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How a warmer world is making pregnancy riskier

Some scientists argue that the link between increasing heat and adverse maternal outcomes is quietly becoming a public health emergency



Sarah Neville in Swansea

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141

In her airy living room with views over the south-west Wales countryside, Sammie Bond, heavily pregnant, lies on a sofa as midwife Sophie Barry-Richards places a monitoring device on her stomach and is rewarded by the rhythmic thump of a healthy heartbeat.

Almost immediately, another, just a little faster, can be heard – and Bond’s seven-year-old son Cadno, playing nearby, is briefly transfixed by this prenatal connection to his new twin siblings.

It is a heartwarming yet commonplace scene repeated daily in homes and healthcare facilities the world over. But in Bond’s case, its significance goes beyond offering reassurance that her rollover pregnancy – a wrenching misfortune, followed by the discovery that the lost baby had been a triplet and two other foetuses had survived – is now on track.

The 38-year-old primary school teacher is at the forefront of efforts to solve a scientific mystery that some experts believe is turning, almost unnoticed, into a global public health emergency.

More than 200 studies have provided compelling evidence of a link between rising temperatures and adverse pregnancy outcomes, including premature birth, stillbirth, low birth weight, congenital abnormalities and hypertensive disorders in mothers, with the earliest dating back to 1939 but a marked uptick in the past decade.

Researchers’ conviction that they will find answers in Swansea, a rainy coastal city where average temperatures rarely top 20C, reflects a striking reality: according to many of the analyses, the association between heat and poor pregnancy outcomes is as strong in temperate countries as those that endure constant debilitating heat.

Cathy Thornton, co-investigator on the “Magenta” project in which Bond is a participant, had initially wondered whether her hometown was the right place to pursue her growing interest in a field where there are so many crucial knowledge gaps. “When we started talking about it, we were like, ‘Should we be doing this in Swansea? Let’s get Brazil on board.’”

However, after reviewing the literature, including studies from Belgium and the US, she realised that extreme heat was a relative, not an absolute concept: the danger lay in a woman’s exposure to levels of heat to which she was not acclimatised.

The ubiquity of the risk has been discovered only recently. “Up until the last five years or so, extreme heat had been considered more of a global south problem,” says Ana Bonell, assistant professor at the London School of Hygiene and Tropical Medicine.

Bonell, who has extensively studied the physiological effects of heat on pregnant women in Gambia, led an international study that in 2023 found a heightened risk of stillbirth at temperatures as low as 12C, and as high as 46C. “We see from the epidemiological evidence that actually everyone is affected,” she says. “You’re not safe anywhere.”

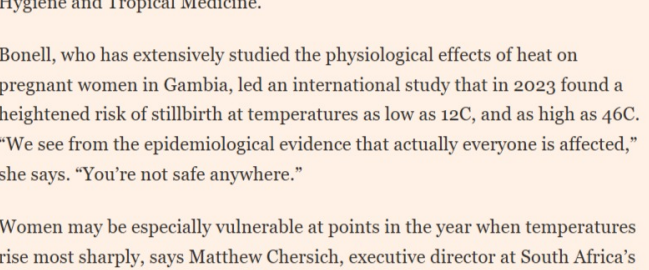
Women may be especially vulnerable at points in the year when temperatures rise most sharply, says Matthew Chersich, executive director at South Africa’s Wits Planetary Health Research Division and a co-author on the Nature study led by his colleague, research clinician Darshnika Lakho. “Spring is a particularly dangerous season for that reason,” he adds.

Both short- and long-term heat exposures have an effect – probably through different biological mechanisms – but the evidence suggests brief episodes of extreme heat are “particularly problematic”, says Nicholas Brink, a clinical researcher who works alongside Chersich.

Yet most women are oblivious to the potential risks. Barry-Richards, anaesthetist midwife on the Magenta team, says midwives, obstetricians and anaesthetists are “not trained or given any knowledge on it”.

The same is true in countries where heat is a constant. Jane Hirst, chair of global women’s health at Imperial College London, says her native Australia regularly experiences 40C temperatures yet “when I talk to my colleagues [there] who work in obstetrics and midwifery, they’re like, ‘No, it’s not really on the radar for us at all.’”

As millions of babies are born into a warming world, experts believe there will be no escaping the far-reaching impacts on society © FT montage/Getty/Reuters



Sammie Bond smiles while holding her 6-week-old twins. The 38-year-old primary school teacher from Wales is at the forefront of efforts to solve the mystery of the impact of heat on maternal health © Jon Rowley/FT

An analysis of 198 of those studies, across 66 mostly high-income countries, published in Nature last year, found that for every 1C increase in heat exposure, there was a 4 per cent increase in the odds of a preterm birth. During heatwaves, the odds increased by 26 per cent.

But as temperatures soar – the global long-term average rise is estimated by the UN at 1.3C since the industrial era and last year was the hottest on record – scientists are still uncertain about the biological processes through which heat causes these damaging effects. Nor is it clear how women can best protect themselves.

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There is strong evidence of a link between rising temperatures and adverse pregnancy outcomes

Percentage increase in the odds of an event

■ Per 1°C temperature rise ■ During a heat wave

Outcome	Per 1°C temperature rise	During a heat wave
Congenital anomalies	~12%	~45%
Preterm birth	~4%	~26%
Low birth weight	~2%	~15%
Obstetric complication	~3%	~20%
Antenatal bleeding	~15%	~18%

Analysis of 198 studies in 66 countries
Source: Lakho, Brink et al. A systematic review and meta-analysis of heat exposure impacts on maternal, fetal and neonatal health (Nature Medicine 2023)

Heat is still viewed as “a normal, even a pleasant, exposure”, argues Chersich – risky for older people, perhaps, but not for women in their physical prime.

Nor until recently have the effects been properly measured, particularly in the developing world where sparse record keeping means conception dates and gestation periods can be uncertain. The result is that “it hasn’t entered the medical curricula or textbooks or as part of the medical training, and it isn’t yet part of public discourse”, he adds.

Yet so extensive are the health impacts of climate change, Chersich believes it should be declared a “Public Health Emergency of International Concern” by the World Health Organization, the same step which led to a co-ordinated global response to the Covid-19 pandemic in 2020.

“These kinds of broad scale impacts that cross [national] boundaries are really devastating,” he says.

The new sense of urgency infusing the search for answers owes much to a decision by the Wellcome Trust, one of the largest scientific funders in the world, to invest around £25m in studies from Sydney to South Africa; the Swansea team alone has received £2.2m.

Alan Dangour, who leads its climate and health work, says that understanding the biological routes through which heat is damaging maternal and foetal health, and finding solutions, is critical to limiting future strain on health systems – and global workforces.

He points to a landmark study into the link between poor maternal nutrition and chronic disease in adulthood which, almost 40 years ago, proved the principle that health destiny can be determined in the womb. “If you’re exposed to extreme heat in utero and you survive, what happens to your health when you’re 20, 30 or 50?”

An investigation under way in South Africa, following 200 women from the second trimester to a year after birth, seeks to build on data that suggests children born during periods of extreme heat have a higher rate of admission to hospital for infections. Dehydrated mothers can also struggle to produce breast milk, leading to nutritional shortages that can affect neurodevelopment, says Renate Strehlau, the clinician scientist leading the work.

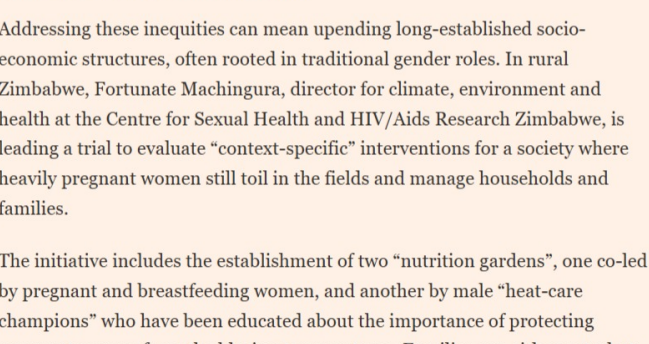
The expansive nature of the threat to global health from a warming planet is inspiring researchers to look beyond traditional academic silos. Dangour says they are bringing together “climate science, environmental science, with physiology, with biology, with mechanistic science, with computational biology . . . to ask questions in different ways”.

This approach is evident in Swansea, where Thornton and her team are deploying sophisticated heat-mapping technology, pioneered by Nasa, to measure land temperature. Meanwhile, monitors installed in study participants’ homes provide precise indoor readings. The aim is to give “a real world measure of individual exposures, rather than just ‘the Met Office said it was 27C today’,” she says.

Researchers are also harnessing big data, drilling into records covering more than 1.1m pregnancies in London and 300,000 in Wales over a 13-year period, and relating them to temperature data.

In a lab at Swansea University, research technician Felicity Church is painstakingly adding antibodies to two tubes. This enables study of different kinds of immune cells in the blood, at various points in the participants’ pregnancies. The antibodies bind to the cells, helping to highlight differences between samples collected during high and lower temperatures.

Some changes in the number and activity of these cells are a hallmark of a healthy pregnancy, says Thornton. But others are correlated with adverse outcomes, and while it is too early to come up with definitive hypotheses, “it does look like, in the heat, these populations of cells undergo further changes in numbers . . . that point to these adverse effects,” she adds.



More than 200 studies have shown evidence of a link between rising temperatures and adverse pregnancy outcomes, including premature birth © Jean-Christophe Verhaegen/AFP/Getty Images

Complicating the attempt to understand the impact of high temperatures on pregnant women, most existing data on heat stress comes from men – often super-fit young athletes. The result is that some strictures backed by leading obstetrics organisations – for example, that pregnant women should not exercise during heatwaves – have been built on tenuous foundations, experts believe.

Ollie Jay, director of the Heat and Health Research Centre at the University of Sydney, “found there wasn’t one study ever that had exposed pregnant women to conditions warmer than 25 degrees Celsius”.

They set up a pilot project to observe women as they exercised in a specially constructed “climate chamber”, but found no evidence that it was harder for them to maintain their core temperature than non-pregnant counterparts.

This thesis will now be tested with a far bigger group, and at temperatures as high as 40C, to calculate the combinations of temperature and humidity that can be tolerated at different stages of pregnancy. Jay adds: “It’s important that we find a way in which we can objectively define what is safe.”

Other researchers are also homing in on the points at which women are most vulnerable. Veronique Filippi, a professor at the London School of Hygiene and Tropical Medicine who studies the impact of extreme heat on maternal and newborn health in Africa, says several analyses suggest heat exposure during the first trimester increases the chances of hypertensive disorders later in the pregnancy.

The objective now is to find practical measures that can mitigate the impact of higher temperatures. Jay has devised an app which each day alerts users, based on their personal profile, to their “heat health risk” and recommends “evidence-based interventions”.

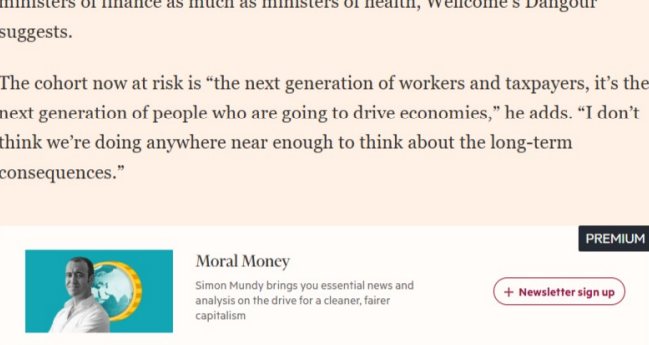
He hopes that, as studies yield more information about how heat is causing harm in pregnancies, the data fed into the app will become richer, guiding women more precisely as to when they need to drink more water, for example.

Consensus of the needs of poorer countries, he and his team have also devised a cheaper alert: a sheet of thermo-sensitive paper which changes colour when the temperature reaches a certain level. As it does so, says Jay, it reveals advice about “actions that people should and shouldn’t be taking, based on the indoor conditions”.

The “adaptation divide” between the global north and south preoccupies Brink, who notes that changes to the built environment are far easier to achieve in wealthier nations.

In Sweden, for example, the effects of heat on pregnancies “are starting to disappear in some areas that are very affluent . . . because they live in a kind of thermo-neutral environment”, reducing the shift in temperature between seasons.

Yet the studies conducted so far underline the disproportionate risk faced by poorer women. The Nature study showed that the odds of preterm birth due to extreme heat exposure were about 50 percentage points higher in low and middle income countries, compared to high-income countries.



Pregnant women exercise together outside Karanda Mission Hospital in Mount Darwin, Zimbabwe. The expansive nature of the threat to global health from a warming planet is inspiring researchers to look beyond traditional academic silos © Jitendra Nikiwara/AFP/Getty Images

Addressing these inequities can mean upending long-established socio-economic structures, often rooted in traditional gender roles. In rural Zimbabwe, Fortunate Machingura, director for climate, environment and health at the Centre for Sexual Health and HIV/Aids Research Zimbabwe, is leading a trial to evaluate “context-specific” interventions for a society where heavily pregnant women still toil in the fields and manage households and families.

The initiative includes the establishment of two “nutrition gardens”, one co-led by pregnant and breastfeeding women, and another by male “heat-care champions” who have been educated about the importance of protecting pregnant women from the blazing temperatures. Families can either eat what they grow or sell it in local markets – easing financial stress so partners can afford to stay close to home in the period just before and after a birth.

One beneficiary is Latejourney Chihoko, who says her current pregnancy has been quite unlike her previous two, during which she walked to work in the direct sun, but never attributed her exhaustion and headaches to the heat. She now understands the importance of staying in the shade, drinking water regularly and taking time to rest, and her husband is spending more time at home to share the chores.

But Nhamodzinetsu Chabata, a government worker and farmer as well as an expectant father, says, “It’s not that easy” for men to defy ingrained expectations of how they should behave. “We’ve got our norms and values within the society that we live in,” he says. “It’s very hard for a man to be seen loitering around the home when we are supposed to be tending for the family . . . some parts of our communities will disapprove.” Sparing expectant mothers also has economic implications.

A woman in the early stages of labour at the Federal Medical Center, Lokoja, Nigeria. Scientists are still uncertain about the biological processes through which heat causes damaging effects – and how pregnant women can protect themselves © Science Photo Library/Reuters

Campaigners hope that the unarguable effects of heat on the wellbeing of mothers and their babies will finally push the issue to the top of the political agenda. Climate change is now widely viewed as a substantial threat to public health; in 2023, for example, the WHO appointed a special envoy for climate change and health.

But Chersich argues that “meaningful changes” will only happen if health sector representatives are given a seat at the table in international negotiations, treated on a par with the environment and energy sectors.

Although it does not specifically mention pregnant women, the Belém Health Action Plan (BHAP), which forms part of the strategic framework for COP30 in Brazil, refers to the need for “gender . . . and child-responsive” approaches “across all climate and health adaptation efforts”.

“Hopefully it’s becoming less overlooked, but it’s still hard for us to get a platform on the bigger climate agenda,” says Imperial’s Hirst.

The dismissive stance of US President Donald Trump towards both global warming and diversity, equity and inclusion, has added another layer of difficulty, she adds. “I have colleagues [in the US] who work on climate change, and they’re not even allowed to use those terms in their research grants anymore.”

People inside a cooling station, with a central temperature reading of 65.5° (24C), in Phoenix, Arizona, in July 2023. Climate change is now widely viewed as a substantial threat to public health © Carlos Barria/Reuters

In Swansea, Bond is preparing to take three fans, a plug-in and two handheld devices into hospital with her, aware she will need a way to cool herself through her double labour. Notoriously warm, the maternity wards at the city’s main hospital occupy a building whose large plate-glass windows cannot be opened, a concrete illustration of how little architects and health planners have considered heat as a factor in pregnancy. Sometimes women’s temperatures spike for no other reason than they are “boiling hot”, says Barry-Richards.

Chersich worries that women are still far too vulnerable at the point of giving birth, particularly in the developing world: the temperature in delivery rooms can be more than 5C higher than it is outside, he notes.

As millions of babies are born into a warming world, experts believe there will be no escaping the far-reaching impacts on society. Yet, for all the work under way, the pace of action still lags behind the scale of the crisis – a concern for ministers of finance as much as ministers of health, Wellcome’s Dangour suggests.

The cohort now at risk is “the next generation of workers and taxpayers, it’s the next generation of people who are going to drive economies,” he adds. “I don’t think we’re doing anywhere near enough to think about the long-term consequences.”



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