SHORT ARTICLE

Association of Ambient Temperature at Delivery with Selected Adverse Pregnancy and Neonatal Outcomes: A Hospital-Based Cross-Sectional Study from Western India

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ABSTRACT

Background: Pregnancy-related physiological changes may increase vulnerability to environmental stressors such as ambient temperature. Evidence from western India regarding the association between temperature and adverse pregnancy outcomes remains limited. **Methods:** A hospital-based cross-sectional study was conducted among 1,346 institutional deliveries at a tertiary care teaching hospital in Gujarat, India. Mean ambient temperature on the day of delivery was obtained from official meteorological records and categorized as <25°C, 25–30°C and >30°C. Maternal and neonatal outcomes including preterm birth, low birth weight, stillbirth, intrauterine fetal death (IUFD), congenital anomalies and neonatal intensive care unit (NICU) admission were assessed. Associations were evaluated using chi-square tests and multivariable logistic regression. **Results:** Preterm birth occurred in 20.3% of deliveries and increased significantly with rising temperature. Higher proportions of preterm birth, stillbirth, IUFD and NICU admission were observed at temperatures >30°C ($p<0.05$). Multivariable analysis showed that higher ambient temperature remained independently associated with increased odds of preterm birth. **Conclusion:** Higher ambient temperature at delivery was associated with adverse pregnancy outcomes, particularly preterm birth and NICU admission.

KEYWORDS

Ambient temperature; Pregnancy outcomes; Preterm birth; Seasonal variation; Neonatal morbidity

INTRODUCTION

Pregnancy is associated with several physiological adaptations including increased metabolic rate, expanded plasma volume, elevated cardiac output and altered thermoregulation. These changes increase endogenous heat production while potentially reducing the body's capacity for heat dissipation, making pregnant women more susceptible to environmental stressors such as extreme ambient temperature (1,2). Short-term thermal stress may influence uterine activity, placental perfusion and maternal hydration, thereby affecting pregnancy and neonatal outcomes (3–5).

Seasonal variations in temperature have been associated with changes in several health outcomes, including cardiovascular events, infectious diseases and reproductive outcomes (6). Increasing epidemiological evidence suggests that exposure to high ambient temperature during pregnancy may increase the risk of adverse outcomes such as preterm birth, stillbirth and neonatal morbidity (3,4,7). Proposed mechanisms include maternal dehydration, inflammatory activation and reduced uteroplacental blood flow.

India accounts for a substantial proportion of the global burden of preterm births and experiences marked seasonal variation in ambient temperature (8,9). In regions such as Gujarat, summer temperatures frequently exceed 40°C. Despite this, region-specific evidence examining the association between ambient temperature and pregnancy outcomes remains limited. Therefore, this study aimed to assess the association between ambient temperature at delivery and selected adverse pregnancy and neonatal outcomes in a tertiary care hospital in western India.

MATERIAL & METHODS

A hospital-based cross-sectional study was conducted at Dhiraj General Hospital, SBKS Medical Institute & Research Centre, Sumandeep Vidyapeeth, Vadodara, Gujarat, India. The study included institutional deliveries occurring during two climatically distinct periods: winter (November 2024–January 2025) and summer (March–May 2025) to examine the association between ambient temperature at delivery and selected pregnancy and neonatal outcomes.

The study included women who delivered at the study facility during two climatically distinct seasons representing relatively high and low ambient temperature periods. A total of 1,346 institutional deliveries were included in the analysis.

Singleton pregnancies resulting in institutional deliveries with documented gestational age, recorded birth weight and available temperature data corresponding to the date of delivery were included. Multiple pregnancies, pregnancies complicated by major pre-existing chronic medical conditions and records with incomplete key variables were excluded.

Daily ambient temperature corresponding to the date of delivery was obtained from official meteorological records. Mean daily temperature was calculated as the average of daily minimum and maximum temperatures. Temperature exposure was categorized into three groups: <25°C, 25–30°C and >30°C, based on regional climatic conditions and thresholds relevant for thermal stress.

Data were retrospectively extracted from antenatal registers, labour room records and neonatal intensive care unit (NICU) registers using a structured data extraction form.

Maternal characteristics included age, place of residence, antenatal care visits and presence of maternal complications such as anaemia, hypertensive disorders or gestational diabetes. Neonatal outcomes included birth weight, preterm birth, stillbirth, intrauterine fetal death (IUFD), congenital anomalies and NICU admission.

Data were analysed using standard statistical software. Categorical variables were expressed as frequencies and percentages. Associations between temperature categories and pregnancy outcomes were assessed using the chi-square test. Multivariable logistic regression analysis was performed to assess the independent association between ambient temperature and preterm birth after adjusting for maternal age, residence, antenatal care visits and maternal complications. Results were expressed as adjusted odds ratios (aOR) with 95% confidence intervals. A p-value <0.05 was considered statistically significant.

Ethical approval was obtained from the Institutional Ethics Committee with reference number SVIEC/ON/MEDI/SRP/July/24/145.

RESULTS

A total of 1,346 deliveries were analysed, including 543 deliveries during summer and 803 during winter. The majority of participants (49.5%) were aged between 18–25 years and most resided in rural areas (84.7%). Nearly all women (95.0%) had attended four or more antenatal visits.

Low birth weight was observed across all temperature categories. The highest proportion of low-birth-weight infants was observed at 25–30°C (45.8%). Although the proportion of low-birth-weight infants varied slightly across temperature groups, the association between temperature and birth-weight category was not statistically significant.

Mean birth weight showed minimal variation across ambient temperature ranges, with minor fluctuations and a slight peak around 35.5°C. While total deliveries fluctuated across temperature ranges, the frequency of preterm births tended to increase at higher ambient temperatures.

In contrast, several adverse pregnancy outcomes showed significant associations with ambient temperature (Table 1). The prevalence of preterm birth was 20.3% and increased from 17.3% at <25°C to 26.1% at >30°C (p=0.001). Similarly, stillbirth (1.4% vs 3.7%; p=0.018) and intrauterine fetal death (1.1% vs 3.2%; p=0.024) were more frequent at higher temperatures. NICU admission also increased with rising temperature, from 15.0% at <25°C to 25.8% at >30°C (p<0.001). Congenital malformations did not show a significant association with temperature (p=0.088).

Table 1: Association between ambient temperature at delivery and adverse pregnancy outcomes (N=1346)

Outcome	<25°C (n=660)	25–30°C (n=249)	>30°C (n=437)	Test statistic #	p value
Preterm birth					
Yes	114 (17.3%)	60 (24.1%)	114 (26.1%)	13.47	0.001*
No	546 (82.7%)	189 (75.9%)	323 (73.9%)		
Stillbirth					
Yes	9 (1.4%)	3 (1.2%)	16 (3.7%)	7.96	0.018*
No	651 (98.6%)	246 (98.8%)	421 (96.3%)		
Intrauterine fetal death					
Yes	7 (1.1%)	3 (1.2%)	14 (3.2%)	7.48	0.024*
No	653 (98.9%)	246 (98.8%)	423 (96.8%)		
NICU admission					
Yes	99 (15.0%)	54 (21.7%)	117 (25.8%)	23.23	<0.001*
No	561 (85.0%)	195 (78.3%)	320 (73.2%)		
Congenital Malformation					
Yes	12 (1.8%)	10 (4%)	16 (3.7%)	4.84	0.088
No	648 (98.2%)	239 (96%)	421 (96.3%)		

**- p < 0.05 considered statistically significant.*

 # - Chi-square test was used where expected cell counts were adequate, Fisher's exact test was applied for outcomes with small expected cell frequencies

Multivariable logistic regression analysis showed that higher ambient temperature remained independently associated with preterm birth after adjusting for maternal age, residence, antenatal care visits and

maternal complications (Table 2). Compared with temperatures below 25°C, the adjusted odds of preterm birth were higher at 25–30°C (aOR 1.51; 95% CI 1.15–1.98) and >30°C (aOR 1.63; 95% CI 1.18–2.26). Other maternal factors included in the model were not significantly associated with preterm birth.

Table 2: Multivariable logistic regression analysis of factors associated with preterm birth

Variable	Category	Crude OR (95% CI)	Adjusted OR (95% CI)	p-value
Temperature	**<25°C (Ref)**	1	1	–
	25–30°C	1.44 (1.10–1.88)	1.51 (1.15–1.98)	0.003*
	>30°C	1.59 (1.20–2.10)	1.63 (1.18–2.26)	0.002*
Maternal age	**<30 (Ref)**	1	1	–
	≥30	1.02 (0.75–1.39)	1.05 (0.77–1.43)	0.775
Residence	**Rural (Ref)**	1	1	–
	Urban	1.12 (0.81–1.56)	1.19 (0.83–1.69)	0.347
ANC visits	**≥4 (Ref)**	1	1	–
	≤3	1.01 (0.61–1.68)	0.98 (0.53–1.79)	0.936
Maternal complication	**No (Ref)**	1	1	–
	Yes	1.42 (1.01–2.00)	1.37 (0.99–1.90)	0.057

**- p < 0.05 considered statistically significant.*

DISCUSSION

This study demonstrated a significant association between ambient temperature at delivery and several adverse pregnancy outcomes in a tertiary care setting in western India. Deliveries occurring at higher ambient temperatures, particularly above 30°C, were associated with increased proportions of preterm birth, stillbirth, intrauterine fetal death and neonatal ICU admission.

Preterm birth showed the most consistent association with ambient temperature in this study. Similar findings have been reported in several epidemiological studies examining heat exposure during pregnancy (3,4,7). A systematic review and meta-analysis reported that increasing temperature was associated with higher risk of preterm birth, suggesting that thermal stress may act as a trigger for early onset of labour (3). Potential mechanisms include maternal dehydration, reduced uteroplacental perfusion and activation of inflammatory pathways that stimulate uterine contractions (5).

Stillbirth and intrauterine fetal death were also more frequent at higher temperatures in the present study. Previous research has similarly reported increased risks of fetal demise during periods of extreme heat (4). Heat exposure may impair placental blood flow and increase oxidative stress, thereby compromising oxygen and nutrient delivery to the fetus.

Neonatal ICU admission showed the strongest association with temperature in this study. This likely reflects the combined impact of prematurity and fetal compromise, which are common reasons for NICU admission. In settings with limited neonatal resources, even moderate increases in NICU admissions may place substantial strain on healthcare services.

The findings are particularly relevant in the Indian context, where large populations are exposed to high ambient temperatures and climate change is increasing the frequency and intensity of heatwaves (1). Pregnant women in low- and middle-income settings may be particularly vulnerable due to outdoor occupational exposure, limited access to cooling and challenges in maintaining adequate hydration.

From a public health perspective, identifying temperature-related risks during pregnancy is important for developing climate-sensitive maternal health strategies. Simple preventive measures such as heat-risk counselling, hydration advice and closer monitoring during high-temperature periods may help reduce preventable adverse outcomes.

The cross-sectional design limits causal inference, and temperature exposure was assessed using meteorological records rather than individual-level exposure measurements. In addition, temperature exposure during earlier stages of pregnancy was not evaluated. Seasonal factors such as variations in maternal nutrition, infections and environmental conditions may also influence pregnancy outcomes and could not be fully accounted for in the present analysis. Nevertheless, the study provides region-specific evidence from a high-temperature setting and highlights the potential influence of short-term thermal exposure around the time of delivery.

CONCLUSION

Higher ambient temperature at the time of delivery was associated with increased risk of preterm birth and neonatal ICU admission in this study. These findings suggest that short-term thermal exposure during the peripartum period may influence pregnancy outcomes in regions experiencing high temperatures. Incorporating heat-risk awareness, hydration advice and closer monitoring during hot periods may help mitigate adverse outcomes. Further studies examining temperature exposure throughout pregnancy are warranted.

RECOMMENDATION

In view of the observed association between higher ambient temperature and adverse pregnancy outcomes, it is recommended that heat-risk awareness be integrated into routine antenatal care services. Pregnant women should be counselled regarding adequate hydration, avoidance of excessive heat exposure and early recognition of warning symptoms. Health systems should strengthen preparedness during high-temperature periods by ensuring availability of basic cooling measures and closer monitoring of high-risk pregnancies. Incorporation of climate-sensitive strategies into maternal health programmes may help in reducing preventable adverse outcomes.

LIMITATION OF THE STUDY

The cross-sectional design of the study limits the ability to establish a causal relationship between ambient temperature and pregnancy outcomes. Temperature exposure was assessed using meteorological data rather than individual-level exposure, which may not fully reflect personal variations. Additionally, exposure during earlier stages of pregnancy was not evaluated. Potential confounding factors such as maternal nutritional status, infections and occupational exposure could not be completely controlled.

RELEVANCE OF THE STUDY

This study provides region-specific evidence from western India on the association between ambient temperature at delivery and adverse pregnancy and neonatal outcomes. It highlights the potential impact of short-term thermal exposure during the peripartum period, particularly on preterm birth and neonatal morbidity. The findings add to the existing body of literature on climate and maternal health and emphasize the need for climate-resilient maternal healthcare strategies in high-temperature settings.

AUTHORS CONTRIBUTION

All authors have contributed equally.

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Nil

CONFLICT OF INTEREST

There are no conflicts of interest.

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DECLARATION OF GENERATIVE AI AND AI ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

The authors haven't used any generative AI/AI assisted technologies in the writing process.

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