Birth Weight in a Warming World: Is the 'Healthy Immigrant Effect' a Protective Factor against Extreme Heat?

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Short Abstract

Research into the relationship between migration and health often centers around the so-called "healthy immigrant paradox." This paradox hinges on the observation that, despite their higher levels of socioeconomic vulnerability, migrants exhibit, on average, better health outcomes than native populations. This advantage includes better perinatal and birth outcomes. Recent literature has also assessed the impact of extreme heat on maternal and perinatal health. Bridging these two strands of literature, our central research question is: *Can the health advantage observed among migrants offset the adverse impact of exposure to extreme heat on birth weight?*

We compiled a dataset by merging birth register data from 2018 to 2021 in Spain (1,201,585 births, of which 299,643 correspond to immigrant mothers) and climate records from the National Meteorology Agency in order to analyze the relationship between birth weight and the number of "orange alarm" days (>37ºC) in the province of birth. These data allow to explore the interplay between migrant status and extreme heat on birth weight (VLBW [<1,500 g], LBW [<2,500 g] and macrosomia [>4,000 g]). Controls in our model include: maternal age, education, activity, and occupational type, paternal presence, and newborn's sex. We employed two distinct modeling approaches: linear probability models and quantile regression.

Our preliminary results indicate that exposure to extreme heat has a negative impact on birth outcomes across migrant status. Therefore, it appears that the "healthy immigrant effect" does not provide protection to babies of migrant origin against the adverse effects of exposure to extreme weather conditions during gestation.

Long abstract

Background

Socioeconomic differentials in birth outcomes have been systematically documented over the past five decades (Cozzani 2023). These disparities are a matter of significant public concern, as birth outcomes consistently serve as indicators of children's health and well-being during childhood and as predictors of their success in later life stages (Torche and Conley 2015).

Gestation marks a critical phase in human development, where even minor adverse events can have profound and enduring effects on fetal development and birth outcomes (Almond and Mazumder 2013; Currie and Almond 2011). Among the existing threats to a healthy pregnancy and perinatal health, climate-related shocks are increasingly attracting attention. Pregnancy raises the vulnerability of women to environmental hazards, including exogenous heat. Recent reviews and meta-analyses of the literature consistently highlight the association between extreme heat

and maternal and perinatal health (Chersich et al. 2020). Specifically, exposure to heat waves increases the risk of preterm birth due to factors such as dehydration and impaired thermoregulation, associated to oxytocin release from altered blood viscosity (Bekkar et al. 2020). Heat has also been associated to reduced birth weights as a result of compromised uterine blood flow and placental-fetal exchange (Bekkar et al. 2020). Furthermore, extreme heat is also associated with other perinatal conditions, including placental abruption, gestational hypertension, preeclampsia, gestational diabetes, miscarriage, fetal distress, congenital birth defects, diarrhea, and sudden infant death syndrome (Baharav et al. 2023). While many of these associations have been examined in terms of socioeconomic background (Conte Keivabu and Cozzani 2022), migrant status has largely been overlooked. This is the precise focus of our contribution.

Migration can be a distressing experience for family dynamics and child wellbeing (Cebolla-Boado and González Ferrer 2022). It often leads to a downgrade, at least temporarily, in one's socioeconomic status compared to their place of origin (Ichou 2014). Yet migrants have systematically been described as an advantaged group, primarily due to their positive self-selection into migration (Ichou and Wallace 2019; Riosmena, Wong, and Palloni 2013). This migrant advantage has also been observed in perinatal health, particularly in the context of reducing the risk of low birth weight (Juárez et al. 2015). Children born to migrant mothers are less likely to have pathologically low birth weights, which encompasses “low birth weight” (<2,500 g) and “very low birth weight” (<1,500 g), than children born to native mothers. However, being born to a migrant mother not only confers an advantage but also heightens the risk of macrosomia, i.e. pathologically elevated birth weights (>4,000 g) (Cebolla-Boado and Salazar 2016).

Hence, migrants find themselves in a paradoxical situation, appearing advantaged in health outcomes while facing socioeconomic vulnerability, which, in turn, increases their exposure to extreme climatic events (Chersich et al. 2020). This unique context prompts us to investigate whether their initial health advantage can mitigate the effects of extreme heat exposure during pregnancy. Finding the answer to this question holds significant implications, not only for understanding the social epidemiology of migration but also for advancing research on climate change and the reproductive health of vulnerable populations.

Data

We created a unique dataset by combining birth register data spanning from 2018 to 2021 in Spain (*Movimiento Natural de la Población*, *Boletín del Parto*, INE) with climate records from the National Meteorology Agency (AEMET). This dataset allowed us to investigate the relationship between the occurrence of "orange alarm" days (>37ºC) in a given province and birth weight. Our analytical sample comprises a total of 1,201,585 births (of which 299,643 correspond to immigrant mothers), for which we have information on the number of days under extreme heat in their province of birth. Our data enables us to explore the impact of both migrant status and extreme heat on birth weight (VLBW [<1,500 g], LBW [<2,500 g] and macrosomia or neonatal overweight [>4,000 g]). Our model incorporates various control variables, including maternal education (primary or less, secondary, university), employment status (unemployed, employed, economically inactive) and age (<34 or >35), and newborn’s sex (1: female).

Methods

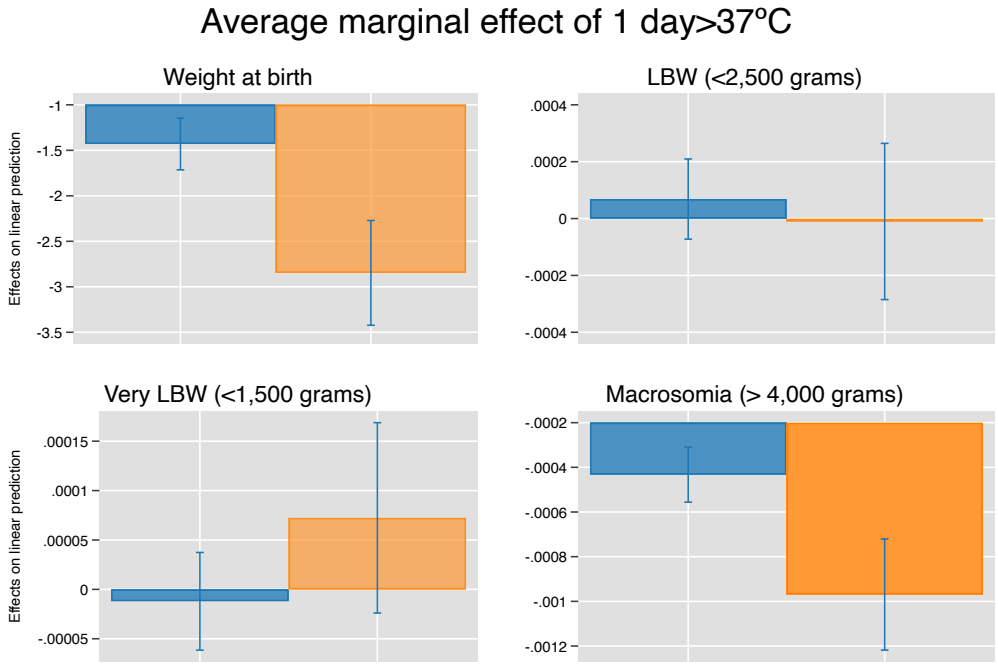
We used two distinct modeling approaches to examine the interplay between migrant status and extreme heat in relation to birth weight.

Firstly, we adopted the conventional approach, which involved analyzing birth weight and recoding it as a dichotomous variable, specifically focusing on pathological weights (LBW/VLBW and macrosomia). For this analysis, we utilized OLS regression and linear probability models.

Secondly, we adopted a more innovative and, in our view, methodologically robust approach by employing quantile regression to jointly assess the impact of our variables of interest on each percentile of birth weight (Cebolla-Boado and Salazar 2016). This approach allowed for simultaneous estimations across different birth weight percentiles: weights below 1,500 grams (VLBW: 1st percentile), below 2,500 grams (LBW: 9th percentile), above 4,000 grams (macrosomia: 95th percentile), as well as healthy birth weights falling between the 10th and the 94th percentiles.

It is important to note that in this abstract, our focus is primarily on graphical interpretations of the results. We have included confidence intervals to provide reassurance, even though the estimations are derived from the entire dataset.

Preliminary results



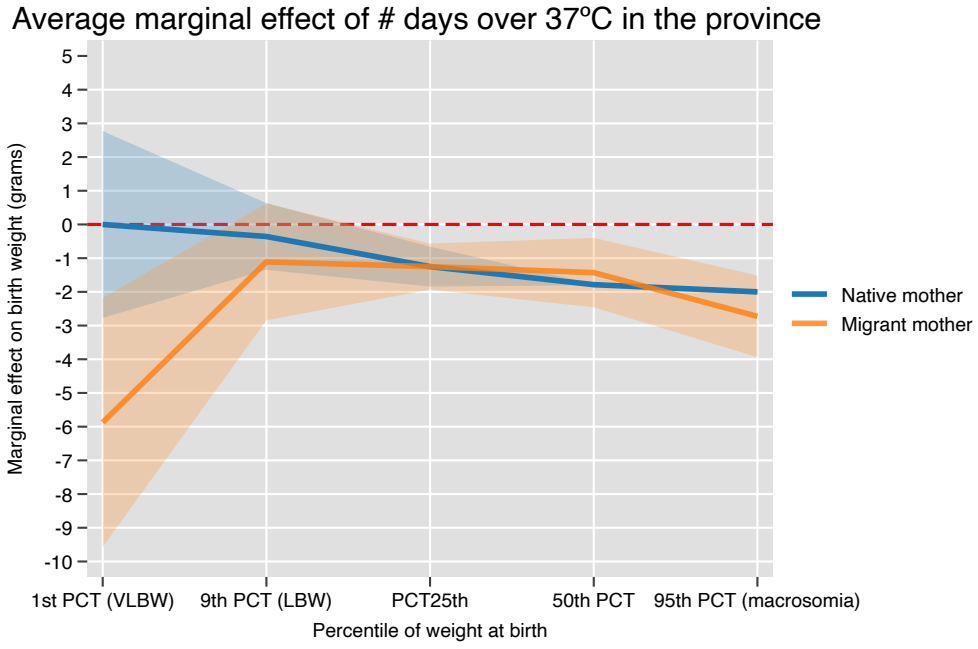
Estimated from four separate OLS regressions where dependent variable is weight at birth and controls for migrant status, days of extreme heat, baby sex, maternal age, education and activity, and pregnancy term in August.

The panels presented in the first plot illustrate the marginal effect of exposure to heat across maternal migrant status as obtained from more traditional analyses, where distinct equations are estimated for birth weight and the risk of falling into pathologically low and high weights. To be specific, the first panel pertains to the continuous representation of birth weight, the second pertains to LBW, the third to VLBW, and finally, the fourth addresses macrosomic births.

The marginal effect of heat on continuous birth weight is notably more pronounced for migrant-origin children than for native ones. Exposure to an additional day of extreme heat results in an average reduction of nearly 3 grams in the birth weight of babies born to migrant mothers, whereas those born to native mothers experience a decrease of only 1.5 grams. However, the impact of extreme heat for babies born to migrants and natives on the likelihood of experiencing pathological birth weights is exceedingly marginal and non-significant, with the sole exception of macrosomia.

Secondly, we present the findings of a quantile regression analysis that explores the interaction between heat exposure and maternal migrant status across the entire spectrum of birth weights. Specifically, we conducted joint estimations for our variables of interest at the 1st percentile (VLBW), 9th percentile (LBW), 95th percentile (macrosomia), and the median (50th percentile). This analytical approach enables us to document simultaneous the average birth weight for babies falling within these birth weight categories.

The summarized results are depicted in the following graph, illustrating, again, the marginal effect of an additional day of extreme heat (>37°C) in the province of birth across maternal migrant status.



Estimated from Quantile regressions where dependent variable is weight at birth and controls for migrant status, days of extreme heat, baby sex, maternal age, education and activity, and pregnancy term in August.

The model suggests that babies born to migrant mothers with extremely low birth weights (VLBW) are much lighter than those born to native mothers. Specifically, one extra day of heat implies an extra average loss of 6 grams compared to identical babies born to native mothers. For the rest of the selected percentiles of weight at birth, the children of migrants and natives suffer a similar weight loss from being exposed to extreme heat.

Tentative conclusions

Our preliminary results confirm that exposure to extreme heat has a negative impact on birth outcomes across migrant status. Thus, it seems that the healthy immigrant effect found at perinatal stages does nothing to protect migrant origin babies from extreme weather conditions.

However, the most harmful effect of heat is not readily apparent when analyzing the risk of falling into pathological categories of birth weight, as most conventional research designs do. Using quantile regression, it becomes evident that heat exacerbates the adverse conditions for babies born to migrant mothers when they fall into pathologically low birth weights.

Further research to be included in the paper

The paper then digs into the effect of maternal socioeconomic status, paternal presence in the household, union status, and pregnancy term of exposure to heat as well as ethnic differentials within the category of migrant mothers to further understand the mechanisms that produce this extra migrant vulnerability.

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