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Does Humidity Matter? Prenatal Heat and Child Growth in South Asia

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Does Humidity Matter? Prenatal Heat and Child Growth in South Asia

A Thesis submitted in partial satisfaction of the requirements for the degree of Master of Arts

in Geography

by

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ABSTRACT

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Kathryn Henry McMahon

Extreme heat under climate change has already begun to threaten health, particularly for mothers and babies in the hottest parts of the world. When exposure occurs in utero, extreme heat can undermine child growth and development, leading to devastating later-life consequences for both health and socio-economic stability. Previous research, however, has often overlooked the role of humidity, which, when paired with extreme heat, can result in deadly heat stress and associated health complications. Understanding the relative effects of heat versus humid heat is important for understanding the magnitude and location of the effects of climate change, and for targeting interventions. I compare the impact of prenatal exposure to heat versus humid heat extremes on child height attainment in three South Asian countries (India, Bangladesh, and Nepal) using fine-scale climate records, trimester-level exposure identification, comprehensive data on 200,000 children from the Demographic and Health Surveys, and a rigorous fixed effects design. I find that extreme humid heat in the third trimester is five times more detrimental to height attainment than heat alone, and that maternal heat exposure in the period preceding pregnancy may have lasting negative impacts on growth trajectories after birth—a critical exposure period that has received little-to-no attention thus far with respect to child health. Specifically, the average child's height-for-age Z-score declines by 0.002 units for every additional day in the third trimester that wet-bulb globe temperatures exceed 29°C. Combining these effects with new projections of wet-bulb

globe temperature, I estimate that by 2050, climate change could increase the mean number of hot-humid days in the third trimester by 56.5% in my study region, pushing more than 930,000 additional children under 5 into stunting even before accounting for future population growth. This estimate shrinks to 315,000 children when I consider future exposure to heat alone, implying that failing to account for humidity may lead to significant underestimates of the true effects of extreme heat on child health. I further find that children without adequate sanitation access and whose mothers lack formal education or belong to systematically marginalized castes are more vulnerable to the adverse health effects of prenatal exposure to humid heat. My results provide new insight into which heat events are most dangerous for early life health and when, in a region where near-annual heat waves already affect millions and are projected to worsen under further climate change.

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I. INTRODUCTION

Climate change poses a critical threat to human health and well-being through a combination of rising temperatures, increasingly variable precipitation patterns, and more frequent and extreme weather events (Pachauri et al., 2014). These trends are of particular concern for infants and young children in tropical low- and middle-income countries, who are already exposed to many of the world's most extreme climate conditions and whose growth and development is highly dependent on proper nutrition, healthy environments, and adequate care (Burke et al., 2015; Carleton and Hsiang, 2016). This vulnerability begins even before birth; extreme weather events during pregnancy can undermine fetal development, translating into consequences for infant health at birth and physical growth trajectories in early childhood. Critically, disruptions to height attainment in the first five years of life can have long-term devastating impacts on everything from earnings and educational attainment to chronic disease risk in adulthood, making height attainment (measured by a standardized height-for-age ratio) an important marker of the health risks associated with climate change (Alderman, 2006; Almond and Currie, 2011; Davenport et al., 2017; Grace, Verdin, et al., 2021).

Although an increasing number of studies have expanded our understanding of how precipitation shocks are related to child height attainment (Grace et al., 2012; Kumar et al., 2016; Cooper et al., 2019; Dimitrova and Muttarak, 2020), the impact of extreme heat exposure is often overlooked. Those studies that do add temperature fail to consider the interaction between temperature and humidity, which can greatly influence our physiological experience of heat (Grace et al., 2015; Grace et al., 2021, McMahon and Gray, 2021). Humidity slows or prevents the evaporation of sweat from our skin, undermining the human body's natural cooling mechanism during times of extreme heat (Parsons, 2014). Ambient air temperature is therefore a coarse measure of the biological stress associated with heat exposure, which is better captured by composite metrics like the wet-bulb globe temperature, which accounts for the additional factors (like humidity) that lead to heat stress (Parsons, 2006; Budd, 2008). Pregnant people are particularly susceptible to heat stress due to hormonal changes that influence the thermoregulatory system and because metabolic heat production increases as the fetus and placenta develop. Due in part to this heightened vulnerability, extreme heat during pregnancy can shorten gestation, reduce birth weights, and increase rates of pregnancy loss and infant mortality (Davenport et al., 2017; Basu et al., 2018; Ward et al., 2019; Randell et al., 2020). Together, these factors might suggest that our estimates of the health risk associated with heat extremes during pregnancy substantially underestimate the true effect when combined with humidity. Furthermore, hot and humid locations are distinct from hot and dry locations, and if the two effects differ, these disparate locations may face different levels of climate threat (Tuholske et al., 2021).

Social and physical vulnerability to extreme heat intersect in South Asia, where inequalities in resource access and high rates of child undernutrition come head-to-head with rapidly accelerating exposure to extreme hot-humid heat (Pachauri et al., 2014; Tuholske et al., 2021). In this paper, I conduct a spatially-granular analysis of the effects of prenatal exposure to hot-humid heat on height attainment for approximately 200,000 children in Bangladesh, India, and Nepal. Importantly, I deviate from the existing literature by shifting the focus away from temperature and precipitation shocks, which interact with each other and blur the lines between different types of heat events. Instead, I utilize short-run variation in wet bulb globe temperature ($WBGT_{max}$) and observe its effect on rates of stunting in over

200,000 children under five, a key indicator of chronic undernutrition at a critical stage of growth and development. To isolate the unique impact of hot-humid heat, I run a parallel analysis with conventional temperature predictors (T_{max}) and compare the magnitude and precision of predictions from both models, as well as the relative roles of trimester-level exposure timing and demographic characteristics. By leveraging this more precise heat metric at high spatial resolutions, I highlight the early-life health risks of prenatal exposure to one distinct type of extreme heat. My findings suggest that hot-humid heat in the third trimester is five-times more detrimental to child growth than heat alone in South Asia, and that maternal heat exposure during the period before conception has long-lasting negative effects on both fertility and child health after birth. I further find that these adverse effects are amplified among socially and materially vulnerable groups, including mothers with little-to-no formal education and those lacking access to adequate sanitation infrastructure. To my knowledge, this is the first paper to directly test the effects of hot-humid heat on height-for-age against those of heat alone, as well as the first to document the potential danger of pre-conception heat exposure for child stunting.

II. BACKGROUND

In recent years, a growing body of research has demonstrated that global climate change affects human health in a myriad of ways. Moreover, these impacts are not distributed evenly across the globe; the consequences of climate change are emerging more rapidly and with more intensity in low- and middle-income countries in the global tropics, threatening those communities that often bear the least responsibility for anthropogenic environmental change (Pachauri et al., 2014; Frame et al., 2017; Mora et al., 2017). Within populations, those most vulnerable to the health risks of climate change include the elderly, those with existing health conditions, pregnant people, and young children. Nutritional health is particularly critical and delicate during pregnancy and early childhood, and it is sensitive to environmental stressors that may influence food security, disease rates, heat stress, or financial and material stability, as illustrated by Randell et al. (2020) in Figure 1. These earliest shock exposures can have lifelong devastating impacts; disruptions to health nutrition during the first 1,000 days after conception has been quantifiably linked to educational, financial, and physical outcomes well into adulthood (Rayco-Solon et al., 2005; Almond and Currie, 2011; Ramakrishnan et al. 2012; Nobles et al., 2019). While the relationship between climate extremes and child nutrition is highly context dependent, scholars generally find that both extremely wet (del Ninno and Lundberg, 2005; Dimitrova and Muttarak, 2020; Thiede and Gray, 2020) and dry (Grace et al., 2012; Kumar et al., 2016; Davenport et al.; 2017) conditions increase rates of stunting in children under five, a widely used indicator of chronic undernutrition. McMahon & Gray (2021), for instance, estimate that an additional day of extreme rain reduces height-for-age Z-score for children under five in South Asia by 0.003 and 0.006 units when exposure occurs during the prenatal period and the first year of life, respectively. Meanwhile, extreme heat is consistently associated with increased rates of low or reduced birth weight, pre-term birth, and pregnancy loss (Davenport et al., 2020; Kuehn and McCormick, 2017) as well as mortality in at-risk populations (Deschênes et al., 2016). In two multi-national studies in sub-Saharan Africa, Grace et al. (2015) find that an additional day during gestation temperatures reaching at least 100°F (38°C) can reduce mean birth weights by up to 0.9 grams, depending on trimester of exposure, while Davenport et al. (2020) estimate that a 10% increase in the number of days over 104°F (40°C) raises the likelihood of late-stage pregnancy loss by 1.9%.

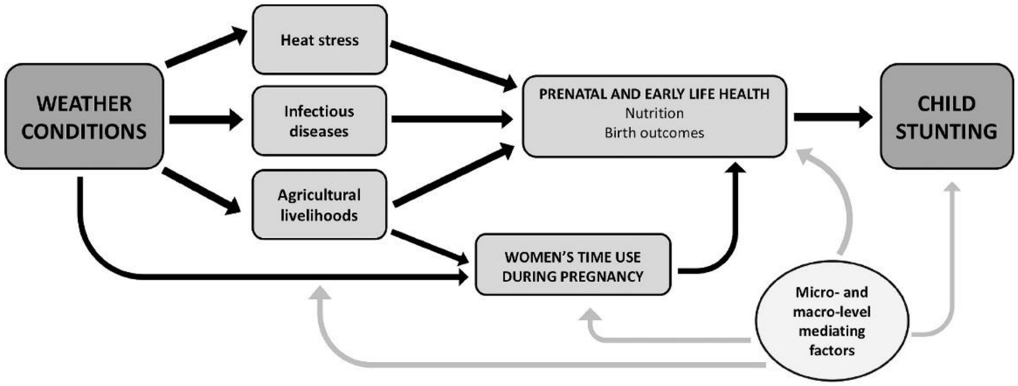


Figure 1: **Conceptual model of the linkages between weather conditions and child stunting, taken from Randell et al. (2020).**

A. Heat, Humidity, and Prenatal Exposures

Although an increasing number of studies have expanded our understanding of how temperature and precipitation shocks are related to indicators of food insecurity and child nutrition, current approaches do not consider the interactive effects of these two predictors during humid heat shocks, which may pose a distinct threat to child health. Existing research in the fields of epidemiology and physiology show that human body temperature is a function of more than just air temperature; humidity, wind speed, sunlight intensity, rates of physical activity, clothing, and preexisting health conditions all impact our bodies' perception of heat (Parsons, 2014; Bernard and Iheanacho, 2015; Vanos et al., 2020). Wet-bulb globe temperature is a heat stress metric designed to capture the combined effect of these factors in hot-humid environments (Parsons, 2006; ISO, 2017). High values of maximum wet-bulb globe temperature ($WBGT_{max}$) indicate dangerous conditions which can culminate in heat exhaustion, reduced productivity, cardiovascular events, and death in extreme cases (Burke et al. 2015; Cheung et al., 2016; Mora et al., 2017; Pradhan et al., 2019; Raymond et al., 2020; Vanos et al., 2020). Parsons et al. (2022) estimate that contemporary levels of humid heat already cost the global economy over 2 trillion per year (650 billion hours of labor), while

Pradhan et al. (2019) find that deaths due to cardiovascular causes rose to 58% among young Nepali migrant workers in Qatar during hot months (WBGT>31°C).

Furthermore, developing evidence indicates that pregnant people are at a heightened risk for the health consequences associated with hot-humid environments. Changing hormone levels and increased production of metabolic heat inhibit heat dissipation during pregnancy, making maternal core temperature more sensitive to the effects of hot-humid heat and increasing the risk of maternal heat stress, pregnancy loss, and complications at birth (Carolan-Olah and Frankowska, 2014; Zhang et al., 2017; Basu et al., 2018). Scholars also document declines conception rates during periods of extreme heat; Barreca et al. (2018) find that birth rates fall by up to 0.4% nine months after a hot day in the United States, likely due to short-term changes in reproductive health. Because of its wide-ranging effects on fertility, birth outcomes, and mortality after birth, population-level studies of prenatal heat and post-natal health can suffer from selection bias at several junctures. First, heat-induced fertility changes like those documented by Barreca et al. (2018) can reduce conceptions among parents with the most susceptibility (or exposure) to extreme heat. Next, post-conception but still prenatal selection can occur if rates of pregnancy loss are highest among the most heat-exposed women. Finally, we may see post-natal mortality among the most affected children, which may also be associated with upstream heat-related outcomes such as low birth weight or pre-term birth. Indeed, Wilde et al. (2014) find that hotter-than-average temperatures at the time of conception improves the later life outcomes of surviving children through selection. Taken together, this evidence suggests that hot-humid heat exposure may pose a greater threat to maternal and infant health than heat alone, though selection may lead us to underestimate its true effect. Nevertheless, the role of humidity in determining the impact of heat events on child health outcomes remains overlooked in the scientific literature to date, leaving considerable uncertainty around how climate change may influence health in regions, like South Asia, with increasing exposure to hot-humid extremes (Pachauri et al., 2014; Matthews et al., 2017; Tuholske et al., 2021).

B. Differential Vulnerability to Climate Extremes

Recent evidence demonstrates that children's vulnerability to prenatal climate shocks is highly dependent on the precise timing and duration of exposure to extreme conditions in utero (Shively et al., 2015; Grace, Verdin, et al., 2021) and varies widely across socio-demographic characteristics. Despite importance of exposure timing, most analyses of prenatal climate shocks and child growth either treat the year preceding birth as a single exposure period (Shively et al., 2015; Thiede and Gray, 2020; Randell et al., 2020; McMahon and Gray, 2021) or focus on only the immediate effects of trimester-level shocks, such as birth weight or non-live birth outcomes (Grace, Verdin, et al., 2021; Catalano and Bruckner, 2006). Though these advances have been highly valuable, a set of unanswered questions remain about the longer-run effects of trimester-level climate shocks and the role that exposure timing may play. Lingering undernutrition among 2-5 year-olds are of particular concern, given that the potential for catch-up growth has been shown to be limited after age two (Ninno and Lundberg, 2005). Finally, research strongly suggests that there are inequities in impact across and within communities themselves, driven by demographic characteristics related to resource access and social marginalization (Dimitrova and Muttarak, 2020; Nicholas et al., 2021; McMahon and Gray, 2021). In the South Asian context, existing research finds that household- and community-level access to sanitation infrastructure is a particularly strong determinant of nutritional vulnerability, and that sanitation access can mitigate harmful effects of early life shocks on height-for-age (Spears, 2020; Brown, Kandpal, et al., 2022; McMahon and Gray, 2021).

C. South Asian Context

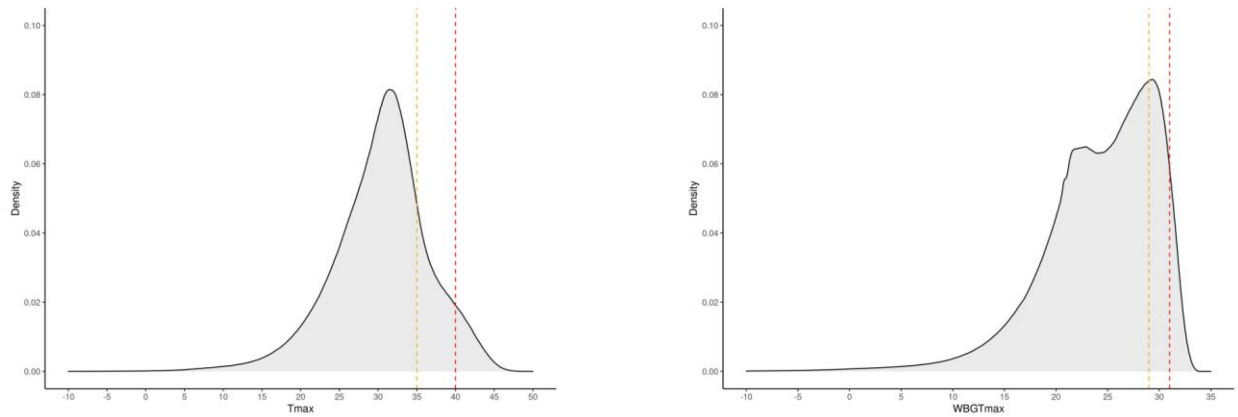
This work builds on existing research that identifies South Asia as a region burdened by both high rates of chronic undernutrition and extreme heat exposure, the latter of which is projected to increase dramatically under future climate change. Even in a scenario where societies succeed in limiting warming to 2°C above preindustrial levels, for instance, Matthews et al. (2017) predict that South Asia will suffer from deadly heat events every year. Nor are these burdens unrelated; existing research shows that children's nutritional status is highly sensitive to environmental shocks in the region (Shively et al., 2015). This literature has focused largely on precipitation extremes thus far, demonstrating that both drought (Shively et al., 2015; Kumar et al., 2016) and flood (del Ninno and Lundberg 2005; Tiwari et al., 2017; Dimitrova and Muttarak, 2020) conditions increase children's risk of stunting, suggesting a nonlinear relationship between precipitation and height attainment (Cooper et al., 2019). Though the impact of temperature extremes has been widely overlooked thus far, McMahon and Gray (2021) find early suggestive evidence that exposure to both cold and hot shocks in the first two years of life may undermine growth, particularly in Nepal and Pakistan. In addition to these population-level trends, scholars consistently find that the health effects of climate extremes vary considerably throughout the region depending on precise time and place of exposure (Shively et al., 2015; McMahon and Gray, 2021), access to adequate sanitation (Spears, 2020; McMahon and Gray, 2021), and levels of inequality across gender and caste (Coffey et al., 2019; Dimitrova et al., 2020; McMahon and Gray, 2021).

III. DATA & MEASURES

A. Heat Data

I construct localized heat exposure records for each DHS survey location (cluster) using the Climate Hazards Center InfraRed Temperature with Stations data (CHIRTS), a high-resolution gridded temperature product created by the Climate Hazards Center at UC Santa Barbara. CHIRTS is the most robust temperature product available to date, improving upon previous datasets by combining satellite imagery with in-situ station observations to produce accurate, fine-scale (0.05° resolution) temperature estimates in otherwise data-sparse regions (Funk et al., 2019; Verdin et al., 2020). This product is particularly crucial in enabling my use of $WBGT_{max}$ as a key explanatory variable. Though in situ $WBGT_{max}$ observations are sparse, particularly in the Global South, I use closely approximated $WBGT_{max}$ developed with satellite-derived temperature and humidity inputs from CHIRTS and down-scaled reanalysis data from ERA5, respectively (Bernard and Iheanacho, 2015; Tuholske et al., 2021).

My primary explanatory variables of interest capture a given child's degree of daily exposure to extreme values of maximum temperature (T_{max}) and maximum wet-bulb globe temperature ($WBGT_{max}$) during each of the four trimesters preceding birth. Whereas daily T_{max} simply records the highest ambient air temperature in a given diurnal cycle with no information about humidity, $WBGT_{max}$ was designed by the United States military to capture multiple dimensions of human heat stress in an effort to reduce heat illness during basic training (Budd, 2008). In addition to ambient air temperature, $WBGT_{max}$ contains information about relative humidity, wind speed, and sunlight intensity, all of which play a role in determining the body's capacity for heat dissipation (Bernard and Iheanacho, 2015). I select two absolute heat thresholds for each variable to capture a greater degree of the nonlinearity in the relationship between extreme heat and child health. Though many existing studies use relative thresholds (e.g., based on percentiles of local temperature distributions or deviations from a historical mean; McMahon and Gray, 2021), I argue that absolute metrics are better suited for capturing the physiological mechanisms that link extreme heat and maternal and infant health in the prenatal period (Randell et al., 2020). For T_{max}, I choose 35°C and 40°C as my low and high thresholds, given that these have been consistently linked to increased risk of heat-induced morbidity and mortality (Deschênes, 2014; Barreca, Clay, et al., 2016). Because critical biological thresholds for $WBGT_{max}$ are not as established in the literature, and to ensure maximum comparability across variables, I select values of $WBGT_{max}$ that occur with comparable frequency in my sample to the corresponding low and high thresholds for T_{max}. This approach yields $WBGT_{max}$ thresholds of 29°C and 31°C, both of which are flagged as hazardous by such organizations as the US Marines and the Occupational Safety and Health Administration and have been linked to increased risk for outdoor laborers (OSHA, 2017; Bernard and Iheanacho, 2015; Parsons et al., 2022). Figure 2 depicts the distribution of T_{max} and $WBGT_{max}$, and the orange and red lines denote the low and high heat thresholds I select for each.



(a) T_{max} (b) $WBGT_{max}$

Figure 2: **Density curves of daily T_{max} and $WBGT_{max}$ in all clusters (1983-2016).** Orange and red dotted lines mark the low (T_{max}=35°C, $WBGT_{max}$=29°C) and high (T_{max}=40°C, $WBGT_{max}$=31°C) thresholds, respectively.

B. Child Health Data

I leverage data on child growth trajectories, demographic characteristics, and village locations from the Demographic and Health Surveys (DHS), funded by USAID. The DHS collect detailed, representative data on anthropometrics and demographics in countries that often lack adequate local and national health data. I access the DHS child questionnaires in a user–friendly format from IPUMS (Boyle et al., 2022). The DHS also provide geographic identifiers at multiple scales for each household. This information becomes the key for integrating large-scale survey and environmental data. My sample includes 0- to 5-year-old children from all IPUMS-DHS surveys in Bangladesh, India, and Nepal that contain both child anthropometric records (i.e., height and weight, measured at the time of survey) and geographic identifiers at the DHS' smallest spatial unit. These spatial units are referred to as "clusters" and are approximately the size of a single rural village or urban city block. In total, my final dataset contains 209,741 observations from the following DHS rounds: Bangladesh 1999-2000 (N=4,649), Bangladesh 2004 (N=4,922), Bangladesh 2007 (N=4,220), India 2015- 2016 (N=183,942), Nepal 2001 (N=5,662), Nepal 2006 (N=4,479), and Nepal 2016

(N=1,951). It is useful to note that while DHS round-specific sampling weights help to balance unequal sample sizes between rounds, the majority of my observations are from India 2015-2016.

My outcome measures for child height include a continuous Z-score of height-for-age ratio (HAZ) and binary indicator variables for stunting and severe stunting (HAZ < -2 and HAZ < -3; WHO, 2006). These anthropometric measurements are observed at the time of survey only. Figure 3 presents the distribution of HAZ in my sample, with markers for both WHO stunting thresholds as well as the sample median. The height-for-age Z-score for each child is calculated relative to the median height among a globally-representative population of children of the same age and sex (WHO, 2006), and ranges from -6 to 6 standard deviations. Strikingly, the sample median falls close to HAZ = -2, meaning that nearly 50% of all 0-5 year-olds in my sample were stunted at the time of survey. To account for potential selection bias in my individual-level models of child height, I will also consider the total number of births per month recorded at the state level across all DHS rounds. Though I am primarily investigating the effects of extreme heat on HAZ and stunting because of existing evidence linking them to adverse outcomes for well-being in adulthood (Alderman, 2006; Almond and Currie, 2011), my conceptual framework based on the epidemiological literature suggests that extreme heat during the year preceding birth may also lead to higher rates of early- and late-stage miscarriage, pre-term birth, and reductions in fertility related to biological or behavioral mechanisms (Barreca, Deschênes, et al., 2018; Randell et al., 2020). Where these outcomes of extreme heat exposure exist, they may be systematically removing the children who are most vulnerable to heat from my sample, whether through mortality or reductions in fertility among the most vulnerable mothers. Such selection bias would mean that my estimates of the true heat effect on child health are biased downwards. I will therefore conduct a secondary set of models (described below) using total births as the dependent variable in order to test for selection bias in the main results on HAZ. Like the measures of child height, I construct this state-level variable for births per month using the child questionnaires.

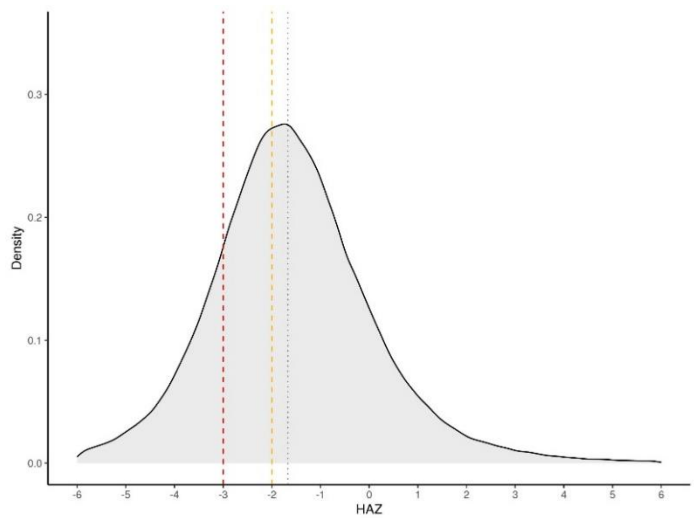


Figure 3: **Density curve of HAZ in all DHS clusters.** Black dotted line marks the sample median. Orange and red dashed lines mark the WHO thresholds for stunting and severe stunting, respectively.

C. Data Integration

To define trimester-level heat exposure for each child in my sample, I first extract a 34-year record (1983-2016) of CHIRTS daily T_{max} and $WBGT_{max}$ values at the cluster level. This is done by calculating a spatially-weighted mean of all pixel values that fall within 10 kilometers of a given cluster for each day from 1983-2016. I include a 10-kilometer buffer to account for the random displacement of cluster locations (up to 10km) conducted by the DHS to protect survey respondents' privacy. Though some scholars have argued for alternative approaches to account for such displacement in population-environment research (Grace, Nagle, et al., 2019), this buffer technique remains robust when dealing with temperature variables. I then use unique DHS identifiers to link individual children to their local heat records at the cluster level. To protect my identification of individual-level heat exposure, I exclude any respondents who moved residences at any point during the child's life or prenatal year, as well as those lacking data on migration history altogether (N=120,608). With the resulting integrated dataset, I identify all days in which cluster-level values of $WBGT_{max}$ and T_{max} exceeded one or more of my biologically-relevant thresholds. Finally, I use information on children's age and month of birth from the DHS to count the total number of hot days in each of the four trimesters before birth. In addition to trimesters 1-3, during which gestation takes place, I also observe heat exposure during 'trimester 0', which spans the three months preceding conception. Aside from the importance of proper nutrition during this period (Grace, Verdin, et al., 2021), extreme heat during trimester 0 has been shown reduce conceptions (Lam and Miron, 1996; Barreca et al., 2018) and decrease the birth weights of babies born 9-12 months later (Grace et al., 2015), suggesting that these pre-conception months are important determinants of health trajectories for mothers and babies throughout pregnancy and beyond. Because the DHS does not record exact date of birth (only month and year) for the vast majority of children in my sample, I mark the start and end of each trimester using the 15th day of a given month. Though consistent across observations, this strategy means that a fraction of hot days is necessarily mis-assigned for any child not born on the 15th of the month. Figure 3 shows the joint spatial distribution of prenatal heat exposure (defined at both thresholds of $WBGT_{max}$ and T_{max}) and stunting occurrence across all DHS clusters in my sample.

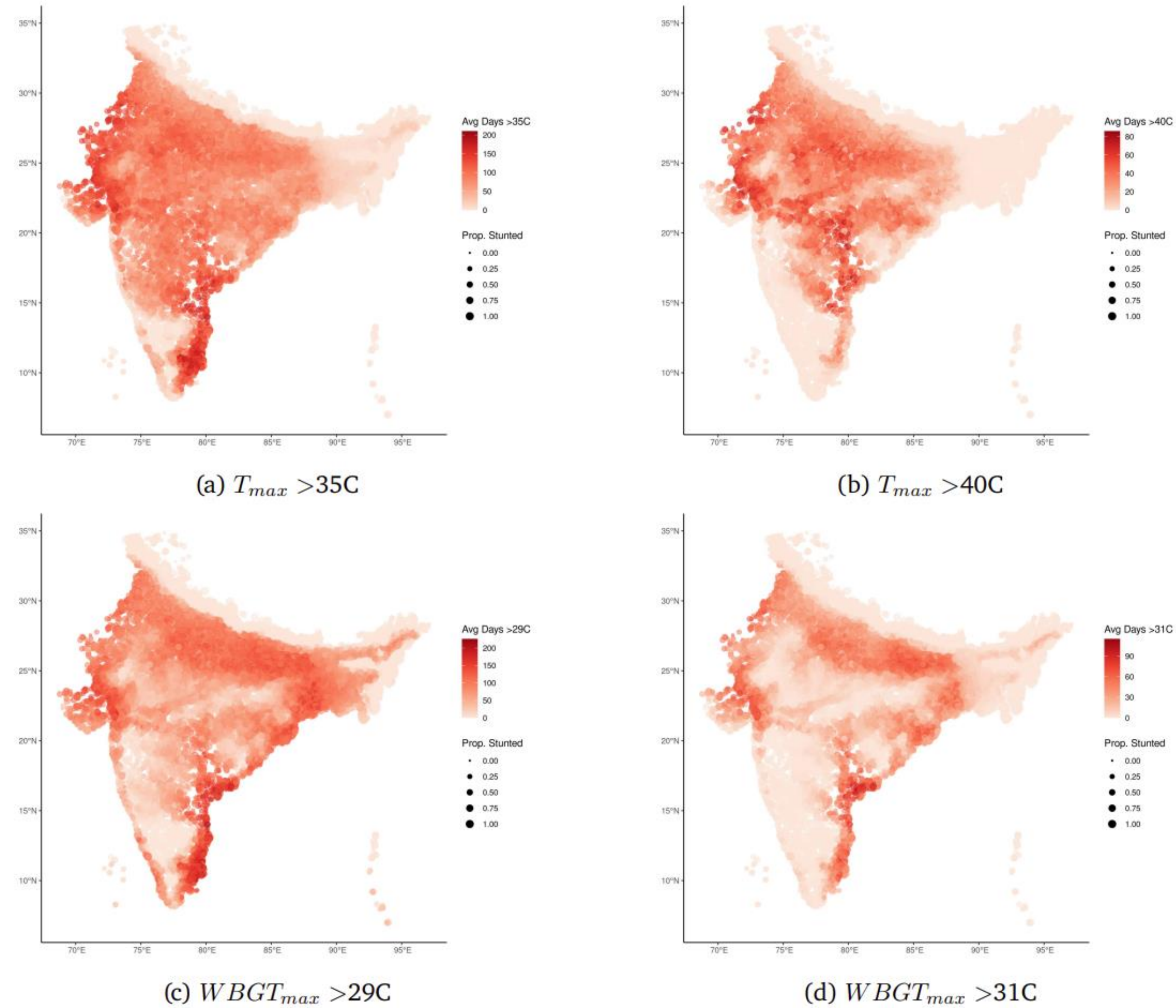


Figure 4: Joint spatial distribution of average prenatal heat exposure and stunting rates by DHS cluster. Each point represents a cluster, where color is determined by the cluster-level average number of hot days experienced by 0-5 year olds during trimesters 1-3. Point size reflects the proportion of 0-5 year olds stunted at the time of survey.

IV. EMPIRICAL STRATEGY

A. Height-For-Age Estimation

Analytic methods include both descriptive and inferential statistics, conducted while controlling for a comprehensive set of demographic factors and including a fixed effects regression technique that accounts for potential spatial and temporal confounders to undernutrition. All analyses are replicated for both sets of heat variables (high and low thresholds of $WBGT_{max}$ and T_{max} each), with particular attention to differential predictive power between them, evaluated based on the magnitude and precision of parameter coefficients. My first model of child height is estimated as follows:

$$Y_{ij} = \beta_0 + \beta_1 W_{j\tau} + X_{ij} + \mu_j + \gamma_{ts} + \epsilon_{ij} \quad \text{(Model 1)}$$

where Y_{ij} is the value of one of two height-related independent variables (HAZ or stunting) for child *i* in DHS cluster *j*. I model both outcomes in a linear regression framework, which implies a linear probability model for my binary stunting indicator. Meanwhile, β_1 is the coefficient on the number of days (W_{jt}) that fall above a given heat threshold in each trimester τ. The explanatory variable $W_{j\tau}$ enters the model using a cumulative stepwise function evaluated at each of the four trimesters τ before child *i*'s birth. The X_{ij} term is a comprehensive set of controls at the child, maternal, and household levels. These include the child's sex, twin status, birth order, and birth location (health clinic or other); mother's educational attainment, parity, religion, and marital status; and an indicator variable for whether the household has access to an improved toilet (defined using DHS classifications). A set of individual-level controls for child's age in months, birth month, mother's age in years, and month of DHS survey is also captured in X_{ij} to account for nonlinearity in height-for-age across age groups and seasonal variation in nutritional status. μ_j represents cluster fixed effects, which controls for latent and time-invariant community-level characteristics that influence children's heights. Finally, I include state-by-survey-year fixed effects (γ_{ts}) to flexibly capture macro-level trends in child health and nutrition over time. With these robust fixed effects, the remaining variation comes from within-cluster differences in prenatal heat exposure among individuals, based on the varying ages of children in my sample. I further include DHS sampling weights to account for the clustered sampling design and unequal sample sizes across countries and survey years, and I cluster standard errors at the DHS cluster level.

While model (1) provides an initial look at the relationship between HAZ and each of my four heat thresholds, we may wish to compare the effects of T_{max} and $WBGT_{max}$ extremes more directly. For this purpose, my second model includes exposure to both T_{max}>35°C and $WBGT_{max}$>29°C among the covariates:

$$Y_{ij} = \beta_0 + \beta_1 T35_{j\tau} + \beta_2 WBGT29_{j\tau} + X_{ij} + \mu_j + \gamma_{ts} + \epsilon_{ij} \quad \text{(Model 2)}$$

where the outcome, controls, and fixed effects terms all remain the same as above. β_1 now captures the effect of a marginal increase in the number of days where T_{max} exceeded 35°C in cluster *j* during each trimester *τ* on my approximation of the conditional mean of HAZ, holding other covariates (now including hot-humid heat exposure) constant. On the other hand, *β2* now reports the marginal effect of trimester-level exposure to days with $WBGT_{max}$>29°C, unconfounded by T_{max}. I fit two additional models that are not presented in the main body of the paper; the first is identical to model (2) but uses the corresponding high heat thresholds, T_{max}>40°C and $WBGT_{max}$>31°C, and the second uses all four thresholds in a single regression. These equations and corresponding results are excluded from the main text due to concerns about low sample variation in the highest heat thresholds as well as strong positive correlation between the high and low thresholds of the same metric in the same trimester (e.g., T_{max}>35°C and T_{max}>40°C in trimester 1, given that the latter indicator completely predicts the former for any given day). See the appendix for further details.

B. Births Estimation

Given that HAZ is calculated using height measurements from the time of survey alone, there may be reasonable concern about selection into my sample. For instance, it may be that the women who are most vulnerable to heat exposure are less likely to conceive during periods of extreme heat, due to changes in either reproductive health or fertility behavior, or else more likely to suffer pregnancy loss or similar complications when extreme heat occurs. To investigate potential selection bias in the main results on child height, my final equation models births at the state level and takes the following form:

$$Y_{st} = \beta_0 + \beta_1 W_{s\tau} + \mu_s + \gamma_t + \epsilon_{st} \qquad \text{(Model 3)}$$

where Y_{st} denotes the number of births recorded in a given state *s* and month-year *t* (where equivalent calendar months in different years are distinct from each other). The primary explanatory variable of interest, $W_{s\tau}$, reflects the average number of hot days experienced in trimester τ experienced by all children born in state *s* and month-year *t*. As above, $W_{s\tau}$ enters the model through a cumulative stepwise function for each trimester, μ_s is a state-survey fixed effect, and γ_t contains fixed effects for both calendar month and year. Standard errors are clustered at the state-survey level. To supplement and check the robustness of the results from this model, I also fit a Poisson regression and a negative binomial regression, both of which are commonly used to model count variables. The results from these alternate models can be found in the appendix.

V. RESULTS

A. Descriptive Analysis

Table 1 reports simple descriptive statistics for all individual-level child health outcomes and explanatory variables (including trimester-specific heat exposure metrics and demographic controls) used in analyses. First, and notably, chronic undernutrition is widespread among 0-5 year-olds in my sample; 39% of children are stunted, and 17% are severely stunted. Additionally, 3% of all children in my sample died within the first month after their birth (neonatal mortality) and 5% within the first year (infant mortality). This number is reflected in the 5% of observations coded as "Missing" for HAZ, stunting, severe stunting, and child's age. Because my outcome for total births per month is aggregated to the state level and therefore has a different sample size (N=3,677), it is omitted from Table 1. Instead, I note here that the mean number of births per month across all states and months in my dataset is 61.62, with a standard deviation of 110.50.

Summary statistics for the maternal demographic variables suggest that the vast majority (99%) of mothers in my sample are married, and most have had two or more children by the time of DHS survey. 53% of mothers are stunted, suggesting an accumulation of undernutrition into adulthood for many women in my sample. A large majority of women received either no formal education (37%) or a secondary school qualification (40%), only 53% of surveyed households had access to an improved toilet, and only a fifth were qualified as urban by DHS standards. Finally, Table 1 gives an overview of the distribution of extreme heat (for all heat thresholds) throughout the prenatal period across my integrated dataset. Within each heat threshold, there tends to be slightly fewer hot days on average during trimester 0 compared with later trimesters, suggesting an underlying seasonal trend in fertility. The frequency of days exposed to the lower (T_{max}>35°C & $WBGT_{max}$>29°C) and higher (T_{max}>40°C & $WBGT_{max}$>31°C) heat thresholds is largely consistent between the two variables, and the difference between the mean and median number of hot days per trimester for each row reflects the left-skewness of the heat distributions (see Figure 2). Though not reported in Table 1, additional exploratory analyses reveal high levels of positive correlation between the lower and higher thresholds of each heat exposure variable (e.g. T_{max}>35°C & T_{max}>40°C) at the trimester level (Pearson coefficient >0.8 in all cases). There is also a moderate positive correlation between T_{max}>35°C & $WBGT_{max}$>29°C (Pearson coefficient = ~0.67) and T_{max}>40°C & $WBGT_{max}$>31°C (Pearson coefficient = ~0.58).

B. Main Analysis

Figure 5 presents the coefficients and 95% confidence intervals on prenatal heat exposure from my first models of HAZ (5a), stunting (5b), and severe stunting (5c), estimated as described above using a comprehensive suite of fixed effects and demographic controls (see appendix for full regression results tables). The coefficients from each model show a clearly nonlinear pattern in the heat-height relationship depending on trimester of exposure, where exposure during the beginning and end of the prenatal period (trimesters 0 and 3) appears to be most detrimental to growth. This general pattern holds for all outcomes and heat metrics, though there is notable variation in the magnitudes among heat variables and thresholds. For example, holding all explanatory variables constant, one additional day with $WBGT_{max}$>29°C during trimesters 0 and 3 decrease the linear projection of HAZ by 0.001 (SE=0.0006) and 0.002 (SE=0.0006) standard deviations, respectively. On the other hand, an additional day above the higher $WBGT_{max}$ threshold, 31°C, does not appear to decrease in HAZ in any trimester. On the contrary, an extra hot-humid day at the $WBGT_{max}$>31°C level in trimester 1 corresponds to a 0.002 standard deviation increase in HAZ (SE=0.0008) which may be consistent with increased probability of pregnancy loss or infant mortality among vulnerable groups. There is a similar relationship between the high and low thresholds for conventional temperature; the estimated coefficients on T_{max}>40°C are more positive than those on T_{max}>35°C for every trimester of exposure. For T_{max}, a 0.001 (SE=0.0006) standard deviation decrease in average HAZ with an additional day above 35°C in trimester 0 is the only effect that is statistically significantly different from zero at the 5% level. Panels 5b and 5c show the coefficients on stunting and severe stunting, using an otherwise identical model specification to the regression of HAZ. Here, the plotted coefficients represent the change in the linear projection of the probability of the outcome (stunting or severe stunting) given an additional day of extreme heat, holding the other explanatory variables constant. Because they illustrate very similar patterns within and between heat metrics to those in Panel 5a, I do not stress them here. After adjusting for multiple hypothesis testing using the Hommel method (Hommel, 1988), which is robust to positive association between tests, all but one of the coefficients[1] on $WBGT_{max}$ exposure remain statistically significant at the 5% level across all outcomes, whereas only the reduction in the probability of severe stunting associated with second trimester exposure to T_{max}>40°C retains equal significance.

To compare the relative health risks of heat and hot-humid heat more directly, Figure 6 depicts the estimated coefficients of interest from my second model of child height, which takes all trimester-level counts of days with T_{max}>35°C *and* days with $WBGT_{max}$>29°C as covariates in the same regression (see Empirical Strategy for full model details). While there is no longer a statistically detectable difference in the effects of T_{max} and $WBGT_{max}$

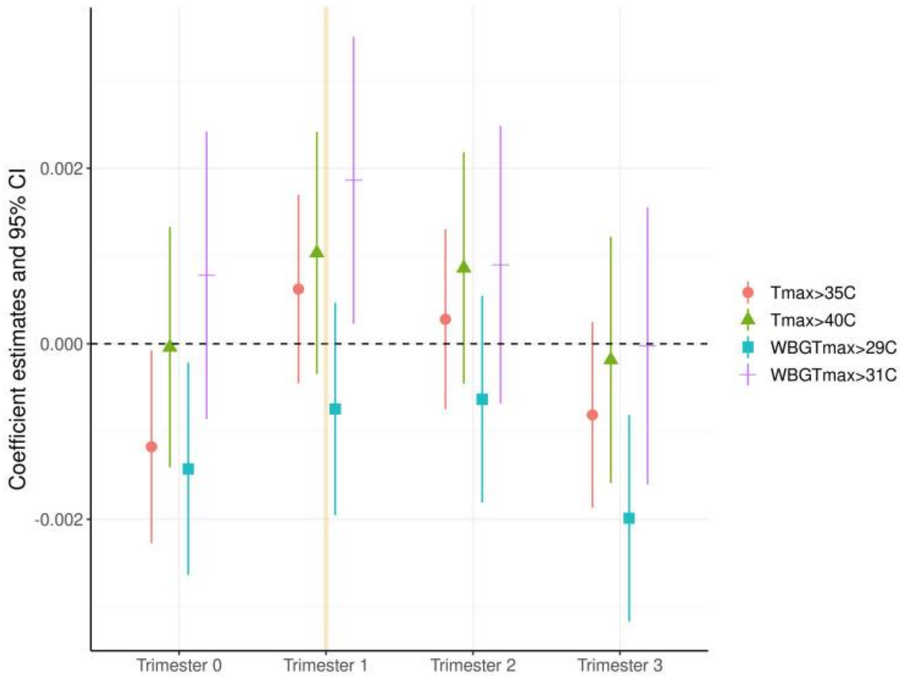
[1] The estimated effect of exposure to $WBGT_{max}$>29°C in trimester 0 on the probability of stunting is now marginally significant (P = 0.059).

exposures during trimester 0 on HAZ, Figure 6 reveals that exposure to wet-bulb globe temperatures above 29°C is increasingly detrimental to child growth as pregnancy progresses. When exposure occurs in trimester 2, an additional day with $WBGT_{max}$>29°C corresponds to an average decrease in HAZ by 0.001 standard deviations (SE=0.0007). When an equivalent exposure occurs in trimester 3, however, the estimated effect doubles in magnitude to a decrease of 0.002 (SE=0.0007). There is no corresponding decrease in HAZ associated with exposure to maximum temperatures above 35°C in any trimester after conception. With the exception of trimester 0, the point estimates on T_{max}>35°C exposure remain positive or close to zero.

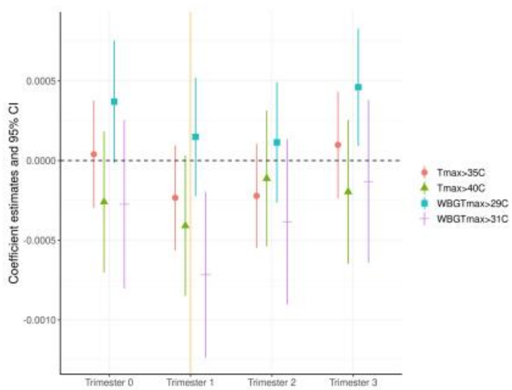
Because the results presented in Figures 5-6 only include children who were alive at the time of DHS survey, I conduct a secondary state-level fixed-effects analysis regressing total births per month on heat exposure. This is an investigation of potential selection bias in my estimates of the effect of extreme heat on child height; if extreme heat during the exposure period of interest is also reducing the number of children that are born, then the coefficients plotted in Figures 5-6 underestimate the true costs of prenatal exposure to extreme heat for child health. Figure 7 displays the results of this investigation, where each "trimester" refers to the three-month period corresponding to the trimesters of gestation preceding the month of observation. Most notably, extreme heat exposure 9-12 months before the observed month (designated as trimester 0) has the greatest impact on total births. During this period, an additional day with $WBGT_{max}$>29°C and T_{max} >40°C corresponds to an estimated reduction of 0.36 births (SE=0.18) and 1.5 births (SE=0.51) per state, respectively. The heat effect shrinks as exposure occurs in later trimesters; an extra day with T_{max}>40°C in trimester 1 leads to 0.5 fewer births (SE=0.29) in the observed month, and extreme heat in the previous 0-6 months (trimesters 2 and 3) have little-to-no effect on total births. Overall, the coefficients on every heat metric follow the same general curve from trimester 0 to trimester 3, and the effect size of the high heat threshold generally exceed that of the low heat threshold for both T_{max} and $WBGT_{max}$ (though the effect of $WBGT_{max}$ is estimated with lower confidence).

	Unique (#)	Missing (%)	Mean	SD	Min	Median	Max
Child Demographics							
Height-for-age	1201	5	−1.57	1.66	−6.00	−1.67	6.00
Stunted	2	0	0.39	0.49	0.00	0.00	1.00
Severely stunted	2	0	0.17	0.37	0.00	0.00	1.00
Neonatal mortality	2	0	0.03	0.18	0.00	0.00	1.00
Infant mortality	2	0	0.05	0.21	0.00	0.00	1.00
Age (months)	61	5	30.82	16.95	1.00	31.00	60.00
Birth order	16	0	2.57	1.62	1.00	2.00	16.00
Twin	2	0	0.02	0.13	0.00	0.00	1.00
Female	2	0	0.48	0.50	0.00	0.00	1.00
Maternal Demographics							
Stunted	2	0	0.53	0.50	0.00	1.00	1.00
Parity	16	0	2.86	1.65	1.00	2.00	16.00
Married	2	0	0.99	0.11	0.00	1.00	1.00
Educational Attainment							
None	2	0	0.37	0.48	0.00	0.00	1.00
Primary	2	0	0.16	0.37	0.00	0.00	1.00
Secondary	2	0	0.40	0.49	0.00	0.00	1.00
Higher	2	0	0.07	0.26	0.00	0.00	1.00
Religion							
Christian	2	0	0.07	0.25	0.00	0.00	1.00
Hindu	2	0	0.70	0.46	0.00	1.00	1.00
Muslim	2	0	0.20	0.40	0.00	0.00	1.00
Buddhist	2	0	0.01	0.11	0.00	0.00	1.00
Sikh	2	0	0.01	0.11	0.00	0.00	1.00
Jain	2	0	0.00	0.03	0.00	0.00	1.00
Improved toilet	2	0	0.53	0.50	0.00	1.00	1.00
Urban	2	0	0.21	0.41	0.00	0.00	1.00
Prenatal Heat Exposure							
Days with Tmax>35C							
Trimester 0	93	0	17.32	25.08	0.00	3.00	92.00
Trimester 1	93	0	18.30	25.70	0.00	3.00	92.00
Trimester 2	93	0	20.41	26.64	0.00	5.00	92.00
Trimester 3	93	0	19.51	26.13	0.00	4.00	92.00
Days with Tmax>40C							
Trimester 0	84	0	4.86	11.72	0.00	0.00	84.00
Trimester 1	86	0	5.30	12.14	0.00	0.00	86.00
Trimester 2	83	0	6.11	12.90	0.00	0.00	84.00
Trimester 3	82	0	5.75	12.50	0.00	0.00	82.00
Days with WBGTmax>29C							
Trimester 0	93	0	20.41	26.95	0.00	3.00	92.00
Trimester 1	93	0	20.26	27.07	0.00	3.00	92.00
Trimester 2	93	0	22.91	28.16	0.00	7.00	92.00
Trimester 3	93	0	23.52	28.73	0.00	7.00	92.00
Days with WBGTmax>31C							
Trimester 0	82	0	5.98	12.25	0.00	0.00	84.00
Trimester 1	84	0	6.08	12.49	0.00	0.00	83.00
Trimester 2	84	0	7.05	13.37	0.00	0.00	84.00
Trimester 3	84	0	7.29	13.63	0.00	0.00	84.00

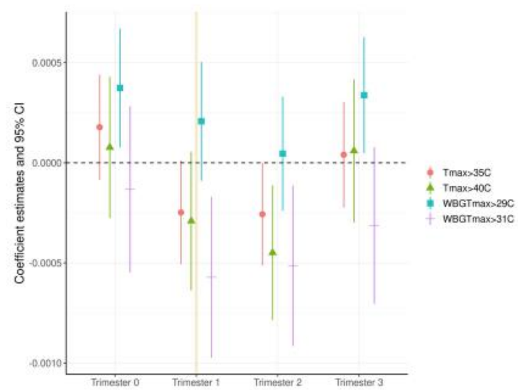
Table 1: **Unweighted summary statistics for explanatory variables and outcomes (N=209,741).**



(a) HAZ



(b) Stunting



(c) Severe Stunting

Figure 5: Results from HAZ model 1. Coefficients and 95% confidence intervals for the estimated effect of extreme heat exposure on HAZ (Panel 5a), stunting (Panel 5b), and severe stunting (Panel 5c). The yellow vertical line represents conception. Controls for child's sex, twin status, birth order, birth location, child's age in months, birth month, month of survey, mother's age in years, mother's educational attainment, parity, religion, marital status, and improved toilet access are included in the model but not shown. Fixed effects for cluster and state-by-survey-year are also omitted (see appendix for full regression results tables).

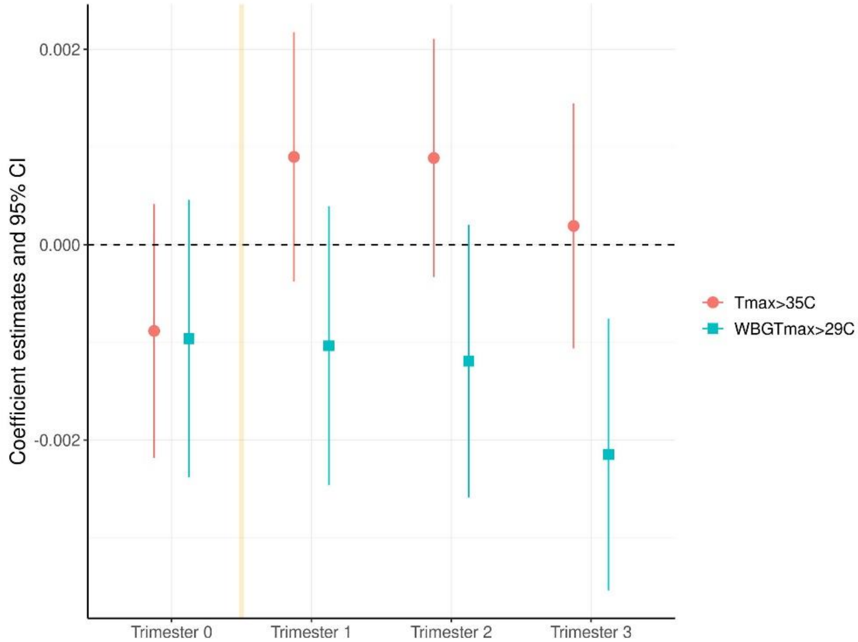


Figure 6: **Results from HAZ model 2.** Coefficients and 95% confidence intervals for the estimated effect of extreme heat exposure on HAZ, using regression model 2 (see Empirical Strategy). The yellow vertical line represents conception. Controls for child's sex, twin status, birth order, birth location, child's age in months, birth month, month of survey, mother's age in years, mother's educational attainment, parity, religion, marital status, and improved toilet access are included in the model but not shown. Fixed effects for cluster and state-by-survey-year are also omitted (see appendix for full regression results tables).

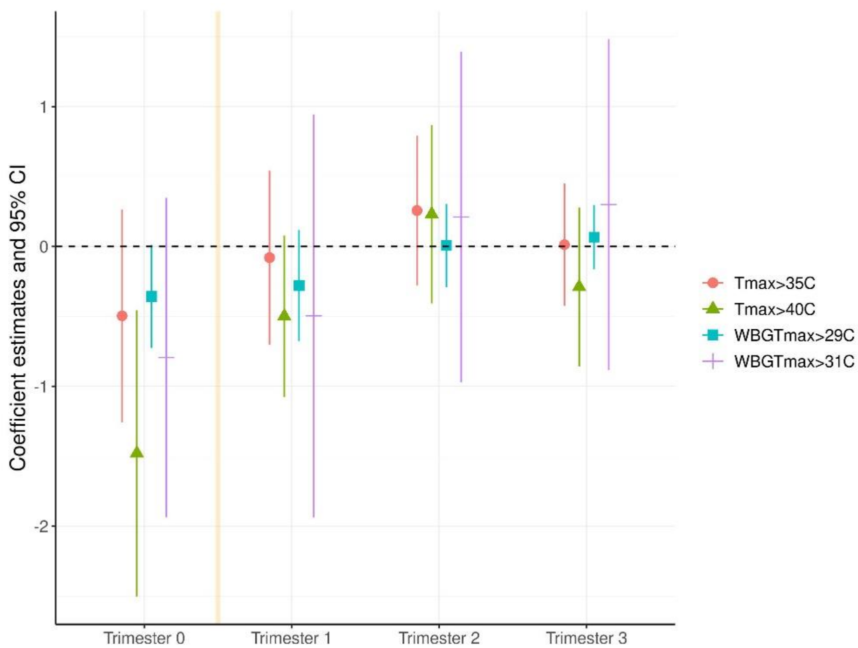
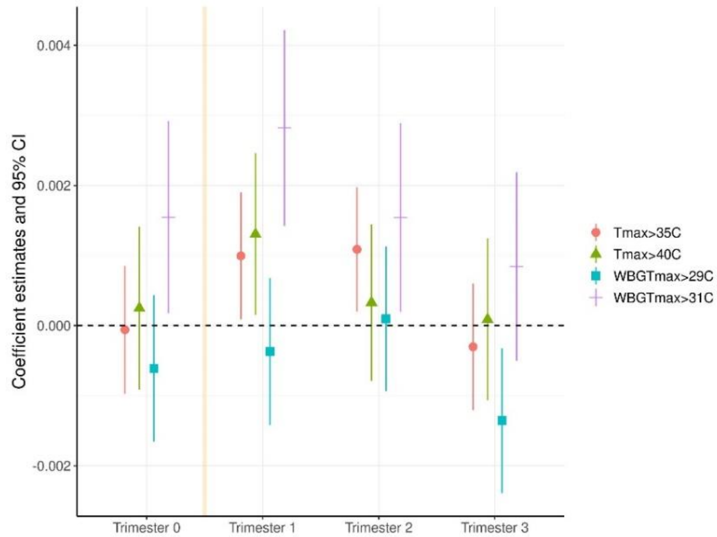


Figure 7: **Births results.** Coefficients and 95% confidence intervals for the estimated effect of extreme heat exposure on total births per month at the state level. The yellow vertical line represents conception. Fixed effects for state (by survey), month, and year are included in the model but not shown (see appendix for full regression results table, as well as results from alternate specifications using poisson and negative binomial regression).

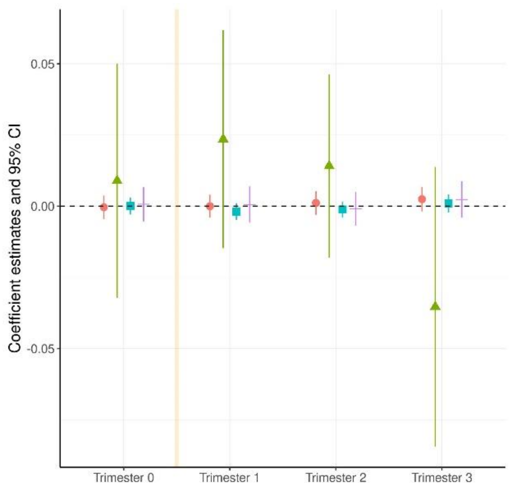
C. Effect Heterogeneity

I next test for heterogeneity in the effect of extreme heat on child height by replicating the main results with certain geographic subsets of the sample and by including interaction terms between key sociodemographic characteristics and my heat exposure variables. First, I rerun Model 1 separately for each country – Bangladesh, India, and Nepal. The coefficients of interest and corresponding 95% confidence intervals from these models can be viewed in Figure 8, and the regression results tables can be found in the Appendix. I find considerable differences in the direction, and magnitude, and temporal dynamics of the relationship between extreme heat and HAZ across countries. While the trend for each heat metric still follows an inverted U-shaped pattern by trimester of exposure among children in India, Figure 8 shows that only exposure to $WBGT_{max}$>29°C in the third trimester corresponds to a decrease in HAZ after birth. Indeed, these findings suggest that 0-5 year-olds in India who are exposed to any extreme heat during trimesters 1 and 2 or days with $WBGT_{max}$>31°C in any trimester are taller on average than their non-exposed counterparts. This in stark contrast to the observed results in Nepal, where nearly all point estimates for heat exposure are negative, and days with $WBGT_{max}$>31°C or T_{max}>40°C are particularly harmful in trimester 3. Meanwhile, the model detects no clear difference in the heights of exposed and non-exposed children in Bangladesh (though the coefficients on the number of days with T_{max}>40°C are estimated with little precision in each trimester, as indicated by the large standard errors). Figure 9 subsequently reveals that the main effects of extreme heat on HAZ do not vary as significantly among urban and rural clusters as among countries, though mothers and babies in rural places appear more vulnerable to hot-humid heat exposure ($WBGT_{max}$>29°C) in the third trimester.

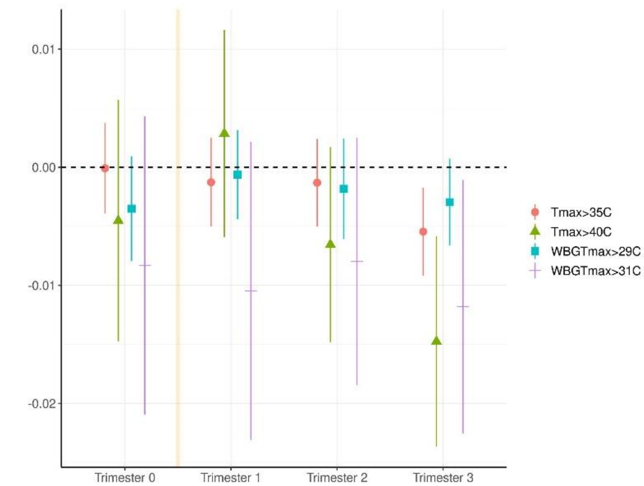
Finally, I depict heterogeneity in the main results according to socio-demographic characteristics by plotting the interactive effects of extreme heat and sanitation access, maternal educational attainment, and caste, which is available for India only (Figures 10-12). Taken together, these figures indicate that extreme heat exposure is more likely to translate into reductions in HAZ for socially disadvantaged mothers and their children, whereas heat-exposed children from privileged backgrounds are often even taller than their non-exposed counterparts. For instance, for every additional hot day (by any of my definitions) in trimesters 0 or 3, the average child belonging to households without an improved toilet is approximately 0.002 standard deviations shorter for their age than if the heat exposure had not occurred, a magnitude larger than that observed in the aggregate model (see Figure 5). By contrast, I estimate that extreme heat exposure in trimester 0 has no negative effect on HAZ for children with access to an improved toilet, and exposure to an additional day with T_{max}>40°C or $WBGT_{max}$>31°C even correspond to an increase in HAZ of about 0.003 standard deviations in every trimester. While exposure to $WBGT_{max}$>29°C in trimester 3 poses a risk for children with all toilet types, its estimated negative effect is twice as large for those who lack access to adequate sanitation. Likewise, children whose mothers have received no formal education or who belong to a disadvantaged ("scheduled") caste or tribe are shorter for their age on average following exposures to extreme heat in trimesters 0 and 3, while those whose mothers have received at least a secondary education and who do not belong to a disadvantaged social or ethnic group are not. I observe the same pattern of social vulnerability to heat for other under-resourced groups, such as children with many older siblings, and present these additional analyses in the Appendix.



(a) India

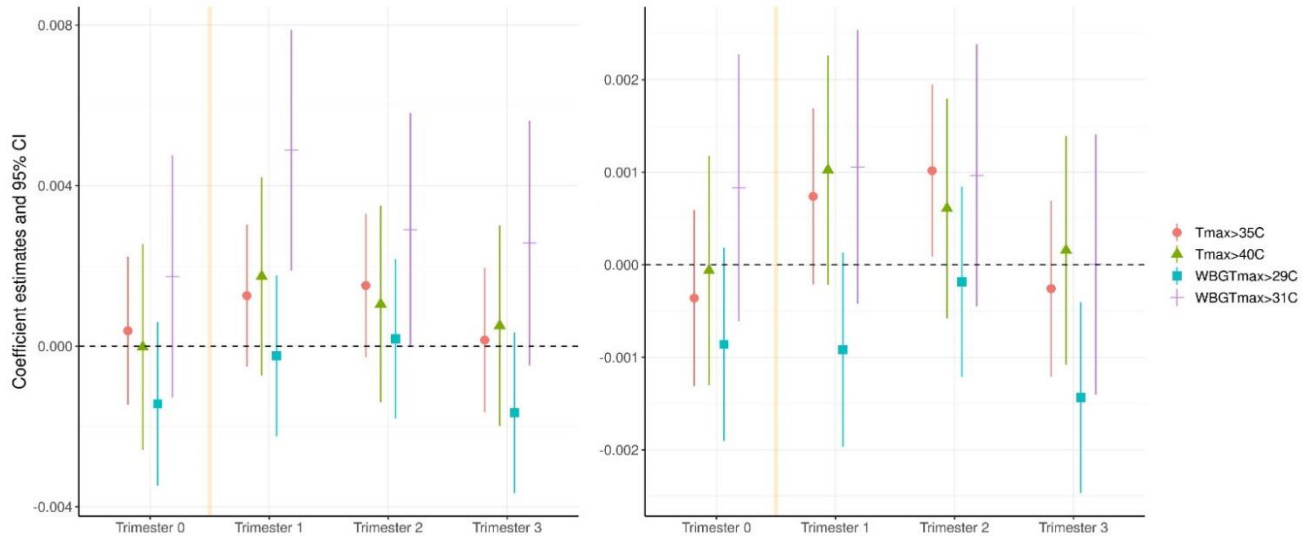


(b) Bangladesh



(c) Nepal

Figure 8: **HAZ results (model 1) by country.** Coefficients and 95% confidence intervals for the estimated effect of extreme heat exposure on HAZ, separated by country. The yellow vertical line represents conception. Controls and fixed effects for cluster and state-by-survey-year are omitted (see appendix for regression results tables).



(a) Urban (b) Rural

Figure 9: HAZ results (model 1) by rurality. Coefficients and 95% confidence intervals for the estimated effect of heat on HAZ, separated by urban/rural. The yellow vertical line represents conception. Controls and fixed effects for cluster and state-by-survey-year included in the model but not shown.

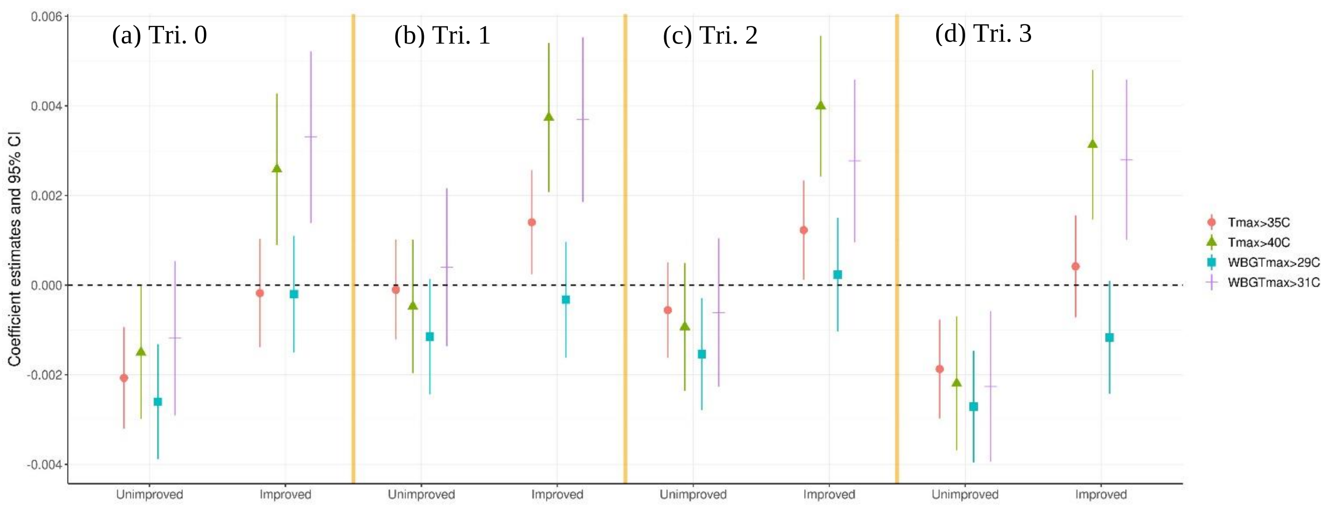


Figure 10: HAZ results by access to an improved toilet. Coefficients and 95% confidence intervals for the interactive effect of heat and improved toilet on HAZ. Yellow vertical lines delineate each trimester. Controls and fixed effects for cluster and state-by-survey-year included in the model but not shown.

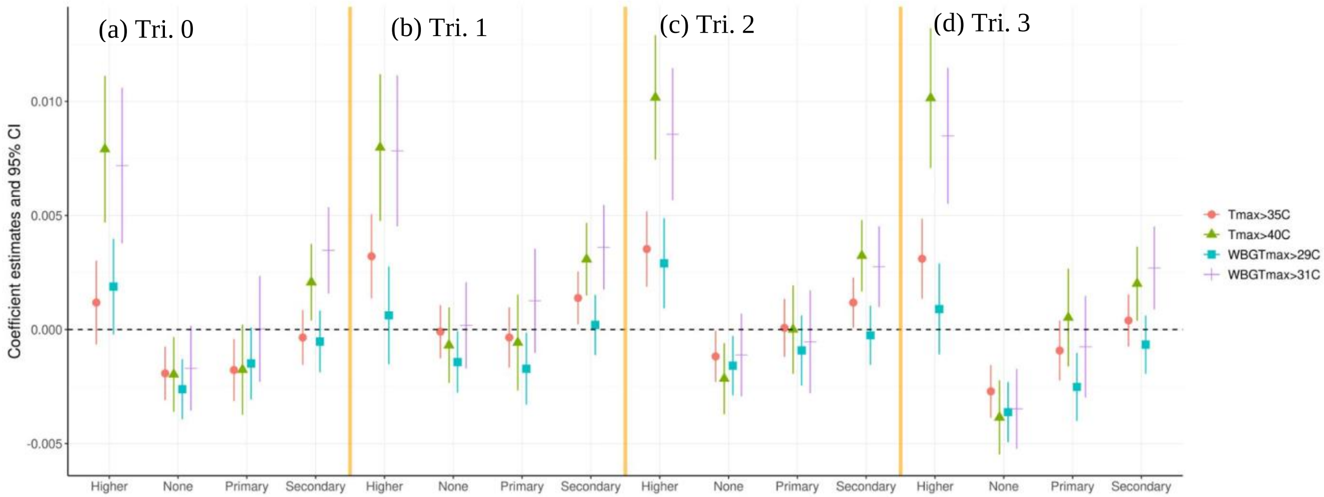


Figure 11: HAZ results (model 1) by mother's education. Coefficients and 95% confidence intervals for the interactive effect of extreme heat and mother's educational attainment on HAZ. Yellow vertical lines delineate each trimester. Controls and fixed effects for cluster and state-by-survey-year included in the model but not shown.

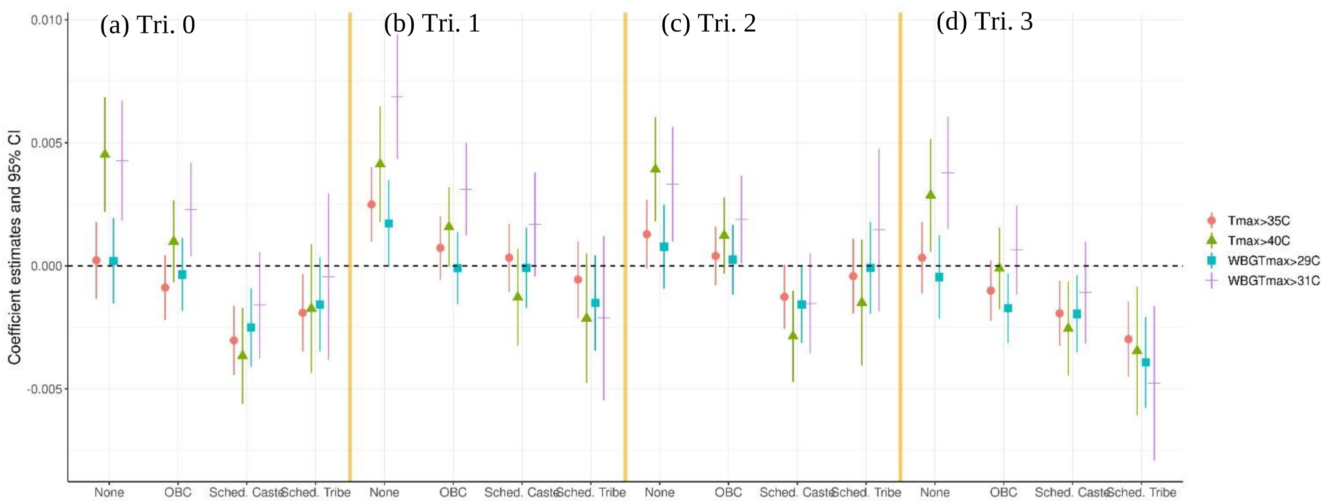


Figure 12: HAZ results (model 1) by caste. Coefficients and 95% confidence intervals for the interactive effect of extreme heat and mother's caste on HAZ. Yellow vertical lines delineate each trimester. Controls and fixed effects for cluster and state-by-survey-year included in the model but not shown. Uses observations from India only (N= 173,628).

VI. DISCUSSION & NEXT STEPS

My initial findings suggest that exposure to extreme heat during the year before birth undermines child development, lowering height-for-age and increasing the odds of stunting and severe stunting for 0-5 year-olds in Bangladesh, India, and Nepal. When I explicitly compare the effects of trimester-level exposure to heat versus combined heat and humidity, I find that hot-humid extremes have the strongest negative impact on HAZ, particularly when exposure occurs during trimester 0 and trimester 3. Exposure to one additional day with $WBGT_{max}$>29°C during the third trimester decreases HAZ by 0.002 standard deviations and raises the baseline probability of stunting among 0-5 year-olds in my sample by 0.128%, an effect five times the size of that caused by an additional day with T_{max}>35°C during the same period. These point estimates are consistent with previous research on climate-induced stunting; two recent studies find that a 0.003 unit decrease in HAZ is associated with both (a) each day of monsoon onset in Indonesia and (b) each day with extreme rain in South Asia during the prenatal period (Thiede and Gray, 2020; McMahon and Gray, 2021). This work also adds to the evidence that social and demographic factors play a critical role in determining children's vulnerability to climate shocks (Dimitrova and Muttarak, 2020; Nicholas et al., 2021). By interacting heat exposure with indicators of social vulnerability, I find that children without adequate sanitation access and whose mothers lack formal education or belong to systematically marginalized social groups are at greater risk for the lasting health effects of prenatal heat exposure.

Moreover, my results corroborate previous scholars' assertions that precise exposure timing plays a critical role in determining the long-term impacts of climate shocks on child health (Grace, Verdin, et al., 2021). The adverse effects of heat exposure during trimester 3 documented above align with existing epidemiological evidence that heat stress and dehydration towards the end of gestation can induce labor prematurely, thereby increasing rates of pre-term birth and associated health risk for mothers and babies (Davenport et al. 2020, Randell et al. 2020). Meanwhile, the negative relationship between height attainment and heat exposure during trimester 0 points towards the importance of women's health at the outset of pregnancy for determining children's outcomes at birth and beyond. Indeed, previous research has linked extreme heat during this pre-conception window with decreases in both conception rates (Barreca et al., 2018) and birth weights (Grace et al., 2015). Though more research is needed to illuminate the exact mechanisms linking extreme heat during trimester 0 with height attainment after birth, the physiological consequences of extreme heat exposure during the weeks leading up to and following conception may set children on a path towards slower growth, particularly those children from under-resourced households and communities (as evidenced by Figures 10-12). Though Model 2 did not detect any difference between the relative impacts of hot and hot-humid conditions during trimester 0, the significance of this pre-conception period remains consistent across many alternate specifications of Model 1, including the inclusion of additional placebo exposure periods (see Appendix).

Given that 39% of all children in my sample are already stunted and humid heat exposure is projected to worsen in South Asia under climate change, these effects may pose a threat to ongoing efforts to improve child health in South Asia. To approximate the effect of future warming on rates of child stunting at a regional scale, I combine my model results with new projections of $WBGT_{max}$ and T_{max} produced by the Climate Hazards Center (Williams et al., 2023). These data leverage the same heat records that I leverage in the main analysis, but they are now perturbed according to various future warming scenarios. Replicating the procedure used in the primary dataset, I use each child's date and location of birth to link my sample of 0- to 5-year-olds to the conditions they would have experienced during their prenatal year under a high-emissions climate change scenario (SSP5-8.5) with 2050 warming. With these data, I calculate that the average child would have been exposed to 36 days with $WBGT_{max}$>29°C and 28 days with T_{max}>35°C during trimester 3 under 2050 warming, representing a 56.5% and 47% increase in average exposure from my sample mean of 23 days and 19 days, respectively. Applying my finding that each day with $WBGT_{max}$>29°C during the third trimester reduces HAZ by an average 0.002 units, this additional hot-humid heat would have the potential to induce stunting among vulnerable children whose HAZ scores fall between -1.97 and -2. This group makes up 0.9% (N=1691) of all children in my nationally representative dataset, a fraction that contains more than 930,000 children under the age of 5 when combined with United Nations Population Division population estimates from each county at the time of each DHS survey round (Boyle et al., 2022). Given that population growth is often the largest contributor to rising rates of hot-humid heat exposure in South Asia (Tuholske et al., 2021), this approximation may well be an underestimate of the true number of children who will be vulnerable to heat-induced stunting in 2050 after accounting for the growing population. Using the same logic and corresponding point estimate from a regression of HAZ on T_{max} exposure (β=0.001 per day with Tmax>35°C; see Appendix), increased heat alone under a 2050 warming scenario would only have the power to induce stunting in approximately 315,000 children at the regional scale. This difference implies that failing to account for the added effect of humidity would lead us to underestimate the vulnerable population by 615,000 children.

Though my main models of height attainment might appear to imply that the lower heat thresholds are most dangerous for health, a supplementary analysis of the impacts of extreme heat on total births suggests that selection bias may lead to downward bias on the main coefficients at higher heat thresholds, particularly when it comes to early-term exposures to the highest values of T_{max}. This result aligns with existing evidence linking extreme heat to reductions in fertility via reproductive health (Barreca, Deschênes, et al., 2018) and may shed light on previous studies that document counter-intuitive effects of warming for child health (Wilde et al., 2014; McMahon and Gray, 2021). I hope that these findings will further prove to be useful guideposts for research on the effects of prenatal heat going forward, especially as the current literature lacks consensus on critical heat thresholds and exposure windows for maternal and infant health outcomes (Ravanelli et al., 2019).

A. Limitations

While these initial results are highly suggestive, there are several limitations to the data and model specifications that could influence the analysis and findings presented here. First, the DHS variables for children's age, month and year of birth, and length of residence in their current household rely on respondents' recall, and therefore may be subject to measurement error based on flawed memory and approximations (see Lyons-Amos & Stones 2017, Singh et al. 2022 for discussions on age heaping in the DHS). This potential measurement error may then affect my identification of heat exposure, which is based on exact month of birth and location of each mother within her cluster of residence during the year before giving birth. I am also unable to define exact trimesters given that the DHS lacks complete and reliable information on day of birth and length of gestation, meaning that I necessarily take on some measurement error at the sub-monthly scale in my variables for the total number of hot days per trimester. Data limitations further inhibit my ability to identify the mechanisms that drive the relationship between heat exposure and HAZ that I observe here; though I look for suggestive evidence using agricultural controls and a variable indicating recent diarrhea among children (see Appendix), these data alone lack the specificity and power needed to identify or eliminate precise mechanisms.

In addition to these data-related factors, the results appear sensitive to the specification of heat thresholds and the combination of data from disparate countries. Exposure to the hottest thresholds is likely too rare within my sample for their effects on HAZ to be estimated reliably or with any generalizability. This is particularly true in the case of days with $WBGT_{max}$>31°C, which seem to be concentrated largely within a subset of the sample that all share certain characteristics that are associated with higher HAZ scores (urban, well-educated, etc.). As such, the effects of exposure to these high thresholds that I estimate here should be interpreted with caution. Furthermore, Figure 8 reveals that the relationship between heat exposure and HAZ varies widely by country, with observations in India appearing to drive much of the pattern observed in the aggregate model. Several of the heat variables are very rare in Bangladesh and Nepal, for instance, meaning that their effects are estimated with very little precision for observations in those countries. It is also unclear how pooling all three countries affects the use of DHS survey weights (West et al., 2017), which are even further disrupted during data pre-processing by the systematic removal of observations with missing data for key variables (e.g., length of residence in current household). These factors require more attention going forward and should be considered in the interpretation of my preliminary findings.

B. Next Steps

My results thus far indicate that hot-humid extremes during the year before a child's birth can undermine growth into early childhood, and that this combination may prove more dangerous in South Asia than heat alone. Going forward, I have a host of ideas for improving the analysis presented here as well as for the direction of future research on heat, humidity, and child and maternal health. To address concerns mentioned above, the specification of the heat thresholds could be improved by transforming the high and low threshold indicators for each heat variable into a single factor variable with three levels (e.g. for T_{max}<35°C, 35°C<T_{max}<40°C, and T_{max}>40°C). This would eliminate the issue of high correlation between thresholds in each trimester and would make the coefficients on the high and low thresholds more directly comparable. An alternate approach could be to define and remove observations experiencing "normal" levels of heat exposure, to create a cleaner comparison between those with high and low heat exposure. Next, because I observe considerable effect heterogeneity between countries, it would be wise to use a map of residuals to correct for regional misspecification or even to separate Bangladesh, India, and Nepal completely in all analyses. Separation by country would also take care of any bias introduced by pooling survey weights across countries. I may also wish to relax the analysis by removing the state-by-survey year fixed effect from the main HAZ specification. While this fixed effect helps to isolate the effect of short-run events like daily heat exposures by controlling for trends in the outcome driven by state-level policies and social change, it may be removing more useful variation from the analysis than is necessary or desired. Finally, I plan to explore specification improvements to my models of both HAZ and state-level births. For the former, I will try moving from my current linear regression model, which approximates the conditional mean of the distribution of HAZ, to a quantile regression model, with the hopes of clarifying how the left tail of the HAZ distribution (which is of greatest interest given the lifetime health costs associated with stunting) moves with prenatal heat exposure. For my model of births, considerable improvements could be made by first defining the "exposed" population (e.g. women of reproductive age) and subsequently using that population to construct an appropriate birth rate variable, following formal demographic methodology.

On a larger scale, my work emphasizes the need for studies that think carefully about exposure timing, key thresholds, and make use of novel remotely-sensed climate and environmental measures to understand the impacts of disparate climate events on fertility and health in early childhood. Future research might further investigate the heat-fertility relationship through an individual-level birth-interval analysis (perhaps using the DHS fertility calendars as harmonized by IPUMS-DHS), better isolate the combined impact of heat and humidity by comparing the effect of hot-humid extremes and dry heat extremes (perhaps measured by vapor pressure deficit), and attempt to identify mechanisms linking heat exposure and child health using data on mechanism-specific risk factors or agricultural and biological outcomes related to heat exposure (see Figure 13).

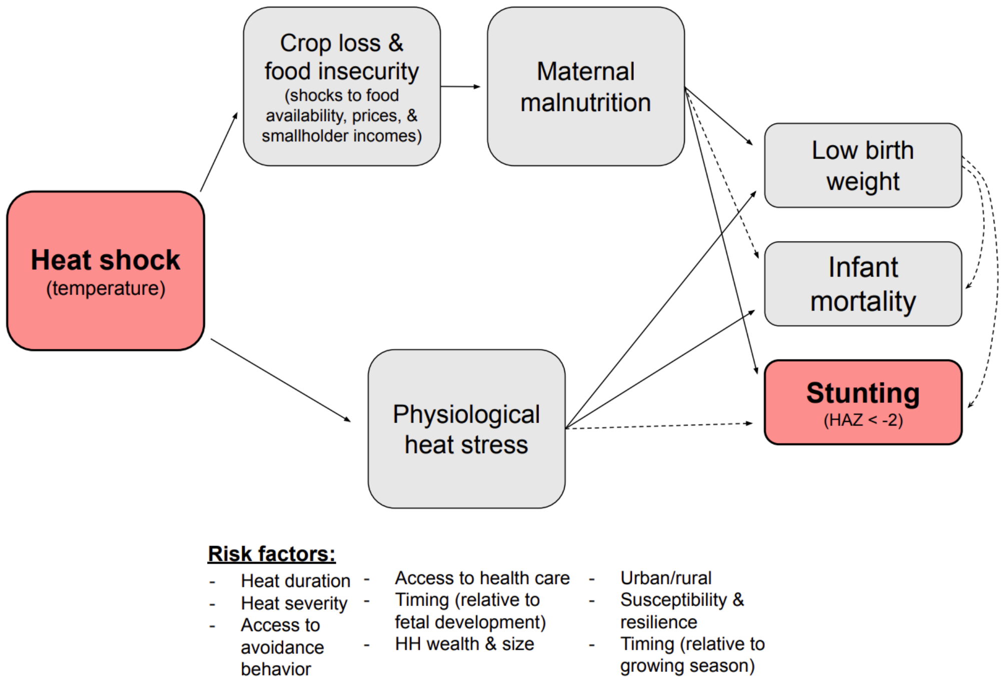


Figure 13: Simplified conceptual model of two primary mechanisms linking in utero heat shocks with child health outcomes. Indirect linkages are represented by dotted lines.

REFERENCES

Alderman, H. (2006). “Long term consequences of early childhood malnutrition”. Oxford Economic Papers 58:3, pp. 450–474.

Almond, Douglas and Janet Currie (2011). “Killing Me Softly: The Fetal Origins Hypothesis”. Journal of Economic Perspectives 25:3, pp. 153–172.

Barreca, Alan, Karen Clay, et al. (2016). “Adapting to Climate Change: The Remarkable Decline in the US Temperature-Mortality Relationship over the Twentieth Century”. Journal of Political Economy 124:1. Publisher: The University of Chicago Press, pp. 105–159.

Barreca, Alan, Olivier Deschênes, and Melanie Guldi (2018). “Maybe next month? Temperature shocks and dynamic adjustments in birth rates”. Demography 55:4, pp. 1269–1293.

Basu, R., Rau, R., Pearson, D., & Malig, B. (2018). “Temperature and term low birth weight in California”. American journal of epidemiology, 187(11), 2306-2314.

Bernard, Thomas E and Ivory Iheanacho (2015). “Heat index and adjusted temperature as surrogates for wet bulb globe temperature to screen for occupational heat stress”. Journal of Occupational and Environmental Hygiene 12:5, pp. 323–333.

Boyle, Elizabeth Heger, Miriam King, and Matthew Sobek (2022). IPUMS -Demographic and Health Surveys: Version 9 [dataset].

Brown, Caitlin, Eeshani Kandpal, et al. (2022). Unequal Households or Communities?: Decomposing the Inequality in Nutritional Status in South Asia. Working Paper. Washington, DC: World Bank.

Brown, Molly E., Edward R. Carr, et al. (2017). “Do markets and trade help or hurt the global food system adapt to climate change?” Food Policy 68: pp. 154–159.

Budd, Grahame M (2008). “Wet-bulb globe temperature (WBGT)—its history and its limitations”. Journal of science and medicine in sport 11:1, pp. 20–32.

Burke, Marshall, Solomon M. Hsiang, and Edward Miguel (2015). “Global non-linear effect of temperature on economic production”. Nature 527:7577, pp. 235–239.

Carleton, Tamma A. and Solomon M. Hsiang (2016). “Social and economic impacts of climate”. Science 353:6304. Publisher: American Association for the Advancement of Science.

Carolan-Olah, M., & Frankowska, D. (2014). “High environmental temperature and preterm birth: a review of the evidence”. Midwifery, 30(1), 50-59.

Catalano, Ralph and Tim Bruckner (2006). “Secondary sex ratios and male lifespan: Damaged or culled cohorts”. Proceedings of the National Academy of Sciences 103:5, pp. 1639–1643.

Cheung, S. S., Lee, J. K., & Oksa, J. (2016). “Thermal stress, human performance, and physical employment standards”. Applied physiology, nutrition, and metabolism, 41(6), S148-S164.

Coffey, D., Deshpande, A., Hammer, J., & Spears, D. (2019). “Local social inequality, economic inequality, and disparities in child height in India”. Demography, 56(4), 1427-1452.

Davenport, Frank et al. (2017). "Child health outcomes in sub-Saharan Africa: A comparison of changes in climate and socio-economic factors". Global Environmental Change 46: pp. 72–87.

Davenport, F., Dorélien, A., & Grace, K. (2020). "Investigating the linkages between pregnancy outcomes and climate in sub-Saharan Africa". Population and Environment, 41, 397-421.

Deschênes, O., Greenstone, M., & Guryan, J. (2009). "Climate change and birth weight". American Economic Review, 99(2), 211-217.

Deschênes, Olivier (2014). "Temperature, human health, and adaptation: A review of the empirical literature". Energy Economics 46: pp. 606–619.

Dimitrova, Anna and Raya Muttarak (2020). "After the floods: Differential impacts of rainfall anomalies on child stunting in India". Global Environmental Change 64: p. 102130.

Frame, D., Joshi, M., Hawkins, E., Harrington, L. J., & de Roiste, M. (2017). "Population-based emergence of unfamiliar climates". Nature Climate Change, 7(6), 407-411.

Funk, Chris et al. (2019). "A High-Resolution 1983–2016 Tmax Climate Data Record Based on Infrared Temperatures and Stations by the Climate Hazard Center". Journal of Climate 32:17 pp. 5639–5658.

Grace, K., Davenport, F., Funk, C., Lerner, A.M., (2012). "Child malnutrition and climate in Sub-Saharan Africa: An analysis of recent trends in Kenya". Appl. Geogr. 35 (1-2), 405–413

Grace, Kathryn, Frank Davenport, et al. (2015). "Linking climate change and health outcomes: Examining the relationship between temperature, precipitation and birth weight in Africa". Global Environmental Change 35: pp. 125–137.

Grace, Kathryn, Nicholas N Nagle, et al. (2019). "Integrating environmental context into DHS analysis while protecting participant confidentiality: A new remote sensing method". Population and development review 45:1, p. 197.

Grace, Kathryn, Andrew Verdin, et al. (2021). "Exploring Strategies for Investigating the Mechanisms Linking Climate and Individual-Level Child Health Outcomes: An Analysis of Birth Weight in Mali". Demography 58:2, pp. 499–526.

Hoddinott, John and Bill Kinsey (2001). "Child Growth in the Time of Drought". Oxford Bulletin of Economics and Statistics 63:4, pp. 409–436.

Hommel, G. (1988). "A stagewise rejective multiple test procedure based on a modified Bonferroni test". Biometrika, 75(2), 383-386.

ISO. (2017). 7243: Ergonomics of the thermal environment—assessment of heat stress using the WBGT (wet bulb globe temperature) index. Int Org Standard Geneva Switzerland.

Kandpal, Eeshani (2011). "Beyond Average Treatment Effects: Distribution of Child Nutrition Outcomes and Program Placement in India's ICDS". World Development 39:8, pp. 1410–1421.

Kuehn, L., & McCormick, S. (2017). "Heat exposure and maternal health in the face of climate change". International journal of environmental research and public health, 14(8), 853.

Kumar, S., Molitor, R., Vollmer, S., (2016). "Drought and early child health in rural India". Population and Development Review 42 (1), 53–68.
Lam, D. A., & Miron, J. A. (1996). "The effects of temperature on human fertility". Demography, 33(3), 291-305.
Lyons-Amos, M., & Stones, T. (2017). "Trends in Demographic and Health Survey data quality: an analysis of age heaping over time in 34 countries in Sub Saharan Africa between 1987 and 2015". BMC Research Notes, 10(1), 1-7.
Martorell, Reynaldo and Amanda Zongrone (2012). "Intergenerational Influences on Child Growth and Undernutrition". Paediatric and Perinatal Epidemiology 26: (s1), pp. 302–314.
Matthews, T. K., Wilby, R. L., & Murphy, C. (2017). "Communicating the deadly consequences of global warming for human heat stress". Proceedings of the National Academy of Sciences, 114(15), 3861-3866.
Mora, C., Dousset, B., Caldwell, I. R., Powell, F. E., Geronimo, R. C., Bielecki, C. R., ... & Trauernicht, C. (2017). "Global risk of deadly heat". Nature climate change, 7(7), 501-506.
McMahon, Kathryn and Clark Gray (2021). "Climate change, social vulnerability and child nutrition in South Asia". Global Environmental Change 71: p. 102414.
Nicholas, Khristopher et al. (2021). "Climate anomalies and childhood growth in Peru". Population and Environment.
Ninno, Carlo del and Mattias Lundberg (2005). "Treading water". Economics & Human Biology 3:1, pp. 67–96. OSHA (2017).
Nobles, J., & Hamoudi, A. (2019). "Detecting the effects of early-life exposures: why fecundity matters". Population research and policy review, 38, 783-809.
OSHA Technical Manual, Section III, Chapter 4. Heat Stress.
Pachauri, R. K. et al. (2014). Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Geneva, Switzerland, IPCC, pp. 151, ISBN: 978-92-9169-143-2.
Parsons, K. (2006). "Heat stress standard ISO 7243 and its global application". Industrial health, 44(3), 368-379.
Parsons, K. (2014). *Human thermal environments: the effects of hot, moderate, and cold environments on human health, comfort, and performance*. CRC press, ed. 3.
Parsons, Luke A et al. (2022). "Global labor loss due to humid heat exposure underestimated for outdoor workers". Environmental Research Letters 17:1, p. 014050.
Pradhan, B., Kjellstrom, T., Atar, D., Sharma, P., Kayastha, B., Bhandari, G., & Pradhan, P. K. (2019). "Heat stress impacts on cardiac mortality in Nepali migrant workers in Qatar". Cardiology, 143(1), 37-48.
Ramakrishnan, U., Grant, F., Goldenberg, T., Zongrone, A., Martorell, R., (2012). "Effect of women's nutrition before and during early pregnancy on maternal and infant outcomes: a systematic review". Pediatr. Perinatal Epidemiol. 26, 285–301.

Randell, Heather, Clark Gray, and Kathryn Grace (2020). “Stunted from the start: Early life weather conditions and child undernutrition in Ethiopia”. Social Science & Medicine 261: p. 113234.
Ravanelli, Nicholas et al. (2019). “Heat stress and fetal risk. Environmental limits for exercise and passive heat stress during pregnancy: a systematic review with best evidence synthesis”. British journal of sports medicine 53:13, pp. 799–805.
Rayco-Solon, P., Fulford, A.J., Prentice, A.M., (2005). “Maternal preconceptional weight and gestational length”. Am. J. Obstet. Gynecol. 192 (4), 1133–1136.
Raymond, C., Matthews, T., & Horton, R. M. (2020). “The emergence of heat and humidity too severe for human tolerance”. Science Advances, 6(19), eaaw1838.
Shively, Gerald, Celeste Sununtnasuk, and Molly Brown (2015). “Environmental variability and child growth in Nepal”. Health & Place 35: pp. 37–51.
Singh, M., Kashyap, G. C., & Bango, M. (2022). “Age heaping among individuals in selected South Asian countries: evidence from Demographic and Health Surveys”. Journal of Biosocial Science, 54(4), 725-734.
Spears, Dean (2020). “Exposure to open defecation can account for the Indian enigma of child height”. Journal of Development Economics.
Thiede, Brian C. and Clark Gray (2020). “Climate exposures and child undernutrition: Evidence from Indonesia”. Social Science & Medicine 265: p. 113298.
Tiwari, S., Jacoby, H.G., Skoufias, E., (2017). “Monsoon babies: rainfall shocks and child nutrition in Nepal”. Econ. Dev. Cult. Change 65 (2), 167–188.
Tuholske, Cascade et al. (2021). “Global urban population exposure to extreme heat”. Proceedings of the National Academy of Sciences 118:41.
Vanos, J. K., Baldwin, J. W., Jay, O., & Ebi, K. L. (2020). “Simplicity lacks robustness when projecting heat-health outcomes in a changing climate”. Nature communications, 11(1), 6079.
Verdin, Andrew et al. (2020). “Development and validation of the CHIRTS-daily quasi-global high-resolution daily temperature data set”. Scientific Data 7:1, p. 303.
Ward, A., Clark, J., McLeod, J., Woodul, R., Moser, H., & Konrad, C. (2019). “The impact of heat exposure on reduced gestational age in pregnant women in North Carolina, 2011–2015.” International journal of biometeorology, 63, 1611-1620.
West, B. T., Sakshaug, J. W., & Kim, Y. (2017). “Analytic Error as an Important Component of Total Survey Error: Results from a Meta-Analysis’. Total survey error in practice, 487-510.
Williams, E., Funk, C.,Peterson, P., Tuholske, C. (2023). The Climate Hazards Center Coupled Model Intercomparison Project Phase 6 (CHC-CMIP6) climate projection dataset, version 1.0. https://doi.org/10.21424/R47H0M
WHO (2006). WHO child growth standards. World Health Organization.
Zhang, Y., Yu, C., & Wang, L. (2017). “Temperature exposure during pregnancy and birth outcomes: an updated systematic review of epidemiological evidence”. Environmental Pollution, 225, 700-712.

APPENDIX

Dependent Variable:	Height-for-age Z-score (HAZ)								Height-for-age Z-score (HAZ)							
	Tmax > 35C				Tmax > 40C				WBGTmax > 29C				WBGTmax > 31C			
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables																
Female (child)	0.06***	0.06***	0.06***	0.06***	0.07***	0.07***	0.07***	0.07***	0.06***	0.06***	0.06***	0.06***	0.07***	0.07***	0.07***	0.07***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Birth place (ref=Clinic)																
Home	-0.04***	-0.04***	-0.04***	-0.04***	-0.04***	-0.04***	-0.04***	-0.04***	-0.04***	-0.04***	-0.04***	-0.04***	-0.04***	-0.04***	-0.04***	-0.04***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Other	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
Mother's Education (ref=Higher)																
None	-0.49***	-0.49***	-0.50***	-0.50***	-0.49***	-0.49***	-0.49***	-0.49***	-0.49***	-0.49***	-0.49***	-0.49***	-0.49***	-0.49***	-0.49***	-0.49***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Primary	-0.41***	-0.41***	-0.41***	-0.41***	-0.41***	-0.41***	-0.41***	-0.41***	-0.41***	-0.41***	-0.41***	-0.41***	-0.41***	-0.41***	-0.41***	-0.41***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Secondary	-0.24***	-0.24***	-0.24***	-0.24***	-0.24***	-0.24***	-0.24***	-0.24***	-0.24***	-0.24***	-0.24***	-0.24***	-0.24***	-0.24***	-0.24***	-0.24***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Improved Toilet	0.22***	0.22***	0.22***	0.22***	0.22***	0.22***	0.22***	0.22***	0.22***	0.22***	0.22***	0.22***	0.22***	0.22***	0.22***	0.22***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Number of extreme days																
Trimester 3	-0.001***	-0.0009**	-0.0002	-0.0008	-0.0007	-0.0006	-0.0002	-0.0002	-0.001***	-0.001***	-0.001**	-0.002***	-0.001**	-0.001**	-0.0004	-2.4×10^{-5}
	(0.0004)	(0.0004)	(0.0005)	(0.0005)	(0.0006)	(0.0006)	(0.0007)	(0.0007)	(0.0004)	(0.0004)	(0.0005)	(0.0006)	(0.0006)	(0.0006)	(0.0007)	(0.0008)
Trimester 2		0.0008**	0.001***	0.0003		0.0006	0.0009	0.0009		0.0004	0.0005	-0.0006		-2.3×10^{-6}	0.0004	0.0009
		(0.0004)	(0.0004)	(0.0005)		(0.0006)	(0.0006)	(0.0007)		(0.0004)	(0.0004)	(0.0006)		(0.0006)	(0.0006)	(0.0008)
Trimester 1			0.001**	0.0006			0.001	0.001			0.0002	-0.0007			0.001**	0.002**
			(0.0005)	(0.0006)			(0.0006)	(0.0007)			(0.0005)	(0.0006)			(0.0007)	(0.0008)
Trimester 0				-0.001**				-3.9×10^{-5}				-0.001**				0.0008
				(0.0006)				(0.0007)				(0.0006)				(0.0008)
Fixed-effects																
DHS cluster	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State-survey year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics																
Observations	198,710	198,710	198,710	198,710	198,710	198,710	198,710	198,710	198,710	198,710	198,710	198,710	198,710	198,710	198,710	198,710
R^2	0.33920	0.33923	0.33927	0.33930	0.33916	0.33917	0.33918	0.33918	0.33924	0.33926	0.33926	0.33930	0.33919	0.33919	0.33922	0.33922
Within R^2	0.01834	0.01839	0.01846	0.01851	0.01829	0.01830	0.01833	0.01833	0.01842	0.01843	0.01843	0.01849	0.01833	0.01833	0.01838	0.01839

Clustered (DHS Cluster) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table A1.1: **HAZ regression results (model 1) with standard errors.** Controls for twin status, mother's parity, mother's marital status, religion, child's birth month, mother's age in years, survey month and child's age in months included in the model but not shown.

Dependent Variable:	Height-for-age Z-score (HAZ)							
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables								
Female (child)	0.06***	0.06***	0.06***	0.06***	0.06***	0.06***	0.06***	0.06***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Birth place (ref=Clinic)								
Home	-0.04***	-0.04***	-0.04***	-0.04***	-0.04***	-0.04***	-0.04***	-0.04***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Other	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
Mother's Education (ref=Higher)								
None	-0.49***	-0.49***	-0.49***	-0.50***	-0.50***	-0.50***	-0.50***	-0.49***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Primary	-0.41***	-0.41***	-0.41***	-0.41***	-0.41***	-0.41***	-0.41***	-0.41***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Secondary	-0.24***	-0.24***	-0.24***	-0.24***	-0.24***	-0.24***	-0.24***	-0.24***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Improved Toilet	0.22***	0.22***	0.22***	0.22***	0.22***	0.22***	0.22***	0.22***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Number of extreme days								
Tmax > 35C								
Trimester 3	-0.001***	-0.0009**	-0.0002	-0.0008	-0.0001	-0.0001	-8.5×10^{-5}	0.0002
	(0.0004)	(0.0004)	(0.0005)	(0.0005)	(0.0006)	(0.0006)	(0.0006)	(0.0006)
Trimester 2		0.0008**	0.001***	0.0003	0.0004	0.0006	0.0006	0.0009
		(0.0004)	(0.0004)	(0.0005)	(0.0005)	(0.0006)	(0.0006)	(0.0006)
Trimester 1			0.001**	0.0006	0.0004	0.0005	0.0007	0.0009
			(0.0005)	(0.0006)	(0.0006)	(0.0006)	(0.0006)	(0.0006)
Trimester 0				-0.001**	-0.001**	-0.001**	-0.001**	-0.0009
				(0.0006)	(0.0006)	(0.0006)	(0.0006)	(0.0007)
WBGTmax > 29C								
Trimester 3					-0.001***	-0.001***	-0.002***	-0.002***
					(0.0004)	(0.0004)	(0.0005)	(0.0007)
Trimester 2						-0.0004	-0.0005	-0.001*
						(0.0005)	(0.0005)	(0.0007)
Trimester 1							-0.0004	-0.001
							(0.0006)	(0.0007)
Trimester 0								-0.0010
								(0.0007)
Fixed-effects								
DHS cluster	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State-survey year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics								
Observations	198,710	198,710	198,710	198,710	198,710	198,710	198,710	198,710
R^2	0.33920	0.33923	0.33927	0.33931	0.33937	0.33937	0.33938	0.33939
Within R^2	0.01834	0.01839	0.01846	0.01851	0.01860	0.01861	0.01861	0.01863

Clustered (DHS Cluster) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table A1.2: **HAZ regression results (model 2) with standard errors.** Controls for twin status, mother's parity, mother's marital status, religion, child's birth month, mother's age in years, survey month and child's age in months included in the model but not shown.

Dependent Variable:	Stunting								Stunting							
	Tmax > 35C				Tmax > 40C				WBGTmax > 29C				WBGTmax > 31C			
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables																
Female (child)	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Birth place (ref=Clinic)																
Home	0.008*	0.008*	0.008*	0.008*	0.008*	0.008*	0.008*	0.008*	0.008*	0.008*	0.008*	0.008*	0.008*	0.008*	0.008*	0.008*
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Other	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Mother's Education (ref=Higher)																
None	0.14***	0.14***	0.14***	0.14***	0.14***	0.14***	0.14***	0.14***	0.14***	0.14***	0.14***	0.14***	0.14***	0.14***	0.14***	0.14***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Primary	0.11***	0.11***	0.11***	0.11***	0.11***	0.11***	0.11***	0.11***	0.11***	0.11***	0.11***	0.11***	0.11***	0.11***	0.11***	0.11***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Secondary	0.06***	0.06***	0.06***	0.06***	0.06***	0.06***	0.06***	0.06***	0.06***	0.06***	0.06***	0.06***	0.06***	0.06***	0.06***	0.06***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Improved Toilet	-0.06***	-0.06***	-0.06***	-0.06***	-0.06***	-0.06***	-0.06***	-0.06***	-0.06***	-0.06***	-0.06***	-0.06***	-0.06***	-0.06***	-0.06***	-0.06***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Number of extreme days																
Trimester 3	0.0003**	0.0002*	7.8×10^{-5}	9.8×10^{-5}	2×10^{-5}	4.2×10^{-5}	-8.7×10^{-5}	-0.0002	0.0003***	0.0003**	0.0002	0.0005**	0.0003**	0.0003*	1.6×10^{-5}	-0.0001
	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0003)
Trimester 2		-0.0002*	-0.0003**	-0.0002		0.0001	1.9×10^{-5}	-0.0001		-0.0001	-0.0002	0.0001		-5.2×10^{-5}	-0.0002	-0.0004
		(0.0001)	(0.0001)	(0.0002)		(0.0002)	(0.0002)	(0.0002)		(0.0001)	(0.0001)	(0.0002)		(0.0002)	(0.0002)	(0.0003)
Trimester 1			-0.0003*	-0.0002			-0.0003	-0.0004*			-9.1×10^{-5}	0.0001			-0.0006**	-0.0007***
			(0.0001)	(0.0002)			(0.0002)	(0.0002)			(0.0001)	(0.0002)			(0.0002)	(0.0003)
Trimester 0				3.9×10^{-5}				-0.0003				0.0004*				-0.0003
				(0.0002)				(0.0002)				(0.0002)				(0.0003)
Fixed Effects																
DHS cluster	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State-survey year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics																
Observations	198,710	198,710	198,710	198,710	198,710	198,710	198,710	198,710	198,710	198,710	198,710	198,710	198,710	198,710	198,710	198,710
R^2	0.27427	0.27429	0.27431	0.27432	0.27424	0.27424	0.27426	0.27427	0.27430	0.27432	0.27432	0.27435	0.27424	0.27424	0.27426	0.27427
Within R^2	0.01566	0.01569	0.01572	0.01572	0.01562	0.01562	0.01564	0.01566	0.01570	0.01572	0.01573	0.01577	0.01562	0.01562	0.01564	0.01566

Clustered (DHS Cluster) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table A2: **Stunting regression results (model 1) with standard errors.** Controls for twin status, mother's parity, mother's marital status, religion, child's birth month, mother's age in years, survey month and child's age in months included in the model but not shown.

Dependent Variable:	Severe Stunting							
	Tmax > 35C				Tmax > 40C			
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables								
Female (child)	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Birth place (ref=Clinic)								
Home	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Other	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Mother's Education (ref=Higher)								
None	0.08***	0.08***	0.08***	0.08***	0.08***	0.08***	0.08***	0.08***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Primary	0.05***	0.05***	0.05***	0.05***	0.05***	0.05***	0.05***	0.05***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Secondary	0.02***	0.02***	0.02***	0.02***	0.02***	0.02***	0.02***	0.02***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Improved Toilet	-0.04***	-0.04***	-0.04***	-0.04***	-0.04***	-0.04***	-0.04***	-0.04***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Number of extreme days								
Trimester 3	0.0002**	0.0001	-5×10^{-5}	4×10^{-5}	0.0003*	0.0002	2.7×10^{-5}	6×10^{-5}
	(9×10^{-5})	(9.1×10^{-5})	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0002)
Trimester 2		-0.0003***	-0.0004***	-0.0003**		-0.0004***	-0.0005***	-0.0004***
		(8.9×10^{-5})	(9.3×10^{-5})	(0.0001)		(0.0001)	(0.0001)	(0.0002)
Trimester 1			-0.0003***	-0.0003*			-0.0003**	-0.0003*
			(0.0001)	(0.0001)			(0.0002)	(0.0002)
Trimester 0				0.0002				7.7×10^{-5}
				(0.0001)				(0.0002)
Fixed Effects								
DHS cluster	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State-survey year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics								
Observations	198,710	198,710	198,710	198,710	198,710	198,710	198,710	198,710
R^2	0.22128	0.22136	0.22143	0.22144	0.22127	0.22133	0.22137	0.22137
Within R^2	0.01326	0.01336	0.01345	0.01347	0.01325	0.01333	0.01337	0.01337

Dependent Variable:	Severe Stunting							
	WBGTmax > 29C				WBGTmax > 31C			
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables								
Female (child)	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Birth place (ref=Clinic)								
Home	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Other	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Mother's Education (ref=Higher)								
None	0.08***	0.08***	0.08***	0.08***	0.08***	0.08***	0.08***	0.08***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Primary	0.05***	0.05***	0.05***	0.05***	0.05***	0.05***	0.05***	0.05***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Secondary	0.02***	0.02***	0.02***	0.02***	0.02***	0.02***	0.02***	0.02***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Improved Toilet	-0.04***	-0.04***	-0.04***	-0.04***	-0.04***	-0.04***	-0.04***	-0.04***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Number of extreme days								
Trimester 3	0.0002*	0.0001	9.5×10^{-5}	0.0003**	9.2×10^{-5}	3.6×10^{-5}	-0.0002	-0.0003
	(8.1×10^{-5})	(8.2×10^{-5})	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0002)
Trimester 2		-0.0002***	-0.0002***	4.6×10^{-5}		-0.0003**	-0.0004***	-0.0005**
		(8.2×10^{-5})	(8.6×10^{-5})	(0.0001)		(0.0001)	(0.0001)	(0.0002)
Trimester 1			-3.5×10^{-5}	0.0002			-0.0005***	-0.0006***
			(0.0001)	(0.0001)			(0.0002)	(0.0002)
Trimester 0				0.0004**				-0.0001
				(0.0001)				(0.0002)
Fixed Effects								
DHS cluster	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State-survey year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics								
Observations	198,710	198,710	198,710	198,710	198,710	198,710	198,710	198,710
R^2	0.22128	0.22134	0.22134	0.22140	0.22126	0.22129	0.22137	0.22137
Within R^2	0.01326	0.01334	0.01334	0.01340	0.01323	0.01328	0.01337	0.01337

Clustered (DHS Cluster) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table A3: **Severe stunting regression results (model 1) with standard errors.** Controls for twin status, mother's parity, mother's marital status, religion, child's birth month, mother's age in years, survey month and child's age in months included in the model but not shown.

Dependent Variable:	Births per month (state-level)								Births per month (state-level)							
	Tmax > 35C				Tmax > 40C				WBGTmax > 29C				WBGTmax > 31C			
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables																
Number of extreme days																
Trimester 3	0.08	0.14*	0.19	0.010	0.16	0.39*	0.56**	-0.29	0.23*	0.25**	0.15	0.06	0.60**	0.71**	0.66	0.29
	(0.08)	(0.08)	(0.11)	(0.22)	(0.17)	(0.22)	(0.26)	(0.28)	(0.11)	(0.12)	(0.09)	(0.11)	(0.30)	(0.33)	(0.42)	(0.59)
Trimester 2		0.55***	0.57***	0.25		1.1***	1.2***	0.23		0.26**	0.24**	0.002		0.73**	0.70*	0.21
		(0.17)	(0.18)	(0.27)		(0.33)	(0.36)	(0.32)		(0.10)	(0.10)	(0.15)		(0.31)	(0.36)	(0.59)
Trimester 1			0.10	-0.08			0.37***	-0.50*			-0.18	-0.28			-0.11	-0.50
			(0.19)	(0.31)			(0.13)	(0.29)			(0.14)	(0.20)			(0.43)	(0.72)
Trimester 0				-0.50				-1.5***				-0.36*				-0.80
				(0.38)				(0.51)				(0.18)				(0.57)
Fixed-effects																
Month	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State-DHS round	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics																
Observations	3,677	3,677	3,677	3,677	3,677	3,677	3,677	3,677	3,677	3,677	3,677	3,677	3,677	3,677	3,677	3,677
R^2	0.84008	0.84267	0.84273	0.84414	0.84008	0.84247	0.84267	0.84538	0.84063	0.84136	0.84161	0.84256	0.84093	0.84215	0.84217	0.84310
Within R^2	0.18315	0.19638	0.19667	0.20387	0.19534	0.19637	0.21021		0.18593	0.18968	0.19096	0.19579	0.18745	0.19369	0.19381	0.19857

Clustered (State-DHS round) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table A4: **Births regression results (model 3) with standard errors (state-level)**.

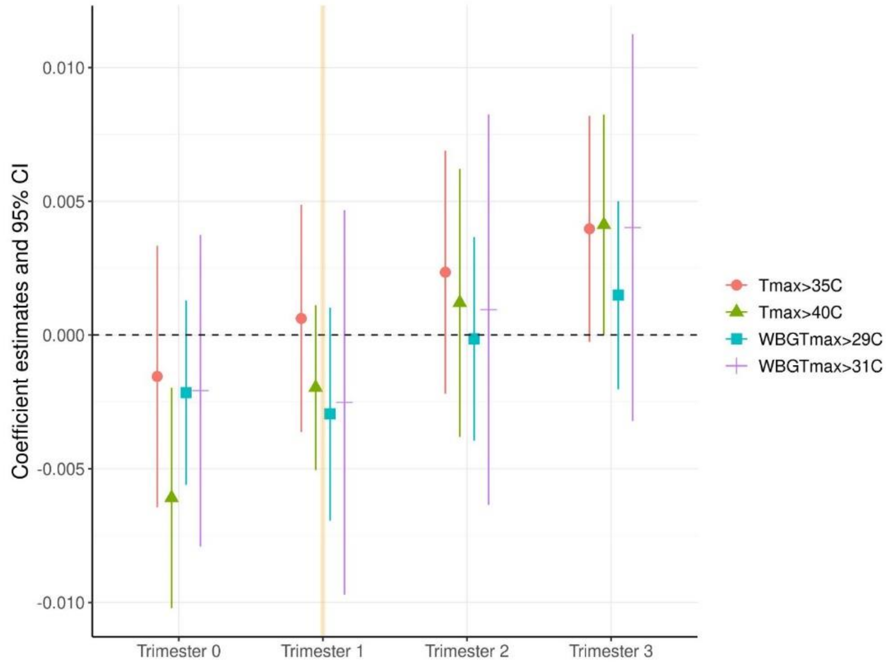


Figure A1: Alternate births results using Poisson regression. Coefficients and 95% confidence intervals for the estimated effect of extreme heat exposure on total births per month at the state level. The yellow vertical line represents conception. Fixed effects for state (by survey), month, and year are included in the model but not shown.

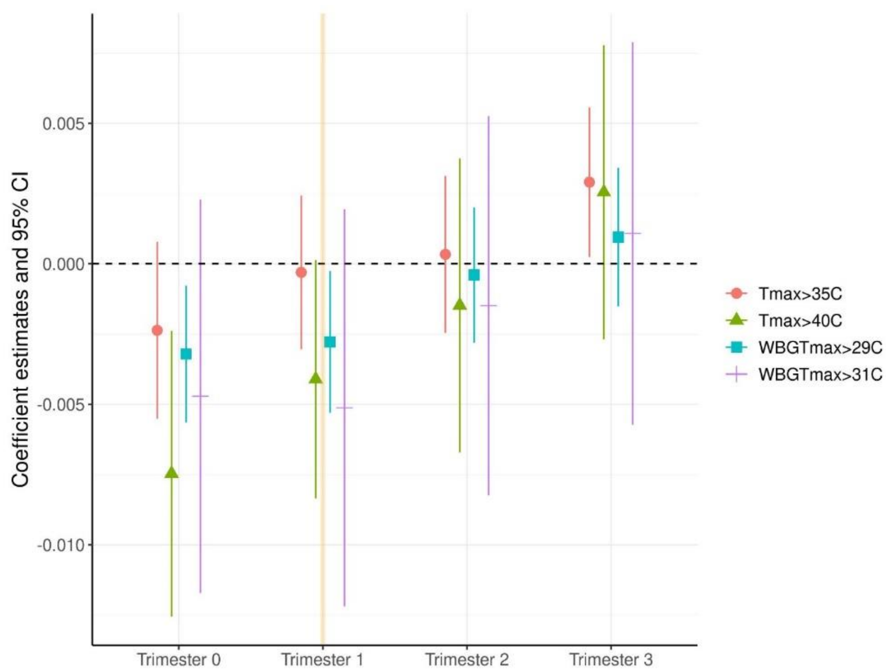


Figure A2: Alternate births results using negative binomial regression. Coefficients and 95% confidence intervals for the estimated effect of extreme heat exposure on total births per month at the state level. The yellow vertical line represents conception. Fixed effects for state (by survey), month, and year are included in the model but not shown.

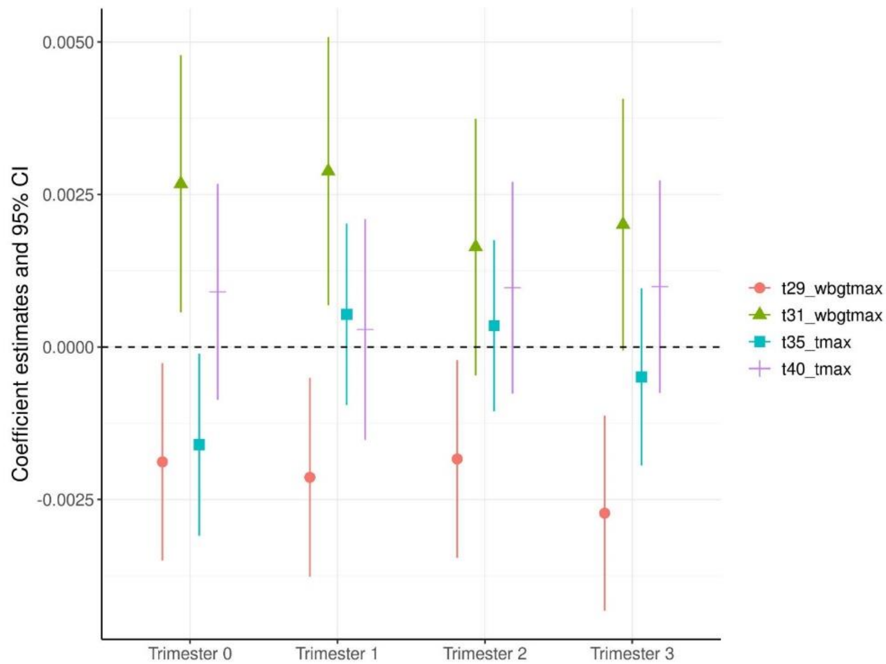


Figure A3: Alternate HAZ results using all heat thresholds. Coefficients and 95% confidence intervals for the estimated effect of extreme heat exposure on HAZ when all are taken as covariates in a single regression model. Controls from Model 1 are included in the model but not shown. Fixed effects for cluster and state-by-survey-year also included in the model but not shown.

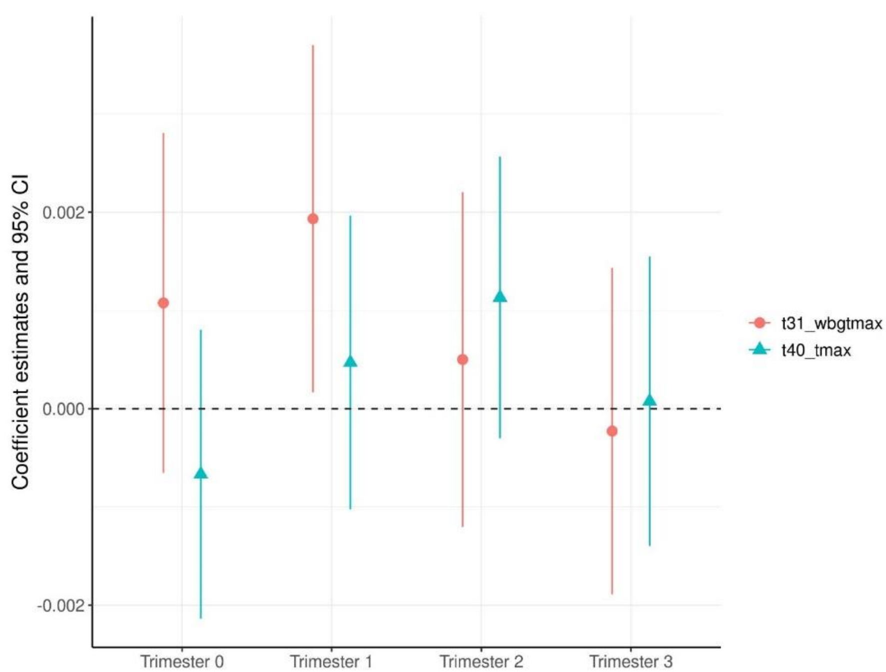


Figure A4: Alternate HAZ results using both high heat thresholds. Coefficients and 95% confidence intervals for the estimated effect of extreme heat exposure on HAZ. The yellow vertical line represents conception. Controls from Model 1 are included in the model but not shown. Fixed effects for cluster and state-by-survey-year also included in the model but not shown.

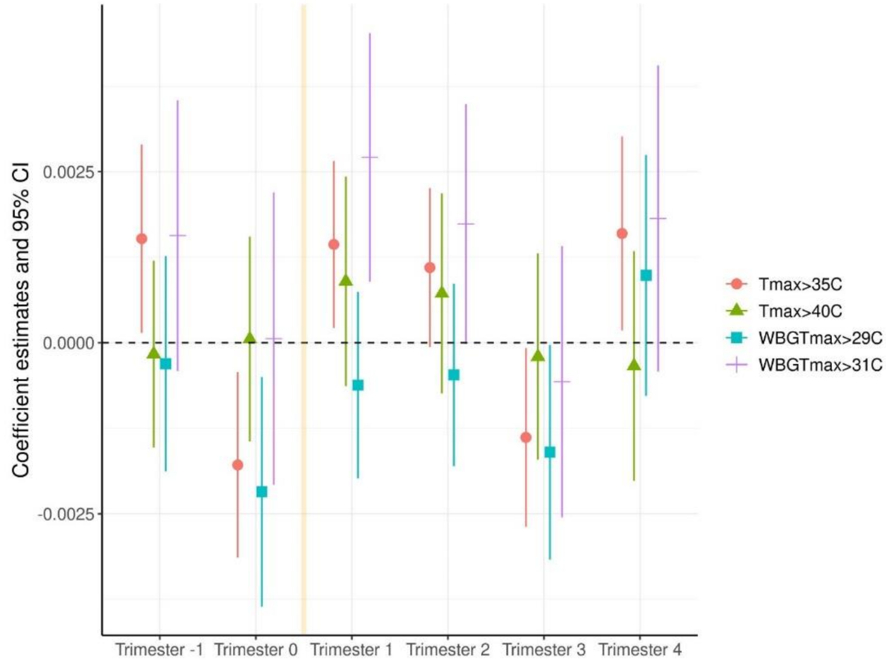


Figure A5: Alternate HAZ results with additional exposure periods. Coefficients and 95% confidence intervals for the estimated effect of extreme heat exposure on HAZ, including the period 3-6 months before conception (trimester -1) and 0-3 months after birth (trimester 4). The yellow vertical line represents conception. Controls from Model 1 are included in the model but not shown. Fixed effects for cluster and state-by-survey-year also included in the model but not shown.

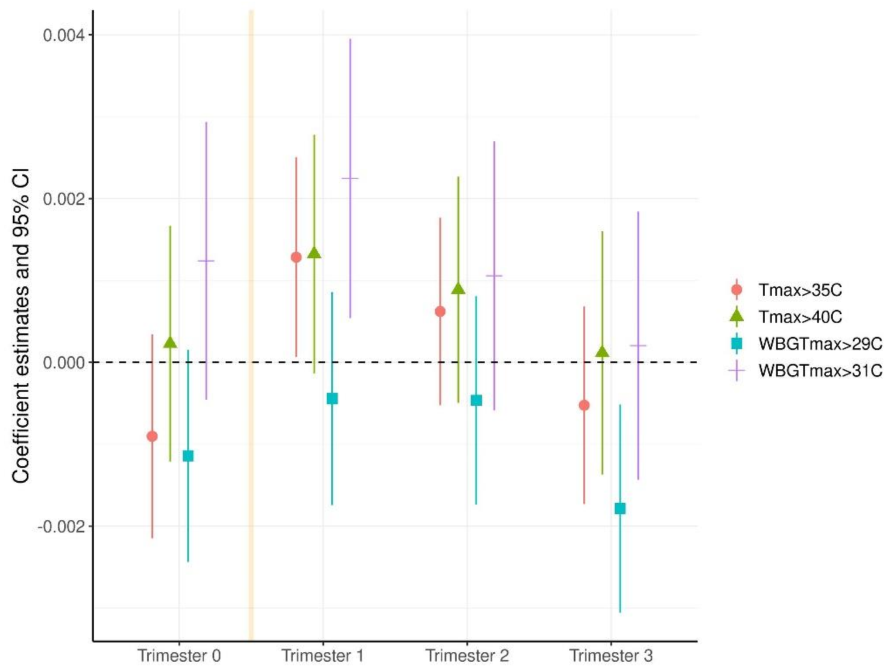


Figure A6: Alternate HAZ results with precipitation controls. Coefficients and 95% confidence intervals for the estimated effect of extreme heat exposure on HAZ. The yellow vertical line represents conception. Controls from Model 1 included in the model but not shown, along with total precipitation in each trimester (CHIRPS monthly data; Funk et al. 2015). Fixed effects for cluster and state-by-survey-year also included in the model but not shown.

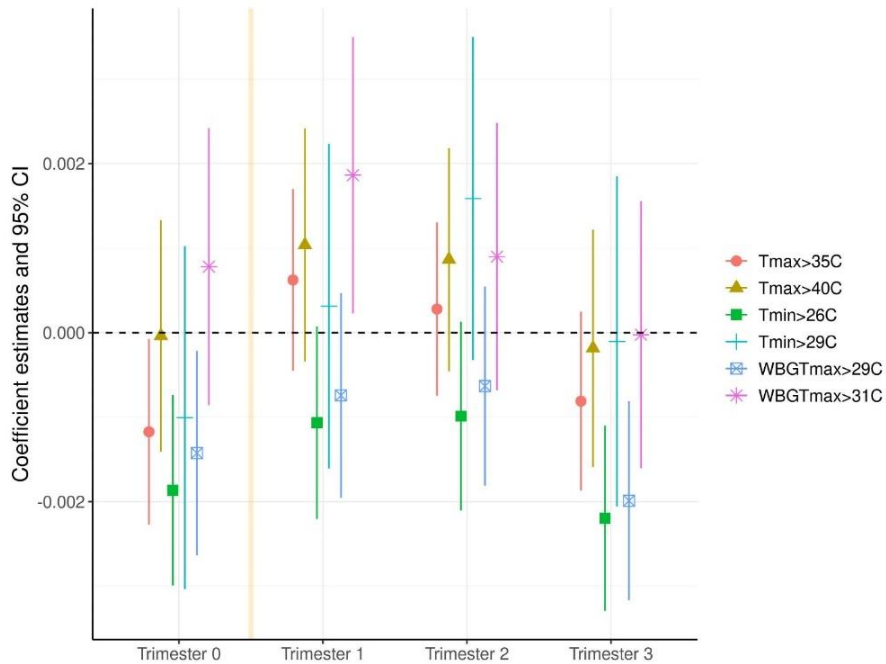


Figure A7: Alternate HAZ results T_{min} variables (model 1). Coefficients and 95% confidence intervals for the estimated effect of extreme heat exposure on HAZ. The yellow vertical line represents conception. Controls from Model 1 are included in the model but not shown. Fixed effects for cluster and state-by-survey-year also included in the model but not shown.

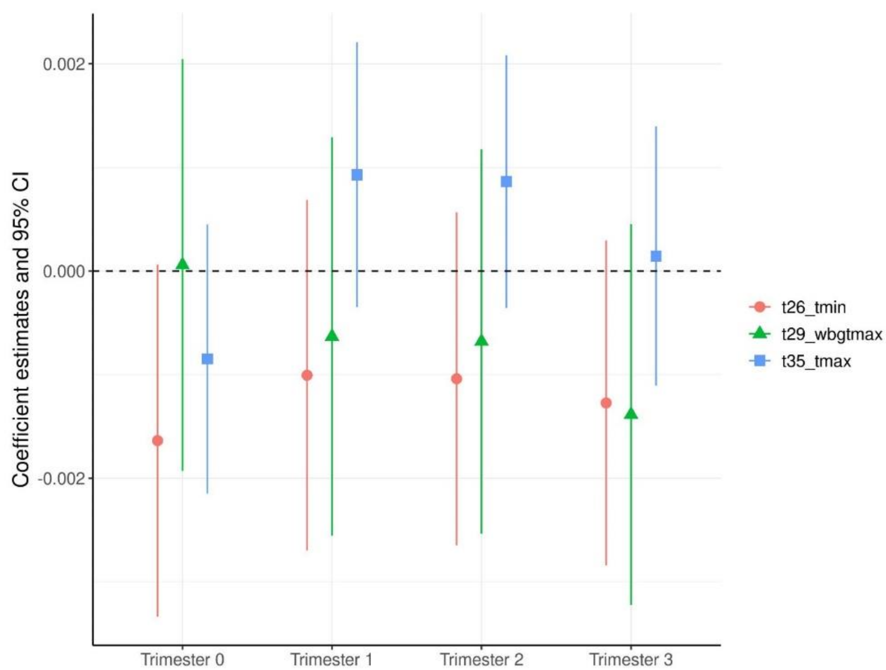


Figure A8: Alternate HAZ results T_{min} variables (model 2). Coefficients and 95% confidence intervals for the estimated effect of extreme heat exposure on HAZ when all are taken as covariates in a single regression model. The yellow vertical line represents conception. Controls from Model 1 are included in the model but not shown. Fixed effects for cluster and state-by-survey-year also included in the model but not shown.

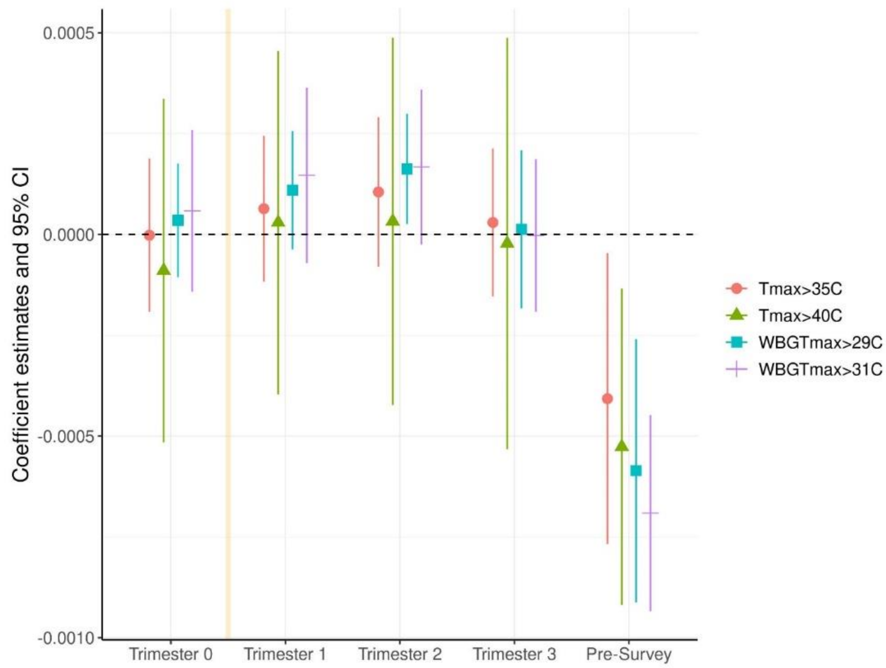


Figure A9: Heat effects on probability of recent diarrhea (state level). Coefficients and 95% confidence intervals for the estimated effect of extreme heat exposure in each trimester and in the 3 months prior to DHS survey on the probability of experiencing diarrhea within the last two weeks for children under 5. The yellow vertical line represents conception. Controls from Model 1 are included in the model but not shown. Fixed effects for state-by-survey-year also included in the model but not shown. The model does not include DHS cluster fixed effects, given that heat exposure during the pre-survey period does not vary within clusters. Standard errors are clustered at the state level.

Dependent Variable:	Height-for-age Z-score (HAZ)								Height-for-age Z-score (HAZ)							
	Tmax > 35C				Tmax > 40C				WBGTmax > 29C				WBGTmax > 31C			
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables																
Female (child)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Birth place (ref=Clinic)																
Home	-0.20***	-0.19***	-0.19***	-0.20***	-0.20***	-0.20***	-0.20***	-0.20***	-0.19***	-0.19***	-0.19***	-0.20***	-0.20***	-0.20***	-0.20***	-0.20***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Other	-0.60**	-0.60**	-0.60**	-0.60**	-0.58**	-0.58**	-0.59**	-0.59**	-0.60**	-0.60**	-0.60**	-0.60**	-0.60**	-0.60**	-0.60**	-0.60**
	(0.27)	(0.27)	(0.27)	(0.27)	(0.26)	(0.26)	(0.26)	(0.26)	(0.27)	(0.27)	(0.27)	(0.27)	(0.27)	(0.27)	(0.27)	(0.27)
Mother's Education (ref=Higher)																
None	-0.66***	-0.66***	-0.66***	-0.66***	-0.66***	-0.66***	-0.66***	-0.66***	-0.66***	-0.66***	-0.66***	-0.66***	-0.66***	-0.66***	-0.66***	-0.66***
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
Primary	-0.60***	-0.60***	-0.60***	-0.60***	-0.60***	-0.60***	-0.60***	-0.60***	-0.60***	-0.60***	-0.60***	-0.60***	-0.60***	-0.60***	-0.60***	-0.60***
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Secondary	-0.35***	-0.35***	-0.35***	-0.35***	-0.35***	-0.35***	-0.35***	-0.35***	-0.35***	-0.35***	-0.35***	-0.35***	-0.35***	-0.35***	-0.35***	-0.35***
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Improved Toilet	0.13***	0.13***	0.13***	0.13***	0.13***	0.13***	0.13***	0.13***	0.13***	0.13***	0.13***	0.13***	0.13***	0.13***	0.13***	0.13***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Number of extreme days																
Trimester 3	0.002	0.003	0.003	0.003	-0.04*	-0.04*	-0.04	-0.04	0.002	0.002	0.0010	0.0010	0.002	0.002	0.002	0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.02)	(0.03)	(0.03)	(0.03)	(0.001)	(0.001)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)
Trimester 2		0.001	0.001	0.001		0.008	0.01	0.01		-0.0009	-0.001	-0.001		-0.001	-0.001	-0.0009
		(0.002)	(0.002)	(0.002)		(0.02)	(0.02)	(0.02)		(0.001)	(0.001)	(0.001)		(0.003)	(0.003)	(0.003)
Trimester 1			9.5×10^{-5}	-7.6×10^{-6}			0.02	0.02			-0.002	-0.002			0.0004	0.0006
			(0.002)	(0.002)			(0.02)	(0.02)			(0.002)	(0.002)			(0.003)	(0.003)
Trimester 0				-0.0004				0.009				7.3×10^{-5}				0.0007
				(0.002)				(0.03)				(0.002)				(0.003)
Fixed Effects																
DHS cluster	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State-survey year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics																
Observations	12,763	12,763	12,763	12,763	12,763	12,763	12,763	12,763	12,763	12,763	12,763	12,763	12,763	12,763	12,763	12,763
R^2	0.28361	0.28364	0.28364	0.28364	0.28382	0.28383	0.28392	0.28393	0.28369	0.28372	0.28383	0.28383	0.28356	0.28358	0.28358	0.28358
Within R^2	0.03871	0.03875	0.03875	0.03876	0.03899	0.03901	0.03913	0.03914	0.03882	0.03886	0.03901	0.03901	0.03865	0.03867	0.03867	0.03867

Clustered (DHS Cluster) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table A5: **HAZ regression results (model 1) with standard errors for Bangladesh only.** Controls for twin status, mother's parity, mother's marital status, religion, child's birth month, mother's age in years, survey month and child's age in months included in the model but not shown.

Dependent Variable:	Height-for-age Z-score (HAZ)								Height-for-age Z-score (HAZ)							
	Tmax > 35C				Tmax > 40C				WBGTmax > 29C				WBGTmax > 31C			
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables																
Female (child)	0.09***	0.09***	0.09***	0.09***	0.09***	0.09***	0.09***	0.09***	0.09***	0.09***	0.09***	0.09***	0.09***	0.09***	0.09***	0.09***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Birth place (ref=Clinic)																
Home	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Other	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)
Mother's Education (ref=Higher)																
None	-0.48***	-0.48***	-0.48***	-0.48***	-0.48***	-0.48***	-0.48***	-0.48***	-0.48***	-0.48***	-0.48***	-0.48***	-0.48***	-0.48***	-0.48***	-0.48***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Primary	-0.39***	-0.39***	-0.39***	-0.39***	-0.39***	-0.39***	-0.39***	-0.39***	-0.39***	-0.39***	-0.39***	-0.39***	-0.39***	-0.39***	-0.39***	-0.39***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Secondary	-0.24***	-0.24***	-0.24***	-0.24***	-0.24***	-0.24***	-0.24***	-0.24***	-0.24***	-0.24***	-0.24***	-0.24***	-0.24***	-0.24***	-0.24***	-0.24***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Improved Toilet	0.23***	0.23***	0.23***	0.23***	0.23***	0.23***	0.23***	0.23***	0.23***	0.23***	0.23***	0.23***	0.23***	0.23***	0.23***	0.23***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Number of extreme days																
Trimester 3	-0.0010***	-0.0009***	-0.0003	-0.0003	-0.0005	-0.0005	-1.8×10^{-5}	8.8×10^{-5}	-0.001***	-0.0010***	-0.0009**	-0.001**	-0.001**	-0.001**	-2.6×10^{-5}	0.0008
	(0.0003)	(0.0003)	(0.0004)	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0006)	(0.0003)	(0.0003)	(0.0004)	(0.0005)	(0.0004)	(0.0005)	(0.0006)	(0.0007)
Trimester 2		0.0009***	0.001***	0.001**		-0.0001	0.0002	0.0003		0.0006**	0.0006**	9.6×10^{-5}		-3.8×10^{-5}	0.0005	0.002**
		(0.0003)	(0.0003)	(0.0004)		(0.0005)	(0.0005)	(0.0006)		(0.0003)	(0.0003)	(0.0005)		(0.0005)	(0.0005)	(0.0007)
Trimester 1			0.001***	0.0010**			0.001**	0.001**			4.7×10^{-5}	-0.0004			0.002***	0.003***
			(0.0004)	(0.0005)			(0.0005)	(0.0006)			(0.0004)	(0.0005)			(0.0006)	(0.0007)
Trimester 0				-5.9×10^{-5}				0.0003				-0.0006				0.002**
				(0.0005)				(0.0006)				(0.0005)				(0.0007)
Fixed Effects																
DHS cluster	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State-survey year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics																
Observations	174,668	174,668	174,668	174,668	174,668	174,668	174,668	174,668	174,668	174,668	174,668	174,668	174,668	174,668	174,668	174,668
R^2	0.32633	0.32637	0.32641	0.32641	0.32629	0.32629	0.32631	0.32631	0.32635	0.32637	0.32637	0.32638	0.32631	0.32631	0.32636	0.32638
Within R^2	0.01660	0.01666	0.01672	0.01672	0.01654	0.01654	0.01657	0.01657	0.01663	0.01666	0.01666	0.01667	0.01657	0.01657	0.01665	0.01668

Clustered (DHS Cluster) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table A6: **HAZ regression results (model 1) with standard errors for India only.** Controls for twin status, mother's parity, mother's marital status, religion, child's birth month, mother's age in years, survey month and child's age in months included in the model but not shown.

Dependent Variable:	Height-for-age Z-score (HAZ)								Height-for-age Z-score (HAZ)							
	Tmax > 35C				Tmax > 40C				WBGTmax > 29C				WBGTmax > 31C			
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables																
Female (child)	-0.010	-0.010	-0.010	-0.010	-0.009	-0.009	-0.009	-0.010	-0.008	-0.008	-0.008	-0.009	-0.009	-0.009	-0.009	-0.009
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Birth place (ref=Clinic)																
Home	-0.17***	-0.17***	-0.17***	-0.17***	-0.17***	-0.17***	-0.17***	-0.17***	-0.17***	-0.17***	-0.17***	-0.17***	-0.17***	-0.17***	-0.17***	-0.17***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Other	-0.28***	-0.28***	-0.28***	-0.28***	-0.28***	-0.28***	-0.28***	-0.28***	-0.28***	-0.28***	-0.28***	-0.28***	-0.28***	-0.28***	-0.28***	-0.28***
	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)
Mother's Education (ref=Higher)																
None	-0.44***	-0.44***	-0.44***	-0.44***	-0.43***	-0.43***	-0.43***	-0.43***	-0.44***	-0.44***	-0.44***	-0.44***	-0.44***	-0.44***	-0.44***	-0.44***
	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)
Primary	-0.36***	-0.36***	-0.36***	-0.36***	-0.36***	-0.36***	-0.36***	-0.36***	-0.37***	-0.37***	-0.37***	-0.37***	-0.36***	-0.37***	-0.37***	-0.37***
	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)
Secondary	-0.24***	-0.24***	-0.24***	-0.24***	-0.24***	-0.24***	-0.24***	-0.24***	-0.25***	-0.25***	-0.25***	-0.24***	-0.24***	-0.25***	-0.25***	-0.25***
	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)
Improved Toilet	0.23***	0.23***	0.23***	0.23***	0.23***	0.23***	0.23***	0.23***	0.23***	0.23***	0.23***	0.23***	0.23***	0.23***	0.23***	0.23***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Number of extreme days																
Trimester 3	-0.005***	-0.005***	-0.005***	-0.005***	-0.01***	-0.01***	-0.01***	-0.01***	-0.002*	-0.002*	-0.001	-0.003	-0.006	-0.006	-0.010*	-0.01**
	(0.001)	(0.001)	(0.002)	(0.002)	(0.004)	(0.004)	(0.004)	(0.004)	(0.001)	(0.001)	(0.002)	(0.002)	(0.004)	(0.005)	(0.005)	(0.005)
Trimester 2		-0.0009	-0.001	-0.001		-0.006*	-0.005	-0.007		0.0009	0.001	-0.002		-0.003	-0.005	-0.008
		(0.001)	(0.001)	(0.002)		(0.003)	(0.004)	(0.004)		(0.001)	(0.001)	(0.002)		(0.005)	(0.005)	(0.005)
Trimester 1			-0.001	-0.001			0.004	0.003			0.001	-0.0006			-0.009	-0.01
			(0.002)	(0.002)			(0.004)	(0.004)			(0.002)	(0.002)			(0.006)	(0.006)
Trimester 0				-9×10^{-5}				-0.004				-0.004				-0.008
				(0.002)				(0.005)				(0.002)				(0.006)
Fixed Effects																
DHS cluster	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State-survey year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics																
Observations	11,279	11,279	11,279	11,279	11,279	11,279	11,279	11,279	11,279	11,279	11,279	11,279	11,279	11,279	11,279	11,279
R^2	0.35088	0.35092	0.35096	0.35096	0.35077	0.35092	0.35098	0.35104	0.35029	0.35033	0.35036	0.35055	0.35015	0.35018	0.35034	0.35048
Within R^2	0.02261	0.02267	0.02273	0.02273	0.02243	0.02266	0.02275	0.02284	0.02171	0.02178	0.02182	0.02210	0.02150	0.02155	0.02179	0.02199

Clustered (DHS Cluster) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table A7: **HAZ regression results (model 1) with standard errors for Nepal only.** Controls for twin status, mother's parity, mother's marital status, religion, child's birth month, mother's age in years, survey month and child's age in months included in the model but not shown.

Dependent Variable:	Height-for-age Z-score (HAZ)								Height-for-age Z-score (HAZ)							
	Tmax > 35C				Tmax > 40C				WBGTmax > 29C				WBGTmax > 31C			
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables																
Female (child)	0.11***	0.11***	0.11***	0.11***	0.11***	0.11***	0.11***	0.11***	0.11***	0.11***	0.11***	0.11***	0.11***	0.11***	0.11***	0.11***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Birth place (ref=Clinic)																
Home	-0.12***	-0.12***	-0.12***	-0.12***	-0.12***	-0.12***	-0.12***	-0.12***	-0.12***	-0.12***	-0.12***	-0.12***	-0.12***	-0.12***	-0.12***	-0.12***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Other	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14
	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)
Mother's Education (ref=Higher)																
None	-0.48***	-0.48***	-0.48***	-0.48***	-0.48***	-0.48***	-0.48***	-0.48***	-0.48***	-0.48***	-0.48***	-0.47***	-0.48***	-0.47***	-0.48***	-0.48***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Primary	-0.42***	-0.42***	-0.42***	-0.42***	-0.42***	-0.42***	-0.42***	-0.42***	-0.42***	-0.42***	-0.42***	-0.42***	-0.42***	-0.42***	-0.42***	-0.42***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Secondary	-0.19***	-0.19***	-0.19***	-0.19***	-0.19***	-0.19***	-0.19***	-0.19***	-0.19***	-0.19***	-0.19***	-0.19***	-0.19***	-0.19***	-0.19***	-0.19***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Improved Toilet	0.23***	0.23***	0.23***	0.23***	0.23***	0.23***	0.23***	0.23***	0.23***	0.23***	0.23***	0.23***	0.23***	0.23***	0.23***	0.23***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Number of extreme days																
Trimester 3	-0.0008	-0.0007	-6.7×10^{-5}	0.0001	-0.0004	-0.0003	0.0005	0.0005	-0.001**	-0.001**	-0.0007	-0.002	-0.0007	-0.0006	0.002	0.003*
	(0.0006)	(0.0006)	(0.0008)	(0.0009)	(0.0010)	(0.0010)	(0.001)	(0.001)	(0.0006)	(0.0006)	(0.0007)	(0.001)	(0.0010)	(0.001)	(0.001)	(0.002)
Trimester 2		0.001*	0.001**	0.002*		0.0005	0.001	0.001		0.001**	0.001**	0.0002		0.0006	0.002	0.003**
		(0.0006)	(0.0006)	(0.0009)		(0.0010)	(0.001)	(0.001)		(0.0006)	(0.0006)	(0.001)		(0.0010)	(0.001)	(0.002)
Trimester 1			0.001	0.001			0.002	0.002			0.0007	-0.0002			0.004***	0.005***
			(0.0007)	(0.0009)			(0.001)	(0.001)			(0.0007)	(0.001)			(0.001)	(0.002)
Trimester 0				0.0004				-1.9×10^{-5}				-0.001				0.002
				(0.0009)				(0.001)				(0.001)				(0.002)
Fixed Effects																
DHS cluster	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State-survey year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics																
Observations	42,500	42,500	42,500	42,500	42,500	42,500	42,500	42,500	42,500	42,500	42,500	42,500	42,500	42,500	42,500	42,500
R^2	0.36879	0.36885	0.36889	0.36889	0.36876	0.36876	0.36881	0.36881	0.36887	0.36895	0.36897	0.36900	0.36876	0.36877	0.36896	0.36898
Within R^2	0.02380	0.02389	0.02395	0.02395	0.02374	0.02375	0.02382	0.02382	0.02391	0.02404	0.02406	0.02412	0.02375	0.02377	0.02405	0.02409

Clustered (DHS Cluster) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table A8: **HAZ regression results (model 1) with standard errors for urban clusters only.** Controls for twin status, mother's parity, mother's marital status, religion, child's birth month, mother's age in years, survey month and child's age in months included in the model but not shown.

Dependent Variable:	Height-for-age Z-score (HAZ)								Height-for-age Z-score (HAZ)							
	Tmax > 35C				Tmax > 40C				WBGTmax > 29C				WBGTmax > 31C			
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables																
Female (child)	0.08***	0.08***	0.08***	0.08***	0.08***	0.08***	0.08***	0.08***	0.08***	0.08***	0.08***	0.08***	0.08***	0.08***	0.08***	0.08***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Birth place (ref=Clinic)																
Home	-0.009	-0.009	-0.009	-0.009	-0.009	-0.009	-0.009	-0.009	-0.009	-0.009	-0.009	-0.009	-0.009	-0.009	-0.009	-0.009
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Other	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
Mother's Education (ref=Higher)																
None	-0.51***	-0.51***	-0.51***	-0.51***	-0.51***	-0.51***	-0.51***	-0.51***	-0.51***	-0.51***	-0.51***	-0.51***	-0.51***	-0.51***	-0.51***	-0.51***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Primary	-0.42***	-0.42***	-0.42***	-0.42***	-0.42***	-0.42***	-0.42***	-0.42***	-0.42***	-0.42***	-0.42***	-0.42***	-0.42***	-0.42***	-0.42***	-0.42***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Secondary	-0.28***	-0.28***	-0.28***	-0.28***	-0.28***	-0.28***	-0.28***	-0.28***	-0.28***	-0.28***	-0.28***	-0.28***	-0.28***	-0.28***	-0.28***	-0.28***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Improved Toilet	0.22***	0.22***	0.22***	0.22***	0.22***	0.22***	0.22***	0.22***	0.22***	0.22***	0.22***	0.22***	0.22***	0.22***	0.22***	0.22***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Number of extreme days																
Trimester 3	-0.0007**	-0.0006**	-4.9×10^{-5}	-0.0003	-0.0003	-0.0003	0.0002	0.0002	-0.0007**	-0.0006**	-0.0009**	-0.001***	-0.0008*	-0.0008*	-0.0004	5.5×10^{-6}
	(0.0003)	(0.0003)	(0.0004)	(0.0005)	(0.0005)	(0.0005)	(0.0006)	(0.0006)	(0.0003)	(0.0003)	(0.0004)	(0.0005)	(0.0005)	(0.0005)	(0.0006)	(0.0007)
Trimester 2		0.001***	0.001***	0.001**		0.0003	0.0006	0.0006		0.0006**	0.0005*	-0.0002		0.0002	0.0004	0.0010
		(0.0003)	(0.0003)	(0.0005)		(0.0005)	(0.0005)	(0.0006)		(0.0003)	(0.0003)	(0.0005)		(0.0005)	(0.0005)	(0.0007)
Trimester 1			0.0009**	0.0007			0.001*	0.001			-0.0004	-0.0009*			0.0006	0.001
			(0.0004)	(0.0005)			(0.0006)	(0.0006)			(0.0004)	(0.0005)			(0.0006)	(0.0008)
Trimester 0				-0.0004				-6.3×10^{-5}				-0.0009				0.0008
				(0.0005)				(0.0006)				(0.0005)				(0.0007)
Fixed Effects																
DHS cluster	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State-survey year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics																
Observations	156,210	156,210	156,210	156,210	156,210	156,210	156,210	156,210	156,210	156,210	156,210	156,210	156,210	156,210	156,210	156,210
R^2	0.31425	0.31432	0.31435	0.31435	0.31423	0.31423	0.31425	0.31425	0.31426	0.31428	0.31428	0.31429	0.31424	0.31424	0.31425	0.31425
Within R^2	0.01585	0.01594	0.01599	0.01599	0.01581	0.01581	0.01584	0.01584	0.01585	0.01588	0.01589	0.01591	0.01583	0.01583	0.01584	0.01585

Clustered (DHS Cluster) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table A9: **HAZ regression results (model 1) with standard errors for rural clusters only.** Controls for twin status, mother's parity, mother's marital status, religion, child's birth month, mother's age in years, survey month and child's age in months included in the model but not shown.

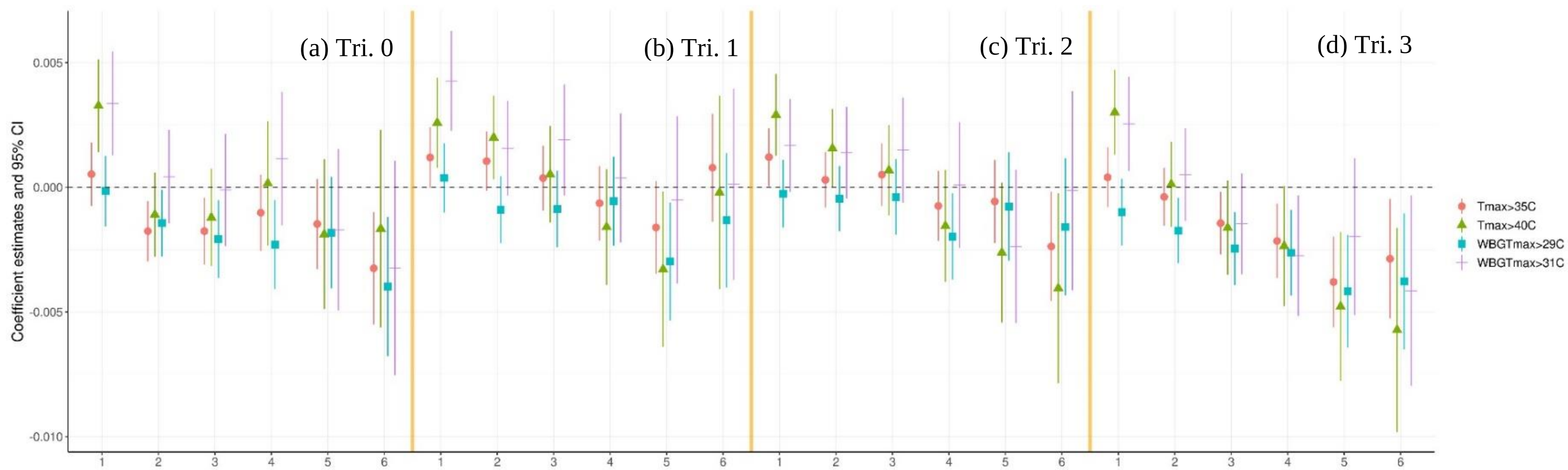


Figure A10: HAZ results (model 1) by birth order. Coefficients and 95% confidence intervals for the interactive effect of heat and birth order (1-6 depicted) on HAZ. Yellow vertical lines delineate each trimester. Controls and fixed effects for cluster and state-by-survey-year included in the model but not shown.

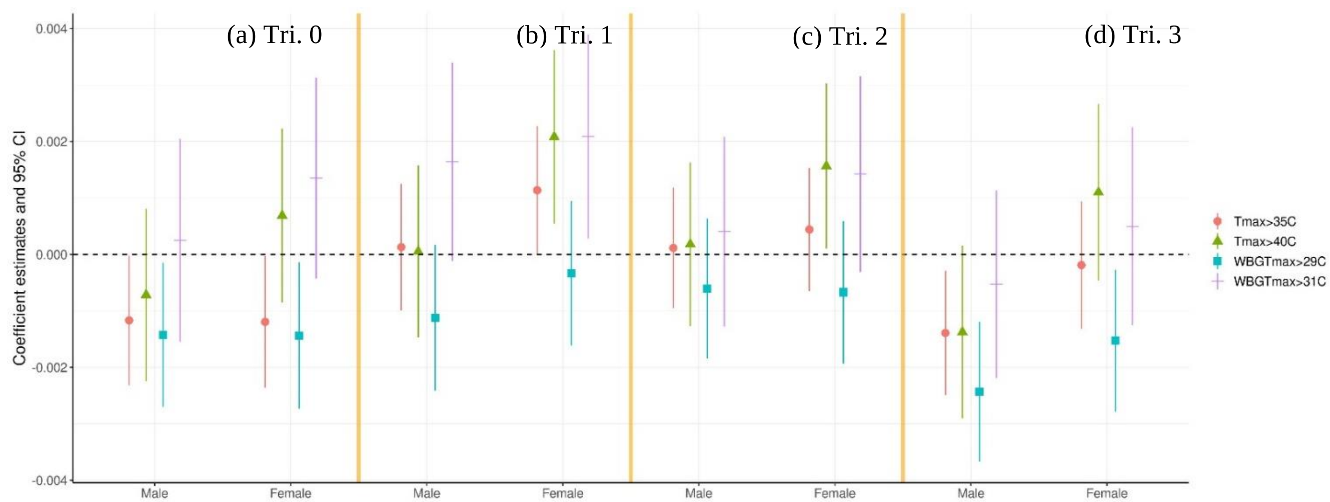


Figure A11: HAZ results (model 1) by child's sex. Coefficients and 95% confidence intervals for the interactive effect of extreme heat and child's sex on HAZ. Yellow vertical lines delineate each trimester. Controls and fixed effects for cluster and state-by-survey-year included in the model but not shown.

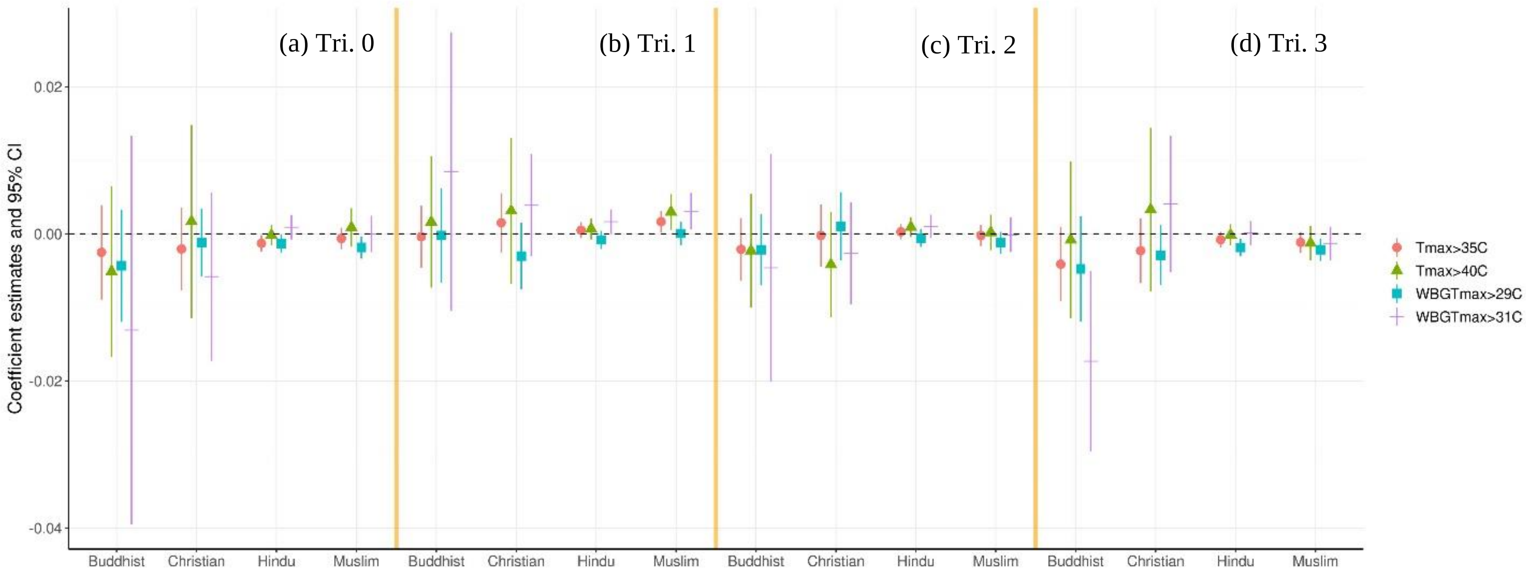


Figure A12: HAZ results (model 1) by religion. Coefficients and 95% confidence intervals for the interactive effect of extreme heat and mother's religion on HAZ. Yellow vertical lines delineate each trimester. Controls and fixed effects for cluster and state-by-survey-year included in the model but not shown.