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ABSTRACT

Temperature and Contraceptive Use in Low- and Middle-Income Countries

This study estimates the effect of climate change on contraceptive use in a global context. We link women's monthly contraceptive calendar data from the Demographic and Health Surveys in 44 low- and middle-income countries with high resolution daily temperature data, exploiting the random component of local temperature deviations to causally estimate this effect. We find that high temperatures impact contraceptive use, driven by changes in short-acting reversible contraception. However, these impacts are region-specific: while temperature shocks reduce contraceptive use in sub-Saharan Africa and Latin America, they increase in South and Southeast Asia. We find clear heterogeneities by education, age, parity, and urban/rural status. Our estimates imply that temperature-related climate change in sub-Saharan Africa – the most impacted region – will reduce contraceptive use by 2.4-4.3 percent by 2100. We conclude that the disproportionate worsening of climatic conditions in low- and middle-income countries will exacerbate already-existing global disparities in contraceptive access and use.

JEL Classification: I15, J13, Q54, O15

Keywords: contraception, climate change, temperature, fertility, demography

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Introduction

Climate change has been shown to significantly impact human reproductive health.[1–3] One of the most fundamental aspects of reproductive health is contraceptive use. Yet despite the central importance of both contraception and climate change to human wellbeing, surprisingly little research has examined how they intersect.[3,4] This gap is particularly noticeable since family planning has been shown to reduce vulnerability and enhance resilience to climate change, and given the large amount of resources spent on both family planning initiatives (over $4 billion annually in low- and middle-income countries),[5] and climate change finance (over $1 trillion annually worldwide).[6] In addition, contraceptive use is a key determinant of a host of demographic, health, and well-being outcomes, including being one of the most important proximate determinants of fertility[7], better infant and maternal health[8], longer intervals between births[9], and is a proxy for reproductive health service access generally[10].

While some studies have investigated the effect of climate change on contraceptive use,[11–15] the current evidence is country specific and employs vastly different analytical approaches, limiting the generalizability and comparability of the results. Previous studies have employed different operationalizations of varying climate indicators, such as rainfall,[11-14] crop loss[12] and annual temperature,[11] and have analyzed these indicators at different time scales and geographic resolution. Research evaluating the relationship between more acute environmental events and contraceptive use has primarily focused on the effect of natural disasters, finding overall reduced contraceptive prevalence following a climatic shock.[16] These studies rely on specific events over short time periods, and point primarily to disruptions in access.

As a result, these studies do not show consistent findings. Studies using chronic indicators of environmental stress or variability show that poor environmental quality is associated with lower contraceptive use in India[13] and Nepal,[15] whereas in Uganda[14], Tanzania[12] and Indonesia,[11] contraceptive use increases following periods of adverse environmental conditions. This empirical ambiguity may not only reflect differing contexts, data sources, definitions of shocks and methodological approaches, but also of complex and often contradictory theoretical impacts of climate change and contraceptive use.

This is particularly salient for the effect of climate change on planned fertility behavior, for which the evidence is very sparse. It is widely accepted that there is a causal link between temperature and fertility rates,[2,17–21] yet the mechanisms behind these changes are speculative at best. For example, when exposed to climate related stressors, couples or individuals might adjust their fertility intentions and family size ideals due to changes in the costs, benefits, and uncertainties of raising children – the direction of which is ambiguous.[22–24] Similarly, when faced with adverse climate effects, couples might adjust their sexual activity as a response, which in turn could change their contraceptive use, especially if relying on natural and short-acting family planning methods.[12,25,26]

Our study provides the first systematic and comparative assessment of the effect of temperature on contraceptive use in low- and middle-income countries (LMICs). We analyze this relationship across 44 LMICs by pooling data on 1.4 million women from all available contraceptive calendars in the Demographic and Health Surveys (DHS) conducted between 2000 and 2022. We link this data to high resolution, sub-national daily temperature data from the National Oceanic and Atmospheric Administration (NOAA). To harness exogenous variation in temperature, we only utilize the subnational region- and month-specific, seasonality-adjusted, random component of temperature, which allows our results to be interpreted causally. Rather than using temperature as a continuous variable in a linear model, we employ a non-parametric approach which operationalizes monthly temperature as the number of discrete days the maximum temperature falls into a series of 5°C temperature bins. This allows us to flexibly incorporate non-linearities in the effect of temperature on contraception. In addition, we also control for all possible observed and unobserved time invariant individual characteristics by using woman fixed effects.

We find that temperature has distinct impacts across global regions. Overall, sub-Saharan Africa experiences the most pronounced effects of temperature on contraceptive use, where one additional day of exposure to temperatures above 35°C is associated with a decrease in the probability of contraceptive use by 0.07 percent. In contrast, South and Southeast Asia see the opposite – a positive effect – while Latin America sees no effect. We observe the most pronounced effects are on short-acting reversible (SARC) methods, which is intuitive since these methods are among the easiest to adjust and the most susceptible to interruptions in access. We also find heterogeneous effects based on a woman's age, wealth, urbanicity, distance to health facilities, and her number of children.

Having a clear sense of how climate change impacts individuals' reproductive health, decision-making, and overall well-being can inform reproductive health policy responses to climate change. This is particularly relevant for low- and middle-income countries where adverse climate events are projected to be more frequent. In addition, climate change may exacerbate pre-existing inequalities in reproductive health, since it disproportionately affects poorer women who have fewer resources to adapt. To the best of our knowledge, this is the first study to estimate this relationship in a global, multi-country, systematic analysis, which makes use of high-resolution climate data over a 27-year period, a vast improvement over existing single-country studies using much smaller time windows.

Results

We focus on the effect of temperature on women's contraceptive use across three world regions: Latin America (LA) (142,217 women), South and Southeast Asia (SSEA) (704,705 women) and sub-Saharan Africa (SSA) (603,877 women). Baseline contraceptive use differs across regions: while in SSEA and LA contraceptive use was relatively high at 57 and 59 percent respectively, only 22 percent of women in SSA reported using any contraceptive method. In LA and SSA the most common contraceptive type was short-acting reversible (SARC) methods, in contrast with SSEA which had a higher proportion of women relying on permanent methods. Given the differences in climate across regions, the distribution of days across the temperature bins also differs, with LA reporting the lowest average number of days per month with temperatures above 35°C. Detailed descriptive statistics are available in Table S3.

Panel A of Figure 1 presents our main results. We report OLS estimates of contemporaneous exposure to temperature on the probability of using any method of contraception, compared to a day in our reference category (20-25°C). We find a negative relationship between temperature and any contraception use in LA and SSA, and a positive relationship in SSEA. Our results estimate that an additional 35°C day is associated with an 0.07 percent ($p<0.05$) reduction in the probability of contraceptive use in sub-Saharan Africa. According to the Intergovernmental Panel on Climate Change (IPCC), under a range of global warming scenarios, sub-Saharan Africa could see an additional 10 to 24 such days annually by 2050 compared to the baseline period of 1995–2014.[32] Inputting our estimated coefficient into these projections implies that contraceptive use could fall between 0.4 and 1.1 percent due to temperature-related climate change by 2050, and triple that amount by 2100.

Panel B of Figure 1 presents our results by contraceptive method type. We find that the estimated declines in contraceptive use in SSA are driven predominantly by SARC methods. An additional 25-30°C day decreases the probability of using a SARC by 0.06% ($p<0.05$), and by 0.08% ($p<0.01$) and 0.11% ($p<0.01$) for days between 30-35°C and above 35°C respectively. Interestingly, we observe the opposite in SSEA for natural family planning (NFP) and SARC methods. In SSEA, exposure to temperatures above 35°C are associated with an increased use of these types of methods, albeit the relationship is only marginally significant for SARC methods ($p=0.1$). We found no discernible pattern in the relationship between temperature and the use of long-acting reversible contraceptive (LARC) methods across the three world regions. Similarly, there was no significant association between temperature and the use of permanent methods in LA and SSEA. However, in sub-Saharan Africa, we estimate a marginally significant ($p = 0.1$) increase in the use of permanent methods when temperatures ranged from 30-35°C. However, only 1.33% of women used this method in the region.

In order to explore heterogeneity by various contextual factors, we estimated separate models for different population subgroups and present them in Figure 2. While these relationships between contraceptive use and temperature among different population subgroups is generally stable within world regions, there are some exceptions. Similar to previous findings in the climate-fertility literature,[18,21,33] our results suggest no apparent differences in the effect of temperature on contraceptive use by socioeconomic status in LA and SSEA. However, in SSA we find an inverse gradient, where women in the highest wealth quintile experience significant negative effects of high temperature on contraceptive use, potentially due their higher baseline proportion of use. Similarly, in SSA urban residents seem most vulnerable to temperature. However, in LA rural women have the most pronounced negative effect of temperature on contraceptive use. This result may indicate a widening of inequalities in health as heatwaves become more common.

Younger women (15–24 years old) appear more sensitive to high temperatures in SSA and SSEA. In sub-Saharan Africa, where temperature reduced contraceptive use, this group sees the largest negative effects. Similarly, in SSEA they experience the largest increase in the probability of using any contraceptive method at temperatures above 30°C ($p<0.05$), a world region where temperature increases contraceptive use. Differences by parity are less pronounced but follow similar patterns, where nulliparous women have a slightly higher susceptibility. Finally, women that report having a problem with the distance to the closest health facility experience negative effects of temperature on contraceptive use in LA and SSA. Figure S3 in the supplementary appendix presents our results on the effect of temperatures on the use of SARC methods. These results reinforce our findings on overall use, suggesting that the use of these methods is particularly sensitive to temperature conditions.

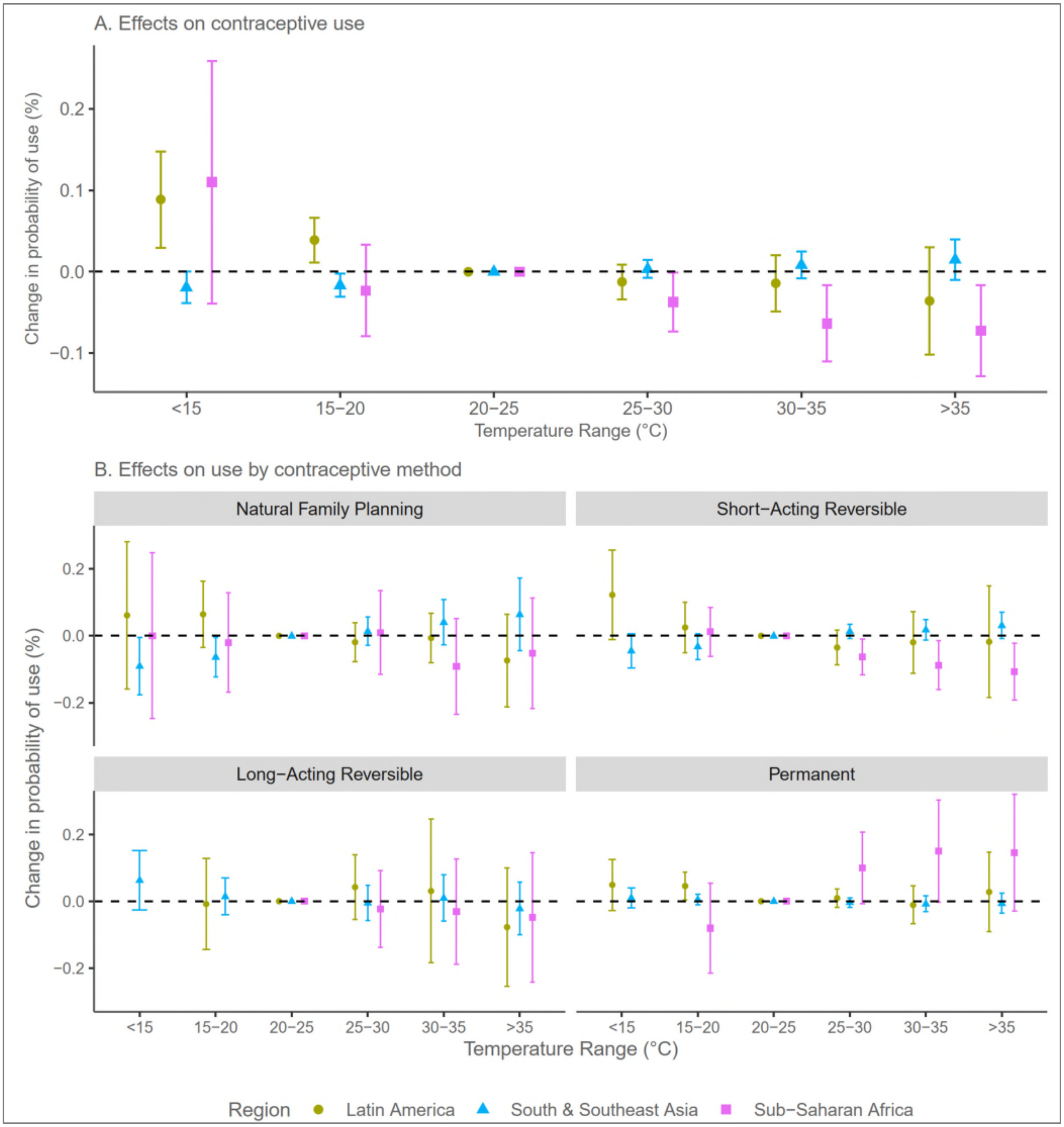

Figure 1. Effect of daily maximum temperature on contraceptive use, by world region. Plotted probability changes from separate fixed effects regression models estimated for each region. All models include subnational unit-month, subnational unit-time and individual fixed effects. Points represent the percentage change in the probability of contraceptive use; vertical lines indicate 95% confidence intervals. Standard errors are clustered at the subnational unit level. (A) Estimated effect of daily maximum temperature on use of any contraceptive method. (B) Estimated effect on contraceptive use by method type. For visual aid, estimated coefficients in the lower temperature bins are not plotted if CI were outside the bounds of the plot. Results for other traditional and modern contraceptive methods, and contraceptive non-use are available in Figure S2 of the supplementary appendix.

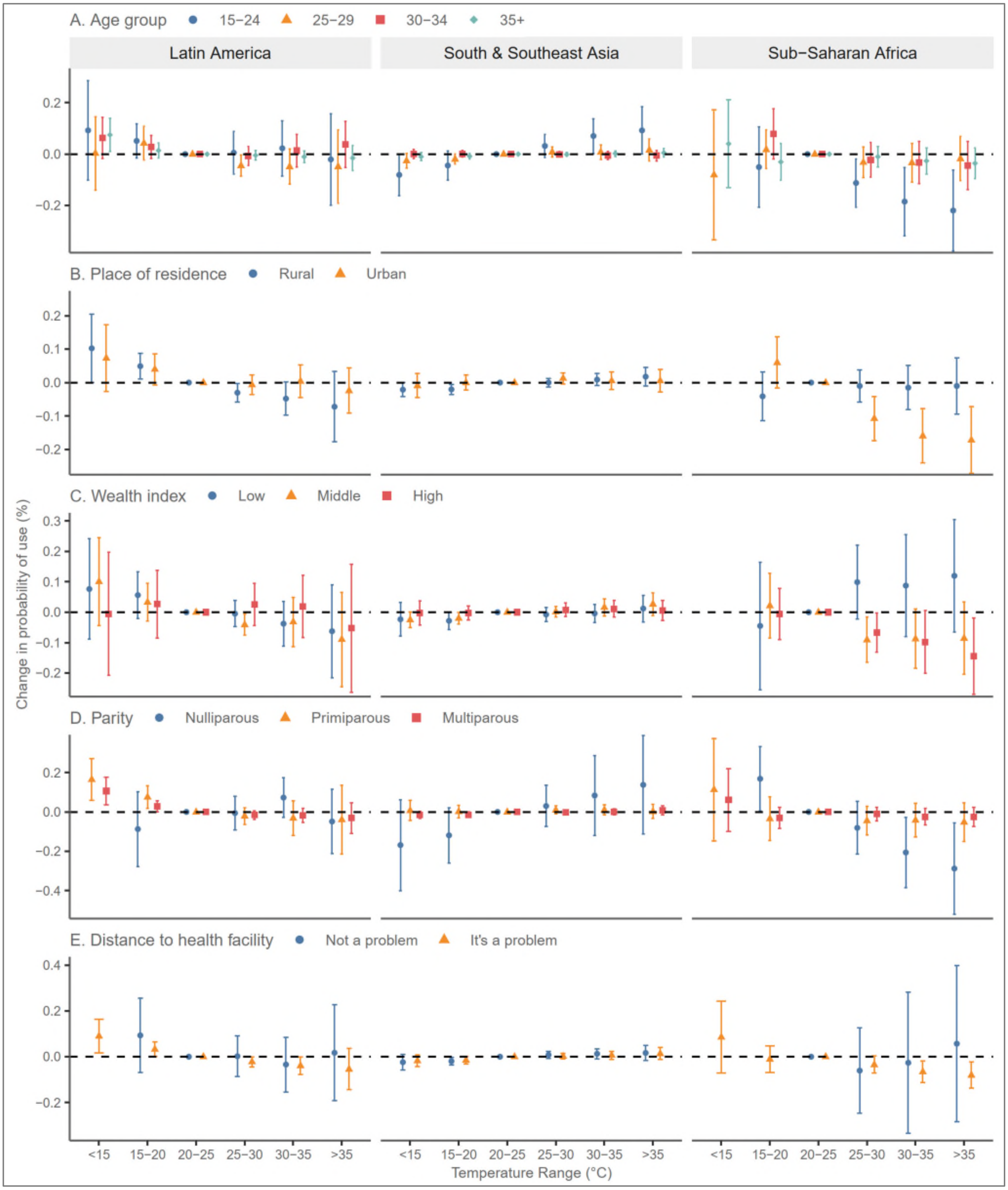

Figure 2. Heterogenous effect of daily maximum temperature on contraceptive use, by world region. Plotted probability changes from separate fixed effects regression models estimated for each region. All models include subnational unit-month, subnational unit-time and individual fixed effects. Points represent the percentage change in the probability of contraceptive use; vertical lines indicate 95% confidence intervals. Standard errors are clustered at the subnational unit level. Estimated effect by (A) age group, (B) urbanicity, (C) wealth index, (D) parity, and (E) whether or not distance to health facility represents a problem. For visual aid, estimated coefficients in the lower temperature bins are not plotted if CI were outside the bounds of the plot.

To test for robustness across different measures of high temperature, we use two alternative bin specifications using relative temperature measures rather than absolute as in our main specification. First, we construct bins based on the percentile distribution of temperature in each region-month.[21,34] Second, we test changes in the standard deviation of temperature in a region-month.[31,35] These analyses show that in sub-Saharan Africa, exposure to high temperatures is consistently associated with a reduced probability of contraceptive use across all three temperature measures. Following the epidemiological literature's definition of "extremely hot" days,[34] one additional day of maximum temperature above the 97.5th percentile reduces the probability of contraceptive use by 0.09% ($p<0.1$) in SSA. Using the standard deviation measure, we find negative and significant effects in SSA starting at a one standard deviation shock, consistent with our main results. Interestingly, the positive effect in SSEA is significantly stronger using the standard deviation indicator than in our main results using absolute temperature. Here an additional day with maximum temperatures above 2 standard deviations from the mean increases the probability of contraceptive use of any kind by 0.046 percent ($p<0.05$) (see Figure S4).

To account for dynamic effects of temperature, we estimated a distributed lag model with individual month effects up to 12 months prior to reported contraceptive use. We estimated separate models for the absolute (≥30°C) and both relative (>97.5th percentile and >2 standard deviations) temperature measures. Figure S5 presents our findings. For SSA, we find the strongest declines in contraceptive use between three to six months after exposure, after which there is a rebound. This creates a U-shaped pattern, suggesting that the adverse short- and medium-term impacts of heat on contraceptive use diminish over time.

We further test the sensitivity and robustness of our main estimates in several ways. First, we replicate the main analysis using two alternative sample definitions: one of married or cohabiting women only, and another excluding infecund or menopausal women. Overall, the results of these analyses are in line with our main findings (see Figure S6). Second, we evaluate the robustness of our estimates under alternative model specifications. Following previous literature,[18,19] Model 2 included country-specific quadratic time trends, and country-time and region-year fixed effects. Model 3 excludes the time-trends from Model 2, and Model 4 controls for age and educational attainment. Table S4 presents the results of our main model compared to the three alternative specifications, supporting the robustness of our estimates to different models. Lastly, we conducted a placebo test showing that exposure to future temperatures has no effect on contraceptive use (see Figure S7).[17,33]

Discussion

Using data on monthly contraceptive use from over 1.45 million women over 27 years and across 44 countries in Latin America, South and Southeast Asia and sub-Saharan Africa, this study found that high temperatures reduce contraceptive use in SSA, and have either no or slightly positive effects in LA and SSEA. Furthermore, our results suggest that temperature mainly affects the use of short-acting reversible contraceptives. There are several possible theoretical mechanisms by these results could be explained. As some studies show that extreme weather events prevent women from seeking reproductive health services [2,13,22], it may be that the effects on SARC use are mediated by temperature induced income shocks, access disruption, or reduced socioeconomic and bargaining power of women. Nonetheless, our results could also be caused by behavioral changes in sexual activity or fertility intentions. Our data do not allow us to test each of these hypotheses directly, therefore exploring the linkages between temperature, contraceptive behavior, fertility intentions, and access to health services are a fruitful area of future research.

Several caveats should be considered when interpreting our results. First, there may be recall bias inherent in the calendar data from the DHS. Second, DHS data record certain variables (such as fertility intentions) at the time of survey only, rather than over time like the contraceptive calendar data. Third, there is no way to identify climate-induced migration behavior, which would attenuate the effect of climate on contraceptive behavior if those most affected were more likely to move. To address this limitation, we only included observations from women who had lived in the same place for at least a year before the interview, and if they moved less than five years ago, we kept calendar entries that matched the length of their residence. In spite of these challenges, we provided suggestive evidence regarding heterogeneities by population subgroups, rather than complete mediation analyses with the variables only recorded at the time of survey. This analysis points to differential effects of temperature on contraceptive use of younger, urban, and nulliparous women. Similarly, wealth and distance to health facilities seem to play a role in this relationship.

Our study builds on existing research by expanding the understanding of the relationship between climate change, sexual and reproductive health, and fertility. With a focus on low- and middle-income regions, we provide the first systematic and comparative assessment of the effect of temperature on contraceptive use. Our analysis reveals significant differences in how temperature affects contraceptive use across various regions and populations. Importantly, our findings suggest that climate change may exacerbate existing disparities in access to sexual and reproductive healthcare globally, highlighting the importance of incorporating contraception into climate-resilient reproductive health services.

Methods and Materials

Contraceptive Use Data.

Demographic and Health Survey (DHS) data provides nationally representative cross-sectional data across low- and middle-income countries. For this study, we use the DHS Contraceptive Calendar data, which collects a monthly retrospective history of women's reproduction and contraceptive use for 5 years prior to the interview.[27] Our outcome variables consist of two woman-year-month contraceptive use indicators. First, a binary indicator of whether the woman is using any contraceptive method in a given month, and second, a vector variable pertaining to the type of method, namely: natural family planning, short acting reversible methods, long acting reversible methods, permanent methods, and other traditional and modern methods (see Table S1 of the supplementary appendix for specific DHS Contraceptive Calendar codes).

Our sample consists of 89 surveys conducted between 2000 and 2022 where the place of residence of the interviewee is georeferenced with latitude and longitude coordinates. Our period of analysis covers contraceptive histories of women in 29 African, 9 Asian and 6 Latin American countries between January 1995 and July 2022 (see Table S2). Our main analysis restricts the full sample to women of reproductive age, 15-49 years old, who initiated their sexual life and lived in the place of residence at least one full year prior the interview. For those women living less than 5 years in said residence, we keep calendar entries only corresponding to their length of residence. In addition to the contraceptive variables, we extract information on women's date of birth, urban-rural classification, and socioeconomic characteristics.

Temperature Data.

We used daily temperature data from the National Oceanic and Atmospheric Administration,[28] containing global daily temperature on a 0.5 x 0.5 grid since 1976. We operationalized these daily temperatures into monthly temperature "bins" representing the number of days when daily maximum temperature falls within a given temperature range in a given month. Specifically, we construct four 5°C bins from 15°C to 35°C, along with two additional bins grouping the days with temperatures falling below 15°C and above 35°C. This approach has the advantage of being easily interpretable, as well as being a non-parametric approach which allows for perfect flexibility in estimating the non-linear effects of temperature on contraceptive use.[17,18,29–33] We present the daily temperature distribution graphically in Figure S1 of the supplementary appendix.

Using the coordinate indicators of the DHS, we generate a longitudinal sample of 1.45 million women living in 79,716 geo-spatial clusters within 668 subnational (first administrative unit) regions. The unit of analysis in our sample is a woman in a specific year and month, giving us a panel with 81,184,059 woman-year-month observations.

Analytical Strategy.

Since the spatial variation in temperature is largely fixed and not randomly assigned, naïve cross-sectional comparisons alone are unable to isolate the causal effects of temperature exposure from other influences such as seasonality or geography. To address this challenge, we follow current best practice by exploiting temperature deviations within narrowly specified geo-temporal units which allows us to capture time-invariant geographic differences, seasonal patterns, and locality-specific time trends in contraceptive use.[17,19,29,30] This limits the effect of temperature on contraceptive use to the random year-to-year variation within each subnational region, allowing us to interpret our results causally. Specifically, we estimate fixed effects regression models of the following form:

$$C_{it} = \sum_{j}^{J} \beta_j \, TEMP_{i,t}^{j} + \alpha_{rm} + \delta_{rt} + \lambda_i + e_r$$

where our outcomes of interest C_{it} is a contraceptive use indicator for a woman *i* at year-month t. $TEMP_{i,t}$ is a vector of j count variables corresponding to the number of days in each of the *j* temperature bins at the woman's cluster of residence at time t. The 20-25°C bin is excluded as a reference category. Critical to our analytical strategy, we include subnational region-month fixed effects α_{rm}; subnational region-time fixed effects δ_{rt}; and individual fixed effects λ_i. Finally, we cluster standard errors at the region level, to account for serial correlation.

Our coefficients of interest, β_j, represent the estimated effects of one additional day when the maximum temperature falls into a given range *j* on the probability of contraceptive use, relative to a day with a maximum temperature between 20-25°C. Intuitively, β_j compares the probability of contraceptive use on a particularly hot or cold month in a given subnational region with relative to normal temperatures in the same calendar month in the same region in other years. This accounts for unobserved differences in seasonal patterns of our outcomes of interest, without which we could not attribute differences in contraceptive use to random variations in temperature alone. We account for time- and space-specific changes in each region, including such variables as economic conditions, policy decisions, funding of health services, etc. among others, through δ_{rt}. Finally, individual fixed effects λ_i controls for time-invariant unobserved women's characteristics like religious affiliation, education, upbringing, genetics, or ethnicity.

Contributors

KDSC and JW contributed to study conceptualization and methods. KDSC contributed to data collection and verification, and performed the formal analysis. KDSC did the data visualization, including constructing the tables and figures. KDSC and JW wrote, reviewed and approved the manuscript. All authors had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Declaration of Interest

We declare no competing interests.

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Supplementary Appendix

Assessing the Impact of Temperature on Contraceptive Use in Low- and Middle-Income Countries.

Katherine del Salto-Calderon[*] Joshua Wilde[†]

September 29, 2025

Suplementary Tables

Demographic and Health Survey's Data

Table S1: **Recoding Contraceptive Methods into Method Type Categories.**

Method	**DHS Codes**
Contraceptive non-use	0
Natural Family Planning	
Abstinence	A
Basal body temperature (Philippines)	E, U, G
Lactational amenorrhea	L
Rhythm	8
Standard days method	D, H, K, O, Q, R, S, a, M
Withdrawal	9
Short Acting Reversible	
Condom	5
Contraceptive patch	H, K
Diaphragm	4
Female condom	C
Foam and Jelly	F
Injectables	3, I
Monthly (Chinese) Pill	D
Pill	1
Long Acting Reversible	
IUD	2
Implants/Norplant	N
Permanent	
Female sterilization	6
Male sterilization	7
Other	
Other traditional methods	W
Emergency contraception	E, O
Other modern methods	M, X

Note: ICF. 2000-2022. Demographic and Health Surveys (various) [Datasets]. Funded by USAID. Rockville, Maryland.

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Table S2: **Number of DHS Surveys and Women per Country.**

	Surveys	Women (N)
Latin America		
Bolivia	2008	12,212
Colombia	2010	35,917
Guatemala	2015	18,360
Guyana	2009	2,784
Honduras	2011	16,236
Peru	2000, 2007, 2009	56,708
South & Southeast Asia		
Bangladesh	2011, 2014, 2017	45,848
Cambodia	2010, 2014, 2021	38,581
East Timor	2009, 2016	13,815
India	2020	499,922
Indonesia	2003	26,918
Myanmar	2016	8,442
Nepal	2006, 2011, 2016, 2022	35,429
Pakistan	2017	14,574
Philippines	2003, 2022	21,176
Sub-Saharan Africa		
Angola	2015	10,769
Benin	2012, 2017	20,690
Burkina Faso	2010	13,852
Burundi	2010, 2016	15,772
Comoros	2012	1,541
Ethiopia	2005, 2011, 2016	33,215
Gabon	2019	5,193
Gambia	2019	4,973
Ghana	2008, 2014	10,832
Guinea	2018	7,208
Kenya	2008, 2014, 2022	28,054
Lesotho	2009, 2014	9,213
Liberia	2013, 2019	11,969
Madagascar	2008, 2021	28,991
Malawi	2004, 2010, 2015	43,664
Mali	2012, 2018	17,958
Mauritania	2020	8,395
Mozambique	2011	11,935
Namibia	2006, 2013	12,938
Niger	2012	9,514
Nigeria	2008, 2013, 2018	89,327
Rwanda	2010, 2015, 2019	26,485
Senegal	2010, 2012, 2014, 2015, 2016, 2017, 2018, 2019	59,498
Sierra Leone	2008, 2013, 2019	27,440
South Africa	2016	6,440
Tanzania	2010, 2015	16,558
Uganda	2006, 2011, 2016	24,740
Zambia	2007, 2013, 2018	26,063
Zimbabwe	2005, 2010, 2015	20,650

Note: ICF. 2000-2022. Demographic and Health Surveys (various) [Datasets]. Funded by USAID. Rockville, Maryland.

Descriptive Statistics

Table S3: **Summary Statistics.**

	Latin America		South & Southeast Asia		Sub-Saharan Africa	
	Contraceptive use (woman-time), n (%)					
Non-use	3,323,669.00	(41.15%)	17,725,704.00	(42.78%)	24,692,417.00	(77.97%)
Any method	4,753,779.00	(58.85%)	23,712,630.00	(57.22%)	6,975,860.00	(22.03%)
Method type						
Natural Family Planning	1,002,723.00	(12.41%)	3,811,443.00	(9.20%)	783,373.00	(2.47%)
Short-Acting Reversible	1,949,926.00	(24.14%)	6,762,575.00	(16.32%)	4,616,833.00	(14.58%)
Long-Acting Reversible	468,647.00	(5.80%)	1,151,345.00	(2.78%)	1,025,517.00	(3.24%)
Permanent	1,237,622.00	(15.32%)	11,886,509.00	(28.68%)	420,378.00	(1.33%)
Other modern methods	39,264.00	(0.49%)	70,662.00	(0.17%)	21,595.00	(0.07%)
Other traditional methods	55,597.00	(0.69%)	30,096.00	(0.07%)	108,164.00	(0.34%)
	Temperature Bins (Days), mean (SD)					
Absolute temperature						
15°C or lower	1.44	(4.70)	0.75	(3.92)	0.22	(1.45)
15°C to 20°C	4.73	(8.21)	1.22	(3.83)	1.14	(3.04)
20°C to 25°C	7.43	(9.00)	3.11	(6.10)	4.89	(6.85)
25°C to 30°C	9.42	(9.63)	7.90	(8.37)	9.96	(8.78)
30°C to 35°C	6.81	(9.80)	12.18	(10.28)	9.34	(9.43)
35°C or above	0.59	(2.43)	5.27	(9.19)	4.88	(8.97)
Percentiles						
2.5 percentile	0.96	(1.72)	0.95	(2.76)	0.83	(1.66)
2.5 to 5	0.82	(1.27)	0.87	(1.98)	0.81	(1.38)
5 to 10	1.58	(1.95)	1.61	(2.97)	1.58	(2.10)
10 to 90	24.08	(5.28)	23.76	(7.62)	24.22	(5.37)
90 to 95	1.48	(2.20)	1.55	(2.83)	1.53	(2.46)
95 to 97.5	0.75	(1.54)	0.82	(1.90)	0.75	(1.58)
97.5 percentile	0.76	(2.14)	0.89	(2.69)	0.69	(1.90)
Standard Deviation						
< -2	1.32	(1.84)	1.34	(2.32)	1.25	(1.73)
-2 to -1.5	1.10	(1.34)	1.48	(2.15)	1.26	(1.49)
-1.5 to -1	2.11	(1.96)	2.46	(2.71)	2.15	(1.96)
-1 to 1	22.05	(4.86)	20.24	(5.55)	21.95	(4.18)
1 to 1.5	2.57	(2.78)	3.34	(3.30)	2.83	(2.65)
1.5 to 2	0.85	(1.69)	1.23	(2.04)	0.78	(1.38)
>2	0.43	(1.97)	0.35	(1.18)	0.21	(0.73)
	Individual Characteristics					
	Never used	**Ever used**	**Never used**	**Ever used**	**Never used**	**Ever used**
Age	32.97 (9.85)	30.29 (8.61)	32.54 (9.03)	32.57 (7.8)	29.74 (9.34)	28.81 (8.03)
Marital status						
Married	14.58%	85.42%	27.08%	72.92%	58.81%	41.19%
Not married	33.25%	66.75%	62.81%	37.19%	60.45%	39.55%
Place of residence						
Rural	23.97%	76.03%	29.79%	70.21%	62.53%	37.47%
Urban	16.76%	83.24%	29.12%	70.88%	52.07%	47.93%
Wealth index						
Low	24.90%	75.10%	33.72%	66.28%	72.28%	27.72%
Lower-middle	19.55%	80.45%	29.84%	70.16%	64.95%	35.05%
Middle	17.73%	82.27%	28.69%	71.31%	59.15%	40.85%
Upper-middle	16.94%	83.06%	28.27%	71.73%	52.23%	47.77%

Table S3: **Summary Statistics.** *(continued)*

High	16.49%	83.51%	26.67%	73.33%	45.50%	54.50%
Missing values	4,307	14,194			2,610	2,713
Parity						
Nulliparous	30.73%	69.27%	75.35%	24.65%	72.01%	27.99%
Primiparous	23.67%	76.33%	39.65%	60.35%	59.59%	40.41%
Multiparous	16.19%	83.81%	22.44%	77.56%	56.78%	43.22%
Missing values					1	0
Distance to health facility						
No Problem	29.45%	70.55%	25.90%	74.10%	52.26%	47.74%
Problem	20.49%	79.51%	31.49%	68.51%	59.18%	40.82%
Missing values	5,378	30,620	7,332	23,239	26,466	16,501

Note:

Total sample covers the period between January 1995 and July 2022 and includes 1,450,799 women and 81,184,059 observations.

[1] Reference category

[2] Sociodemographic characteristics defined at the time of interview, except for Age and Parity. Presented percentage of women in each category by contraceptive use, where Ever Used, means a woman used contraception at least one month in our period of analysis.

[a] Source: ICF. 2000-2022. Demographic and Health Surveys (various) [Datasets]. Funded by USAID. Rockville, Maryland.

Model Results

Table S4: **Linear probability models predicting the effect of maximum temperature on overall contraceptive use**

	Latin America				South & Southeast Asia				Sub-Saharan Africa			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Temperature Range												
15°C or lower	0.00052**	0.00031**	0.00031**	0.00052**	-0.00011+	-0.00015*	-0.00015*	-0.0001+	0.00024	0.00024*	0.00024*	0.00024
	(0.0002)	(0.0001)	(0.0001)	(0.0002)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0001)	(0.0001)	(0.0002)
15°C to 20°C	0.00023**	0.00016**	0.00016**	0.00023**	-0.00009*	-0.00016*	-0.00016*	-0.00009*	-0.00005	-0.00005	-0.00005	-0.00005
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0000)	(0.0001)	(0.0001)	(0.0000)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
25°C to 30°C	-0.00007	-0.00004	-0.00004	-0.00007	0.00002	0.00002	0.00002	0.00002	-0.00008*	-0.00004	-0.00004	-0.00008*
	(0.0001)	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
30°C to 35°C	-0.00008	-0.00003	-0.00003	-0.00008	0.00005	0.00003	0.00003	0.00005	-0.00014**	-0.00009*	-0.00009*	-0.00014**
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0001)
35°C or above	-0.00021	-0.00019	-0.00019	-0.00019	0.00009	0.00009	0.00009	0.00008	-0.00016*	-0.00009*	-0.00009*	-0.00016*
	(0.0002)	(0.0001)	(0.0001)	(0.0002)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0000)	(0.0000)	(0.0001)
Age												
25 to 29				0.05***				0.122***				0.027***
				(0.01)				(0.01)				(0.00)
30 to 34				0.041***				0.176***				0.032***
				(0.01)				(0.01)				(0.00)
35 to 49				0.006				0.173***				0.029***
				(0.01)				(0.01)				(0.00)
Education												
No Education				-0.028				1.883				0.039
				(0.04)				(1.88)				(0.03)
Higher Education				-0.646**				29.111*				-0.597
				(0.23)				(11.88)				(0.44)
N	8077448	8077448	8077448	8077448	41438334	41438334	41438334	41438118	31668277	31668277	31668277	31667070
R2	0.690	0.689	0.689	0.690	0.800	0.800	0.800	0.802	0.686	0.686	0.686	0.687
R2 Adj.	0.684	0.684	0.684	0.684	0.796	0.796	0.796	0.798	0.680	0.680	0.680	0.680
ID	X	X	X	X	X	X	X	X	X	X	X	X
Province^month	X	X	X	X	X	X	X	X	X	X	X	X
Province^year^month	X			X	X			X	X			X
Province^year		X	X			X	X			X	X	
Country^year^month		X	X			X	X			X	X	
Quadratic country specific		X				X				X		

Note: Estimated effects of temperature on contraceptive use. Temperature bins are based on absolute temperature; the reference bin is the 20 to 25 Degrees Celcius. Robust standard errors, clustered at the subnational unit level, are shown in parentheses. Model 1 is our main model, and it includes subnational unit-month, subnational unit-year-month and individual fixed effects. Models 2 and 3, follow previous literature with alternative fixed effects especifications. Model 2 additionally includes a country specific quadratic time trend. Model 4 adds to our main model covariates accounting for categorical age and educational attainment groups. Reference category for age is women between 15 and 24 years old, and for Education is primary or secondary education. *** p<0.001, ** p<0.01, * p<0.05, + p<0.1

Supplementary Figures

Descriptive Statistics

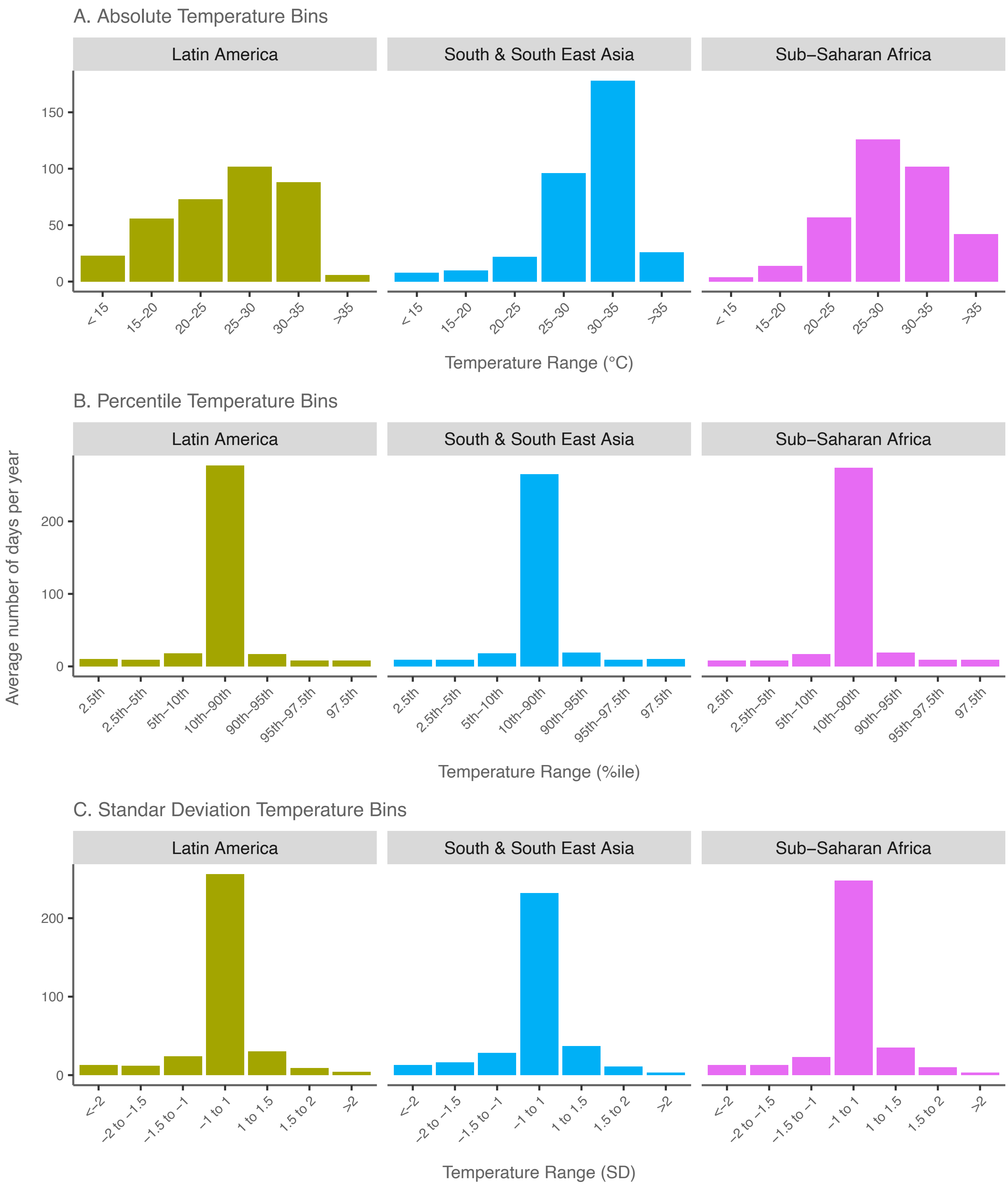

Figure S1: **Distribution of Daily Maximum Temperature.** Mean number of days per year between January 1995 and July 2022 with recorded daily maximum temperatures falling within the following temperature ranges: (A) Absolute temerature ranges in Celsius; relative temperature bins measured as (B) Percentiles of monthly historical average, and (C) Deviations from the region-month historical average. *Source:* NOAA weather data.

Model Results

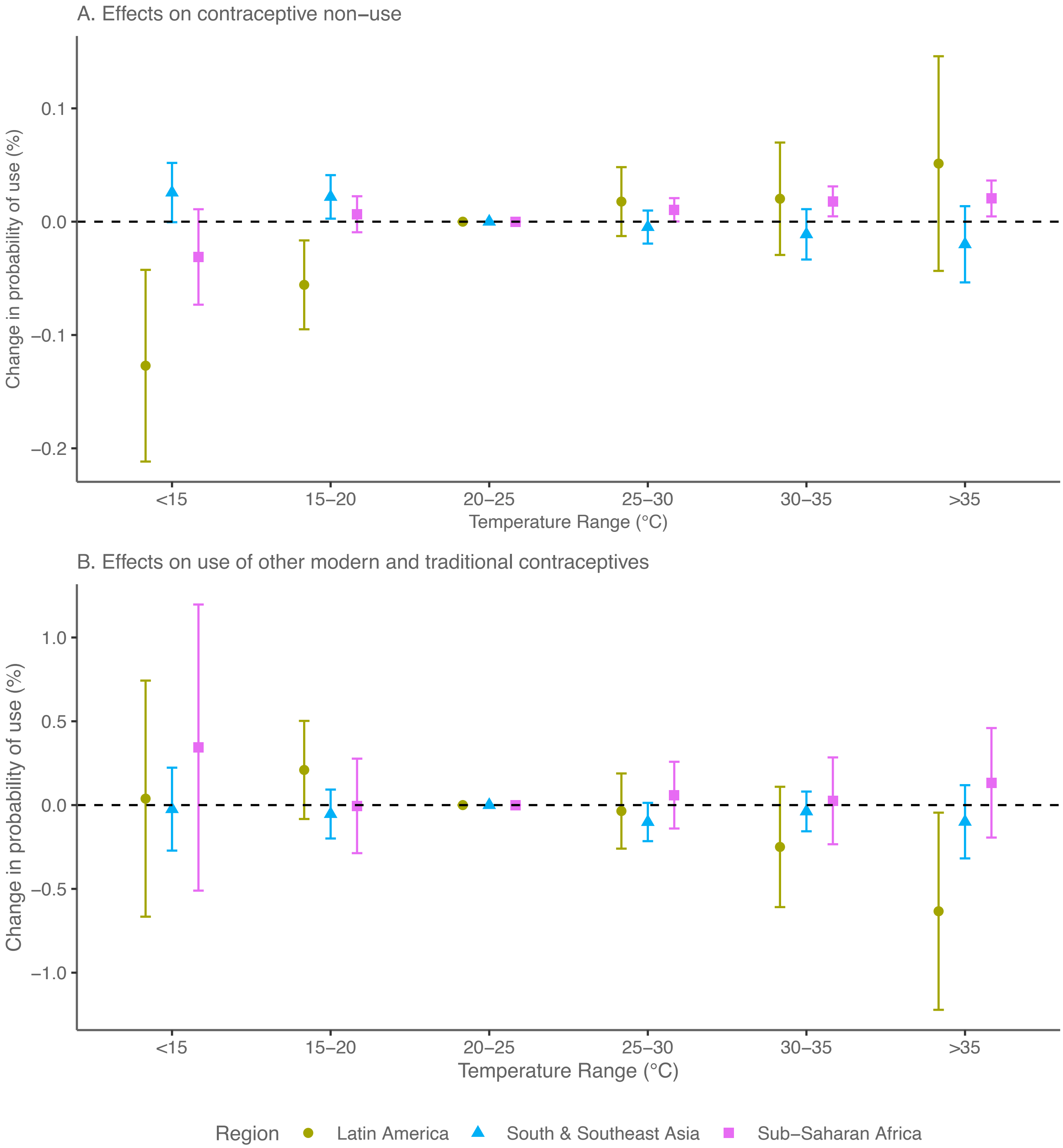

Figure S2: **Effect of daily maximum temperature on contraceptive non-use and use of other modern and traditional methods, by world region.** Plotted probability changes from separate fixed effects regression models estimated for each region. All models include subnational unit-month, subnational unit-time and individual fixed effects. Points represent the percentage change in the probability of contraceptive use; vertical lines indicate 95% confidence intervals. Standard errors are clustered at the subnational unit level. (A) Estimated effect of daily maximum temperature on contraceptive non-use. (B) Estimated effect on use of other modern and traditional contraceptive methods.

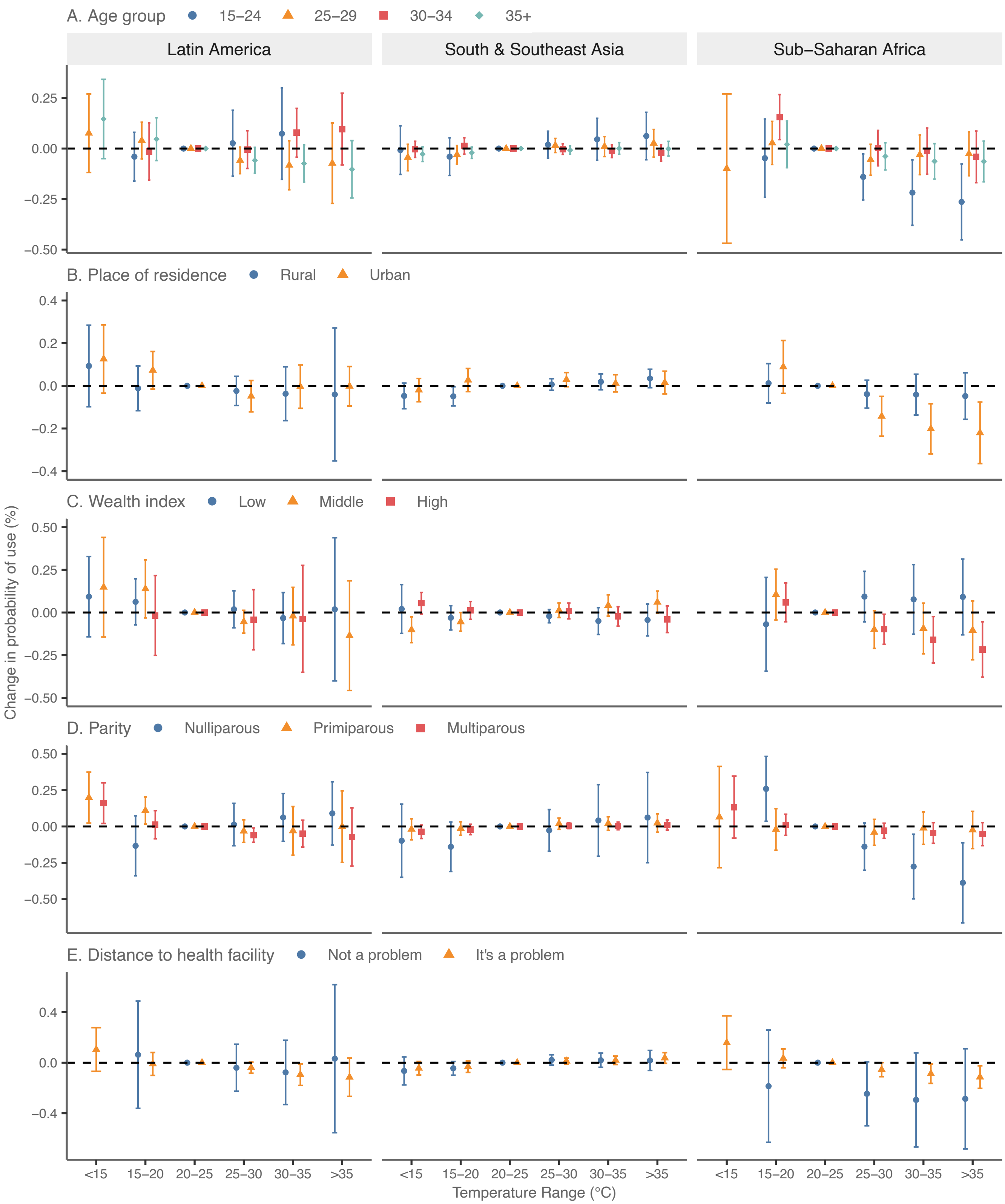

Figure S3: **Heterogenous effect of daily maximum temperature on use of short-acting reversible methods, by world region.** Plotted probability changes from separate fixed effects regression models estimated for each region. All models include subnational unit-month, subnational unit-time and individual fixed effects. Points represent the percentage change in the probability of contraceptive use; vertical lines indicate 95% confidence intervals. Standard errors are clustered at the subnational unit level. Estimated effect by (A) age group, (B) urbanicity, (C) wealth index, (D) parity, and (E) whether or not distance to health facility represents a problem. For visual aid, estimated coefficients in the lower temperature bins are not plotted if CI were outside the bounds of the plot.

Robustness and Sensitivity Analyses

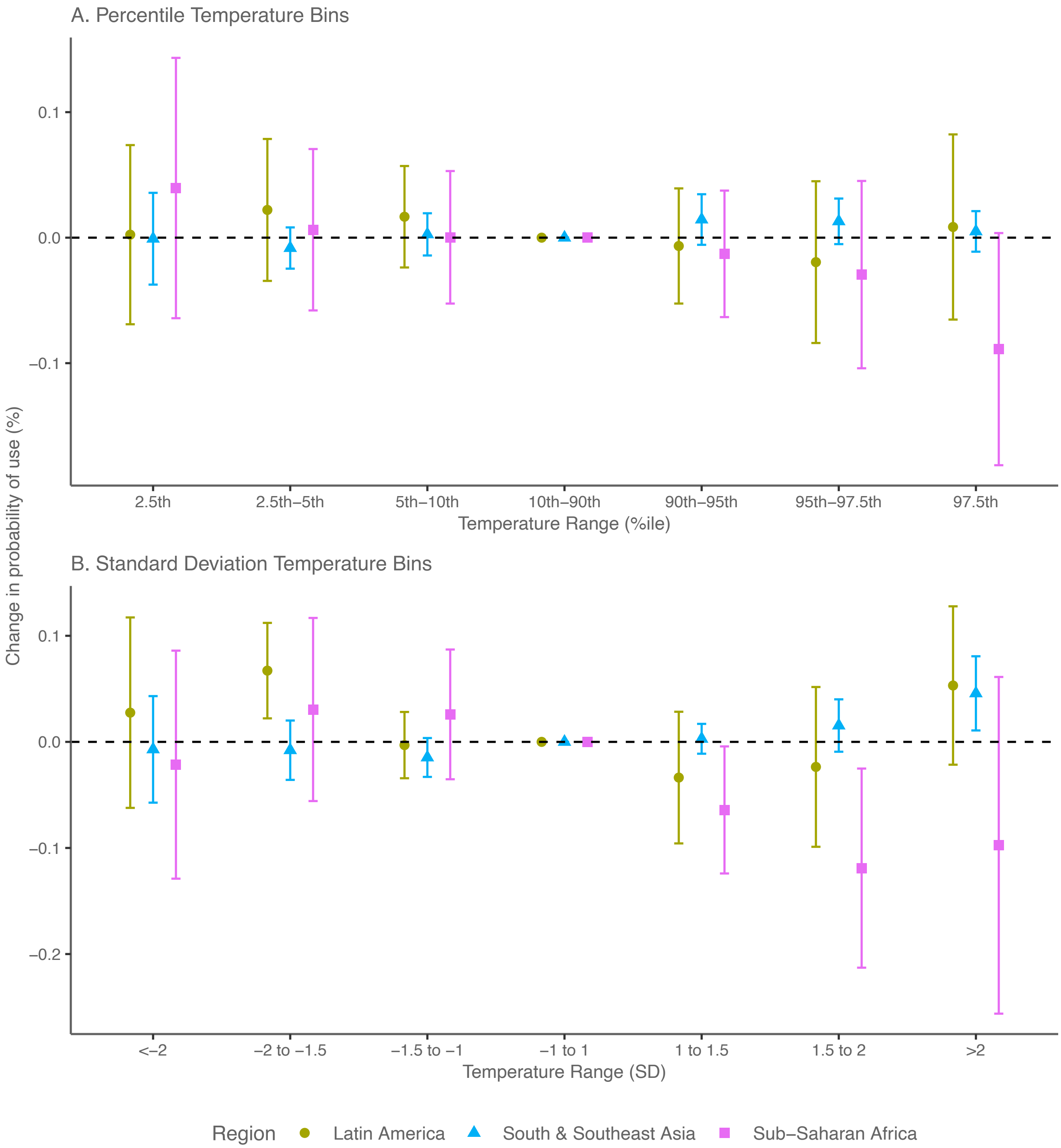

Figure S4: **Effect of relative daily maximum temperature on contraceptive use, by world region** Plotted probability changes from separate fixed effects regression models for each world region. All models include subnational unit-month, subnational unit-year-month and individual fixed effects. Points are rescaled to show the percentage change in the probability of contraceptive use; lines show the 95% CI; standard errors are clustered at the subnational unit level. (A) Binning method based on percentiles of monthly historical average.(B) Binning method in terms of deviations from the region-month historical average.

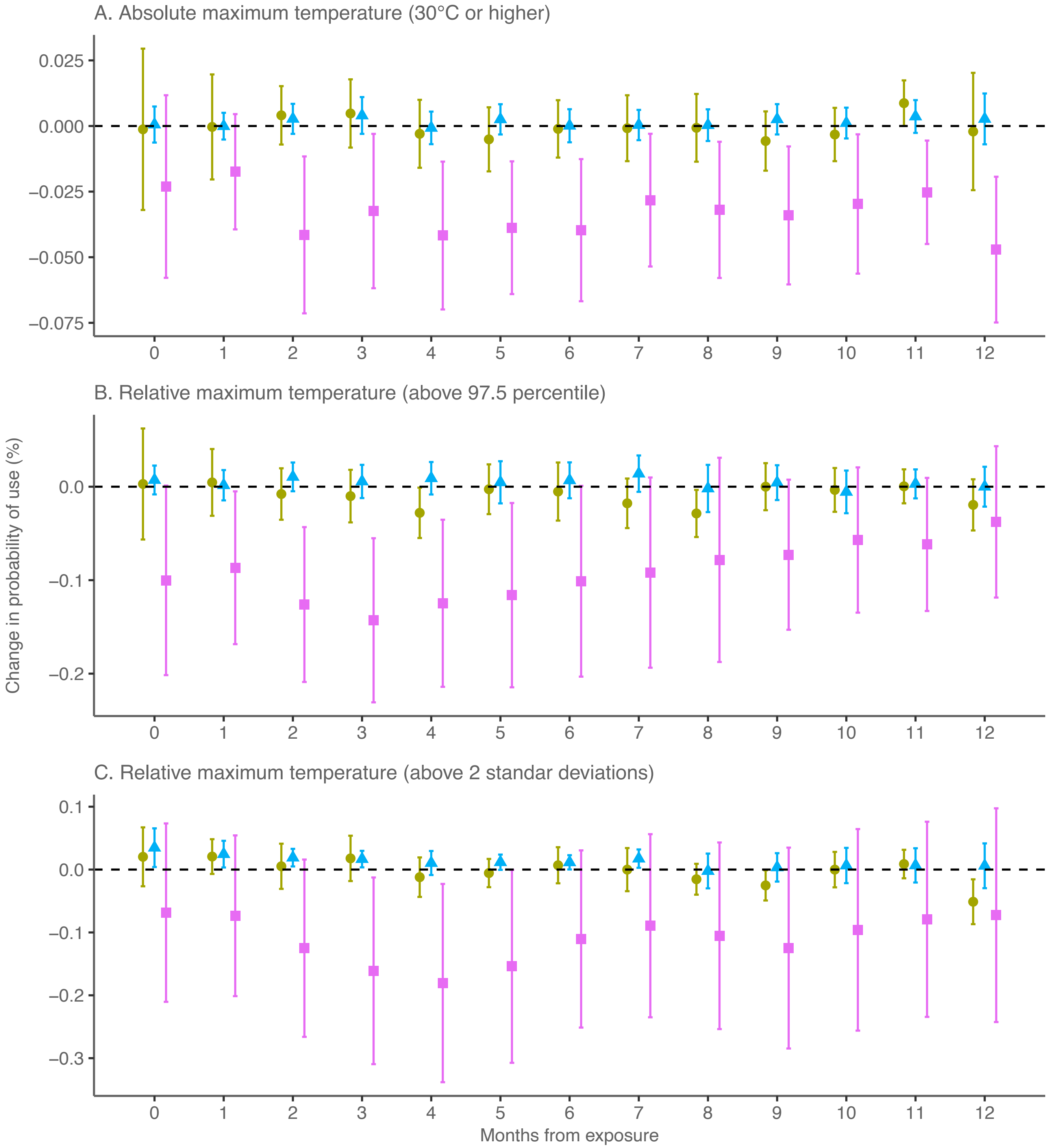

Figure S5: **Monthly effects of daily maximum temperature on contraceptive use, by world region.** Plotted probability changes from separate fixed effects regression models estimated for each region. All models include subnational unit-month, subnational unit-time and individual fixed effects. Points represent the percentage change in the probability of contraceptive use; vertical lines indicate 95% confidence intervals. Standard errors are clustered at the subnational unit level. (A) Monthly effects of exposure to daily maximum temperatures at or above 30°C. (B) Monthly effects of exposure to daily temperatures above the 97.5th percentile of the historical temperature distribution at the cluster level. (C) Monthly effects of exposure to daily temperatures more than two standard deviations above the historical seasonal average at the cluster level.

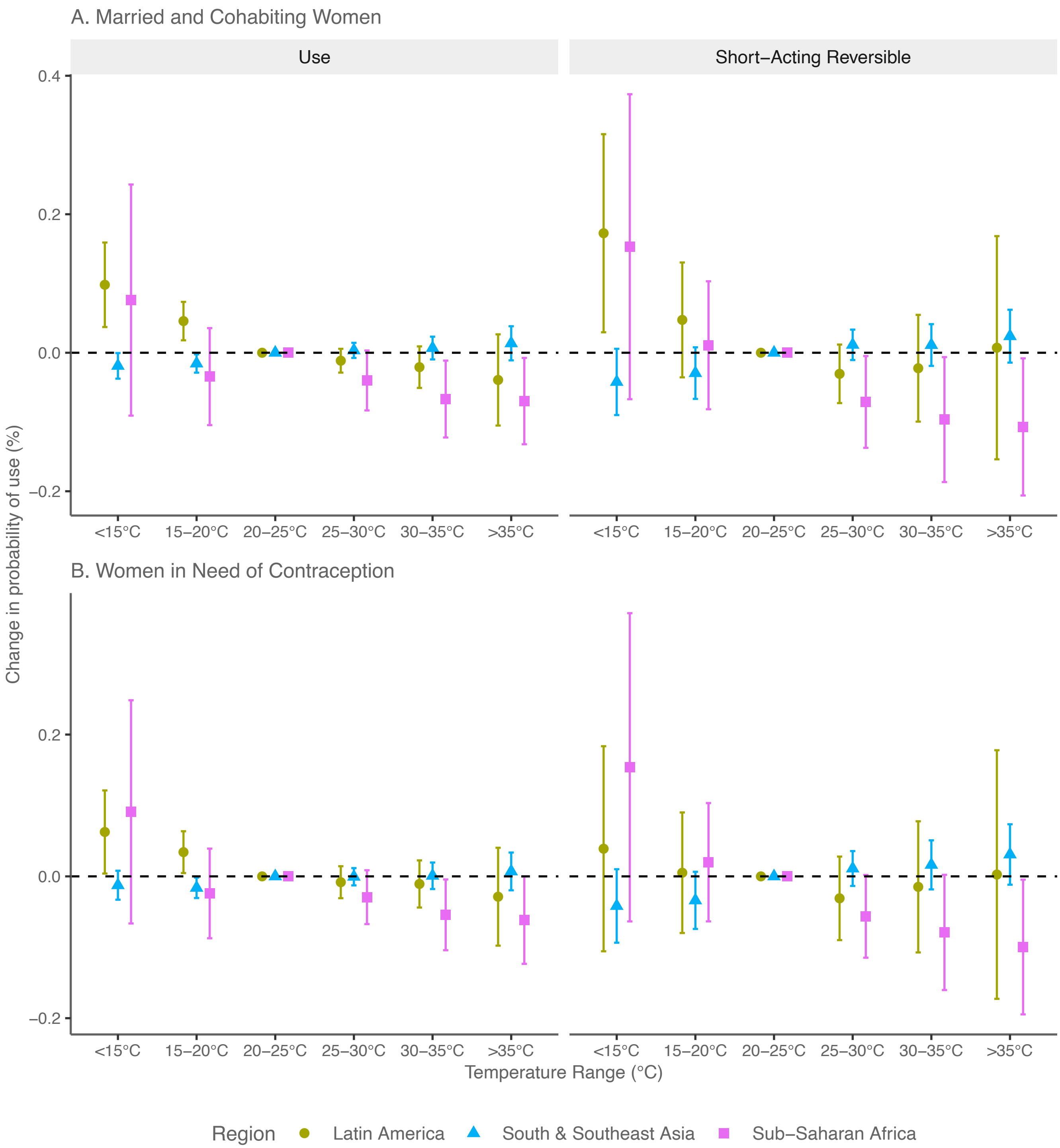

Figure S6: **Effect of daily maximum temperature on contraceptive use, by world region.** Plotted probability changes from separate fixed effects regression models estimated for each region. All models include subnational unit-month, subnational unit-time and individual fixed effects. Points represent the percentage change in the probability of contraceptive use; vertical lines indicate 95% confidence intervals. Standard errors are clustered at the subnational unit level. Estimated effect on overall contraceptive use (left) and use of short-acting reversible methods (right). (A) Effect on women of reproductive age, that are married or cohabiting at the time of interview. (B) Effect on women of reproductive age who were not deemed menopausal or infecund at the time of interview.

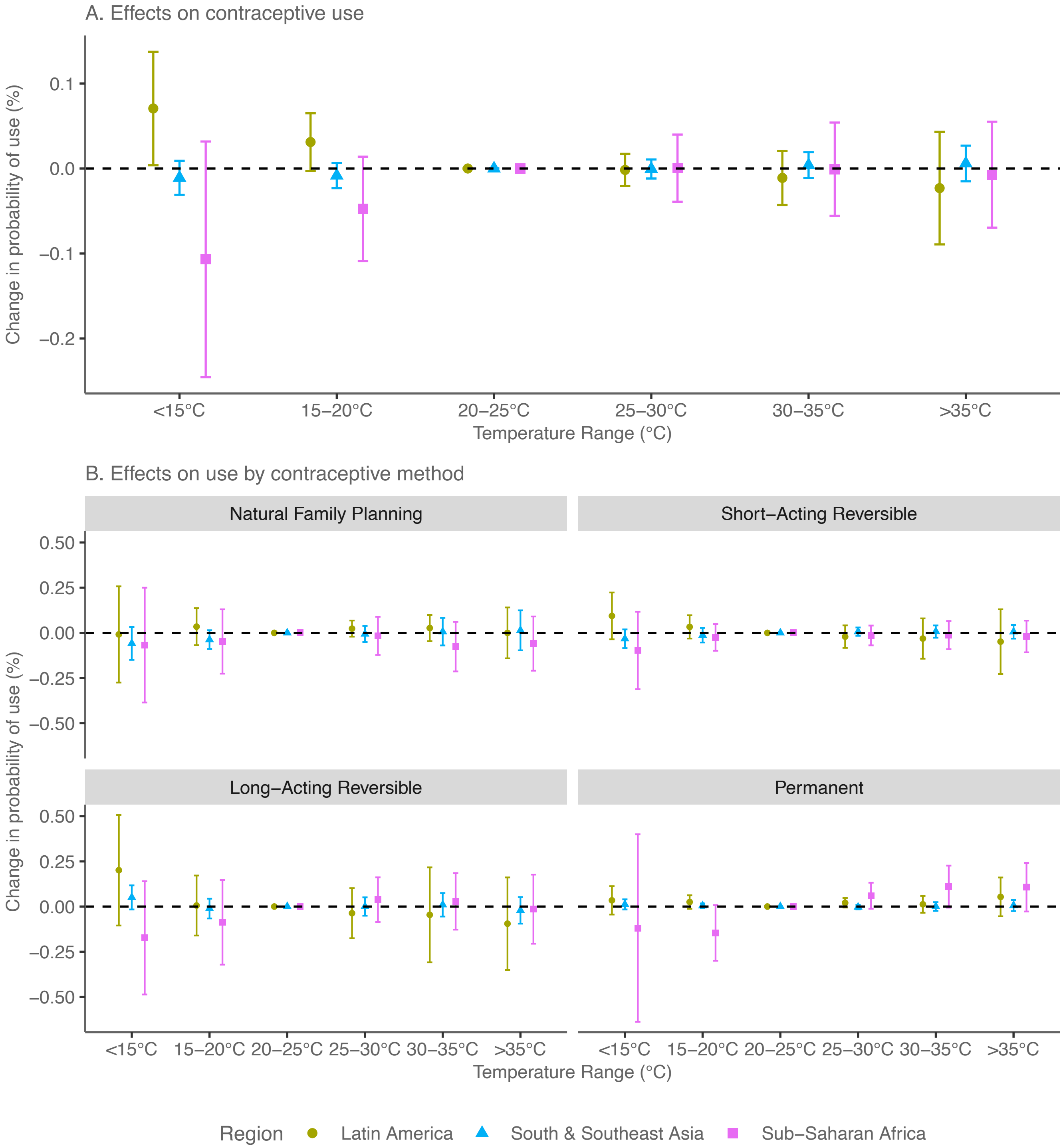

Figure S7: **Placebo test. Effect of future temperature on contraceptive use.** Plotted probability changes from separate fixed effects regression models estimated for each region. All models include subnational unit-month, subnational unit-time and individual fixed effects. Points represent the percentage change in the probability of contraceptive use; vertical lines indicate 95% confidence intervals. Standard errors are clustered at the subnational unit level. (A) Estimated effect on any contraceptive use. (B) Estimated effect on contraceptive use by method type.