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ABSTRACT

We provide the first estimates of the negative impact of exposure to extremely high temperatures during pregnancy on mothers' labor market outcomes. We employ individual-level survey data from China and leverage plausibly exogenous fluctuations in heat exposure within cities. The results demonstrate that exposure to extremely hot weather during pregnancy reduces women's wages and labor supply later in life and increases the likelihood that they will work in an unskilled sector. The effects are stronger for heat exposure during the third gestational trimester. The mechanism for these results is that extreme temperature exposure during pregnancy undermines maternal health. Our analysis proposes a new channel through which extreme weather generates health and economic costs.

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1 Introduction

Hot countries are likely to be poor, with national income falling 8.5 percent per degree Celsius in cross-country variation; even for sub-national regions within countries, hot regions tend to be less-developed (Dell et al., 2009). Prior research proposes several explanations for this negative association between temperature and economic prosperity, highlighting the implications of high temperatures for health and productivity (Costello et al., 2009; Deryugina and Hsiang, 2017), mortality (He and Tanaka, 2023), human capital accumulation (Garg et al., 2020), political institutions (Burke and Leigh, 2010), and agricultural production (Schlenker and Roberts, 2009). We add female labor market outcomes to this list.

Recent evidence suggests that women's increased contribution to the overall economy has significantly boosted economic growth (Hsieh et al., 2019; Duflo, 2012), but women are still likely to experience career discontinuity and labor supply reductions in response to motherhood (Goldin, 2014). Ambient heat waves during pregnancy may impair child and maternal health and consequently negatively impact female workers' performance in labor markets. This may be another indirect mechanism through which high temperatures hurt economic development. But little is known so far about how gestational heat exposure impacts labor market outcomes for female workers.

In this paper, we use individual-level data in China to examine how gestational exposure to extreme temperatures undermines maternal labor market outcomes. Further, we analyze the underlying mechanisms driving the consequences associated with heat exposure during pregnancy. To the best of our knowledge, this is the first attempt to evaluate how high temperatures trigger economic losses through the indirect channel of labor market disadvantage for mothers.

China provides a good laboratory in which to undertake this analysis because it is home to 18% of the world's population and is highly vulnerable to weather shocks. Additionally, China is a geographically expansive nation with varying climatic conditions, allowing us to look at behavioral responses to differential temporal changes of temperature across geographical locations. We use individual-level data describing women, linking their exposure to extremely hot weather during their first pregnancy with their labor market outcomes later in life in 2010, including earnings, labor supply and industry choices. The rich micro data also contains a wide range of variables on child and maternal health, which facilitates the analysis of underlying mechanisms driving the effects of temperatures on maternal outcomes.

Gestational exposure to heat waves is potentially correlated with other determinants of labor market outcomes. For example, females giving birth in different seasons within a year may differ in their socioeconomic status, and geographic locations with distinct climates may differ in economic opportunities. The empirical challenge of this study is to isolate the causal relationship between gestational heat exposure and labor market outcomes from the possible confluence of other factors. We follow the literature to control for city-by-delivery-month fixed effects as well as year fixed effects for each woman's first pregnancy. The identifying assumption is that comparing women giving birth in a particular city-month across different years would render exogenous the exposure to extreme heat waves that a woman experiences during pregnancy (as in Burke et al. (2015); Deryugina and Hsiang (2017); Dell et al. (2012)).

Our results document that gestational exposure to heat waves seems not to affect labor force participation for women later in life, but appears to alter their labor market outcomes at the intensive margin. In particular, experiencing extreme heat waves in the third trimester significantly reduces maternal wages and labor supply later in life, whereas heat exposure during the first and second trimesters does not have any meaningful effects. A one SD (14.6 days) increase in third-trimester gestational days with maximum temperature over 90 °F reduces annual work hours by 10% and annual income by up to 19%. Women who suffer from high temperatures in the third trimester are also significantly more likely to end up in an unskilled sector. Taken together, the detrimental effects of extremely hot weather appear to be concentrated in the third trimester.

About 8.4 million women in China experienced their first birth in 2000; on average, they experienced 12.3 extremely hot days (>90 °F) in the third gestational trimester (China Population Census 2000). Our estimates, if taken as causal, suggest that the extreme heat experienced by these women would lead to income losses of up to 26.9 billion Chinese Yuan per year, based on a back-of-the-envelope calculation. The monetized estimates are conservative, as we do not take into account the potential income losses for women giving birth in 2000 who had a birth in a prior year.

As in the literature, our identification strategy relies on the premise that variation in temperature over different years within a particular city and month is uncorrelated with unobserved determinants of heat exposure and future labor market outcomes. While our identification assumption is inherently untestable, we conduct several indirect tests. First, we show that the occurrence of extremely hot days does little to affect miscarriage, stillbirth, or the gender of children in our context. Second, we document that extreme heat exposure is not related to maternal socioeconomic status, such as educational attainment. Third, we find no evidence of selective fertility based on socioeconomic status, or of non-random migration in response to ambient heat waves. Finally, our results are robust to accounting for exposure to abnormally hot weather leading up to and following the pregnancy, the incidence of extremely cold days, and different secular trends across regions, and to using alternative measures of extremely hot weather.

There is no shortage of explanations for why heat exposure during pregnancy may affect labor market outcomes. A priori, we view three mechanisms as particularly plausible: maternal health problems associated with high temperatures, children's health outcomes, and temperature-related changes in agricultural income. Empirically, we find more consistency with the maternal health mechanism. We show that extreme heat during the third trimester significantly leads to various maternal health issues, including reproductive illness, motor system disease, deviations from optimal BMI, and mental health problems, while high temperatures occurring during the first and second trimesters do not appear to have any meaningful maternal health consequences.

The intriguing heterogeneity of maternal health consequences by the timing of pregnancy is consistent with our baseline labor market results by gestational trimester, as well as the pattern documented by the health literature (Chen et al., 2022; Cil and Cameron, 2017; Kim et al., 2021). Alternatively, the effects of in utero exposure to extreme heat on children's health are not concentrated in a particular trimester, and elevated temperatures during pregnancy do not meaningfully affect the amount of time mothers spend caring for other family members. Additionally, accounting for agricultural production hardly changes our estimated effects of high temperatures on maternal labor outcomes. Therefore, these alternative channels appear not to be of first-order importance in this context.

Our work is related to several strands of literature and sub-disciplines in economics. First, we are among the first to demonstrate how exposure to extremely hot weather during pregnancy negatively impacts mothers' labor market outcomes by damaging their health. Environmental economists have documented that in utero extreme heat exposure damages infants and children's health and even their future human capital development (Deschênes et al., 2009; Fishman et al., 2019; Graff Zivin et al., 2018). We go further by analyzing the maternal labor market consequences associated with extreme hot weather. Hence, the gestational exposure to high temperatures may be even more damaging than environmental economists previously thought.

Second, development economists have demonstrated that high temperatures negatively affect economic growth (Dell et al., 2009, 2012). We show that women who have experienced extreme heat waves during pregnancy are likely to end up in a disadvantaged labor market position. As limited economic opportunities for females are costly to society from an economic efficiency perspective (Hsieh et al., 2019), we propose a new mechanism through which high temperatures can generate economic costs. Third, we speak to the literature on the sources of lower wages and labor supply for females (Bertrand et al., 2010; Goldin, 2014). Our work is among the first to uncover how extreme temperatures reduce earnings and labor supply for mothers and potentially exacerbate the child penalty.

The remainder of this paper proceeds as follows. Section 2 describes the data and Section 3 shows descriptive patterns of high temperatures and maternal labor market outcomes. Section 4 describes our empirical specification, Section 5 presents the estimates of how gestational heat exposure hurts mothers' labor market outcomes, and Section 6 discusses the potential mechanisms driving our empirical pattern. Section 7 concludes.

2 Data

2.1 Data on Extreme Weather

The weather data come from the Institute of Geographic Sciences and Natural Resources Research (GSNR) under the Chinese Academy of Sciences. The database covers consecutive daily weather records of 2479 monitoring stations across 31 Chinese provinces from 1950 to 2018, including daily temperature, precipitation, wind speed, and sunshine duration. We measure city-level daily weather conditions by taking an inverse-distance weighted average of all these weather variables from stations that are located within a 200 km radius of each city's centroid. The weights are the inverse of their squared distance to each city, so that more distant stations are given less weight (as in Deschênes and Greenstone (2011)). Our primary variable of interest is the exposure to extremely hot weather during each mother's gestational period. We follow the recent work on extreme weather in China (Hu and Li, 2019) and the U.S. (Graff Zivin and Neidell, 2014; Park et al., 2020; Neidell et al., 2021) to define high-temperature days based on daily maximum temperature. We count the number of days with maximum temperature exceeding 90 °F during each gestational trimester in cities where mothers lived during pregnancy. In later sections, we show that our results are robust to using alternative measures of extremely high temperatures, including cooling degree days based on various temperature cutoffs (as in Albouy et al. (2016) and Graff Zivin et al. (2018)).

2.2 Data on Pregnancy Histories, Health, and Labor Market Outcomes

Information on individual fertility histories and mothers' later-life outcomes are drawn from the China Family Panel Studies (CFPS) 2010. CFPS is a nationally representative survey of Chinese families and individuals. First, the dataset records pregnancy and fertility histories of women who have ever given birth, which allow us to trace back when and where these women were during their pregnancies and measure the gestational exposure to extreme weather. On average, women in our sample gave birth for the first time 12 years prior to the survey year in 2010.[1] Second, the survey contains a wide range of labor market variables. Therefore, we are able to uncover how extreme heat during pregnancy affected women's later-life labor market outcomes in 2010. Third, the dataset also provides detailed information on both mothers' and children's health status. Experiencing extremely high temperature may negatively affect mothers' outcomes by hurting their own or their children's health. Hence, CFPS 2010 enables us to evaluate the underlying mechanisms driving our empirical pattern. We link extreme temperature shocks during pregnancy for female respondents' first childbirth with their labor market outcomes in 2010. We drop observations with missing values in their fertility histories, current employment status, and the first child's birth date and birth place. The primary sample includes 3681 women across 25 Chinese provinces. Note that

[1] We follow Banerjee and Maharaj (2020), Fishman et al. (2019), and Nilsson (2017) to count backward 9 months from the time of the birth and measure the exposure to extreme heat during each gestational trimester.

we employ CFPS 2010 instead of other CFPS waves, because it is the only wave of the survey that records the exact birth location of each child.

We combine China Population Census data for 2005 and 2010 to examine the contemporaneous labor market consequences associated with extremely hot weather during pregnancy. We limit the sample to women who gave birth within one year of each census, and quantify the contemporaneous effect of extreme temperatures on their labor market outcomes.

A potential concern with our analysis is the sample selection issue, as prenatal exposure to extreme heat waves may reduce the survival rate of the fetus. We thus supplement our analysis with data from the China Health and Nutrition Survey (CHNS), which contains information on miscarriages and infant mortality. Appendix Table A1 reports summary statistics and a description of the key variables used in the study.

3 Patterns of Temperatures and Maternal Outcomes

In this section, we describe the empirical patterns of gestational exposure to extremely hot weather and mothers' labor market outcomes later in life. These patterns motivate the more rigorous analysis in subsequent sections.

Figure 1 illustrates the time trend of extreme heat events in Chinese cities between 2000 and 2010. We divide cities into two groups based on whether the yearly occurrence of high-temperature days is above the national mean. The left panel shows that, on average, the "hot" city group experiences 20 more high-temperature days in each year than the "cold" city group. The right panel shows the SD of within-city variation in the number of high-temperature days. [2] The two panels jointly indicate that those "hot" cities which experience more extreme heat waves also have a larger within-city volatility in extremely high temperatures. The large spatial dispersion in mean exposure to heat waves, combined with the differential fluctuation in heat events across regions, allow us to evaluate the economic effects of extreme temperatures in China.

Consistent with prior research, we look at the consequences of exposure to extreme temperatures separately by trimester of pregnancy. If geographical differences in the occurrence of extreme weather events are correlated with regional

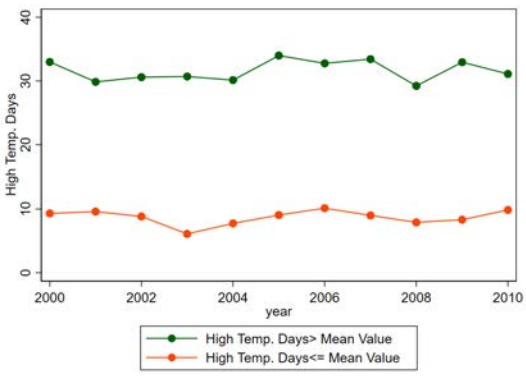
[2] We regress the count of high-temperature days on city fixed effects and calculate the SD of regression residuals for the two city groups.

economic development or quality of health care, associations between temperature exposure and labor market outcomes may be confounded. We account for the potential confounding of spatial differences in economic opportunities and health facilities by leveraging city-level inter-annual fluctuations in temperature. Specifically, we regress a binary variable on individual labor-force participation in the survey year and the number of high-temperature days in each trimester on city-by-delivery-month fixed effects, delivery-year fixed effects, and other weather conditions. We then predict the regression residuals. Figure 2 shows the relationship between mothers' residual employment status later in life and extreme temperature exposure in each trimester during their pregnancy for the first childbirth. We do not observe any detectable relationship between gestational exposure to high temperature and employment status, after accounting for city-by-delivery-month-level unobservables and delivery-year-specific confounders. Hence, experiencing extreme temperature seems not to impact mothers' labor market outcomes at the extensive margin.

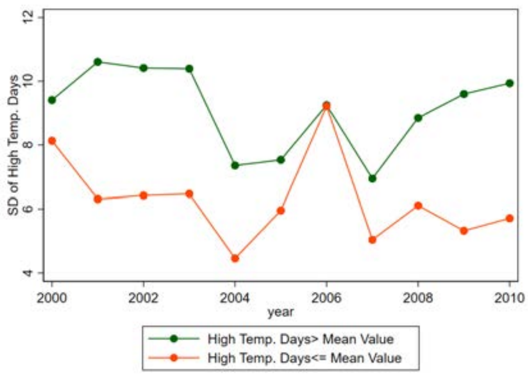
We then turn our attention to labor market impacts at the intensive margin and limit our sample to mothers who have a job in the survey year. Figure 3 repeats the same residual analysis and plots how the number of hours worked per year is associated with the number of high-temperature days in each gestational trimester. While there is no detectable association between labor supply later in life and extremely high temperatures for the first and second trimesters (Figures 3a and 3b), we observe a clear and strong negative relationship between residuals of mothers' annual working hours and their exposure to extreme heat in the third trimester during pregnancy (Figure 3c).

Figure 4 illustrates how experiencing extreme heat is associated with the amount of wages that mothers receive in the survey year. Like the pattern of labor supply, our predicted wage residuals are negatively correlated with exposure to extreme temperatures in the third trimester, but seem to have no clear relationship with high temperatures during the first and second trimesters. Taken together, extremely hot weather during the third gestational trimester may not have an extensive margin effect on mothers' labor market outcomes but may impact their future labor supply and earnings. Nevertheless, temperature exposure in the first two trimesters seems not to be related to these labor market outcomes.

Figure 1: High Temperatures by Year



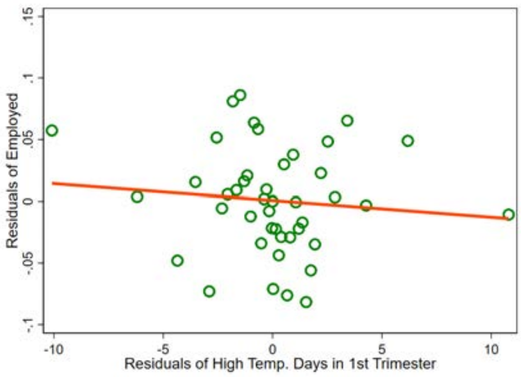
(a) Trend of High Temp. Days



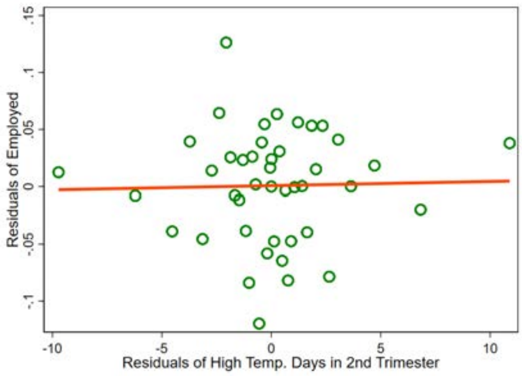
(b) Trend of within city High Temp. Days

Notes: We divide Chinese cities into two groups based on whether the yearly number of days with maximum temperature is higher than 90 °F. The left panel shows the trend of the occurrence of high-temperature days for the two city groups. We predict the residuals from the regression of the yearly occurrence of high-temperature days on city fixed effects; the within-city standard deviations of high-temperature days are calculated as the SD of the regression residuals. The right panel shows the trend of the within-city SD of high-temperature days for the two city groups.

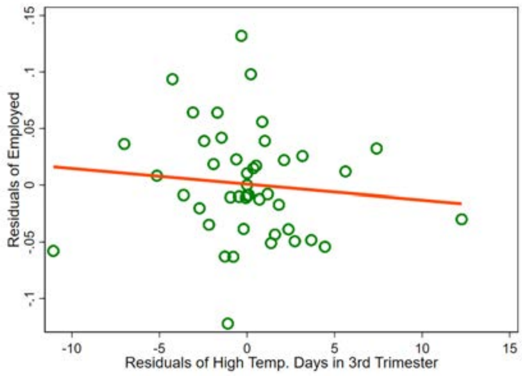
Figure 2: High Temperatures during Pregnancy and Labor-force Participation



(a) High Temp. Days in 1st Trimester



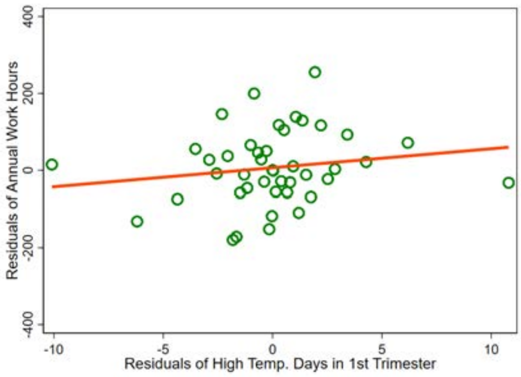
(b) High Temp. Days in 2nd Trimester



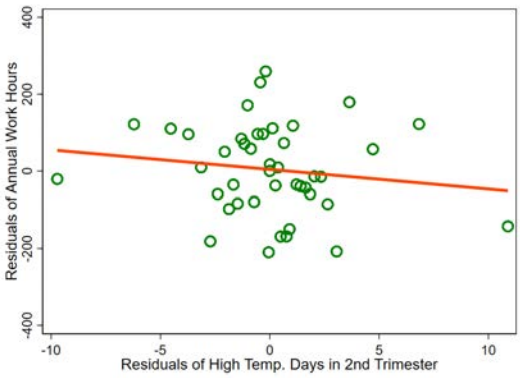
(c) High Temp. Days in 3rd Trimester

Notes: Residuals of employment are obtained from the regression of a binary variable on the labor-force participation of each individual mother in 2010 on city-by-delivery-month fixed effects, delivery-year fixed effects and other weather conditions (wind speed, precipitation and sunshine duration). Residuals of high-temperature days are obtained from the regression of the number of days with maximum temperature > 90 °F in each trimester on the same set of independent variables. Observations are grouped into 50 groups according to the quantile of the residuals of high-temperature days in each trimester. The y-axis denotes the mean value of the residuals of labor-force participation in each quantile and the x-axis denotes the mean value of the residuals of high-temperature days in each quantile. Data come from the China Family Panel Survey 2010 and the Institute of Geographic Sciences and Natural Resources Research.

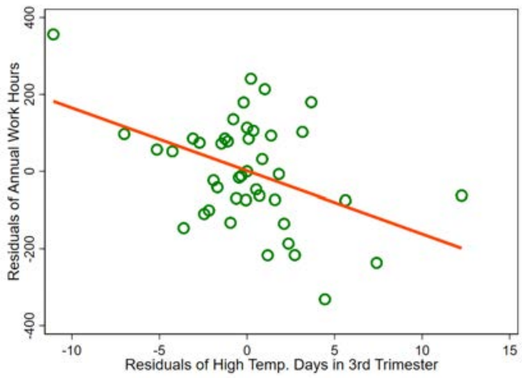
Figure 3: High Temperatures during Pregnancy and Annual Work Hours



(a) High Temp. Days in 1st Trimester



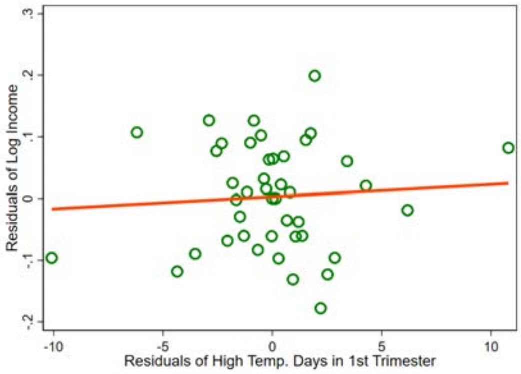
(b) High Temp. Days in 2nd Trimester



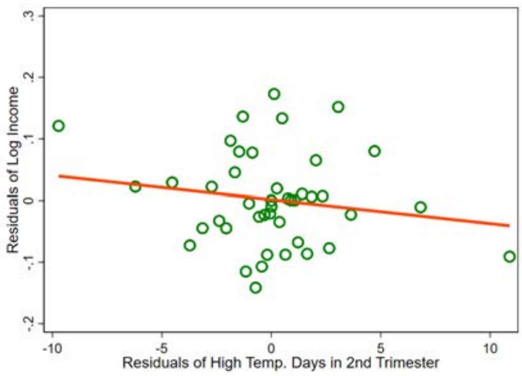
(c) High Temp. Days in 3rd Trimester

Notes: Residuals of annual working hours are obtained from the regression of yearly working hours of each individual mother in 2010 on city-by-delivery-month fixed effects, delivery-year fixed effects and other weather conditions (wind speed, precipitation and sunshine duration). Residuals of high-temperature days are obtained from the regression of the number of days with maximum temperature > 90 °F in each trimester on the same set of independent variables. Observations are grouped into 50 groups according to the quantile of the residuals of high-temperature days in each trimester. The y-axis denotes the mean value of the residuals of annual working hours in each quantile and the x-axis denotes the mean value of the residuals of high-temperature days in each quantile. Data come from the China Family Panel Survey 2010 and the Institute of Geographic Sciences and Natural Resources Research.

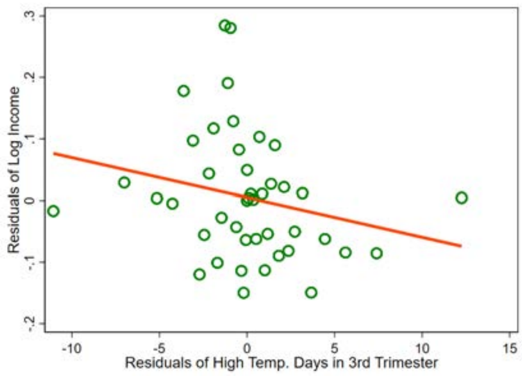
Figure 4: High Temperatures during Pregnancy and Maternal Wages



(a) High Temp. Days in 1st Trimester



(b) High Temp. Days in 2nd Trimester



(c) High Temp. Days in 3rd Trimester

Notes: Wage residuals are obtained from the regression of wages received by each individual mother in 2010 on city-by-delivery-month fixed effects, delivery-year fixed effects and other weather conditions (wind speed, precipitation and sunshine duration). Residuals of high-temperature days are obtained from the regression of the number of days with maximum temperature > 90 °F in each trimester on the same set of independent variables. Observations are grouped into 50 groups according to the quantile of the residuals of high-temperature days in each trimester. The y-axis denotes the mean value of the wage residuals in each quantile and the x-axis denotes the mean value of the residuals of high-temperature days in each quantile. Data come from China Family Panel Survey 2010 and the Institute of Geographic Sciences and Natural Resources Research.

4 Empirical Specification

We begin our empirical analysis with the labor market outcomes of mothers. Our empirical specification is as follows:

$$Y_{i,ctm} = \psi_0 + \psi_1 Temp_1 + \psi_2 Temp_2 + \psi_2 Temp_3 + X\beta + \xi_{cm} + \eta_t + v_{ctm} \quad (1)$$

where the dependent variable $Y_{i,ctm}$ represents the labor market outcomes of mother i who gave birth in city c in year t and month m. The outcomes include labor market participation, wage, industry choices and labor supply, recorded in CFPS 2010 or the Population Census of China. $Temp_{T1}$, $Temp_{T2}$, $Temp_{T3}$ are our primary variables of interest, which are exposure to extremely high temperatures from gestational trimester 1 to trimester 3, respectively, for mother $i's$ first childbirth.[3] We focus on the first child, as the literature documents that the event of having a first child generates sharp changes in labor market outcomes that are arguably orthogonal to unobserved determinants of these outcomes (Kleven et al., 2019a,b). We measure extremely hot weather as the number of days with daily maximum temperature > 90 °F in each gestational trimester in the baseline analysis, and employ alternative measures of extreme weather as robustness checks in Section 5.2.4. X is a vector of controls, including mother i's demographic characteristics and other weather conditions during gestation, involving precipitation, wind speed and sunshine duration. ξ_{cm} is city-by-month-of-delivery fixed effects, and η_t is the year of delivery fixed effects.

There are two identification challenges. First, the spatial distribution of temperature may be correlated with region-specific confounders such as economic development and access to health facilities. Second, temperature varies by season and the timing of pregnancy may be associated with maternal unobservables. For instance, if in a particular region, less-educated mothers tend to give birth in summer and are more likely to earn lower wages in the future, the region-specific seasonal fertility pattern would bias our estimates. The city-by-delivery-month FEs (ξ_{cm}) in equation 1 control for all location-specific seasonal unobservables and location-specific time-invariant confounders that may be correlated with local temperature and may also affect both the timing of pregnancy of local women and

[3] We include the exposure to extremely cold weather in Section 5.2.4 and do not find any evidence that cold weather during pregnancy affects women's labor market outcomes. Hence, we focus on extreme heat exposure in the baseline analysis.

their labor market outcomes (as in Banerjee and Maharaj (2020)). The identifying assumption is that comparing women giving birth in a particular city-month over different years would render exogenous the event of extreme heat during pregnancy. Indeed, year-to-year fluctuations in temperature within a region are typically assumed to be exogenous by the literature (Burke et al. (2015); Deryugina and Hsiang (2017); Dell et al. (2012)). Delivery year FEs (η_t) account for year-specific shocks to the health care system and labor market conditions in China.

Ambient extreme heat exposure during pregnancy may affect a mother's later-life labor market outcomes through two different health channels: that of the mother and that of the child. We next use the following specification to examine the two underlying health mechanisms:

$$\begin{aligned} Health_{i,ctm} =& \psi_0 + \psi_1 Temp_{T1} + \psi_2 Temp_{T2} + \psi_2 Temp_{T3} \\ &+ X\beta + \xi_{cm} + \eta_t + v_{ctm} \end{aligned} \tag{2}$$

where the dependent variable $Health_{i,ctm}$ denotes either the health status of mother i who gave birth in city c, year t and month m, or the health condition of her child who was born in city c, year t and month m. Mothers' and their children's health information are recorded in CFPS 2010. If the primary mechanism driving the empirical pattern lies in children's health conditions, we expect that extremely hot weather during gestation would increase the time that mothers spend taking care of their family members, including the children who experienced prenatal exposure to extreme temperatures. Therefore, in Section 6.2, we evaluate how gestational exposure to ambient extreme heat alters the amount of time that mothers spend on their families. Section 6.2 also looks at the potential effects of in utero exposure to extreme heat on infant mortality, which may also negatively affect maternal health and labor outcomes.

5 Empirical Results

5.1 Baseline Results

Table 1 presents the implications of exposure to heat waves during pregnancy on mothers' later life labor market outcomes. We use the sample of women who have ever given birth and control for city-by-delivery-month fixed effects, delivery-year fixed effects, maternal demographic attributes, and other weather variables across all specifications. We sometimes include current residential province fixed effects (columns 2, 5, 8) and residential city fixed effects (columns 3, 6, 9). Residential location fixed effects account for regional differences in labor market conditions across China in the survey year. Columns 1-3 of Table 1 show the labor market effect through the extensive margin, where the outcome variable is a binary variable for labor market participation. Consistent with the graphical analysis in Section 3, the coefficient estimates of extremely hot days are statistically insignificant across all three gestational trimesters. Therefore, exposure to extreme heat may not affect mothers' employment status in the long run.

Columns 4-6 look at the intensive effect of extreme heat on labor supply. We limit our sample to those who have a job, based on CFPS 2010. We employ annual working hours as the dependent variable. While the effects of ambient heat exposure are statistically insignificant in the first and second gestational trimester, exposure to extreme heat in the third trimester leads to a significant decline in labor supply. The patterns are robust across different specifications. The point estimates imply that a one SD increase (14.6 days) in third-trimester gestational days with maximum temperature over 90 °F would reduce annual labor supply by 190 hours, which corresponds to about 10% of the mean of the dependent variable of yearly working hours (1824).

In columns 7-9, we turn our attention to the skill intensity of industries where mothers work in the survey year.[4] We find a pattern similar to the results of labor supply; the effects of exposure to heat waves are more pronounced in the third trimester. Women who experienced extremely hot temperature in the third trimester are significantly more likely to end up in an industry in the bottom quintile of skill intensity. Note that we have controlled for mothers' individual-specific skill level and other socio-demographic characteristics in the estimation.

[4]We follow Ahsan and Chatterjee (2017) to define industry-specific skill intensity as $EI_{ind} = \sum_{f=1}^{L_{ind}} (\frac{\omega_f}{\sum_f^{L_{ind}} \omega_f}) \times e_f$, where e_f is individual $f's$ education category, ω_f is an individual's sampling weight, and L_{ind} is the total number of workers within an industry. We categorize a respondent's educational level into various rankings: not literate (=0), below primary school (=1), primary school (=2), middle school (=3), high school (=4), technical secondary school (=5), pre-college (=6), college (=7), master (=8) and PhD (=9). We define a low-skilled industry as an industry in the bottom quintile of industry-specific skill intensity.

Table 1: Extreme Heat during Gestation and Mothers' Labor Market Outcomes

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dependent Variable:		Employed (=1)			Annual Work Hours			Low-skill Industry (=1)	
High Temp. Days in 1st Trimester	0.000504	0.000504	0.000505	-7.936	-7.936	-8.517	0.00334	0.00334	0.00356
	(0.00236)	(0.00237)	(0.00237)	(7.269)	(7.316)	(7.549)	(0.00262)	(0.00263)	(0.00273)
High Temp. Days in 2nd Trimester	-0.000165	-0.000165	-0.000322	-2.051	-2.051	-1.459	0.00292	0.00292	0.00273
	(0.00240)	(0.00241)	(0.00244)	(5.927)	(5.964)	(6.247)	(0.00276)	(0.00277)	(0.00286)
High Temp. Days in 3rd Trimester	-0.00155	-0.00155	-0.00152	-13.05**	-13.05**	-13.41**	0.00456**	0.00456*	0.00468*
	(0.00192)	(0.00193)	(0.00195)	(6.154)	(6.194)	(6.389)	(0.00229)	(0.00231)	(0.00238)
Observations	3,681	3,681	3,681	1,940	1,940	1,940	2,024	2,024	2,024
Mean of Dep. Var.	0.550	0.550	0.550	1824	1824	1824	0.560	0.560	0.560
Weather Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Birth City×Birth Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Birth Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	No	Yes	No	No	Yes	No	No	Yes	No
City FE	No	No	Yes	No	No	Yes	No	No	Yes
Mean of 1st Trimester	7.522	7.522	7.522	7.522	7.522	7.522	7.522	7.522	7.522
SD of 1st Trimester	13.51	13.51	13.51	13.51	13.51	13.51	13.51	13.51	13.51
Mean of 2nd Trimester	8.596	8.596	8.596	8.596	8.596	8.596	8.596	8.596	8.596
SD of 2nd Trimester	13.93	13.93	13.93	13.93	13.93	13.93	13.93	13.93	13.93
Mean of 3rd Trimester	9.271	9.271	9.271	9.271	9.271	9.271	9.271	9.271	9.271
SD of 3rd Trimester	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63

Notes: High-temperature days are defined as those with daily maximum temperatures higher than 90 °F. We count the number high-temperature days in each gestational trimester for each mother's first childbirth. Demographics include age, age squared, the number of children, and an indicator for junior middle school and above. Weather controls include wind speed, precipitation and sunshine duration. We define a low-skilled industry as an industry in the bottom quintile of industry-specific skill intensity. Data come from the 2010 China Family Panel Survey (CFPS). Robust standard errors, clustered at the level of the city where mothers gave birth for the first time, are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

CFPS 2010 reports only individual earnings for people in non-agricultural sectors. Because we incorporate women in the agricultural sector in Table 1, we cannot quantify the income effects associated with extreme heat. We thus exclude women in the agricultural sector in Table 2, and revisit how gestational exposure to extremely high temperatures alters mothers' labor market outcomes.

Table 2 Panel A shows the effects on employment status (columns 1-3) and labor supply (columns 4-6). Panel B columns 1-3 present the estimates for the propensity of working in a low-skilled industry. Similar to the results of Table 1, which includes the agricultural sample, ambient extreme heat exposure during gestation does not have an extensive margin effect on labor market participation, but heat waves occurring in the third trimester significantly negatively affect mothers' labor supply and industry choices later in life. In addition, compared to the corresponding estimates in Table 1, the coefficients on the number of extremely hot days during the third trimester become substantially larger in magnitude. The differential impacts between trimester 3 and other gestational trimesters also increase in magnitude.

Extreme heat waves may negatively affect local agricultural income as well as mothers' and children's health. The increased differential effects by gestational trimester after excluding the agricultural female workers indicate that the health costs of high temperature exposure (which may in turn hurt mothers' labor outcomes) seem to be concentrated in the third trimester. This may explain our baseline empirical pattern. In Section 6, we will rigorously examine the health effects of extreme heat during pregnancy for both mothers and their children.

Table 2 Panel B columns 4-6 documents the income effects associated with exposure to heat waves during pregnancy. Once again, the income effects are only significantly different from zero for the third gestational trimester. Exposure to a one SD increase (14.6 days) in the number of extremely hot days (>90 °F) during trimester three is associated with a 19% reduction in annual earnings in the long run.

Table 2: Exclude Women in Agricultural Sector

	(1)	(2)	(3)	(4)	(5)	(6)
			Panel A			
	Employed (=1)			Annual Work Hours		
High Temp. Days in 1st Trimester	2.45e-05	2.45e-05	-9.95e-05	0.349	0.349	-1.047
	(0.00401)	(0.00405)	(0.00419)	(10.67)	(10.82)	(11.71)
High Temp. Days in 2nd Trimester	-0.000529	-0.000529	-0.00111	-9.260	-9.260	-10.09
	(0.00340)	(0.00343)	(0.00334)	(8.017)	(8.130)	(8.671)
High Temp. Days in 3rd Trimester	-0.000383	-0.000383	-0.000417	-24.81**	-24.81**	-26.58**
	(0.00346)	(0.00349)	(0.00360)	(9.582)	(9.716)	(10.37)
Observations	1,543	1,543	1,543	912	912	912
Mean of Dep. Var.	0.546	0.546	0.546	2382	2382	2382
			Panel B			
	Low-skill Industry (=1)			Log Annual Income		
High Temp. Days in 1st Trimester	0.00385	0.00385	0.00382	0.00191	0.00191	0.00193
	(0.00347)	(0.00351)	(0.00371)	(0.00518)	(0.00527)	(0.00565)
High Temp. Days in 2nd Trimester	0.00450	0.00450	0.00467	-0.00856	-0.00856	-0.00855
	(0.00341)	(0.00345)	(0.00358)	(0.00622)	(0.00632)	(0.00675)
High Temp. Days in 3rd Trimester	0.00576**	0.00576**	0.00571**	-0.0132***	-0.0132***	-0.0132**
	(0.00245)	(0.00249)	(0.00262)	(0.00481)	(0.00488)	(0.00518)
Observations	976	976	976	823	823	823
Mean of Dep. Var.	0.0871	0.0871	0.0871	9.658	9.658	9.658
Weather Control	Yes	Yes	Yes	Yes	Yes	Yes
Demographics	Yes	Yes	Yes	Yes	Yes	Yes
Birth City×Birth Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Birth Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	No	Yes	No	No	Yes	No
City FE	No	No	Yes	No	No	Yes
Mean of 1st Trimester	7.522	7.522	7.522	7.522	7.522	7.522
SD of 1st Trimester	13.51	13.51	13.51	13.51	13.51	13.51
Mean of 2nd Trimester	8.596	8.596	8.596	8.596	8.596	8.596
SD of 2nd Trimester	13.93	13.93	13.93	13.93	13.93	13.93
Mean of 3rd Trimester	9.271	9.271	9.271	9.271	9.271	9.271
SD of 3rd Trimester	14.63	14.63	14.63	14.63	14.63	14.63

Notes: High-temperature days are defined as those with daily maximum temperatures higher than 90 °F. We count the number high-temperature days in each gestational trimester for each mother's first childbirth. Demographics include age, age squared, the number of children, and an indicator for junior middle school and above. Weather controls include wind speed, precipitation and sunshine duration. We define a low-skilled industry as an industry in the bottom quintile of industry-specific skill intensity. Data come from 2010 China Family Panel Survey (CFPS). Robust standard errors, clustered at the level of the city where mothers gave birth for the first time, are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Based on our findings, we provide a back-of-the-envelope estimate of the monetized costs of gestational heat exposure through its effect on maternal labor market outcomes. Our results imply that a one-day increase in extreme hot days (>90 °F) during trimester three for a given mother would reduce her later-life yearly earning by approximately 260 Chinese Yuan in 2000.[5] According to the China

[5]Our results show that a one-day increase in extremely hot days (>90 °F) during trimester three would reduce yearly income by 1.3%, and an average woman's income was 260 Chinese Yuan in 2000.

Population Census 2000, about 8.4 million women gave birth for the first time in 2000. On average, those women experienced 12.3 extremely hot days (>90 °F) in the third trimester. As a result, extreme heat for those who had their first child in 2000 would result in income losses of as large as about 26.9 billion Chinese Yuan per year. Our back-of-the-envelope calculation provides a conservative estimate of the costs imposed on female workers by heat waves occurring in the gestational period, because we do not consider the potential income losses for women who had given birth prior to 2000 and had another baby in that year.

We next evaluate the contemporaneous effects of ambient heat exposure during pregnancy in Table 3. We combine data from the China Population Census 2005 and 2010 and restrict the sample to women who give birth within one year of the census. We leverage within-city changes in extremely high temperature exposure over five years. Although extreme heat does not affect women's employment status, these weather events have significant contemporaneous effects on the probability of mothers working a low-skilled industry. This is reminiscent of Goldin (2014)'s findings that American women seem to switch to a different job after they have a baby.

Taken together, exposure to extremely hot weather during gestation hurts women's later-life labor market outcomes and also has a contemporaneous negative effect on mothers' industry choices. Moreover, the effects of such exposure seem to be particularly concentrated in the third trimester.

5.2 Robustness Check

5.2.1 Sample Selection Due to in Utero Mortality

In our baseline analysis, we use the sample of mothers who have ever given birth. Because in utero exposure to heat waves may result in miscarriages, a potential sample selection issue may bias our baseline estimates. If that were the case, the negative effect of extremely high temperatures on the survival of a fetus would be stronger in pregnancies among women with less educational attainment and lower socioeconomic status (Banerjee and Maharaj, 2020; Chen et al., 2016). Less educated mothers may be in a poor position to invest in mitigation in response to extreme weather shocks, due to budget constraints or less awareness of risks. Since less educated mothers are also more likely to earn lower wages and work in a low-skilled industry, the underlying sample selection may cause a downward

Table 3: The Contemporaneous Effects

Dependent Variable:	(1) Employed (=1)	(2)	(3) Low-skill Industry (=1)	(4)
High Temp. Days in 1st Trimester	-0.000393	-0.000440	0.000512	0.000272
	(0.00121)	(0.00120)	(0.00108)	(0.00104)
High Temp. Days in 2nd Trimester	-0.000442	-0.000488	-0.000655	-0.000717
	(0.00131)	(0.00130)	(0.00102)	(0.000938)
High Temp. Days in 3rd Trimester	0.000984	0.00102	0.00211**	0.00214**
	(0.00106)	(0.00105)	(0.00105)	(0.00102)
Observations	43,172	43,172	34,728	34,728
Mean of Dep. Var.	0.725	0.725	0.725	0.725
Weather Control	Yes	Yes	Yes	Yes
Demographics	No	Yes	No	Yes
Birth City FE × Birth Month FE	Yes	Yes	Yes	Yes
Birth Year FE	Yes	Yes	Yes	Yes
Adjusted R-squared	0.208	0.211	0.190	0.251
Mean of 1st Trimester	12.46	12.46	12.64	12.64
SD of 1st Trimester	17.19	17.19	17.32	17.32
Mean of 2nd Trimester	12.68	12.68	13.20	13.20
SD of 2nd Trimester	18.67	18.67	18.97	18.97
Mean of 3rd Trimester	6.882	6.882	6.820	6.820
SD of 3rd Trimester	12.25	12.25	12.21	12.21

Notes: High-temperature days are defined as those with daily maximum temperatures higher than 90 °F. We count the number high-temperature days in each gestational trimester for each mother's first childbirth. Demographics include age, age squared, the number of children, and an indicator for junior middle school and above. Weather controls include wind speed, precipitation and sunshine duration. We define a low-skilled industry as an industry in the bottom quintile of industry-specific skill intensity. Data come from the 2010 Population Census. Robust standard errors, clustered at the level of the city where mothers gave birth for the first time, are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

estimation bias of the effect of extreme temperatures during gestation on mothers' labor market outcomes.

Moreover, fetal mortality selection may be gender differentiated, because a male fetus may be more vulnerable to negative shocks. For instance, Valente (2015) shows that maternal stress in utero may decrease the male-to-female sex ratio at birth in Nepal. Since parents may spend less time on their daughter in China (Gao et al., 2023b), if there were gender-differentiated fetal mortality selection driven by high temperatures in our context, it would reduce the time that mothers spend on children and in turn benefit the mothers' careers. However, we estimate the opposite: women are worse off in their careers after experiencing extreme temperatures in gestation. Therefore, the potential gender selection in utero would lead to an underestimation of the effects of gestational exposure to extreme heat.

To further examine the potential concern over sample selection, we employ alternative data–the China Health and Nutrition Survey–to evaluate the effects of extreme temperature in utero on fetal survival. In Table A2, we regress an indicator for miscarriage and stillbirth on the number of extremely hot days during pregnancy. The results document that the effects of high temperature exposure during pregnancy on the survival of a fetus are close to zero, irrespective of gestational trimester. Our results are in accordance with Banerjee and Maharaj (2020), who find no association between high temperatures and miscarriages in India. Table A3 further examines the concern over in utero gender selection, demonstrating that gestational exposure to heat waves has nothing to do with the gender of children.

5.2.2 Fertility Responses to Heat Exposure

One may expect that women of different socioeconomic status may have differential fertility responses to heat exposure, which may confound the relationship between gestational exposure to heat waves and labor market outcomes. We therefore test selective fertility based on maternal socioeconomic status, as measured by mothers' educational achievement. In Table A4, we regress mothers' educational achievements on exposure to extreme heat in each of the three gestational trimesters, as well as three months before conception and three months after giving birth. We find no evidence of selective fertility in response to ambient heat waves based on mothers' socioeconomic status. In Table A5, we replicate our baseline estimates and additionally control for delivery month by maternal education fixed effects; the results are quantitatively and qualitatively unchanged. Thus, our results are unlikely to be driven by differential fertility reactions to high temperatures or differential seasonal fertility patterns by socioeconomic status.

5.2.3 Migration Responses to Heat Exposure

Recent evidence suggests that people may migrate to other cities to mitigate the adverse effects of air pollution in China (Khanna et al., 2021). Hence, we expect that prospective parents may also migrate in response to high temperature shocks. We follow Gao et al. (2023a) to use individual data drawn from the China Population Census 2010 to examine whether reproductive-aged women migrate in response to heat waves. Table A6 shows that exposure to extremely hot weather does not meaningfully affect the migration choices of reproductive-aged women, regardless of their skill levels. The absence of migration responses to heat waves may be owing to the *hukou* restrictions in China. First, migrants without a local *hukou* have only limited access to local health facilities. Second, some cities require women to obtain the approval of the local Family Planning Office before they give birth; migrant women without a local *hukou* find it harder to get such approval in many cases. Although the regulation is not very stringently implemented, giving birth without such approval would result in extra monetary and time costs.

5.2.4 Additional Controls and Alternative Measures

We next assess whether our empirical pattern is robust to controlling for various potential confounders. First, we count the number of extremely cold days with temperature below 20 °F during each gestational trimester (as in Deschênes and Greenstone (2011)), and control for exposure to extremely cold weather during gestation in Table A7. Adding the number of extremely cold days in each trimester hardly changes our results. In addition, the effects of extreme cold are statistically insignificant for all three gestational trimesters. [6] The results are consistent with the literature that the health costs associated with exposure to heat waves are greater than those associated with cold temperatures (Deschênes et al., 2009; Chen et al., 2020).

Extreme heat waves may change the frequency of sexual activities and in turn affect when prospective mothers become pregnant. Moreover, postnatal exposure to heat waves may also hurt children and their mothers' health. In Table A8, we include the number of extremely hot days three months prior to conception and three month after childbirth. Our estimates of gestational exposure to heat waves are similar. The effects of high temperatures in the third trimester on labor supply and industry-specific skill intensity remain significantly positive, with a slight increase in magnitude. However, neither ambient heat exposure three months prior to conception nor three months after childbirth significantly affects mothers' labor market outcomes.

A remaining concern is that differential secular time trends across regions may confound our results. If extreme temperatures and labor market conditions during pregnancy have unobserved time trends, our estimates would be confounded by these trends. To address this concern, Table A9 controls for flexible province-

[6] The occurrence of extremely cold weather is concentrated in northern China; the public heating system in the north can mitigate the adverse effect of extreme low temperatures.

specific time trends. Adding region-specific time trends does little to affect our empirical pattern.

We next examine how sensitive our results are to different measures of extremely hot weather. In Table A10, we employ the number of Cumulative Cooling Degree Days (CDD) above 65 °F (as in Albouy et al. (2016)) and 70 °F (as in Graff Zivin et al. (2018)) as alternative measures for ambient heat waves. We find a similar empirical pattern. Once again, the labor market effects of extreme heat are larger in magnitude for the third gestational trimester.

To sum up, our baseline estimates are robust to potential sample selection issues as well as various controls and alternative measures of extremely high temperatures. In the subsequent section, we examine the underlying mechanisms through which ambient heat exposure undermines mothers' labor market outcomes.

6 Mechanisms

In this section, we evaluate the underlying mechanisms through which extreme heat waves during gestation undermine maternal labor market outcomes. At least four potential mechanisms may be responsible for the empirical pattern we report.

First, ambient heat exposure may have a direct negative effect on prospective mothers' health, which in turn could negatively affect their work performance and job choices. Second, prenatal exposure to extreme temperature may hurt children's health, which in turn induces mothers to sacrifice their careers in order to spend more time with their children. Third, high temperature shocks in utero may result in infant mortality, which in turn triggers mental health issues for mothers because of the grief of losing a child. Fourth, rising temperatures during the gestational period may reduce crop yields and rural households' income, which may indirectly affect fetal and maternal health and even mothers' labor market outcomes. We examine the implications of each of these mechanisms, and find the strongest support for the first one: the labor market consequences of gestational exposure to heat waves are related to its direct effect on mothers' health.

6.1 The Direct Effects on Maternal Health

Studies in health and physiology have identified significant maternal health risks associated with gestational exposure to extreme temperatures, including pregnancy-associated hypertension and eclampsia, preeclampsia, and gestational diabetes mellitus (Cil and Cameron, 2017; Kim et al., 2021; Shashar et al., 2020; Su et al., 2020; Xiong et al., 2020). Cil and Cameron (2017) and Kim et al. (2021) document a significant association between extreme heat exposure during the last two gestational trimesters and hypertension, eclampsia and emergency hospitalization in the U.S. Chen et al. (2022) uncover the effect of high temperatures on high blood pressure during pregnancy in Nanjing, China and demonstrate the strongest thermal effect in the third trimester.

In this section, we use nationally representative data in China to examine how extreme heat during pregnancy hurts women's health outcomes later in life. We estimate equation 2 in Section 4. Table 4 Panel A presents the estimated effects on mothers' physical health. The health effects of extreme heat events occurring in the first and second gestational trimester are statistically indistinguishable from zero, whereas ambient heat exposure during the third trimester has significantly negative effects on various health outcomes. In particular, experiencing a one SD increase in extremely hot days during the third trimester reduces the probability of being in the optimal range of BMI (22.5 to 25.0) by 8 % (columns 1-3) [7], and increases the incidence of reproductive illness by 1.4 % (columns 1-3) and the incidence of motor system disease by 1.2 % (columns 4-6).

Table 4 Panel B shows the resulting effects on mothers' mental health. Women who are exposed to extreme heat waves during the third trimester appear to be more likely to feel hopeless about the future (columns 1-3) and feel frustrated with everything (columns 4-6). In sum, we find an intriguing empirical pattern that is highly consistent with our baseline labor market results, as the labor market effects of extremely high temperatures also appear to be concentrated in the third gestational trimester.

[7] Prospective Studies Collaboration (2009) and Berrington de Gonzalez et al. (2010) document that the optimal BMI is 22.5 to 25.0 in terms of minimizing all-cause mortality.

Table 4: Extreme Heat during Gestation and Mothers' Health Outcomes

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: Physical Health									
	BMI: 22.5-25(=1)			Having Female Reproductive System Disease (=1)			Motor System Disease(=1)		
High Temp. Days in 1st Trimester	0.000294	0.000294	0.000164	0.000373	0.000373	0.000373	-0.000379	-0.000379	-0.000376
	(0.00210)	(0.00211)	(0.00213)	(0.000500)	(0.000502)	(0.000510)	(0.000756)	(0.000759)	(0.000773)
High Temp. Days in 2nd Trimester	0.00251	0.00251	0.00259	2.44e-05	2.44e-05	1.62e-05	0.000477	0.000477	0.000471
	(0.00211)	(0.00212)	(0.00213)	(0.000789)	(0.000792)	(0.000810)	(0.000442)	(0.000443)	(0.000453)
High Temp. Days in 3rd Trimester	-0.00574***	-0.00574***	-0.00572***	0.00102**	0.00102**	0.00102*	0.000872**	0.000872**	0.000872**
	(0.00165)	(0.00165)	(0.00168)	(0.000509)	(0.000511)	(0.000522)	(0.000411)	(0.000412)	(0.000419)
Observations	3,681	3,681	3,681	3,681	3,681	3,681	3,681	3,681	3,681
Mean of Dep. Var.	0.237	0.237	0.237	0.0130	0.0130	0.0130	0.0125	0.0125	0.0125
Panel B: Mental Health									
	Feel Hopeless about the Future(=1)			Feel that Everything is Difficult (=1)					
High Temp. Days in 1st Trimester	-0.000289	-0.000289	-0.000303	-0.000599	-0.000599	-0.000582			
	(0.000764)	(0.000766)	(0.000780)	(0.000983)	(0.000987)	(0.00100)			
High Temp. Days in 2nd Trimester	-0.000272	-0.000272	-0.000233	-0.00192	-0.00192	-0.00194			
	(0.000777)	(0.000779)	(0.000792)	(0.00120)	(0.00120)	(0.00123)			
High Temp. Days in 3rd Trimester	0.00132	0.00132	0.00136	0.00209**	0.00209**	0.00209**			
	(0.000848)	(0.000851)	(0.000868)	(0.000859)	(0.000862)	(0.000876)			
Observations	3,681	3,681	3,681	3,681	3,681	3,681			
Mean of Dep. Var.	0.0326	0.0326	0.0326	0.0551	0.0551	0.0551			
Weather Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Birth City×Birth Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Birth Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	No	Yes	No	No	Yes	No	No	Yes	No
City FE	No	No	Yes	No	No	Yes	No	No	Yes
Mean of 1st Trimester	7.522	7.522	7.522	7.522	7.522	7.522	7.522	7.522	7.522
SD of 1st Trimester	13.51	13.51	13.51	13.51	13.51	13.51	13.51	13.51	13.51
Mean of 2nd Trimester	8.596	8.596	8.596	8.596	8.596	8.596	8.596	8.596	8.596
SD of 2nd Trimester	13.93	13.93	13.93	13.93	13.93	13.93	13.93	13.93	13.93
Mean of 3rd Trimester	9.271	9.271	9.271	9.271	9.271	9.271	9.271	9.271	9.271
SD of 3rd Trimester	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63

Notes: High-temperature days are defined as those with daily maximum temperatures higher than 90 °F. We count the number high-temperature days in each gestational trimester for each mother's first childbirth. Demographics include age, age squared, the number of children, and an indicator for junior middle school and above. Weather controls include wind speed, precipitation and sunshine duration. Data come from the 2010 China Family Panel Survey (CFPS). Robust standard errors, clustered at the level of the city where mothers gave birth for the first time, are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

6.2 The Direct Effects on Children's Health and Infant Mortality

Prenatal exposure to extreme heat waves may hurt children's health and academic performance, which may induce their mothers to spend more time on the family and in turn reduce their labor supply. Table 5 Panel A shows the effects of in utero exposure to high temperature on children's health. Extreme heat waves appear to negatively affect children's overall health (as measured by a self-reported health index), increase the probability of being wasted [8], and reduce their height. Nevertheless, we find a pattern that differs from our estimates of maternal health and labor market outcomes, as the effects of heat waves on children's health seem not to be concentrated in the third gestational trimester. Table 5 Panel B looks at children's cognitive skills. Once again, the effects are not concentrated in the third trimester. As presented in Table 6, extreme temperature exposure during pregnancy does not have any significant effects on the amount of time that mothers spend on the family; the coefficient estimates are insignificant across all gestational trimesters.

Recent evidence suggests that negative environmental factors in utero may lead to infant mortality (Gamper-Rabindran et al., 2010). The grief of losing a child may result in mothers suffering from mental health problems, which may hurt their labor market outcomes. Table A11 uses data from CHNS to further examine how prenatal exposure to heat waves affects infant mortality in China. We look at mortality for those younger than age 1 in columns 1 and 2 and an older cohort with ages between 1 and 5 in columns 3 and 4. Extreme heat waves occurring in the second trimester are significantly negatively associated with survival of an infant within one year of age, whereas high temperature shocks do not have any significant effects on the mortality of children aged between 1 and 5, regardless of gestational trimester. Additionally, extreme heat exposure in the third trimester has nil impact on the survival of children and infants, even though it is strongly negatively associated with maternal labor market outcomes.

[8] Based on the WHO standard, wasted is defined as BMI-for-age z score below -2.

Table 5: Extreme Heat during Gestation and Children's Health and Cognitive Outcomes

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Panel A: Health Status								
	Self-reported Good Health (=1)			Wasted (=1)			Top 10% Height (=1)		
High Temp. Days in 1st Trimester	-0.00378*	-0.00378*	-0.00413**	-0.00270	-0.00270	-0.00270	0.000852	0.000852	0.000705
	(0.00195)	(0.00196)	(0.00200)	(0.00173)	(0.00174)	(0.00179)	(0.00164)	(0.00165)	(0.00168)
High Temp. Days in 2nd Trimester	0.00241	0.00241	0.00184	0.00211*	0.00211*	0.00213	0.000332	0.000332	0.000361
	(0.00221)	(0.00222)	(0.00225)	(0.00126)	(0.00126)	(0.00130)	(0.00169)	(0.00170)	(0.00172)
High Temp. Days in 3rd Trimester	0.00156	0.00156	0.00166	-0.00131	-0.00131	-0.00132	-0.00240**	-0.00240**	-0.00236**
	(0.00192)	(0.00193)	(0.00196)	(0.00192)	(0.00193)	(0.00198)	(0.00115)	(0.00115)	(0.00118)
Observations	2,444	2,444	2,444	2,634	2,634	2,634	2,674	2,674	2,674
Mean of Dep. Var.	0.332	0.332	0.332	0.0581	0.0581	0.0581	0.0707	0.0707	0.0707
	Panel B: Cognitive Skills								
	Score on Vocabulary Test			Score on Math Test					
High Temp. Days in 1st Trimester	-0.0401	-0.0401	-0.0378	0.0295	0.0295	0.0273			
	(0.0384)	(0.0387)	(0.0406)	(0.0337)	(0.0340)	(0.0355)			
High Temp. Days in 2nd Trimester	-0.119**	-0.119**	-0.119**	0.0206	0.0206	0.0170			
	(0.0466)	(0.0470)	(0.0491)	(0.0274)	(0.0276)	(0.0289)			
High Temp. Days in 3rd Trimester	-0.0313	-0.0313	-0.0324	-0.00610	-0.00610	-0.00550			
	(0.0406)	(0.0410)	(0.0428)	(0.0271)	(0.0273)	(0.0284)			
Observations	1,456	1,456	1,456	1,456	1,456	1,456			
Mean of Dep. Var.	23.91	23.91	23.91	13.04	13.04	13.04			
Weather Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Birth City×Birth Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Birth Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	No	Yes	No	No	Yes	No	No	Yes	No
City FE	No	No	Yes	No	No	Yes	No	No	Yes
Mean of 1st Trimester	7.522	7.522	7.522	7.522	7.522	7.522	7.522	7.522	7.522
SD of 1st Trimester	13.51	13.51	13.51	13.51	13.51	13.51	13.51	13.51	13.51
Mean of 2nd Trimester	8.596	8.596	8.596	8.596	8.596	8.596	8.596	8.596	8.596
SD of 2nd Trimester	13.93	13.93	13.93	13.93	13.93	13.93	13.93	13.93	13.93
Mean of 3rd Trimester	9.271	9.271	9.271	9.271	9.271	9.271	9.271	9.271	9.271
SD of 3rd Trimester	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63

Notes: High-temperature days are defined as those with daily maximum temperatures higher than 90 °F. Demographics include age and the number of children in the household. CFPS 2010 includes a self-reported health assessment for each child based on a 5-point score (1 = very healthy, 5 = very unhealthy). In Panel A columns 1-3, self-reported good health is an indicator that equals one if the health assessment score equals one and is zero otherwise. Based on the WHO standard, wasted is defined as BMI-for-age z score below -2 (Panel A columns 4-6). Top 10% Height is an indicator defined based on the height distribution for each age- and gender-specific cohort (Panel A columns 7-9). Weather controls include wind speed, precipitation and sunshine duration. Data come from the 2010 China Family Panel Survey (CFPS). Robust standard errors, clustered at the birth city level, are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 6: The Amount of Time Spent on Family

	(1)	(2)	(3)
Dependent Variable:	Log Weekly Hours Taking Care of Family Members		
High Temp. Days in 1st Trimester	-0.0637	-0.0637	-0.0637
	(0.0491)	(0.0493)	(0.0500)
High Temp. Days in 2nd Trimester	-0.0285	-0.0285	-0.0275
	(0.0587)	(0.0588)	(0.0599)
High Temp. Days in 3rd Trimester	-0.00660	-0.00660	-0.0159
	(0.0616)	(0.0618)	(0.0622)
Observations	3,681	3,681	3,681
Mean of Dep. Var.	14.10	14.10	14.10
Weather Control	Yes	Yes	Yes
Demographics	Yes	Yes	Yes
Birth City×Birth Month FE	Yes	Yes	Yes
Birth Year FE	Yes	Yes	Yes
Province FE	No	Yes	No
City FE	No	No	Yes
Mean of 1st Trimester	7.522	7.522	7.522
SD of 1st Trimester	13.51	13.51	13.51
Mean of 2nd Trimester	8.596	8.596	8.596
SD of 2nd Trimester	13.93	13.93	13.93
Mean of 3rd Trimester	9.271	9.271	9.271
SD of 3rd Trimester	14.63	14.63	14.63

Notes: High-temperature days are defined as those with daily maximum temperature higher than 90 °F. We count the number of high-temperature days in each gestational trimester for each mother's first childbirth. Demographics include age, age squared, the number of children, and an indicator for junior middle school and above. Weather controls include wind speed, precipitation and sunshine duration. Data come from the 2010 China Family Panel Survey (CFPS). Robust standard errors, clustered at the level of the city where mothers gave birth for the first time, are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1 *** p<0.01, ** p<0.05, * p<0.1.

6.3 The Indirect Effect through Affecting Agricultural Production

Rising temperatures may negatively impact agricultural production. In the presence of inadequate consumption smoothing for poor rural households, reduced agricultural income owing to abnormal heat events may hurt fetal and maternal health, which may change mothers' labor market trajectories. Recall that, in Section 5.1 Table 2, we restrict the sample of mothers to those who work in $non - agricultural$ sectors and find that extreme heat waves during the prenatal period still severely impact their career outcomes. To additionally evaluate the role played by agricultural production, we control for the amount of local crop yield during the gestational year and re-estimate the labor market consequences of heat waves in Table A12 and the corresponding maternal health consequences in Table A13. Accounting for agricultural production hardly changes our empirical pattern of maternal labor outcomes. Indeed, the results demonstrate significantly negative effects of extreme high temperatures during trimester three on labor supply and industry-level skill intensity as well as various maternal health outcomes, even after controlling for local crop yield.

In sum, these evidences suggest that mothers' health is at least an important mechanism driving the effects of gestational exposure to extreme heat events on their later-life labor market outcomes. However, we acknowledge that the effects of heat waves in utero on children's health and infant mortality may also be a potential pathway, since we do not find strong evidence to rule out these alternative underlying mechanisms. Indirect effects through agricultural production are unlikely to be a mechanism in our context.

7 Conclusion

Our analysis highlights the negative effects of extreme temperature on maternal labor market outcomes. We document that female workers experiencing exposure to extremely hot weather during pregnancy are significantly more likely to earn lower wages, work for fewer hours, and be trapped in a low-skilled sector later in life. Nevertheless, high temperatures during gestation do not have a meaningful extensive margin effect on labor force participation. An important mechanism driving the empirical pattern is that abnormal heat waves during gestation negatively affect mothers' physical and psychological health.

Other work documents that high temperatures in utero hurt children's health and academic performance (Deschênes et al., 2009; Fishman et al., 2019; Isen et al., 2017; Graff Zivin et al., 2018). Our contribution is to provide new evidence on the health and economic losses stemming from mothers' health and career outcomes. Therefore, the overall health and economic costs associated with temperature shocks during the crucial gestational period may be larger than environmental economists have previously thought.

Finally, our analysis sheds light on the debate in the development and macroeconomics literature over the potential negative association between temperature and economic growth (Dell et al., 2009, 2012). Extreme heat exposure during pregnancy generates health burdens that reduce women's wages and labor supply in the long run, which reduces their contribution to the economy. Therefore, our work suggests a new mechanism whereby high temperatures can trigger economic losses.

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Appendix

Table of Contents

A1 Summary Statistics of Key Variables

Table A1: Summary Statistics of Key Variables

Variable name	Mean	Std. dev
Panel A: CFPS Adults		
Employed (=1)	0.550	0.498
Annual Work Hours	1,824.078	1,080.508
Low-skill Industry (=1)	0.560	0.497
Annual Income (Chinese Yuan)	19,739.744	17,015.133
BMI: 22.5-25(=1)	0.237	0.425
Having Female Reproductive System Disease (=1)	0.013	0.113
Motor System Disease (=1)	0.014	0.116
Feel Hopeless about the Futures(=1)	0.033	0.178
Feel that Everything is Difficult (=1)	0.055	0.228
Age	35.904	7.052
The Number of Children	1.579	0.689
Junior Middle School and Above (=1)	0.513	0.500
Panel B: CFPS Children		
Self-reported Good Health (=1)	0.333	0.471
Wasted (=1)	0.058	0.234
Top 10% Height (=1)	0.071	0.257
Score in Vocabulary Test	23.914	6.829
Score in Math Test	13.041	4.993
Age in Month	112.667	62.691
Female (=1)	0.494	0.500
Panel C: Weather		
High Temp. Days in 1st Trimester	7.522	13.512
High Temp. Days in 2nd Trimester	8.596	13.933
High Temp. Days in 3rd Trimester	9.271	14.629
Mean Precipitation (mm)	676.649	419.228
Daily Sunshine Duration (Hours)	5.605	1.282
Wind Speed (m/s)	2.092	0.687

Notes: Table shows summary statistics for key variables. Data on variables in Panels A and B come from 2010 China Family Panel Studies, and data on variables in Panel C come from the Institute of Geographic Sciences and Natural Resources Research.

A2 Results on In Utero Selection

Table A2: Extremely High Temperatures and Miscarriage

	(1)	(2)	(3)
	Dependent Variable: Miscarriage (=1)		
High Temp. Days in 1st Trimester	0.00120	0.00111	0.000897
	(0.00245)	(0.00263)	(0.00240)
High Temp. Days in 2nd Trimester	-2.27e-05	4.50e-05	0.00172
	(0.00232)	(0.00246)	(0.00243)
High Temp. Days in 3rd Trimester	-0.000618	-0.000268	-0.00135
	(0.00220)	(0.00222)	(0.00202)
Observations	1,427	1,427	1,427
Mean of Dep. Var.	0.153	0.153	0.153
Adjusted R-squared	0.102	0.133	0.186
Weather Control	Yes	Yes	Yes
Demographics	No	No	Yes
Birth City×Birth Month FE	Yes	Yes	Yes
Birth Year FE	No	Yes	Yes
Mean of 1st Trimester	11.98	11.98	11.98
SD of 1st Trimester	18.06	18.06	18.06
Mean of 2nd Trimester	10.20	10.20	10.20
SD of 2nd Trimester	16.43	16.43	16.43
Mean of 3rd Trimester	10.81	10.81	10.81
SD of 3rd Trimester	16.81	16.81	16.81

Notes: The dependent variable is a binary variable for miscarriage. High-temperature days are defined as those with daily maximum temperatures higher than 90 °F. We count the number of high-temperature days in each gestational trimester. Demographics include age, age squared, the number of children, and an indicator for junior middle school and above. Weather controls include wind speed, precipitation and sunshine duration. Individual-level data come from the China Health and Nutrition Survey (CHNS). Robust standard errors clustered at the birth city level are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table A3: Extremely High Temperatures and In Utero Gender Selection

	(1)	(2)	(3)
Dependent Variable:		Female (=1)	
High Temp. Days in 1st Trimester	0.000300	0.000300	0.000575
	(0.00231)	(0.00232)	(0.00234)
High Temp. Days in 2nd Trimester	-0.00240	-0.00240	-0.00206
	(0.00224)	(0.00224)	(0.00227)
High Temp. Days in 3rd Trimester	-0.000440	-0.000440	-0.000329
	(0.00234)	(0.00235)	(0.00237)
Observations	3,681	3,681	3,681
Mean of Dep. Var.	0.494	0.494	0.494
Weather Control	Yes	Yes	Yes
Demographics	Yes	Yes	Yes
Birth City×Birth Month FE	Yes	Yes	Yes
Birth Year FE	Yes	Yes	Yes
Province FE	No	Yes	No
City FE	No	No	Yes
Mean of 1st Trimester	7.522	7.522	7.522
SD of 1st Trimester	13.51	13.51	13.51
Mean of 2nd Trimester	8.596	8.596	8.596
SD of 2nd Trimester	13.93	13.93	13.93
Mean of 3rd Trimester	9.271	9.271	9.271
SD of 3rd Trimester	14.63	14.63	14.63

Notes: The dependent variable is an indicator that equals one if the child is female and is zero otherwise. High-temperature days are defined as those with daily maximum temperatures higher than 90 °F. We count the number of high-temperature days in each gestational trimester for each mother's first childbirth. Demographics include age, age squared, the number of children, and an indicator for junior middle school and above. Weather controls include wind speed, precipitation and sunshine duration. Data come from the 2010 China Family Panel Survey (CFPS). Robust standard errors, clustered at the level of the city where mothers gave birth for the first time, are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1 *** p<0.01, ** p<0.05, * p<0.1.

A3 Results on Differential Fertility Responses by Skill

Table A4: Extreme Heat during Gestation and Maternal Educational Achievement

	(1)	(2)	(3)	(4)
Dependent Variable:	Junior Middle School and Above (=1)		Pre-college and Above (=1)	
High Temp. Days during 3 Months before Conception		0.000680		0.000665
		(0.00277)		(0.00126)
High Temp. Days in 1st Trimester	-0.00276	-0.00273	0.00377	0.00379
	(0.00242)	(0.00242)	(0.00253)	(0.00255)
High Temp. Days in 2nd Trimester	0.00243	0.00245	0.000146	0.000169
	(0.00225)	(0.00223)	(0.000979)	(0.000960)
High Temp. Days in 3rd Trimester	0.00105	0.000869	-0.000415	-0.000594
	(0.00173)	(0.00192)	(0.000877)	(0.000833)
High Temp. Days during 0–2 Months after Birth		-0.000520		-0.000431
		(0.00198)		(0.000936)
Observations	3,681	3,681	3,681	3,681
Mean of Dep. Var.	0.513	0.513	0.0706	0.0706
Adjusted R-squared	0.249	0.249	0.0932	0.0926
Weather Control	Yes	Yes	Yes	Yes
Demographics	Yes	Yes	Yes	Yes
Birth City×Birth Month FE	Yes	Yes	Yes	Yes
Birth Year FE	Yes	Yes	Yes	Yes
Mean of 1st Trimester	7.522	7.522	7.522	7.522
SD of 1st Trimester	13.51	13.51	13.51	13.51
Mean of 2nd Trimester	8.596	8.596	8.596	8.596
SD of 2nd Trimester	13.93	13.93	13.93	13.93
Mean of 3rd Trimester	9.271	9.271	9.271	9.271
SD of 3rd Trimester	14.63	14.63	14.63	14.63

Notes: High-temperature days are defined as those with daily maximum temperatures higher than 90 °F. We count the number of high-temperature days in each gestational trimester for each mother's first childbirth. Demographics include age, age squared, and the number of children. Weather controls include wind speed, precipitation and sunshine duration. We define a low-skilled industry as an industry in the bottom quintile of industry-specific skill intensity. Data come from the 2010 China Family Panel Survey (CFPS). Robust standard errors, clustered at the level of the city where mothers gave birth for the first time, are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1 *** p<0.01, ** p<0.05, * p<0.1.

Table A5: Control for Delivery Month by Maternal Education Level

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dependent Variable:		Employed (=1)			Annual work hours			Low-skill Industry (=1)	
High Temp. Days in 1st Trimester	0.000696	0.000696	0.000720	-8.193	-8.193	-8.747	0.00356	0.00356	0.00378
	(0.00239)	(0.00239)	(0.00240)	(7.137)	(7.183)	(7.413)	(0.00263)	(0.00264)	(0.00274)
High Temp. Days in 2nd Trimester	0.000258	0.000258	0.000105	-2.276	-2.276	-1.481	0.00252	0.00252	0.00230
	(0.00242)	(0.00243)	(0.00246)	(5.622)	(5.658)	(5.953)	(0.00260)	(0.00262)	(0.00271)
High Temp. Days in 3rd Trimester	-0.00135	-0.00135	-0.00132	-12.32**	-12.32**	-12.73**	0.00392*	0.00392*	0.00402*
	(0.00195)	(0.00195)	(0.00198)	(5.836)	(5.874)	(6.068)	(0.00220)	(0.00221)	(0.00228)
Observations	3,681	3,681	3,681	1,940	1,940	1,940	2,024	2,024	2,024
Mean of Dep. Var.	0.550	0.550	0.550	1824	1824	1824	0.560	0.560	0.560
Adjusted R-squared	0.210	0.202	0.174	0.220	0.200	0.115	0.480	0.467	0.413
Weather Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Birth City×Birth Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Birth Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	No	Yes	No	No	Yes	No	No	Yes	No
City FE	No	No	Yes	No	No	Yes	No	No	Yes
Mean of 1st Trimester	7.522	7.522	7.522	7.522	7.522	7.522	7.522	7.522	7.522
SD of 1st Trimester	13.51	13.51	13.51	13.51	13.51	13.51	13.51	13.51	13.51
Mean of 2nd Trimester	8.596	8.596	8.596	8.596	8.596	8.596	8.596	8.596	8.596
SD of 2nd Trimester	13.93	13.93	13.93	13.93	13.93	13.93	13.93	13.93	13.93
Mean of 3rd Trimester	9.271	9.271	9.271	9.271	9.271	9.271	9.271	9.271	9.271
SD of 3rd Trimester	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63

Notes: We control for delivery-month fixed effects interacted with an indicator for mothers having junior middle school or above education. High-temperature days are defined as those with daily maximum temperatures higher than 90 °F. We count the number of high-temperature days in each gestational trimester for each mother's first childbirth. Demographics include age, age squared, the number of children, and an indicator for junior middle school and above. Weather controls include wind speed, precipitation and sunshine duration. We define a low-skilled industry as an industry in the bottom quintile of industry-specific skill intensity. Data come from the 2010 China Family Panel Survey (CFPS). Robust standard errors, clustered at the level of the city where mothers gave birth for the first time, are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1 *** p<0.01, ** p<0.05, * p<0.1.

A4 Results on Migration Responses to High Temperatures

Table A6: Migration Responses to High Temperatures

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent Variable: Migration (=1)					
	Total		Low Skilled		High Skilled	
High Temp. Days	0.000177	0.000171	9.94e-05	9.94e-05	0.000166	0.000166
	(0.000148)	(0.000150)	(0.000113)	(0.000113)	(0.000181)	(0.000181)
Observations	1,300,458	1,300,458	244,284	244,284	1,056,174	1,056,174
Mean of Dep. Var.	0.123	0.123	0.0969	0.0969	0.129	0.129
Weather Control	Yes	Yes	Yes	Yes	Yes	Yes
Demographics	No	Yes	No	Yes	No	Yes
Birth Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Mean of High Temp. Days	44.60	44.60	42.34	42.34	45.13	45.13
SD of High Temp. Days	29.35	29.35	31.84	31.84	28.72	28.72

Notes: Following Khanna et al. (2021) and Gao et al. (2023b), the dependent variable is an indicator for leaving one's *hukou* city. High-temperature days are defined as those with daily maximum temperatures higher than 90 °F. We count the number of high-temperature days in the year prior to the census. Demographics include age, age squared, the number of children, and an indicator for junior middle school and above. Weather controls include wind speed, precipitation and sunshine duration. High-skilled women are those who have junior middle school and above education; low-skilled women are those who did not receive junior middle school education. Data come from the 2010 Census. Robust standard errors clustered at the birth city level are reported in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

A5 Results on Additional Controls and Alternative Measures

Table A7: Control for Cold Temperatures during Pregnancy

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dependent Variable:	Employed (=1)			Annual Work Hours			Low-skill Industry (=1)		
High Temp. Days in 1st Trimester	0.000686	0.000686	0.000694	-8.043	-8.043	-8.532	0.00323	0.00323	0.00342
	(0.00241)	(0.00242)	(0.00242)	(7.295)	(7.342)	(7.571)	(0.00255)	(0.00257)	(0.00266)
High Temp. Days in 2nd Trimester	6.81e-06	6.81e-06	-0.000142	-2.276	-2.276	-1.582	0.00279	0.00279	0.00258
	(0.00237)	(0.00237)	(0.00240)	(5.648)	(5.684)	(5.969)	(0.00258)	(0.00260)	(0.00269)
High Temp. Days in 3rd Trimester	-0.00143	-0.00143	-0.00140	-13.23**	-13.23**	-13.55**	0.00448*	0.00448*	0.00458*
	(0.00195)	(0.00196)	(0.00198)	(6.101)	(6.140)	(6.330)	(0.00228)	(0.00230)	(0.00237)
Low Temp. Days in 1st Trimester	0.000994	0.000994	0.00101	-4.505	-4.505	-4.388	-0.00164	-0.00164	-0.00162
	(0.00321)	(0.00322)	(0.00327)	(7.918)	(7.969)	(8.184)	(0.00355)	(0.00357)	(0.00366)
Low Temp. Days in 2nd Trimester	-0.000885	-0.000885	-0.00138	-10.43	-10.43	-10.23	-0.00217	-0.00217	-0.00217
	(0.00365)	(0.00366)	(0.00370)	(9.761)	(9.823)	(10.14)	(0.00357)	(0.00359)	(0.00370)
Low Temp. Days in 3rd Trimester	0.000726	0.000726	0.000691	1.463	1.463	1.586	0.00405	0.00405	0.00408
	(0.00327)	(0.00328)	(0.00333)	(14.41)	(14.50)	(14.92)	(0.00379)	(0.00381)	(0.00391)
Observations	3,681	3,681	3,681	1,940	1,940	1,940	2,024	2,024	2,024
Mean of Dep. Var.	0.550	0.550	0.550	1824	1824	1824	0.560	0.560	0.560
Adjusted R-squared	0.213	0.205	0.177	0.224	0.205	0.122	0.479	0.467	0.413
Weather Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Birth City×Birth Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Birth Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	No	Yes	No	No	Yes	No	No	Yes	No
City FE	No	No	Yes	No	No	Yes	No	No	Yes
Mean of 1st Trimester	7.522	7.522	7.522	7.522	7.522	7.522	7.522	7.522	7.522
SD of 1st Trimester	13.51	13.51	13.51	13.51	13.51	13.51	13.51	13.51	13.51
Mean of 2nd Trimester	8.596	8.596	8.596	8.596	8.596	8.596	8.596	8.596	8.596
SD of 2nd Trimester	13.93	13.93	13.93	13.93	13.93	13.93	13.93	13.93	13.93
Mean of 3rd Trimester	9.271	9.271	9.271	9.271	9.271	9.271	9.271	9.271	9.271
SD of 3rd Trimester	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63

Notes: Low-temperature days are defined as those with daily minimum temperature below 20 °F. We control for the number of low-temperature days in each gestational trimester for each mother's first childbirth. Demographics include age, age squared, the number of children, and an indicator for junior middle school and above. Weather controls include wind speed, precipitation and sunshine duration. We define a low-skilled industry as an industry in the bottom quintile of industry-specific skill intensity. Data come from the 2010 China Family Panel Survey (CFPS). Robust standard errors, clustered at the level of the city where mothers gave birth for the first time, are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1 *** p<0.01, ** p<0.05, * p<0.1.

Table A8: Control for Heat Exposure Before Conception and After Giving Birth

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dependent Variable:	Employed (=1)			Annual work hours			Low-skill Industry (=1)		
High Temp. Days during 3 Months	-0.00167	-0.00167	-0.00174	1.327	1.327	1.519	0.000178	0.000178	0.000121
before Conception	(0.00232)	(0.00233)	(0.00235)	(7.474)	(7.522)	(7.680)	(0.00317)	(0.00319)	(0.00328)
High Temp. Days in 1st Trimester	0.000646	0.000646	0.000657	-8.067	-8.067	-8.544	0.00314	0.00314	0.00332
	(0.00233)	(0.00234)	(0.00235)	(7.313)	(7.360)	(7.590)	(0.00252)	(0.00254)	(0.00263)
High Temp. Days in 2nd Trimester	-0.000129	-0.000129	-0.000288	-2.516	-2.516	-1.812	0.00275	0.00275	0.00254
	(0.00235)	(0.00236)	(0.00239)	(5.638)	(5.674)	(5.943)	(0.00261)	(0.00263)	(0.00272)
High Temp. Days in 3rd Trimester	-0.000915	-0.000915	-0.000852	-13.46**	-13.46**	-13.84**	0.00442*	0.00442*	0.00453*
	(0.00195)	(0.00196)	(0.00199)	(6.679)	(6.722)	(6.914)	(0.00263)	(0.00265)	(0.00273)
High Temp. Days during 0–2 Months	-0.000129	-0.000129	-0.000207	-3.010	-3.010	-3.129	0.000365	0.000365	0.000397
After Birth	(0.00214)	(0.00215)	(0.00216)	(7.363)	(7.410)	(7.603)	(0.00244)	(0.00246)	(0.00253)
Observations	3,681	3,681	3,681	1,940	1,940	1,940	2,024	2,024	2,024
Mean of Dep. Var.	0.550	0.550	0.550	1824	1824	1824	0.560	0.560	0.560
Adjusted R-squared	0.213	0.205	0.177	0.224	0.205	0.122	0.478	0.467	0.413
Weather Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Birth City×Birth Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Birth Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	No	Yes	No	No	Yes	No	No	Yes	No
City FE	No	No	Yes	No	No	Yes	No	No	Yes
Mean of 1st Trimester	7.522	7.522	7.522	7.522	7.522	7.522	7.522	7.522	7.522
SD of 1st Trimester	13.51	13.51	13.51	13.51	13.51	13.51	13.51	13.51	13.51
Mean of 2nd Trimester	8.596	8.596	8.596	8.596	8.596	8.596	8.596	8.596	8.596
SD of 2nd Trimester	13.93	13.93	13.93	13.93	13.93	13.93	13.93	13.93	13.93
Mean of 3rd Trimester	9.271	9.271	9.271	9.271	9.271	9.271	9.271	9.271	9.271
SD of 3rd Trimester	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63

Notes: High-temperature days are defined as those with daily maximum temperatures higher than 90 °F. We count the number of high-temperature days in each gestational trimester for each mother's first childbirth. Demographics include age, age squared, the number of children, and an indicator for junior middle school and above. Weather controls include wind speed, precipitation and sunshine duration. We define a low-skilled industry as an industry in the bottom quintile of industry-specific skill intensity. Data come from the 2010 China Family Panel Survey (CFPS). Robust standard errors, clustered at the level of the city where mothers gave birth for the first time, are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1 *** p<0.01, ** p<0.05, * p<0.1.

Table A9: Control for Province by Delivery Year Time Trend

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dependent Variable:	Employed (=1)			Annual work hours			Low-skill Industry (=1)		
High Temp. Days in 1st Trimester	-1.79e-05	-1.79e-05	3.89e-05	-8.617	-8.617	-9.225	0.00284	0.00284	0.00302
	(0.00231)	(0.00232)	(0.00231)	(7.825)	(7.875)	(8.163)	(0.00253)	(0.00255)	(0.00264)
High Temp. Days in 2nd Trimester	-0.000475	-0.000475	-0.000551	-2.839	-2.839	-2.160	0.00238	0.00238	0.00213
	(0.00253)	(0.00254)	(0.00258)	(5.657)	(5.694)	(5.935)	(0.00252)	(0.00254)	(0.00263)
High Temp. Days in 3rd Trimester	-0.00178	-0.00178	-0.00167	-11.77*	-11.77*	-12.19*	0.00426*	0.00426*	0.00435*
	(0.00200)	(0.00200)	(0.00203)	(6.385)	(6.426)	(6.676)	(0.00220)	(0.00221)	(0.00229)
Observations	3,681	3,681	3,681	1,940	1,940	1,940	2,024	2,024	2,024
Mean of Dep. Var.	0.550	0.550	0.550	1824	1824	1824	0.560	0.560	0.560
Adjusted R-squared	0.214	0.207	0.179	0.227	0.208	0.123	0.485	0.473	0.419
Weather Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Birth City×Birth Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Birth Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	No	Yes	No	No	Yes	No	No	Yes	No
City FE	No	No	Yes	No	No	Yes	No	No	Yes
Mean of 1st Trimester	7.522	7.522	7.522	7.522	7.522	7.522	7.522	7.522	7.522
SD of 1st Trimester	13.51	13.51	13.51	13.51	13.51	13.51	13.51	13.51	13.51
Mean of 2nd Trimester	8.596	8.596	8.596	8.596	8.596	8.596	8.596	8.596	8.596
SD of 2nd Trimester	13.93	13.93	13.93	13.93	13.93	13.93	13.93	13.93	13.93
Mean of 3rd Trimester	9.271	9.271	9.271	9.271	9.271	9.271	9.271	9.271	9.271
SD of 3rd Trimester	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63

Notes:High-temperature days are defined as those with daily maximum temperature higher than 90 °F. We count the number of high-temperature days in each gestational trimester for each mother's first childbirth. Demographics include age, age squared, the number of children, and an indicator for junior middle school and above. Weather controls include wind speed, precipitation and sunshine duration. We define a low-skilled industry as an industry in the bottom quintile of industry-specific skill intensity. Data come from 2010 China Family Panel Survey (CFPS). Robust standard errors, clustered at the level of the city where mothers gave birth for the first time, are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1 *** p<0.01, ** p<0.05, * p<0.1.

Table A10: Alternative Measures of High Temperature Exposure

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dependent Variable:	Employed (=1)			Annual work hours			Low-skill Industry (=1)		
Panel A: Cooling degree days based on the cutoff of 65 °F									
CDD in 1st Trimester	3.83e-06	3.83e-06	1.39e-05	-0.353	-0.353	-0.387	0.000280	0.000280	0.000290
	(0.000164)	(0.000164)	(0.000164)	(0.490)	(0.493)	(0.503)	(0.000187)	(0.000188)	(0.000194)
CDD in 2nd Trimester	6.90e-05	6.90e-05	8.43e-05	-0.683	-0.683	-0.647	-2.78e-05	-2.78e-05	-4.13e-05
	(0.000203)	(0.000204)	(0.000207)	(0.439)	(0.441)	(0.457)	(0.000171)	(0.000172)	(0.000178)
CDD in 3rd Trimester	8.37e-05	8.37e-05	9.47e-05	-0.785	-0.785	-0.831*	0.000311**	0.000311**	0.000330**
	(0.000147)	(0.000148)	(0.000150)	(0.487)	(0.490)	(0.500)	(0.000152)	(0.000153)	(0.000160)
Observations	3,681	3,681	3,681	1,940	1,940	1,940	2,024	2,024	2,024
Panel B: Cooling degree days based on the cutoff of 70 °F									
CDD in 1st Trimester	7.18e-05	7.18e-05	8.27e-05	-0.784	-0.784	-0.830	0.000289	0.000289	0.000301
	(0.000176)	(0.000177)	(0.000176)	(0.622)	(0.626)	(0.643)	(0.000224)	(0.000226)	(0.000233)
CDD in 2nd Trimester	4.48e-05	4.48e-05	6.25e-05	-0.570	-0.570	-0.510	0.000138	0.000138	0.000117
	(0.000242)	(0.000243)	(0.000247)	(0.539)	(0.542)	(0.566)	(0.000210)	(0.000212)	(0.000219)
CDD in 3rd Trimester	2.85e-05	2.85e-05	3.90e-05	-0.850	-0.850	-0.904	0.000388**	0.000388**	0.000405**
	(0.000168)	(0.000169)	(0.000171)	(0.566)	(0.570)	(0.587)	(0.000182)	(0.000183)	(0.000191)
Observations	3,681	3,681	3,681	1,940	1,940	1,940	2,024	2,024	2,024
Mean of Dep. Var.	0.550	0.550	0.550	1824	1824	1824	0.560	0.560	0.560
Weather Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Birth City×Birth Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Birth Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	No	Yes	No	No	Yes	No	No	Yes	No
City FE	No	No	Yes	No	No	Yes	No	No	Yes

Notes: In panel A, cooling degree days are defined as the sum, over all days in each gestational trimester in which it is hotter than 65 °F, of the difference between each day's mean temperature and 65 °F. In panel B, cooling degree days are defined as the sum, over all days in each gestational trimester in which it is hotter than 70 °F, of the difference between each day's mean temperature and 70 °F. We additionally control for heating degree days across all columns in panels A and B. Demographics include age, age squared, the number of children, and an indicator for junior middle school and above. Weather controls include wind speed, precipitation and sunshine duration. We define a low-skilled industry as an industry in the bottom quintile of industry-specific skill intensity. Data come from the 2010 China Family Panel Survey (CFPS). Robust standard errors, clustered at the level of the city where mothers gave birth for the first time, are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

A6 Additional Results on Underlying Mechanisms

Table A11: Prenatal Heat Exposure and Infant and Children Mortality

	(1)	(2)	(3)	(4)
	Dependent Variable: Indicator for Mortality (=1)			
	Aged below 1		Aged between 1-5	
High Temp. Days in 1st Trimester	0.000821	0.000853	-0.000391	-0.000377
	(0.000711)	(0.000698)	(0.000700)	(0.000685)
High Temp. Days in 2nd Trimester	0.00128**	0.00110**	-0.000315	-0.000397
	(0.000550)	(0.000522)	(0.000819)	(0.000824)
High Temp. Days in 3rd Trimester	-0.000174	-8.99e-05	6.25e-05	0.000116
	(0.000829)	(0.000779)	(0.000316)	(0.000349)
Observations	1,209	1,209	1,374	1,374
Mean of Dep. Var.	0.00662	0.00662	0.00655	0.00655
Weather Control	Yes	Yes	Yes	Yes
Demographics	No	Yes	No	Yes
Birth City×Birth Month FE	Yes	Yes	Yes	Yes
Birth Year FE	Yes	Yes	Yes	Yes
Mean of 1st Trimester	12.17	12.17	11.51	11.51
SD of 1st Trimester	18.30	18.30	17.56	17.56
Mean of 2nd Trimester	10.84	10.84	10.98	10.98
SD of 2nd Trimester	16.98	16.98	16.99	16.99
Mean of 3rd Trimester	10.96	10.96	11.86	11.86
SD of 3rd Trimester	16.95	16.95	17.45	17.45

Notes:High-temperature days are defined as those with daily maximum temperature higher than 90 °F. We count the number of high-temperature days in each gestational trimester. Demographics include age, age squared, the number of children, and an indicator for junior middle school and above. Weather controls include wind speed, precipitation and sunshine duration. Data come from the China Health and Nutrition Survey (CHNS). Robust standard errors clustered at the birth city level are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1 *** p<0.01, ** p<0.05, * p<0.1.

Table A12: Maternal Labor Market Outcomes: Control for Crop Yield

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dependent Variable:	Employed (=1)			Annual Work Hours			Low-skill Industry (=1)		
High Temp. Days in 1st Trimester	0.000772	0.000772	0.000798	-8.896	-8.896	-9.363	0.00292	0.00292	0.00311
	(0.00240)	(0.00241)	(0.00240)	(7.443)	(7.490)	(7.723)	(0.00254)	(0.00256)	(0.00265)
High Temp. Days in 2nd Trimester	0.000101	0.000101	-3.68e-05	-2.666	-2.666	-1.962	0.00260	0.00260	0.00239
	(0.00235)	(0.00235)	(0.00238)	(5.735)	(5.772)	(6.064)	(0.00261)	(0.00263)	(0.00272)
High Temp. Days in 3rd Trimester	-0.00133	-0.00133	-0.00128	-13.88**	-13.88**	-14.19**	0.00427*	0.00427*	0.00437*
	(0.00198)	(0.00198)	(0.00201)	(6.242)	(6.282)	(6.478)	(0.00228)	(0.00229)	(0.00237)
Observations	3,681	3,681	3,681	1,940	1,940	1,940	2,024	2,024	2,024
Mean of Dep. Var.	0.550	0.550	0.550	1824	1824	1824	0.560	0.560	0.560
Adjusted R-squared	0.213	0.206	0.178	0.225	0.206	0.123	0.479	0.467	0.414
Weather Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Birth City×Birth Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Birth Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	No	Yes	No	No	Yes	No	No	Yes	No
City FE	No	No	Yes	No	No	Yes	No	No	Yes
Mean of 1st Trimester	7.522	7.522	7.522	7.522	7.522	7.522	7.522	7.522	7.522
SD of 1st Trimester	13.51	13.51	13.51	13.51	13.51	13.51	13.51	13.51	13.51
Mean of 2nd Trimester	8.596	8.596	8.596	8.596	8.596	8.596	8.596	8.596	8.596
SD of 2nd Trimester	13.93	13.93	13.93	13.93	13.93	13.93	13.93	13.93	13.93
Mean of 3rd Trimester	9.271	9.271	9.271	9.271	9.271	9.271	9.271	9.271	9.271
SD of 3rd Trimester	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63

Notes:High-temperature days are defined as those with daily maximum temperature higher than 90 °F. We count the number of high-temperature days in each gestational trimester for each mother's first childbirth. We control for local crop yield when each mother gave birth for the first time. Demographics include age, age squared, the number of children, and an indicator for junior middle school and above. Weather controls include wind speed, precipitation and sunshine duration. We define a low-skilled industry as an industry in the bottom quintile of industry-specific skill intensity. Individual-level data come from the 2010 China Family Panel Survey (CFPS). Robust standard errors, clustered at the level of the city where mothers gave birth for the first time, are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1 *** p<0.01, ** p<0.05, * p<0.1.

Table A13: Maternal Health Outcomes: Control for Crop Yield

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	BMI: 22.5-25(=1)			Having Female Reproductive System Disease (=1)			Disc Disease(=1)		
High Temp. Days in 1st Trimester	5.32e-05	5.32e-05	-6.99e-05	0.000335	0.000335	0.000334	-0.000579	-0.000579	-0.000581
	(0.00210)	(0.00210)	(0.00212)	(0.000509)	(0.000511)	(0.000519)	(0.000736)	(0.000739)	(0.000752)
High Temp. Days in 2nd Trimester	0.00228	0.00228	0.00237	-1.14e-05	-1.14e-05	-1.94e-05	0.000250	0.000250	0.000246
	(0.00211)	(0.00212)	(0.00213)	(0.000789)	(0.000792)	(0.000810)	(0.000375)	(0.000376)	(0.000385)
High Temp. Days in 3rd Trimester	-0.00607***	-0.00607***	-0.00603***	0.000971*	0.000971*	0.000969*	0.000684*	0.000684*	0.000686*
	(0.00166)	(0.00167)	(0.00169)	(0.000522)	(0.000524)	(0.000534)	(0.000346)	(0.000347)	(0.000353)
Observations	3,681	3,681	3,681	3,681	3,681	3,681	3,681	3,681	3,681
Mean of Dep. Var.	0.237	0.237	0.237	0.0130	0.0130	0.0130	0.00897	0.00897	0.00897
	Feel Hopeless about the Futures(=1)			Feel that Everything is Difficult (=1)					
High Temp. Days in 1st Trimester	-0.000258	-0.000258	-0.000272	-0.000629	-0.000629	-0.000607			
	(0.000762)	(0.000764)	(0.000778)	(0.000997)	(0.001000)	(0.00102)			
High Temp. Days in 2nd Trimester	-0.000242	-0.000242	-0.000205	-0.00195	-0.00195	-0.00196			
	(0.000787)	(0.000789)	(0.000802)	(0.00121)	(0.00121)	(0.00124)			
High Temp. Days in 3rd Trimester	0.00136	0.00136	0.00140	0.00205**	0.00205**	0.00206**			
	(0.000861)	(0.000864)	(0.000881)	(0.000870)	(0.000872)	(0.000885)			
Observations	3,681	3,681	3,681	3,681	3,681	3,681			
Mean of Dep. Var.	0.0326	0.0326	0.0326	0.0551	0.0551	0.0551			
Weather Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Birth City×Birth Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Birth Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	No	Yes	No	No	Yes	No	No	Yes	No
City FE	No	No	Yes	No	No	Yes	No	No	Yes
Mean of 1st Trimester	7.522	7.522	7.522	7.522	7.522	7.522	7.522	7.522	7.522
SD of 1st Trimester	13.51	13.51	13.51	13.51	13.51	13.51	13.51	13.51	13.51
Mean of 2nd Trimester	8.596	8.596	8.596	8.596	8.596	8.596	8.596	8.596	8.596
SD of 2nd Trimester	13.93	13.93	13.93	13.93	13.93	13.93	13.93	13.93	13.93
Mean of 3rd Trimester	9.271	9.271	9.271	9.271	9.271	9.271	9.271	9.271	9.271
SD of 3rd Trimester	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63

Notes: High-temperature days are defined as those with daily maximum temperature higher than 90 °F. We count the number of high-temperature days in each gestational trimester for each mother's first childbirth. We control for local crop yield when each mother gave birth for the first time. Demographics include age, age squared, the number of children, and an indicator for junior middle school and above. Weather controls include wind speed, precipitation and sunshine duration. We define a low-skilled industry as an industry in the bottom quintile of industry-specific skill intensity. Data come from the 2010 China Family Panel Survey (CFPS). Robust standard errors clustered, at the level of the city where mothers gave birth for the first time, are reported in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$ *** $p<0.01$, ** $p<0.05$, * $p<0.1$.