Web extra

Supplement 1

Updated search

Preterm birth

Date of search 2019/09/11 Medline(Pubmed)
1094 records located. 12 eligible on screening of title or abstract

((preterm) OR Obstetric Labor, Premature[MeSH Terms]) AND ((((((weather) OR temperature) OR meteoro*)) OR ((((climate) OR (((((“ambient temperature”[title/abstract] OR “heat strain”[title/abstract] OR “heat exposure”[title/abstract] OR “heat stress”[title/abstract] OR Heating[mesh] OR “Heat Stress Disorders”[MESH] OR “hot temperature*”[title/abstract] OR “extreme heat”[MESH] OR “Heat stroke”[MESH] OR “heatstroke”[title/abstract] OR “heat index”[title/abstract] OR “heat episode”[title/abstract] OR “Heat Stress Disorders”[MESH] OR “heat event”[title/abstract] OR “Body temperature”[Mesh:noexp] OR “extreme temperature*”[title/abstract] OR “summer temperature*”[title/abstract] OR “Heat Exhaustion”[mesh] OR “summer weather”[title/abstract] OR “summer temperature*”[title/abstract] OR “heat wave”[title/abstract] OR “heatwave”[title/abstract] OR “indoor temperature”[title/abstract] OR “global temperature*”[title/abstract]))) NOT ((("Animals"[Mesh] NOT ("Animals"[Mesh] AND "Humans"[Mesh])))) NOT (“Chemicals and Drugs Category”[MeSH]) NOT ((("Plants"[Mesh] NOT ("Plants"[Mesh] AND "Humans"[Mesh])))))))) AND Obstetric Labor, Premature[MeSH Terms]))))

Birth weight

Date of search 2019/09/07 Medline(Pubmed)
1758 records located. 8 eligible on screening of title or abstract

(((birth) AND weight)) AND ((((((((weather) OR temperature) OR meteoro*)) OR ((((climate) OR (((((“ambient temperature”[title/abstract] OR “heat strain”[title/abstract] OR “heat exposure”[title/abstract] OR “heat stress”[title/abstract] OR Heating[mesh] OR “Heat Stress Disorders”[MESH] OR “hot temperature*”[title/abstract] OR “extreme heat”[MESH] OR “Heat stroke”[MESH] OR “heatstroke”[title/abstract] OR “heat index”[title/abstract] OR “heat episode”[title/abstract] OR “Heat Stress Disorders”[MESH] OR “heat event”[title/abstract] OR “Body temperature”[Mesh:noexp] OR “extreme temperature*”[title/abstract] OR “summer temperature*”[title/abstract] OR “Heat Exhaustion”[mesh] OR “summer weather”[title/abstract] OR “summer temperature*”[title/abstract] OR “heat wave”[title/abstract] OR “heatwave”[title/abstract] OR “indoor temperature”[title/abstract] OR “global temperature*”[title/abstract]))) NOT ((("Animals"[Mesh] NOT ("Animals"[Mesh] AND "Humans"[Mesh])))) NOT (“Chemicals and Drugs Category”[MeSH]) NOT ((("Plants"[Mesh] NOT ("Plants"[Mesh] AND "Humans"[Mesh])))))))) AND Obstetric Labor, Premature[MeSH Terms]))))))

Stillbirth

Date of search 2019/09/12 Medline(Pubmed).
83 records located. 1 eligible on screening of title or abstract.

(stillbirth) AND ((((((weather) OR temperature) OR meteoro*)) OR ((((climate) OR (((((“ambient temperature”[title/abstract] OR “heat strain”[title/abstract] OR “heat exposure”[title/abstract] OR “heat stress”[title/abstract] OR Heating[mesh] OR “Heat Stress Disorders”[MESH] OR “hot temperature*”[title/abstract] OR “extreme heat”[MESH] OR “Heat stroke”[MESH] OR “heatstroke”[title/abstract] OR “heat index”[title/abstract] OR “heat episode”[title/abstract] OR “Heat Stress Disorders”[MESH] OR “heat event”[title/abstract] OR “Body temperature”[Mesh:noexp] OR “extreme temperature*”[title/abstract] OR “summer temperature*”[title/abstract] OR “Heat Exhaustion”[mesh] OR “summer weather”[title/abstract] OR “summer temperature*”[title/abstract] OR “heat wave”[title/abstract] OR “heatwave”[title/abstract] OR “indoor temperature”[title/abstract] OR “global temperature*”[title/abstract]))) NOT ((("Animals"[Mesh] NOT ("Animals"[Mesh] AND "Humans"[Mesh])))) NOT (“Chemicals and Drugs Category”[MeSH]) NOT ((("Plants"[Mesh] NOT ("Plants"[Mesh] AND "Humans"[Mesh])))))))) AND Obstetric Labor, Premature[MeSH Terms]))))

Original search on MEDLINE (Pubmed) and Web of Science

Pubmed search:

Search covers terms for:

1. The population (those affected by heat: no 1 below) AND
2. Intervention (No. 2a: climate change OR 2b Media OR 2c cooling OR 2d Health promotion)
3. NOT 3 (genetics)

1. Search for the Population (those with heat-related conditions)

(((“ambient temperature”[title/abstract] OR “heat strain”[title/abstract] OR “heat exposure”[title/abstract] OR “heat stress”[title/abstract] OR Heating[mesh] OR “Heat Stress Disorders”[MESH] OR “hot temperature*”[title/abstract] OR “extreme heat”[MESH] OR “Heat stroke”[MESH] OR “heatstroke”[title/abstract] OR “heat index”[title/abstract] OR “heat episode”[title/abstract] OR “Heat Stress Disorders”[MESH] OR “heat event”[title/abstract] OR “Body temperature”[Mesh:noexp] OR “extreme temperature*”[title/abstract] OR “summer temperature*”[title/abstract] OR “Heat Exhaustion”[mesh] OR “summer weather”[title/abstract] OR “summer temperature*”[title/abstract] OR “heat wave”[title/abstract] OR “heatwave”[title/abstract] OR “indoor temperature”[title/abstract] OR “global temperature*”[title/abstract]))) NOT ((("Animals"[Mesh] NOT ("Animals"[Mesh] AND "Humans"[Mesh])))) NOT (“Chemicals and Drugs Category”[MeSH]) NOT ((("Plants"[Mesh] NOT ("Plants"[Mesh] AND "Humans"[Mesh]))))

AND

2. Search strategy for interventions
    a. locating Climate change articles in Pubmed

((“global warming”[Title/Abstract] OR “global warming”[MESH] OR climatic*[Title/Abstract] OR “climate change"[Title/Abstract] OR “climate change”[MESH] OR “Desert Climate”[mesh] OR “El Nino-Southern Oscillation”[Mesh] OR Microclimate[mesh] OR “Tropical Climate”[mesh]))

    b. Search for media (a validated search for social media)

media[title/abstract] OR communication*[title/abstract] OR audiovisual[title/abstract] OR helpline*[title/abstract] OR hotline*[title/abstract] OR telecommunication*[title/abstract] OR educat*[title/abstract] OR radio[title/abstract] OR television[title/abstract] OR TV[title/abstract] OR internet[title/abstract] OR campaign*[title/abstract] OR advert*[title/abstract] OR print*[title/abstract] OR “information campaign”[title/abstract] OR telemedicine[title/abstract] OR telehealth[title/abstract] OR telepharmac* OR e-health[title/abstract] OR ehealth[title/abstract] OR e-pharmac*[title/abstract] OR “social media”[mesh] OR “social media”[title/abstract] OR “social network*”[title/abstract] OR Twitter[title/abstract] OR Facebook[title/abstract] OR Linkedin[title/abstract] OR Pinterest[title/abstract] OR YouTube[title/abstract] OR "daily motion"[title/abstract] OR Yelp[title/abstract] OR Foursquare[title/abstract] OR "Google Circles"[title/abstract] OR Qype[title/abstract] OR Ello[title/abstract] OR Instagram[title/abstract] OR "Pip.io"[title/abstract] OR "Google Buzz"[title/abstract] OR Orkut[title/abstract] OR Tumblr[title/abstract] OR onesocialweb[title/abstract] OR asmallworld[title/abstract] OR bebo[title/abstract] OR myspace[title/abstract] OR folkdirect[title/abstract] OR virb[title/abstract] OR Friendster[title/abstract] OR storyofmylife[title/abstract]

    c. Search for cooling

cooling[title/abstract] OR “Air condition*”[title/abstract] OR “Air-condition*”[title/abstract] OR climatization[title/abstract] OR climatisation[title/abstract] OR ventilation[title/abstract] OR Fan[title/abstract] OR fans[title/abstract]

    d. Search for health promotion and risk

adaptation[title/abstract] OR adapting[title/abstract] OR response[title/abstract] OR alert[title/abstract] OR implement*[title/abstract] OR awareness[title/abstract] OR strategy*[title/abstract] OR strategies[title/abstract] OR ”risk management”[title/abstract] OR ”risk management”[mesh] OR “emergency management”[title/abstract] OR “preparedness”[title/abstract] OR “disaster management”[title/abstract] OR warning*[title/abstract] OR “health promotion”[MeSH] OR “Health education”[MeSH] OR “communication campaign*”[Title/abstract] OR guideline*[Title/Abstract] OR recommendation*[Title/Abstract] OR “Health Services for the Aged”[mesh] OR “health facility planning”[MESH] OR “Public health surveillance”[MeSH] OR “home intervention”[title/abstract] OR “home care”[title/abstract] OR homecare[title/abstract] OR “home care services”[MESH] OR “patient care planning”[MESH] OR “Comprehensive Health Care”[mesh] OR outreach[title/abstract] OR “Patient care team”[MESH] OR multidisciplinary[title/abstract] OR “home visit”[title/abstract] OR “home assessment”[title/abstract] OR “patient management”[title/abstract] OR “social support”[MESH] OR shelter[title/abstract]

3. Not genetics

NOT (Genetic Phenomena[MeSH] OR DNA[title/abstract] OR RNA[title/abstract])

Full search:

((((((((adaptation[title/abstract] OR adapting[title/abstract] OR response[title/abstract] OR alert[title/abstract] OR implement*[title/abstract] OR awareness[title/abstract] OR strategy*[title/abstract] OR strategies[title/abstract] OR ”risk management”[title/abstract] OR ”risk management”[mesh] OR “emergency management”[title/abstract] OR “preparedness”[title/abstract] OR “disaster management”[title/abstract] OR warning*[title/abstract] OR “health promotion”[MeSH] OR “Health education”[MeSH] OR “communication campaign*”[Title/abstract] OR guideline*[Title/Abstract] OR recommendation*[Title/Abstract] OR “Health Services for the Aged”[mesh] OR “health facility planning”[MESH] OR “Public health surveillance”[MeSH] OR “home intervention”[title/abstract] OR “home care”[title/abstract] OR homecare[title/abstract] OR “home care services”[MESH] OR “patient care planning”[MESH] OR “Comprehensive Health Care”[mesh] OR outreach[title/abstract] OR “Patient care team”[MESH] OR multidisciplinary[title/abstract] OR “home visit”[title/abstract] OR “home assessment”[title/abstract] OR “patient management”[title/abstract] OR “social support”[MESH] OR shelter[title/abstract])) OR (cooling[title/abstract] OR “Air condition*”[title/abstract] OR “Air-condition*”[title/abstract] OR climatization[title/abstract] OR climatisation[title/abstract] OR ventilation[title/abstract] OR Fan[title/abstract] OR fans[title/abstract])) OR (media[title/abstract] OR communication*[title/abstract] OR audiovisual[title/abstract] OR helpline*[title/abstract] OR hotline*[title/abstract] OR telecommunication*[title/abstract] OR educat*[title/abstract] OR radio[title/abstract] OR television[title/abstract] OR TV[title/abstract] OR internet[title/abstract] OR campaign*[title/abstract] OR advert*[title/abstract] OR print*[title/abstract] OR “information campaign”[title/abstract] OR telemedicine[title/abstract] OR telehealth[title/abstract] OR telepharmac* OR e-health[title/abstract] OR ehealth[title/abstract] OR e-pharmac*[title/abstract] OR “social media”[mesh] OR “social media”[title/abstract] OR “social network*”[title/abstract] OR Twitter[title/abstract] OR Facebook[title/abstract] OR Linkedin[title/abstract] OR Pinterest[title/abstract] OR YouTube[title/abstract] OR "daily motion"[title/abstract] OR Yelp[title/abstract] OR Foursquare[title/abstract] OR "Google Circles"[title/abstract] OR Qype[title/abstract] OR Ello[title/abstract] OR Instagram[title/abstract] OR "Pip.io"[title/abstract] OR "Google Buzz"[title/abstract] OR Orkut[title/abstract] OR Tumblr[title/abstract] OR onesocialweb[title/abstract] OR asmallworld[title/abstract] OR bebo[title/abstract] OR myspace[title/abstract] OR folkdirect[title/abstract] OR virb[title/abstract] OR Friendster[title/abstract] OR storyofmylife[title/abstract])) OR (((“global warming”[Title/Abstract] OR “global warming”[MESH] OR climatic*[Title/Abstract] OR “climate change"[Title/Abstract] OR “climate change”[MESH] OR “Desert Climate”[mesh] OR “El Nino-Southern Oscillation”[Mesh] OR Microclimate[mesh] OR “Tropical Climate”[mesh]))))) NOT ((Genetic Phenomena[MeSH] OR DNA[title/abstract] OR RNA[title/abstract])))) AND ((((“ambient temperature”[title/abstract] OR “heat strain”[title/abstract] OR “heat exposure”[title/abstract] OR “heat stress”[title/abstract] OR Heating[mesh] OR “Heat Stress Disorders”[MESH] OR “hot temperature*”[title/abstract] OR “extreme heat”[MESH] OR “Heat stroke”[MESH] OR “heatstroke”[title/abstract] OR “heat index”[title/abstract] OR “heat episode”[title/abstract] OR “Heat Stress Disorders”[MESH] OR “heat event”[title/abstract] OR “Body temperature”[Mesh:noexp] OR “extreme temperature*”[title/abstract] OR “summer temperature*”[title/abstract] OR “Heat

Exhaustion”[mesh] OR “summer weather”[title/abstract] OR “summer temperature*”[title/abstract] OR “heat wave”[title/abstract] OR “heatwave”[title/abstract] OR “indoor temperature”[title/abstract] OR “global temperature*”[title/abstract]))) NOT ((("Animals"[Mesh] NOT ("Animals"[Mesh] AND "Humans"[Mesh])))) NOT (“Chemicals and Drugs Category”[MeSH]) NOT ((("Plants"[Mesh] NOT ("Plants"[Mesh] AND "Humans"[Mesh])))))

Web of Science search:

Terms for heat and interventions:

(TS=(ambient temperature OR heat strain OR heat exposure OR heat stress OR extreme heat OR Heat stroke OR heatstroke OR heat index OR heat episode OR heat event OR extreme temperature OR heat exhaustion OR heat wave OR heatwave OR hot temperature OR global temperature OR summer temperature OR summer weather OR outdoor temperature OR “Air conditioner*” OR “air conditioning”)) **OR**

(TI=(ambient temperature OR heat strain OR heat exposure OR heat stress OR extreme heat OR Heat stroke OR heatstroke OR heat index OR heat episode OR heat event OR extreme temperature OR heat exhaustion OR heat wave OR heatwave OR hot temperature OR global temperature OR summer temperature OR summer weather OR outdoor temperature OR “air conditioner*” OR “air conditioning”))

AND LANGUAGE: (English OR Chinese OR German) **AND DOCUMENT TYPES:** (Article)

WC/SU

(WC=(Medicine, Research & Experimental OR Public, Environmental & Occupational Health OR Health Care Sciences & Services OR Primary Health Care OR Film, Radio, Television OR urban studies OR Behavioral Sciences OR communication OR Infectious Diseases OR Planning & Development)) OR

(SU=(Communication OR Biomedical Social Sciences OR Health Policy & Services OR Public, Environmental & Occupational Health OR Urban Studies OR Research & Experimental Medicine OR Infectious Diseases OR Health Care Sciences & Services OR Behavioral OR Film, Radio & Television))

NOT

NOT TS=(wildlife OR animal OR fish OR flora OR conservation OR soil OR “heat shock protein” OR ”heat shock proteins” OR genetic OR “DNA” OR “RNA”)

Indexes:

Science Citation Index Expanded (SCI-EXPANDED) --1945-present

Social Sciences Citation Index (SSCI) --1945-present

Arts & Humanities Citation Index (A&HCI) --1975-present

Contents

Table 1a-d: Description of studies, including study quality

Supplementary Table 1a. Description of studies assessing associations between exposure to high temperatures and preterm birth

Author (year)	Country of study	Climate zone#	Aim	Year of study	Study design	Study population
Low-income countries						
	-					
Lower-middle income countries						
	-					
Upper-middle income countries						
Zhong (2018)[1]	Changsha, Hunan Province, China	Humid subtropical	To explore associations between PTB and long-term exposure to seasonal and diurnal temperatures during pregnancy	2002-2010	Time series	Survey in 36 kindergartens in 2011-2012 (children 1-8 years old), Urban
Zheng (2018)[2]	Changsha, Hunan Province, China	Humid subtropical	To examine associations between PTB and long-term exposure to high and low temperatures during different windows	2004-2010	Time series	Survey in 36 kindergartens in 2011-2012 (children 1-8 years old), Urban
He (2016)[3]	Guangzhou, China	Dry-winter humid subtropical	To investigate association between maternal exposure to ambient temperature and PTB	2001-2011	Time series	Registry includes >97% of deliveries in Guangzhou. Singleton and vaginal births. 20-43 weeks gestation. Urban
Liang (2016)[4]	Shenzhen, China	Humid subtropical	To increase awareness of policy makers and clinicians of the role of temperature exposure on PTB	2005-2011	Time series	Singleton. Excluded women with unknown or implausible LMP. Urban. Birth registry database
Guo (2018)[5]	132 cities in 30 provinces in China	-	To explore effects of exposure to extreme environmental temperatures during pregnancy on PTB	2010-2013	Time series	Women 15-49 years. Singleton. 94% urban. National register
Wu (2019)[6]	Wuhan city, Hubei province, China	Humid subtropical	To assess a series of exposure windows before delivery to illustrate the relationship between diurnal temperature range and PTB, and to explore potential modification effects between the diurnal temperature range and maternal age, pre-pregnancy BMI, birth season and infant gender	Sept. 2012-Oct. 2014	Time series	Singleton. <42 weeks gestation. 1 hospital. Urban
Andalon (2016)[7]	Colombia (whole country)	-	To study relationships between health outcomes at birth and foetal exposure to temperature shocks	1999–2008	Time series	National registry of live births. Rural, semi-rural areas
Muresan (2016)[8]	Cluj-Napoca, Transylvania, Romania	Warm summer continental or hemiboreal	To analyse the possible correlation between incidence of PTB and meteorological parameters	Jan.-Dec. 2014	Time series	Population registry. Excluded if no ultrasound in 1st trimester
Mohammadi, (2019)[9]	Sabzevar, north eastern Iran	Cold desert	To examine the hypothesis of an association between environmental heat stress and PTB	2011-2017	Time series	Records from 4 hospitals. N total births not stated.
High-income countries						
East Asia, Pacific						
Strand (2012)[10]	Brisbane, Australia	Humid subtropical	To investigate relations between maternal exposure to ambient temperature and risks of PTB and stillbirth	2005–2009	Time series	Hospital records. Singleton >20 weeks gestation. Urban
Wang (2013)[11]	Brisbane, Australia	Humid subtropical	To investigate effects of heat waves on PTB and how the birth-related effects of heat wave changed when	2000-2010. Warm seasons (Nov.–March)	Time series	Singleton, spontaneous delivery, >20 weeks gestation or >400g

Author (year)	Country of study	Climate zone#	Aim	Year of study	Study design	Study population
			different temperature thresholds and durations were used to define a heat wave			
Wang (2019)[12]	Brisbane, Australia	Humid subtropical	To assess effects of heat wave exposure in each month of pregnancy on the risk of PTB and stillbirth	2000-2010. Warm seasons (Nov.–March)	Time series	Singleton. >19 gestation weeks, >400g. Urban
Li (2018a)[13]	Brisbane, Australia	Humid subtropical	To assess the overall impact of hot and cold temperatures on duration of gestation and birth weight, and any possible susceptible period to temperature exposure for different pregnant outcomes	2001-2010	Time series	Singleton, >20 weeks gestation, >400 g birth weight.
Mathew (2017)[14]	Alice springs, Northern Territory, Australia	Hot semi-arid	To evaluated whether high ambient temperature increases risk of preterm birth in a Central Australian town of the Northern Territory	1986-2013	Time series	Town in remote region of the country. Singletons. Excludes elective C-section births
Li (2018b)[15]	Brisbane, Australia	Humid subtropical	To assess effects of temperature at different stages of pregnancy on the risk of PTB and stillbirth, and change over time in associations	1994-2013	Time series	>400g, >20 weeks gestation. Urban
Tustin, (2004)[16]	Dunedin, New Zealand	Oceanic	To investigate effect of maternal exposure to sunshine and temperature, especially whether temperature in 2nd trimester or sunshine in 1st trimester can explain seasonal variation in birth weight	1999-2002	Time series	All births in Dunedin. Term defined as ≥38 weeks. Rural
Son (2019)[17]	Seoul, South Korea	Hot summer continental	To investigate associations between heat exposure and PTB and term low birth weight	2004–2012	Time series	Singleton. Urban
Weng (2018)[18]	Taiwan, China	-	To examine relations between neonatal outcomes and temperatures at birth	2001-2010		Birth records. Singleton. Stillbirths excluded
European Union and Central Asia						
Giorgis-Allemand (2017)[19]	Denmark, France, Greece, Hungary, Italy, Lithuania, Norway, Spain, Sweden, The Netherlands, United Kingdom	-	To characterize associations of atmospheric pollutants and meteorological factors with PTB	1994-2010	Time series	Singleton, only 1st pregnancy in women with >1 birth. 13 cohorts from 11 countries
Schifano (2016)[20]	Rome, Italy, and Barcelona, Spain	Mediterranean hot summer	To evaluate effect of maternal short-term exposure to temperature and urban air pollutants on risk of birth by week of gestation in Rome and Barcelona during warm season	Rome: 2001-2010. Barcelona 2007-2012. Warm seasons (April-Oct.)	Time series	Singleton, women 12-54 years, spontaneous labour. Excluded congenital anomalies, C- sections if not after spontaneous labour (Rome), all C-sections (Barcelona). >22 weeks gestation (Rome), >24 weeks gestation (Barcelona). Urban
Cox (2016)[21]	Flanders, Belgium	Oceanic	To study associations between ambient temperature and PTB	1998-2011	Time series	Singleton non-induced vaginal births, 22-42 weeks gestation
Wolf (2012)[22]	Brandenburg and Saxony, Germany	-	To examine seasonal rhythms of adverse pregnancy outcome in 2 German populations and add to the quantification of current and possible future health impacts of temperature rise	Brandenburg (2002-2010), Saxony (2005-2009)	Time series	Singleton, 20-44 weeks gestation, birth weight >200g

Author (year)	Country of study	Climate zone#	Aim	Year of study	Study design	Study population
Schifano (2013)[23]	Rome, Italy	Mediterranean hot summer	To evaluate effects of maternal short-term exposure to high and low ambient temperatures and to urban air pollutants on probability of PTB, focusing on exposure in last month of pregnancy	2001-2010	Time series	Singleton. Spontaneous labour, >22 weeks gestation, women 11-54 years. Excluded congenital anomalies
Asta (2019)[24]	Bologna, Turin, Trieste, Rome, Palermo, Venice, Italy	Rome, Palermo (Mediterranean hot summer). Trieste Turin Venice (Humid subtropical)	To evaluate the association between short term maternal exposure to high temperature and air pollution on PTBs	2001-2010. Warm season (April-Oct.)	Time series	Certificate of Delivery Care Registry. Singleton, >22 weeks gestation. Urban
Dadvand (2011)[25]	Barcelona, Spain	Mediterranean hot summer	To investigate impact of maternal short-term exposure to extreme heat on the length of pregnancy.	2001- 2005	Time series	Births 1 hospital. Singleton, with spontaneous labour, mothers residing in city. Urban
Arroyo (2016)[26]	Madrid, Spain	Mediterranean hot summer	To assess environmental factors as acute (0-7 days before birth) stressors that could increase number of deliveries and PTBs	2001-2009	Time series	Singleton. Urban
Vicedo-Cabrera (2014)[27]	Valencia, Spain	Cold semi-arid	To explore associations between exposure during the last weeks of pregnancy and elevated temperatures through different temperature indicators and assessing different temperature interval-specific risks of pre-term births	2006-2010. Warm season (May–Sept.)	Time series	Birth register of all live births. Singleton vaginal births, 22-42 weeks gestation. Urban
Bruckner (2014)[28]	Uppsala, Sweden	Warm summer continental or hemiboreal	To test the relation between cold temperature and stillbirth in a society that routinely confronts cold	1915-1929	Time series	Birth records early 20th century population, 1 hospital. >24 weeks gestation
Vicedo-Cabrera (2015)[29]	Stockholm, Sweden	Warm summer continental or hemiboreal	To explore the associations between heat and cold during late pregnancy and risk of PTB	1998-2006. Warm season (May-Sept.)	Time series	Swedish Medical Birth Register. Singleton, spontaneous labour, gestation 22-42 weeks
Lee (2008)[30]	North West Thames region, London, United Kingdom	Oceanic	To investigate whether exposure to environmental factors, including air pollution and climatic factors, affected risk for PTB	1988-2000	Time series	Singleton. Excluded implausible birth weight, gestation <24 weeks, congenital anomalies. Urban
Latin America and Caribbean						
Yu (2018)[31]	San Juan, Mayagüez and Ponce regions, Puerto Rico	Hot Arid	To assess the integrative weather effects on PTB	1994-2012	Time series	National Center for Health Statistics. Singleton
Middle East and North Africa						
Yackerson (2008)[32]	Negev, Israel	Hot semi-arid	To detect the correlations between variations in the atmospheric state, typical for the regions close to big deserts, and the incidence of PTB and preterm premature rupture of membrane	Jan.-Dec. 1999	Time series	Hospital database.
Walfisch, (2016)[33]	Negev, Israel	Hot semi-arid	To identify seasonality, temporal variation and effects of heat stress on PTB incidence, and to identify trends in rates of spontaneous and induced PTD	1988-2012	Time series	Singleton. 1 hospital
North America						

Author (year)	Country of study	Climate zone#	Aim	Year of study	Study design	Study population
Auger (2014)[34]	Montreal, Quebec, Canada	Warm summer continental or hemiboreal	To determine association between maximum outdoor temperature and birth timing.	1981-2010. Warm seasons (June-Sept)	Time series	Register of all live births. Singleton. Urban
Lajinian (1997)[35]	Brooklyn, New York, USA	Hot summer continental	To determine if extremely high heat-humidity index is associated with PTB.	March 1993-March 1994	Time series	Singleton, 20-36 weeks. Excluded induced, C-section births, cervical cerclage. 1 hospital. Urban
Porter (1999)[36]	Chicago, USA	Hot summer continental	To examine the relationship between gestation length and heat exposure during summer months of Chicago heat wave of 1995	1995. Warm season (June-Aug.)	Time series	Singleton. Urban
Sun (2019)[37]	403 counties, USA	-	To examine associations between daily mean temperature and risk of PTB and whether these associations varied by geographic region, climate zone and personal characteristics	1989-2002	Time series	Singleton, 20-43 weeks
Carmichael, (2014)[38]	468 counties, across the country, USA	-	To examine whether a set of social, environmental and health-related factors explain geographic variability and disparities in risk of PTB among black and white women	1998–2002	Time series	Counties with ≥20 deliveries. Singleton. 20–31 weeks gestation. Black and white women. Counties cover 61.1% of USA births to whites and 90.9% of USA births to blacks.
Basu (2010)[39]	12 counties of California, USA	-	Assess association between temperature and PTB during the warm season	1999-2006. Warm season (May-Sept.)	Case-crossover	Singleton. >20 weeks. Excludes induced deliveries, births at improbable gestation or birth weight
Cil (2017)[40]	3000 counties across USA	-	To investigate risks of heat waves for adverse conditions for newborns and pregnant women	1989-2008	Time series	Singleton
Kloog (2015)[41]	Whole state of Massachusetts, USA	-	To study associations between temperature and live birth outcomes	2000-2008	Time series	Singleton births >22 weeks gestation
Ha (2017)[42]	12 sites across USA	-	To determine associations between ambient temperature and early delivery	2002-2008. Warm season (May to Sept.)	Time series and case-crossover	Birth registry. Singleton. ≥23 weeks gestation. Predominantly urban
Basu (2017)[43]	Northern California, USA	-	To examine whether maternal demographics, behavioural and medical conditions increase heat-related PTBs	1995-2009	Case-crossover	Singleton. Excludes induced births and pre-labour C-section
Avalos (2017)[44]	Northern California, USA	-	To investigate association between maternal exposure to temperature and spontaneous PTB, while taking into account differences by warm and cold seasons, coastal and inland regions, infant gender and gestational age	1995-2009	Case-crossover	Birth registry. Singleton, spontaneous labour, 16-44 weeks gestation, mothers >18, women's 1st birth in the period if >1
Ngo (2016)[45]	Manhattan, New York, USA	Hot summer continental	To estimate the impacts of extreme temperatures on birth weight and gestational age and to project impacts of climate change	1985-2010	Time series	Population registry. Urban
Kent (2014)[46]	Alabama, USA	Humid subtropical	To examine whether different heat indexes alter associations between heat waves and outcomes, and if associations differ by rurality	1990-2010. Warm season (May -Sept.)	Case-crossover	>24 weeks gestation. Rural

Author (year)	Country of study	Climate zone#	Aim	Year of study	Study design	Study population
Ward (2019)[47]	North Carolina, USA	-	To describe relationships between heat exposure and PTB and to determine thresholds at which health impacts occur for various meteorological variables of heat exposure	2011–2015. Warm season (May-Sept.)	Case-crossover	Birth certificate data. Singleton

PTB preterm birth. USA United States of America. Studies listed in order of World Bank income classification group, then geographical region and year of data collection. Köppen–Geiger climate classification system#

Supplementary Table 1b. Descriptions of studies assessing associations between exposure to high temperatures, and changes in birth weight

Author (year)	Country of study	Climate zone#	Aim	Year of study	Study design	Study population
Multi-country studies						
Wells (2002)[48]	140 populations worldwide, including: Africa (40 countries); Asia (30 countries); Central/South America (25 countries); and Europe, North America, Australia, New Zealand (35 countries)	-	To consider the hypothesis that environmental heat load and birth weight are associated using data from a wide range of populations	Birth weight data 1992 WHO report	Time series	Populations in report selected if >200 individuals and temperature data provided
Jensen (2013)[49]	68 countries and territories worldwide (all continents)	-	To amalgamate ecological, physiological and medical perspectives on BW and IQ variation and quantify the effect of climate and then determine the average variation in human BW per degree change in temperature	1971-2000	Time series	Populations sampled in surveys of BW or birth registers
Grace, (2015)[50]	Burkina Faso, Central African Republic, Ethiopia, Guinea, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Tanzania, Uganda, Zambia, Zimbabwe (19 countries)	-	To examine relationships between birth weight, precipitation, and temperature in African countries	Surveys in 1990-2010, births <5 years before each survey	Time series	DHS survey respondents. Singleton (birth weight reported by mother or on a birth record)
Molina (2017)[51]	Bolivia, Colombia, and Peru (Andean region)	-	To understand how temperature variability can affect foetal health.	Demographic and Health Surveys in 1990–2013. Births before those periods	Time series	Singleton, weigh 500-6500gm, mothers 15-45 years, lived in same area for >2 years before childbirth
Lower-middle income countries						
Rashid (2017)[52]	Matlab, Bangladesh	Tropical savanna climate with non-seasonal or dry-winter characteristics	To examine whether temperature during pregnancy influences foetal growth and thus size of birth	2001-2003	Time series	Singleton. Rural
Upper-middle income countries						
Andalon (2016)[7]	Colombia	-	To study relationships between health outcomes at birth and foetal exposure to temperature shocks	1999–2008	Time series	National registry of live births. Rural, semi-rural areas
Elter (2004)[53]	Istanbul, Turkey	Mediterranean hot summer	To investigate effect of season on birth weight and determine meteorological factors and specific periods of exposure which contribute to seasonal variation in birth weight	1992-2003	Time series	Singleton. Term. 1 hospital. Urban
MacVicar (2017)[54]	Kanungu District, Uganda	Tropical savanna climate with non-	To examine associations between meteorological factors and birth weight, identify the highest-risk	2012-2015	Time series	1 hospital. Singleton. Rural

Author (year)	Country of study	Climate zone[#]	Aim	Year of study	Study design	Study population
		seasonal or dry-winter characteristics	period for exposures during pregnancy and compare effects of exposures on birth weight in Indigenous and non-Indigenous mothers.			
High-income countries						
East Asia, Pacific						
Li (2018a)[13]	Brisbane, Australia	Humid subtropical	To assess the overall impact of hot and cold temperatures on duration of gestation and birth weight, and any possible susceptible period to temperature exposure for different pregnant outcomes	2001-2010	Time series	Singleton, >20 weeks gestation, >400gm birth weight
Tustin, (2004)[16]	Dunedin, New Zealand	Oceanic	To investigate effect of maternal exposure to sunshine and temperature, especially whether temperature in 2nd trimester or sunshine in 1st trimester can explain seasonal variation in birth weight	1999-2002	Time series	All births in Dunedin, New Zealand. Term (≥38 weeks). Rural
Son (2019)[17]	Seoul, South Korea	Hot summer continental	To investigate associations between heat exposure and preterm birth and term low birth weight	2004–2012	Time series	Singleton, term. Urban
Weng (2018)[18]	Taiwan, China	-	To examine relations between neonatal outcomes and temperatures at birth	2001-2010	Time series	Singleton
Europe, Central Asia						
Wolf (2012)[22]	Brandenburg and Saxony, Germany	-	To examine seasonal rhythms of adverse pregnancy outcome in 2 German populations and add to the quantification of current and possible future health impacts of temperature	Brandenburg (2002-2010). Saxony (2005-2009)	Time series	Singleton, 20-44 weeks gestation, birth weight >200g
Poeran (2016)[55]	Netherlands (whole country)	Oceanic	To study impacts of temperature extremes and cumulative sunshine on birth weight, distinguishing among 5 exposure windows: peri-conception; 1st, 2nd, 3rd trimester and on day of delivery	2000-2008	Time series	Netherlands Perinatal Registry. Singleton.
Sienkiewicz (2018)[56]	Podlaskie Province, Poland	Warm summer continental or hemiboreal	To assess seasonal variations in cerebral palsy births	1990-2014	Case-control study	All cases of cerebral palsy at the hospital, and age- and gender-matched controls. Excluded children with progressive damage to developing brain; metabolic, degenerative, and infectious disorders; children <3 years.
Madsen (2010)[57]	Oslo, Norway	Warm summer continental or hemiboreal	To examine associations between ambient environmental exposure such as air pollution and temperature, and birth weight	1999-2002	Time series	National Birth Registry. Singleton, >37 weeks, weight <1000gm. Urban
Dadvand (2014)[58]	Barcelona, Spain	Mediterranean hot summer	To explore associations of residential proximity to major roads and term LBW and SGA, and	2001-2005	Time series	Singleton. Term. Urban

Author (year)	Country of study	Climate zone#	Aim	Year of study	Study design	Study population
			whether temperatures mediates these associations			
Diaz (2016)[59]	Madrid, Spain	Mediterranean hot summer	To analyse influence of air pollution, noise levels and temperature on LBW in term births	2001-2009	Time series	Singleton. Term. Urban
Bruckner (2014)[28]	Uppsala, Sweden	Warm summer continental or hemiboreal	To test the relation between cold temperature and stillbirth in a society that routinely confronts cold	1915-1929	Time series	>24 weeks gestation. 1 Hospital birth records early 20th century population. Gestation LMP
Lawlor (2005)[60]	Aberdeen, Scotland, United Kingdom	Oceanic	To assess effects of ambient outdoor temperature during gestation on birth weight and assess whether associations with temperature during gestation explain seasonal patterns in birth weight	1950-1956	Time series	Women born in Aberdeen 1950-1956. Urban
Murray (2000)[61]	Northern Ireland, United Kingdom	Oceanic	To investigate whether birth weight was seasonal in Northern Ireland and the nature of the relation between foetal growth and climate by estimating individual exposure to meteorological factors during specific periods of gestation	1971-1986	Time series	Singleton, term. Gestation LMP
Middle East and North Africa						
Chodick (2007)[62]	Israel (whole country)	-	To investigate effect of season on birth weight and whether it is expressed also in fluctuations of proportions of extreme birth weights	1998-2004	Time series	Singleton
Kloog (2018)[63]	Southern Israel	-	To investigate association between temperature, and term LBW and small for gestational age	2004-2013	Time series	1 hospital. Singleton, term
North America						
Sun (2019)[64]	403 counties across USA	-	To investigate the association of temperature during pregnancy with risk of term small for gestational age and birth weight, and whether the association varied by trimester, geographic region and climate zone	1989-2002	Time series	Singleton. Gestation measured LMP
Kloog (2015)[41]	Massachusetts, USA	Hot summer continental	To study associations between temperature live birth outcomes among singleton births	2000-2008	Time series	Singleton births >22 weeks gestation. Birth Registry
Ha (2017)[65]	12 sites across USA	-	To investigate exposures to temperature extremes and air pollutants in relation to SGA and LBW	2002–2008	Time series	Singleton, ≥23 weeks gestation
Ngo (2016)[45]	Manhattan, New York, USA	Humid subtropical	To estimate the impacts of extreme temperatures on birth weight and gestational age and to project impacts of climate change	1985-2010	Time series	Urban
Basu (2018)[66]	California, USA	-	To evaluate LBW from both long and short-term temperature exposure	1999-2013	Time series	Singleton, 37-44 weeks

LBW low birth weight. Studies listed in order of World Bank income classification group, then geographical region and year of data collection. Köppen–Geiger climate classification system#

Supplementary Table 1c. Description of studies assessing associations between exposure to high temperatures and stillbirth

Author (year)	Country of study	Climate zone#	Aim	Year of study	Study design	Study population
Low-income countries						
			-			
Lower-middle income countries						
			-			
Upper-middle income countries						
			-			
High-income countries						
East Asia, Pacific						
Strand (2012)^[10]	Brisbane, Australia	Humid subtropical	To investigate relations between maternal exposure to temperature and risks of PTB and SB	2005–2009	Time series	Population registry. Singleton. >400gm. Urban
Wang (2019)[12]	Brisbane, Australia	Humid subtropical	To assess effects of heat wave exposure in each month of pregnancy on the risk of preterm birth and SB	2000-2010. Warm seasons (Nov.–March)	Time series	Population registry Singleton. >400gm. Urban
Li (2018b)[15]	Brisbane, Australia	Humid subtropical	To assess effects of temperature at different stages of pregnancy on risk of preterm birth and SB, and change over time in associations	1994-2013	Time series	Population registry >400gm. Urban
Weng (2018)[18]	Taiwan, China	-	To examine relations between neonatal outcomes and temperatures at birth	2001-2010	Time series	Birth records in Birth Notification System database. Singleton.
European Union and Central Asia						
			-			
Latin America and Caribbean						
			-			
Middle East and North Africa						
			-			
North America						
Ha (2017)[67]	12 clinical centres (15 hospital referral regions) across USA	-	To determine associations between acute and chronic exposures to temperature extremes and stillbirth risks and to estimate the excess number of stillbirths potentially attributable to extreme temperatures	2002-2008	Time series, case-crossover and case control	Consortium on Safe Labor Study (CSL) cohort. Singleton. Death ≥23 weeks gestation

Author (year)	Country of study	Climate zone#	Aim	Year of study	Study design	Study population
Auger (2017)[68]	Quebec, Canada	Warm summer continental or hemiboreal	To determine the relationship between elevated temperatures and risk of SB	1981-2011. Warm seasons (April-Sept.)	Case-crossover	Registry for the province. Singleton (sub-analysis with multiple pregnancies), >500gm. Semi urban
Rammah (2019)[69]	Harris county, Texas, USA	Humid subtropical	To examine associations between temperature and SBs and among SBs with and without placental abruption	2007-2013. Warm seasons (May-Sept.)	Case-crossover	Foetal death records. Singleton, gestation 20-43 weeks. SBs with placental abruption is abruption initiating or contributing to cause of death
Basu (2016)[70]	California, USA	-	To examine relationship between temperature and SB	1999-2009. Warm season (May–Oct.)	Case-crossover	Foetal death records. >20 weeks gestation

NS not significant. CI confidence interval. HR hazard ratio. OR odds ratio. RR risk ratio. Tmax maximum temperature. Tmin minimum temperature. sd standard deviation. vs versus. d day. gm gram. SB stillbirth. m month. WBGT wet bulb globe temperature. Stillbirths >20 weeks gestation. ^excluded from meta-analysis as a low quality study. PTB preterm birth. LagXb=x days before birth. Studies listed in order of World Bank income classification group, then geographical region and year of data collection. Köppen–Geiger climate classification system#

Supplementary Table 1d Critical appraisal of research evidence: Risk of bias table

Short Title	Were the criteria for inclusion in the sample clearly defined?	Were the study subjects and the setting described in detail?	Was the exposure measured in a valid and reliable way?	Were objective, standard criteria used for measurement of the condition?	Were confounding factors identified?	Were strategies to deal with confounding factors stated?	Were the outcomes measured in a valid and reliable way?	Was appropriate statistical analysis used?	Total
Preterm birth									
Andalon (2016)	No	Yes	No	Yes	Yes	Yes	Yes	Unclear	5
Arroyo (2016)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	7
Asta (2019)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Auger (2014)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	8
Avalos (2017)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Basu (2010)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	7
Basu (2017)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	7
Bruckner (2014)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Carmichael (2014)	Yes	No	No	Yes	Yes	Yes	Unclear	Yes	6
Cil (2017)	Unclear	No	Yes	Unclear	Yes	Yes	Unclear	Yes	4
Cox (2016)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Dadvand (2011)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Giorgis-Allemand (2017)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Guo (2018)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Ha (2017)	Yes	Yes	Yes	Yes	Yes	Yes	Unclear	Yes	7
He (2016)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Kent (2014)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	7
Kloog (2015)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Lajinian (1997)	Yes	No	Yes	Yes	No	No	Yes	Unclear	4
Lee (2008)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Li (2018a)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Li (2018b)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Liang (2016)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Mathew (2017)	Yes	Yes	Yes	Yes	Yes	Yes	No	No	6
Mohammadi (2019)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Muresan (2016)	Yes	No	Yes	Yes	No	No	Yes	Unclear	4

Short Title	Were the criteria for inclusion in the sample clearly defined?	Were the study subjects and the setting described in detail?	Was the exposure measured in a valid and reliable way?	Were objective, standard criteria used for measurement of the condition?	Were confounding factors identified?	Were strategies to deal with confounding factors stated?	Were the outcomes measured in a valid and reliable way?	Was appropriate statistical analysis used?	Total
Ngo (2016)	No	No	Yes	Unclear	Yes	Yes	Unclear	Yes	4
Porter (1999)	Yes	No	Yes	Yes	Yes	No	Yes	No	5
Schifano (2013)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Schifano (2016)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Son (2019)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Strand (2012)	Yes	Yes	Yes	Yes	Yes	No	Yes	No	6
Sun (2019)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Tustin (2004)	Yes	No	Yes	Yes	No	No	Yes	No	4
Vicedo-Cabrera (2014)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Vicedo-Cabrera (2015)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Walfisch (2016)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	7
Wang (2013)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Wang (2019)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Ward (2019)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Weng (2018)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	6
Wolf (2012)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	6
Wu (2019)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	7
Yackerson (2008)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	6
Yu (2018)	Yes	No	No	Yes	No	No	Yes	Yes	5
Zheng (2018)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	7
Zhong (2018)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	7
Birth weight									
Andalon (2016)	No	Yes	No	Yes	Yes	Yes	Yes	Unclear	5
Basu (2018)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Bruckner (2014)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Chodick (2007)	Yes	Yes	No	Yes	Yes	Yes	Yes	No	6
Dadvand (2014)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Diaz (2016)	Yes	Yes	Yes	Yes	Unclear	Unclear	Yes	Yes	6

Short Title	Were the criteria for inclusion in the sample clearly defined?	Were the study subjects and the setting described in detail?	Was the exposure measured in a valid and reliable way?	Were objective, standard criteria used for measurement of the condition?	Were confounding factors identified?	Were strategies to deal with confounding factors stated?	Were the outcomes measured in a valid and reliable way?	Was appropriate statistical analysis used?	Total
Elter (2004)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	6
Grace (2015)	Yes	No	Yes	Yes	No	No	No	Yes	4
Ha (2017)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Jensen (2013)	Yes	No	No	Yes	Yes	Yes	No	Yes	5
Kloog (2015)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Kloog (2018)	Yes	Yes	Yes	Yes	Yes	Yes	Unclear	Yes	7
Lawlor (2005)	No	Yes	No	Yes	Yes	Yes	Yes	Yes	6
Li (2018a)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
MacVicar (2017)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	7
Madsen (2010)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Molina (2017)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	7
Murray (2000)	Yes	Yes	Yes	Yes	Yes	No	Yes	No	6
Ngo (2016)	No	No	Yes	Unclear	Yes	Yes	Unclear	Yes	4
Poeran (2016)	Yes	Yes	Unclear	Yes	Yes	Yes	Yes	Yes	7
Rashid (2017)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	7
Sienkiewicz (2018)	Yes	Yes	No	Yes	No	No	Yes	Unclear	4
Son (2019)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Sun (2019)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Tustin (2004)	Yes	No	Yes	Yes	No	No	Yes	No	4
Wells (2002)	Yes	No	Unclear	Unclear	Yes	Yes	Unclear	Yes	4
Weng (2018)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	6
Wolf (2012)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	6
Stillbirth									
Auger (2017)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	7
Basu (2016)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Ha (2017)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Li (2018b)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Rammah (2019)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8

Short Title	Were the criteria for inclusion in the sample clearly defined?	Were the study subjects and the setting described in detail?	Was the exposure measured in a valid and reliable way?	Were objective, standard criteria used for measurement of the condition?	Were confounding factors identified?	Were strategies to deal with confounding factors stated?	Were the outcomes measured in a valid and reliable way?	Was appropriate statistical analysis used?	Total
Strand (2012)	Yes	Yes	Yes	Yes	Yes	No	Yes	No	6
Wang (2019)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Weng (2018)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	7

Joanna Briggs Institute Critical Appraisal tools (2017). "JBI Systematic Reviews: Checklist for Analytical Cross Sectional Studies." https://joannabriggs.org/sites/default/files/2019-05/JBI_Critical_Appraisal-Checklist_for_Analytical_Cross_Sectional_Studies2017_0.pdf.

Supplementary Tables 2a-2c: Results of studies assessing associations between high temperatures and the study outcomes

Supplementary Table 2a. Results of studies assessing associations between exposure to high temperatures and preterm birth

Author (year)	Country of study	N in study		PTB risk	Study outcomes	Subgroup analysis
	Low-income countries					
	-					
	Lower-middle income countries					
	-					
	Upper-middle income countries					
Zhong (2018)[1]	Changsha, Hunan Province, China	N=3509. N PTB=141		4.0%	Whole pregnancy OR=1.34 (95%CI=1.11 to 1.62) per 1°C increase in mean temperature. OR per increase of 1°C in 1st trimester whole period NS and all seasons aside from Summer OR=1.93 (95%CI=1.32 to 2.82). 2nd trimester whole period OR=1.03 (95%CI=1.00 to 1.06), Spring OR=1.51 (95%CI=1.32 to 1.74), Summer OR=1.77 (95%CI=1.32 to 2.37). 3rd trimester whole period NS, Spring OR=1.44 (95%CI=1.17 to 1.76). Whole of pregnancy: Spring OR=1.57 (95%CI=1.24 to 1.97), summer OR=1.78 (95%CI=1.06 to 2.98). Winter, Autumn NS, point estimate around 1.0. OR for 1d increase in extreme heat exposure (>30°C). 1st trimester OR=1.00 (95%CI=0.99 to 1.02). 2nd trimester OR=1.01 (95%CI=1.00 to 1.02). 3rd trimester OR=0.98 (95%CI=0.96 to 0.99). Whole pregnancy OR=0.99 (95%CI=0.97 to 1.00)	Night time temperature impacts > day time for overall, spring and summer. OR in males > females. OR in ≥30 year olds higher than <30 year olds
Zheng (2018)[2]	Changsha, Hunan Province, China	N=3604. N PTB=145. N females=1676 N PTB=70. N males=1928 N PTB=75		4.0%. Females 4.2%. Males 3.9%	OR is per 0.5°C increase. High temperatures (above median in each period) Conception month: OR=1.14 (95%CI=1.04 to 1.24). 1st trimester high temperature OR=1.23 (95%CI=1.12 to 1.35). 2nd trimester OR=0.86 (95%CI=0.80 to 0.93; P<0.001. 3rd trimester high temperature OR=1.22 (95%CI=1.10 to 1.35). Birth month high temperature (>19.9ºC) OR=1.00 (95%CI=0.91 to 1.09). Whole pregnancy high temperature (>18.2ºC) OR=2.57 (95%CI=1.98 to 3.33). Extreme heat day (>90th centile). Odds of PTB per 2 days/month increase in number of extreme heat days. Conception month OR=1.15 (95%CI=1.04 to 1.26). 1st trimester OR=1.10 (95%CI=0.99 to 1.23). 2nd trimester OR=0.59 (95%CI=0.49 to 0.70). 3rd trimester OR=1.14 (95%CI=1.04 to 1.25). Birth month OR=1.10 (95%CI=1.01 to 1.19). Entire pregnancy OR=1.51 (95%CI=1.05 to 2.18). U shape (base 18°C)	Gender of infant OR is odds per 0.5 °C increase. Males, high temperature Conception month OR=1.11 (95%CI=1.02 to 1.20) P<0.05. 1st trimester OR=1.03 (95%CI=0.96 to 1.11) 2nd trimester OR=1.08 (95%CI=0.99 to 1.18). 3rd trimester OR=1.11 (95%CI=1.00 to 1.25; P<0.05). Birth month OR=0.95 (95%CI=0.84 to 1.07). Entire pregnancy OR=2.22 (95%CI=1.61 to 3.06; P<0.001). Females, high temperature in conception month (>19.8 °C) OR=1.31 (95%CI=1.12 to 1.52) P<0.001. 1st trimester OR=1.25 (95%CI=1.09 to 1.43) P<0.001. 2nd trimester OR=1.08 (95%CI=0.99 to 1.19). 3rd trimester OR=1.31 (95%CI=1.13 to 1.53; P<0.001). Birth month OR=1.05 (95%CI=0.93 to 1.19). Entire pregnancy OR=2.76 (95%CI=1.88 to 4.04; p<0.001)
He (2016)[3]	Guangzhou, China	N=838,146. N PTB=47,209		5.6%	All estimates compared to median temperature in area (24.4°C). Moderate heat (95th centile, >30.7°C): lag07d HR=1.019 (95%CI=0.984 to 1.056); last 4 weeks of pregnancy	

Author (year)	Country of study	N in study		PTB risk	Study outcomes	Subgroup analysis
					HR=1.075 (95%CI=1.020 to 1.132); from week 20 onwards HR=1.073 (95%CI=1.016 to 1.133); cumulative exposure over pregnancy HR=1.074 (95%CI=1.016 to 1.135). Extreme heat (99th centile, >31.9°C): lag07d HR=1.026 (95%CI=0.981 to 1.074); last 4 weeks of pregnancy HR=1.100 (95%CI=1.029 to 1.176); from week 20 onwards; 1.095 (95%CI=1.021 to 1.175); cumulative exposure over pregnancy HR=1.096 (95%CI=1.022 to 1.175). Extreme heat in gestation windows: weeks 20–31 HR=1.45 (95%CI=1.15 to 1.83), week 32–34 HR=1.29 (95%CI=1.08 to 1.54) and weeks 35–36 was 1.08 (95%CI=0.97 to 1.21). [at moderate and extreme heat lag07d NS and stepwise HR with periods closer to birth] U shape (base at 25°C)	
Liang (2016)[4]	Shenzhen, China	N=1,040,638. N PTB=58,411		5.6%	Reference group is median of daily mean temperatures. Cumulative effects of high temperature 95th centiles RR=0.69 (95%CI=0.60 to 0.80) and 99th centile RR=0.62 (95%CI=0.52 to 0.74). Negative associations with 95th centile (all P<0.05): lag10d RR=0.99 (95%CI=0.97 to 1.00); lag15d RR=0.99 (95%CI=0.98 to 1.00); lag20d RR=0.99 (95%CI=0.98 to 1.00); lag25d RR=0.99 (95%CI=0.98 to 1.00); lag30d RR=0.99 (95%CI=0.97 to 1.00). 99th centile (all P<0.05): lag10d RR=0.98 (95%CI=0.97 to 1.00); lag15d RR=0.98 (95%CI=0.97 to 0.99); lag20d RR=0.98 (95%CI=0.97 to 0.99); lag25d RR=0.98 (95%CI=0.97 to 0.99); lag30d RR=0.98 (95%CI=0.96 to 1.00)	NS 95th centile in women 15-19 years RR=1.04 (95%CI=0.56 to 1.94). Significant in women 20-34 RR=0.70 (95%CI=0.60 to 0.82) and women >35 RR=0.66 (95%CI=0.45 to 0.98). RR for 95th centile: female RR=0.64 (95%CI=0.52 to 0.78). Males RR=0.74 (95%CI=0.62 to 0.88)
Guo (2018)[5]	132 cities in 30 provinces in China	N=1,020,471. N PTB=73,240. Cold area PTB n=12,433. Medium temperature area PTB n=29,266. Hot area PTB n=25,665		7.2%	>95% centile of local Tmean, compared to 5-95% centile. For cold areas, NS findings, but all in direction of effect. Medium areas NS preconception, weeks 1-7 gestation, weeks 8-14, weeks 15-21, all direction of protective effect; 4 weeks before birth OR=1.157 (95%CI=1.098 to 1.219); NS 1 week before birth, direction of effect. Hot areas preconception OR=1.229 (95%CI=1.166 to 1.295); weeks 1-7 OR=1.110 (95%CI=1.052 to 1.172); weeks 8-14 OR=1.150 (95%CI=1.090 to 1.213); weeks 15-21 OR=1.106 (95%CI=1.048 to 1.167); 4 weeks before birth OR=1.056 (95%CI=0.998 to 1.118; P=0.060); 1 week before birth OR=1.069 (95%CI=1.010 to 1.132)	
Wu (2019)[6]	Wuhan city, Hubei province, China	N=11,056. N PTB=618		5.6%	Diurnal temperature range=Tmax minus the Tmin on the same day. Mean range during each period. Range PTB significant in lag0_14d (5.4% increase PTB risk per 1°C increase in range (95%CI=0.6 to 10.4). Tertiles of range lag0_14d: Low reference group. Medium OR=1.349 (95%CI=1.076 to 1.692). High OR=1.420 (95%CI=1.078 to 1.870; P test for trend=0.021	Lag0_14d OR increase per 1C. Highest to lowest risk: Age ≥28, <28. BMI >20, BMI<20. Season: cold, warm. Sex: female, male. Tests for interaction NS
Andalon (2016)[7]	Colombia (whole country)	N=1,250,000. N PTB=193,750		15.5%	'Heat shock' (temperature in ≥1 month anytime during pregnancy that is >0.7 z-scores of sd from long-term mean (1901–1997)). -0.3% point reduction in probability of full-term pregnancy (95%CI=0.0 to 0.6%; P<0.05). No step-wise impacts with increase in sd (0.7–1.0 to 1.0–1.5; to 1.5–2.0 to ≥2.0). NS pattern of heat exposure and trimesters, but impacts on PTB estimates highest in 2nd and 3rd trimester	
Muresan (2016)[8]	Cluj-Napoca, Transylvania, Romania	N PTB=138		-	Mean weekly temperature and sd of the mean, correlated with N PTBs in that week (52 weeks in total, lag07d). Mean weekly temperature r=0.306 (P=0.027). sd in each week r=0.307 (p=0.007)	
Mohammadi, (2019)[9]	Sabzevar, north eastern Iran	N PTB=3140		-	Lag0d highest impact, lag1, 2, 3, 4, 5, 6, 7, 8d also significant. NS findings at larger lags. PTB in heat wave days (mean daily temperature >90th percentile ≥2 consecutive days) compared to non-HW days (RR 1.21, 95%CI=1.08 to 1.37). Compared to median value, lag0d. Mean temperature RR 75th centile=1.25 (95%CI=1.12 to 1.4) RR 99th centile=1.6 (95%CI=1.37 to 1.87). Maximum temperature RR 75th centile=1.18	

Author (year)	Country of study	N in study		PTB risk	Study outcomes	Subgroup analysis
					(95%CI=1.07 to 1.3) RR 99th centile=1.53 (95%CI=1.33 to 1.76). Apparent temperature (dry bulb temperature, vapour pressure, air velocity) RR 75th centile=1.26 (95%CI=1.16 to 1.37), RR 99th centile=1.55 (95%CI=1.36 to 1.77)	
	High-income countries					
	East Asia, Pacific					
Strand (2012)[10]	Brisbane, Australia	N=101,870. N PTB not provided		-	Temperature in lag028d. Increasing temperature increased HR at gestation 28-36 weeks (significant), but NS at <28 weeks gestation. HR for PTB 28-36 weeks similar at lag07d to lag028d. HR PTB lag028d 28–36 weeks gestation=1.20 at 27°C vs 21°C (95%CI=1.0,1.40)	
Wang (2013)[11]	Brisbane, Australia	N=50,848. N PTB=3347		6.6%	9 definitions of heat waves (90th centile, 95th, 98th, duration 2-4d). HR for exposure to ≥1 HW day in lag07d. All 9 definitions significant HR from 1.13 (95%CI=1.03 to 1.24) to 2.00 (95%CI=1.37 to 2.91). Highest HR with HW defined as >98th centile, 4 days duration.	Significant in indigenous women, NS with non-indigenous. Significant in women >34 years, NS in other age groups. Significant in married or stable cohabiting relationships, NS for other women. Significant male gender, NS females. Primiparous women (P=0.09). Uncertain if differences between groups significant
Wang (2019)[12]	Brisbane, Australia	N=277,133. N PTB=17,368		6.3%	Exposure in each gestation month binary variable, 6 HWs: 90th centile (duration 2, 3, 4d); 95th centile (duration 2, 3, 4d). All definitions and 9 months gestation HRs were significant. For most definitions, HR point estimates were highest in m1-6. In most months the longer the duration of HW the higher the OR. OR similar in 90th and 95th centile, 95th lower than 90th in some comparisons. In 42 of 72 measures HR>1.20, 16>1.4. HR at 90th centile duration 2d highest in m2=1.42 (95%CI=1.29 to 1.56) and lowest in m7 (HR=1.09; 95%CI=0.99 to 1.20), median in m3 (HR=1.29; 95%CI=1.17 to 1.42)	-
Li (2018a)[15]	Brisbane, Australia	N=237,585. N PTB=15,047		6.3%	1st week of pregnancy; 1st 4 weeks; lag06d, lag028d. Maximum temperature >30°C (reference group) vs 25–30°C, 20–25°C, ≤20°C categories based on distribution of temperature, effect of temperature on outcomes) Mean duration of gestation similar in temperature groups for all 4 lags (38.92-38.98 weeks). NS. Multivariate NS	-
Mathew (2017)[14]	Alice springs, Northern Territory, Australia	N=16,870. N PTB=1401. N Indigenous= 7996. N PTB=951. N Non-indigenous=8873 N PTB=450		8.3% (Indigenous 11.9%; non-Indigenous 5.1%)	Compared to 50th centile temperature for whole period (30°C). RR>1 for temperature 41-45°C (Tmax). Increase in RRs about 2%; exponential increase in RR (2-3 weeks before delivery) about 4.5% with ≥41°C. Only significant at lag15_20 at ≥45°C Cumulative effects of exposure to Tmax 40°C for 21 days increases PTB risk 8.3% (95%CI=1.03-1.15)	Effects sizes higher in non-indigenous than indigenous population
Li (2018b)[15]	Brisbane, Australia	N=289,351. N PTB=22,822		7.9%	Similar findings for Tmax and Tmin daily temperatures. Comparison mean daily temperature 75th centile and temperature at minimum PTB prevalence. 1st trimester HR=1.04 (95%CI=0.98 to 1.09). 2nd trimester HR=1.03 (95%CI=0.99 to 1.07) 3rd trimester HR=1.11 (95%CI=1.08 to 1.15). Comparison 95th centile vs temperature at minimum PTB prevalence 1st trimester HR=1.07 (95%CI=1.00 to 1.14). 2nd trimester HR=1.03 (95%CI=0.99 to 1.08). 3rd trimester HR=1.21 (95%CI=1.16 to 1.26). U shape in 3rd trimester (base 19,5°C)	Lower HR in 2013 compared to 1994 for >75th centile comparison HR for mean daily temp high temperature exposure in the 3rd trimester decreased from 1994 Also in 3rd trimester (95th centile comparison), decreased HR from 1994 [HR=1.53

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						(95%CI=1.44 to 1.63)] to 2013 [1.19 (95%CI=1.13 to 1.25)]
Tustin, (2004)[16]	Dunedin, New Zealand	N=7,039. N PTB not provided		-	In each year, the 3 months with highest mean temperatures (peaks) compared with 3 months when mean temperatures were lowest (trough). All comparisons P>0.05. 1st trimester mean gestation weeks in peak months=36.7 (sd=0.05) vs mean gestation weeks in trough months=39.6 (sd=0.05). 2nd trimester mean gestation weeks in peak months=39.6 vs mean gestation weeks in trough months=39.7. 3rd trimester mean gestation weeks in peak months=39.6 (sd=0.05) vs mean gestation weeks in trough months=39.7 (sd=0.05)	-
Son (2019)[17]	Seoul, South Korea	N=813,820. N PTB=32,908		4.0%	Heat Index (air temperature and relative humidity). HR are for a quartile increase in heat index. PTB whole pregnancy HR=1.033 (95%CI=1.005 to 1.061) [ES Q4 vs Q1=1.10; SE=0.044], lag028 HR=1.013 (95%CI=1.005 to 1.022) [ES Q4 vs Q1=1.039; SE=0.013], lag07 HR=1.012 (95%CI=1.004 to 1.020).	HR for whole pregnancy exposure higher in women <25, but also elevated in women >29 (significant difference). Women with both low education and low SES HR=1.100 (95%CI=1.032 to 1.173), highest of all sub-groups examined. NS diffs in sub-groups: Female 1.041 vs male 1.026; <=12 years education 1.046 vs >12 1.026; lower SES 1.049 vs high SES 1.016
Weng (2018)[18]	Taiwan, China	N=2,045,748. N PTB not provided		-	Temperature at birth. 21.5-23.4°C (reference group, lowest risk). Temperature 23.5-25.4°C RR=1.00 (95%CI=0.97 to 1.02). Temperature 25.5-27.4°C RR=1.04 (95%CI=1.02 to 1.07). Temperature 27.5-29.4°C RR=1.11 (95%CI=1.08,1.13). Temperature 29.5-30.8°C RR=1.05 (95%CI=1.02,1.08). U shape (base 23.5-25.4°C)	
	European Union and Central Asia					
Giorgis-Allemand (2017)[19]	Denmark, France, Greece, Hungary, Italy, Lithuania, Norway, Spain, Sweden, The Netherlands, United Kingdom	N=71,493. N PTB=3533		4.9%	1st trimester exposure had stronger association than 2nd trimester, 1 or 4 weeks before childbirth and whole-pregnancy. Mean temperatures. 1st trimester temperatures, compared to PTB<5°C, OR for PTB 1.13 (95%CI=1.00 to 1.27) with 5°C–9.9°C; 1.14 (95%CI=0.99 to 1.33) with 10°C–14.9°C, and 1.20 (95%CI=0.99 to 1.45) with ≥15°C (P for test for trend=0.08). Prevalence of PTB if temp <5°C: 4.3% prem; 5-9.9°C: 4.8%; 10-14.9°C: 5.1%; ≥15°C 7.6%; P<0.001. NS association of whole-pregnancy temperature and PTB (P=0.45)	
Schifano (2016)[20]	Rome, Italy, and Barcelona, Spain	Barcelona N=27,255. N 22-32 weeks=173, N 33-36 weeks=1071. Rome N=78,633, N PTB 22-32 weeks=484, N 33-36 weeks=3830		Rome 5.5%. Barcelona 4.6%	Maximum apparent temperature (includes air and dew-point temperature). Lags 02 days used as strongest in Rome, no clear difference in lags in Barcelona. Barcelona: HR per 1°C increase=1.003 (95%CI=0.998 to 1.008); HR rise with quartile increase=1.025 (95%CI=0.984 to 1.067) [ES Q4 vs Q1=1.077; SE=0.065). Highest HR per 1°C Tmax increase in 22–26 week gestation HR=1.071 (95%CI=1.036 to 1.106), decreased stepwise by gestation period (5 periods in total) to 36th week HR=1.033 (95%CI=1.020 to 1.045). Significant at all gestations. Rome: HR per 1°C increase=1.012 (95%CI=1.009 to 1.015). HR per quartile increase=1.132 (95%CI=1.100 to 1.165) [ES Q4 vs Q1=1.45; SE=0.056]. As in Barcelona, highest HR per 1°C increase in 22–26 week of gestation HR=1.071 (95%CI=1.052 to 1.091) and decreased stepwise to 1.032 (95%CI=1.026 to 1.038) at 36 weeks. Significant at all gestations	

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Cox (2016)[21]	Flanders, Belgium	N=807,835. N PTB=27,076		3.4%	Centiles are temperatures over whole study period, all compared to median. Tmin lag01d 95th centile RR=1.085 (95%CI=1.024 to 1.150). 99th centile RR=1.156 (95%CI=1.048 to 1.276). Lag03d 95th centile RR=1.103 (95%CI=1.034 to 1.176). Lag06d 95th centile RR=1.088 (95%CI=1.007 to 1.175). Tmax lag01d 95th centile RR=1.096 (95%CI=1.011 to 1.187). 99th centile RR=1.145 (95%CI=1.005 to 1.306). NS, but <32 weeks estimates higher than 32-36	Impacts of heat on females higher than males, highest in women ≥35 years
Wolf (2012)[22]	Brandenburg and Saxony, Germany	Brandenburg N=128,604. N PTB =8717. Saxony N=162,913. N PTB=10,277		Brandenburg 6.8%. Saxony 6.3%	Comparisons of mean temperatures in quintile (baseline, coldest to hottest). Brandenburg. PTB 1st trimester 2nd quintile OR=1.00 (95%CI=0.92 to 1.09), 3rd OR=0.91 (95%CI=0.79 to 1.04) 4th OR=1.01 (95%CI=0.85 to 1.20) 5th OR=0.91 (95%CI=0.75 to 1.10); P=0.06. All other comparisons NS. Saxony PTB 1st trimester: 2nd quintile OR=0.93 (95%CI=0.87 to 1.01) 3rd OR=0.99 (95%CI=0.88 to 1.11) 4th OR=1.02 (95%CI=0.87 to 1.19) 5th OR=1.13 (95%CI=0.92 to 1.37) P=0.09. Inconsistent findings	
Schifano (2013)[23]	Rome, Italy	N=132,691. N PTB 22-32 weeks=847. N PTB 33-36 weeks=6412		5.5%	Apparent temperature (includes air and dew-point temperature). Only lags 0-2d significant in warm season (April-Dec.). Percent change of 1.87% (95%CI=0.86 to 2.87) per 1°C increase in temperature. 20.93% increase per IQR increase (95%CI=9.37 to 33.72). Analysis by gestation, impact only significant for 33-36 weeks gestation: 1.93% change (95%CI=0.88 to 2.98) vs 22-32 weeks: −1.02% change (95%CI not provided). Percent change in daily n PTB=19.21% for HW days compared with non-HW days (95%CI=7.91 to 31.69). HW defined as >2 days with Tmax >monthly 90th centile or daily Tmin >monthly 90th centile, and Tmax >median monthly value over time. NS impact in cold season. PTB–temperature association linear in warm season, also in cold season, but less steep slope	Increase in percent PTB lag02d with 1°C rise higher in women hospitalized for chronic disease in 2 years preceding delivery (7.32%), women <20 years. Lower in women with tertiary education
Asta (2019)[24]	Bologna, Turin, Trieste, Rome, Palermo, Venice, Italy	N=121,797. N PTB=6135		5.0%	Tmax (temperature and dew point). 90th vs 75th centile in each city. lag02d Palermo RR=1.02 (95%CI=0.95 to 1.09). lag01d Bologna RR=1.09 (95%CI=0.90 to 1.32). lag03d Venice RR=1.94 (95%CI=1.32 to 2.85). lag02d Rome RR=1.06 (95%CI=1.03 to 1.10). lag3_6d Turin RR=1.03 (95%CI=0.97 to 1.07). lag14_20d Trieste RR=1.06 (95%CI=0.95 to 1.20). U shape in Venice (base 22.5°C)	Interaction (P<0.05) noted in Rome only: higher RR in women <20 years, those with chronic conditions in 2 years before childbirth
Dadvand (2011)[25]	Barcelona, Spain	N=7585. N PTB not provided		-	Temperature baseline (1983-2006). Regression coefficient is change in gestational days and exposure to HI90, HI95 and HI99 heat indexes. 90th centile: lag1d coefficient=-0.9 (95%CI=-2.1 to 0.4; p=0.17). lag2d coefficient=–1.0 (95%CI=–2.1 to 0.0; p=0.06. HI95 lag0d coefficient=–0.2 (95%CI=–0.4 to –0.1; P<0.01). lag1d coefficient=–1.6 (95%CI=–3.5 to 0.2; p=0.08). HI99 centile Lag1d coefficient=–5.3 (95%CI=–10.1 to –0.5; p=0.03). lag1d estimates increase from 90th to 95th to 99th centile (dose response pattern)	
Arroyo (2016)[26]	Madrid, Spain	N=298,705. PTB=24,620		8.2%	Results for an IQR increase in Tmax >34°C. lag 1d RR=1.055 (95%CI=1.018 to 1.092) [ES IQR 1 vs IQR2=1.11; SE=0.038]	
Vicedo-Cabrera (2014)[27]	Valencia, Spain	N=20,148. N PTB=1067		5.3%	Apparent temperature measures. Tmax >50th centile vs <50th. Lag2d RR=1.17 (95%CI=0.99 to 1.38). Lag3d RR=1.12 (95%CI=1.01 to 1.24). Lag day 8, 10, 11, 14 also significant (RR=1.02-1.06). Tmax >90th centile vs <50th. Lag2d RR=1.23 (95%CI=1.00 to 1.52). Lag day 9, 10, 11, 12 also significant RR 1.06-1.07. Tmin. >50th centile vs <50th Lag days 4, 5 significant RR=1.04-1.05. 90th centile lag day 3, 4, 5, 6 significant RR=1.05 to 1.07	

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Bruckner (2014)[28]	Uppsala, Sweden	N=13,657. N PTB not provided		-	Compared to 50th centile, logHR of PTB rose with temperature. >75th centile PTB increased HR=1.52 (95%CI=1.22 to 1.90) per 1°C increase in temperature vs 50th centile. J-shape (inflection at 7.5°C)	
Vicedo-Cabrera (2015)[29]	Stockholm, Sweden	N=36,577. N PTB=1204		3.3%	Moderate heat: RR increase in daily mean temperature from the annual median value to the 75th centile of the warm season. Lagd0 to lag21 NS RR=1.02-1.03, lag22d RR=1.04 (95%CI=1.00 to 1.08], lag23d RR=1.04 (95%CI=1.00 to 1.08), lag24d RR=1.04 (95%CI=1.00 to 1.09), lag25d RR=1.05 (95%CI=1.00 to 1.09), lag26d RR=1.05 (95%CI=1.00 to 1.10), lag27d RR=1.05 (95%CI=1.00 to 1.11), lag28d RR=1.05 (95%CI=1.00 to 1.11). Slope of maximum cumulative temperature RR=2.50 (95%CI=1.02 to 6.15) when temperature at 75th centile. Extreme heat >99th centile vs 75th centile of warm NS and point estimates around 1.0	
Lee (2008)[30]	North West Thames region, London, United Kingdom	N=482,765. N PTB=29,716		6.2%	lag01d, 02d, 03d, 04d, 05d, 06d OR around 1.0, NS. lag0d daily Tmax OR=1.00 (95%CI=0.99 to 1.00) daily Tmin OR=1.00 (95%CI=1.00 to 1.00)	
	Latin America and Caribbean					
Yu (2018)[31]	San Juan, Mayagüez and Ponce regions, Puerto Rico	N=1,005,340. N PTB=145,774		14.5%	Lag0_28d. San Juan (capital city), Mayagüez small temperature impacts, even reduced PTB at high temperatures. Ponce PTB rises with temperature (warmest of the 3 regions). 90th centile similar patterns. Ponce Mayagüez lag0_28d smaller impacts than lag0d. San Juan lag0_28d and lag0d similar	
	Middle East and North Africa					
Yackerson (2008)[32]	Negev, Israel	N=11,979 N PTB=992		8.3%	Tmax regression coefficient=-0.09 (SE=0.03, P=0.008). Change in temp (Tmax-Tmin regression) lag3d coefficient P=0.01	
Walfisch (2016)[33]	Negev, Israel	N=263,709. N PTB=20,825		7.9%	RR increase in PTB per 1 heat stress unit (mean wet and dry temperature)=1.06 (95%CI=1.04 to 1.08). Spontaneous PTB IRR=1.07 (95%CI=1.05 to 1.10). Induced PTB IRR=0.99, (95%CI=0.97 to 1.01). [lag period uncertain]. Increase in 1 heat stress unit increases PTB by 3.7% for PTD <34 weeks (higher than PTB 34-36 weeks) Linear association	
	North America					
Auger (2014)[34]	Montreal, Quebec, Canada	N=206,929. PTB=12,390		6.0%	Maximum temperature in week before childbirth and risk of delivery. Preterm: 3 consecutive days ≥32°C HR=0.92 (95%CI=0.74 to 1.14). N days ≥32°C, HR compared to 0 days. 1d HR=0.98 (95%CI=0.91 to 1.06); 2d HR=1.03 (95%CI=0.90 to 1.18); 3d HR=0.91 (95%CI=0.72 to 1.15); 4–7d HR=0.82 (95%CI=0.55 to 1.21). Early term (37-39 weeks): HR compared to 0 days ≥32°C. 1d HR=1.02 (95%CI=0.98 to 1.06) 2d HR=0.96 (95%CI=0.89 to 1.04) 3d HR=1.08 (95%CI=0.97 to 1.21) 4–7d HR=1.27 (95%CI=1.07 to 1.52); 3 consecutive days ≥32°C HR=1.17 (95%CI=1.06 to 1.29); 10% greater hazard of delivery at 35°C relative to 20°C (P<0.05)	
Lajinian (1997)[35]	Brooklyn, New York, USA	N not provided		-	Heat-humidity index (humidity, dry bulb temperature), calculated for 4 periods each 7 days: coldest and hottest weeks in winter and summer. N PTB in that week/total pregnancies 20-36 weeks in that week. Coldest winter week 1.23% (12/972; HI=25.0); hottest winter week 1.25% (12/961; HI=42.7); coldest summer week 2.00% (21/1031; HI=63.3); hottest summer week 3.00% (30/1008; HI=79.5). Linear trend of % PTB over the 4 weeks P<0.002	
Porter (1999)[36]	Chicago, USA	N=11,792. N PTB not provided		-	Maximum apparent temperatures categorised as <90°F, 90°F to 99°F, 100°F to 109°F, ≥110°F. NS for any comparisons of mean gestation. Lag0d: <90°F 38.6. 90-99°F 38.7. 100-110°F 38.7.	Lag0d difference <90F and ≥110F: lowest income 0.4 weeks, highest

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					≥110°F 38.9. Lag1d <90°F 38.7. 90-99°F 38.7. 100-110°F 38.8. ≥110°F 38.7. Lag2d <90°F 38.6. 90-99°F 38.7. 100-110°F 38.8. ≥110°F 38.8. All comparisons NS	income 0.1 weeks. Hispanics 0.0 weeks whites 0.2 weeks, blacks. 0.4 weeks. <12 years education 0.0 weeks. >12 years education 0.4 weeks
Sun (2019)[37]	403 counties, USA	N=31,921,046. N PTB=2,973,909		9.3%	National Centre for Health Statistics. 95th centile vs median lag04d RR=1.025 (95%CI=1.015 to 1.036), lag1d significant. Lag0d, lag2d lag3d NS. Linear shape	Climate zones, highest in hot-dry/mixed-dry RR=1.057. Women <25 years RR=1.039 (95%CI=1.022 to 1.055), 25-34 RR=1.019 (95%CI=1.005 to 1.034), ≥35 RR=0.990 (95%CI=0.965 to 1.017) (significant difference). Male RR=1.033 (95%CI=1.020 to 1.047), female 1.012 (95%CI=0.998 to 1.026). White RR=1.025 (95%CI=1.012 to 1.037) Non-white RR=1.015 (95%CI=0.989 to 1.043). <9 years education RR=1.030 (95%CI=1.016 to 1.044), ≥9 years RR=1.009 (95%CI=0.994 to 1.025). Early PTB (20-33 weeks) RR=1.024 (95%CI=1.006 to 1.042). Late PTB RR=1.026 (95%CI=1.015 to 1.038)
Carmichael (2014)[38]	468 counties, across the country, USA	N black=2,607,150. N PTB=422,358. N white= 6,986,984. N=656,777		Black 16.2%. White 9.4%	No overall population measures	Measure is % increase in PTB with a 1F 10^{-2} change (reference is mean July temperature). Blacks: 0.02% for 20-31 week PTB (NS). 0.114% for 32-36 weeks PTB (P<0.001). Whites: 0.01% for 20-31 weeks PTB (P<0.001). 0.06% for 32-36 weeks PTB (P<0.001) [measurement of timing of exposure not given]
Basu (2010)[39]	12 counties of California, USA	N PTB=58,681		-	8.6% increase (95%CI=6.0 to 11.3) in PTB with a 10F increase in mean apparent temperature in lag0-6d [ES 3X10°F=1.047; SE=0.007]. All lags day 0, 1, 2, 3, 4, 5, 6 were associated. Association strongest for PTB at weeks 34-35	% change per 10F (5.6°C) lag 0-6d: Maternal age <20 years 14.0% (95%CI=6.6 to 22.0); <25 11.0% (95%CI=6.6 to 15.5); 25-34 9.4% (95%CI=4.8 to 14.2); >35 3.6% (95%CI=-2.4 to 10.0) [<20 years of age vs >35 years P=0.04]. Other subgroups NS. Race: Black 14.9% (95%CI=5.0 to 25.8); Asian 10.2% (95%CI=2.0 to 19.1); Hispanic 8.1% (95%CI=4.6 to 11.7); White 6.6% (95%CI=0.9 to 12.7). Female 10.1% (95%CI=5.9 to 14.4), male 7.8% (95%CI=4.2 to 11.6).

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						High School only 9.7% (95%CI=6.2 to 13.2); college 7.0% (95%CI=2.7 to 11.6) Linear association
Cil (2017)[40]	3000 counties across USA	N=570,000. N PTB not provided		-	HW is heat index (temperature and relative humidity) above 'established thresholds'. Exposure ≥1 HW in each trimester (or 3 months before conception). HW in 2nd trimester lower gestational age at birth (coefficient=-0.019; P<0.05; other trimesters NS)	
Kloog (2015)[41]	Whole state of Massachusetts, USA	N=462,400. N PTB=11,993		2.6%	Temperatures both from predictive modelling and weather stations. PTB OR with predicted temperature per IQR change in mean temperature in whole pregnancy=1.02 (95%CI=1.00 to 1.05); OR=1.07 (95%CI=0.87 to 1.27) [ES for 2 IQR change=1.047; SE=0.007] with temperature from weather stations. Some models using predictive temperatures showed increases gestation at higher temperatures, while weather station data showed gestation decrease	
Ha (2017)[42]	12 sites across USA	N=223,375. N early PTB (<34 weeks)=3,855. N late PTB (34-36 weeks)=7,345		5.0%	RR >90th centile vs 10-90th, reference temperatures are 3 months preconception. Early PTB: weeks 1-7 gestation RR=1.11 (95%CI=1.01 to 1.21); weeks 8-14 RR=1.06 (95%CI=0.96 to 1.17); weeks 15-21 RR=1.18 (95%CI=1.07 to 1.29); weeks 22-28 RR=1.08 (95%CI=0.98 to 1.19) [data on weeks 29-36 not provided] Late PTB: weeks 1-7 RR=1.05 (95%CI=0.99 to 1.11); weeks 8-14 RR=1.01 (95%CI=0.94 to 1.08); weeks 15-21 RR=1.18 (95%CI=1.11 to 1.27); weeks 22-28 RR=1.00 (95%CI=0.93 to 1.07). Cumulative exposure (total pregnancy exposure) to hot temp was associated with PTB in pregnancies from weeks0_34 and weeks0_36. Case-crossover analysis: Increase in odds of early PTB per 5°F increase in temperature in lag06d: OR=1.16 (95%CI=1.12 to 1.19); late PTB OR=1.12 (95%CI=1.10 to 1.15)	
Basu (2017)[43]	N. California, USA	N PTB=14,466		-	Mean daily apparent temperature lag0-6 before birth compared with exposures for the same mother at 7 and 28 days before or after that week. Results are % change per 10°F (5.6°C) increase in apparent temperature. Warm season 11.63% (95%CI=4.08 to 19.72) [ES 3X10°F=1.06; 0.022); cold season 6.18% (95%CI=−2.96 to 16.18)	Sub-group comparisons NS. Maternal age 18-19 years 30.99% (95%CI=−1.00 to 75.06%); 20-24 years 12.74% (95%CI=−8.61 to 39.09%), 25-35 years 11.62% (95%CI=2.02 to 22.14) ≥35 years 11.62% (95%CI=−2.96 to 28.40%). Black 24.60% (95%CI=1.00, 55.27%), Hispanic 17.35% (95%CI=3.04 to 34.98), Asian 7.25% (95%CI=−11.31 to 30.99), White 7.25% (95%CI=−6.77 to 22.14%). Mothers who smoked during pregnancy 30.99% (95%CI=0 to 71.6%) did not smoke 10.51% (95%CI=2.02 to 18.53%). Mother consumed alcohol 34.98% (95%CI=−29.54 to 161.16%), did not drink 11.62% (95%CI=4.08 to 19.72). Hypertension 37.71% (95%CI=5.12 to 80.39%), diabetes 23.36%

Author (year)	Country of study	N in study		PTB risk	Study outcomes	Subgroup analysis
						(95%CI=1.00 to 52.19%), pre-eclampsia 18.53% (95%CI=−3.92 to 47.70%), depression 17.35% (95%CI=−5.83 to 44.77%) without depression 11.62% (95%CI=3.04 to 20.92%)
Avalos (2017)[44]	Northern California, USA	N PTB=14,466		-	All measures are % change in PTB with 10°F (5.6°C) increase in mean apparent temperature (temperature and dew-point temperature). Warm season mean apparent temperature lag06d, lag4, 5, 6d significant. Lag06d 11.6% (95%CI=4.1% to 19.7%) Cold season lag06d 6.2% (95%CI=-3.0% to 16.2%)	Warm season: lag06d.Coastal region 12.75% (95%CI=3.05% to 23.37%) vs inland regions 7.25% (95%CI=-7.69% to 25.86%). Late PTB (week 36) 22.1% (95%CI=4.1%-44.8%), early PTB (week 35) 9.4% (95%CI=-2.0% to 24.6%), very early PTB (<35 weeks) 12.8% (4.8 to 19.9). Females 13.9% (95%CI=4.1% to 25.9%), males 10.5% (95%CI=1.01% to 20.9%). All tests for interaction between sub-groups in warm season NS Cold season: lag06d. Coastal region 12.8% (95%CI=3.1% to 23.4%) vs Inland region -4.9% (95%CI=-20.5% to 12.75%), test for interaction p=0.08. Late PTB (week 36) 24.6%, (95%CI=5.1% to 49.2%), early PTB (week 35) 0.00% (95%CI=-9.5% to 10.52%), very early PTB (<35 weeks) 5.1% (95%CI: -4.9% to 17.4%). Interaction between late and early PTB p=0.04, and between late and very early p=0.11). Females 13.88% (95%CI=3.05% to 25.9%), males 1.01% (95%CI=-7.7% to 10.5%). Interaction p=0.01
Ngo (2016)[45]	Manhattan, New York, USA	N=510,781. N PTB not provided		-	Compared to 45-65°F. Each extra day >85°F gestation -0.0039 weeks (46 min). Other comparisons NS and small.	Compared to overall population, point estimates higher in <18 year olds. Largest to smallest impact: <12 years education higher impact compared to Bachelor or higher education; Hispanics, blacks, whites
Kent (2014)[46]	Alabama, USA	N=543,980. N PTB=60,466		11.1	Associations between heat wave indices and PTB positive for 9/15 heat wave definitions. Heat index of mean daily temperature >95th centile for ≥2 consecutive days: Lag06d. 11.6% (95%CI=0.9 to 23.4%) higher % PTB on heat wave versus non–heat wave days. Heat Index of mean daily temperature>98th centile for ≥2 days: 32.4% (95%CI=3.7 to 69.1%).	No effect modification noted by rurality

Author (year)	Country of study	N in study		PTB risk	Study outcomes	Subgroup analysis
					Heat indices using mean daily temperatures increased from 90th centile (1.5% higher PTB; 95%CI=–3.5 to 6.9%) to 95th and 98th centiles (higher point estimates with increased cut-off value). NS for PTB and apparent temperature HIs. In 10/15 heat indices, the longer the duration of heat waves the larger the point estimate of associations (unknown if significant) Associations between heat wave days and the outcomes similar between 1st heat wave of the season and later ones, and between early and late-season heat waves	
Ward (2019)[47]	North Carolina, USA	N=600,927. N PTB=29,854		5.0%	lag0d. Tmin. Reference group: is temperature when OR became >1. Mountain region, 82-83 centile (reference group): 84–86 centile OR=1.01 (95%CI=1.01 to 1.02), 86–88 OR=1.04 (95%CI=1.03 to 1.04) 88–90 OR=1.06 (95%CI=1.05 to 1.07), 90–92 OR=1.08 (95%CI=1.05 to 1.11) 92–94 OR=1.10 (95%CI=1.05 to 1.14), 94–96 OR=1.11 (95%CI=1.04 to 1.17), 96–98 OR=1.12 (95%CI=1.04 to 1.19) Piedmont Region 84-85 centile (reference group): 86–88 centile OR=1.01 (95%CI=1.00 to 1.01), 88–90 OR=1.01 (95%CI=1.01 to 1.02), 90–92 OR=1.02 (95%CI=1.00 to 1.05), 92–94 OR=1.03 (95%CI=0.98 to 1.07), 94–96 OR=1.03 (95%CI=0.97 to 1.09), 96–98 OR=1.04 (95%CI=0.97 to 1.11), 98–100 OR=1.04 (95%CI=0.97 to 1.11) Coastal Plains Region 82-82 centile (reference group): 84–86 OR=1.01 (95%CI=1.01 to 1.01), OR=86–88 1.02 (95%CI=1.02 to 1.02), 88–90 OR=1.03 (95%CI=1.03 to 1.03), 90–92 OR=1.04 (95%CI=1.03 to 1.05), 92–94 OR=1.05 (95%CI=1.02 to 1.08), 94–96 OR=1.06 (95%CI=1.01 to 1.10), 96–98 OR=1.06 (95%CI=1.01 to 1.12), 98–100 OR=1.07 (95%CI=1.00 to 1.13) Clear dose-dependent rises in OR with temperature. Lag03d similar findings	Highest impacts in Mountain regions, then Coastal Plains, then Piedmont. Socioeconomic status Coastal Plains poorest, Mountain region then Piedmont

PTB preterm birth. Tmax maximum temperature. Tmin minimum temperature. IQR inter-quartile range. sd standard deviation. RR risk ratio. OR odds ratio. HR Hazard ratio. CI confidence interval. NS not significant. C-section Caesarean section. Studies listed in order of World Bank income classification group, then geographical region and year of data collection. Grey shaded study outcomes are those used in meta-analyses. LagXb=x days before birth. D day m month vs versus gm gram. ES effect size. SE standard error. For calculating quartile 4 versus quartile 1 ES, for a 1 quartile change of Ψ and its standard error of se(Ψ), the ES for a 3 quartile change is Ψ^3, and SE=3*Ψ^2*se(Ψ)

Supplementary Table 2b. Results of studies assessing associations between exposure to high temperatures and birth weight

Author (year)	LBW risk	N in study	Study outcomes	Subgroup analysis
			Multiple countries	
Wells (2002)[48]	-	Median sample size=5558. Mean sample size=97,237	Annual heat index (0-4), drawn from monthly discomfort ratings using temperature and humidity data. Simple linear regression weight (gm) and heat index r=-0.59 (P<0.001). Analysis with 108 populations with full data: 1 unit rise in heat index birth weight decreases 2.7% (P=0.002). Linear relationship	
Jensen (2013)[49]	-	Data not provided	1°C increase in Tmax reduces birth weight by 23gm (0.75% change), 2°C=45gm (1.46%), 3°C=68gm (2.21% change). All significant. Reduction in birth weight by 1.05% per 1°C in range 20-25°C LBW increases with Tmax (P<0.001) and Tmin (P<0.001)	
Grace, (2015)[50]	11.0%	N=61,075. N LBW=6694	Change in weight (gm) per day >100°F. 3 months pre-conception -0.45 (P<0.1), 1st trimester -0.71 (P<0.01), 2nd trimester -0.85 (P<0.001), 3rd trimester -0.24 (NS). Larger estimates with temperature threshold >105°F. LBW rises with temperature. Regression coefficient for LBW with n days >100°F 3 months pre-conception -0.17 (NS), 1st trimester -0.20 (P<0.1), 2nd trimester -0.33 (P<0.01), 3rd trimester -0.17 (NS). Also significant findings with days above 105°F	
Molina (2017)[51]	7.0%	N=86,021	Birth weight 19.7gm lower with 1 sd above historical mean temperature mean (P<0.01) in whole pregnancy period [ES=39.4; SE=7.64]. 1st trimester 1 sd above mean lower birth weight by 16.4gm (P<0.05). 2nd and 3rd trimester NS. LBW 0.7% increase in absolute % of LBW with each sd > historical mean temperature (P<0.05 [ES=1.014 (2sd); SE=0.007])	
			Lower-middle income countries	
Rashid (2017)[52]	30.5%	N=3267. N LBW=997	Birth weight. Mean daily temperature correlated with outcome. Weight rises 5.97gm per 1°C temperature in week 12 (p=0.052), 4.7gm in week 19 (P=0.028). Reduction in birth weight at lag6 weeks in some analyses	Higher impacts (increases in birth weight with higher temperatures) in women with BMI <18.5kg/m^2 significant at week 17, week 19, week 24, week 30 of gestation, 6 weeks before childbirth, 4 weeks before childbirth, 2 weeks before childbirth and at birth. Women BMI ≥18.5kg/m^2 significant at weeks 12, 6 weeks before childbirth
			Upper-middle income countries	
Andalon (2016)[7]	1.8%	N=1,250,000. N LBW=22,500	Birth weight. 'Heat shock' (temperature in ≥1 month anytime during pregnancy that is >0.7 z-scores from long-term mean (1901–1997): birth weight -3.6gm (P<0.05). LBW -0.1% NS	Impacts on birth weight appear higher in women <=23 years and with only primary education (unknown if significant)
Elter (2004)[53]	-	N=3333	Birth weight. Mean values for each trimester of mean daily temperature. Temperature in 2nd trimester associated with reduced birth weight (beta coefficient=0.001; p=0.018). NS in other trimesters (data not provided)	-
MacVicar (2017)[54]	6.4%	N=3691. N LBW=237	Birth weight. Per 1°C increase in mean temperature, birth weight increased 41.8gm in 3rd trimester (95%CI=0.64 to 82.92). Other trimesters NS, low point estimates. Entire pregnancy change per 1°C temperature=26.03 (95%CI=35.33 to 87.40). Driest season (June-Aug), 1°C increase in mean temperature in 3rd trimester=123.06gm	No interaction between gender and outcome. Higher effects in

Author (year)	LBW risk	N in study	Study outcomes	Subgroup analysis
			rise (95%CI=18.95 to 227.18; P<0.05). Rainy season (Sept.-Nov) 98.37gm rise per 1°C (95%CI=23.04 to 173.7; P<0.05). Other seasons NS. LBW NS association (data not provided).	vulnerable indigenous population
			High-income countries	
			East Asia, Pacific	
Li (2018a)[13]	-	N=237,585	Birth weight. TMax >30°C (reference group) vs 25–30 °C, 20–25°C, ≤20°C categories based on distribution of temperature, effect of temperature on outcomes). Mean birth weight 1st week and 1st 4 weeks NS. lag07d >30°C vs 25-30°C 0.006kg (95%CI=0.000 to 0.013; P=0.066); 20–25°C 0.011kg (95%CI=0.008 to 0.018; P=0.041), ≤20°C 0.018kg (95%CI=0.010 to 0.031; P=0.024). lag028 >30°C vs 25-30°C 0.003kg (95%CI=-0.004 to 0.011; P=0.349), 20–25°C 0.013kg (95%CI=0.002 to 0.024; P=0.021) ≤20°C 0.008kg (95%CI=-0.016 to 0.033; P=0.527). 'almost linear' relationship (stepwise)	-
Tustin (2004)[16]	-	N=7,039	Birth weight. 1st trimester mean birth weight in peak months=3554gm (sd=23) vs mean birth weight in trough months=3566gm (sd=22). 2nd trimester mean birth weight in peak months=3542g, vs mean birth weight in trough months=3558gm. 3rd trimester mean birth weight in peak months=3519gm (sd=23) vs mean birth weight in trough months=3552gm (sd=21)	-
Son (2019)[17]	1.5%	N=813,820. N term LBW=12,298	LBW. Heat Index (air temperature and relative humidity). HR are for a quartile increase in heat index. Term LBW NS: whole pregnancy HR=1.006 (95%CI=0.961 to 1.052) [ES Q4 vs Q1=1.018; SE=0.07); lag028 HR=1.005 (95%CI=0.990 to 1.019)	-
Weng (2018)[18]	-	N=2,045,748. N LBW data not provided	LBW. Temperature at birth. Temperature 21.5-23.4°C (reference group). Temperature 23.5-25.4°C RR=1.05 (95%CI=1.02 to 1.07). Temperature 25.5-27.4°C RR=1.07 (95%CI=1.04 to 1.09). Temperature 27.5-29.4°C RR=1.09 (95%CI=1.07 to 1.12). Temperature 29.5-30.8°C RR=1.07 (95%CI=1.04 to 1.10)	-
			Europe, Central Asia	
Wolf (2012)[22]	Brandenburg 4.9%. Saxony 4.9%	Brandenburg N=128,604. N LBW=6242. Saxony N=162,913. N LBW=8034	LBW. Comparisons of mean temperatures in quintile (baseline, coldest to hottest), term LBW. Brandenburg. 2nd trimester: 2nd quintile OR=0.85 (95%CI=0.70 to 1.02), 3rd OR=0.68 (95%CI=0.51 to 0.91) 4th OR=0.70 (95%CI=0.48 to 1.00) 5th OR=0.81 (95%CI=0.53 to 1.25) P=0.05. Saxony 1st trimester: 2nd quartile OR=0.99 (95%CI=0.86 to 1.14), 3rd OR=0.91 (95%CI=0.73 to 1.14) 4th OR=0.97 (95%CI=0.72 to 1.31) 5th OR=0.74 (95%CI=0.51 to 1.06) P=0.06. Alternative analysis methods found associations between rise in temperature and higher LBW risk. Inconsistent findings	-
Poeran (2016)[55]	-	n=1,460,401	Results are change in gm BW per 1°C increase in mean Tmin. 2nd trimester 0.4 (95%CI=0.0 to 0.8; P<0.05). 3rd trimester 1.5 (95%CI=1.2 to 1.7; P<0.001). T max. reduction in weight per 1°C increase: conception day +/- 3d) -0.4 (95%CI=-0.8 to -0.1; P<0.001). 1st trimester -2.1 (95%CI=-2.4 to -1.7; P<0.001). 2nd trimester -2.4 (95%CI=-2.8 to -2.0; P<0.01). 3rd trimester -2.1 (95%CI=-2.5 to -1.8; P<0.001). Lag0d -0.4 (95%CI=-0.6 to -0.1; P<0.01)	Inland areas higher temperature impacts than coastal
Sienkiewicz (2018)[56]	-	N=205 cases, 205 controls	LBW. NS association between mean temperature and LBW (data not provided)	-
Madsen (2010)[57]	1.2%	N=25,229. N LBW=303	Birth weight. NS birth weight and temperature (mean difference in birth weight per temperature quartile)	-

Author (year)	LBW risk	N in study	Study outcomes	Subgroup analysis
Dadvand (2014)[58]	3.0%	N=6438. N LBW=190	LBW Average temp over whole pregnancy. LBW OR=1.21 (95%CI=0.98 to 1.49) per quartile increase in temperature [ES Q4 vs Q1=1.77; SE=0.47)	-
Diaz (2016)[59]	1.1%	N=298,705. LBW=3290	LBW. NS association between a 'heat wave' week (mean Tmax in week >34) and term LBW (data not provided)	-
Bruckner (2014)[28]	-	N=13,657	Birth weight NS finding coefficient=-0.24 (95%CI=-0.66 to 0.18)	-
Lawlor (2005)[60]	-	N=12,150	Birth weight. Temperature around conception -2.4gm per 1°C (95%CI=-4.6 to -0.2). Mean temperature in middle of 1st trimester and birth weight (hotter temperature associated with lower birth weight). Stepwise change -5.4gm/1°C (95%CI=-7.9 to -2.9; P test for trend <0.001). Temp in mid-2nd trimester NS association. 3rd trimester step-wise increase in weight per quartile increase in temp (P test for trend=0.002). Gains 1.3gm /1°C (95%CI=0.5 to 2.1). Temperature around childbirth similar finding	-
Murray (2000)[61]	-	N=5,418,817	-	Females, with an increase of 1°C in mean daily Tmax in 2nd trimester mean birth weight rose 3.5gm (SE=0.88; p<0.001). Males 1.02gm (SE=0.88; P=0.25)
			Middle East and North Africa	
Chodick (2007)[62]	5.6%	N=225,545. N LBW=12,724	Monthly mean of minimum daily temperature. Month 1 of pregnancy regression coefficient for birth weight per 1°C=0.77 (95%CI=0.11 to 1.42; P=0.02). Month 4 of pregnancy regression coefficient per 1°C=1.45 (95%CI=0.78 to 2.13; p<0.01)	-
Kloog (2018)[63]	3.1%	N=56,141. N LBW=1716	LBW U shape (base +/- 20°C). Quartile 25-75 is reference group. Entire pregnancy mean temperature exposure >75th OR=1.17 (95%CI=0.99 to 1.38) 1st trimester mean temp >75th centile OR=1.03 (95%CI=0.82 to 1.31); 2nd trimester OR=1.14 (95%CI=0.92 to 1.41), 3rd trimester OR=1.02 (95%CI=0.92 to 1.12). No lags significant.	No interaction detected by ethnicity or urbanity level
			North America	
Sun (2019)[64]	-	N=29,597,735	Birth weight. Mean daily temperature. Reference temperature 40-50th centiles Entire pregnancy temperatures. Birth weight (difference in gm compared to reference group) >90th difference=–15gm (95%CI=–17 to –13). 80–90th difference=–11gm (95%CI=–12 to –9). Impacts in 2nd, 3rd trimesters were similar to temperature impacts in all pregnancy. Temperature 1st trimester NS, point estimates around 1.0. Largest impacts were in marine and cold/very cold climate zones. Inverse U-shape	
Kloog (2015)[41]	-	N=462,400. N LBW not provided	Birth weight. In predicted and weather station measures, at lag07d, lag0_14d, lag30d, 3rd trimester and all pregnancy) weight decreased with increased IQR temperature. With predicted temperature, 3rd trimester impacts larger than entire pregnancy impacts or the impacts in lag07d. Term birth weight was -5.0gm per IQR over all pregnancy (95%CI=–7.8 to –2.3), -8.9gm (95%CI=–16.2 to –1.5) at lag07d, but -16.6gm (95%CI=–27.4 to –5.9) in lag30d and -16.7gm (95%CI=–29.7 to –3.7) in 3rd trimester [ES=33.4; SE=13.3]. NS weather station temperature birth weight associations. LBW. OR for LBW with IQR rise in predictive temperature over entire pregnancy=1.04 (95%CI=0.96 to 1.13). ES=1.08; SE=0.087], and with weather station measures=1.02 (95%CI=0.45 to 2.30)	
Ha (2017)[65]	2.0%	N=220,572. N LBW=4,322	>95th percentile for temperature vs <95th. LBW preconception RR=1.01 (95%CI=0.88 to 1.17); 1st trimester RR=1.02 (95%CI=0.88 to 1.17); 2nd trimester RR=1.06 (95%CI=0.92 to 1.22); 3rd trimester RR=1.31 (95%CI=1.15 to 1.50); all pregnancy RR=2.49 (95%CI=2.20 to 2.83)	

Author (year)	LBW risk	N in study	Study outcomes	Subgroup analysis
Ngo (2016)[45]	-	N=514,104	Birth weight inverted U-shape. Compared to 45-65°F. Each extra day of >85 °F in 1st trimester BW -1.12gm (P<0.1). 2nd trimester -1.15gm (P<0.05). Cumulative impact during whole of pregnancy birth weight -1.7gm (P<0.10). LBW Each extra day of >85°F probability of LBW in 2nd trimester increases 0.00046 (P<0.10). Other comparisons NS and small.	Compared to overall population, point estimates higher in <18 year olds. <12 years education larger estimates than tertiary education. Largest to smallest impact: Hispanics, blacks, whites
Basu (2018)[66]	2.1%	N=2,076,230. N LBW=43,629	LBW. U-shaped in 1st, 3rd trimester and overall (base 12.8°C to 18.3°C). Linear in 2nd trimester. Reference value temperature above which OR rises. Apparent temperature (temperature and relative humidity). All outcomes are % change in OR of LBW per 10°F increase in temperature. Whole of pregnancy 13.0% (95%CI=4.1 to 22.7) [ES 3X 10°F above base=1.09; SE=0.03). 1st trimester −7.4% (95%CI=−12.5 to −2.0). 2nd trimester 1.7% (95%CI=0.3 to 3.2). 3rd trimester 15.8% (95%CI=5.0 to 27.6). Lag0_28d NS, Lag0_14d 2.6% (95%CI=0.2, 5.0).	LBW association based on whole pregnancy ≥55F; data not provided on whether differences between subgroups are significant). Highest to lowest point estimates. Race: Black, white, Asian, Hispanic. Age: ≥40 years, 11-18 years, 19-24, 25-29, 30-39. Education: <high school, high school, college. Gender: male, female. Season: warm, cold. BMI underweight, overweight, normal. WIC enrolment (marker of low SES): yes, no

LBW low birth weight. Tmax maximum temperature. Tmin minimum temperature. IQR inter-quartile range. sd standard deviation. RR risk ratio. OR odds ratio. HR Hazard ratio. CI confidence interval. NS not significant. C-section Caesarean section. Studies listed in order of World Bank income classification group, then geographical region and year of data collection. Grey shaded study outcomes are those used in meta-analyses. LagXd=x days before birth. D day. m month. vs versus. gm gram. ES effect size. SE standard error. For calculating quartile 4 versus quartile 1 ES, for a 1 quartile change of Ψ and its standard error of se(Ψ), the ES for a 3 quartile change is Ψ^3, and SE=$3*\Psi^2*se(\Psi)$

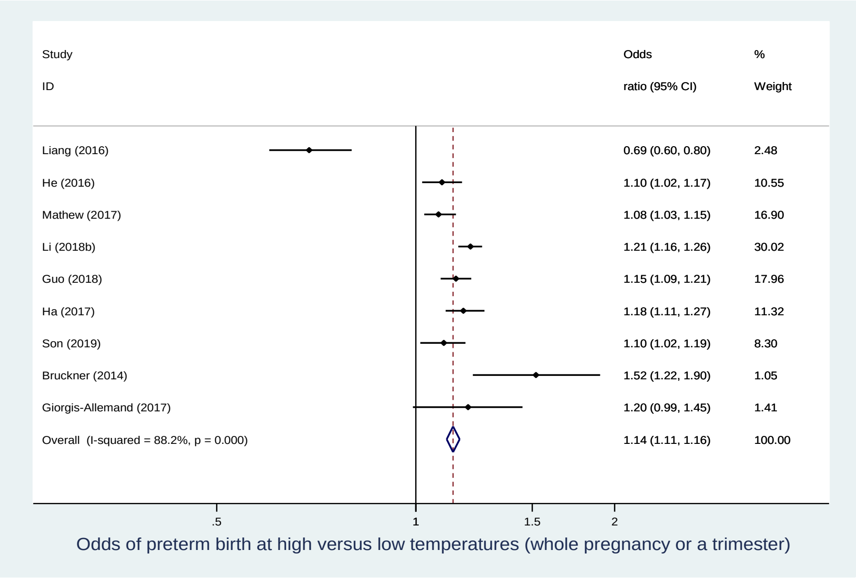
Supplementary Table 2c. Results of studies assessing associations between exposure to high temperatures and stillbirth

Author (year)	Country of study	per 1000 births	N	Study outcomes	Subgroup analysis
Low-income countries					
Lower-middle income countries					
Upper-middle income countries					
High-income countries					
East Asia, Pacific					
Strand (2012)^[10]	Brisbane, Australia	6.4	N=101,870. N SB=653	Temp in lag028d. Increasing mean temperatures increased risk of SB up to 21°C (reference group), e.g. HR of a stillbirth birth at 12°C about 0.3, compared with 21°C. Significant at 20-36 weeks gestation, but not at ≥37 weeks Above 21°C plateau/reduces risk (U shape), NS difference in HR at high temp. Patterns with lag07d similar, except larger point estimate HR reduction at higher temperatures, e.g. 25°C vs 21°C RR=0.82 (95%CI=0.64 to 1.02). At 15°C expect 353 stillbirths per 100,000 pregnancies, at 23°C 610 per 100,000 pregnancies.	
Wang (2019)[12]	Brisbane, Australia	2.5	N=277,133. N SBs=705	Exposure in each gestation month binary variable, 6 heat wave definitions: 90th centile (duration 2, 3, 4d); 95th centile (duration 2, 3, 4d). All OR point estimates m1-m9 of pregnancy >1. m10 OR<1. For most heat wave definitions, point estimate OR higher in m1-6 than m7, m9. Heat wave definition 90th centile 2d, m1-6 ranged from HR=1.54 (95%CI=1.27 to 1.87) to HR=1.75 (95%CI=1.44 to 2.12), but HR=0.97 (95%CI=0.74 to 1.27) m7, HR=1.46 in m8 (95%CI=1.09 to 1.96), lowered in M9, m10. 95th centile for 4d highest risk in m8 HR=1.52 (95%CI=1.11 to 2.09)	
Li (2018b)[15]	Brisbane, Australia	6.2	N=289,351. N SBs=1783	Comparison mean daily temperature at different centiles and temperature at minimum PTB prevalence. 75th centile 1st trimester HR=1.13 (95%CI=0.90 to 1.42), 2nd trimester HR=1.11 (95%CI=1.04 to 1.19), 3rd trimester HR=1.91 (95%CI=0.91 to 4.02). 95th centile 1st trimester HR=1.05 (95%CI=0.96 to 1.16) 2nd trimester HR=1.47 (95%CI=1.24 to 1.74) 3rd trimester HR=2.23 (95%CI=1.02 to 5.33).	Change over time: 95th centile and temperature at minimum PTB prevalence: 1st and 3rd trimester lower point estimates of association in 2013 than 1994 (uncertain if significant), similar in 2nd
Weng (2018)[18]	Taiwan, China	9.6	N=2,123,751. N SBs=20,475	Temperature at birth 21.5-23.4 (reference group, lowest level). Temperature 23.5-25.4°C RR=1.08 (95%CI=1.01 to 1.14). Temperature 25.5-27.4°C RR=1.09 (95%CI=1.03 to 1.15). Temperature 27.5-29.4°C RR=1.16 (95%CI=1.10 to 1.22). Temperature 29.5-30.8°C RR=1.17 (95%CI=1.09 to 1.26)	
European Union and Central Asia					
Latin America and Caribbean					
Middle East and North Africa					

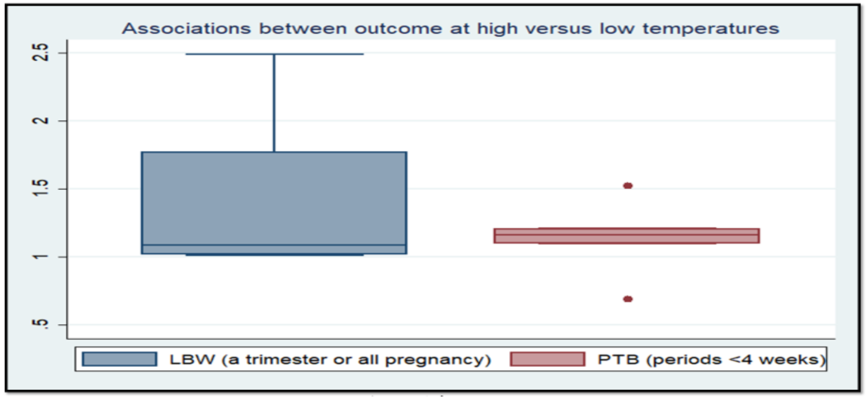
Author (year)	Country of study	per 1000 births	N	Study outcomes	Subgroup analysis
North America					
Ha (2017)[67]	12 clinical centres (15 hospital referral regions) across USA	4.4	N=223,375. N stillbirths=992	Compared to 10–90th centile temperatures during whole pregnancy, >90th centile OR of stillbirth=3.71 (95%CI=3.07 to 4.47). Preconception OR=1.02 (0.80 to 1.30). 1st trimester OR=0.83 (0.63 to 1.08). 2nd trimester OR=1.03 (0.78 to 1.34). 3rd trimester not assessed as N small. Warm season (May-Sept.) lag06d OR=1.06 (95%CI=1.03 to 1.09) per 1°C increase in temperature. Cold season (Oct.-April) OR=1.00 (0.98 to 1.02)	Similar findings when stillbirths stratified by intrapartum and antepartum
Auger (2017)[68]	Quebec, Canada	-	N=5047 SBs (N preterm SB=3198. N term SB=1693)	Maximum daily temperature. All SBs: lag2d: ≥28°C OR=1.10 (95%CI=0.97 to 1.25) vs 11.5-19.9°C. lag3d OR=1.08 (95%CI=0.95 to 1.22) 28 v 15.5-19. Lag4d, lag5d similar. Lag6d OR=1.14 (95%CI=1.00 to 1.29) (≥28°C vs 15-19.9°C). NS for preterm SBs. Term SB (all compared to 20°C) temp >28°C lag3d OR=1.16 (95%CI=1.02 to 1.33). >30°C OR=1.22 (95%CI=1.02 to 1.46), 32 degrees OR=1.28 times (95%CI=1.03 to 1.60). Lag6d, compared to 15-19.9°C, temperatures ≥28°C OR=1.32 for term SB (95%CI=1.06 to 1.65). NS lag7d, lag8d	Multiple pregnancies also associated with term SBs, not preterm SB
Rammah (2019)[69]	Harris county, Texas, USA	-	N SBs=709. N SBs with placental abruption=87	OR with 10°F increase in apparent temperature (ambient and dew point temperature). OR=1.25-1.37. Significant, for lag days 1, 2, 3, 4, 5, 6 (highest lag1d 1.37 [1.16-1.61]). With moving averages (means of lag days) highest with lag06d: OR=1.45 (95%CI=1.18 to 1.77). Analysis restricted to hottest months (June, July and August), lag06g OR=2.57 (95%CI=1.72 to 2.84)	Lag1_6d OR of SB with 10°F increase in temperature: Black 1.61 (95%CI=1.12 to 2.30). Hispanic 1.60 (95%CI=1.19 to 2.15). White 0.90 (95%CI=0.54 to 1.50). SB with placental abruption had highest odds lag1d OR=1.93 (95%CI=1.15 to 3.23)
Basu (2016)[70]	California, USA	-	N=8510 SBs	Lags associated lag2d, 3, 4, 5, 6, 23, 24, 25, 26. All results cumulative average of lags2–6d and % increase per 10°F increase in apparent temperature: 10.4% (95%CI=4.4 to 16.8) [ES 3X 10°F=1.34; SE=0.10]. Associations in weeks 20–25 and 31–33, but not 34-36 and 37-44 (near 0 point estimate). Cold season NS	NS difference: women <25 years 11.8%, 95%CI=1.5 to 23.2); 25–34 years 10.1% (95%CI=0.8 to 20.2); ≥35 years 4.9% (95%CI=−8.8 to 20.6). High school or less 10.6% (95%CI=2.9 to 18.8) vs some college 7.4%, (95%CI=−4.9 to 21.4). Most racial groups 9.4-10.8% increase per 10°F (wide CIs). Asians 4.8% increase (95%CI=−16.5 to 31.5). Only significant in Hispanics. Male foetuses 13.3% (95%CI=4.8 to 22.4), female 9.8% (95%CI=−1.9 to 22.9)

NS not significant. CI confidence interval. HR hazard ratio. OR odds ratio. RR risk ratio. Tmax maximum temperature. Tmin minimum temperature. sd standard deviation. vs versus. d day. gm gram. SB stillbirth. m month. WBGT wet bulb globe temperature. Stillbirths >20 weeks gestation. ^excluded from meta-analysis as a low-quality study. PTB preterm birth. LagXb=x days before birth. Studies listed in order of World Bank income classification group, then geographical region and year of data collection. Köppen–Geiger climate classification system[#] ES effect size. SE standard error. For calculating quartile 4 versus quartile 1 ES, for a 1 quartile change of Ψ and its standard error of se(Ψ), the ES for a 3 quartile change is Ψ3, and SE=3*Ψ2*se(Ψ)

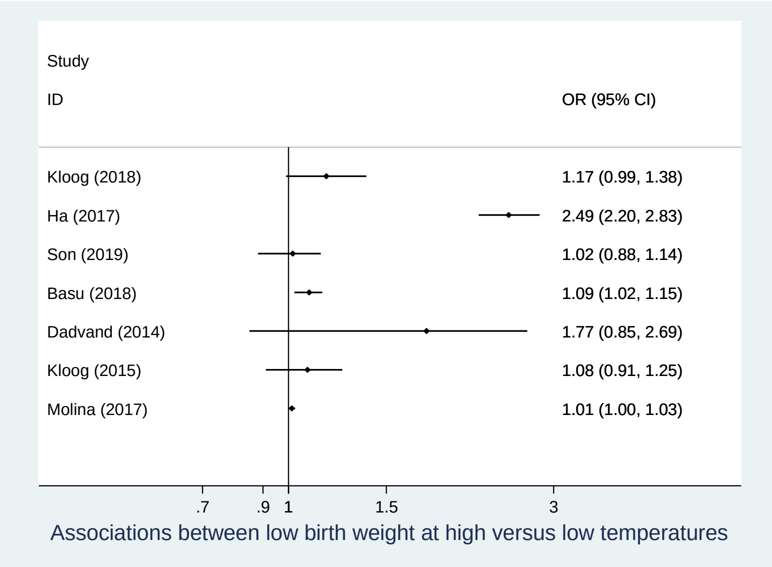
Supplementary Figures



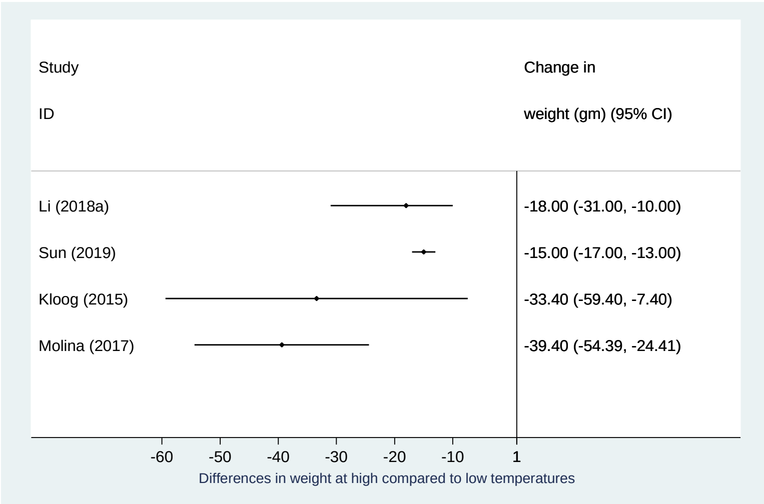
Supplementary Figure 1: Odds of preterm birth at high versus low temperatures (whole pregnancy or a whole trimester)



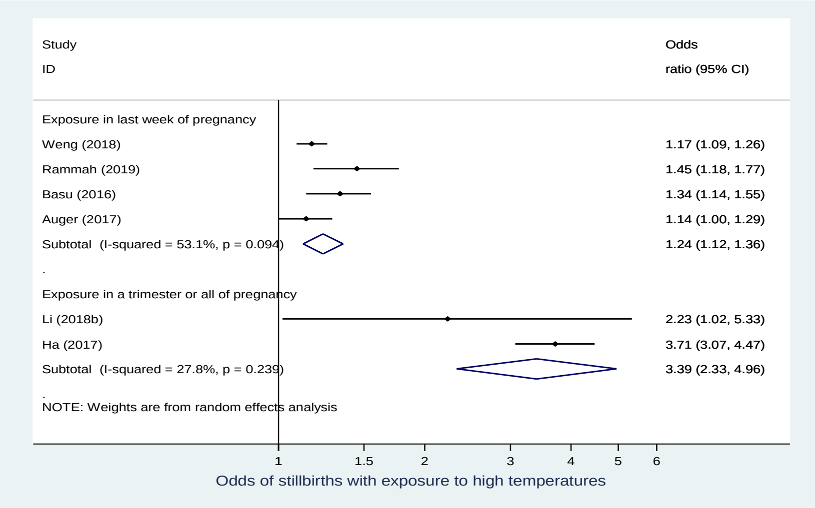
Supplementary Figure 2 Box and Whiskers plot of associations between preterm birth and low birth weight outcome at high versus low temperatures



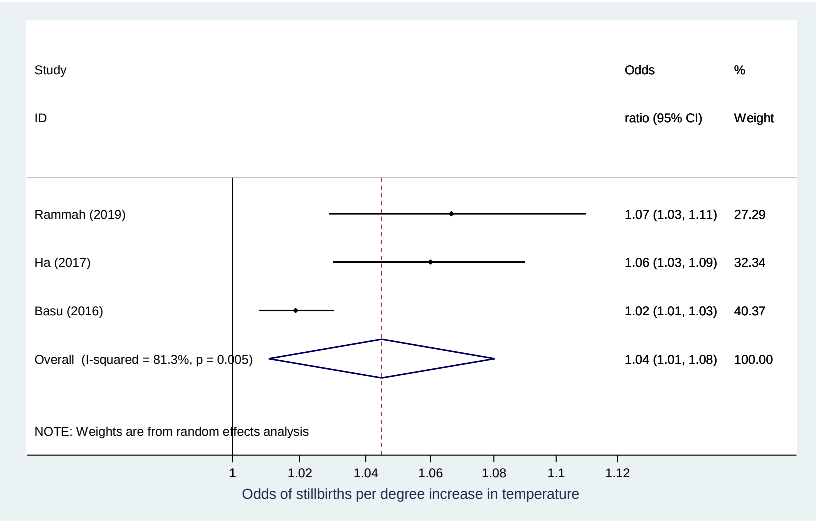
Supplementary Figure 3: Associations between low birth weight at high versus low temperatures



Supplementary Figure 4: Differences in weight at high compared to low temperatures



Supplementary Figure 5: Odds of stillbirths with exposure to high temperatures



Supplementary Figure 6: Odds of stillbirth per degree rise in temperature

Supplementary Figure 7a: Lag analysis for preterm birth, by trimester, month of gestation and in the final week of pregnancy

Author (year)	pre-concept	1st tri m1	1st tri m2	1st tri m3	2nd tri m1	2nd tri m2	2nd tri m3	3rd tri m1	3rd tri m2	3rd tri m3 (lag 28d)		7d	6d	5d	4d	3d	2d	1d	0d
Upper-middle income countries																			
Zhong (2018)																			
Zheng (2018)																			
He (2016)																			
Liang (2016)										d10, 15, 20, 25, 30									
Guo (2018)																			
Wu (2019)										d0-14									
Andalon (2016)																			
Muresan (2016)																			
Mohammadi, (2019)																			
High-income countries																			
East Asia, Pacific																			
Strand (2012)																			
Wang (2013)																			
Wang (2019)																			
Li (2018)^																			
Mathew (2017)																			
Li (2018)																			
Tustin (2004)^																			
Son (2019)																			
Weng (2018)																			
European Union and Central Asia																			
Giorgis-Allemand (2017)																			
Schifano (2016)																			
Cox (2016)																			
Wolf (2012)^																			
Schifano (2013)																			
Asta (2019																			
Dadvand (2011)																			

Author (year)	pre-concept	1st tri m1	1st tri m2	1st tri m3	2nd tri m1	2nd tri m2	2nd tri m3	3rd tri m1	3rd tri m2	3rd tri m3 (lag 28d)		7d	6d	5d	4d	3d	2d	1d	0d
Arroyo (2016)																			
Vicedo-Cabrera (2014)										d8-14									
Bruckner (2014) ^										d21-28									
Vicedo-Cabrera (2015)																			
Lee (2008) ^																			
Latin America and Caribbean																			
Yu (2018)																			
Middle East and North Africa																			
Yackerson (2008)																			
Walfisch, (2016) ^																			
North America																			
Auger (2014) ^																			
Lajinian (1997) ^																			
Porter (1999) ^																			
Sun (2019)																			
Carmichael, (2014) ^																			
Basu (2010)																			
Cil (2017)																			
Kloog (2015) ^																			
Ha (2017)																			
Basu (2017)																			
Avalos (2017)																			
Ngo (2016) ^																			
Kent (2014)																			
Ward (2019)																			

^not provided or no significant lags. Pre-concep. pre-conception. d day. m month. tri. trimester. Red shading denotes lag periods where higher temperatures were associated with increased preterm births. Dark red shading shows the lag period with highest point estimate. Green shading indicates lag periods where higher temperatures were associated with fewer preterm births

Supplementary Figure 7b: Lag analysis for birth weight, by trimester and month of gestation

Author (year)	pre-concept	1st tri m1	1st tri m2	1st tri m3	2nd tri m1	2nd tri m2	2nd tri m3	3rd tri m1	3rd tri m2	3rd tri m3 (lag 28d)
Multiple countries										
Wells (2002)^										
Jensen (2013)^										
Grace, (2015)										
Molina (2017)										
Lower-middle income countries										
Rashid (2017)										Only w12, w19
Upper-middle income										
Weng (2018)*										
Andalon (2016)^										
Elter (2004)										
MacVicar (2017)										
High-income countries										
East Asia, Pacific										
Li (2018)										
Tustin, (2004)^										
Son (2019)^										
Europe, Central Asia										
Wolf (2012)										
Poeran (2016)*										
Sienkiewicz (2018)^										
Madsen (2010)^										
Dadvand (2014)^										
Diaz (2016)^										
Bruckner (2014)^										
Lawlor (2005)										
Middle East and North Africa										
Murray (2000)										

Chodick (2007)										
Kloog (2018)^										
North America										
Sun (2019)										
Kloog (2015)										
Ha (2017)										
Ngo (2016)										
Basu (2018)										

^not provided or not significant lags. Pre-concep. pre-conception. d day. m month. tri. trimester. *Also significant finding at lag0d. Red shading denotes lag periods where higher temperatures were associated with higher birth weight. Dark red shading shows the lag period with highest point estimate Green shading indicates lag periods where higher temperatures were associated with a lower birth weight

Supplementary Figure 7c: Lag analysis for stillbirths, by trimester, month and in the final week of pregnancy

Author (year)	pre-concep	1st tri m1	1st tri m2	1st tri m3	2nd tri m1	2nd tri m2	2nd tri m3	3rd tri m1	3rd tri m2	3rd tri m3 (lag 28d)		7d	6d	5d	4d	3d	2d	1d	0d
Ha (2017)																			
Strand (2012)																			
Wang (2019)																			
Li (2018)																			
Auger (2017)																			
Weng (2018)																			
Rammah (2019)																			
Basu (2016)																			

Pre-concep. pre-conception. d day. m month. tri. trimester. Red shading denotes lag periods where higher temperatures were associated with higher stillbirths. Dark red shading shows the lag period with highest point estimate. No studies on temperature-stillbirth associations were done in low- and middle-income countries

Supplementary Figure 8a Analysis of temperature-outcome associations socio-economic status of mother

1st author (year)	**Low socioeconomic status**	**High socioeconomic status**
Preterm birth		
Tustin, (2004)		
Schifano (2013)		
Porter (1999)		
Sun (2019)		
Basu (2010)		
Ngo (2016)		
Birth weight		
Andalon (2016)		
Ngo (2016)		
Basu (2018)		
Stillbirth		
Basu (2016)		

Red shading is the population group at highest risk

Supplementary Figure 8b Associations between high temperatures and study outcomes by gender of newborn

1st author (year)	**Female newborns**	**Male newborns**
Preterm birth		
Zhong (2018)		
Zheng (2018)		
He (2016)		
Wu (2019)		
Wang (2013)		
Tustin, (2004)		
Cox (2016)		
Sun (2019)		
Basu (2010)		
Avalos (2017)		
Birth weight		
Ngo (2016)		
Basu (2018)		
Stillbirths		
Basu (2016)		

Sub-groups with the highest effect estimates shown in red shading.

References

1. Zhong Q, Lu C, Zhang W, et al. Preterm birth and ambient temperature: Strong association during night-time and warm seasons. *Journal of thermal biology* 2018;78:381-90.
2. Zheng X, Zhang W, Lu C, et al. An epidemiological assessment of the effect of ambient temperature on the incidence of preterm births: Identifying windows of susceptibility during pregnancy. *Journal of thermal biology* 2018;74:201-07. doi: 10.1016/j.jtherbio.2018.04.001
3. He JR, Liu Y, Xia XY, et al. Ambient Temperature and the Risk of Preterm Birth in Guangzhou, China (2001-2011). *Environmental Health Perspectives* 2016;124(7):1100-06. doi: 10.1289/ehp.1509778
4. Liang ZJ, Lin Y, Ma YZ, et al. The association between ambient temperature and preterm birth in Shenzhen, China: a distributed lag non-linear time series analysis. *Environmental Health* 2016;15:11. doi: 10.1186/s12940-016-0166-4
5. Guo T, Wang Y, Zhang H, et al. The association between ambient temperature and the risk of preterm birth in China. *The Science of the total environment* 2018;613-614:439-46. doi: 10.1016/j.scitotenv.2017.09.104
6. Wu M, Song L, Zheng X, et al. Prenatal exposure of diurnal temperature range and preterm birth: Findings from a birth cohort study in China. *Science of the Total Environment* 2019;656:1102-07.
7. Andalon M, Azevedo JP, Rodriguez-Castelan C, et al. Weather Shocks and Health at Birth in Colombia. *World Development* 2016;82:69-82. doi: 10.1016/j.worlddev.2016.01.015
8. Muresan D, Staicu A, Zaharie G, et al. The influence of seasonality and weather changes on premature birth incidence. *Clujul Medical* 2017;90(3):273.
9. Mohammadi D, Naghshineh E, Sarsangi A, et al. Environmental extreme temperature and daily preterm birth in Sabzevar, Iran: a time-series analysis. *Environmental health and preventive medicine* 2019;24(1):5.
10. Strand LB, Barnett AG, Tong SL. Maternal Exposure to Ambient Temperature and the Risks of Preterm Birth and Stillbirth in Brisbane, Australia. *American Journal of Epidemiology* 2012;175(2):99-107. doi: 10.1093/aje/kwr404
11. Wang J, Williams G, Guo Y, et al. Maternal exposure to heatwave and preterm birth in Brisbane, Australia. *BJOG : an international journal of obstetrics and gynaecology* 2013;120(13):1631-41. doi: 10.1111/1471-0528.12397
12. Wang J, Tong S, Williams G, et al. Exposure to Heat Wave During Pregnancy and Adverse Birth Outcomes: An Exploration of Susceptible Windows. *Epidemiology* 2019;30:S115-S21.
13. Li S, Wang J, Xu Z, et al. Exploring associations of maternal exposure to ambient temperature with duration of gestation and birth weight: a prospective study. *BMC pregnancy and childbirth* 2018;18(1):513.
14. Mathew S, Mathur D, Chang A, et al. Examining the effects of ambient temperature on pre-term birth in Central Australia. *International journal of environmental research and public health* 2017;14(2):147.
15. Li S, Chen G, Jaakkola JJK, et al. Temporal change in the impacts of ambient temperature on preterm birth and stillbirth: Brisbane, 1994-2013. *The Science of the total environment* 2018;634:579-85. doi: 10.1016/j.scitotenv.2018.03.385
16. Tustin K, Gross J, Hayne H. Maternal exposure to first-trimester sunshine is associated with increased birth weight in human infants. *Developmental Psychobiology: The Journal of the International Society for Developmental Psychobiology* 2004;45(4):221-30.

17. Son JY, Lee JT, Lane KJ, et al. Impacts of high temperature on adverse birth outcomes in Seoul, Korea: Disparities by individual- and community-level characteristics. *Environmental research* 2019;168:460-66. doi: 10.1016/j.envres.2018.10.032
18. Weng YH, Yang CY, Chiu YW. Adverse neonatal outcomes in relation to ambient temperatures at birth: A nationwide survey in Taiwan. *Archives of environmental & occupational health* 2018;73(1):48-55. doi: 10.1080/19338244.2017.1299084
19. Giorgis-Allemand L, Pedersen M, Bernard C, et al. The Influence of Meteorological Factors and Atmospheric Pollutants on the Risk of Preterm Birth. *American Journal of Epidemiology* 2017;185(4):247-58. doi: 10.1093/aje/kww141
20. Schifano P, Asta F, Dadvand P, et al. Heat and air pollution exposure as triggers of delivery: A survival analysis of population-based pregnancy cohorts in Rome and Barcelona. *Environment international* 2016;88:153-59. doi: 10.1016/j.envint.2015.12.013
21. Cox B, Vicedo-Cabrera AM, Gasparrini A, et al. Ambient temperature as a trigger of preterm delivery in a temperate climate. *Journal of Epidemiology and Community Health* 2016;70(12):1191-99. doi: 10.1136/jech-2015-206384
22. Wolf J, Armstrong B. The association of season and temperature with adverse pregnancy outcome in two German states, a time-series analysis. *PloS one* 2012;7(7):e40228. doi: 10.1371/journal.pone.0040228
23. Schifano P, Lallo A, Asta F, et al. Effect of ambient temperature and air pollutants on the risk of preterm birth, Rome 2001-2010. *Environment international* 2013;61:77-87. doi: 10.1016/j.envint.2013.09.005
24. Asta F, Michelozzi P, Cestari L, et al. [Effects of high temperature and air pollution on the risk of preterm births. Analysis in six Italian cities, 2001-2010]. *Epidemiol Prev* 2019;43(2-3):152-60. doi: 10.19191/EP19.2-3.P152.054
25. Dadvand P, Basagana X, Sartini C, et al. Climate extremes and the length of gestation. *Environmental health perspectives* 2011;119(10):1449-53. doi: 10.1289/ehp.1003241
26. Arroyo V, Diaz J, Ortiz C, et al. Short term effect of air pollution, noise and heat waves on preterm births in Madrid (Spain). *Environmental Research* 2016;145:162-68. doi: 10.1016/j.envres.2015.11.034
27. Vicedo-Cabrera AM, Iniguez C, Barona C, et al. Exposure to elevated temperatures and risk of preterm birth in Valencia, Spain. *Environmental research* 2014;134:210-7. doi: 10.1016/j.envres.2014.07.021
28. Bruckner TA, Modin B, Vagero D. Cold ambient temperature in utero and birth outcomes in Uppsala, Sweden, 1915-1929. *Annals of epidemiology* 2014;24(2):116-21. doi: 10.1016/j.annepidem.2013.11.005
29. Vicedo-Cabrera AM, Olsson D, Forsberg B. Exposure to Seasonal Temperatures during the Last Month of Gestation and the Risk of Preterm Birth in Stockholm. *International Journal of Environmental Research and Public Health* 2015;12(4):3962-78. doi: 10.3390/ijerph120403962
30. Lee SJ, Hajat S, Steer PJ, et al. A time-series analysis of any short-term effects of meteorological and air pollution factors on preterm births in London, UK. *Environmental Research* 2008;106(2):185-94. doi: 10.1016/j.envres.2007.10.003
31. Yu X, Feric Z, Cordero JF, et al. Potential influence of temperature and precipitation on preterm birth rate in Puerto Rico. *Scientific reports* 2018;8(1):16106.
32. Yackerson N, Piura B, Sheiner E. The influence of meteorological factors on the emergence of preterm delivery and preterm premature rupture of membrane. *Journal of perinatology : official journal of the California Perinatal Association* 2008;28(10):707-11. doi: 10.1038/jp.2008.69

33. Walfisch A, Kabakov E, Friger M, et al. Trends, seasonality and effect of ambient temperature on preterm delivery. *The Journal of Maternal-Fetal & Neonatal Medicine* 2017;30(20):2483-87.
34. Auger N, Naimi AI, Smargiassi A, et al. Extreme heat and risk of early delivery among preterm and term pregnancies. *Epidemiology (Cambridge, Mass)* 2014;25(3):344-50. doi: 10.1097/EDE.0000000000000074
35. Lajinian S, Hudson S, Applewhite L, et al. An association between the heat-humidity index and preterm labor and delivery: A preliminary analysis. *American Journal of Public Health* 1997;87(7):1205-07. doi: 10.2105/ajph.87.7.1205
36. Porter KR, Thomas SD, Whitman S. The relation of gestation length to short-term heat stress. *American Journal of Public Health* 1999;89(7):1090-92. doi: 10.2105/ajph.89.7.1090
37. Sun S, Weinberger KR, Spangler KR, et al. Ambient temperature and preterm birth: A retrospective study of 32 million US singleton births. *Environment international* 2019;126:7-13.
38. Carmichael SL, Cullen MR, Mayo JA, et al. Population-level correlates of preterm delivery among black and white women in the US. *PloS one* 2014;9(4):e94153.
39. Basu R, Malig B, Ostro B. High ambient temperature and the risk of preterm delivery. *American journal of epidemiology* 2010;172(10):1108-17. doi: 10.1093/aje/kwq170
40. Cil G, Cameron TA. Potential Climate Change Health Risks from Increases in Heat Waves: Abnormal Birth Outcomes and Adverse Maternal Health Conditions. *Risk Analysis* 2017;37(11):2066-79. doi: 10.1111/risa.12767
41. Kloog I, Melly SJ, Coull BA, et al. Using Satellite-Based Spatiotemporal Resolved Air Temperature Exposure to Study the Association between Ambient Air Temperature and Birth Outcomes in Massachusetts. *Environmental Health Perspectives* 2015;123(10):1053-58. doi: 10.1289/ehp.1308075
42. Ha SD, Liu DP, Zhu YY, et al. Ambient Temperature and Early Delivery of Singleton Pregnancies. *Environmental Health Perspectives* 2017;125(3):453-59. doi: 10.1289/ehp97
43. Basu R, Chen H, Li DK, et al. The impact of maternal factors on the association between temperature and preterm delivery. *Environmental Research* 2017;154:109-14. doi: 10.1016/j.envres.2016.12.017
44. Avalos LA, Chen H, Li DK, et al. The impact of high apparent temperature on spontaneous preterm delivery: a case-crossover study. *Environ Health* 2017;16(1):5. doi: 10.1186/s12940-017-0209-5
45. Ngo NS, Horton RM. Climate change and fetal health: The impacts of exposure to extreme temperatures in New York City. *Environmental research* 2016;144:158-64.
46. Kent ST, McClure LA, Zaitchik BF, et al. Heat waves and health outcomes in Alabama (USA): the importance of heat wave definition. *Environmental health perspectives* 2014;122(2):151-8. doi: 10.1289/ehp.1307262
47. Ward A, Clark J, McLeod J, et al. The impact of heat exposure on reduced gestational age in pregnant women in North Carolina, 2011–2015. *International journal of biometeorology* 2019:1-10.
48. Wells JC, Cole TJ. Birth weight and environmental heat load: a between-population analysis. *American journal of physical anthropology* 2002;119(3):276-82. doi: 10.1002/ajpa.10137

49. Jensen PM, Sørensen M. Differences in human birth weight and corollary attributes as a result of temperature regime. *Annals of human biology* 2013;40(5):385-95.
50. Grace K, Davenport F, Hanson H, et al. Linking climate change and health outcomes: Examining the relationship between temperature, precipitation and birth weight in Africa. *Global Environmental Change* 2015;35:125-37.
51. Molina O, Saldarriaga V. The perils of climate change: In utero exposure to temperature variability and birth outcomes in the Andean region. *Economics & Human Biology* 2017;24:111-24.
52. Rashid H, Kagami M, Ferdous F, et al. Temperature during pregnancy influences the fetal growth and birth size. *Tropical medicine and health* 2017;45(1):1.
53. Elter K, Ay E, Uyar E, et al. Exposure to low outdoor temperature in the midtrimester is associated with low birth weight. *The Australian & New Zealand journal of obstetrics & gynaecology* 2004;44(6):553-7. doi: 10.1111/j.1479-828X.2004.00314.x
54. MacVicar S, Berrang-Ford L, Harper S, et al. Whether weather matters: Evidence of association between in utero meteorological exposures and foetal growth among Indigenous and non-Indigenous mothers in rural Uganda. *PloS one* 2017;12(6):e0179010.
55. Poeran J, Birnie E, Steegers EA, et al. The impact of extremes in outdoor temperature and sunshine exposure on birth weight. *J Environ Health* 2016;78(6):92-100.
56. Sienkiewicz D, Paszko-Patej G, Okurowska-Zawada B, et al. Seasonal Variations in Cerebral Palsy Births. *Archives of Medical Research* 2018;49(2):114-18. doi: 10.1016/j.arcmed.2018.05.001
57. Madsen C, Gehring U, Walker SE, et al. Ambient air pollution exposure, residential mobility and term birth weight in Oslo, Norway. *Environmental Research* 2010;110(4):363-71. doi: 10.1016/j.envres.2010.02.005
58. Dadvand P, Ostro B, Figueras F, et al. Residential Proximity to Major Roads and Term Low Birth Weight The Roles of Air Pollution, Heat, Noise, and Road-Adjacent Trees. *Epidemiology* 2014;25(4):518-25. doi: 10.1097/ede.0000000000000107
59. Díaz J, Arroyo V, Ortiz C, et al. Effect of environmental factors on low weight in non-premature births: a time series analysis. *PLoS One* 2016;11(10):e0164741.
60. Lawlor DA, Leon DA, Davey Smith G. The association of ambient outdoor temperature throughout pregnancy and offspring birthweight: findings from the Aberdeen Children of the 1950s cohort. *BJOG : an international journal of obstetrics and gynaecology* 2005;112(5):647-57. doi: 10.1111/j.1471-0528.2004.00488.x
61. Murray LJ, O'Reilly DP, Betts N, et al. Season and outdoor ambient temperature: effects on birth weight. *Obstetrics & Gynecology* 2000;96(5):689-95.
62. Chodick G, Shalev V, Goren I, et al. Seasonality in birth weight in Israel: New evidence suggests several global patterns and different etiologies. *Annals of Epidemiology* 2007;17(6):440-46. doi: 10.1016/j.annepidem.2006.10.013
63. Kloog I, Novack L, Erez O, et al. Associations between ambient air temperature, low birth weight and small for gestational age in term neonates in southern Israel. *Environmental Health* 2018;17(1):76.
64. Sun S, Spangler KR, Weinberger KR, et al. Ambient Temperature and Markers of Fetal Growth: A Retrospective Observational Study of 29 Million US Singleton Births. *Environmental health perspectives* 2019;127(6):067005.

65. Ha SD, Zhu YY, Liu DP, et al. Ambient temperature and air quality in relation to small for gestational age and term low birthweight. *Environmental Research* 2017;155:394-400. doi: 10.1016/j.envres.2017.02.021
66. Basu R, Rau R, Pearson D, et al. Temperature and term low birth weight in California. *American journal of epidemiology* 2018;187(11):2306-14.
67. Ha S, Liu D, Zhu Y, et al. Ambient Temperature and Stillbirth: A Multi-Center Retrospective Cohort Study. *Environmental health perspectives* 2017;125(6):067011. doi: 10.1289/EHP945
68. Auger N, Fraser WD, Smargiassi A, et al. Elevated outdoor temperatures and risk of stillbirth. *International journal of epidemiology* 2017;46(1):200-08.
69. Rammah A, Whitworth KW, Han I, et al. Temperature, placental abruption and stillbirth. *Environment international* 2019;131:105067.
70. Basu R, Sarovar V, Malig BJ. Association Between High Ambient Temperature and Risk of Stillbirth in California. *American Journal of Epidemiology* 2016;183(10):894-901. doi: 10.1093/aje/kwv295