Session: Global Neonatal & Children's Health 2

241 - Heat Stress and Birth Outcomes in a Pregnancy Cohort in Rural Amhara, Ethiopia

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Background: Prenatal extreme heat exposure is associated with increased incidence of adverse pregnancy outcomes including preterm birth, low birthweight, and miscarriage. However, few studies have investigated the ramifications of prenatal heat exposure in low- and middle-income countries such as Ethiopia, which ranks 15th on the UNICEF Children's Climate Risk Index.

Objective: To assess associations between pre-conception and prenatal heat exposure and birth outcomes including anthropometric z-scores, gestational age, preterm birth and stillbirth.

Design/Methods: We conducted secondary analysis of data from the Enhancing Nutrition and Antenatal Infection Treatment study, a randomized clinical effectiveness trial that enrolled 2392 patients at < 24 weeks gestation at 12 health centers in rural Amhara, Ethiopia from August 2020 to July 2022. Pregnancies were followed until 1 month postpartum. Daily wet bulb globe temperature (WBGT) was approximated based on the individual's place of residence or antenatal care center with MODIS-Aqua satellite land surface temperature data (1:30pm) and Global Forecasting Systems relative humidity data (12pm), using the Stull's equation. We averaged daily WBGT by trimester, overall pregnancy, and the 6-month pre-conception period for each

pregnancy. We used linear and logistic regression to examine associations between heat exposure and continuous and dichotomous outcomes, respectively, adjusting for relevant covariates.

Results: Birth anthropometrics: Increased first and third trimester and overall pregnancy WBGT were associated with decreased birth head circumference-for-age z-score (T1 effect size -0.032 cm per 1°C increase, 95% CI -0.050 to -0.014; T3 -0.019, 95% CI -0.037 to -0.000; and overall pregnancy -0.033, 95% CI -0.060 to -0.006). There were no associations between WBGT and weight- and length-for-age z-scores. Gestational age: Increased pre-conception WBGT was associated with lower gestational age (-0.039 weeks per 1°C increase, 95% CI -0.074 to -0.004). Preterm birth: Increased third trimester WBGT was associated with increased odds of preterm birth (odds ratio of 1.067 per degree increase, 95% CI 1.017 to 1.120). Stillbirth: We found no significant association between heat exposure and stillbirth.

Conclusion(s): Infants born to mothers with increased pre-pregnancy or prenatal heat exposure were born at younger gestations and with lower head circumference-for-age z-scores. Further studies are needed to better characterize heat exposures and associated pregnancy outcomes and neurodevelopment in climate-vulnerable countries such as Ethiopia.

Table 1. Cohort and Exposure Descriptive Statistics, Ethiopian Study Cohort, N=2194

	Mean + SD or n (%)
Maternal prenatal characteristics	
Age at enrollment (years)	26.3 ± 5.5
BMI at enrollment (kg/m^2)*	20.7 ± 2.4
Nulliparous*	646 (29.6)
Education*	
No formal education	1046 (47.9)
Primary or lower	624 (28.6)
Secondary or higher	516 (23.6)
Occupation*	
Farmer	1069 (48.9)
Housewife	634 (29.0)
Other	292 (22.1)
Birth and infant characteristics	
Male sex*	1068 (50.6)
Single gestation	2117 (96.5)
Stillbirth*	40 (1.9)
Gestational age (weeks)*	39.8 ± 2.1
Preterm live birth*	174 (8.3)
Birth weight for age z-score*	-0.97 ± 0.97
Birth length for age z-score*	-0.77 ± 1.41
Birth head circumference for age z-score*	0.50 ± 1.25
Heat exposure variables	
Pre-pregnancy average WBGT (°C)	27.78 ± 2.9
First trimester average WBGT (°C)	26.98 ± 3.9
Second trimester average WBGT (°C)*	26.82 ± 3.8
Third trimester average WBGT (°C)*	27.30 ± 3.9
Pregnancy average WBGT (°C)	27.00 ± 2.4

Values are expressed as mean ± SD for continuous variables or n (%) for categorical variables.
*Totals do not add up to cohort N due to missing values.
BMI = Body Mass Index; WBGT = Wet Bulb Globe Temperature

Table 2. Associations between Heat Stress and Continuous Birth Outcomes

Outcome	Exposure	Adjusted* β (95% CI)	p value
Birth weight for age z-score (BWAZ)	Pre-pregnancy WBGT	0.005 (-0.011, 0.021)	0.538
	Trimester 1 WBGT	-0.003 (-0.016, 0.010)	0.680
	Trimester 2 WBGT	0.009 (-0.004, 0.022)	0.167
	Trimester 3 WBGT	0.001 (-0.013, 0.014)	0.890
	Pregnancy WBGT	0.009 (-0.011, 0.029)	0.375
Birth length for age z-score (BLAZ)	Pre-pregnancy WBGT	0.016 (-0.008, 0.041)	0.188
	Trimester 1 WBGT	-0.009 (-0.029, 0.011)	0.379
	Trimester 2 WBGT	-0.010 (-0.030, 0.010)	0.334
	Trimester 3 WBGT	0.010 (-0.011, 0.031)	0.349
	Pregnancy WBGT	-0.015 (-0.046, 0.016)	0.345
Birth head circumference for age z-score (BHCAZ)	Pre-pregnancy WBGT	-0.015 (-0.036, 0.007)	0.180
	Trimester 1 WBGT	-0.032 (-0.050, -0.014)	**<0.001**
	Trimester 2 WBGT	0.009 (-0.009, 0.027)	0.318
	Trimester 3 WBGT	-0.019 (-0.037, -0.000)	**0.044**
	Pregnancy WBGT	-0.033 (-0.060, -0.006)	**0.017**
Gestational age at birth (GA)	Pre-pregnancy WBGT	-0.039 (-0.074, -0.004)	**0.029**
	Trimester 1 WBGT	0.005 (-0.023, 0.033)	0.732
	Trimester 2 WBGT	0.008 (-0.020, 0.036)	0.585
	Trimester 3 WBGT	-0.022 (-0.051, 0.007)	0.135
	Pregnancy WBGT	0.011 (-0.033, 0.056)	0.626

Data is available for the following number of study participants in pre-pregnancy and pregnancy models (n): birth weight-for-age z-score (1600), birth length-for-age z-score (1540), birth head circumference-for-age z-score (1537), gestational age (1631) and in trimester models: birth weight-for-age z-score (1599), birth length-for-age z-score (1539), birth head circumference-for-age z-score (1537), gestational age (1618). Effect sizes were calculated using linear regression models.

Bold text denotes $p<0.05$.

*Models are adjusted for maternal age, body mass index (BMI), education level (categorical; no formal education, primary or lower, secondary or higher) and parity (categorical; first pregnancy or prior delivery > 24 weeks gestational age). Analyses of anthropometrics are additionally adjusted for gestational age at birth in weeks. Trimester-specific outcomes are additionally adjusted for other trimesters as all three were included in one model.

WBGT = Wet Bulb Globe Temperature

Table 3. Associations between Heat Stress and Dichotomous Birth Outcomes

Outcome	Exposure	Adjusted* β** (95% CI)	p value
Preterm Birth	Pre-pregnancy WBGT	0.045 (-0.009, 0.100)	0.102
	Trimester 1 WBGT	0.011 (-0.035, 0.058)	0.608
	Trimester 2 WBGT	-0.043 (-0.091, 0.005)	0.078
	Trimester 3 WBGT	0.065 (0.017, 0.113)	**0.008**
	Pregnancy WBGT	-0.018 (-0.086, 0.050)	0.609
Stillbirth	Pre-pregnancy WBGT	0.023 (-0.087, 0.133)	0.680
	Trimester 1 WBGT	-0.060 (-0.158, 0.038)	0.231
	Trimester 2 WBGT	-0.014 (-0.0112, 0.085)	0.785
	Trimester 3 WBGT	0.008 (-0.088, 0.104)	0.869
	Pregnancy WBGT	-0.111 (-0.248, 0.025)	0.111

Data is available for the following number of study participants in adjusted pre-pregnancy and pregnancy models (n): preterm birth (2086) and stillbirth (2126) and in trimester models: preterm birth (2082) and stillbirth (2119). Effect sizes were calculated using logistic regression models. Bold text denotes $p<0.05$.

*Models are adjusted for maternal age, BMI, education level (categorical; no formal education, primary or lower, secondary or higher), and parity (categorical; first pregnancy or prior delivery > 24 weeks GA). Trimester-specific outcomes are additionally adjusted for other trimesters as all three were included in one model.

**β describes increased log odds for outcome with every 1 degree C increase in wet bulb globe temperature (WBGT).