



Fertility in Fevered Planet, Hidden Costs of Global Warming

The impact of climate change and global warming on human fertility is multifaceted. Its direct pathophysiological effects, such as heat stress and exposure to air pollution, affect men, women, adolescents, and pregnant individuals through different mechanisms and are often associated with impaired or reduced fertility, pregnancy complications, and miscarriage. In addition to the direct pathological effects, global warming has a tremendous impact on the social, economic, and environmental structures, which in turn indirectly influences the processes, goals, and outcomes of human reproduction (1).

Global warming, particularly through extreme heat exposure, profoundly alters physiological and biological pathways involved in human fertility. In females, heat stress disrupts ovarian function, reduces ovarian reserve, and impairs folliculogenesis and oocyte development. This includes chromosomal abnormalities, increased follicular atresia, and apoptosis in granulosa cells. For example, an average of 1°C increase in maximum temperature for 90 days before ovarian reserve testing is associated with a 1.6% reduction in antral follicle count (AFC). At the molecular level, elevated temperatures increase the production of reactive oxygen species (ROS), deplete antioxidant defenses like reduced glutathione (GSH), and trigger ferroptosis, especially in granulosa cells. Hormonal imbalances, such as reduced estradiol levels, further compromise reproductive function. In males, high ambient temperatures interfere with testicular thermoregulation, reducing sperm concentration and motility due to germ cell apoptosis and DNA damage during spermatogenesis. In a study published in the *Journal of Demography*, researchers found that days with average temperatures above 80°F (equal to 27°C) were associated with a large decline in birth rates eight to ten months later. This phenomenon is not caused by reduced sexual activity in high temperatures; it may even increase, but the effect is driven by the detrimental effect of heat on spermatogenesis and sperm functions. A 1°C increase in hot night excess (HNE) leads to a decline in both progressive and total sperm motility. The impact of heat excess was greatest on men who already had impaired sperm parameters, such as those with oligoasthenoteratozoospermia (OAT). Beyond individual reproductive systems, heat exposure is associated with poor pregnancy outcomes, including increased risks of miscarriage, stillbirth, preterm birth, low birth weight, and congenital anomalies like neural tube and heart defects (1-3).

Climate change indirectly affects reproductive health through multiple interconnected pathways. Air pollution and chemical contaminants, including fine particulate matter (PM_{2.5}), nitrogen dioxide (NO₂), and pollutants from wildfire smoke such as polycyclic aromatic hydrocarbons (PAHs), are associated with reduced fertility in both genders, reduced IVF success rates, and increased risks of adverse pregnancy outcomes, such as preterm birth. These pollutants can also cause oxidative stress, DNA damage, chromosomal abnormality, and epigenetic alterations that potentially affect future generations. Climate change has a wide range of impacts on the socioeconomic and behavioral dimensions of communities, including reproductive outcomes. For example, climate-induced disruptions in agricultural production and income stability, particularly in low- and middle-income countries, can alter reproductive behaviors in these communities, increasing contraceptive use and preventing childbearing. In addition, rising global temperatures and the spread of climate-sensitive vector-borne diseases (*e.g.*, dengue fever, malaria, Zika) significantly increase the risks during pregnancy, including stillbirth, low birth weight, and congenital anomalies. These impacts are disproportionately borne by vulnerable populations, particularly women, pregnant individuals, and those with lower socioeconomic status, due to their physiological susceptibility and unequal exposure to climate change as well as other environmental and social stressors (2, 4).

Effective mitigation of further climate change and adaptation to unavoidable heat waves require integrated global policies, infrastructure transformation, and targeted public health strategies, particularly to protect vulnerable populations. Root cause analysis (RCA) focuses on limiting global warming to 1.5°C through sharp reductions in greenhouse gas emissions, large-scale replacement of fossil fuels with renewable green energy, and land-use changes including afforestation, sustainable agricultural practices, and decarbonization of transport through a shift to cleaner energy sources such as electricity, hydrogen, and biofuels (1, 2).

Adaptation strategies aim to reduce vulnerability and encompass policy and governance measures, such as location-specific heat action plans (HAPs), early warning systems, emergency funding, legal recognition of heat waves as disasters, and adaptive social protections. Urban and infrastructure adaptations focus on

minimizing urban heat islands through the development of green spaces, cool roofs, improved building design with passive ventilation and filtration, resilient water and electricity systems, and managed displacement in extreme cases. Health system preparedness requires strengthening access to health care, establishing cooling centers, providing hydration and heat protection kits, and targeted outreach to vulnerable groups, including pregnant women and the adolescents. Economic and behavioral interventions include workplace protection, empowering women with family planning education, and improving cooling technologies such as air conditioning, which have been shown to reduce heat-related reproductive impacts (5).

Climate change and extreme heat pose a critical harm to reproductive health, manifesting as reduced fertility, diminished sperm quality, failure of ovarian function, and adverse pregnancy outcomes such as preterm birth and low birth weight. To mitigate the threats to reproductive health, the most important step is the urgent and sustainable reduction of climate change, particularly through rapid decarbonization and elimination of air-pollution by cutting greenhouse gas emissions to limit global warming to 1.5°C. At the same time, effective global plans must prioritize adaptation by empowering women, strengthening health care systems, and implementing targeted protection measures during critical reproductive periods. Based on the above evidence, climate change is a silent killer that intensifies inequality, poses enormous risks to vulnerable populations, and requires urgent action for adaptation and preparedness, particularly in the context of humanitarian responses.

References

1. Fernandez ACG, Pelnekar S, Robinson JF, Shaw GM, Padula AM, Woodruff TJ, et al. Climate change and reproductive health. *Endocr Rev.* 2025;4:bnaf026.
2. Papadiochou A, Diamanti A, Metallinou D, Georgakopoulou VE, Taskou C, Kagkouras I, et al. Impact of climate change on reproductive health and pregnancy outcomes: a systematic review. *Cureus.* 2024;16(8):e68221.
3. Kılavuz M, Ağralı C, Kanbay Y. As the planet warms, women pay the price: the climate change and reproductive health crisis. *J Egypt Public Health Assoc.* 2025;100(1):14.
4. Sergott RC, Grossman RI, Savino PJ, Bosley TM, Schatz NJ. Systematic review of climate change effects on reproductive health. *Fertil Steril.* 2022;118(2):215-23.
5. International federation of red cross and red crescent societies (IFRC), United nations office for the coordination of humanitarian affairs. Extreme heat: preparing for the heat waves of the future. Geneva: IFRC; 2022 Oct 10. Available from: <https://www.ifrc.org/document/extreme-heat-preparing-heat-waves-future>.

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