternal core body temperature, including neural tube defects (NTDs) (eg, spina bifida, anencephalus/encephalocoele), are well documented with concentrated heat exposures (hot tubs, saunas, etc.).[21] However, less research has investigated connections with high ambient heat.[21] A retrospective cohort study in Canada identified that exposure to 86°F (30°C) (relative to 68°F [20°C]) was associated with increased risk of NTDs when the exposure occurred during the neural tube closure window of gestation (prevalence ratio, 1.56; 95% CI, 1.04-2.35).[21] More research is needed on heat exposure associations with birth defects, especially for noncardiac congenital abnormalities including NTDs, orofacial clefts, hypospadias, and ocular defects.

Diarrheal Disease

Diarrheal diseases are the second highest cause of death in children under 5.[49] Diarrheal diseases contribute to growth reductions, delayed cognitive development, and greater susceptibility to chronic disease and infection, with the most severe impacts concentrated in low-resource settings.[48,49] In a global meta-analysis covering multiple development contexts, Levy et al found that 65% of studies reviewed saw a positive relationship between temperature and all-cause diarrheal diseases.[48] Likewise, Carlton et al conducted a similar review of studies concentrated in Bangladesh, Australia, and the United Kingdom, also noting that elevations in temperature were strongly associated with higher rates of diarrheal disease.[48,49] Few studies examining relationships between diarrheal diseases and pregnancy were identified in this review; however, research in Nepal identified a potential association between diarrheal disease during pregnancy and increased risk of SGA births.[50]

Vector-Borne Diseases

The effects of heat on vector populations and VBDs is dependent on existing VBD burden and baseline average temperatures.[51,52] Regions historically on the upper end of a vector's ideal temperature range may experience decreases in vector prevalence and VBDs as heat waves or unusually high average temperatures exceed the vector's temperature range and limit proliferation.[51,52] However, when heat waves or unusually high temperatures occur in regions historically beneath a vector's ideal temperature range, increases in vector proliferation, the introduction of new vectors, and outbreaks of VBDs in previously unexposed or low prevalence regions may occur.[51–53] Outbreaks in historically low exposure regions are of significant concern, as low population immunity may influence higher mortality.[51–53] In a case study conducted in Rwanda, Loevinsohn identified that after a year of record high temperatures, malaria incidence increased by 337%.[53] Increased incidence was most pronounced among low acquired immunity groups ($P < .001$) and those in high altitude regions ($P < .005$), which may have contributed to the rapid increase in fatality rate (RR, 4.85; $P < .001$).[53]

VBDs are a major driver of poor perinatal health outcomes. Malaria alone is a primary cause of mortality in low-resource countries, disproportionately affecting young children and pregnant women.[50] VBDs can also influence adverse pregnancy and birth outcomes. A systematic review across 14 countries found that dengue infection was associated with increased risk of preeclampsia and cesarean birth.[65] Contracting dengue during pregnancy also increased the risk of miscarriage, PTB, and low birth weight.[54] A meta-analysis spanning studies in 10 sub-Saharan African countries, Colombia, Indonesia, and Thailand suggested that pregnancy-associated malaria increased the risk of low birth weight by 63% (95% CI, 1.48-1.80) and PTB by 23% (95% CI, 1.07-1.41).[55]

Sudden Infant Death Syndrome

Temperature extremes and incremental temperature changes are correlated with increased incidence of SIDS.[56] Auger et al

Table 1. Recommendations for Patients

Recommendations
1. Check your local news, weather, and health services for heat wave alerts and safety tips. Learn the signs and symptoms of overheating in adults and children, and consult your health care provider on how to keep yourself and dependents safe from heat. Check in with friends, neighbors, and family members during heat waves and high heat and humidity conditions.
2. Drink extra water, even when not thirsty. Avoid sugary drinks, alcohol, and caffeine. Eat small, frequent meals. Use cooking techniques that do not release as much heat or steam and avoid using the oven.
3. Speak with your health care provider about managing heat-related risks in extreme-age pregnancies,[5] if you have a disability impairing your ability to access cooling, or if you have underlying health conditions such as asthma, cardiovascular disease, or chronic obstructive pulmonary disease.[6]
4. Speak with your provider about how your medicine might affect you during heat waves. Individuals taking medications that alter the ability to thermoregulate may be at greater risk of heat-related illness. These medications include, but are not limited to, anticholinergics,[70] antihistamines,[71] blood pressure medications (including antihypertensives, ACE inhibitors, beta blockers, and calcium channel blockers),[70] decongestants,[70] diuretics,[71] opioids,[72] and psychotropic or psychiatric medicines[73] (including antipsychotics,[71] lithium,[73] SSRIs,[72] stimulants such as Adderall and Ritalin,[70] and tricyclic antidepressants[70]).
5. Speak with your provider about how to minimize heat risk at work and at home. Low-income status,[5] historical social or racial marginalization,[27] minimal or no access to cooling, and outdoor work (such as construction or agriculture) or heat-exposed indoor work (such as in industrial and light-industrial facilities or warehouses) are all associated with greater risk of heat-related illness.
6. Install thermometers. The WHO and WMO recommend that electric fans (such as ceiling fans) not be used when dry-bulb temperatures are above 95°F (35°C), as moving hot air around an individual can worsen heat stress.[9] Above 95°F (35°C), electric fans should be turned off and air conditioning should be used.[9]
7. If you work outdoors or in hot indoor workplaces, take regular breaks, use a buddy system, and rehydrate in shaded or air conditioned areas.
8. If you cannot access cooling at work or at home, seek alternative cooling locations, such as official cooling centers, public libraries, or other air conditioned public spaces and shaded outdoor areas.
9. Avoid heavy exercise during peak heat hours of the day.
10. Wear loose-fitting, lightweight, and light-colored clothing. Wear a hat and put on sunscreen of at least SPF 15 at least 30 min prior to going outside.
11. Cool as much of the body's surface as possible with cold baths or showers and cold towels, with a priority for face, hands/wrist, groin, underarms, and feet. Moisten skin with water and use a fan or wind to increase evaporation under 95°F (35°C). Use air conditioning above 95°F (35°C).
12. Sleep as cool as possible with cotton, bamboo, or linen sheets. Sleep low to the ground if possible.
13. Open windows during cool times of day. Close windows during warm times of day. Install shades, reflective windows, light-colored curtains, air conditioning, and/or shading structures. Use external shade to reduce heat into homes and buildings, and keep blinds closed if no external shading is possible.

Abbreviations: ACE, angiotensin-converting enzyme; SSRI, selective serotonin reuptake inhibitor; WHO, World Health Organization; WMO, World Meteorological Organization.

found that maximum daily temperatures greater than or equal to 84.2°F (29°C) were associated with 2.78 times higher odds of SIDS (OR, 2.78; 95% CI, 1.64-4.70) and that this relationship increased proportionally with higher temperatures.[56] A potential explanatory mechanism is that heat stress interactions with brainstem abnormalities overwhelm the autonomic nervous system, leading to SIDS.[56] One study noted that cold temperatures were strongly correlated with an increase in SIDS.[66] However, Auger et al hypothesize that an increase in SIDS is more likely to result from high room temperatures and over swaddling, rather than cold outdoor temperatures.[56] Auger et al recommend that monitoring high ambient temperatures in infant bedrooms be included in the safe sleep recommendations of the American Academy of Pediatrics.[56]

IMPLICATIONS FOR PRACTICE

Midwives and other health care providers are critical in modifying patient response to elevated heat and can advise on reducing and mediating heat risks to pregnant individuals and neonates. Health care providers who care for pregnant people and infants should be aware of heat risks and recommend protective actions during high heat (See Table 1).[40,62,67] In their practice, perinatal care providers can optimize ventilation in clinics and labor suites, monitor hydration, and make cold, potable water available.[5] The WHO and WMO recommend that electric fans (such as ceiling fans) not be used when dry-bulb temperatures exceed 95°F (35°C), as circulating hot air can worsen heat stress.[9] Above 95°F (35°C), electric fans should be turned off and air conditioning should be used, if

available.[9] Fan use may worsen heat stress more in exceptionally hot and arid regions, such as the Middle East or southwest United States, and in hot and humid regions, such as northern India and parts of Pakistan.[68] No research on conditions when fan use may be detrimental specifically for pregnancy or labor was identified, and future research should examine precise thresholds. In conditions in which space cooling is not possible, moving labor and neonatal intensive care units to lower floors and away from roofs can help reduce ambient indoor temperatures.[5,43] In settings where air conditioning is not accessible, efforts to cool the laboring patient, such as keeping them well-hydrated, applying wet cloths to the skin, and hand fanning, may help mitigate hyperthermia, but more research is needed to define conditions when these interventions are effective or when more substantial interventions may be needed. In home birth settings without air conditioning, laboring individuals should be monitored for signs of hyperthermia and transferred to a facility with air conditioning if heat-related risks or symptoms are identified.

Patients should be counseled on the links between high heat, dehydration, and health risks, especially to themselves and their infants. Access to adequate hydration during hot days can mitigate risks. Clinician advocacy for safer working conditions could advance protections and improve outcomes for heat-exposed pregnant workers.

Given the variability of extreme heat definitions in both the literature and from official weather and health services, it can be difficult for clinicians to know when heat may be dangerous and how to advise patients. When local, critical WBGT are met or exceeded, all persons, and especially those who are pregnant, should be advised to immediately cool off. Clinicians' ability to authorize days off work may vary by location, but when WBGTs exceed local thresholds for health impacts, it is advisable to recommend that pregnant patients avoid overexertion during peak heat hours.

Policy maker, public health, and health care provider interventions that increase access to health care and prenatal care are needed to support resilience to heat.[69] Interventions that improve the thermal comfort of homes, workplaces, and communities would benefit the health of pregnant people and infants. These interventions can include increased access to cool, potable water, passive cooling (eg, shade, green and blue spaces, cool roofs, thermally and energy efficient buildings), active cooling (eg, air conditioning), public health interventions, including better indicators of when heat impacts health, and early warning systems. Heat-health early warning systems and medical alerts for pregnant people and infants during heat waves are theorized to decrease heat-related disease burdens.[28,56,67] Integrating interventions with global and local public health strategies, local stakeholder interventions, and the insurance industry could increase the longevity and efficacy of interventions.[69] Table 2 provides additional resources for providers.

Table 2. Resources for Providers

Resources
The Climate Resilience for Frontline Clinics Toolkit (https://www.americares.org/what-we-do/community-health/climate-resilient-health-clinics/)
Global Heat Health Information Network (ghhin.org)
National Integrated Heat Health Information System (heat.gov)
American Red Cross (redcross.org)
World Health Organization (who.int)
The Climate Psychiatry Alliance (climatepsychiatry.org)
Local heat exposure guidance (eg Understanding Heat Exposure in Miami-Dade County: https://storymaps.arcgis.com/stories/6f1e91cf8a8e4d5d9bd67525575c042e)
Local Health Department guidance on heat (eg Extreme heat information for clinicians, Victoria Department of Health: https://www.health.vic.gov.au/environmental-health/extreme-heat-information-for-clinicians)
Pharmaceutical and drug reference guides

CONCLUSION

Heat exposure is associated with increased risk of maternal and neonatal mortality and morbidity through numerous obstetric and neonatal complications. A lack of globally consistent definitions and criteria for heat exposure limits researcher and practitioner ability to provide guidance on which heat conditions are dangerous for pregnant individuals and neonates. This review examines heat-related health impacts in pregnant people and neonates and recommends actions that practitioners and patients can take to improve health outcomes and patient care in conditions of heat.

CONFLICT OF INTEREST

The authors have no conflicts of interest to disclose.

REFERENCES

1. Xu C, Kohler TA, Lenton TM, Svenning JC, Scheffer M. Future of the human climate niche. *Proc Natl Acad Sci USA*. 2020;117(21):11350-11355. doi: 10.1073/pnas.1910114117
2. National Oceanic and Atmospheric Administration, National Weather Service. Accessed March 14, 2023. Weather Related Fatality and Injury Statistics. https://www.weather.gov/hazstat/
3. Global climate in 2015-2019: climate change accelerates. World Meteorological Organization. Published September 19, 2019. Accessed March 14, 2023. https://public.wmo.int/en/media/press-release/global-climate-2015-2019-climate-change-accelerates
4. Sun S, Spangler KR, Weinberger KR, Yanosky JD, Braun JM, Wellenius GA. Ambient temperature and markers of fetal growth: a retrospective observational study of 29 million U.S. singleton births. *Environ Health Perspect*. 127(6):067005. doi: 10.1289/EHP4648
5. 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. doi: 10.1136/bmj.m3811
6. Schifano P, Lallo A, Asta F, De Sario M, Davoli M, Michelozzi P. Effect of ambient temperature and air pollutants on the risk of preterm birth, Rome 2001-2010. *Environ Int*. 2013;61:77-87. doi: 10.1016/j.envint.2013.09.005
7. Bernstein AS, Sun S, Weinberger KR, Spangler KR, Sheffield PE, Wellenius GA. Warm season and emergency department visits to U.S. children's hospitals. *Environ Health Perspect*. 130(1):017001. doi: 10.1289/EHP8083

8. Thompson R, Hornigold R, Page L, Waite T. Associations between high ambient temperatures and heat waves with mental health outcomes: a systematic review. *Public Health*. 2018;161:171-191. doi: 10.1016/j.puhe.2018.06.008
9. McGregor GR, Bessemoulin P, Ebi KL, Menne B, eds. *Heatwaves and Health: Guidance on Warning-System Development*. World Meteorological Organization; World Health Organization; 2015. Accessed March 14, 2023. https://library.wmo.int/doc_num.php?explnum_id=3371
10. Wang J, Tong S, Williams G, Pan X. Exposure to heat wave during pregnancy and adverse birth outcomes: an exploration of susceptible windows. *Epidemiol Camb Mass*. 2019;30(Suppl 1)S115-S121. doi: 10.1097/EDE.0000000000000995
11. Wang Q, Li B, Benmarhnia T, et al. Independent and combined effects of heatwaves and $PM_{2.5}$ on preterm birth in Guangzhou, China: a survival analysis. *Environ Health Perspect*. 128(1):017006. doi: 10.1289/EHP5117
12. Ebi KL, Teisberg TJ, Kalkstein LS, Robinson L, Weiher RF. Heat watch/warning systems save lives: estimated costs and benefits for Philadelphia 1995-98. *Bull Am Meteorol Soc*. 2004;85(8):1067-1074. doi: 10.1175/BAMS-85-8-1067
13. Strand LB, Barnett AG, Tong S. The influence of season and ambient temperature on birth outcomes: a review of the epidemiological literature. *Environ Res*. 2011;111(3):451-462. doi: 10.1016/j.envres.2011.01.023
14. National Oceanic and Atmospheric Administration, National Integrated Heat Health Information System, Office of Climate Change and Health Equity. *Climate and Health Outlook: Extreme Heat*. Office of Climate Change and Health Equity; 2022. https://www.hhs.gov/sites/default/files/climate-health-outlook-may-2022.pdf
15. Kim J, Lee A, Rossin-Slater M. What to expect when it gets hotter: the impacts of prenatal exposure to extreme temperature on maternal health. *Am J Health Econ*. 2021;7(3):281-305. doi: 10.1086/714359
16. Hsu A, Sheriff G, Chakraborty T, Manya D. Disproportionate exposure to urban heat island intensity across major US cities. *Nat Commun*. 2021;12(1):2721. doi: 10.1038/s41467-021-22799-5
17. Gronlund CJ, Yang AJ, Conlon KC, et al. Time series analysis of total and direct associations between high temperatures and preterm births in Detroit, Michigan. *BMJ Open*. 2020;10(2):e032476. doi: 10.1136/bmjopen-2019-032476
18. Rammah A, Whitworth KW, Han I, Chan W, Hess JW, Symanski E. Temperature, placental abruption and stillbirth. *Environ Int*. 2019;131:105067. doi: 10.1016/j.envint.2019.105067
19. Samuels L, Nakstad B, Roos N, et al. Physiological mechanisms of the impact of heat during pregnancy and the clinical implications: review of the evidence from an expert group meeting. *Int J Biometeorol*. 2022;66(8):1505-1513. doi: 10.1007/s00484-022-02301-6
20. He S, Kosatsky T, Smargiassi A, Bilodeau-Bertrand M, Auger N. Heat and pregnancy-related emergencies: risk of placental abruption during hot weather. *Environ Int*. 2018;111:295-300. doi: 10.1016/j.envint.2017.11.004
21. Auger N, Fraser WD, Arbour L, Bilodeau-Bertrand M, Kosatsky T. Elevated ambient temperatures and risk of neural tube defects. *Occup Environ Med*. 2017;74(5):315-320. doi: 10.1136/oemed-2016-103956
22. Qu Y, Zhang W, Ryan I, et al. Ambient extreme heat exposure in summer and transitional months and emergency department visits and hospital admissions due to pregnancy complications. *Sci Total Environ*. 2021;777:146134. doi: 10.1016/j.scitotenv.2021.146134
23. Preston EV, Eberle C, Brown FM, James-Todd T. Climate factors and gestational diabetes mellitus risk - a systematic review. *Environ Health*. 2020;19(1):112. doi: 10.1186/s12940-020-00668-w
24. Ha S, Nguyen K, Liu D, et al. Ambient temperature and risk of cardiovascular events at labor and delivery: a case-crossover study. *Environ Res*. 2017;159:622-628. doi: 10.1016/j.envres.2017.09.010
25. Weng YH, Yang CY, Chiu YW. Adverse neonatal outcomes in relation to ambient temperatures at birth: a nationwide survey in Taiwan. *Arch Environ Occup Health*. 2018;73(1):48-55. doi: 10.1080/19338244.2017.1299084
26. Zhang Y, Yu C, Wang L. Temperature exposure during pregnancy and birth outcomes: an updated systematic review of epidemiological evidence. *Environ Pollut*. 2017;225:700-712. doi: 10.1016/j.envpol.2017.02.066
27. McElroy S, Ilango S, Dimitrova A, Gershunov A, Benmarhnia T. Extreme heat, preterm birth, and stillbirth: a global analysis across 14 lower-middle income countries. *Environ Int*. 2022;158:106902. doi: 10.1016/j.envint.2021.106902
28. Ilango SD, Weaver M, Sheridan P, et al. Extreme heat episodes and risk of preterm birth in California, 2005-2013. *Environ Int*. 2020;137:105541. doi: 10.1016/j.envint.2020.105541
29. Poursafa P, Keikha M, Kelishadi R. Systematic review on adverse birth outcomes of climate change. *J Res Med Sci*. 2015;20(4):397-402.
30. Son JY, Lee JT, Lane KJ, Bell ML. Impacts of high temperature on adverse birth outcomes in Seoul, Korea: disparities by individual- and community-level characteristics. *Environ Res*. 2019;168:460-466. doi: 10.1016/j.envres.2018.10.032
31. Zheng X, Zhang W, Lu C, Norbäck D, Deng Q. An epidemiological assessment of the effect of ambient temperature on the incidence of preterm births: identifying windows of susceptibility during pregnancy. *J Therm Biol*. 2018;74:201-207. doi: 10.1016/j.jtherbio.2018.04.001
32. Kwag Y, Kim MH, Oh J, Shah S, Ye S, Ha EH. Effect of heat waves and fine particulate matter on preterm births in Korea from 2010 to 2016. *Environ Int*. 2021;147:106239. doi: 10.1016/j.envint.2020.106239
33. Zhou G, Yang M, Chai J, et al. Preconception ambient temperature and preterm birth: a time-series study in rural Henan, China. *Environ Sci Pollut Res Int*. 2021;28(8):9407-9416. doi: 10.1007/s11356-020-11457-w
34. Huang M, Strickland MJ, Richards M, et al. Acute associations between heatwaves and preterm and early-term birth in 50 US metropolitan areas: a matched case-control study. *Environ Health*. 2021;20(1):47. doi: 10.1186/s12940-021-00733-y
35. Sun X, Luo X, Cao G, et al. Associations of ambient temperature exposure during pregnancy with the risk of miscarriage and the modification effects of greenness in Guangdong, China. *Sci Total Environ*. 2020;702:134988. doi: 10.1016/j.scitotenv.2019.134988
36. Zhao S, Xu J, Li W, et al. High-temperature exposure and risk of spontaneous abortion during early pregnancy: a case-control study in Nanjing, China. *Environ Sci Pollut Res Int*. 2023;30(11):29807-29813. doi: 10.1007/s11356-022-24315-8
37. Asamoah B, Kjellstrom T, Östergren PO. Is ambient heat exposure levels associated with miscarriage or stillbirths in hot regions? A cross-sectional study using survey data from the Ghana Maternal Health Survey 2007. *Int J Biometeorol*. 2018;62(3):319-330. doi: 10.1007/s00484-017-1402-5
38. Li S, Chen G, Jaakkola JJK, Williams G, Guo Y. Temporal change in the impacts of ambient temperature on preterm birth and stillbirth: Brisbane, 1994-2013. *Sci Total Environ*. 2018;634:579-585. doi: 10.1016/j.scitotenv.2018.03.385
39. Kanner J, Williams AD, Nobles C, et al. Ambient temperature and stillbirth: risks associated with chronic extreme temperature and acute temperature change. *Environ Res*. 2020;189:109958. doi: 10.1016/j.envres.2020.109958
40. Richards M, Huang M, Strickland MJ, et al. Acute association between heatwaves and stillbirth in six US states. *Environ Health*. 2022;21(1):59. doi: 10.1186/s12940-022-00870-y
41. Lin Y, Hu W, Xu J, et al. Association between temperature and maternal stress during pregnancy. *Environ Res*. 2017;158:421-430. doi: 10.1016/j.envres.2017.06.034
42. Cil G, Cameron TA. Potential climate change health risks from increases in heat waves: abnormal birth outcomes and adverse maternal health conditions. *Risk Anal*. 2017;37(11):2066-2079. doi: 10.1111/risa.12767

43. Kakkad K, Barzaga ML, Wallenstein S, Azhar GS, Sheffield PE. Neonates in Ahmedabad, India, during the 2010 heat wave: a climate change adaptation study. *J Environ Public Health*. 2014;2014:946875. doi: 10.1155/2014/946875
44. Molina O, Saldarriaga V. The perils of climate change: in utero exposure to temperature variability and birth outcomes in the Andean region. *Econ Hum Biol*. 2017;24:111-124. doi: 10.1016/j.ehb.2016.11.009
45. Kalisch-Smith JI, Ved N, Sparrow DB. Environmental Risk Factors for Congenital Heart Disease. *Cold Spring Harb Perspect Biol*. 2020;12(3):a037234. doi: 10.1101/cshperspect.a037234
46. Agay-Shay K, Friger M, Linn S, Peled A, Amitai Y, Peretz C. Ambient temperature and congenital heart defects. *Hum Reprod*. 2013;28(8):2289-2297. doi: 10.1093/humrep/det244
47. Stingone JA, Luben TJ, Sheridan SC, et al. Associations between fine particulate matter, extreme heat events, and congenital heart defects. *Environ Epidemiol*. 2019;3(6):e071. doi: 10.1097/EE9.0000000000000071
48. Levy K, Woster AP, Goldstein RS, Carlton EJ. Untangling the impacts of climate change on waterborne diseases: a systematic review of relationships between diarrheal diseases and temperature, rainfall, flooding, and drought. *Environ Sci Technol*. 2016;50(10):4905-4922. doi: 10.1021/acs.est.5b06186
49. Carlton EJ, Woster AP, DeWitt P, Goldstein RS, Levy K. A systematic review and meta-analysis of ambient temperature and diarrhoeal diseases. *Int J Epidemiol*. 2016;45(1):117-130. doi: 10.1093/ije/dyv296
50. Newman KL, Gustafson K, Englund JA, et al. Effect of diarrheal illness during pregnancy on adverse birth outcomes in Nepal. *Open Forum Infect Dis*. 2019;6(2):ofz011. doi: 10.1093/ofid/ofz011
51. Githeko AK, Lindsay SW, Confalonieri UE, Patz JA. Climate change and vector-borne diseases: a regional analysis. *Bull World Health Organ*. 2000;78(9):1136-1147.
52. Fouque F, Reeder JC. Impact of past and on-going changes on climate and weather on vector-borne diseases transmission: a look at the evidence. *Infect Dis Poverty*. 2019;8(1):51. doi: 10.1186/s40249-019-0565-1
53. Loevinsohn ME. Climatic warming and increased malaria incidence in Rwanda. *Lancet*. 1994;343(8899):714-718. doi: 10.1016/s0140-6736(94)91586-5
54. Paixão ES, Teixeira MG, Costa MDCN, Rodrigues LC. Dengue during pregnancy and adverse fetal outcomes: a systematic review and meta-analysis. *Lancet Infect Dis*. 2016;16(7):857-865. doi: 10.1016/S1473-3099(16)00088-8
55. Thompson JM, Eick SM, Dailey C, et al. Relationship between pregnancy-associated malaria and adverse pregnancy outcomes: a systematic review and meta-analysis. *J Trop Pediatr*. 2020;66(3):327-338. doi: 10.1093/tropej/fmz068
56. Auger N, Fraser WD, Smargiassi A, Kosatsky T. Ambient Heat and Sudden Infant Death: A Case-Crossover Study Spanning 30 Years in Montreal, Canada. *Environ Health Perspect*. 2015;123(7):712-716. doi: 10.1289/ehp.1307960
57. Basagaña X, Sartini C, Barrera-Gómez J, et al. Heat waves and cause-specific mortality at all ages. *Epidemiology*. 2011;22(6):765-772. doi: 10.1097/EDE.0b013e31823031c5
58. Xiong T, Chen P, Mu Y, et al. Association between ambient temperature and hypertensive disorders in pregnancy in China. *Nat Commun*. 2020;11(1):2925. doi: 10.1038/s41467-020-16775-8
59. Shashar S, Kloog I, Erez O, et al. Temperature and preeclampsia: Epidemiological evidence that perturbation in maternal heat homeostasis affects pregnancy outcome. *PLoS One*. 2020;15(5):e0232877. doi: 10.1371/journal.pone.0232877
60. Beltran AJ, Wu J, Laurent O. Associations of meteorology with adverse pregnancy outcomes: a systematic review of preeclampsia, preterm birth and birth weight. *Int J Environ Res Public Health*. 2013;11(1):91-172. doi: 10.3390/ijerph110100091
61. Ha S, Liu D, Zhu Y, Kim SS, Sherman S, Mendola P. Ambient temperature and early delivery of singleton pregnancies. *Environ Health Perspect*. 2017;125(3):453-459. doi: 10.1289/EHP97
62. Poursafa P, Kelishadi R. What health professionals should know about the health effects of air pollution and climate change on children and pregnant mothers. *Iran J Nurs Midwifery Res*. 2011;16(3):257-264.
63. Kloog I, Novack L, Erez O, Just AC, Raz R. Associations between ambient air temperature, low birth weight and small for gestational age in term neonates in southern Israel. *Environ Health*. 2018;17(1):76. doi: 10.1186/s12940-018-0420-z
64. Zhang W, Spero TL, Nolte CG, et al. projected changes in maternal heat exposure during early pregnancy and the associated congenital heart defect burden in the United States. *J Am Heart Assoc*. 2019;8(3):e010995. doi: 10.1161/JAHA.118.010995
65. Pouliot SH, Xiong X, Harville E, et al. Maternal dengue and pregnancy outcomes: a systematic review. *Obstet Gynecol Surv*. 2010;65(2):107-118. doi: 10.1097/OGX.0b013e3181cb8fbc
66. Ponsonby AL, Jones ME, Lumley J, Dwyer T, Gilbert N. Climatic temperature and variation in the incidence of sudden infant death syndrome between the Australian states. *Med J Aust*. 1992;156(4):246-248, 251. doi: 10.5694/j.1326-5377.1992.tb139744.x
67. Xu Z, Liu Y, Ma Z, Sam Toloo G, Hu W, Tong S. Assessment of the temperature effect on childhood diarrhea using satellite imagery. *Sci Rep*. 2014;4(1):5389. doi: 10.1038/srep05389
68. Morris NB, Chaseling GK, English T, et al. Electric fan use for cooling during hot weather: a biophysical modelling study. *Lancet Planet Health*. 2021;5(6):e368-e377. doi: 10.1016/S2542-5196(21)00136-4
69. Sheffield PE, Landrigan PJ. Global climate change and children's health: threats and strategies for prevention. *Environ Health Perspect*. 2011;119(3):291-298. doi: 10.1289/ehp.1002233
70. Extreme heat - information for clinicians. Victoria State Department of Health website. Accessed March 14, 2023. https://www.health.vic.gov.au/environmental-health/extreme-heat-information-for-clinicians
71. Cuddy MLS. The effects of drugs on thermoregulation. *AACN Clin Issues*. 2004;15(2):238-253. doi: 10.1097/00044067-200404000-00010
72. Cheshire WP, Fealey RD. Drug-induced hyperhidrosis and hypohidrosis: incidence, prevention and management. *Drug Saf*. 2008;31(2):109-126. doi: 10.2165/00002018-200831020-00002
73. Bouchama A, Dehbi M, Mohamed G, Matthies F, Shoukri M, Menne B. Prognostic factors in heat wave related deaths: a meta-analysis. *Arch Intern Med*. 2007;167(20):2170-2176. doi: 10.1001/archinte.167.20.ira70009


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Maternal Adaptive Capacity: A Strengths-Based Theory to Guide Maternal Health Research

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The United States is experiencing a rise in maternal morbidity and mortality that disproportionately affects marginalized groups. Maternal health research is often designed through a lens of deficit, which perpetuates bias and negatively affects care. The purpose of this article is to describe the development of the theory of maternal adaptive capacity, a strengths-based approach to maternal health research that has the potential to promote new discovery in research, reduce biases, empower individuals and improve health outcomes. Walker and Avant's approach to theory derivation is applied to the framework of vulnerability to climate change, a theory commonly used in environmental research. In this derivation the authors explore the parallels between the concept of adaptive capacity related to climate change and maternal health. The new theory of maternal adaptive capacity should be applied and tested in various research modalities to confirm its utility.
J Midwifery Womens Health 2023;68:376–382

INTRODUCTION

The United States is experiencing a crisis in maternal morbidity and mortality. Despite significant research investment, sharp advances in perinatal health care, and improved neonatal morbidity and mortality, maternal morbidity and mortality rates have increased over the past 3 decades.[1,2] Although the United States spends more on health care than any other nation in the world, it also has the worst maternal morbidity and mortality rates of all developed nations.[2,3] In contrast, global maternal morbidity and mortality rates have simultaneously declined.[4] In conjunction with existent and overarching systemic biases, the United States' deficiencies in maternal morbidity and mortality are borne disproportionately by individuals of color, their families, and their communities.[5,6]

Researchers have recognized these crises and are devoting more time and resources to studying maternal morbidity and mortality and maternal health disparities. However, much of this research can be classified as problem-focused. When research is designed with an emphasis on the problems in individuals and not balanced with strengths or context, research findings can be biased toward negativity about the population of study. This negativity contributes to a phenomenon called deficit discourse, a prevailing written and spoken communication about a person or group that emphasizes deficiencies or failures.[7,8] Research involving maternal morbidity and mortality—especially in historically marginalized groups—often begins with hypotheses that problematize the individual and their life circumstances.[9] Problem-focused research designs yield problem-focused research results, which are then widely disseminated. As a result of this approach, deficits become the defining narrative about the population of study. A problem-focused research trajectory inadvertently situates blame with the individual, ignoring context and the systemic challenges humans face. This narrative even permeates into academic and clinical settings and becomes accepted as fact because it originates from research. Soon, poor health in individuals from historically marginalized groups becomes an expected, even justified outcome, further biasing provided health care.

With the prevailing design of problem-focused research, maternal health studies rarely address how individuals can become or stay well. Moreover, limited (if any) studies consider positive outcomes in at-risk individuals or how they might already remain well in their daily lives due to inherent positive traits or other protective assets such as informal support structures. Consequently, rather than continuing a myopic focus on risk, researchers should focus on how individuals vulnerable to maternal health risks remain well. Once these factors have been identified, findings can be leveraged to improve perinatal health outcomes for all populations.

This article describes the development of the theory of maternal adaptive capacity, a theory derived after discovering overlapping ideas and concepts between the challenges individuals face during the pregnancy continuum and the challenges the Earth is facing related to climate change. Although there has been much more significant discussion of these concepts as they relate to climate change rather than to human

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 1526-9523/09/$36.00 doi:10.1111/jmwh.13485

Quick Points

- When research is designed with an emphasis on the problems in individuals and not balanced with strengths or context, research findings can be biased toward negativity about the population of study.
- Due to increasing maternal morbidity and mortality and maternal health disparities, it is imperative that perinatal health research focus on the strengths and protective assets of individuals and groups.
- This article discusses the development of the theory of maternal adaptive capacity, a strengths-focused research framework derived from a framework of vulnerability to climate change used in environmental research.
- Maternal adaptive capacity focuses on the protective assets and strengths of individuals and how they can remain well despite risk.
- Designing maternal health research using the theory of maternal adaptive capacity holds powerful promise for innovative discovery and overcoming biases in research and clinical settings.

health, the hidden positive of this imbalance is that many of those climate change–related findings are rife with opportunities for innovative application to the study of maternal health.

This theory derivation explores adaptive capacity, a concept and theoretical framework in climate change theory widely employed in environmental research of all kinds, applied to maternal populations. The authors recognize that not all childbearing individuals identify as women. For clarity, terms such as *maternal health* are used because they refer to the health of the childbearing individual, in distinction from perinatal health, which could refer to the childbearing individual or the fetus or newborn. The theory of maternal adaptive capacity is intended to apply to childbearing individuals of all genders. As expanded upon below, maternal adaptive capacity emphasizes strengths and protective assets instead of deficiencies and promotes innovative discovery in maternal health research. This new approach will therefore yield different results that can significantly improve the health of maternal populations.

The purpose of this theory derivation is to address maternal health through a strength-based lens to stimulate research and interventions that better serve individuals, most especially from historically marginalized groups. Using Walker and Avant's theory derivation process,[10] we apply maternal health research within the organizing framework of adaptive capacity as has been used in climate change research.

THEORY DEVELOPMENT

The theory of maternal adaptive capacity was developed using theory derivation, a structured process outlined by Walker and Avant[10] whereby a parent theory, typically originating in an unrelated field, is used to guide the development of a new theory. Theory derivation is particularly useful when no data are available or when new insights about a phenomenon are needed to inspire research and testing.[10]

The 5-step theory derivation process commences with the first step, which is to read widely on the topic at hand.[10] After several years of reading on perinatal, sexual, and reproductive health research, our focus turned toward approaches to strengths-based research methods in vulnerable populations.[9] Maternal health theories were explored for the topic at hand, and no existing theory seemed suitable for the specific phenomena.

Step 2 of the process includes using a creative and imaginative process and looking for analogies in other fields.[10] After reading widely in other disciplines and conducting literature searches on terms related to strengths in overcoming risk, such as vulnerability, susceptibility, resilience, and adaptability, theories related to adaptive capacity in climate change appeared to be the most applicable. Thus, adaptive capacity became the guiding concept and theoretical framework for derivation.

The third step, choosing the parent theory, was satisfied by using the framework of adaptive capacity to study maternal health in much the same way it had been used in climate change research. This article outlines steps 4 and 5—a review of the concepts and structures inherent to the parent theory and the development of new statements, definitions, and concepts pertinent to the study area.

Review of Parent Theory

Adaptive capacity was initially formulated from the concept of adaptation within vulnerability and resilience research relating to climate change.[11] Adaptive capacity now stands alone as a theory modeled in over 100 variations.[12] Within the context of climate change, scientists often model adaptive capacity using a major impact event, such as a natural disaster. This enables the exploration of how living systems may overcome and adapt to such risks and circumstances. For example, one scientist may study the adaptive capacity of birds, whereas another may research the adaptive capacity of trees relating to weather variations from climate change.

Whatever the incident or system of study, adaptive capacity embodies "a vector of resources and assets that represents the asset base from which adaptation actions and investments can be made."[13(p400)] Adaptive capacity may be apparent before exposure to a negative occurrence, or it may only be realized once the subject is exposed.[13]

The large existent body of research on vulnerability and adaptation to climate change often does not include the same terminologies or definitions. For example, words such as *coping range*, *adaptive capacity*, and *resilience* may be used interchangeably.[14] We base our theory derivation on

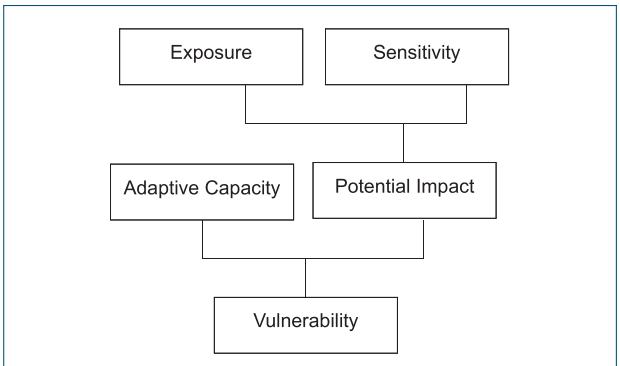

Figure 1. Framework of Vulnerability to Climate Change as Outlined by Schoter and the Intergovernmental Panel on Climate Change

Source: Schoter,[15] Parry et al.[11]

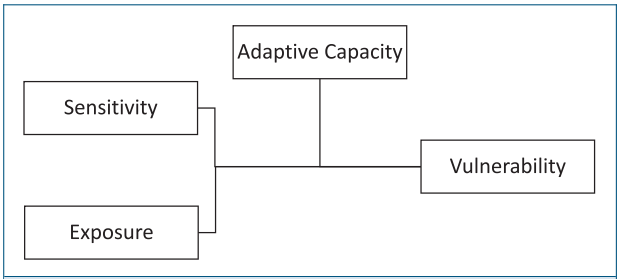

Figure 2. Simplified Framework of Vulnerability to Climate Change with Potential Impact Removed

a framework of vulnerability to climate change as outlined by Schoter[15] and further by the Intergovernmental Panel on Climate Change (IPCC)[11] (Figure 1). This parent model was chosen because it embodies clear concepts and straightforward modeling of adaptive capacity regarding climate change vulnerability.[11] Like our focus, this specific model has been updated and modified through several iterations to focus less on potential impact and vulnerability and more on adaptive capacity. To simplify and add clarity to modeling, we remove potential impact as we build our framework (Figure 2).

Although adaptive capacity has been applied to individual coping mechanisms and preventive health measures to natural disaster, illness, and pandemic, to our knowledge, it has not been used as a framework to discover unidentified factors contributing to overcoming risk in maternal health.[16,17] Nevertheless, adaptive capacity is a flexible theory that is well suited to this area of research. It applies to broad and specific areas on similarly diverse scales (it may be scaled to the individual, the community, or even the globe). The central questions in adaptive capacity are what (or who) is adapting, to what are they adapting, why are they adapting, and from where does the capacity to adapt originate?[18]

This derivation aims to shift the emphasis away from vulnerability to poor outcomes as a decided fate of at-risk maternal individuals and toward adaptive capacity. Instead of premising their inquiries on a mission to identify deficiencies, researchers can use our framework to identify what individuals do right: What are the research participants' strengths? How can identified protective assets be fostered and leveraged to improve health? How can our society empower individuals and communities to reduce their vulnerability and improve their health through adaptive capacity?

When guided by the theory of maternal adaptive capacity, the focus is on strengthening the individual's health and reducing risk through preexisting adaptive capacities or through intervention to bolster adaptive capacity. This presents an opportunity for discovering factors that may make individuals and communities more resilient to risk while furthering how individuals can use already understood factors that facilitate health.

Concepts

Although climate change–related adaptive capacity is modeled in several ways, the focus of these authors' derivation of the theory of maternal adaptive capacity involves major concepts modeled in the framework of vulnerability to climate change, including (1) vulnerability, (2) sensitivity, (3) exposure, and (4) adaptive capacity.[11,15] These concepts are often represented with a focus on vulnerability; however, the theory of maternal adaptive capacity instead emphasizes adaptive capacity as the focus of research, which may help identify solutions to overcoming maternal health risks. Below, we define each of these concepts as related to climate change and then observe their application through a maternal research lens.

Vulnerability

The definition of vulnerability in climate change research is "the propensity or predisposition to be adversely affected."[19(p43)] Within climate change literature, this definition often expands in 2 further directions. The first defines vulnerability in terms of outcomes or the potential damage caused to a system by a hazard.[20] The second defines vulnerability as an inherent quality or the state of a pre-hazard system that affects how the system tolerates the impact of the hazard.[21] In the first case, vulnerability depends on risk; in the latter definition, vulnerability exists independent of hazard.

The term *vulnerability* is controversial when applied to humans by health researchers.[22] Although initially *vulnerable* was used to identify research participants who may need protection from exploitation and harms in research, the term has evolved into a method of labeling individuals and groups.[23,24] The label of vulnerable can bring with it a connotation that there is something wrong with the individual, that the individual has less power or ability, or that there is some sort of deficiency. Furthermore, the term *vulnerable* as applied to a person or group often excludes the social and systemic structures that contextually shape the human experience.

Notwithstanding this debate, there is a consensus that there are individuals and groups that are more vulnerable to harm. Factors that may make an individual susceptible to illness or health problems may relate to the individual (physiologic or psychological), societal and systemic variables, the availability of resources, and the relationships among these factors.

Assessing vulnerability was the original pathway to further exploration of adaptive capacity in climate change research. This parallels the state of maternal health research,

which tends to focus on vulnerability, risk, and exposure and is due for a shift in focus toward adaptive capacity. In maternal adaptive capacity, vulnerability is not viewed as a concept inherent to an individual. Instead, vulnerability is viewed in terms of maternal outcomes—the potential harm to the individual. This removes any premise that an individual is inherently vulnerable. Furthermore, the focus turns to the adaptive capacity concept and how this can reduce vulnerability to harm. Within the proposed maternal adaptive capacity framework, the concept vulnerability becomes outcome-focused and is renamed *maternal outcomes* with an emphasis on how adaptive capacity can improve maternal outcomes.

Exposure

For climate researchers, exposure involves the nature and the degree to which a system is exposed to climate change and its impacts.[19] Examples of exposure in the climate change literature include extreme temperature changes, natural disasters, and disease—for example, regular flooding of an area is evidence of its increased exposure to climate change.

When applying this concept to maternal populations, we simply look at the exposure of pregnancy. This exposure includes all the physiologic, psychological, and social aspects that pregnancy entails. This exposure can be increased by recurrent pregnancy, short interval spacing, multiples, or other factors that increase the risks to which persons are exposed by pregnancy.

Sensitivity

Climate sensitivity is the degree to which a system is affected by climate change exposure. This sensitivity might be adverse, such as when changes in precipitation cause drought and reduce crop yields, or it might be beneficial, as when an area previously had an excess of moisture but now has an appropriate level for crop growth.

When applying sensitivity to maternal populations, the researcher considers how an individual is affected by pregnancy. Considering at-risk pregnant individuals, this includes an increased sensitivity to harm resulting from pregnancy (the exposure) due to various underlying risk factors or predispositions for health problems. Increased sensitivity would be demonstrated by an individual with an underlying predisposition for health problems that may be exacerbated by a pregnancy, like diabetes or hypertension. Additional stressors relating to income, relationships, or abuse such as from racism, as well as other variables that may cause physiologic or psychological stress, increase an individual's sensitivity to risk.

Adaptive Capacity

Although this article is primarily concerned with adaptive capacity as a guiding framework, it is worthwhile for our purposes to discuss it as a concept. As defined by Jakku and Lynam,[25] adaptive capacity "comprises the properties of a system that enable it to modify itself in order to maintain or achieve a desired state in the face of perceived or actual stress."[25(p10)] Applied to climate change, this adaptive capacity includes adjustments to, or preparation for, changing circumstances or potential impacts. Depending on the size and type of system, adaptive capacity could be demonstrated through small changes like a bird moving its nest to a different area, or in large human systems take the form of alterations to physical structures (eg, building a dam to control flood waters). Ultimately, adaptive capacity includes specific actions, practices, processes, or policies to mitigate potential harm and to benefit the system.

Perinatal health professionals may define adaptative capacity as those assets used or developed by an individual—whether physiologic, psychological, social, structural, or economic—that modify the individual's adaptation or response to achieve or maintain good health during the pregnancy continuum. These might include individual traits or other protective assets such as community or informal social networks.

Derived Theory

Using Walker and Avant[10] we derived a theory that can describe the process of using strengths or protective assets to overcome risk and improve maternal outcomes. This theory can be applied to discover the protective assets and strengths (adaptive capacity) in populations that are commonly dismissed and considered vulnerable or at risk. *Maternal adaptive capacity* is a fitting name for this theory, as the emphasis moves away from the vulnerability, sensitivity, and exposure variables that have been the primary focus points in maternal health research. Climate change concepts are appropriately renamed for our framework, as shown in Table 1.

Maternal Adaptive Capacity

The theory of adaptive capacity is intriguing when applied to maternal populations and has parallels to the science of adaptive capacity in climate change. Similar to the baseline climate change vulnerability research approach focusing on exposure and sensitivity, the current paradigm for maternal health research focuses too heavily on the problems and risks of maternal health populations. The current maternal research focus problematizes the exposure (here, pregnancy) and is critical of the individual (presupposing that there is something wrong with the individual—their sensitivity). Furthermore, this research approach becomes a platform to consider ways to "fix" the individual. For example, individuals with higher maternal morbidity and mortality rates in historically marginalized groups are looked at through the lens of sensitivity because current methods require one's asking (often with unspoken or even unrealized moral judgment), what is wrong with these people?

The key focus of maternal adaptive capacity is, where does the capacity to adapt come from, and how is it achieved? Due to the flexibility and broad application of adaptive capacity, it is often regarded as a response to external stressors. However, within the theory of maternal adaptive capacity we focus on the protective assets (eg, traits, habits, support structures) in an individual's life that allow them to achieve health despite external stressors.[26]

Table 1. Concepts in Vulnerability to Climate Change Framework Derived to Concepts in the Theory of Maternal Adaptive Capacity

Concept in Vulnerability to Climate Change	Derived Concept in Maternal Adaptive Capacity	Description of Concept in Maternal Adaptive Capacity
Exposure	Pregnancy	Because this theory relates specifically to maternal health, exposure is the pregnancy. Exposure increases with more pregnancies, short interval spacing, multiples, etc.
Sensitivity	Risk factors	Among maternal risk factors are physiologic, psychological, social, economic, structural, or other attributes that put the individual at a greater risk for poor maternal outcomes.
Vulnerability	Maternal outcomes	Although there are several ways to view vulnerability in health care, in this model, pregnancy risk factors are mitigated by adaptive capacity to affect maternal outcomes; therefore, this concept becomes maternal outcomes. High adaptive capacity may improve maternal outcomes, and low adaptive capacity may make individuals more at risk for harmful effects. As is modeled in our theory, maternal outcomes could be positive or negative, opening the door for innovative research that is not solely focused on negative outcomes.
Adaptive capacity	Adaptive capacity	Adaptive capacity includes the determined and undetermined protective assets, or strengths, that an individual possesses (internal and external) that enable them to mitigate risk and have improved health. These could be physiologic, psychological, or behavioral or involve social or economic factors or resources.

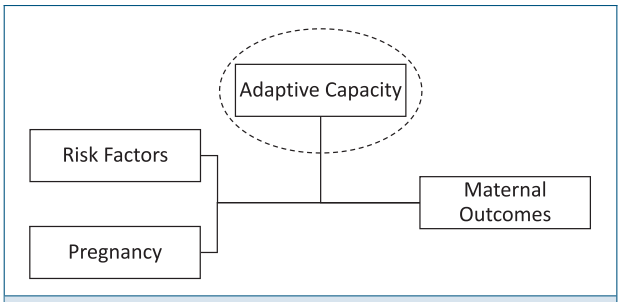

Figure 3. Framework of the Theory of Maternal Adaptive Capacity

In the theory of maternal adaptive capacity, the focus is moved to the adaptive capacity concept by which strengths and protective assets can be identified.

As is commonly cited in literature on adaptive capacity to climate change, adaptive capacity includes the "resources and ability to use resources to implement adaptation strategies."[12(Table 2)] This can mean an individual has preconditions that enable adaptation, and the researcher attempts to discover and mobilize the application of these factors.[27] When applied to maternal adaptive capacity, so-called adaptive capacity preconditions may include social, environmental, physical, and unidentified elements. Researchwise, this creates conditions to discover relevant factors and consider if they may be leveraged into widespread (positive) change. We have modeled the theory of maternal adaptive capacity in Figure 3 and show a description of its applicability in Figure 4.

Assumptions

Walker and Avant[10] do not require that all ideas of the parent theory be included in the derived theory, although the concepts relating to climate change in the vulnerability framework are mostly retained in this derived maternal adaptive capacity theory.[11] For clarity's sake, these concepts were renamed to be more applicable to the derived theory. The theory of maternal adaptive capacity makes the following assumptions:

1. In general, maternal adaptive capacity factors are those attributes of an individual that allow them to prevent, adapt to, or overcome risk, referred to as *protective assets*.
2. Every individual has some degree of adaptive capacity.
3. Poor outcomes do not indicate any deficiency in an individual or their adaptive capacity.
4. Individuals with significant risk factors (sensitivity) who demonstrate positive maternal outcomes are demonstrating an adaptive capacity.
5. Adaptive capacity may be physiologic, psychological, social, economic, structural, or some combination of these. For example, adaptive capacities may be inherent to the individual, such as a personality trait or genetic variation, or they may be external factors that support the individual such as social support.

SUMMARY

Using a theory derivation process, we used as a parent model the framework on vulnerability to climate change to develop the theory of maternal adaptive capacity. The parent framework provided the necessary structure for the derived

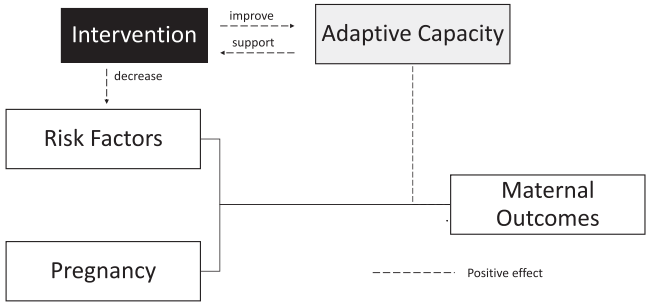

Figure 4. Application of the Theory of Maternal Adaptive Capacity

Research guided by maternal adaptive capacity theory lends itself to discovery of interventions that can decrease risk factors. Greater adaptive capacity may strengthen the efficacy of these interventions. Interventions may be discovered that further strengthen elements of adaptive capacity.

design of a maternal health research approach that focuses on strengths-emphasizing research practices and innovative discovery to overcome actual risk in maternal populations.

To improve maternal health, research should overcome deficit discourse by examining, including, and emphasizing relevant individual and community strengths and protective assets.[9] Identifying strengths does not negate the reality of risk. Instead, it offers a more comprehensive view of the individual, creating a more accurate picture of the studied phenomena. Not only does this kind of strengths-based research challenge deficit discourse, but it also creates space for innovative approaches to discover and implement solutions that improve health and empower individuals.

Designing maternal health research using the theory of maternal adaptive capacity holds powerful promise for future research, practice, and health policy initiatives. There remains a paucity of research on how maternal populations remain well and, especially, on how individuals with significant risk factors for poor maternal outcomes may remain well. This derived theory is a step toward innovative discovery in maternal health with an emphasis on the strengths of individuals, framing research in a manner that can end deficit discourse and its associated ill effects on groups experiencing health disparities.

ACKNOWLEDGMENTS

This theory and research were presented in part at the 46th Annual Research Conference of the Midwest Nursing Research Society in Schaumburg, IL, in March 2022 and at the 17th Annual Clinical Nursing Research Conference of the Cleveland Clinic in Cleveland, OH, in April 2022. The authors would like to acknowledge Tucker Zeleny, PhD, for his assistance with statistical analyses.

CONFLICT OF INTEREST

The authors have no conflicts of interest to disclose.

REFERENCES

1. Hoyert DL. Maternal mortality rates in the United States, 2020. Health E-Stats. National Center for Health Statistics; 2022. https://doi.org/10.15620/cdc:113967
2. Tikkanen R, Gunja MZ, FitzGerald M, Zephyrin L. Maternal mortality and maternity care in the United States compared to 10 other developed countries. Issue brief. The Commonwealth Fund; 2020. https://doi.org/10.26099/411V-9255
3. Tikkanen R, Abrams MK. U.S. health care from a global perspective, 2019: higher spending, worse outcomes? Issue brief. The Commonwealth Fund; 2020. https://doi.org/10.26099/7AVY-FC29
4. Douthard RA, Martin IK, Chapple-McGruder T, Langer A, Chang S. U.S. maternal mortality within a global context: historical trends, current state, and future directions. *J Womens Health (Larchmt)*. 2021;30(2):168-177. https://doi.org/10.1089/jwh.2020.8863
5. Leonard SA, Main EK, Scott KA, Profit J, Carmichael SL. Racial and ethnic disparities in severe maternal morbidity prevalence and trends. *Ann Epidemiol*. 2019;33:30-36. https://doi.org/10.1016/j.annepidem.2019.02.007
6. Miller S, Belizán JM. The true cost of maternal death: individual tragedy impacts family, community and nations. *Reprod Health*. 2015;12(1):56. https://doi.org/10.1186/s12978-015-0046-3
7. Fogarty W, Lovell M, Langenberg J, Heron MJ. *Deficit Discourse and Strengths-Based Approaches: Changing the Narrative of Aboriginal and Torres Strait Islander Health and Wellbeing*. The Lowitja Institute; 2018.
8. Davis LP, Museus SD. What is deficit thinking? An analysis of conceptualizations of deficit thinking and implications for scholarly research. *Currents (Ann Arbor)*. 2019;1(1). https://doi.org/10.3998/currents.17387731.0001.110
9. Mollard E, Hatton-Bowers H, Tippens J. Finding strength in vulnerability: ethical approaches when conducting research with vulnerable populations. *J Midwifery Womens Health*. 2020;65(6):802-807. https://doi.org/10.1111/jmwh.13151
10. Walker LO, Avant KC. Theory derivation. In: *Strategies for Theory Construction in Nursing*. 5th ed. Prentice Hall; 2011:96-104.
11. Parry ML, Canziani OF, Palutikof JP, et al, eds. *Climate Change2007: Impacts, Adaptation and Vulnerability: Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press; 2007.
12. Siders AR. Adaptive capacity to climate change: a synthesis of concepts, methods, and findings in a fragmented field. *Wiley Interdiscip Rev Clim Change*. 2019;10(3):e573. https://doi.org/10.1002/wcc.573
13. Adger WN, Vincent K. Uncertainty in adaptive capacity. *C R Geosci*. 2005;337(4):399-410. https://doi.org/10.1016/j.crte.2004.11.004
14. Smit B, Wandel J. Adaptation, adaptive capacity and vulnerability. *Glob Environ Change*. 2006;16(3):282-292. https://doi.org/10.1016/j.gloenvcha.2006.03.008
15. Schroter D, et al. Vulnerability assessment-analysing the human-environment system in the face of global environmental change. *ESS Bull*. 2004;2(2):11-17.
16. Huppatz E, Lunnay B, Foley K, et al. Adaptive capacity: a qualitative study of midlife Australian women's resilience during COVID-19. *SSM Ment Health*. 2022;2:100080. https://doi.org/10.1016/j.ssmmh.2022.100080

17. Austin EK, Handley T, Kiem AS, Rich JL, Perkins D, Kelly B. Drought, wellbeing and adaptive capacity: why do some people stay well? *Int J Environ Res Public Health*. 2020;17(19):7214. https://doi.org/10.3390/ijerph17197214
18. Smit B, Burton I, Klein RJT, Wandel J. An anatomy of adaptation to climate change and variability. In: Kane SM, Yohe GW, eds. *Societal Adaptation to Climate Variability and Change*. Springer Netherlands; 2000:223-251. https://doi.org/10.1007/978-94-017-3010-5_12
19. Pörtner HO, Roberts DC, Tignor MMB, et al, eds. Summary for policymakers. In: *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press; 2022:3-36.
20. Lim B, Spanger-Siegfried E, Burton I, Malone E, Huq S. *Adaptation Policy Frameworks for Climate Change: Developing Strategies, Policies, and Measures*. Cambridge University Press; 2005.
21. Allen K. Vulnerability reduction and the community-based approach: a Philippines study. In: Pelling M, ed. *Natural Disaster and Development in a Globalizing World*. Routledge; 2003:170-184.
22. ten Have H. Respect for human vulnerability: the emergence of a new principle in bioethics. *J Bioeth Inq*. 2015;12(3):395-408. https://doi.org/10.1007/s11673-015-9641-9
23. Coleman CH. Vulnerability as a regulatory category in human subject research. *J Law Med Ethics*. 2009;37(1):12-18. https://doi.org/10.1111/j.1748-720X.2009.00346.x
24. Schroeder D, Gefenas E. Vulnerability: too vague and too broad? *Camb Q Healthc Ethics*. 2009;18(2):113-121. https://doi.org/10.1017/S0963180109090203
25. Jakku E, Lynam T. *What Is Adaptive Capacity? Report for the South East Queensland Climate Adaptation Research Initiative*. CSIRO Sustainable Ecosystems; 2010.
26. Young KR, Lipton JK. Adaptive governance and climate change in the tropical highlands of western South America. *Clim Change*. 2006;78(1):63-102. https://doi.org/10.1007/s10584-006-9091-9
27. Hill Clarvis M, Engle NL. Adaptive capacity of water governance arrangements: a comparative study of barriers and opportunities in Swiss and US states. *Reg Environ Change*. 2015;15(3):517-527. https://doi.org/10.1007/s10113-013-0547-y

What is a Midwife?

Midwives in the United States provide health care services for individuals across their lifespan. Midwives partner with you to help make important health decisions. Midwives work with other members of the health care team when needed. A midwife may also be your primary care provider. There are 2 main types of midwives. There are some differences in the services offered by each type of midwife.

What types of midwives are there?

- **Certified Nurse-Midwives (CNMs) and Certified Midwives (CMs)** are educated in accredited graduate-level midwifery programs and pass a national certification exam. They must have a license to practice midwifery in the state where they work. CNMs and CMs work in all health care settings including hospitals, birth centers, offices or clinics, and the home. CNMs and CMs provide general pregnancy and reproductive health care and primary care throughout the lifespan. They can prescribe most medications. CNMs and CMs can also care for newborns through the first 30 days of life.
- **Certified professional midwives (CPMs)** may have apprenticeship training or graduate from an accredited education program. CPMs take a national certification exam that is not the same as the one CNMs and CMs take. CPMs provide pregnancy, birth, and postpartum care in community settings—usually in birth centers or homes. CPMs care for newborns. CPMs are not able to prescribe most medications. They do not work in hospitals.

Most midwives in the United States are CNMs. CNMs are licensed in all 50 states. Not all states license CMs and CPMs.

What do midwives do?

Both types of midwives provide care during pregnancy, labor, birth, and postpartum. They also care for newborns. CNMs and CMs care for about 1 of every 10 women who give birth each year in the United States. CNMs and CMs also provide reproductive and primary health care which includes annual physical exams, birth control, menopause care, screening and treatment for sexually transmitted infections, and other health problems. Midwives work with other health care providers.

Why would I choose a midwife for care during my pregnancy?

Midwives view pregnancy and birth as normal life events that can be a healthy time in your life. Midwives are experts in knowing the difference between normal changes that occur and symptoms that require extra attention. Midwives develop special relationships with those who seek midwifery care. They provide care that includes support and education based on the individual's needs.

Midwives use evidence-based medical procedures when there is a specific concern for the health of you or your baby. They work in partnership with other health care providers who can be available if needed. Midwives offer health care that respects the goals and desires of each individual and family. They value sharing information so patients can make informed choices about their health care.

What if I have a high-risk pregnancy or complication during labor?

Your CNM or CM can prescribe medicine, order tests, and provide treatment for common illnesses that may occur during pregnancy. Midwives work with physicians who specialize in complications of pregnancy. If you have a medical problem during pregnancy or complication during labor, your midwife will work with a physician to make sure you get the best and safest care for you and your baby. Midwives do not perform surgery. If you need to have a cesarean birth, the surgery will be done by the physician who works with your midwife. Your midwife will also work with other health care providers: nurses, pediatricians, social workers, nutritionists, doulas, childbirth educators, physical therapists, and other specialists to help you get the care you need.

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What if I want pain medicine during labor?

Your midwife will help you make decisions about how you are going to cope with pain during labor. Midwives can discuss the types of pain you may experience during labor and the different ways that you can manage pain. If you want medicine to cope with your labor pains, your midwife can help you get medicine that is available in the setting where you give birth. Midwives also know other ways to help you cope with labor such as changing positions or being in a tub of water. These can be helpful in addition to pain medications.

Questions to Ask When Choosing a Midwife for Your Care during Pregnancy and Birth

- Can you tell me about yourself? Where did you receive your education? How long have you been a midwife? Where would you care for me during childbirth?
- Do you work with other midwives or physicians? What birth settings do you work in?
- How do you feel about birth?
- If I need medication for pain, how would that be handled?
- If you work in a group, who will attend my birth, and who will be there if you are away?
- How do you recommend that I prepare for childbirth?
- Do you provide labor support and stay with me throughout labor?
- Are you comfortable with doulas or family and friends being with me during labor?
- Do you allow moving around and eating or drinking during labor?
- Can I hold my baby right after birth, breastfeed, and not be separated?
- When do you recommend IVs, fetal heart rate monitoring, Pitocin, or episiotomy?
- Do you care for women who want a vaginal birth after a previous cesarean birth?
- Is your care paid for by my insurance?
- If I want to deliver at home, what equipment do you bring, how do you handle problems during labor, and when would we need to go to the hospital?
- For a home or birth center birth, how often do you transfer to the hospital during labor?
- For a home or birth center birth, what physicians do you work with to provide care if problems occur? Would you stay with me if we need to go to the hospital?
- Are you trained in newborn resuscitation?
- How many times will you visit me at home or see me in the office after my baby is born?

For More Information

Discover Midwives
https://www.discovermidwives.com/what-is-a-midwife/

National Association of Certified Professional Midwives – Who are CPMs?
Who are CPMs? — NACPM
Childbirth Connection: Choosing a Caregiver
Choosing a Maternity Care Provider (childbirthconnection.org)

Childbirth Connection: Resources
Resources (childbirthconnection.org)
Black Birthing Bill of Rights
https://thenaabb.org/black-birthing-bill-of-rights/

Flesch-Kincaid Grade Level: 7.7
Approved April 2023. This handout replaces "What is a Midwife" published in Volume 61, Number 2, March/April 2016.