Supplementary Material

Ambient Temperature and Preterm Birth: A Retrospective Study of 32 Million US Singleton Births

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Table S1. Demographics of 32 million singleton births among 403 US counties from 1989 to 2002.

Characteristics, No. (%)	Preterm Births (20-36 Weeks)	Term Births (37-44 Weeks)	OR for Preterm Birth (95% CI)[a]
Total birth	2,973,909 (9.3)	28,947,137 (90.7)	—
Gestational age, weeks, median (IQR)	35.0 (3.0)	39.0 (2.0)	—
Maternal age, years			
<25	1,179,350 (10.7)	9,804,132 (89.3)	1.34 (1.33, 1.34)
25-34	1,390,758 (8.3)	15,450,201 (91.7)	1 [Reference]
≥35	403,801 (9.9)	3,692,804 (90.1)	1.21 (1.21, 1.22)
Marital status			
Married	1,717,846 (7.8)	20,286,039 (92.2)	1 [Reference]
Unmarried	1,256,063 (12.7)	8,661,098 (87.3)	1.71 (1.71, 1.72)
Maternal race			
White	1,999,007 (8.1)	22,807,833 (91.7)	1 [Reference]
Nonwhite	974,902 (13.7)	6,139,304 (85.8)	1.81 (1.81, 1.82)
Years of education, years			
≤ 8	227,284 (10.9)	1,852,965 (89.1)	1.04 (1.04, 1.04)
9-12	1,571,182 (10.7)	13,170,366 (89.3)	1 [Reference]
13-17	1,103,229 (7.7)	13,280,890 (92.3)	0.69 (0.68, 0.69)
Unknown	72,214 (10.1)	642,916 (89.9)	0.95 (0.94, 0.95)
Smoking during pregnancy			
No	1,897,344 (9.1)	18,840,815 (90.9)	1 [Reference]
Yes	344,353 (12.1)	2,511,387 (87.9)	1.36 (1.35, 1.36)
Unknown[b]	732,212 (8.8)	7,594,935 (91.2)	0.96 (0.96, 0.96)
Alcohol consumption during pregnancy			
No	2,264,166 (9.4)	21,807,369 (90.6)	1 [Reference]
Yes	51,698 (12.4)	365,439 (87.6)	1.37 (1.35, 1.38)
Unknown[b]	658,045 (8.9)	6,774,329 (91.1)	0.94 (0.94, 0.94)
Parity			
0	1,261,636 (9.5)	12,063,405 (90.5)	1 [Reference]
1	849,657 (8.3)	9,352,247 (91.7)	0.88 (0.87, 0.88)
≥ 2	850,362 (10.3)	7,428,996 (89.7)	1.11 (1.11, 1.11)
Unknown	12,254 (10.7)	102,489 (89.3)	1.16 (1.14, 1.18)
Chronic hypertension			
No	2,865,650 (9.2)	28,259,194 (90.8)	1 [Reference]
Yes	43,430 (20.9)	163,910 (79.1)	2.57 (2.54, 2.59)
Unknown	64,829 (11.0)	523,933 (89.0)	1.23 (1.22, 1.24)
Season of conception[c]			
Spring	690,569 (9.4)	6,679,003 (90.6)	0.98 (0.98, 0.99)
Summer	718,648 (9.3)	7,042,737 (90.7)	0.97 (0.97, 0.98)
Fall	803,703 (9.5)	7,679,851 (90.5)	1 [Reference]
Winter	760,989 (9.2)	7,545,546 (90.8)	0.96 (0.96, 0.96)
Geographic Region			
Northeast	715,500 (8.8)	7,428,449 (91.2)	1.01 (1.01, 1.01)
Southeast	566,639 (10.8)	4,705,531 (89.2)	1.26 (1.25, 1.26)
Midwest	591,021 (9.5)	5,655,533 (90.5)	1.10 (1.09, 1.10)
Great Plains	347,421 (10.1)	3,098,420 (89.9)	1.19 (1.18, 1.19)

Northwest	74,808 (7.4)	932,650 (92.6)	0.84 (0.83, 0.84)
Southwest	678,520 (8.7)	7,126,554 (91.3)	1 [Reference]
Climate Zone			
Hot-Humid	533,446 (10.6)	4,498,990 (89.4)	1.26 (1.26, 1.27)
Mixed-Humid	839,539 (10.0)	7,532,030 (90.0)	1.18 (1.18, 1.18)
Hot-Dry/Mixed-Dry	528,042 (9.0)	5,313,985 (91.0)	1.06 (1.05, 1.06)
Cold/Very Cold	914,837 (8.6)	9,664,717 (91.4)	1 [Reference]
Marine	158,045 (7.5)	1,937,415 (92.5)	0.86 (0.86, 0.87)

Abbreviations: IQR, interquartile range; OR, odds ratio; CI, confidence interval.

— denotes not applicable.

[a] Odds ratios were estimated from crude model that without including any covariates.

[b] Smoking and drinking consumption were not recorded on California birth certificates.

[c] Season of conception: spring (March-May), summer (June-August), fall (September-November), and winter (December-February).

Table S2. Sensitivity analysis by testing different modelling choices for extreme heat and cold.

Modelling choices	Extreme Heat[b]	Extreme Cold[b]
Main model[a]	1.025 (1.015, 1.036)	0.985 (0.976, 0.993)
DF/year for seasonal control: 6	1.022 (1.012, 1.032)	0.978 (0.971, 0.986)
DF/year for seasonal control: 10	1.033 (1.023, 1.043)	0.981 (0.973, 0.990)
DF for relative humidity: 5	1.025 (1.015, 1.035)	0.984 (0.976, 0.992)

Abbreviations: DF, degrees of freedom.

[a]The main model was adjusted for long-term and seasonal trends using a natural cubic spline of time with 8 degrees of freedom per year, relative humidity using a natural cubic spline with 3 degrees of freedom, day of week, federal holidays, and the temporal variation of the daily expected count of preterm births.

[b]Extreme heat and cold were defined as the 95th and 5th percentiles, respectively, of county-specific temperature distributions over the study period.

Table S3. Relative risks of preterm birth associated with temperature extremes over the subsequent four days and stratified by preterm birth categories.

Preterm birth categories	Extreme Cold	Extreme Heat
Preterm births (20-36 weeks)	0.985 (0.976, 0.993)	1.025 (1.015, 1.036)
Early preterm births (20-33 weeks)	0.979 (0.964, 0.995)	1.024 (1.006, 1.042)
Late preterm births (34-36 weeks)	0.985 (0.975, 0.995)	1.026 (1.015, 1.038)

Extreme heat and cold were defined as the 95th and 5th percentiles, respectively, of county-specific temperature distributions over the study period.

Table S4. Fraction and number of preterm births attributable to moderate heat.

Subgroup	Fraction of Preterm Births % (empirical CI)	Number of Preterm Births per Million Pregnancies No. (empirical CI)
All US	0.63 (0.49, 0.74)	586 (457, 693)
Geographic Region		
Northeast	0.43 (0.17, 0.66)	375 (149, 583)
Southeast	0.70 (0.48, 0.89)	752 (520, 952)
Midwest	0.75 (0.45, 1.03)	709 (424, 970)
Great Plains	0.52 (0.13, 0.90)	526 (134, 912)
Northwest	0.37 (-0.17, 0.85)	275 (-123, 630)
Southwest	0.76 (0.42, 1.08)	662 (364, 936)
Climate Zone		
Hot-Humid	0.57 (0.29, 0.84)	608 (311, 886)
Mixed-Humid	0.52 (0.27, 0.73)	517 (273, 734)
Hot-Dry/Mixed-Dry	0.82 (0.41, 1.21)	745 (374, 1,095)
Cold/Very Cold	0.72 (0.50, 0.92)	620 (431, 794)
Marine	0.26 (-0.10, 0.62)	195 (-79, 466)

Abbreviations: CI, confidence interval.
Moderate heat was defined as temperatures between 50th and 95th percentile of county-specific temperature distributions.

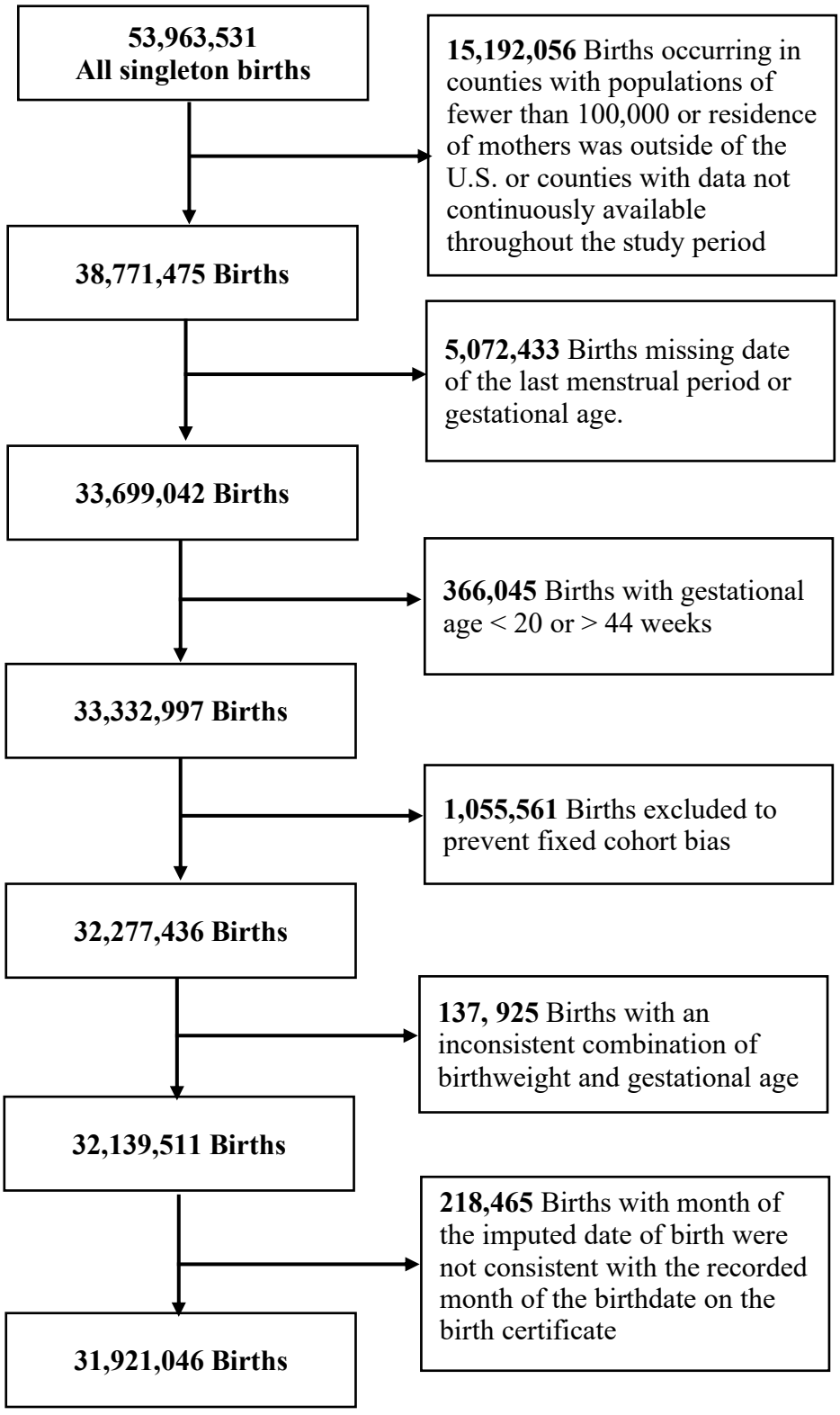

Fig. S1. Flow diagram of birth exclusion in this study.

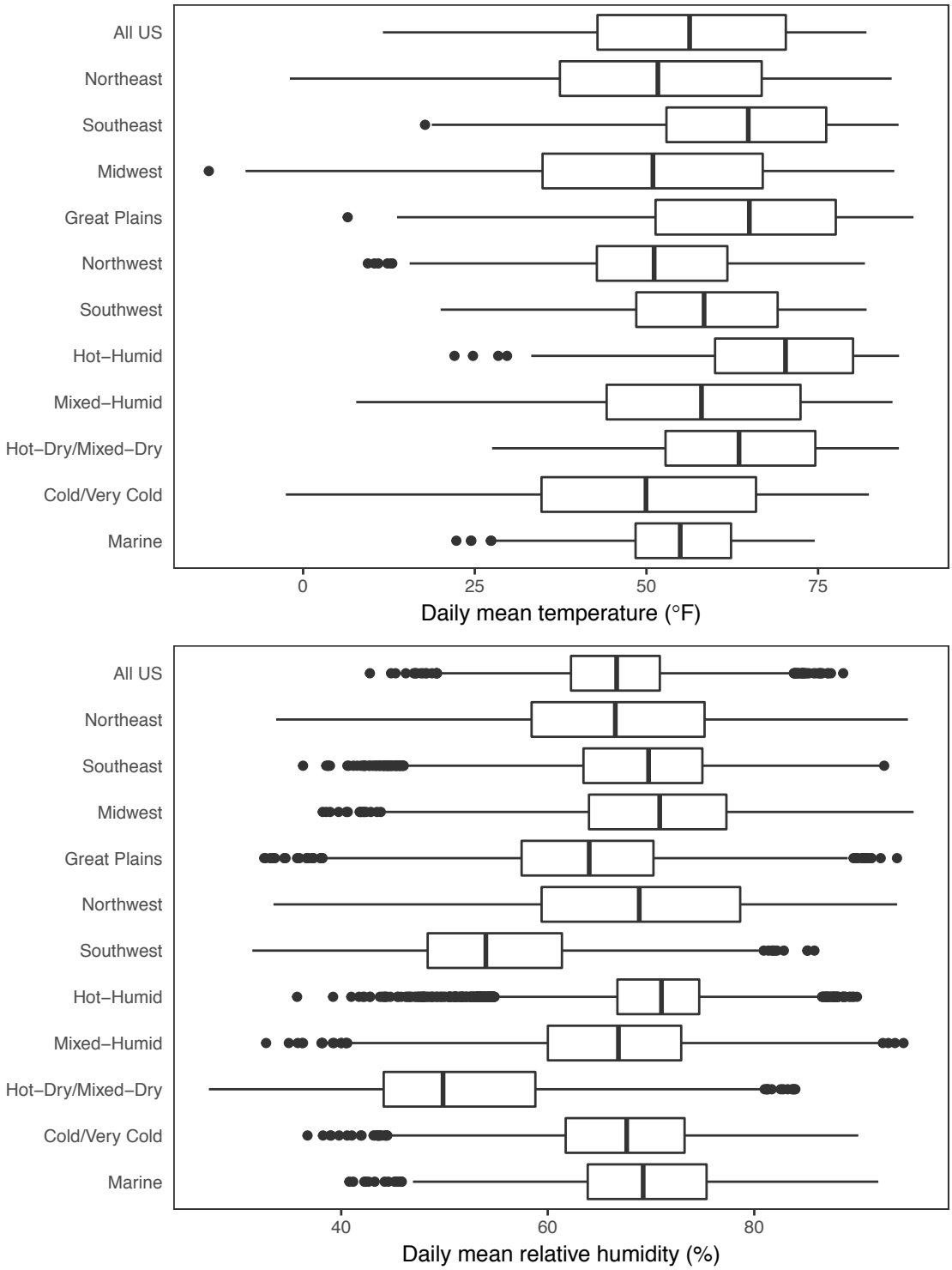

Fig. S2. Daily mean ambient temperature and relative humidity in the contiguous United States, 1989-2002.
Boxes of the box plots cover the interquartile ranges with a center line for the median. Whiskers of the box plots extend to the minimum/maximum observations, with outliers shown as dots.

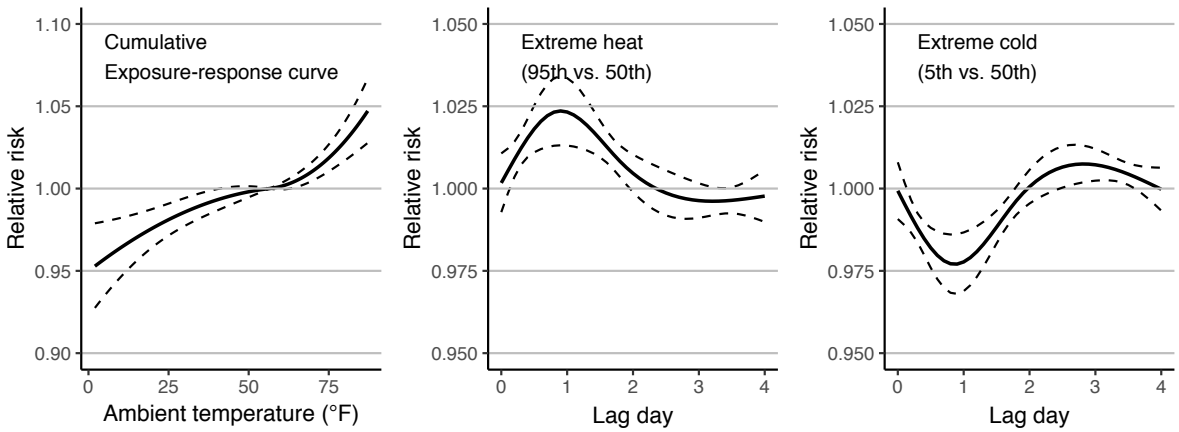

Fig. S3. **Cumulative exposure-response curves for ambient temperature-preterm birth relationships and lag day-specific effects of extreme heat and cold on preterm births.** Extreme heat and cold were defined as the 95th and 5th percentiles, respectively, of the county-specific temperature distributions over the study period.
Models were adjusted for long-term and seasonal trends using a natural cubic spline of time with 8 degrees of freedom per year, relative humidity using a natural cubic spline with 3 degrees of freedom, day of the week, federal holidays, and the temporal variation of the daily expected count of preterm births.

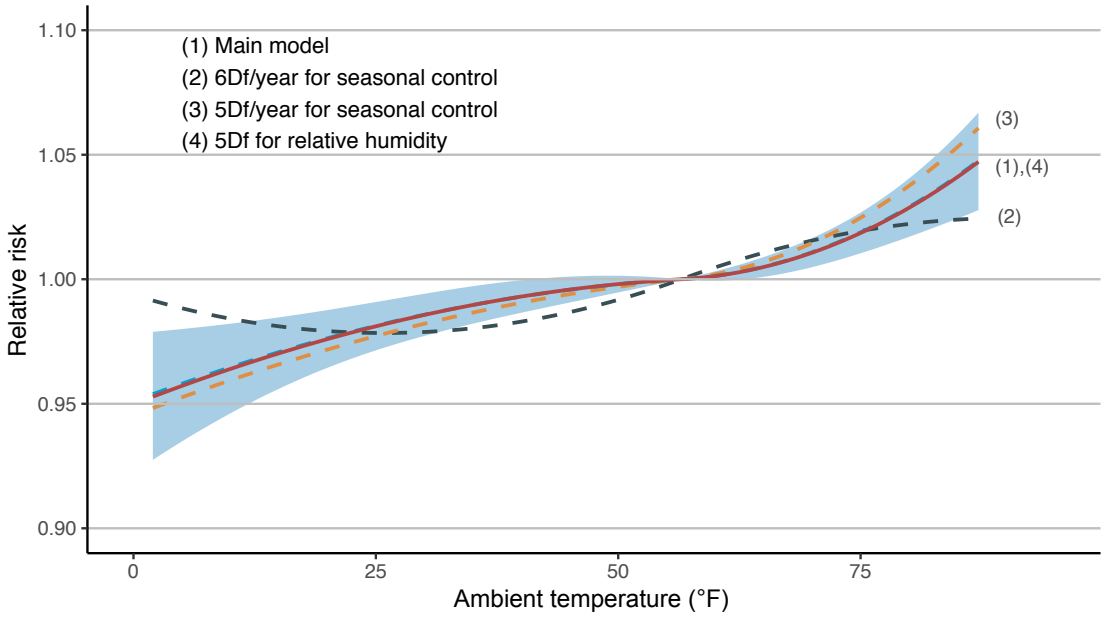

Fig. S4. Sensitivity analysis by testing different modelling choices for cumulative exposure-response curves for ambient temperature-preterm birth relationships.
Abbreviations: DF, degrees of freedom.
The blue shaded areas are the 95% CI of the main model (Model 1).
Lines of Model 1 and Model 4 are overlapping.
The main model was adjusted for long-term and seasonal trends using a natural cubic spline of time with 8 degrees of freedom per year, relative humidity using a natural cubic spline with 3 degrees of freedom, day of the week, federal holidays, and the temporal variation of the daily expected count of preterm births.

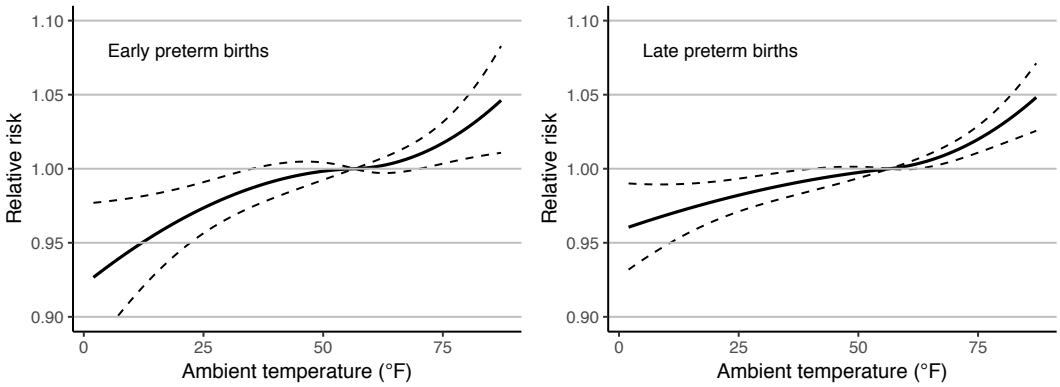

Fig. S5. Cumulative exposure-response curves for ambient temperature-preterm birth relationships for early and late preterm births.
We defined early preterm births as births with gestational age ranging from 20 to 33 weeks, while late preterm births as births with gestational age from 34 to 36 weeks.