

Investigating the Effects of Heatwave on Birthweight: Evidence from a Difference-in-Difference Analysis in sub-Saharan Africa

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Relevance

- Adverse shocks **prior to birth** can severely affect birthweight (e.g. Almond & Currie 2011; Torche 2011)
- With **increasing global warming**, the frequency, intensity and duration of heat related events including **heatwaves** are projected to continue to increase through the 21st century (IPCC 2019)

Why is it important?

- Birthweight is a marker of **early health status** (UNICEF & WHO 2019), it has effects on the **development and well-being** during childhood and adulthood (Barker 2004), and its negative effects can be transmitted to the **next generations** (Currie & Moretti 2007)
- Heatwave impacts may affect **population health** and **well-being** in ways that we hadn't thought of
- This is especially true for countries in SSA, that are exceptionally **vulnerable to climate extremes**

Background

- Heatwave has often been considered a source of **stress** only, triggering the production of hormones related to premature delivery
- While this may be true in high-income countries, it is not necessarily the case in low-income rural contexts
- It may also lead to **nutritional shocks** and alter the **disease environment** which may in turn affect birthweight

Mechanisms of low birthweight

- Low birthweight is caused by two **mechanisms**—reduced gestational age at birth (i.e. premature delivery) or intrauterine growth restriction (IUGR) (Kramer 1987a, 1987b)
 - The effects of stress mainly operate through **reduced gestational age at birth** (Torche 2011) and the effects of undernutrition and diseases are often reflected in **IUGR** (e.g. Almond et al. 2011; Newman et al. 2019)
- The effect on birthweight may depend on when during the pregnancy heatwave occurs, i.e. **first, second or third trimester**

Despite its policy relevance,

- The evidence of the **effect of in utero exposure to climate extremes on birthweight** in SSA is limited, and
- There is no prior evidence on the **timing** and **mechanism** underlying the heatwave effects on birthweight



This study informs when during the gestation heatwave is more critical, and the extent to which gestational age and uterine growth contribute to the effect of heatwave exposure on birthweight

For this research, I match two sources of data



Individual survey data

- Pooled Demographic and Health Surveys (DHS) from 11 countries (Angola, Benin, Burundi, Ethiopia, Malawi, Mali, Nigeria, South Africa, Uganda, Zambia, Zimbabwe) → 64,208 infants
- GPS coordinates of clusters
- New info: date of birth and duration of pregnancy



Climate data

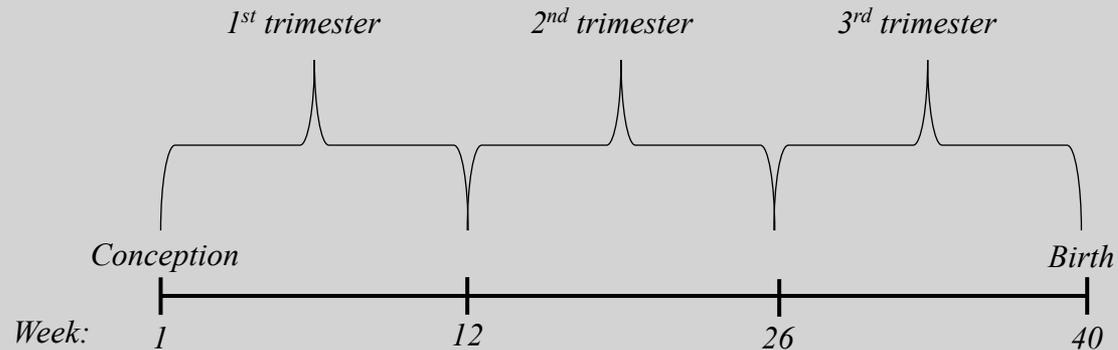
- ERA5 archive from the European Centre for Medium-Term Weather Forecasting
- Maximum temperature
- Every hour from Jan 1979 to December 2019 across grid cells



Using the latitude and longitude data in the **DHS**, each newborn is **matched** to the **climate** grid cell in which they fall

Construction of heatwave index

Heatwave: period of four or more consecutive days with daily maximum temperature (T) higher than the community's 99th centile of daily maximum temperature (t^)*



Is there a period of four and more consecutive days where $T > t^$?*

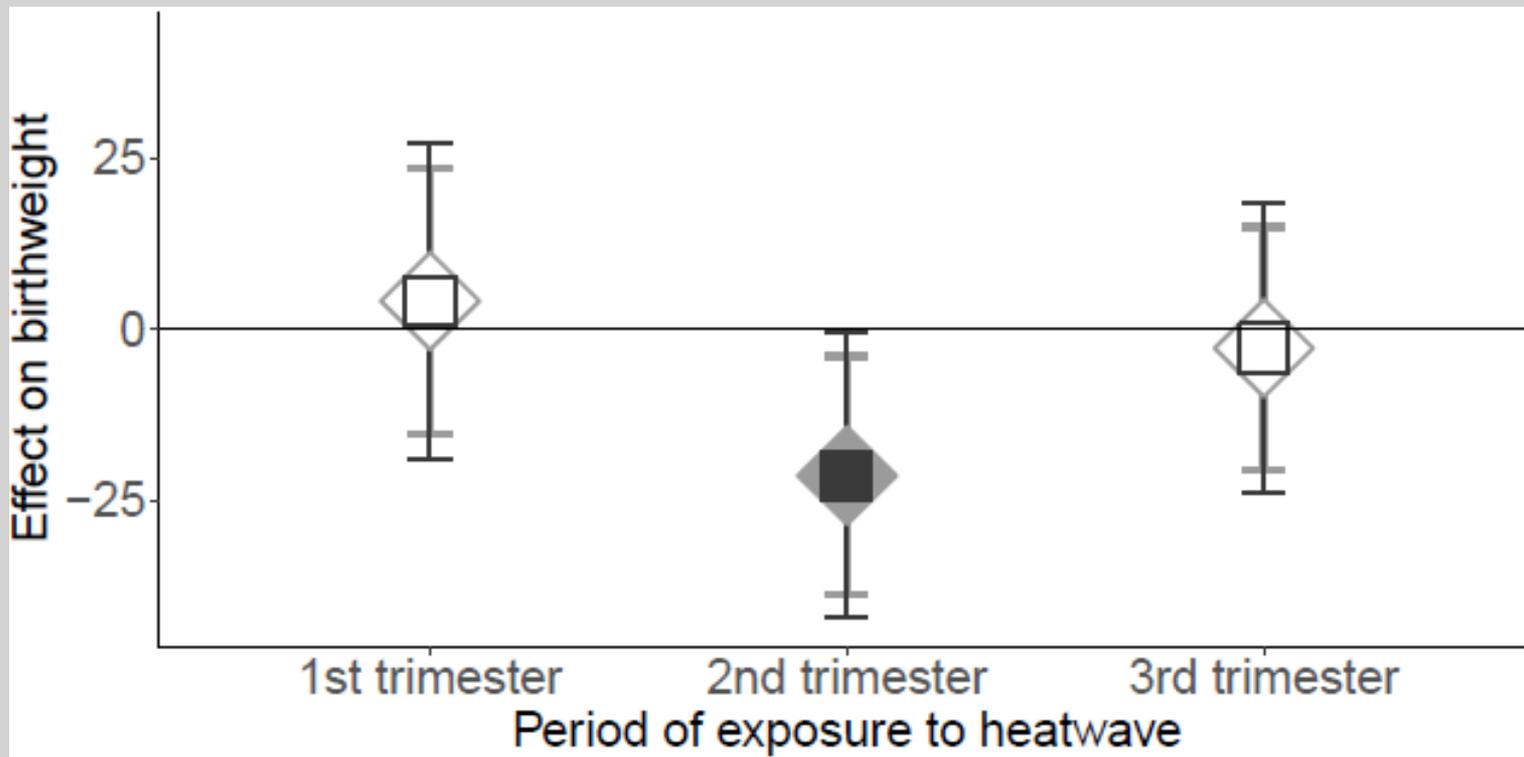
Is there a period of four and more consecutive days where $T > t^$?*

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Difference-in-difference approach:

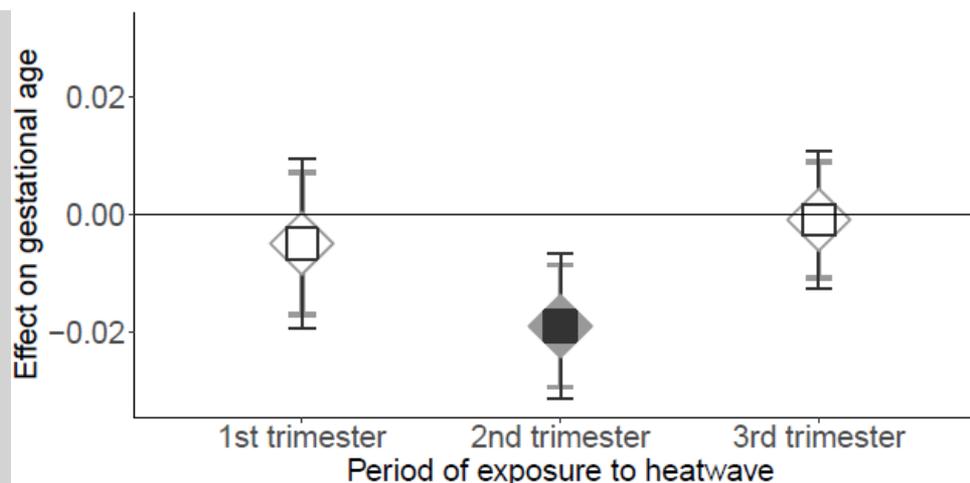
$$y_{iets} = \beta_0 + \beta_1 \text{first trimester}_{et} + \beta_2 \text{second trimester}_{et} + \beta_3 \text{third trimester}_{et} + \underbrace{x'_{it}\beta_4}_{\alpha_e} + \underbrace{\alpha_e}_{\alpha_t} + \underbrace{\alpha_t}_{\alpha_s} + \varepsilon_{iets}$$

Effect of heatwave on birthweight



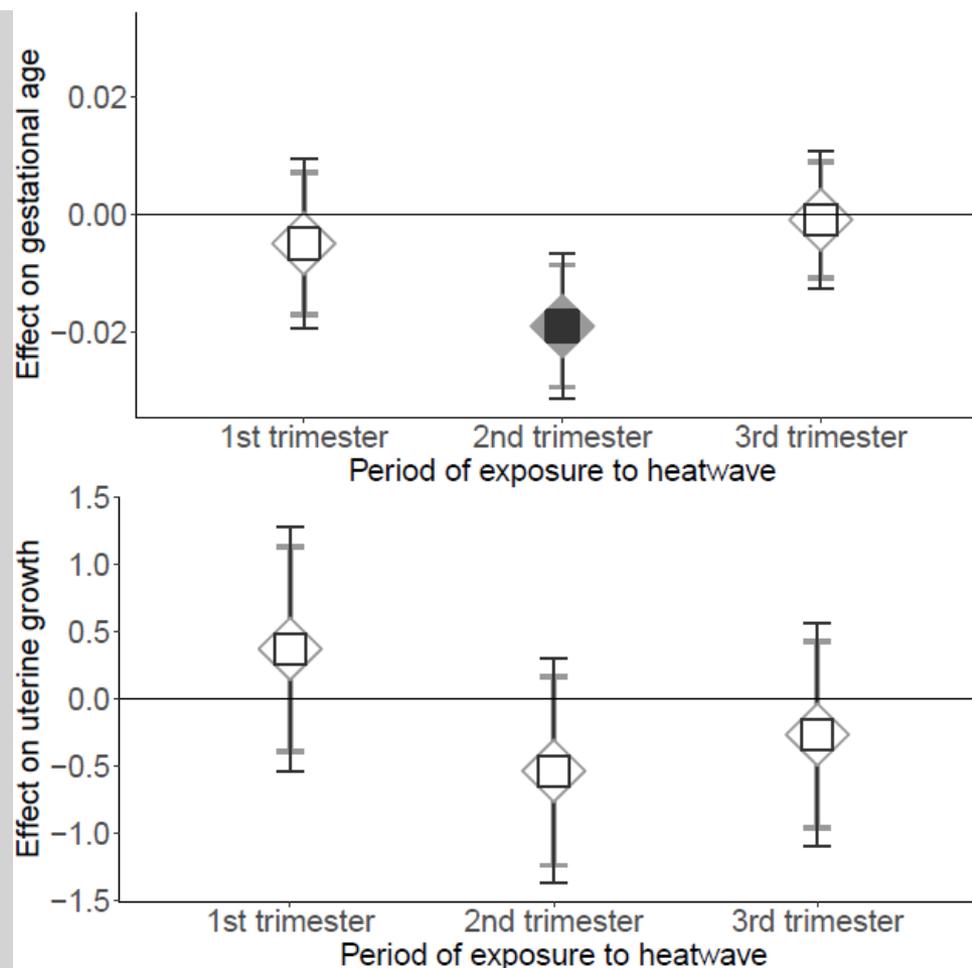
Notes: Dots indicate parameter estimates; light and dark grey vertical bars are the 90 and 95% confidence intervals, respectively; and dots coloured light and dark grey indicate estimates significant at the 10 and 5% levels, respectively. Exposure to heatwave is calculated over the forty-week interval starting from the month of conception and estimated as the effect of exposure to heatwave at different stages of pregnancy, i.e. first, second, and third trimester. Model includes fixed effects for mother's cluster of residence and for month of conception, child and mother characteristics, and survey fixed effects. Standard errors are clustered by DHS cluster.

Mechanisms: GA and UG



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Discussion

- Infants exposed to **heatwave** in the **second trimester** of gestation have significantly **lower birthweight**
- Heatwave in the second trimester of pregnancy affects birthweight through **reduced gestational age**
 - Increased prematurity, rather than intrauterine growth retardation, explains the pronounced effect on low birthweight
- I also find no evidence of **different vulnerability** to heatwave exposure across subgroups of the population

Conclusions

- The findings highlight the importance of early environmental conditions in the production of health and socioeconomic inequalities.
- The results carry important lessons for policymakers to protect *all* pregnant women from heatwave exposure to mitigate the negative impact of climate change.