

Supplementary Information

Temperature-related neonatal deaths attributable to climate change in 29 low- and middle-income countries

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Supplementary Table 1. Outcome and exposure summary statistics for the 29 study countries, Demographic Health Survey (DHS) data

Region	Country	Survey year	Data period of recorded births	Births	Neonatal deaths	Very early neonatal deaths	Daily mean temperature (°C) *
Europe	Albania	2017	2003-2016	8943	30	10	12.6
Sub-Saharan Africa	Angola	2015	2001-2016	32636	798	376	22.0
Asia	Armenia	2016	2002-2015	4917	42	9	7.3
Asia	Bangladesh	2017	2003-2018	26384	875	359	25.8
Sub-Saharan Africa	Benin	2017	2003-2018	32775	1073	380	27.9
Sub-Saharan Africa	Burundi	2016	2002-2016	34203	865	224	20.8
Sub-Saharan Africa	Cameroon	2018	2004-2018	24814	773	253	25.0
Sub-Saharan Africa	Ethiopia	2016 & 2019	2002-2019	43174	1602	622	23.3
Sub-Saharan Africa	Guinea	2018	2004-2018	20966	670	250	26.2
Caribbean	Haiti	2016	2002-2017	17954	511	113	25.2
Asia	India	2020	2005-2019	716667	17666	6760	24.4
Asia	Jordan	2017	2003-2017	31506	292	47	19.5
Sub-Saharan Africa	Liberia	2019	2005-2019	16236	606	275	25.6
Sub-Saharan Africa	Malawi	2015	2001-2015	48184	1286	573	22.4
Sub-Saharan Africa	Mali	2018	2004-2018	24730	863	301	29.0
Asia	Nepal	2016	2002-2016	15548	481	241	13.8
Sub-Saharan Africa	Nigeria	2018	2004-2018	90221	3168	1318	27.3
Asia	Pakistan	2017	2003-2017	34920	1291	325	20.7
Asia	Philippines	2017	2003-2017	30152	411	187	26.0
Sub-Saharan Africa	Rwanda	2019	2005-2019	21316	463	248	19.8

Sub-Saharan Africa	Senegal	2017, 2018 & 2019	2003-2019	66386	1797	302	28.7
Sub-Saharan Africa	Sierra Leone	2019	2005-2019	26801	833	311	26.3
Sub-Saharan Africa	South Africa	2016	2002-2016	9470	222	136	18.3
Asia	Tajikistan	2017	2003-2016	14945	225	37	2.7
Sub-Saharan Africa	Tanzania	2015	2001-2016	25890	759	247	22.9
Asia	Timor-Leste	2016	2002-2016	21003	363	242	25.07
Sub-Saharan Africa	Uganda	2016	2002-2016	40354	1063	447	23.41
Sub-Saharan Africa	Zambia	2018	2004-2018	26519	631	270	22.22
Sub-Saharan Africa	Zimbabwe	2015	2001-2015	15053	414	164	21.82

*Estimated as the mean of daily mean temperatures from the three ISIMIP3a reanalysis datasets: GSWP3-W5E5, 20CRV3-ERA5 and 20CRV3-W5E5

Supplementary Table 2. Summary of Minimum Mortality Temperatures across countries for neonatal mortality

Country	Summary of Minimum Mortality Temperature (°C)	
	Average (Minimum, Maximum)	Standard Deviation
Albania	13.69 (8.46; 16.82)	2.79
Angola	22.92 (18.99; 26.48)	2.28
Armenia	9.33 (5.18; 14.55)	1.97
Bangladesh	27.24 (21.82; 28.59)	0.9
Benin	27.96 (26.84; 29.22)	0.37
Burundi	20.7 (18.38; 23.27)	1.33
Cameroon	24.92 (20.55; 29.99)	2.17
Ethiopia	21.78 (13.75; 30.16)	4
Guinea	25.99 (23.92; 28.33)	1.11
Haiti	25.61 (22.99; 26.98)	0.86
India	25.99 (-1.86; 30.2)	4.1
Jordan	20.37 (18.82; 23.84)	0.86
Liberia	26.02 (24.48; 26.8)	0.51
Malawi	23.26 (18.98; 26.18)	1.52
Mali	28.8 (26.56; 31.92)	1.32
Nepal	21.5 (-6.1; 28)	5.46
Nigeria	27.12 (20.56; 29.64)	1
Pakistan	23.13 (-2.81; 30.83)	6.96
Philippines	26.45 (19.96; 28.06)	1.4
Rwanda	19.3 (16.93; 21.62)	1.35
Senegal	28.14 (23.99; 31.01)	1.15
Sierra Leone	26.56 (25.12; 27.52)	0.57
South Africa	19.16 (10.73; 24.23)	1.95
Tajikistan	11.82 (-3.13; 19.78)	5.69
Tanzania	23.41 (18.15; 27.25)	2.36
Timor-Leste	25.1 (24.55; 26.8)	0.5
Uganda	23.02 (16.93; 26.09)	1.72
Zambia	22.62 (18.91; 25.99)	0.98
Zimbabwe	21.93 (19.08; 26.2)	1.47

*Calculations based on the estimated MMTs for each DHS cluster in a country and averaged across the three ISIMIP3a reanalysis datasets: GSWP3-W5E5, 20CRV3-ERA5 and 20CRV3-W5E5

Supplementary Table 3. Summary of Minimum Mortality Temperatures across countries for very early neonatal mortality

Country	Summary of Minimum Mortality Temperature (°C)	
	Average (Minimum, Maximum)	Standard Deviation
Albania	10.94 (5.53; 14.27)	2.96
Angola	22.37 (18.63; 25.96)	2.22
Armenia	4.99 (0.67; 10.66)	2.02
Bangladesh	26.01 (20.59; 27.48)	0.97
Benin	27.33 (26.34; 28.44)	0.32
Burundi	20.4 (18.04; 22.99)	1.34
Cameroon	24.51 (20.2; 29.07)	2.07
Ethiopia	21.23 (13.37; 29.44)	3.87
Guinea	25.56 (23.55; 27.68)	1.1
Haiti	25.03 (22.42; 26.28)	0.84
India	24.32 (-4.77; 29)	4.42
Jordan	17 (15.09; 20.78)	0.93
Liberia	25.69 (24.16; 26.44)	0.5
Malawi	22.43 (18.24; 25.18)	1.5
Mali	27.88 (26.05; 30.39)	1.06
Nepal	18.98 (-8.62; 25.85)	5.6
Nigeria	26.56 (20.21; 28.69)	0.92
Pakistan	19.68 (-5.98; 28.68)	7.1
Philippines	26.15 (19.68; 27.75)	1.42
Rwanda	19.03 (16.66; 21.32)	1.34
Senegal	27.4 (22.6; 29.84)	1.18
Sierra Leone	26.22 (24.77; 27.15)	0.56
South Africa	17.41 (8.84; 22.49)	2.01
Tajikistan	7.84 (-6.7; 15.49)	5.51
Tanzania	22.92 (17.56; 26.64)	2.34
Timor-Leste	24.83 (24.28; 26.56)	0.49
Uganda	22.7 (16.66; 25.68)	1.68
Zambia	21.87 (18.24; 25.04)	0.94
Zimbabwe	20.64 (17.95; 25.23)	1.5

*Calculations based on the estimated MMTs for each DHS cluster in a country and averaged across the three ISIMIP3a reanalysis datasets: GSWP3-W5E5, 20CRV3-ERA5 and 20CRV3-W5E5

Supplementary Table 4. AIC model selection for models with 2 lags. Bolded lines indicate models with lowest AIC, which were selected for the analysis.

	Natural spline	B-spline
Model: Total neonatal mortality		
1 knot at 10th percentile	118083.9	118090.1
1 knot at 20th percentile	118083.8	118089.8
1 knot at 30th percentile	118084.3	118090.3
1 knot at 40th percentile	118085.4	118090.3
1 knot at 50th percentile	118087.1	118090.3
1 knot at 60th percentile	118088.8	118090.5
1 knot at 70th percentile	118090.4	118090.8
1 knot at 80th percentile	118091.4	118091.0
1 knot at 90th percentile	118092.0	118090.3
1 knot at 95th percentile	118092.1	118092.0
1 knot at 98th percentile	118092.1	118091.2
2 knots at 25 and 50 th percentile	118085.2	118093.8
2 knots at 50 and 75th percentile	118086.1	118095.2
2 knots at 50 and 90th percentile	118087.0	118094.5
2 knots at 75 and 95th percentile	118092.2	118096.3
3 knots at 10, 50, 75th percentile	118089.8	118099.7
Model: Very early neonatal mortality		
1 knot at 10th percentile	29217.38	29222.16
1 knot at 20th percentile	29217.45	29224.21
1 knot at 30th percentile	29217.85	29224.60
1 knot at 40th percentile	29218.42	29224.75
1 knot at 50th percentile	29219.02	29224.67
1 knot at 60th percentile	29219.67	29224.25
1 knot at 70th percentile	29220.31	29224.15
1 knot at 80th percentile	29220.86	29224.56

1 knot at 90th percentile	29221.11	29224.63
1 knot at 95th percentile	29221.17	29224.71
1 knot at 98th percentile	29221.18	29224.09
2 knots at 25 and 50 th percentile	29220.11	29230.06
2 knots at 50 and 75th percentile	29219.69	29230.30
2 knots at 50 and 90th percentile	29219.51	29230.31
2 knots at 75 and 95th percentile	29220.95	29230.01
3 knots at 10, 50, 75th percentile	29224.92	29231.86

Supplementary Table 5. Heat- and cold-related neonatal mortality fraction (95% confidence interval (CI)) in factual and counterfactual scenario and historical heat- and cold-related neonatal mortality fraction (95% confidence interval (CI)) attributable to climate change by country.

Country	Factual scenario		Counterfactual scenario		Heat-related neonatal mortality attributable to climate change (% - 95%CI)	Cold-related neonatal mortality attributable to climate change (% - 95%CI)
	Heat-related neonatal mortality (% - 95%CI)	Cold-related neonatal mortality (% - 95%CI)	Heat-related neonatal mortality (% - 95%CI)	Cold-related neonatal mortality (% - 95%CI)		
Albania	2.4 (0.4, 4.3)	1.9 (1, 2.7)	2 (0.3, 3.6)	2.2 (1.2, 3.2)	0.5 (0.1, 0.9)	-0.3 (-0.6, -0.2)
Angola	1.3 (0.2, 2.6)	3 (1.6, 4.4)	0.7 (0, 1.5)	4.6 (2.5, 6.8)	0.7 (0, 1.4)	-1.5 (-3.4, -0.5)
Armenia	0.7 (0, 1.5)	3.7 (2, 5.3)	0.6 (-0.1, 1.2)	4.2 (2.3, 6.1)	0.2 (0, 0.4)	-0.5 (-1.1, -0.2)
Bangladesh	1.3 (0.2, 2.3)	3.3 (1.8, 4.8)	0.8 (0, 1.7)	3.7 (2, 5.4)	0.4 (0, 0.8)	-0.4 (-0.8, -0.1)
Benin	1.4 (0.2, 2.6)	2.8 (1.5, 4.1)	0.6 (0.1, 1.2)	5.8 (3.2, 8.6)	0.8 (0, 1.5)	-3 (-5, -1.2)
Burundi	1.2 (0.2, 2.2)	3 (1.6, 4.4)	0.5 (0, 0.9)	5.8 (3.3, 8.3)	0.7 (0, 1.4)	-2.8 (-4.6, -1.4)
Cameroon	1.7 (0.3, 3)	2.3 (1.2, 3.4)	0.9 (0.1, 1.9)	5.8 (2.9, 9.1)	0.8 (0, 1.8)	-3.5 (-6.3, -1)
Ethiopia	1.4 (0.2, 2.5)	2.8 (1.5, 4.1)	0.5 (0, 1.1)	6.1 (3.4, 8.8)	0.9 (0, 1.7)	-3.2 (-5.2, -1.5)
Guinea	1.8 (0.3, 3.2)	2.7 (1.4, 3.9)	1 (0.1, 2.1)	5.8 (3, 8.9)	0.8 (0, 1.7)	-3.1 (-5.5, -0.9)
Haiti	1.4 (0.2, 2.6)	2.9 (1.5, 4.2)	0.3 (0, 0.9)	5.4 (2.9, 8.4)	1.1 (0, 2.3)	-2.5 (-4.9, -1)
India	1.5 (0.2, 2.7)	2.8 (1.5, 4)	1.2 (0.2, 2.2)	3.2 (1.6, 4.8)	0.3 (0, 0.6)	-0.4 (-1.1, 0)
Jordan	1.3 (0.2, 2.4)	3.3 (1.8, 4.7)	0.8 (0, 1.7)	3.9 (2.1, 5.8)	0.5 (0.1, 1.2)	-0.6 (-1.4, -0.2)
Liberia	1.5 (0.3, 2.6)	2.9 (1.5, 4.2)	0.6 (0.1, 1.6)	6.4 (3.2, 10.1)	0.9 (0.1, 2)	-3.5 (-6.6, -1)
Malawi	1.3 (0.2, 2.5)	2.8 (1.5, 4)	0.9 (0.1, 1.8)	3.8 (2.1, 5.4)	0.4 (0, 0.8)	-1 (-1.5, -0.5)
Mali	1.6 (0.2, 2.9)	3 (1.7, 4.4)	0.9 (0.1, 1.7)	5.1 (2.9, 7.4)	0.7 (0.1, 1.3)	-2 (-3.4, -0.9)
Nepal	1.4 (0.2, 2.6)	2.7 (1.4, 3.9)	1 (0.1, 1.9)	3 (1.5, 4.6)	0.4 (0.1, 0.8)	-0.3 (-1.1, 0)
Nigeria	1.6 (0.3, 2.9)	2.6 (1.4, 3.8)	0.9 (0.1, 1.8)	4.8 (2.6, 7.3)	0.6 (0, 1.3)	-2.2 (-3.9, -0.8)
Pakistan	1.4 (0.2, 2.5)	3 (1.6, 4.3)	1.1 (0.1, 2.1)	3.5 (1.9, 5)	0.3 (0, 0.7)	-0.5 (-1, -0.2)
Philippines	1.3 (0.2, 2.4)	3 (1.5, 4.4)	0.3 (0, 0.6)	7.6 (4.4, 10.9)	1 (0, 2)	-4.6 (-7, -2.4)
Rwanda	1.2	2.8	0.4	6.6	0.9	-3.8

	(0.1, 2.3)	(1.3, 4.4)	(0, 0.8)	(3.8, 9.4)	(-0.1, 1.7)	(-6, -2)
Senegal	1.4 (0.2, 2.6)	2.9 (1.5, 4.1)	0.7 (0.1, 1.4)	5.2 (2.9, 7.7)	0.7 (0, 1.4)	-2.4 (-4, -1)
Sierra Leone	1.9 (0.3, 3.3)	2.3 (1.1, 3.4)	1 (0.1, 2.5)	5.1 (2.5, 8.4)	0.9 (0, 2.2)	-2.8 (-5.6, -0.7)
South Africa	1.4 (0.1, 2.6)	3 (1.6, 4.2)	0.8 (0, 1.5)	4.2 (2.3, 6)	0.6 (0, 1.2)	-1.2 (-2, -0.6)
Tajikistan	1.6 (0.3, 3)	2.2 (1.2, 3.3)	1.3 (0.2, 2.4)	2.6 (1.3, 3.8)	0.3 (0.1, 0.6)	-0.3 (-0.8, -0.1)
Tanzania	1.1 (0.1, 2.1)	3.3 (1.8, 4.8)	0.5 (0, 1)	5.7 (3.3, 8)	0.6 (0, 1.2)	-2.4 (-3.5, -1.3)
Timor-Leste	1.2 (0.1, 2.2)	3.2 (1.7, 4.6)	0.4 (0, 1)	5.3 (3, 7.6)	0.8 (0, 1.5)	-2.1 (-3.7, -1)
Uganda	1.5 (0.3, 2.8)	2.7 (1.4, 3.9)	0.6 (0.1, 1.2)	7.1 (4.2, 10)	0.9 (0, 1.8)	-4.5 (-6.4, -2.3)
Zambia	1.4 (0.2, 2.5)	3 (1.6, 4.4)	1 (0.1, 2)	3.9 (2, 5.7)	0.3 (0, 0.9)	-0.9 (-1.7, -0.4)
Zimbabwe	1.4 (0.1, 2.6)	2.6 (1.4, 3.8)	0.9 (0.1, 1.8)	3.5 (1.9, 5)	0.5 (0, 0.9)	-0.9 (-1.3, -0.4)

Supplementary Table 6. Heat-related neonatal deaths attributable to climate change and cold-related neonatal deaths averted by climate change by country, expressed as rates, total numbers and as a share of the total heat- and cold-related burdens and including 95% Uncertainty Intervals (UI)

Country	Heat-related neonatal deaths attributable to climate change			Cold-related neonatal deaths averted by climate change		
	Rate (per 100,000 births)	Total number	Share of all heat-related burden (%) *	Rate (per 100,000 births)	Total number	Share of all cold-related burden (%) **
Albania	4 (1, 8)	27 (4, 56)	19	-3 (-5, -1)	-20 (-35, -9)	15
Angola	24 (0, 50)	4825 (68, 9999)	50	-55 (-123, -19)	-10911 (-24454, -3769)	33
Armenia	2 (0, 4)	12 (1, 31)	22	-5 (-11, -2)	-42 (-82, -17)	13
Bangladesh	13 (1, 24)	8064 (873, 15281)	34	-12 (-26, -3)	-7347 (-16117, -2192)	10
Benin	27 (1, 52)	1976 (69, 3742)	56	-101 (-170, -41)	-7243 (-12197, -2976)	52
Burundi	21 (0, 39)	1516 (23, 2909)	62	-79 (-128, -38)	-5808 (-9442, -2823)	49
Cameroon	26 (1, 55)	3826 (121, 8206)	49	-108 (-196, -32)	-16173 (-29382, -4808)	60
Ethiopia	33 (1, 64)	20537 (906, 40511)	64	-121 (-195, -56)	-76016 (-122510, -35172)	53
Guinea	28 (2, 61)	2111 (138, 4679)	44	-111 (-201, -34)	-8484 (-15340, -2600)	53
Haiti	31 (1, 65)	1596 (52, 3328)	79	-70 (-137, -27)	-3559 (-6978, -1386)	46
India	9 (0, 18)	47046 (2433, 90005)	20	-12 (-36, -1)	-58805 (-180473, -5710)	11
Jordan	6 (1, 14)	214 (26, 530)	38	-7 (-17, -2)	-265 (-625, -87)	16
Liberia	32 (2, 71)	896 (50, 2018)	61	-124 (-231, -33)	-3513 (-6527, -942)	55
Malawi	11 (0, 21)	1234 (24, 2359)	31	-26 (-40, -12)	-2937 (-4487, -1391)	26
Mali	28 (2, 52)	3821 (292, 7117)	44	-81 (-136, -35)	-11059 (-18489, -4707)	40
Nepal	12 (2, 23)	1445 (219, 2759)	30	-9 (-31, 0)	-1123 (-3783, -47)	11
Nigeria	25 (2, 51)	31701 (2015, 64325)	40	-86 (-153, -30)	-109236 (-193958, -38248)	46
Pakistan	14 (0, 34)	16632 (250, 39843)	21	-23 (-49, -8)	-26443 (-56785, -9542)	13
Philippines	16 (0, 30)	7043 (-103, 13711)	79	-69 (-104, -35)	-31221 (-47309, -15886)	61

Rwanda	22 (-2, 44)	1484 (-139, 3017)	70	-96 (-152, -50)	-6619 (-10484, -3430)	57
Senegal	20 (1, 40)	1772 (73, 3564)	50	-65 (-110, -29)	-5810 (-9798, -2576)	45
Sierra Leone	35 (2, 87)	1623 (74, 4046)	47	-113 (-222, -27)	-5255 (-10352, -1262)	55
South Africa	8 (0, 15)	1630 (24, 3289)	43	-16 (-25, -7)	-3375 (-5367, -1590)	29
Tajikistan	7 (1, 12)	296 (46, 525)	21	-6 (-15, -2)	-273 (-650, -67)	12
Tanzania	16 (0, 30)	5405 (54, 10387)	56	-60 (-89, -32)	-20874 (-30904, -11084)	42
Timor-Leste	22 (0, 43)	143 (-1, 283)	65	-61 (-105, -28)	-400 (-684, -185)	40
Uganda	23 (1, 45)	6038 (174, 11839)	59	-113 (-162, -59)	-29784 (-42859, -15537)	63
Zambia	9 (0, 26)	995 (38, 2750)	24	-24 (-46, -10)	-2536 (-4987, -1043)	22
Zimbabwe	14 (0, 27)	1225 (2, 2407)	33	-26 (-39, -12)	-2253 (-3461, -1020)	24

*Calculated with respect to heat-related neonatal deaths in the factual scenario.

**Calculated with respect to cold-related neonatal deaths in the counterfactual scenario.

Supplementary Table 7. Heat- and cold-related very early neonatal mortality fraction (95% confidence interval (CI)) in factual and counterfactual scenario and historical heat- and cold-related neonatal mortality fraction (95% confidence interval (CI)) attributable to climate change by country.

Country	Factual scenario		Counterfactual scenario			
	Heat-related very early neonatal mortality (% - 95%CI)	Cold-related very early neonatal mortality (% -95%CI)	Heat-related very early neonatal mortality (% - 95%CI)	Cold-related very early neonatal mortality (% -95%CI)	Heat-related very early neonatal mortality attributable to climate change (% - 95%CI)	Heat-related very early neonatal mortality attributable to climate change (% - 95%CI)
Albania	7.7 (3, 12)	0.3 (-0.2, 0.7)	6.7 (2.6, 10.5)	0.4 (-0.1, 1)	1 (0.2, 1.8)	-0.2 (-0.3, 0)
Angola	3.8 (1.4, 6.1)	2.3 (0.3, 4.2)	2 (0.5, 3.8)	3.4 (0.6, 6.2)	1.9 (0.6, 3.4)	-1.1 (-3, 0)
Armenia	0.2 (-0.1, 0.5)	3.5 (0.3, 6.5)	0.2 (0, 0.4)	4.1 (0.4, 7.6)	0 (-0.1, 0.1)	-0.6 (-1.6, 0)
Bangladesh	3.9 (1.5, 6.2)	2.1 (0.2, 3.9)	2.9 (0.8, 4.8)	2.4 (0.2, 4.5)	1.1 (0.4, 1.8)	-0.3 (-0.9, 0)
Benin	3.9 (1.5, 6.1)	2 (0.2, 3.7)	1.8 (0.6, 3)	4.5 (0.9, 8.1)	2.1 (0.6, 3.4)	-2.5 (-5.1, -0.2)
Burundi	4.2 (1.7, 6.4)	1.8 (0.1, 3.3)	1.7 (0.5, 2.8)	3.9 (0.5, 7)	2.5 (0.9, 4)	-2.1 (-4.3, 0.1)
Cameroon	4.7 (1.9, 7.2)	1.6 (0.2, 3)	2.3 (0.7, 4.5)	4.3 (0.8, 8.4)	2.4 (0.7, 4.4)	-2.7 (-6.3, 0)
Ethiopia	3.9 (1.5, 6.1)	1.8 (0.1, 3.5)	1.6 (0.5, 2.9)	4.4 (0.6, 8.1)	2.3 (0.7, 4)	-2.6 (-5.3, -0.1)
Guinea	5.2 (1.9, 8.1)	1.6 (0, 3.2)	3.1 (0.8, 5.9)	4.1 (0.7, 7.9)	2.1 (0.6, 4.1)	-2.4 (-5.5, -0.2)
Haiti	4.3 (1.6, 6.8)	2 (0.2, 3.8)	1.4 (0.2, 3.1)	3.8 (0.5, 7.4)	2.9 (0.8, 5.5)	-1.7 (-4.4, 0.1)
India	4.2 (1.6, 6.6)	1.9 (0.2, 3.5)	3.5 (1.3, 5.6)	2.1 (0.2, 4.1)	0.7 (0.2, 1.2)	-0.3 (-1.1, 0)
Jordan	3.9 (1.5, 6.1)	2.2 (0.2, 4)	2.6 (0.8, 4.5)	2.7 (0.3, 4.9)	1.4 (0.4, 2.8)	-0.5 (-1.3, 0)
Liberia	4.4 (1.8, 6.8)	1.8 (0, 3.5)	1.8 (0.4, 4.4)	4.6 (0.7, 9.1)	2.6 (0.7, 5.2)	-2.8 (-6.5, -0.2)
Malawi	3.7 (1.3, 5.9)	2 (0.2, 3.8)	2.7 (0.8, 4.4)	2.9 (0.3, 5.3)	1 (0.4, 1.6)	-0.9 (-1.7, 0)
Mali	4.2 (1.6, 6.7)	2.2 (0.3, 4)	2.6 (0.9, 4.3)	3.8 (0.6, 6.9)	1.6 (0.5, 2.6)	-1.6 (-3.5, 0)
Nepal	3.7 (1.4, 5.8)	1.8 (0.1, 3.3)	2.9 (1, 4.6)	2.1 (0.2, 4.1)	0.8 (0.3, 1.4)	-0.3 (-1.3, 0)
Nigeria	4.2 (1.6, 6.6)	1.8 (0.1, 3.5)	2.5 (0.8, 4.3)	3.8 (0.6, 7.2)	1.7 (0.5, 3.1)	-2 (-4.5, -0.1)
Pakistan	3.8 (1.4, 6)	1.7 (0.1, 3.3)	3.2 (1, 5.4)	2.1 (0.2, 4)	0.6 (0, 1.3)	-0.4 (-1.1, 0)
Philippines	4.4	2.1	1.3	5.2	3.2	-3.1

	(1.7, 7)	(0.3, 3.8)	(0.3, 2.2)	(0.9, 9.3)	(1, 5.2)	(-6.3, 0.1)
Rwanda	3.7 (1.3, 6)	2.2 (0.2, 4.3)	1.3 (0.3, 2.3)	5.1 (0.9, 9)	2.4 (0.6, 4.1)	-2.9 (-5.8, 0)
Senegal	4.2 (1.5, 6.8)	1.6 (0.2, 3)	2.3 (0.7, 4)	3.4 (0.6, 6.3)	1.9 (0.5, 3.5)	-1.8 (-3.9, -0.1)
Sierra Leone	5 (2, 7.7)	1.6 (0.1, 3)	2.8 (0.7, 6.1)	3.9 (0.6, 8.2)	2.1 (0.4, 4.6)	-2.4 (-6.1, -0.1)
South Africa	3.9 (1.5, 6.1)	2.6 (0.4, 4.7)	2.6 (0.9, 4.1)	3.6 (0.6, 6.5)	1.3 (0.4, 2.3)	-1 (-2.1, 0)
Tajikistan	5.1 (2.1, 7.8)	2 (0.2, 3.8)	4.3 (1.7, 6.8)	2.3 (0.2, 4.3)	0.8 (0.3, 1.2)	-0.2 (-0.8, 0)
Tanzania	3 (1, 4.9)	2.3 (0.1, 4.4)	1.5 (0.3, 2.6)	4.2 (0.6, 7.5)	1.5 (0.4, 2.6)	-1.9 (-3.5, -0.1)
Timor-Leste	3.5 (1.2, 5.8)	2.3 (0.3, 4.2)	1.4 (0.3, 2.7)	3.9 (0.6, 7)	2.1 (0.6, 3.5)	-1.6 (-3.3, 0)
Uganda	4.3 (1.7, 6.8)	1.7 (0.1, 3.2)	1.9 (0.7, 3.1)	5.4 (1, 9.5)	2.4 (0.7, 4.2)	-3.7 (-6.8, -0.2)
Zambia	3.8 (1.4, 6.1)	2.1 (0.2, 3.9)	3 (1, 5.1)	2.8 (0.4, 5.1)	0.9 (0.2, 2.1)	-0.7 (-1.6, 0)
Zimbabwe	4.2 (1.4, 6.8)	1.3 (0, 2.6)	3 (0.9, 5.1)	2 (0.1, 3.7)	1.2 (0.3, 2)	-0.6 (-1.2, 0)

Supplementary Table 8. Heat-related and cold-related very early neonatal deaths attributable to climate change and cold-related very early neonatal deaths averted by climate change by country, expressed as rates, total numbers and share of total heat- and cold-related burdens and including 95% Uncertainty Intervals (UI)

Country	Heat-related very early neonatal deaths attributable to climate change			Cold-related very early neonatal deaths averted by climate change		
	Rate (per 100,000 births)	Total number	Share of all heat-related burden (%)	Rate (per 100,000 births)	Total number	Share of all cold-related burden (%)
Albania	3 (1, 5)	18 (4, 33)	13	0 (-1, 0)	-3 (-6, 0)	35
Angola	33 (10, 60)	6524 (1923, 11925)	49	-19 (-53, 0)	-3828 (-10451, 95)	32
Armenia	0 (0, 0)	0 (-1, 2)	8	-2 (-4, 0)	-12 (-34, 0)	14
Bangladesh	13 (5, 22)	8268 (3246, 14026)	27	-4 (-11, 0)	-2485 (-6685, 65)	13
Benin	26 (8, 42)	1853 (565, 3009)	54	-31 (-63, -2)	-2203 (-4549, -152)	56
Burundi	17 (6, 28)	1284 (445, 2058)	60	-15 (-30, 1)	-1078 (-2236, 59)	54
Cameroon	26 (8, 48)	3833 (1143, 7135)	51	-29 (-68, 0)	-4385 (-10214, -72)	63
Ethiopia	33 (10, 57)	20859 (6424, 36071)	60	-37 (-76, -1)	-23135 (-47690, -525)	59
Guinea	29 (8, 57)	2241 (642, 4357)	41	-34 (-77, -3)	-2593 (-5888, -238)	60
Haiti	21 (6, 40)	1066 (300, 2038)	67	-13 (-32, 1)	-648 (-1642, 26)	46
India	9 (3, 15)	44044 (13832, 73373)	17	-3 (-14, 0)	-17390 (-68061, 1671)	13
Jordan	3 (1, 7)	120 (39, 252)	35	-1 (-3, 0)	-43 (-117, -2)	18
Liberia	47 (13, 94)	1340 (364, 2649)	60	-51 (-118, -3)	-1438 (-3343, -96)	61
Malawi	12 (4, 19)	1316 (466, 2078)	28	-10 (-19, 0)	-1118 (-2152, -29)	30
Mali	23 (7, 37)	3078 (908, 5016)	38	-23 (-49, 0)	-3069 (-6627, -1)	42
Nepal	11 (3, 19)	1382 (428, 2350)	22	-4 (-17, 0)	-538 (-2121, 31)	15
Nigeria	27 (8, 48)	34071 (10083, 60832)	40	-31 (-70, -2)	-39647 (-88858, -1939)	52
Pakistan	8 (0, 17)	8912 (-9, 19705)	16	-5 (-14, 0)	-5684 (-15673, -304)	18

Philippines	18 (5, 29)	8126 (2486, 13184)	72	-18 (-35, 0)	-7966 (-15967, 153)	60
Rwanda	32 (8, 55)	2204 (562, 3776)	65	-38 (-76, 0)	-2647 (-5263, -22)	57
Senegal	8 (2, 15)	723 (190, 1319)	45	-8 (-17, 0)	-683 (-1480, -31)	53
Sierra Leone	33 (5, 70)	1520 (255, 3256)	43	-36 (-92, -1)	-1683 (-4306, -66)	60
South Africa	11 (3, 18)	2296 (621, 3959)	34	-8 (-17, 0)	-1763 (-3604, -39)	28
Tajikistan	2 (1, 4)	105 (47, 164)	15	-1 (-3, 0)	-33 (-114, 0)	10
Tanzania	13 (4, 22)	4498 (1307, 7530)	51	-16 (-29, -1)	-5451 (-10194, -317)	45
Timor-Leste	39 (10, 65)	254 (68, 422)	60	-30 (-61, 0)	-194 (-395, 1)	41
Uganda	25 (7, 43)	6635 (1888, 11348)	56	-38 (-70, -2)	-10103 (-18399, -625)	68
Zambia	10 (3, 24)	1105 (284, 2620)	23	-8 (-19, 0)	-874 (-2027, -45)	25
Zimbabwe	13 (4, 23)	1160 (325, 1980)	28	-7 (-14, 0)	-628 (-1241, 25)	32

*Calculated with respect to very early neonatal heat-related deaths in the factual scenario.

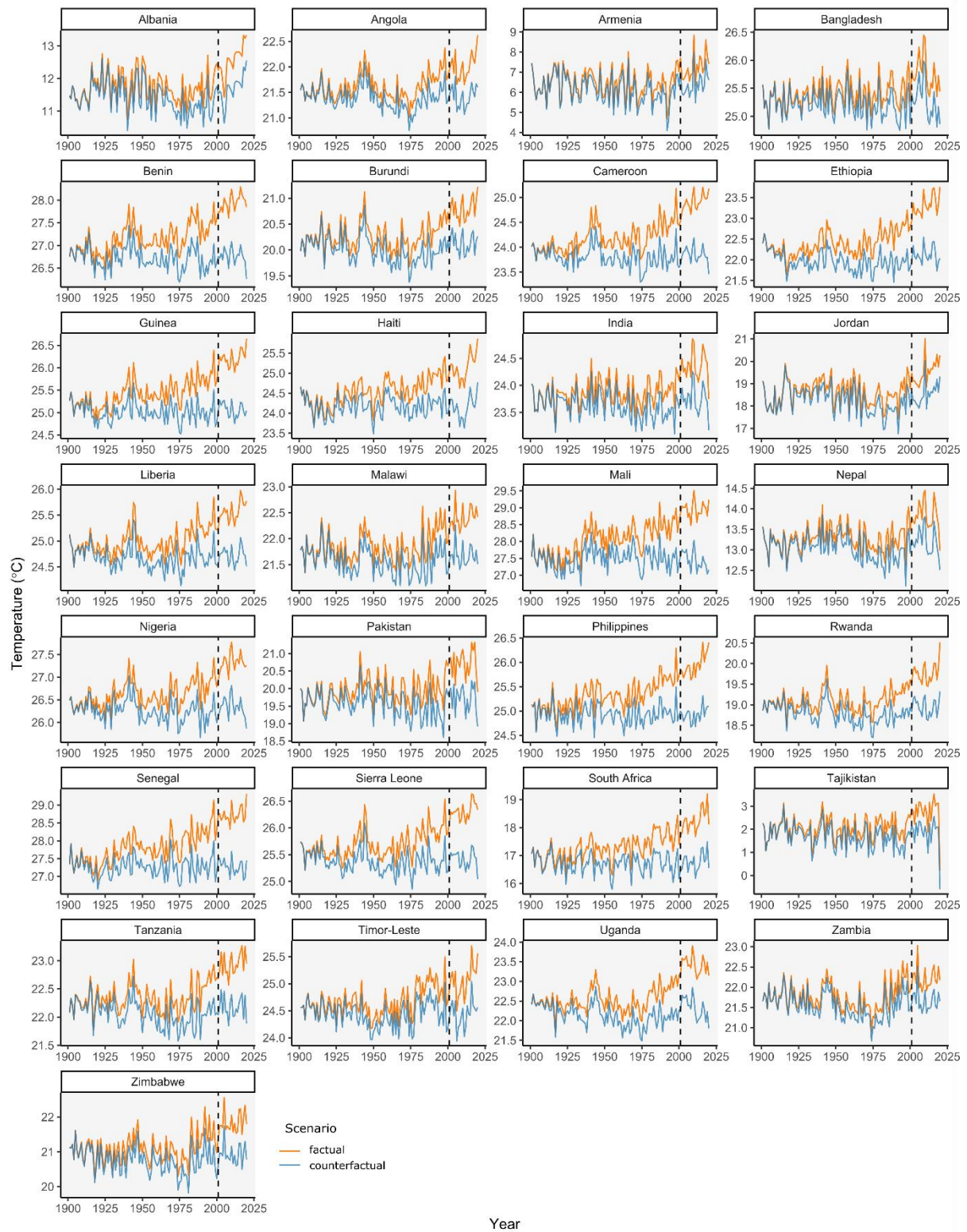
**Calculated with respect to cold-related very early neonatal deaths in the counterfactual scenario.

Supplementary Table 9 Summary of total neonatal deaths and very early neonatal deaths for the 29 locations for the period 2001-2019, UNICEF*

Region	Country	Data period	Births	Neonatal deaths	Very early neonatal deaths
Europe	Albania	2001-2019	706,962	5,970	1,812
Sub-Saharan Africa	Angola	2001-2019	19,876,855	722,089	346,156
Asia	Armenia	2001-2019	764,025	7,689	2,075
Asia	Bangladesh	2001-2019	62,771,163	1,899,494	784,766
Sub-Saharan Africa	Benin	2001-2019	7,189,971	242,006	88,335
Sub-Saharan Africa	Burundi	2001-2019	7,385,509	204,773	51,441
Sub-Saharan Africa	Cameroon	2001-2019	14,992,573	462,927	161,198
Sub-Saharan Africa	Ethiopia	2001-2019	62,897,178	2,354,926	895,125
Sub-Saharan Africa	Guinea	2001-2019	7,644,309	276,540	107,141
Carribbean	Haiti	2001-2019	5,092,004	143,215	37,112
Asia	India	2001-2019	500,810,268	16,197,943	6,162,751
Asia	Jordan	2001-2019	3,707,282	43,637	8,868
Sub-Saharan Africa	Liberia	2001-2019	2,829,920	98,995	51,152
Sub-Saharan Africa	Malawi	2001-2019	11,201,088	295,195	128,578
Sub-Saharan Africa	Mali	2001-2019	13,633,838	544,775	190,035
Asia	Nepal	2001-2019	12,248,923	332,788	168,981
Sub-Saharan Africa	Nigeria	2001-2019	126,977,974	4,933,373	1,994,100
Asia	Pakistan	2001-2019	115,709,872	5,663,523	1,483,550
Asia	Philippines	2001-2019	45,306,761	674,853	254,218
Sub-Saharan Africa	Rwanda	2001-2019	6,889,961	173,673	91,025
Sub-Saharan Africa	Senegal	2001-2019	8,879,802	246,774	37,917
Sub-Saharan Africa	Sierra Leone	2001-2019	4,670,723	185,246	71,061
Sub-Saharan Africa	South Africa	2001-2019	21,484,841	274,676	174,347
Asia	Tajikistan	2001-2019	4,403,244	86,232	13,894
Sub-Saharan Africa	Tanzania	2001-2019	34,788,636	878,558	292,267
Asia	Timor-Leste	2001-2019	651,775	18,648	12,006
Sub-Saharan Africa	Uganda	2001-2019	26,442,665	665,732	272,191
Sub-Saharan Africa	Zambia	2001-2019	10,731,353	296,582	125,318
Sub-Saharan Africa	Zimbabwe	2001-2019	8,790,554	264,256	99,770

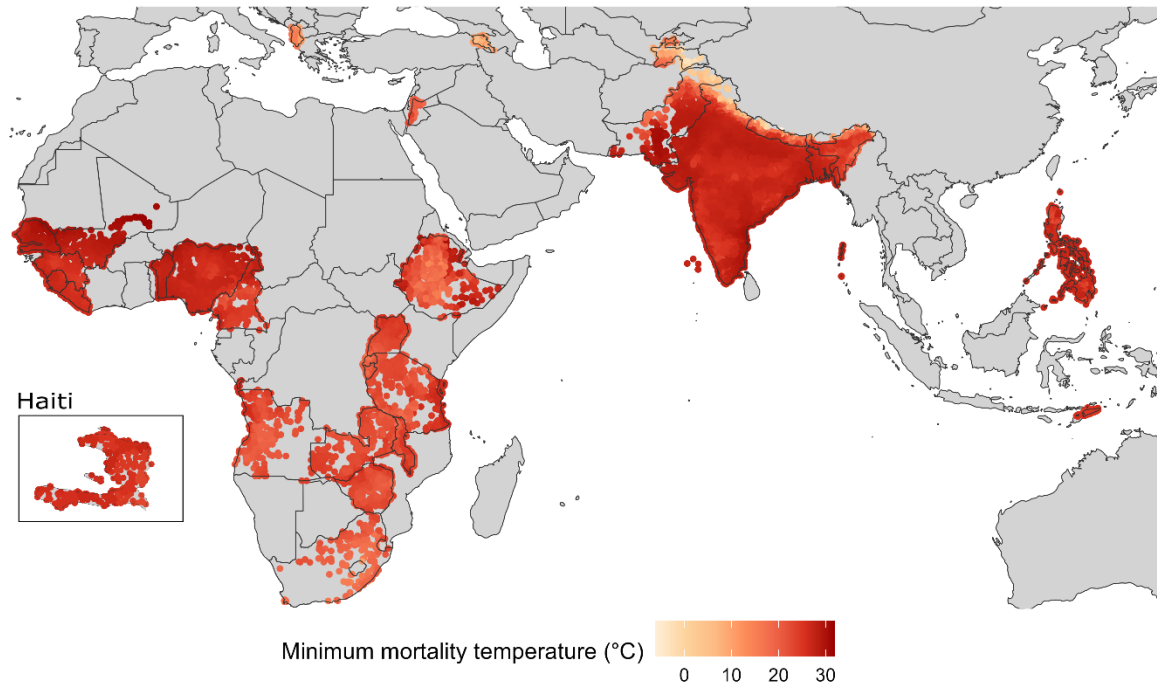
*Source: UNICEF Data Warehouse. https://data.unicef.org/dv_index/

Supplementary Fig. 1: Time series plots of mean daily temperature for factual and counterfactual scenarios in the 29 study countries, in the time period 1900–2019. Mean values computed across the three reanalysis datasets. The dashed vertical line indicates the start of the study period.

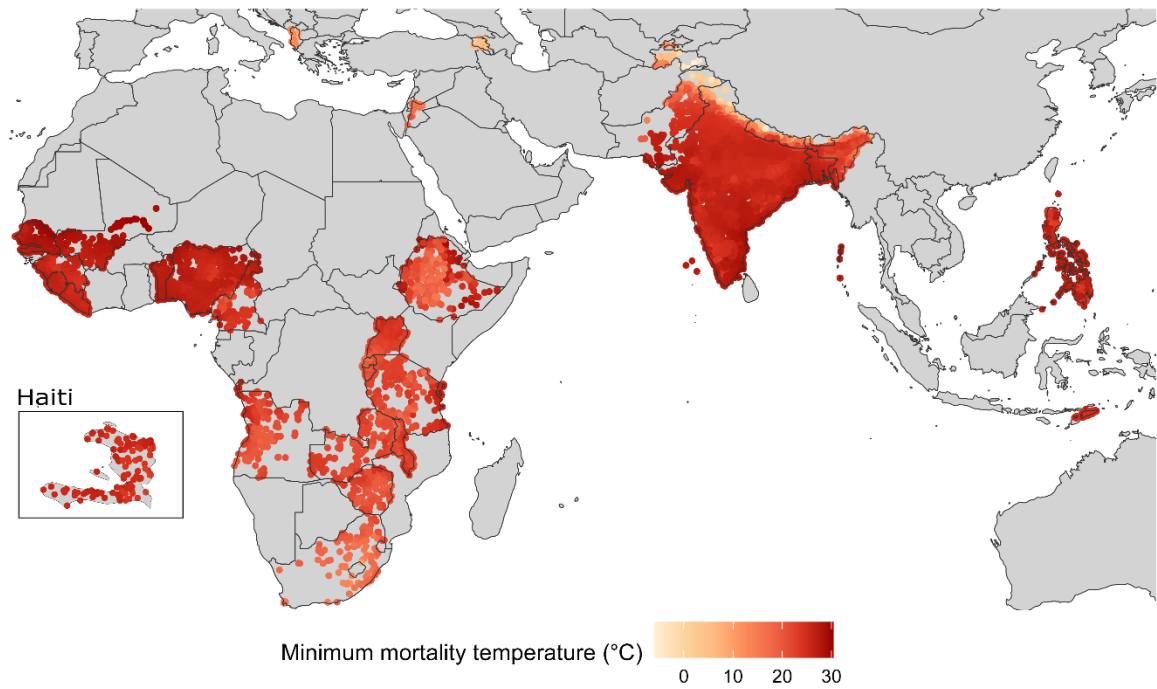


Supplementary Fig. 2: Minimum Mortality Temperatures (MMT) (°C) across DHS clusters. a, neonatal mortality and **b,** very early neonatal mortality. Estimated as the average across the three ISIMIP3a reanalysis datasets: GSWP3-W5E5, 20CRV3-ERA5 and 20CRV3-W5E5.

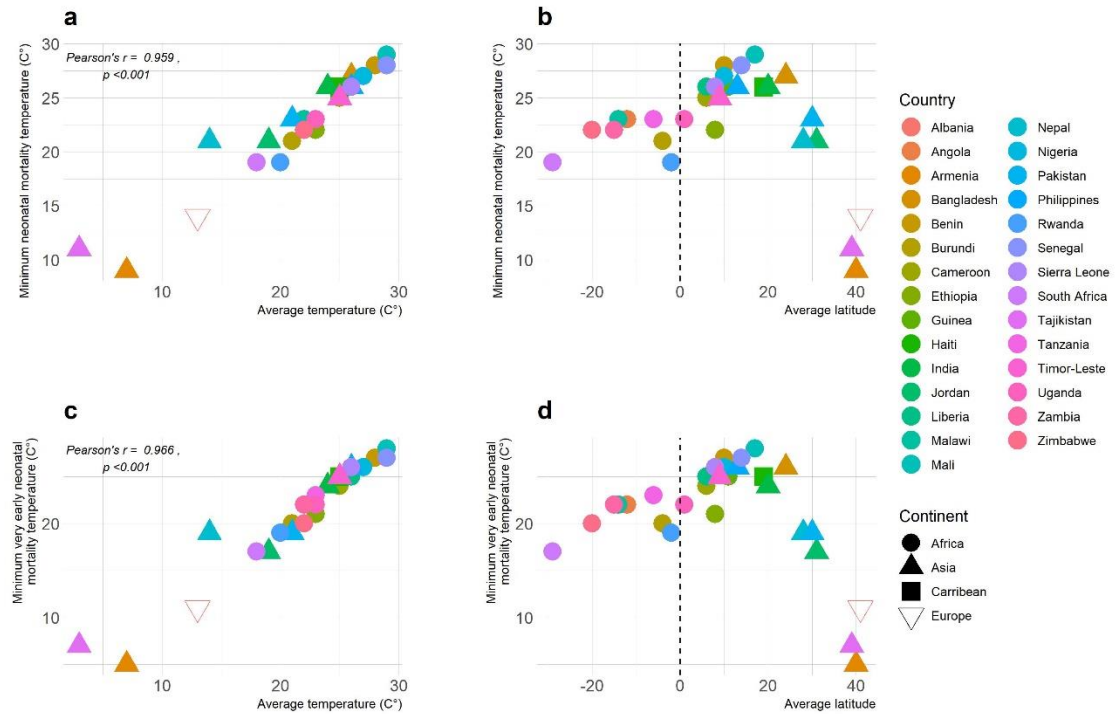
a



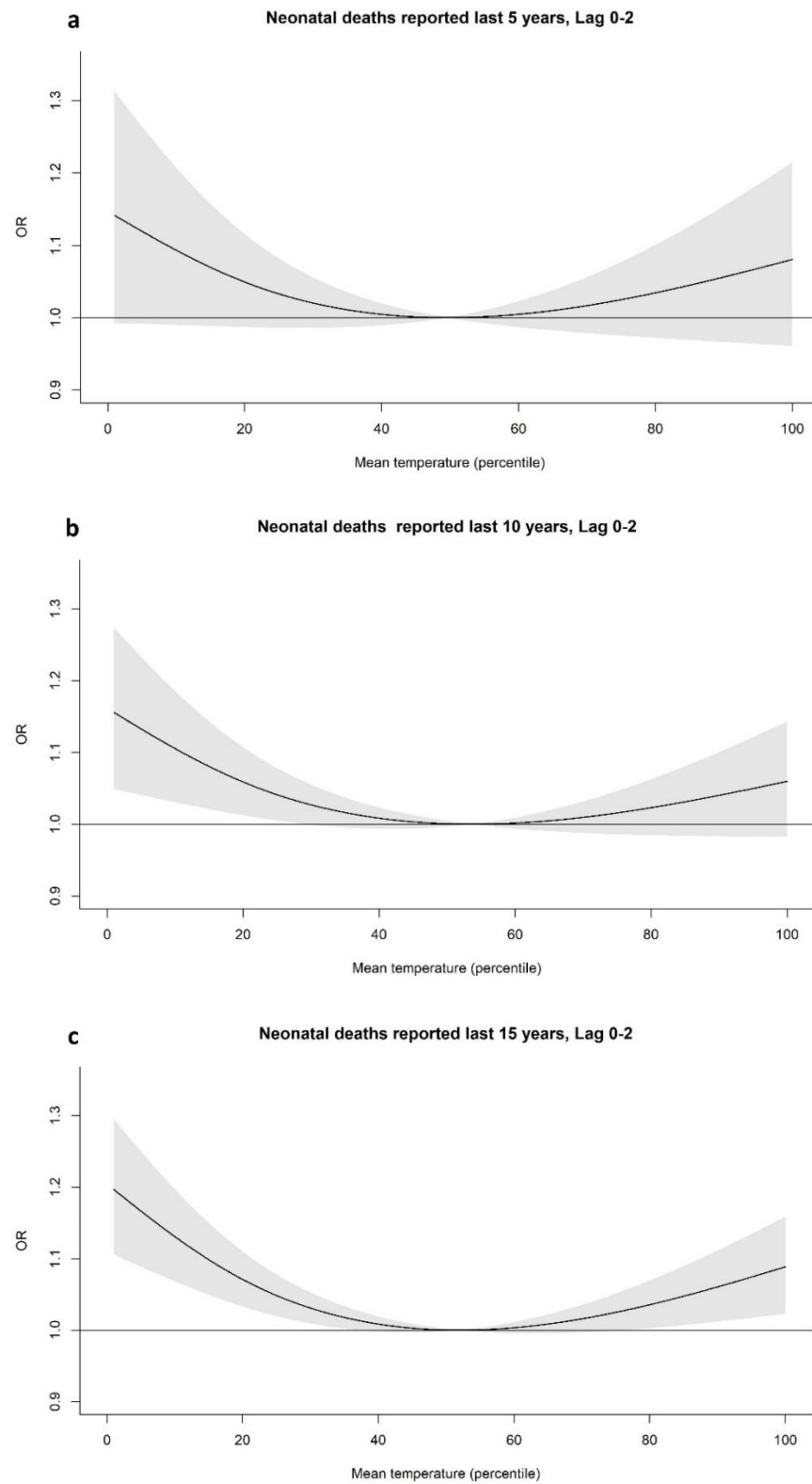
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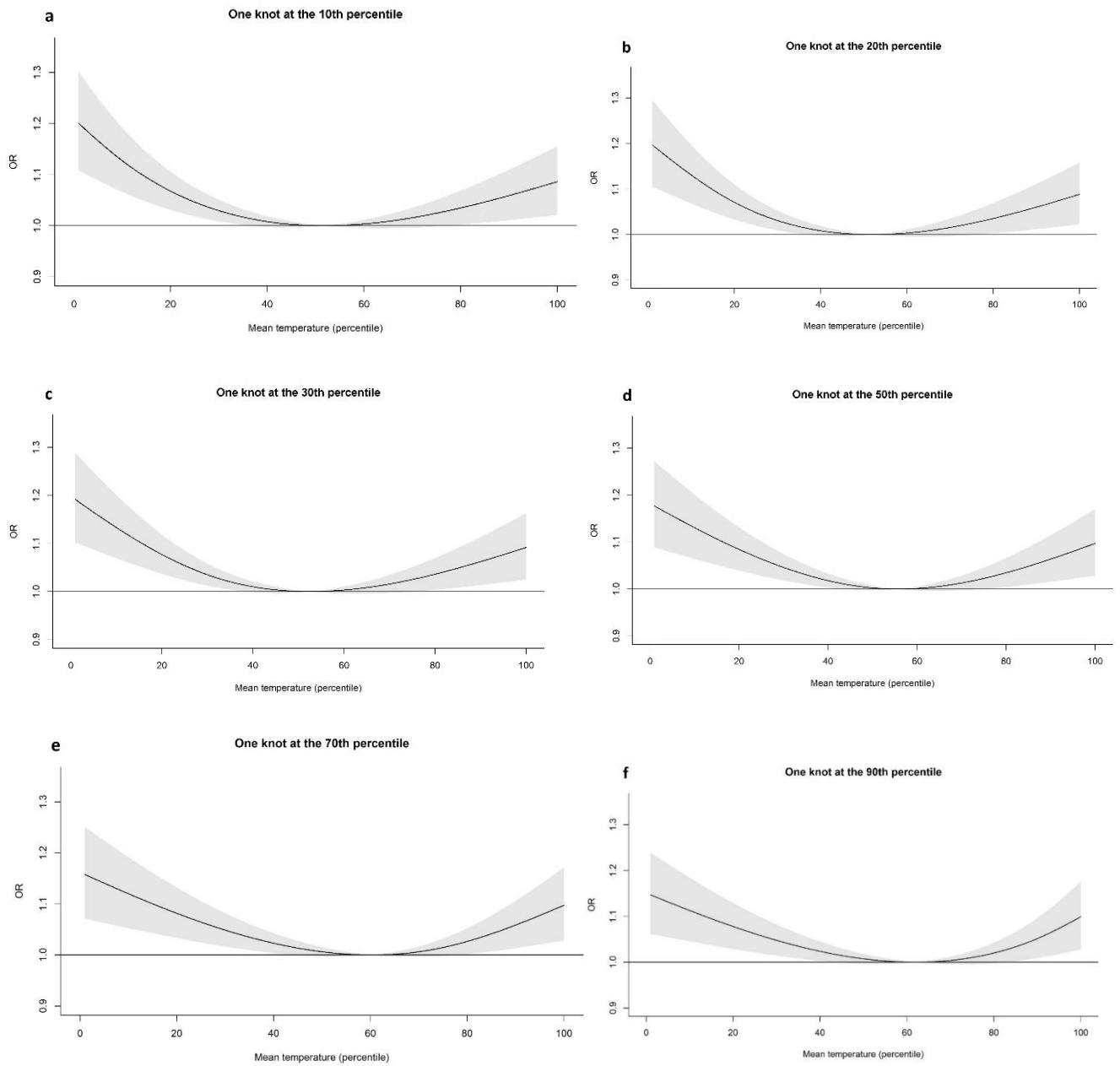
Supplementary Fig. 3: Annual mean temperature and minimum mortality temperature in the 29 countries. **a**, Annual mean temperature and minimum neonatal mortality temperature (°C). **b**, Average latitude and minimum neonatal mortality temperature (°C) **c**, Annual mean temperature and minimum very early neonatal mortality temperature (°C). **d**, Average latitude and minimum very early neonatal mortality temperature (°C)

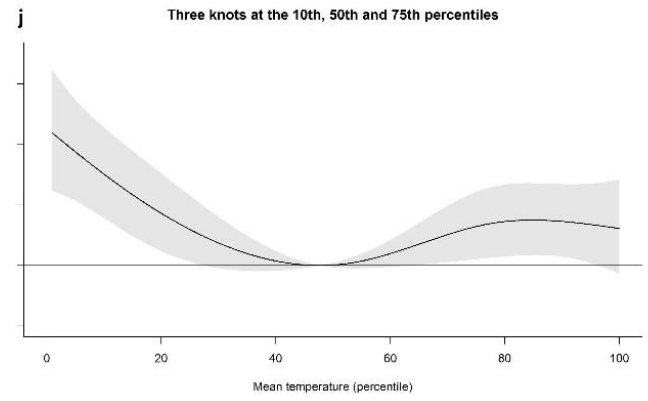
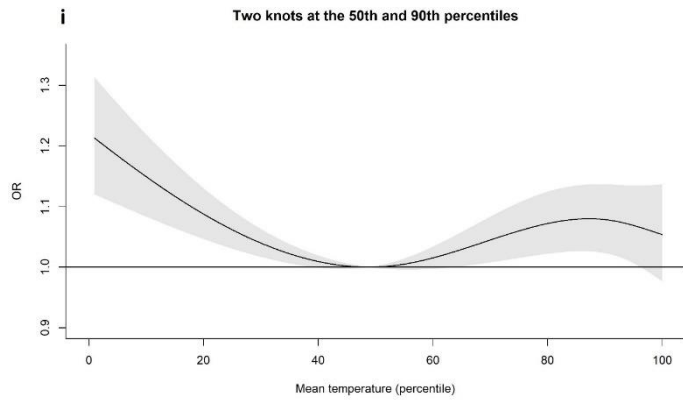
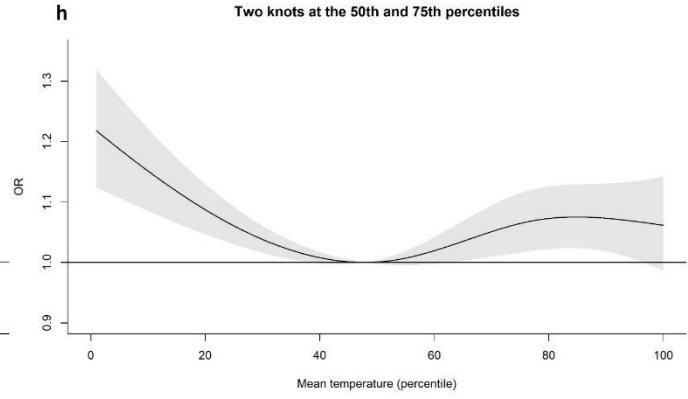
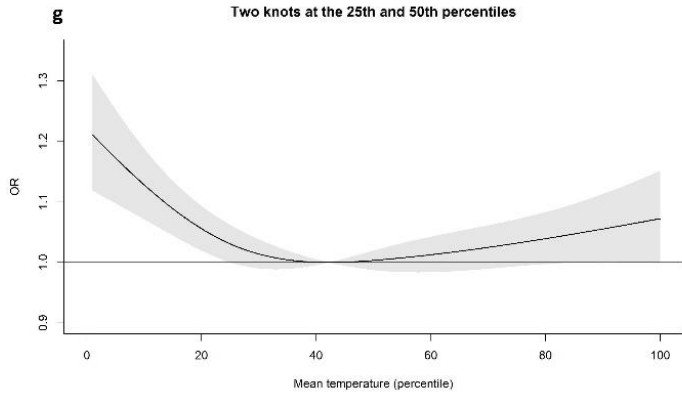


Supplementary Fig. 4: Sensitivity analysis of overall cumulative temperature–neonatal mortality association based on recall period of the mother with temperature dataset gswp3-w5e5

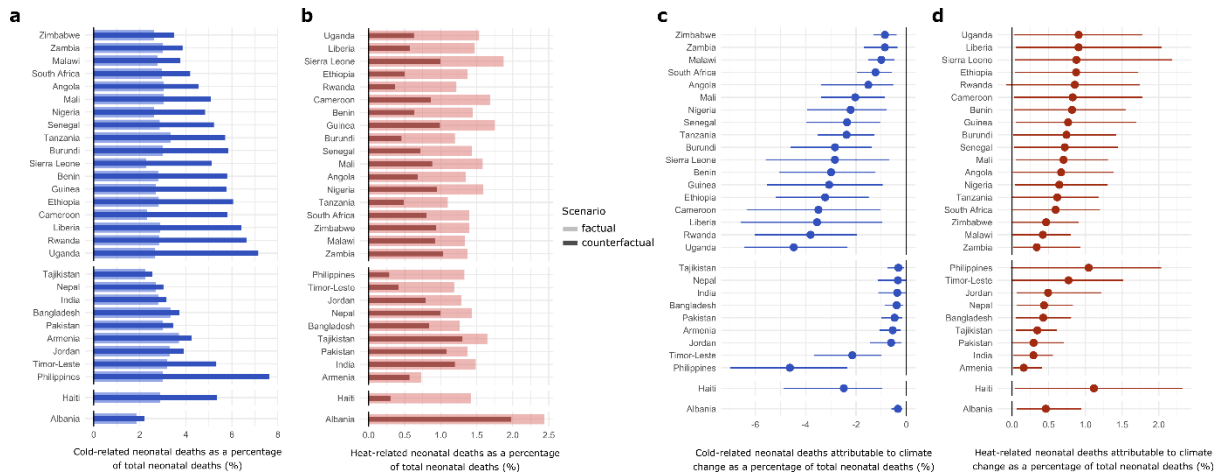


Supplementary Fig. 5: Sensitivity analysis of the overall cumulative temperature–neonatal mortality association based on knots number and placement with temperature dataset gswp3-w5e5

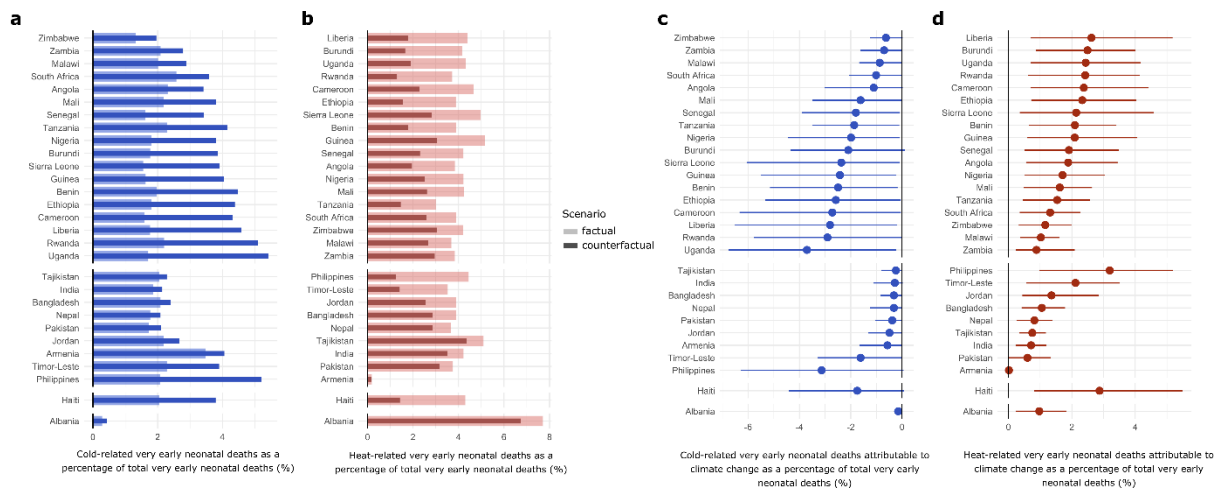




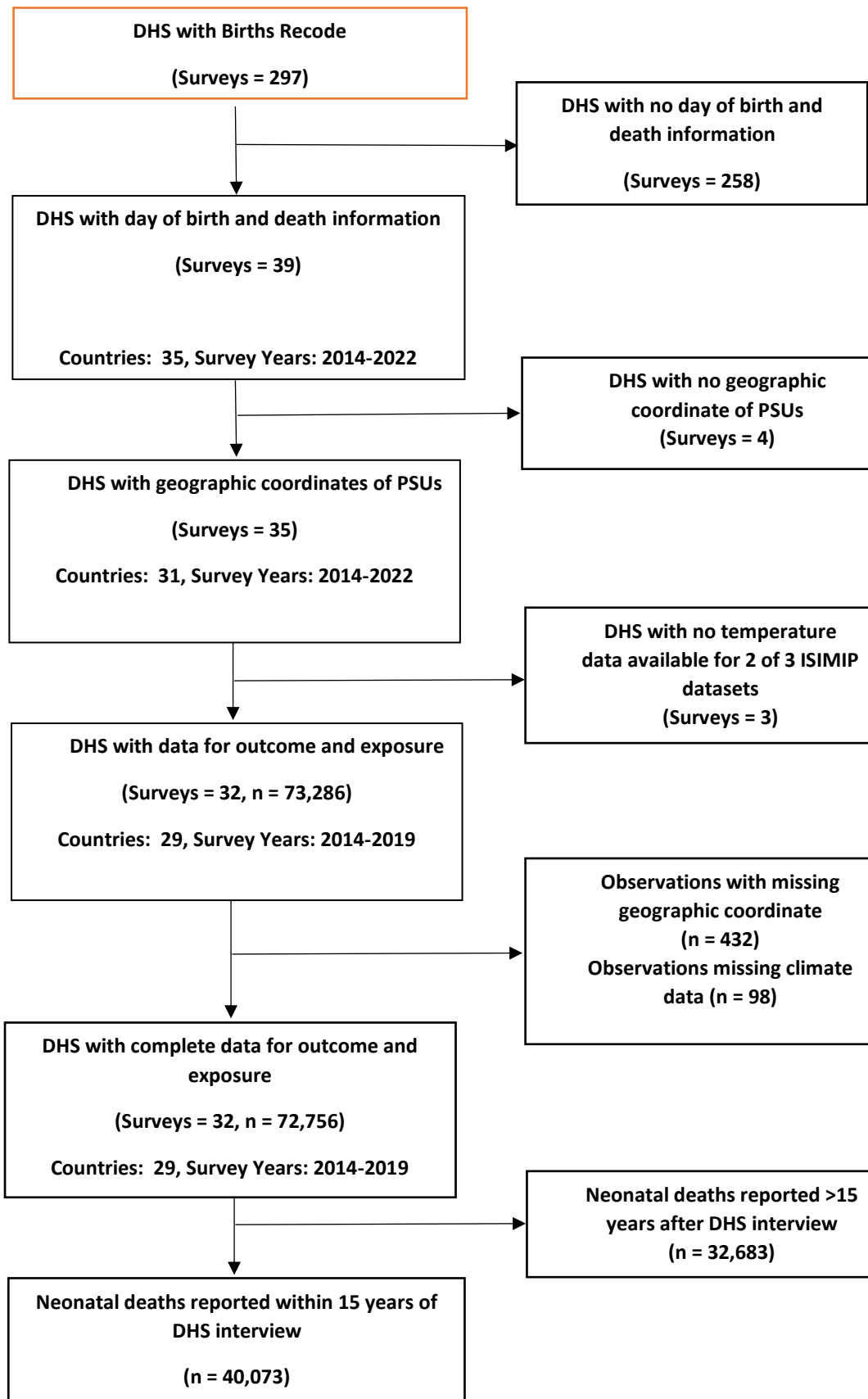
Supplementary Fig. 6: Temperature-related neonatal deaths as a percentage of total neonatal deaths by country. **a**, Cold-related neonatal deaths as a percentage of total neonatal deaths in factual and counterfactual scenarios. **b**, Heat-related neonatal deaths as a percentage of total neonatal deaths in factual and counterfactual scenarios. **c**, Cold-related neonatal deaths attributable to climate change as a percentage of total neonatal deaths, with the corresponding 95% UI. **d**, Heat-related neonatal deaths attributable to climate change as a percentage of total neonatal deaths, with the corresponding 95% UI.



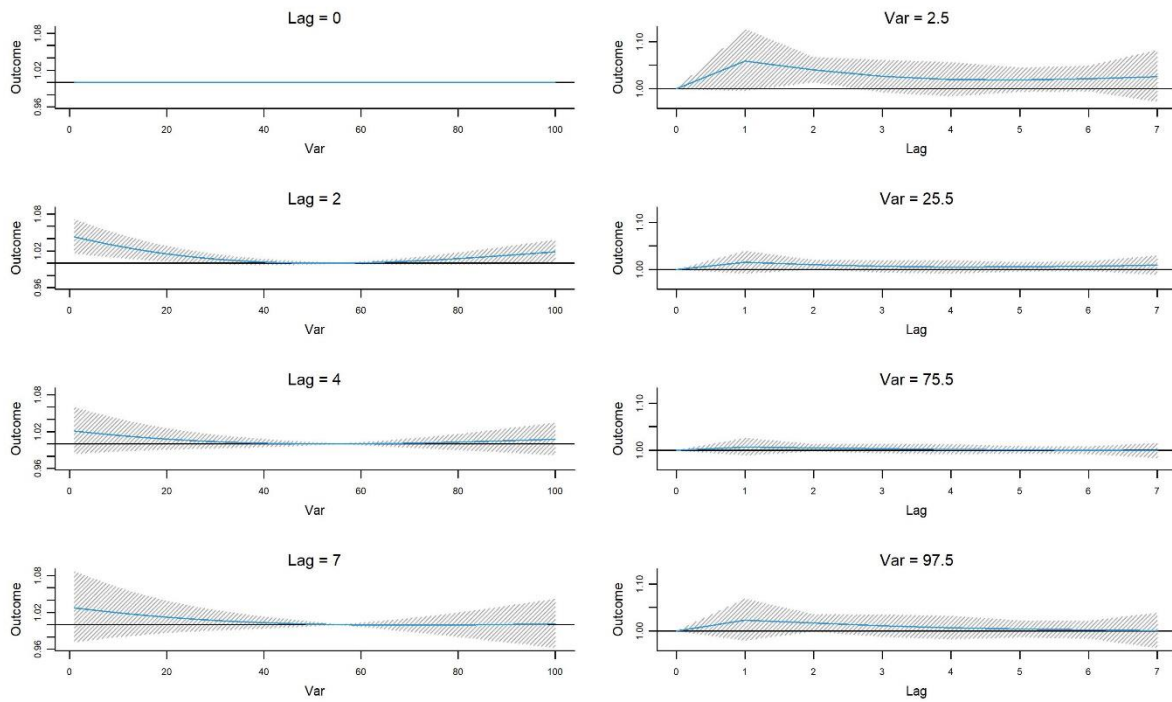
Supplementary Fig. 7: Temperature-related very early neonatal deaths as a percentage of total very early neonatal deaths by country. **a**, Cold-related very early neonatal deaths as a percentage of total very early neonatal deaths in factual and counterfactual scenarios. **b**, Heat-related very early neonatal deaths as a percentage of total very early neonatal deaths in factual and counterfactual scenarios. **c**, Cold-related very early neonatal deaths attributable to climate change as a percentage of total very early neonatal deaths, with the corresponding 95% UI. **d**, Heat-related very early neonatal deaths attributable to climate change as a percentage of total very early neonatal deaths, with the corresponding 95% UI.



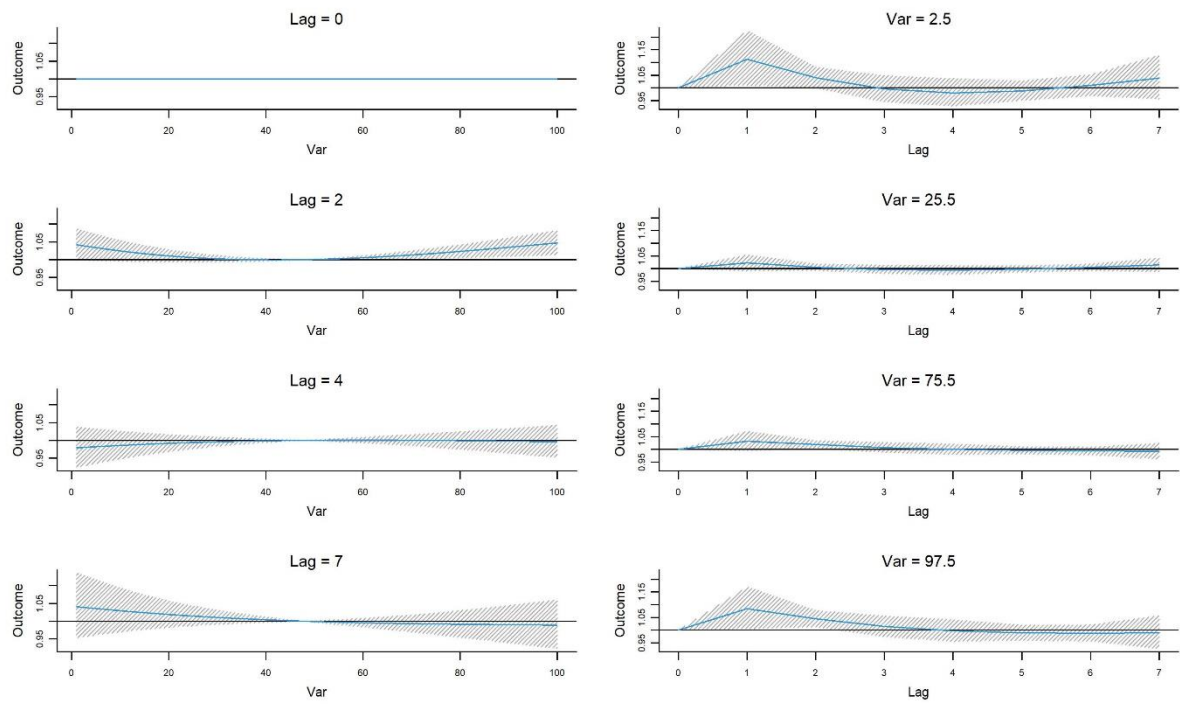
Supplementary Fig. 8: Flowchart of the included Demographic Health Surveys (DHS) and observations



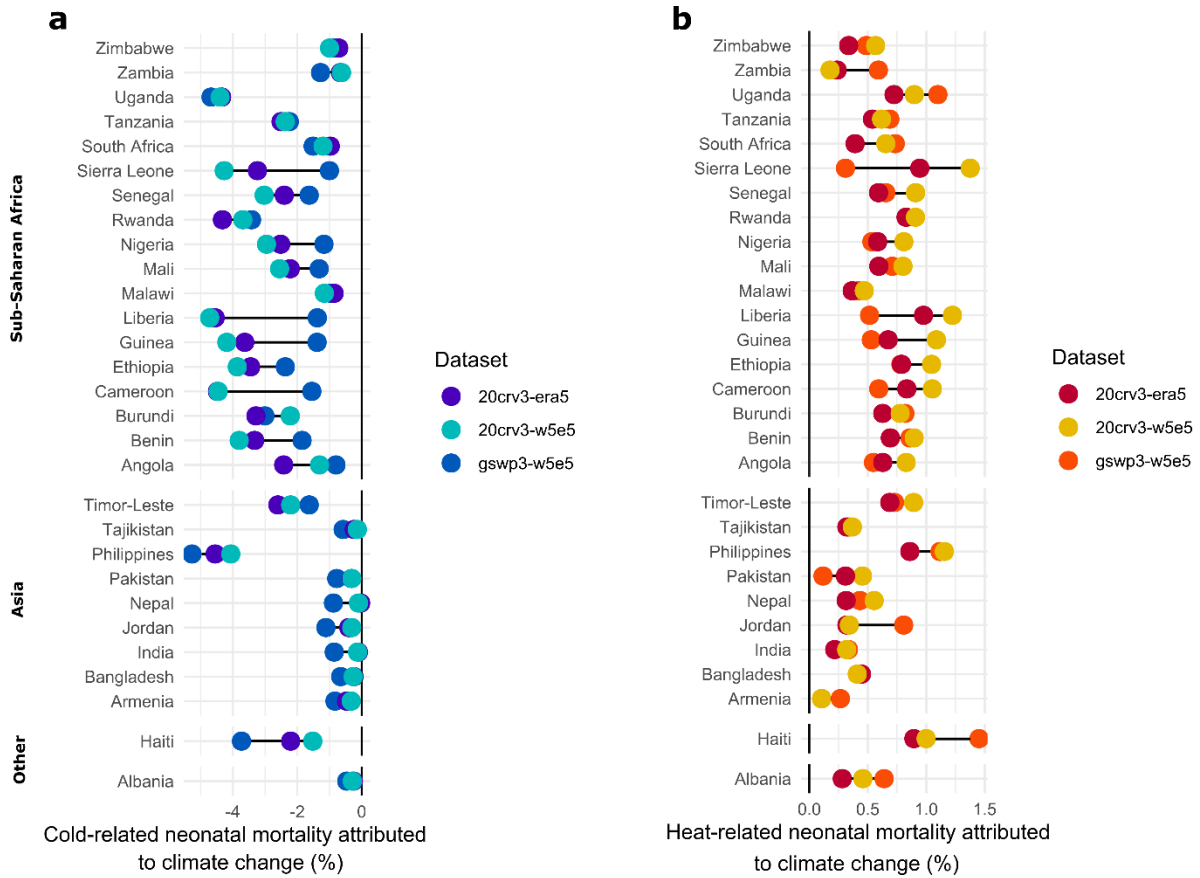
Supplementary Fig. 9: Plot of RR for neonatal mortality by temperature at specific lags (left) and RR by lag at 2.5th, 25.5th, 75.5th and 97.5th percentiles of temperature distribution (right), using temperature reanalysis dataset gswp3-w5e5.



Supplementary Fig. 10: Plot of RR for very early neonatal mortality by temperature at specific lags (left) and RR by lag at 2.5th, 25.5th, 75.5th and 97.5th percentiles of temperature distribution (right), using temperature reanalysis dataset gswp3-w5e5.



Supplementary Fig. 11: Temperature-related neonatal mortality attributable to climate change as a share of total neonatal mortality (%) across reanalysis products. **a**, Percentage of neonatal mortality attributable to climate change-induced reduction in cold. **b**, Percentage of neonatal mortality attributable to climate change-induced heat. Estimated as the difference in temperature-related neonatal mortality between the factual and counterfactual scenarios (2001-2019).



Supplementary Fig. 12: Temperature-related very early neonatal mortality attributable to climate change as a share of total very early neonatal mortality (%) across reanalysis products. a, Percentage of very early neonatal deaths attributable to climate change-induced reduction in cold. **b,** Percentage of very early neonatal deaths attributable to climate change-induced heat. Estimated as the difference in temperature-related very early neonatal mortality between the factual and counterfactual scenarios (2001-2019)

