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Impact Of Increase In Temperature On Pregnancy Outcomes

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ABSTRACT: The review study explores the impact of increasing temperatures due to climate change on pregnancy outcomes. The study analyzes various research articles published between 2016 and 2023 investigating the association between ambient temperature and adverse pregnancy outcomes. The review highlights that exposure to high temperatures during pregnancy is linked to increased risks of preterm birth, low birth weight, stillbirth, and congenital heart defects. The timing of heat exposure during gestation plays a crucial role, with different trimesters showing varying susceptibilities to temperature effects. Socioeconomic factors, maternal characteristics, and geographic location also influence the severity of these impacts. The review emphasizes the need for targeted interventions and adaptation strategies to protect pregnant women and infants from the health effects of rising global temperatures, particularly in vulnerable regions and populations.

Keywords: Temperature increase, extreme heat and preterm birth, climate change and pregnancy implications, and birth complications.

I. INTRODUCTION:

Climate change drives an increase in extreme weather events—such as heat waves, droughts, and storms, these occurrences are expected to become more intense, prolonged, and frequent in the coming decades (IPCC, 2021). From 1910 to 2007, the global average temperature increased by 0.74°C, with a significant rise occurring after the 1970s. Although a safe threshold of a 2°C increase compared to preindustrial levels has been proposed, current models predict that global temperatures will rise by 0.15 to 0.38°C per decade, making it likely that this threshold will be exceeded within this century (Costello *et al.*, 2009; IPCC, 2007).

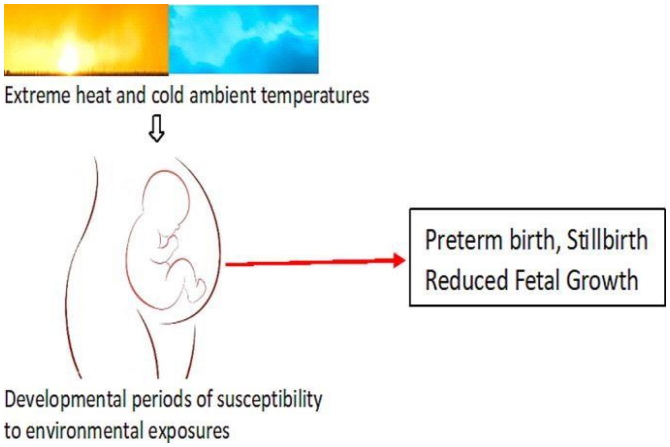

Fig: Graphical representation of impact of increase in temperature on pregnancy outcomes from Nyadanu *et al* (2024)

Climate change impacts human health, including food and water scarcity, poor sanitation, population migration, and changing disease patterns which pose serious risks to vulnerable groups like pregnant women and children, particularly due to heat exposure (Costello *et al.*, 2009).

Rising global temperatures due to climate change pose significant risks to maternal and child health, especially during pregnancy and early development. Prolonged heat exposure can result in maternal dehydration, increased cardiovascular strain, and disruptions in fetal development. Pregnant women exposed to higher temperatures face a heightened risk of preterm labor, intrauterine growth restriction, and complications such as placental abruption and gestational diabetes. These conditions can lead to preterm births and low birth weight, which carry long-term implications, including potential cognitive development challenges and increased susceptibility to chronic conditions like cardiovascular and metabolic disorders later in life.

Extreme temperatures are linked to preterm birth (PTB), low birth weight (LBW), and stillbirth—key indicators of maternal and fetal health that have long-term implications and risks of chronic health conditions and mortality (Blencowe *et al.*, 2019; Chawanpaiboon *et al.*, 2019). Prenatal exposure to high temperatures can disrupt maternal thermal regulation, cause oxidative stress, and increase inflammation, which in turn contribute to these adverse outcomes (Samuels *et al.*, 2022).

Despite a growing body of research on the impact of temperature on birth outcomes, uncertainties remain about the exact mechanisms and their implications for reproductive health (Shankar *et al.*, 2023)). Research has consistently linked high ambient temperatures to complications in childbirth. Heat exposure can negatively affect pregnant women's mental health and limit physical activity. Although animal studies suggest that maternal core temperatures above 39°C may have teratogenic effects during the first trimester, evidence regarding these mechanisms in humans remains limited.

The indirect effects of rising temperatures, such as food insecurity, malnutrition, and the spread of infectious diseases, further elevate risks for pregnant women and their children. Vulnerable populations, particularly those in low—and middle-income regions, are disproportionately affected due to limited access to healthcare, cooling facilities, and other resources that could mitigate these risks. Addressing these concerns through public health interventions, education, and policy measures is essential to improving maternal and child outcomes as global temperatures rise. In the light of above discussion, the present review aims to focus on the impact of pregnancy outcomes in extreme heat situations.

II. OBJECTIVE:

This study aims to review the literature on the "impact of increasing temperature on pregnancy and child outcome" to understand how rising temperature due to climate change affects maternal and fetal health and evaluate the possible etiology.

III. METHODOLOGY:

Information sources and search strategy: A literature review, with the support of Google Scholar, Science Direct, SpringerLink, JSTOR, and Research Gate was conducted with keywords temperature increase, extreme heat and preterm birth, climate change and pregnancy implications, and birth complications.

Eligibility criteria: Qualitative articles published in English between 2016 and 2023 that analyzed and evaluated the association between climate change (ambient temperature) and pregnancy outcomes were included. Thus, 18 articles were found relevant to this topic, but only 9 were suitable according to the eligibility criteria.

IV. RESULTS:

Sl. No.	Title of the Study	Author and Year	Aim	Methodology	Finding/Outcome
1.	Impact of ambient temperature on adverse pregnancy outcomes: a birth cohort study in Fuzhou, China	Lin *et al.*, 2023	To examine the impact of ambient temperature on Adverse Pregnancy Outcomes (APO), WBC count, newborn hearing, and neonatal jaundice	418 participants from Fuzhou Maternity and Child Health Care Hospital; data from a structured questionnaire, air temperature, PM 2.5; Multivariate logistic regression controlling for confounders.	1℃ increase in mean temperature led to a 10% APO rise in early pregnancy; temperature associated with higher WBC count; neonatal jaundice positively correlated with first-trimester temperature, and negative in the later trimester.
2.	The risk of miscarriage is associated with ambient temperature: evidence from coastal Bangladesh	Das *et al.*, 2023	To assess the association of high temperatures with miscarriage risk in Bangladesh's climate-vulnerable coastal region.	Researchers analyzed 22,624 pregnancy outcomes from 13,376 women in Bangladesh (2012-2020), using HDSS data. They matched outcome dates with daily average temperatures and applied logistic regression to assess the link between temperature and miscarriage risk.	Miscarriage risk rose above 22℃, highest at 28℃-32℃; higher risk among older women age 35+, multiparous, near coastal residents.
3.	Associations between ambient temperature and pregnancy outcomes from three South Asian sites of the Global Network Maternal Newborn Health Registry	*Shankar et al.*, 2023	To analyze ambient temperature's impact on stillbirth, preterm birth, low birth weight, and pregnancy hypertension.	A retrospective cohort of 126,273 pregnancies in India and Pakistan; temperature data from local records; Poisson regression analysis.	Higher secondary trimester temperature linked to preterm birth and low birth weight; thirdtrimester heat correlated with gestational hypertension.
4.	Systematic review of ambient temperature exposure during pregnancy and stillbirth: Methods and evidence	Sexton *et al.*, 2021	To review temperature–still birth links, quality/variation of environmental data, and methods for accurate assessment	A systematic review (2000-2020); 538 records screened, 12 eligible; CASP quality assessment; 3.4M births, 42,848 stillbirths from 7 countries. The majority used weather data for temperature, with varied stillbirth definitions.	Stillbirth risk rose below 15℃ and above 23.4℃, especially above 29.4℃;

5.	Associations between ambient heat exposure early in pregnancy and risk of congenital heart defects: a large population-based study	Yu *et al.*, 2021	To investigate heat exposure's association with congenital heart defect (CHD) in early pregnancy.	A retrospective cohort; 19, 18,105 fetuses; extreme heat defined as consecutive days above 90th/ 95th temperature percentiles; longbinomial regression analysis.	Higher CHD prevalence with prolonged heat exposure; notable rise in atrial septal defects (PR=1,252) and patent ductus arteriosus (PR=2.83) associated with EHE90/95 exposures.
6.	Associations between high temperatures in pregnancy and risk of preterm birth, low birth weight, and stillbirths: systematic review and metaanalysis	Chersich *et al.*, 2020	To assess if high-temperature exposure raises the risk for preterm birth, low birth weight, and stillbirth.	There was a systematic review and meta-analysis; of 70 studies that linked high temperatures with adverse birth outcomes.	The preterm birth risk rose by 1.05x per 1°C increase, higher during heat waves; minor decreases in birth weight; stillbirth rates increased by 1.05x per 1°C rise. Effects were most pronounced in low-SES groups.
7.	Impacts of high temperature on adverse birth outcomes in Seoul, Korea: Disparities by individual- and communitylevel characteristics	Son *et al.*,, 2019 Confirm it is sona or son	To investigate the effects of heat during multiple exposure windows on preterm birth and low birth weight in Korea	Retrospective cohort; 813,820 births in Seoul; heat index assessment; exposure windows; whole pregnancy, 4 weeks, and 1-week predelivery; adjusted for maternal and community-I level factors.	There was a higher preterm birth risk for heat exposure during the whole pregnancy and short windows before birth, especially in young mothers and lower SES communities; no link was found with low birth weight.
8.	Temperature during pregnancy influences fetal growth and birth size	Rashid *et al.*, 2017	To assess temperature impact on birth size (weight/length), considering maternal BMI	3,267 pregnant women in rural Bangladesh were analyzed as part of the Maternal and Infant Nutrition Intervention Study in Matlab (MINIMat). Regression analysis assessed temperature effects on birth outcomes at different gestational points, considering factors like maternal BMI, gestational week, season, and infant sex.	In colder months, infants had a mean birth length of 47.5 cm, while those born in hot and dry months had 47.8 cm. Higher temperatures in the last month of pregnancy were linked to longer birth lengths ($P < 0.01$). The mean birth weight was 2693 g, with 30.5% classified as low birth weight. Mid-gestation temperatures increased birth weight, while higher temperatures at 28-30 weeks reduced it for mothers with BMI $\geq$18.5 ($P < 0.05$).

9.	The Perils of Climate Change: In Utero Exposure to Temperature Variability and Birth Outcomes in the Andean Region	Molina *et al.*, 2016	To examine the effects of temperature variability during pregnancy on birth outcomes in Bolivia, Columbia, and Peru.	86,021 children born to mothers who were exposed to increased temperature during pregnancy; historical temperature data (19002010) and DHS data; birth outcomes assessed by municipality/year; fixedeffects analysis	Temperature variability was linked with reduced birth weight and low birth weight, especially in the first trimester; with stronger effects in areas with food insecurity and limited health care access.

The study examined how ambient temperature exposure during pregnancy influences fetal growth and birth outcomes, with findings showing that temperature variations at different stages of gestation can significantly impact birth weight and length, especially in tropical, rural settings like Bangladesh. Higher temperatures during the last month of pregnancy were associated with increased birth length, while elevated mid-gestation temperatures (around 19 weeks) were linked to increased birth weight. In contrast, high temperatures early in pregnancy (around 8 weeks) had adverse effects on birth length, and these temperature impacts were more pronounced among malnourished mothers (BMI <18.5). Seasonal patterns were also observed, with winter births generally resulting in shorter infants. This suggests that the timing of temperature exposure during pregnancy plays a crucial role in fetal development, underscoring the potential risks climate change may pose to maternal and infant health in developing tropical regions (Rashid *et al*., 2017; Sexton *et al*.,2021).

A systematic review of 12 studies across seven countries, comprising 42,848 stillbirths, found that extreme temperatures during pregnancy—both hot and cold—were associated with increased risks of stillbirth, particularly with temperatures below 15°C or above 23.4°C, and the highest risks observed above 29.4°C. The review highlighted that late pregnancy exposure posed a particularly elevated risk, especially in low-resource settings. However, varied methodologies prevented a meta-analysis, and the exact mechanisms remain unclear, calling for more research to understand these associations and to manage ambient temperature exposure as a preventive measure (Sexton *et al*., 2021; Shankar *et al*., 2023).

Another study conducted in Fuzhou, China, expanded on this by examining temperature effects on adverse pregnancy outcomes (APOs), including maternal complications, high white blood cell (WBC) counts, neonatal jaundice, and newborn hearing loss. This study found that higher mean temperatures during the first trimester were positively associated with APOs, with effects lasting up to 10 weeks, while a negative association appeared during the second trimester. Diurnal temperature variations in the third trimester also significantly increased APO risks. Notably, high WBC counts were associated with warmer temperatures in the third trimester, indicating a possible increase in infection risks during pregnancy. The findings underscore that both pregnant women and newborns are vulnerable to temperature extremes, with potential risks exacerbated by climate change (Lin *et al*., 2023).

Further research on preterm birth (PTB) and low birth weight (LBW) supports these findings, linking higher temperatures to adverse pregnancy outcomes, particularly in the second trimester (Chawanpaiboon *et al*., 2019). For PTB, each 5°C increase during the second trimester was associated with a relative risk (RR) of 1.05, with regions like Nagpur showing even higher risks. LBW was also associated with elevated temperatures, as were gestational hypertensive diseases in the third trimester. Although stillbirth incidence did not show statistically significant changes with temperature increases, relative risk estimates suggest potential adverse effects, underscoring the need for strategies to manage heat exposure for pregnant women in high-temperature regions (Samuels *et al*., 2022; Shankar et al., 2023).

A systematic review and meta-analysis of 70 studies from 27 countries further established the link between high temperatures and adverse birth outcomes, notably preterm birth, low birth weight, and stillbirth (Chersisch *et al*., 2020). Findings showed that each 1°C rise in temperature increased preterm birth odds by 1.05-fold, with heat waves further amplifying risks (Chawanpaiboon *et al*., 2019). Socioeconomically disadvantaged groups and age-specific demographics displayed heightened temperature sensitivity, especially in lower-income countries. The review emphasizes the necessity of public health interventions and adaptation strategies, such as air conditioning, to mitigate these heat exposure risks during pregnancy and support maternal and child health amid rising global temperatures (Das *et al*., 2023).

Lastly, research in the Andean region showed that temperature variability impacts birth outcomes significantly, with each standard deviation increase from the local mean reducing birth weight by about 20 grams and increasing the probability of low birth weight by 10% (Molina and Saldarriaga, 2016). This was particularly evident in the first trimester, suggesting the early stages of pregnancy are sensitive to temperature fluctuations. Furthermore, higher agricultural activity in certain areas seemed to lessen adverse outcomes, pointing to food security as a possible mitigating factor against temperature-induced fetal growth issues. The findings across these

studies emphasize the critical need for targeted interventions to protect pregnant women and infants in vulnerable regions from the health effects of climate change (Costello *et al*., 2009).

V. DISCUSSION:

A range of maternal factors has been identified as influencing pregnancy outcomes under rising temperatures. Rashid *et al*. (2017) highlighted that poor maternal nutrition, particularly among mothers with a BMI below 18.5, increases the risk of adverse fetal development when exposed to high temperatures. These mothers are more susceptible to complications like preterm birth and low birth weight, especially during periods of extreme heat. Maternal age is another critical factor, as younger mothers (under 25) and older mothers (over 30) face higher risks of negative birth outcomes under temperature stress. Additional risks are associated with maternal health conditions such as pre-eclampsia and pregnancy-induced hypertension, which can exacerbate vulnerability to temperature extremes. Furthermore, maternal behaviors like smoking and lower physical activity levels during pregnancy have been linked to worsened outcomes in high-temperature conditions. The educational level also plays a role, with higher maternal education correlating with improved pregnancy outcomes, likely due to increased awareness and access to healthcare resources (Rashid *et al*., 2017). These findings underline the importance of maternal health, lifestyle factors, and prenatal care in mitigating the impacts of temperature increases.

Environmental factors further compound these risks, as shown by Sexton *et al*. (2021). They found that extreme temperatures, especially below 15°C and above 23.4°C, significantly increase the risks of adverse pregnancy outcomes, including stillbirth. Pollutants like PM2.5, sulfur dioxide, and nitrogen dioxide are also influential, as they can exacerbate respiratory and cardiovascular strain in pregnant women, worsening outcomes. Seasonal variations and geographic location impact exposure levels, with low-resource areas—where cooling resources and healthcare access are limited—being particularly vulnerable. Son *et al*. (2019) emphasized that socioeconomic disparities are crucial, as lower socioeconomic status (SES) is associated with increased risks for heat-related adverse birth outcomes. In urban, densely populated communities, where resources may be stretched and pollution levels higher, the combination of extreme temperatures and limited socioeconomic resources disproportionately affects lower-income mothers and infants. Geographic variations also contribute to disparities, as certain regions experience amplified effects due to climate, altitude, and access to healthcare facilities.

Socioeconomic and demographic factors further influence how temperature increases impact pregnancy. Shankar *et al*. (2023) observed that gestational timing plays a vital role, with certain trimesters being more sensitive to heat exposure. For instance, heat exposure during the second trimester has been linked to increased preterm birth and low birth weight, while third-trimester exposure is associated with gestational hypertension and related complications. Molina and Saldarriaga (2016) underscored the importance of food security, particularly in regions where agricultural activities are impacted by climate change, affecting maternal nutrition and, in turn, pregnancy outcomes. The study indicated that regions with higher agricultural activity and food availability experience less severe temperature-related adverse effects, suggesting that food security can mitigate some of the impacts of temperature fluctuations. Yu *et al*. (2022) noted that even infant characteristics, such as sex, may influence susceptibility to temperature-induced congenital defects. Population density and community attributes—like political stability and healthcare access—also affect outcomes, as overcrowded or unstable regions are often less equipped to provide resources that protect maternal and fetal health. These findings underscore the multifaceted nature of temperature-related risks in pregnancy and highlight the need for a comprehensive approach that addresses maternal health, environmental and demographic factors, and regional socioeconomic challenges to safeguard maternal and child health outcomes in a warming world.

VI. CONCLUSION:

This review highlights the significant impact of rising temperatures due to climate change on pregnancy outcomes, increasing risks of preterm birth, low birth weight, stillbirth, and congenital defects, particularly among vulnerable populations in low- and middle-income regions. The findings underscore the urgent need for public health interventions and policy development to mitigate heat exposure for pregnant women, enhance healthcare access, and promote awareness of associated risks. Future research should focus on understanding the underlying biological mechanisms and the long-term effects of temperature on maternal and child health, while also developing targeted adaptation strategies to support these populations in the face of ongoing climate change, ultimately ensuring better health outcomes as global temperatures rise.

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