

Factsheet on air pollution, climate change and reproductive health

Published March 2024

Key facts

- Climate change is responsible for global warming, changes in precipitation patterns, more frequent extreme weather events, wildfires, increased air pollution, rising sea and waterway levels, floods, and disruption and migration of human and wildlife populations.
- Climate change affects the social and environmental determinants of health: clean air, safe drinking water, sufficient food, and secure shelter.
- Global heat and air pollution are associated with impaired fertility potential, preterm birth, low birthweight, miscarriage, and stillbirth.
- Limiting human-induced global warming requires strong, rapid, and sustained reductions in greenhouse gas emissions and aerosol pollution aiming to reach net zero CO₂ emissions.

Background information

Climate change refers to long-term alterations in average weather patterns that define local, regional, and global climates. Its main components include global heating, which denotes the increase in Earth's surface temperature from the pre-industrial era (1850-1900), and air pollution.

Human activities, primarily the combustion of fossil fuels, are the primary drivers of global heating, resulting in elevated levels of greenhouse gases in the atmosphere, posing threats to food and water supplies, human health, increasing migration and reducing safety [1]. Between 1960-2020, average temperatures rose by 1.2°C, and without effective mitigation measures, are projected to surpass 3°C above pre-industrial levels by 2100 – an alarming level for life on earth [2].

Air pollution, another substantial contributor to climate change, encompasses various pollutants such as nitrogen oxides, sulphur oxides, ozone, ammonia, carbon monoxide, methane, volatile organic compounds (VOCs), fine particulate matter (PM_{2.5}, PM₁₀), and endocrine disrupting chemicals (EDCs). Activities such as burning fossil fuels, deforestation, land use change, vehicular emissions, aerosols, methane, and wildfires contribute to air pollution. Fine particulate matter resulting from wildfires, household materials, asbestos, heavy metals, fertilizers, and waste/ sewage can further exacerbate pollution by entering the air, soil, water, or food chain.

Air pollution increases vulnerability to EDCs and their impact on human health by disrupting normal cell functions that occur in organs throughout the body. Moreover, high ambient heat levels can affect cell and tissue function and thus human health, including reproductive health.

According to the Intergovernmental Panel on Climate Change (IPCC), approximately 3.3 to 3.6 billion people reside in areas deemed "highly vulnerable" to climate change. Disproportionately affected groups include pregnant females, children, the elderly, individuals in low-income communities, those with disabilities, individuals with pre-existing or chronic medical conditions, and indigenous peoples.

Air pollution and climate change: the link with reproductive health and infertility

Data supporting a link between climate change (temperature changes and air pollution exposures) and human health, including reduced fertility and impaired reproductive health, derive from human epidemiologic studies, many of which are supported by studies in animal models [3-6].

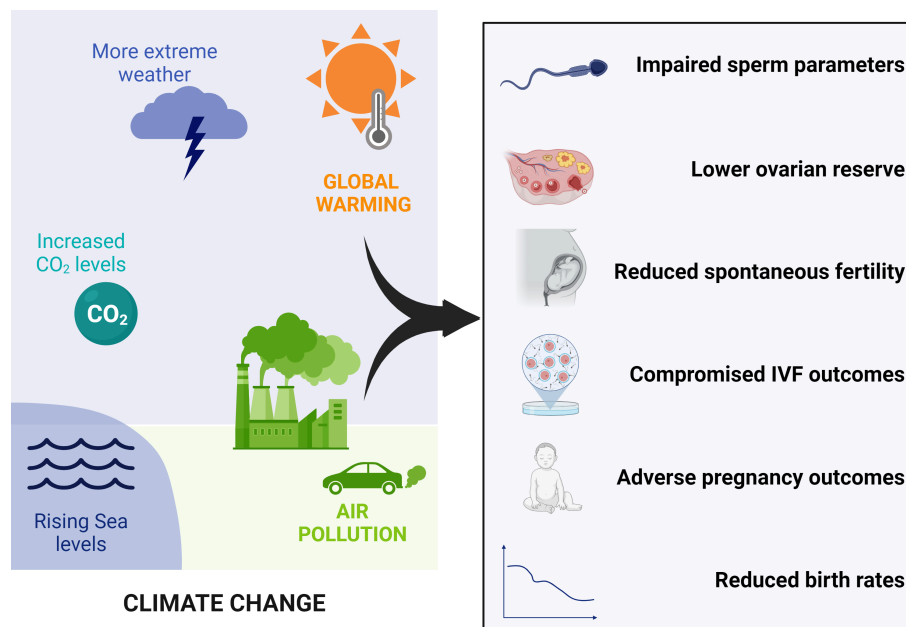


Figure 1. Reproductive factors affected by air pollution and climate change include sperm parameters, ovarian reserve, spontaneous fertility, success of medically assisted reproduction, pregnancy outcomes and offspring health (Created with BioRender.com).

→ Exposures to pollutants and heat are correlated with impaired sperm parameters and ovarian reserve.

- Exposure to vehicular traffic and diesel exhaust pollutants in adulthood correlate with abnormal sperm parameters, chromosome numbers, and DNA fragmentation.
- Epidemiological studies have revealed a strong correlation between human sperm parameters and environmental temperature. Elevated testicular temperatures have been associated with lower sperm counts and altered sperm morphology.

- Some research suggests that residential exposure to fine particulate matter and increases in ambient temperature are significantly correlated with lower ovarian reserve, as assessed by antral follicle count and anti-Müllerian hormone levels.
- **Air Pollution is associated with compromised spontaneous fertility and in vitro fertilisation (IVF) outcomes.**
- Living in the proximity to major roads, with distances less than 200 meters, has been linked to self-reported infertility, with pregnancy rates increasing by 3% for every 200 meters away from a major roadway.
 - In census tracts with high exposure to fine particulate matter, live birth rates per 1,000 pregnant females are significantly decreased.
 - Among sub-fertile populations undergoing IVF, acute and subacute exposure to high levels of fine particulate matter has been shown to impact pregnancy and miscarriage rates.
- **Air Pollution is correlated with adverse pregnancy outcomes, including increased rates of spontaneous miscarriages, stillbirths, pre-term births and low birth weight.**
- Several studies have reported correlations between seasonal variations in ambient air pollutants such as O₃, SO₂, NO₂, CO, PM_{2.5}, PM₁₀ and spontaneous miscarriages.
 - Residing near high-volume freeways significantly heightens the risk of low birth weight.
 - High exposure to CO, NO₂, PM_{2.5} and PM₁₀ during the second trimester of pregnancy, particularly between 20 to 27 weeks, has been associated with increased odds of pre-term birth.
 - Global data on pre-term births indicates that 2.7 million or 18% of total pre-term births worldwide could be attributed to maternal exposure to fine particulate matter, with the highest burdens observed in South/East Asia, North Africa/Middle East, and West Sub-Saharan Africa.
 - Exposure to wildfires up to three weeks prior to delivery has been linked to an increased risk of low birth weight. Additionally, exposure to wildfire fine particulate matter during the second trimester of pregnancy correlates with an elevated risk of pre-term birth, likely due to inflammation and stress.
- **Extreme heat has an effect on pregnant females, fetuses in utero, and birth rates.**
- Prenatal exposure to extreme heat is associated with heightened risks of pre-term birth, low birth weight, and stillbirth.
 - Mothers exposed to heat during delivery are more likely to experience hypertension, poorer pregnancy outcomes, and longer hospital stays.
 - In utero foetal exposure to heat is linked to lasting negative effects on long-term cognitive abilities and adult earnings.
 - Birth rates exhibit a significant association with extreme temperatures.

Time for action: policies to address the effect of climate change on reproductive health.

Facilitate Research

- ✓ Prioritise research on the impacts of air pollution and heat exposure on fertility and pregnancy to guide the development of protective measures.

Support Prevention

- ✓ Promote swift, ethical, and sustained actions to reduce in CO₂ emissions and aerosol pollution aiming to reach net zero CO₂ emissions within the next 20 years.
- ✓ Prioritise ambitious policies and committed economic investments to facilitate substantial reductions in CO₂ emissions, improve air quality and stabilise global temperatures within a 1.5°C increase. Such efforts have been championed by the International Panel on Climate Change and by the Green New Deal resolution in the USA and the European Green Deal.

References¹

1. *Global Warming vs. Climate Change*. <https://climate.nasa.gov/global-warming-vs-climate-change/>.
2. The Intergovernmental Panel on Climate Change., *IPCC report: 'Code red' for human driven global heating, warns UN chief*. <https://news.un.org/en/story/2021/08/1097362>, 9 August 2021
3. Carré J, et al., *Does air pollution play a role in infertility?: a systematic review*. *Environ Health*, 2017. **16**(1): p. 82.
4. Segal TR and Giudice LC, *Before the beginning: environmental exposures and reproductive and obstetrical outcomes*. *Fertil Steril*, 2019. **112**(4): p. 613-621.
5. Segal TR and Giudice LC, *Systematic review of climate change effects on reproductive health*. *Fertil Steril*, 2022. **118**(2): p. 215-223.
6. Watts 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): p. 1836-1878.

¹Only key papers were included, but further detailed references on individual studies can be requested from ESHRE by contacting guidelines@eshre.eu

Developed by the ESHRE expert panel for environmental factors and fertility, consisting of Willem Ombelet, Maribel Acién, Pauliina Damdimopoulou, Linda Giudice, Niels E. Skakkebæk, Miguel Angel Checa, Rémi Béranger, Nicolas Garrido, Karin Sørig Hougaard, Rune Lindahl-Jacobsen, Olwenn Martin, Jeanne Perrin, Cristina Richie, and Nathalie Vermeulen.