

Supplementary Materials for

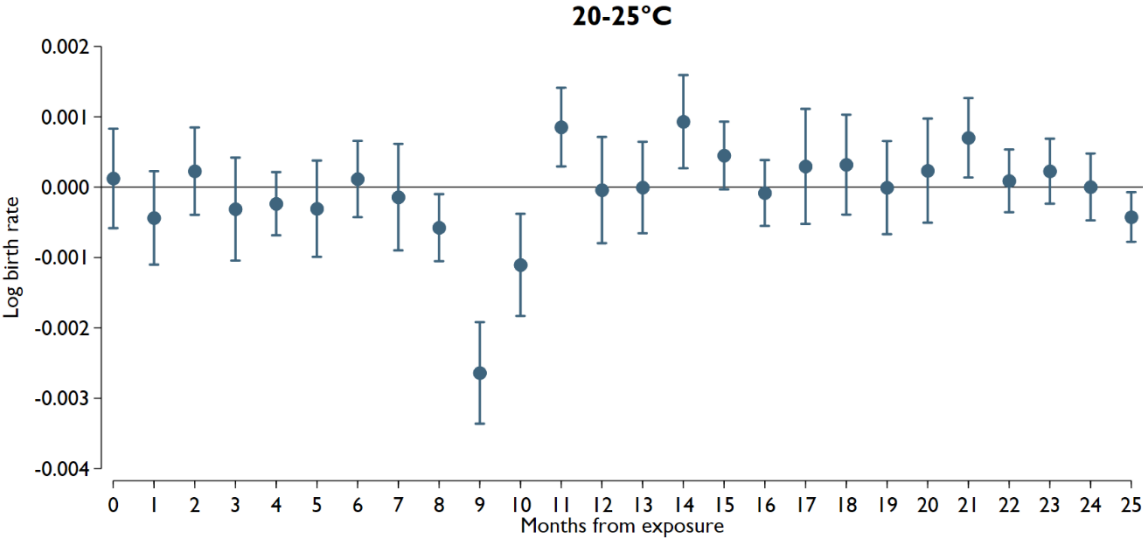
The effect of temperature on birth rates in Europe

This PDF file includes:

Fig. A1-A8

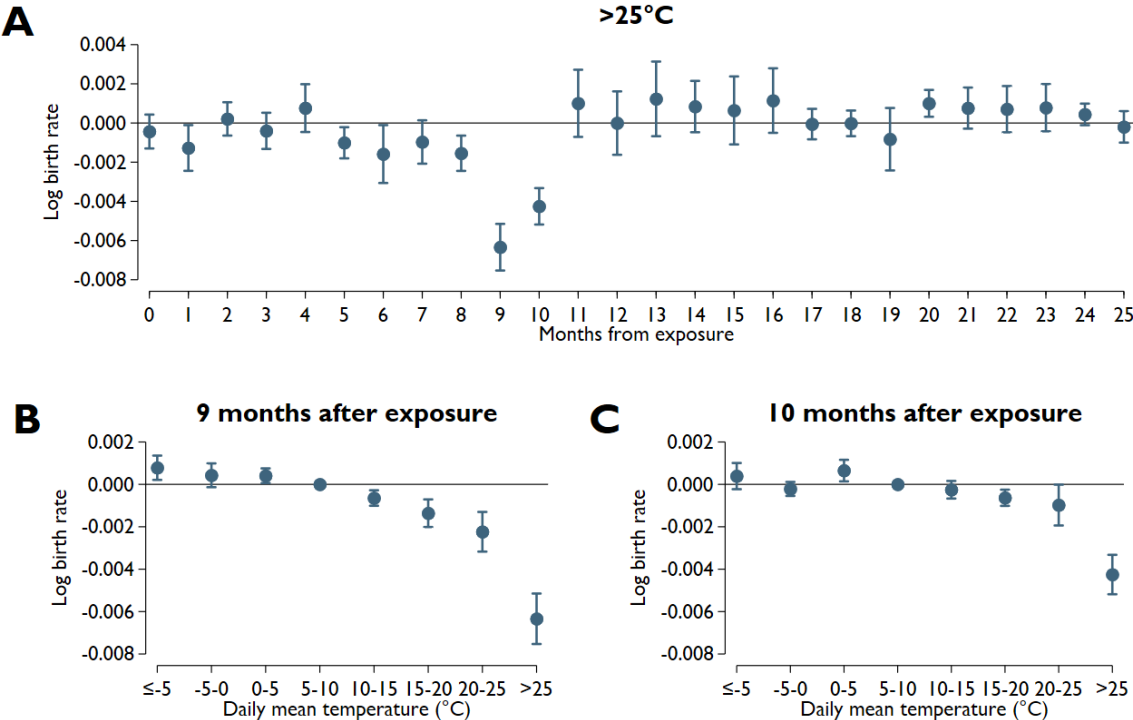
Table A1-A5

Fig. A1: The effect of a 20-25°C day on birth rates



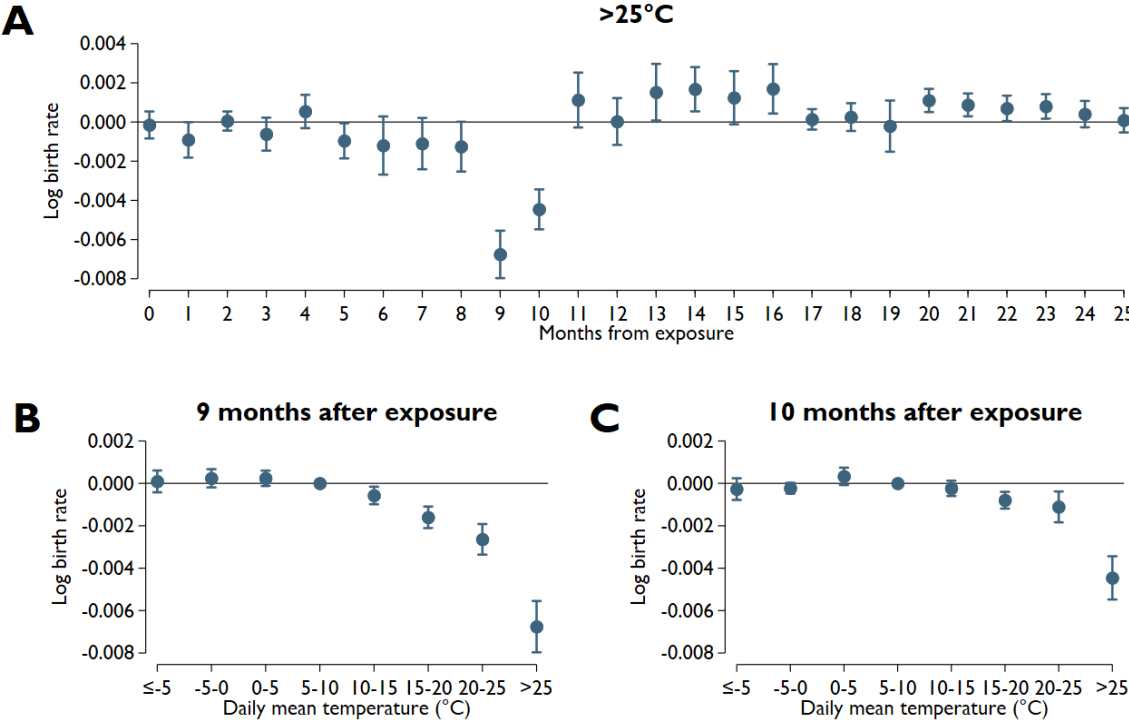
Notes: The error bars represent 95% confidence intervals. The effects are compared to a day with a mean temperature of 5–10°C. The model has country-by-year, country-by-month, and year-by-month fixed effects and country-by-month-specific quadratic time trends. Precipitation and relative humidity are controlled for. The regressions are weighted by the countries' female population at the beginning of the year. Standard errors are clustered by country. N=15,624.

Fig. A2: Estimations based on a balanced panel of countries



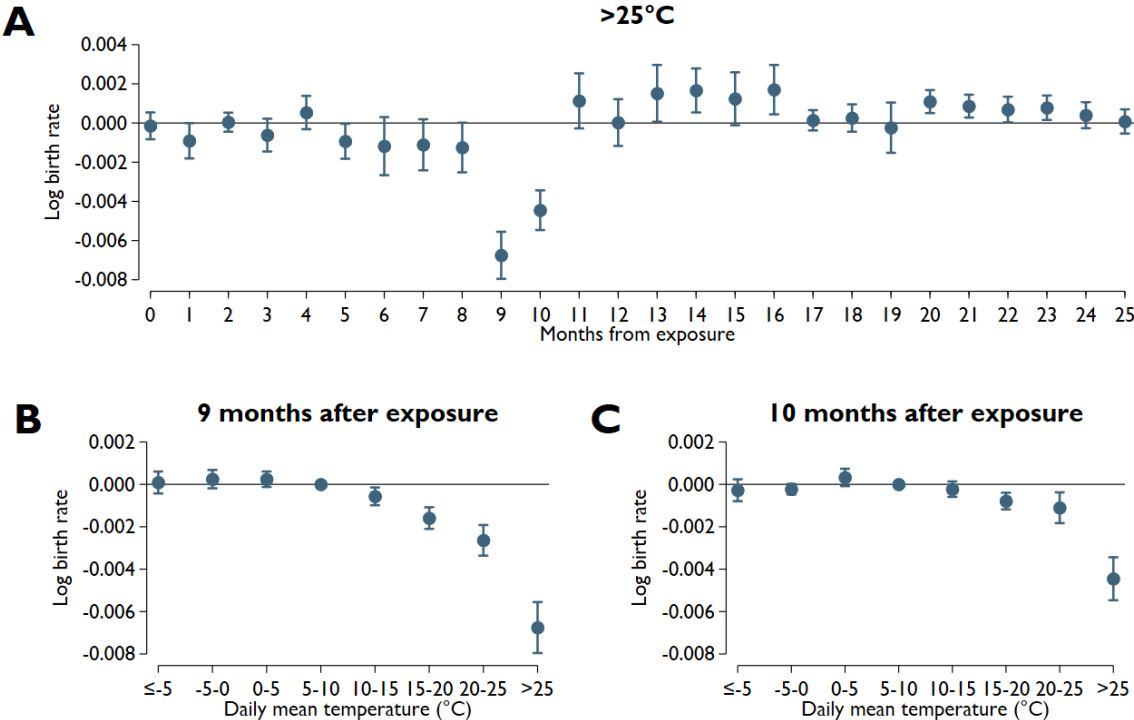
Notes: Only countries with full coverage between 1969 and 2021 are included. The error bars represent 95% confidence intervals. The effects are compared to a day with a mean temperature of 5–10°C. The model has country-by-year, country-by-month, and year-by-month fixed effects and country-by-month-specific quadratic time trends. Precipitation and relative humidity are controlled for. The regressions are weighted by the countries’ female population at the beginning of the year. Standard errors are clustered by country. N=10,176.

Fig. A3: Estimations using the log number of births per 100,000 women aged 15-44 as the dependent variable



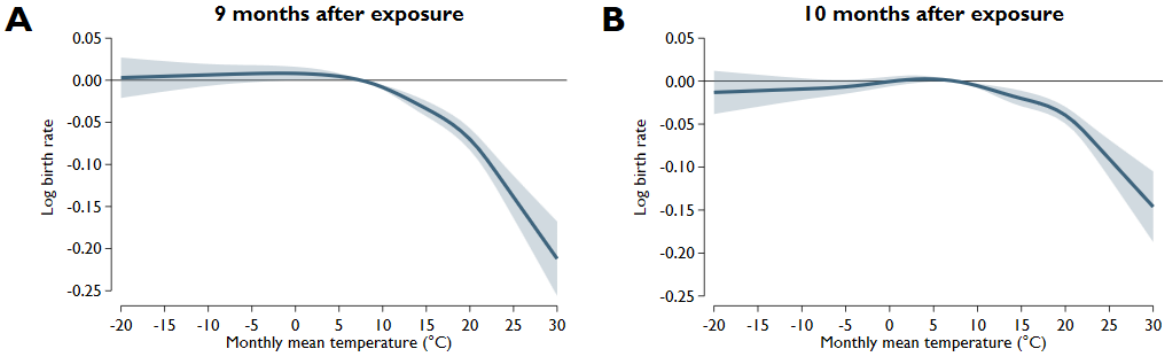
Notes: The error bars represent 95% confidence intervals. The effects are compared to a day with a mean temperature of 5–10°C. The model has country-by-year, country-by-month, and year-by-month fixed effects and country-by-month-specific quadratic time trends. Precipitation and relative humidity are controlled for. The regressions are weighted by the countries' female population at the beginning of the year. Standard errors are clustered by country. N=15,540.

Fig. A4: Estimations using the log number of births as the dependent variable



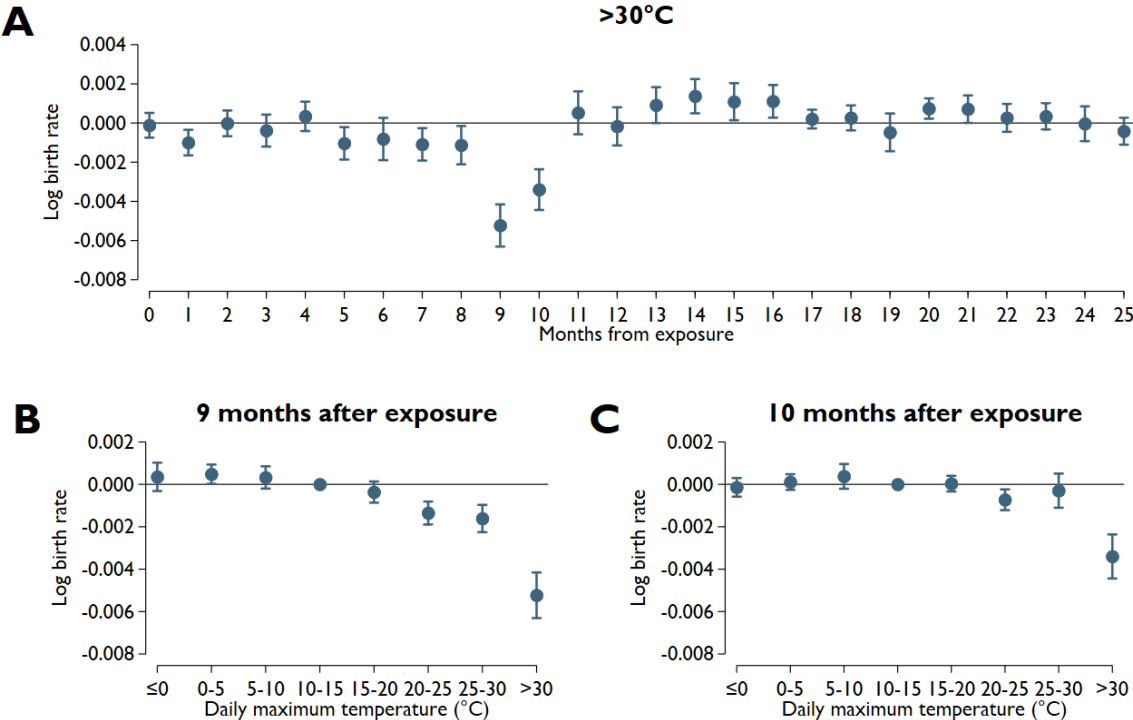
Notes: The error bars represent 95% confidence intervals. The effects are compared to a day with a mean temperature of 5–10°C. The model has country-by-year, country-by-month, and year-by-month fixed effects and country-by-month-specific quadratic time trends. Precipitation and relative humidity are controlled for. The regressions are weighted by the countries’ female population at the beginning of the year. Standard errors are clustered by country. N=15,624.

Fig. A5: Estimations using the monthly mean temperature



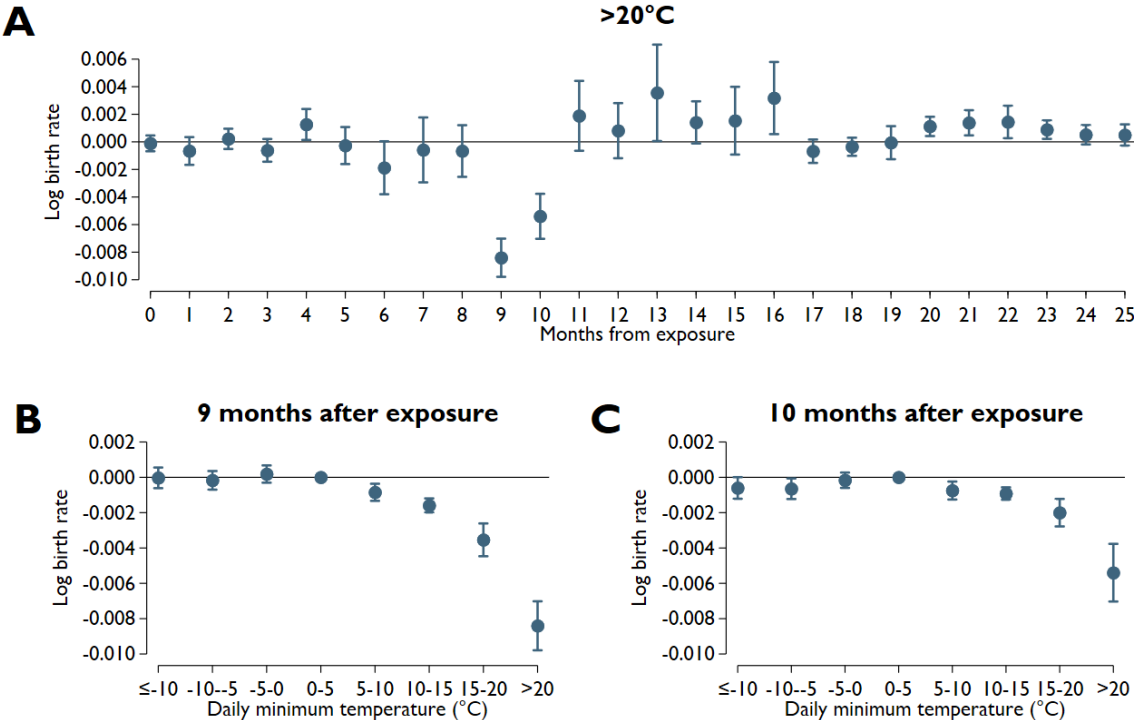
Notes: The temperature estimates come from restricted cubic spline functions with six knots. The shaded areas represent 95% confidence intervals. The reference temperatures are 7.5 °C. The model has country-by-year, country-by-month, and year-by-month fixed effects and country-by-month-specific quadratic time trends. Precipitation and relative humidity are controlled for. The regressions are weighted by the countries' female population at the beginning of the year. Standard errors are clustered by country. N=15,624.

Fig. A6: Estimations using the maximum temperature



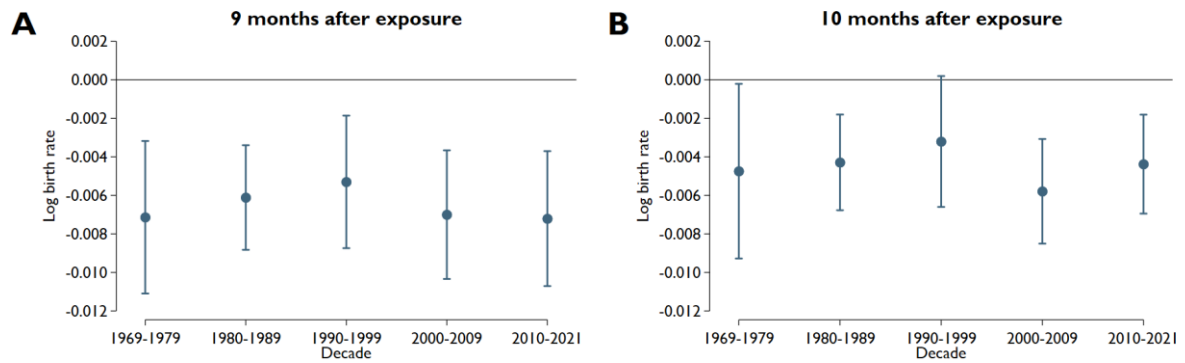
Notes: The error bars represent 95% confidence intervals. The effects are compared to a day with a maximum temperature of 10–15°C. The model has country-by-year, country-by-month, and year-by-month fixed effects and country-by-month-specific quadratic time trends. Precipitation and relative humidity are controlled for. The regressions are weighted by the countries’ female population at the beginning of the year. Standard errors are clustered by country. N=15,624.

Fig. A7: Estimations using the minimum temperature



Notes: The error bars represent 95% confidence intervals. The effects are compared to a day with a minimum temperature of 0–5°C. The model has country-by-year, country-by-month, and year-by-month fixed effects and country-by-month-specific quadratic time trends. Precipitation and relative humidity are controlled for. The regressions are weighted by the countries’ female population at the beginning of the year. Standard errors are clustered by country. N=15,624.

Fig. A8: The temperature-birth rate relationship by decade (the effect of a day with an average temperature of $>25^{\circ}$)



Notes: The error bars represent 95% confidence intervals. The effects are compared to a day with a mean temperature of $5-10^{\circ}\text{C}$. Only countries with full coverage between 1969 and 2021 are included. The model includes lags 0-25 but only lags 9 and 10 are shown (see Eq. 1). In this model, each weather variable is interacted with an indicator for a given decade. The model has country-by-year, country-by-month, and year-by-month fixed effects and country-by-month-specific quadratic time trends. Precipitation and relative humidity are controlled for. The regressions are weighted by the countries' female population at the beginning of the year. $N=10,176$.

Table A1: Spatial and temporal coverage of the sample

Country	Years
AUT	1969-2021
BEL	1969-2021
BGR	1994-2021
CHE	1969-2021
CZE	1992-2021
DEU	1969-2021
DNK	1969-2021
ESP	1969-2021
EST	1969-2021
FIN	1969-2021
FRA	1994-2021
GBR	1973-2018
GRC	1969-2021
HRV	1994-2021
HUN	1994-2021
IRL	1969-2021
ITA	1969-2021
LIE	1980-2021
LTU	1994-2021
LUX	1969-2021
LVA	1996-2021
MKD	1994-2021
MNE	2005-2021
NLD	1969-2021
NOR	1969-2021
POL	1995-2021
PRT	1969-2021
ROU	1995-2021
SRB	2005-2021
SVK	1996-2021
SVN	1994-2021
SWE	1969-2021

Table A2: Sensitivity tests

	(1)	(2)	(3)	(4)	(5)	(6)
Daily mean temperature (°C)	Baseline	C-Y-S FE	R-Y-M FE	Unweighted	Excl. precipitation and humidity	SE clustering: C + YM
9 months from exposure						
≤-5°C	0.0001 (0.0003)	-0.0004 (0.0003)	0.0004 (0.0003)	0.0011 (0.0007)	0.0001 (0.0002)	0.0001 (0.0003)
-5-0°C	0.0002 (0.0002)	-0.0001 (0.0002)	0.0000 (0.0002)	-0.0006 (0.0005)	0.0005* (0.0002)	0.0002 (0.0003)
0-5°C	0.0002 (0.0002)	0.0002 (0.0002)	0.0005** (0.0002)	0.0003 (0.0002)	0.0003 (0.0002)	0.0002 (0.0002)
5-10°C	ref. cat.	ref. cat.	ref. cat.	ref. cat.	ref. cat.	ref. cat.
10-15°C	-0.0006** (0.0002)	-0.0008* (0.0003)	-0.0005* (0.0002)	0.0004 (0.0005)	-0.0005* (0.0002)	-0.0006* (0.0002)
15-20°C	-0.0016** (0.0003)	-0.0018** (0.0003)	-0.0015** (0.0004)	-0.0013** (0.0003)	-0.0014** (0.0002)	-0.0016** (0.0003)
20-25°C	-0.0026** (0.0004)	-0.0031** (0.0006)	-0.0023** (0.0004)	-0.0028** (0.0003)	-0.0022** (0.0002)	-0.0026** (0.0004)
>25°C	-0.0068** (0.0006)	-0.0073** (0.0008)	-0.0060** (0.0006)	-0.0059** (0.0006)	-0.0058** (0.0005)	-0.0068** (0.0007)
10 months from exposure						
≤-5°C	-0.0003 (0.0003)	-0.0006 (0.0003)	-0.0002 (0.0003)	0.0009 (0.0009)	-0.0003 (0.0002)	-0.0003 (0.0003)
-5-0°C	-0.0002 (0.0001)	-0.0006* (0.0002)	-0.0005 (0.0003)	0.0003 (0.0005)	-0.0001 (0.0002)	-0.0002 (0.0002)
0-5°C	0.0003 (0.0002)	0.0000 (0.0002)	0.0001 (0.0002)	0.0008 (0.0005)	0.0002 (0.0002)	0.0003 (0.0002)
5-10°C	ref. cat.	ref. cat.	ref. cat.	ref. cat.	ref. cat.	ref. cat.
10-15°C	-0.0002 (0.0002)	-0.0006 (0.0003)	-0.0003 (0.0002)	0.0004 (0.0004)	-0.0003 (0.0002)	-0.0002 (0.0002)
15-20°C	-0.0008** (0.0002)	-0.0011** (0.0002)	-0.0008** (0.0003)	-0.0002 (0.0003)	-0.0008** (0.0002)	-0.0008** (0.0002)
20-25°C	-0.0011** (0.0004)	-0.0013* (0.0005)	-0.0009* (0.0004)	-0.0009 (0.0008)	-0.0011** (0.0002)	-0.0011** (0.0004)
>25°C	-0.0045** (0.0005)	-0.0054** (0.0009)	-0.0034** (0.0005)	-0.0035** (0.0008)	-0.0040** (0.0005)	-0.0045** (0.0006)
Fixed effects	C-Y, C-M, Y-M	C-Y-S, C-M, Y-M	C-Y, C-M, R-Y-M	C-Y, C-M, Y-M	C-Y, C-M, Y-M	C-Y, C-M, Y-M
Time trend	C-M-specific quadratic	C-M-specific quadratic	C-M-specific quadratic	C-M-specific quadratic	C-M-specific quadratic	C-M-specific quadratic
Precipitation and humidity	Yes	Yes	Yes	Yes	No	Yes
SE clustering	C	C	C	C	C	C + Y-M
Weighted	Yes	Yes	Yes	No	Yes	Yes

Notes: Dependent variable: log birth rate. C-country, R-region, Y-year, S-season, M-month. Regions: (i) Southern Europe = Portugal, Spain, Italy, Greece, Croatia, Montenegro, North Macedonia, Serbia, Slovenia; (ii) Eastern Europe = Bulgaria, Czech Republic, Hungary, Slovakia, Romania, Poland; (iii) Northern Europe = Sweden, Norway, Finland, Denmark, Estonia, Lithuania, Latvia, Ireland, United Kingdom; (iv) Western Europe = Germany, France, Netherlands, Belgium, Luxembourg, Liechtenstein, Switzerland, Austria. N=15,624. * p<0.05, ** p<0.01

Table A3: Estimation using 2°C temperature categories above 20°C

Daily mean temperature (°C)	(1) 9 months from exposure	(2) 10 months from exposure
≤-5°C	0.0001 (0.0002)	-0.0003 (0.0003)
-5-0°C	0.0002 (0.0002)	-0.0002 (0.0001)
0-5°C	0.0003 (0.0002)	0.0003 (0.0002)
5-10°C	ref. cat.	ref. cat.
10-15°C	-0.0005** (0.0002)	-0.0002 (0.0002)
15-20°C	-0.0016** (0.0003)	-0.0008** (0.0002)
20-22°C	-0.0030** (0.0006)	-0.0012* (0.0006)
22-24°C	-0.0015 (0.0009)	-0.0004 (0.0012)
24-26°C	-0.0058** (0.0015)	-0.0038* (0.0016)
26-28°C	-0.0063** (0.0021)	-0.0035 (0.0019)
>28°C	-0.0070** (0.0019)	-0.0056** (0.0018)

Notes: Dependent variable: log birth rate. The model includes lags 0-25 but only lags 9 and 10 are shown (see Eq. 1). The model has country-by-year, country-by-month, and year-by-month fixed effects and country-by-month-specific quadratic time trends. Precipitation and relative humidity are controlled for. The regressions are weighted by the countries' female population at the beginning of the year. Standard errors are clustered by country. N=15,624. * p<0.05, ** p<0.01

Table A4: The effect of heatwave days (alternative definitions)

Daily mean temperature (°C)	(1)	(2)
9 months from exposure		
≤-5°C	0.0001 (0.0002)	0.0001 (0.0002)
-5-0°C	0.0002 (0.0002)	0.0002 (0.0002)
0-5°C	0.0002 (0.0002)	0.0002 (0.0002)
5-10°C	ref. cat.	ref. cat.
10-15°C	-0.0006** (0.0002)	-0.0006** (0.0002)
15-20°C	-0.0016** (0.0003)	-0.0016** (0.0003)
20-25°C	-0.0027** (0.0004)	-0.0026** (0.0004)
>25°C: non-heatwave day	-0.0044 (0.0026)	-0.0063** (0.0017)
>25°C: heatwave day	-0.0073** (0.0006)	-0.0073** (0.0006)
10 months from exposure		
≤-5°C	-0.0003 (0.0002)	-0.0003 (0.0002)
-5-0°C	-0.0002 (0.0001)	-0.0002 (0.0001)
0-5°C	0.0003 (0.0002)	0.0003 (0.0002)
5-10°C	ref. cat.	ref. cat.
10-15°C	-0.0002 (0.0002)	-0.0002 (0.0002)
15-20°C	-0.0008** (0.0002)	-0.0008** (0.0002)
20-25°C	-0.0014** (0.0003)	-0.0013** (0.0003)
>25°C: non-heatwave day	0.0003 (0.0019)	-0.0030* (0.0013)
>25°C: heatwave day	-0.0054** (0.0005)	-0.0055** (0.0004)
Heatwave definition	A period of at least 2 consecutive hot days.	A period of at least 4 consecutive hot days.

Notes: Dependent variable: log birth rate. The model includes lags 0-25 but only lags 9 and 10 are shown (see Eq. 1). The model has country-by-year, country-by-month, and year-by-month fixed effects and country-by-month-specific quadratic time trends. Precipitation and relative humidity are controlled for. The regressions are weighted by the countries' female population at the beginning of the year. Standard errors are clustered by country. N=15,624. * p<0.05, ** p<0.01

Table A5: The effect of temperature on log birth rates by climate (alternative estimation)

Daily mean temperature (°C)	(1) Hot climate	(2) Cold climate
9 months from exposure		
≤-5°C	0.0003 (0.0017)	0.0003 (0.0003)
-5-0°C	-0.0008 (0.0007)	0.0002 (0.0006)
0-5°C	0.0010 (0.0005)	0.0008 (0.0004)
5-10°C	ref. cat.	ref. cat.
10-15°C	-0.0003 (0.0004)	0.0001 (0.0003)
15-20°C	-0.0016* (0.0006)	-0.0007* (0.0003)
20-25°C	-0.0020** (0.0006)	-0.0025** (0.0007)
>25°C	-0.0063** (0.0008)	-0.0121* (0.0054)
10 months from exposure		
≤-5°C	0.0007 (0.0021)	0.0002 (0.0005)
-5-0°C	-0.0014 (0.0009)	0.0003 (0.0004)
0-5°C	0.0008 (0.0005)	0.0005 (0.0004)
5-10°C	ref. cat.	ref. cat.
10-15°C	-0.0000 (0.0003)	0.0005 (0.0006)
15-20°C	-0.0009* (0.0004)	-0.0000 (0.0003)
20-25°C	-0.0005 (0.0006)	-0.0015 (0.0008)
>25°C	-0.0041** (0.0006)	-0.0147** (0.0033)

Notes: Warm climate countries as those with an average annual temperature above 10.5°C and cold climate countries as those with an average annual temperature below 8°C. Dependent variable: log birth rate. The model includes lags 0-25 but only lags 9 and 10 are shown (see Eq. 1). The model has country-by-year, country-by-month, and year-by-month fixed effects and country-by-month-specific quadratic time trends. Precipitation and relative humidity are controlled for. The regressions are weighted by the countries' female population at the beginning of the year. Standard errors are clustered by country. N=8,856. * p<0.05, ** p<0.01