CHAMNHA

CLIMATE, HEAT AND MATERNAL AND NEONATAL HEALTH IN AFRICA

Systematic review of the impacts of extreme heat exposure during pregnancy

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University of the Witwatersrand

WITS RHI

Conflict of Interest Statement:

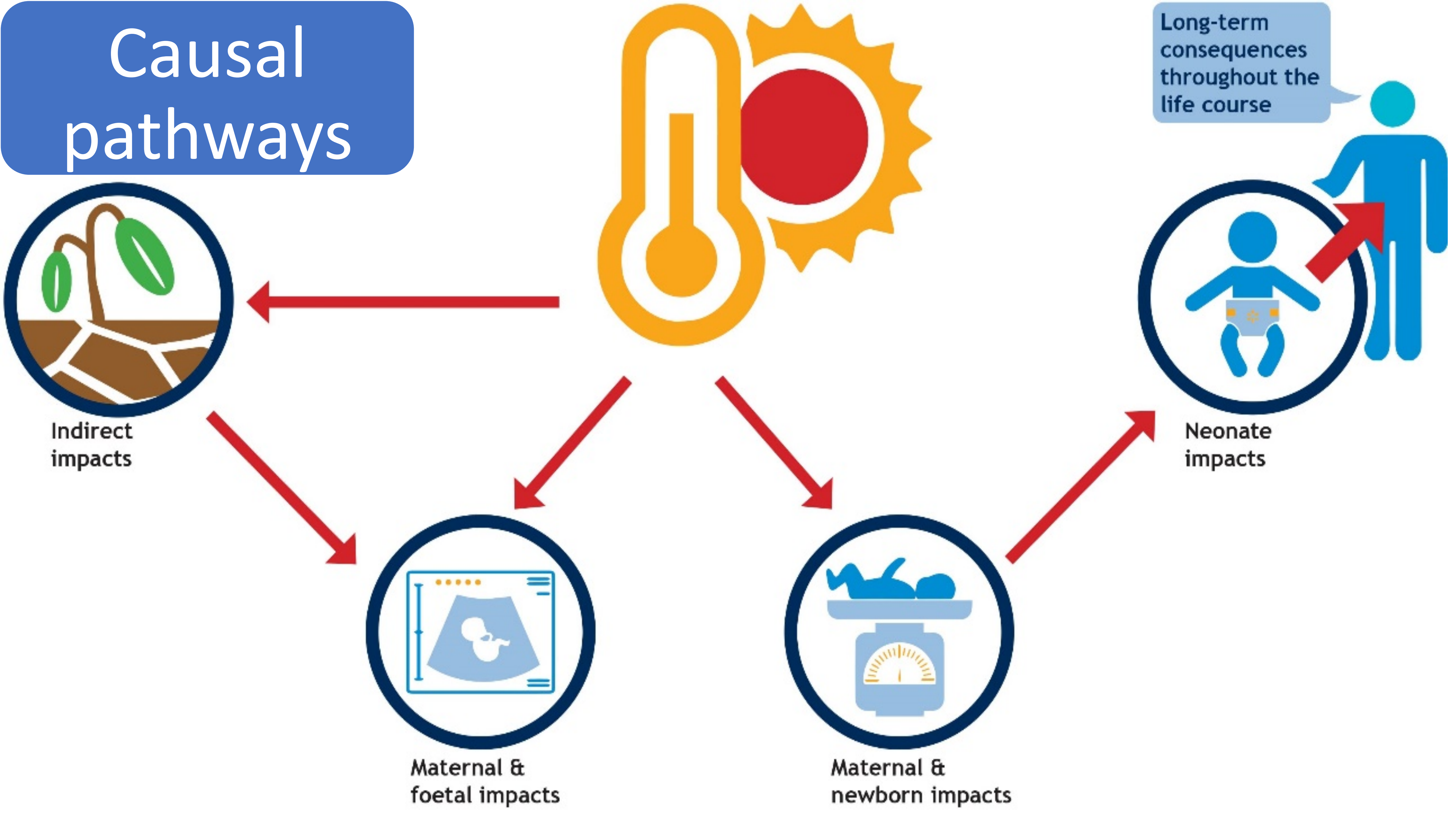
I hold investments in the fossil fuel industry through my pension funds as per the policies of the Wits Health Consortium.

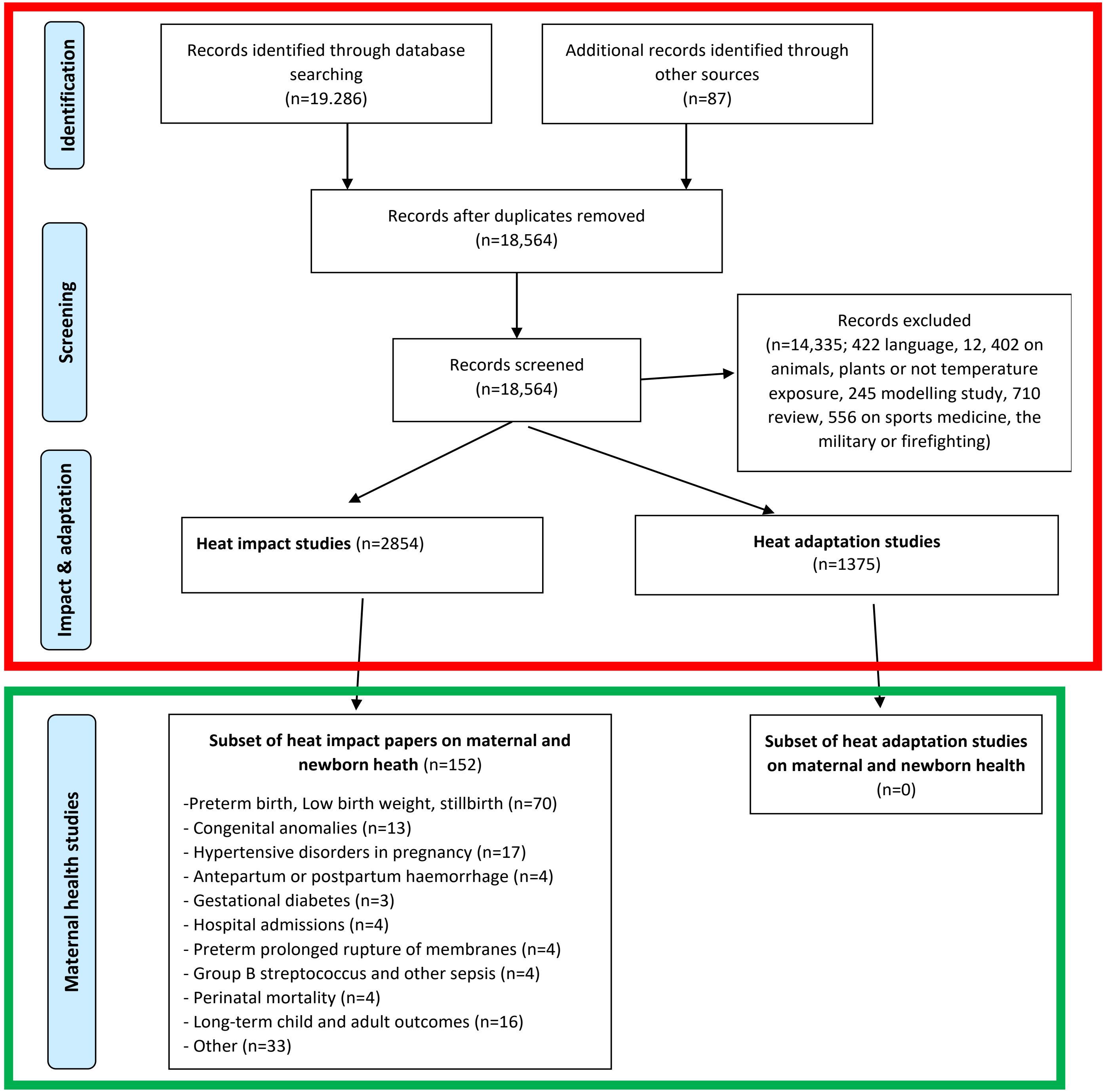
The University of the Witwatersrand holds investments in the fossil fuel industry through their endowments and other financial reserves.

Presentation

- Review structure
- Key findings
- Framework of exposure-outcome pathways
- Framework of interventions

Causal pathways





Stage 1: Systematic mapping

Stage 2: systematic review


Chersich et al. Globalization and Health (2016) 12:51
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Globalization and Health
COMMENTARY Open Access
Perspectives on the methods of a large systematic mapping of maternal health interventions
Matthew Chersich[1,2*], Victor Becerril-Montekio[3], Francisco Becerra-Posada[4], Mari Dumbaugh[5,6], Josephine Kavanagh[2], Duane Blaauw[2], Siphiwe Thwala[2], Elinor Kern[2], Loveday Penn-Kekana[2,7], Emily Vargas[3,8], Langelihle Mlotshwa[2,5], Ashar Dhana[2], Priya Mannava[9], Anayda Portela[10], Mario Tristan[11], Helen Rees[1,12] and Leon Bijlmakers[13]

RESEARCH

thebmj

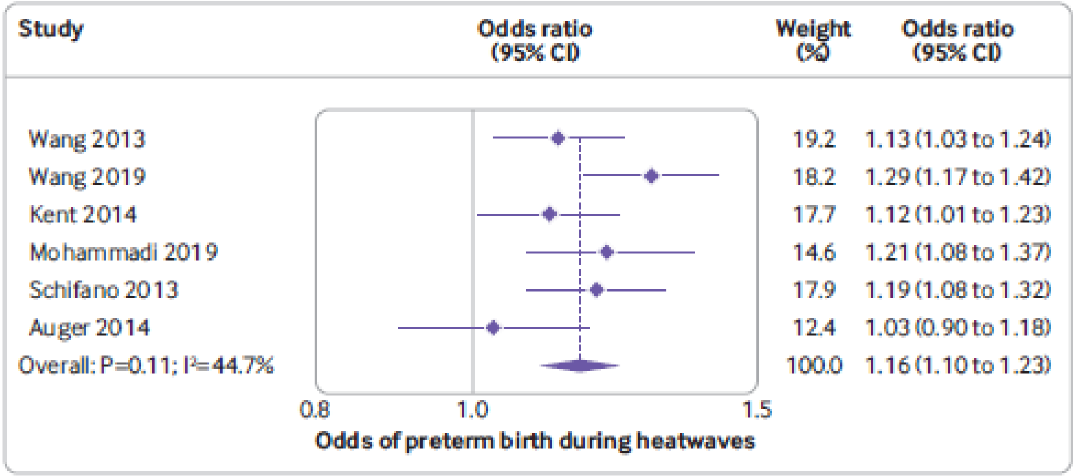
Associations between high temperatures in pregnancy and risk of preterm birth, low birth weight, and stillbirths: systematic review and meta-analysis

Matthew Francis Chersich,[1] Minh Duc Pham,[2,3] Ashtyn Area,[1,4] Marjan Mosalam Haghighi,[5] Albert Manyuchi,[6] Callum P Swift,[7] Bianca Wernecke,[8,9] Matthew Robinson,[10] Robyn Hetem,[11] Melanie Boeckmann,[12] Shakoor Hajat,[13] on behalf of the Climate Change and Heat-Health Study Group

Table 1 | Meta-analysis results by outcome and temperature metric

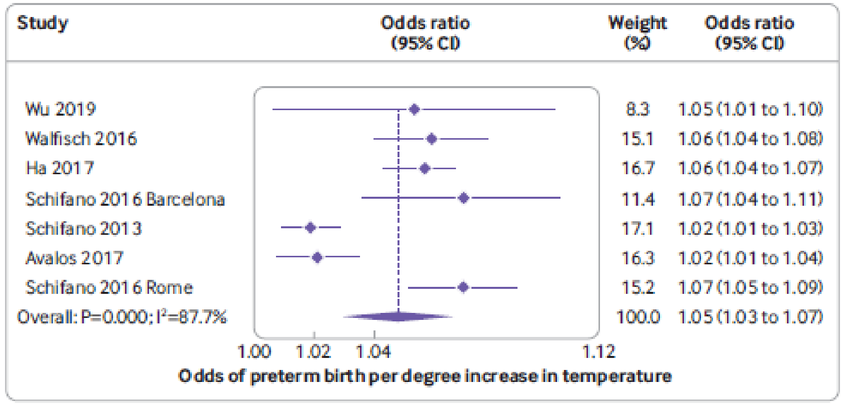
	No of studies	Synthesis method	No of studies in summary measure	Average effect size (OR (95% CI))	I^2 (%)
Preterm birth:					
Odds of preterm birth during heatwaves	6	Meta-analysis	6	1.16 (1.10 to 1.23)	44.7
Odds of preterm birth per 1°C temperature increase	6	Meta-analysis	6	1.05 (1.03 to 1.07); 5% increase per 1°C rise (3% to 7%)	87.7
Odds of preterm birth during high versus low temperatures (exposure over a trimester or all of pregnancy)	9	Meta-analysis	9	1.14 (1.11 to 1.16)	88.2
			8*	1.15 (1.13 to 1.18)	65.2
Odds of preterm birth during high versus low temperatures with exposure period <4 weeks	21	Meta-analysis	21	1.01 (1.01 to 1.02)	89.8
			19†	1.05 (1.04 to 1.05)	83.6
	21	Summary of effect estimates	21	Median OR=1.07 (IQR 1.05-1.16; range 0.99-1.94)	—

Heat exposure and preterm birth: meta-analysis, by temperature metric



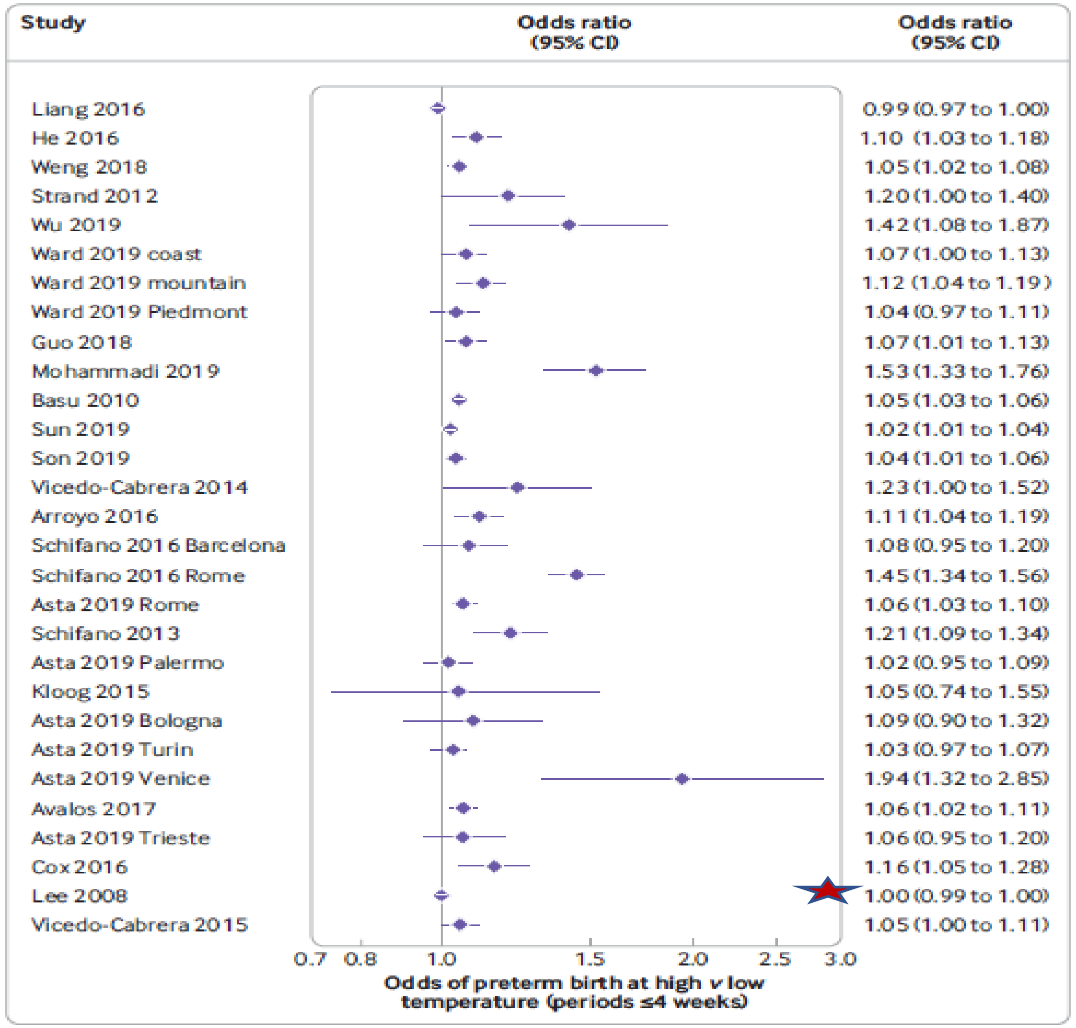
Note: Weights are from random effects analysis

Fig 2 | Odds of preterm birth during heatwaves. Study details are given in supplementary table 2a

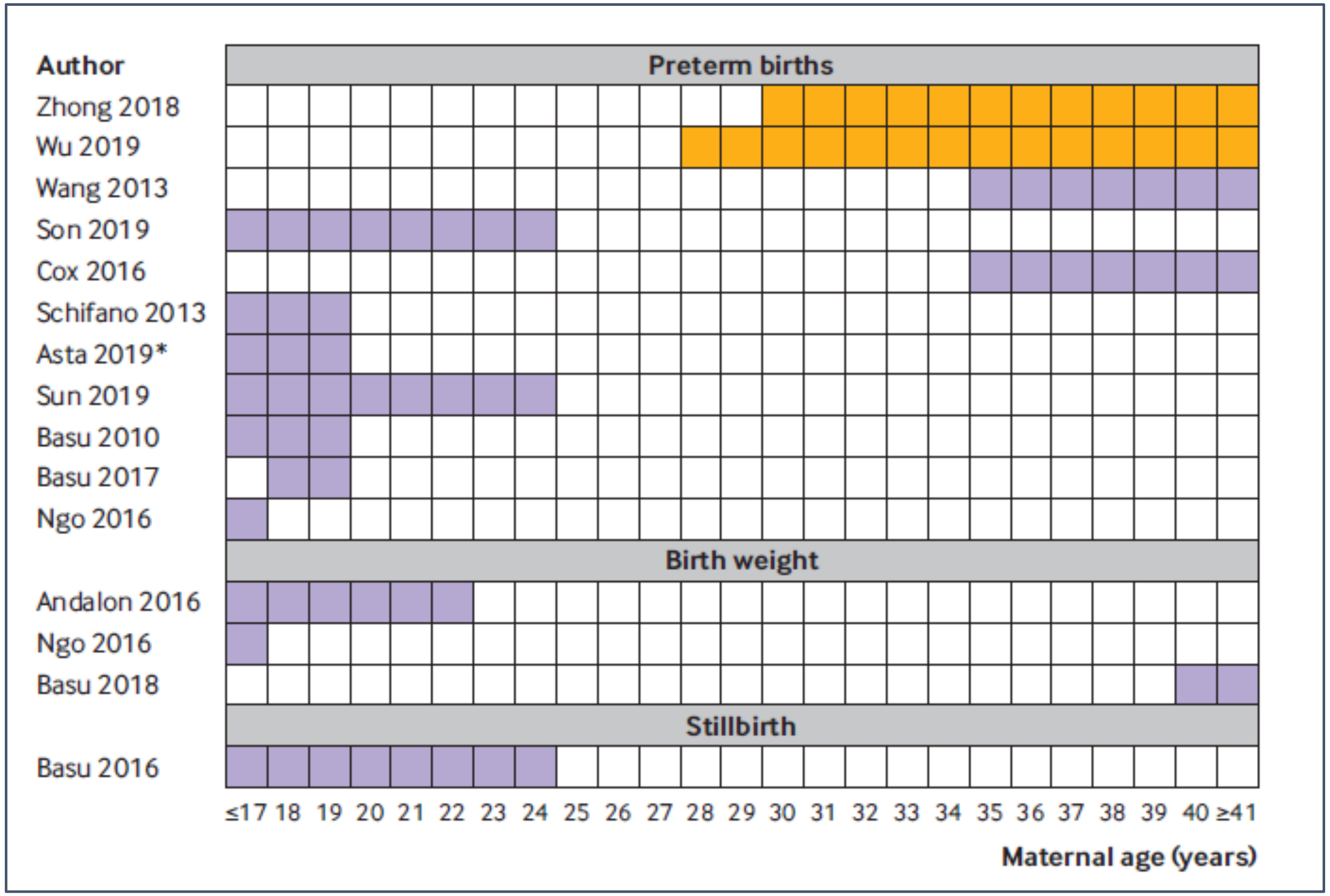


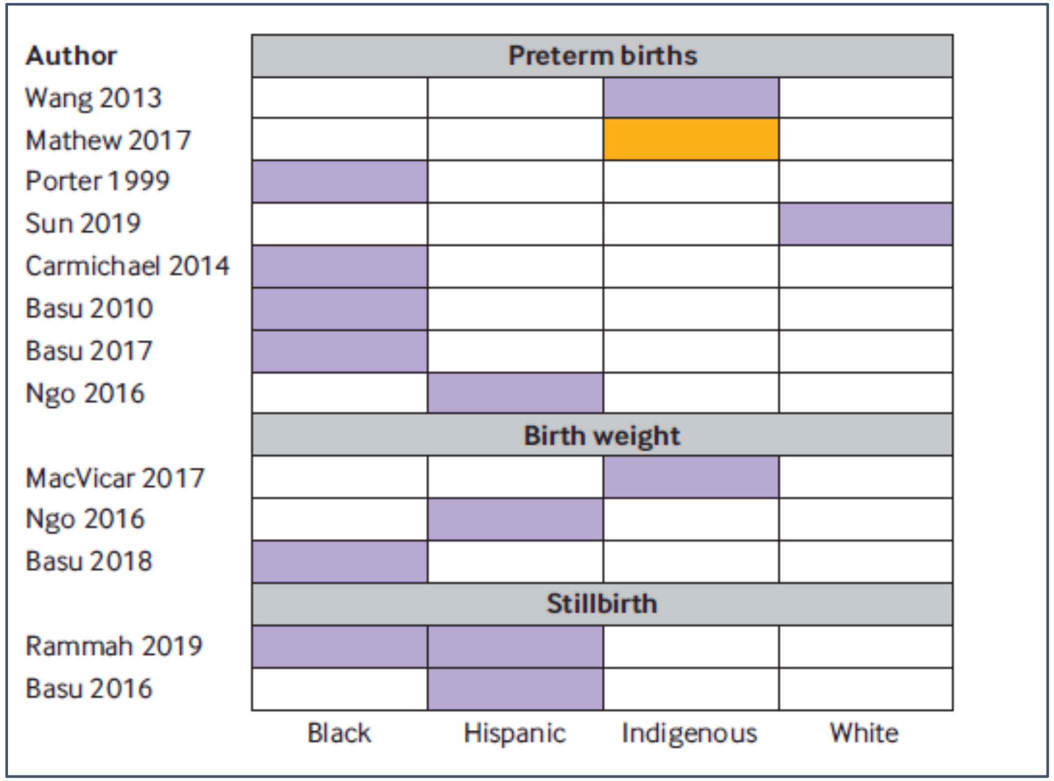
Note: Weights are from random effects analysis

Fig 3 | Odds of preterm birth per degree increase in temperature. Study details are given in supplementary table 2a



A focus on high-risk groups





Lag analyses, by trimester, month and days of the week (example of stillbirth studies)

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)																			

MDPI International Journal of Environmental Research and Public Health

Impacts of High Environmental Temperatures on Congenital Anomalies: A Systematic Review

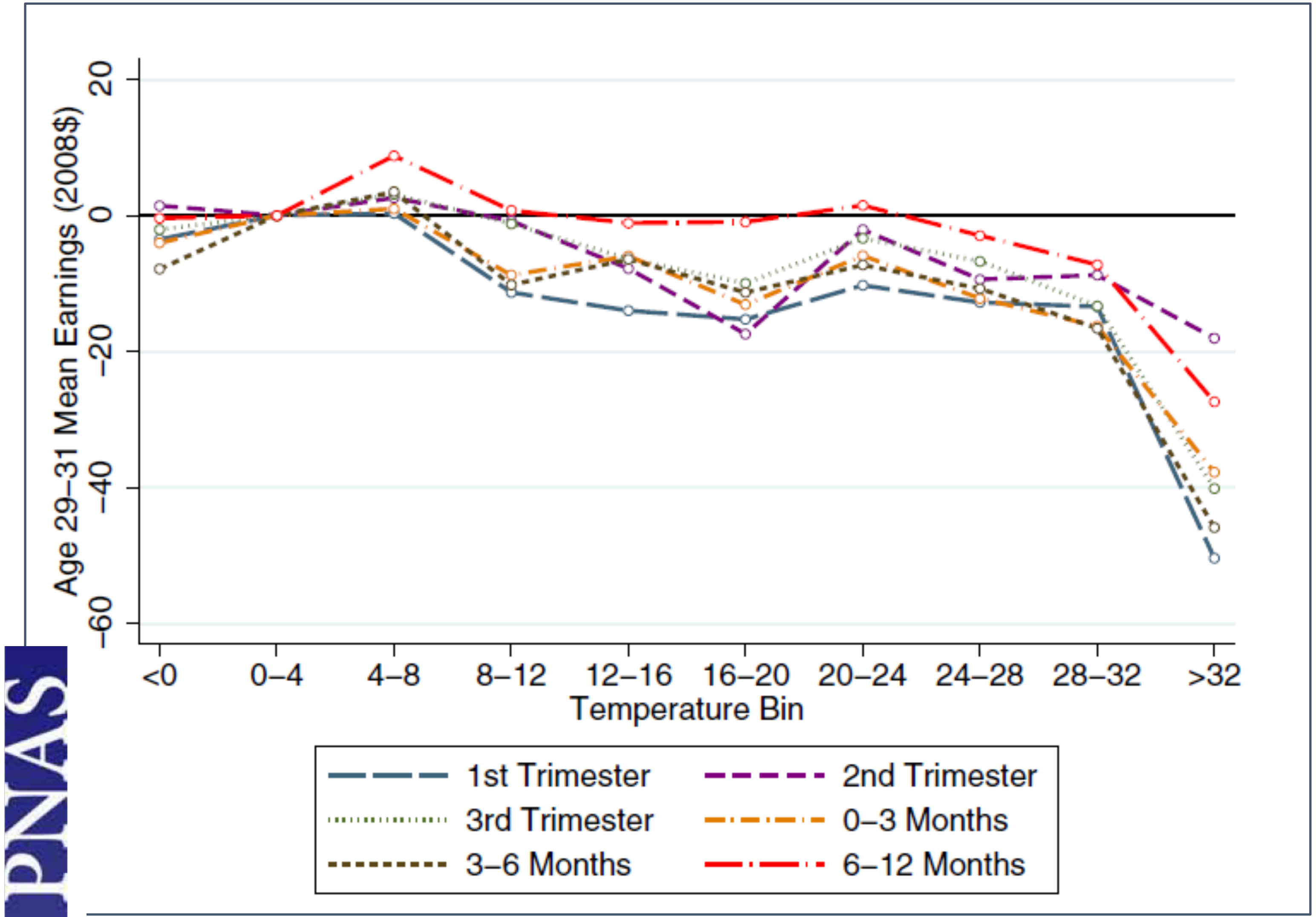
Marjan Mosalman Haghighi, Caradee Yael Wright, [...], and Climate Change and Heat-Health Study Group

Abstract: Links between heat exposure and congenital anomalies have not been explored in detail despite animal data and other strands of evidence that indicate such links are likely. We reviewed articles on heat and congenital anomalies from PubMed and Web of Science, screening 14,880 titles and abstracts in duplicate for articles on environmental heat exposure during pregnancy and congenital anomalies. Thirteen studies were included. Most studies were in North America (8) or the Middle East (3). Methodological diversity was considerable, including in temperature measurement, gestational windows of exposure, and range of defects studied. Associations were detected between heat exposure and congenital cardiac anomalies in three of six studies, with point estimates highest for atrial septal defects. Two studies with null findings used self-reported temperature exposures. Hypospadias, congenital cataracts, renal agenesis/hypoplasia, spina bifida, and craniofacial defects were also linked with heat exposure. Effects generally increased with duration and intensity of heat exposure. However, some neural tube defects, gastroschisis, anopthalmia/microphthalmia and congenital hypothyroidism were less frequent at higher temperatures. While findings are heterogenous, the evidence raises important concerns about heat exposure and birth defects. Some heterogeneity may be explained by biases in reproductive epidemiology. Pooled analyses of heat impacts using registers of congenital anomalies are a high priority.

Long-term outcomes of *in utero* heat exposure

1. Prenatal Temperature Shocks Reduce Cooperation: Evidence from Public Goods Games in Uganda
2. Effect of seasonal programming on fetal development and longevity: links with environmental temperature in Greece
3. Early-Life Environmental Exposures and Height, Hypertension, and Cardiovascular Risk Factors Among Older Adults in India
4. Too hot to handle: The effects of high temperatures during pregnancy on adult welfare outcomes (United States)
5. Relationship between season of birth, temperature exposure, and later life wellbeing (United States)
6. Early-life exposure to weather shocks and child height: Evidence from industrializing Japan
7. Stunted from the start: Early life weather conditions and child undernutrition in Ethiopia
8. Seasonality and ambient temperature at time of conception in term-born individuals - influences on cardiovascular disease and obesity in adult life (Finland)
9. Prenatal exposure to elevated maternal body temperature and risk of epilepsy in childhood: a population-based pregnancy cohort study (Denmark)
10. Influence of environmental temperatures during restation and at birth on eating characteristics in adolescence (United States)
11. Environmental temperature during gestation and body mass index in adolescence: new etiologic clues? (United States)
12. Early-Life Environmental Exposures and Blood Pressure in Children (sub-Saharan Africa)

Long-term impacts of *in utero heat exposure*



PNAS

Relationship between season of birth, temperature exposure, and later life wellbeing

Adam Isen[a,1], Maya Rossin-Slater[b,c,d,1,2], and Reed Walker[c,d,e,f,1]

Methodological challenges

Methodological diversity and bias

- Diversity in exposure measurement (temperature metrics & lag structures)
- Biases (publication bias, multiple testing, low quality studies)
- Reproductive health epidemiology is complex

Statistical heterogeneity

- Physiological acclimatisation
- Progressive adaptation, especially air conditioning ‘nulls’ impacts

FOETOMATERNAL HEAT TRANSFER

FOETAL HEAT DISSIPATION

85% umbilical circulation
15% amniotic fluid

↑ MATERNAL HEAT

Foetus thermally protected through
↑ uterine blood flow

MATERNAL FEBRILE RESPONSE

Foetal thermal protection abandoned
↓ uterine blood flow

MATERNAL THERMOREGULATION

MATERNAL HEAT DISSIPATION

Enhanced in gestational hypothermia

↑ HEAT BURDEN

Foetal & placental metabolism
↑ metabolic heat in skeletal muscle resulting from ↑ body mass
Uterine contractions at parturition

↑ EXOGENOUS & ENDOGENOUS HEAT

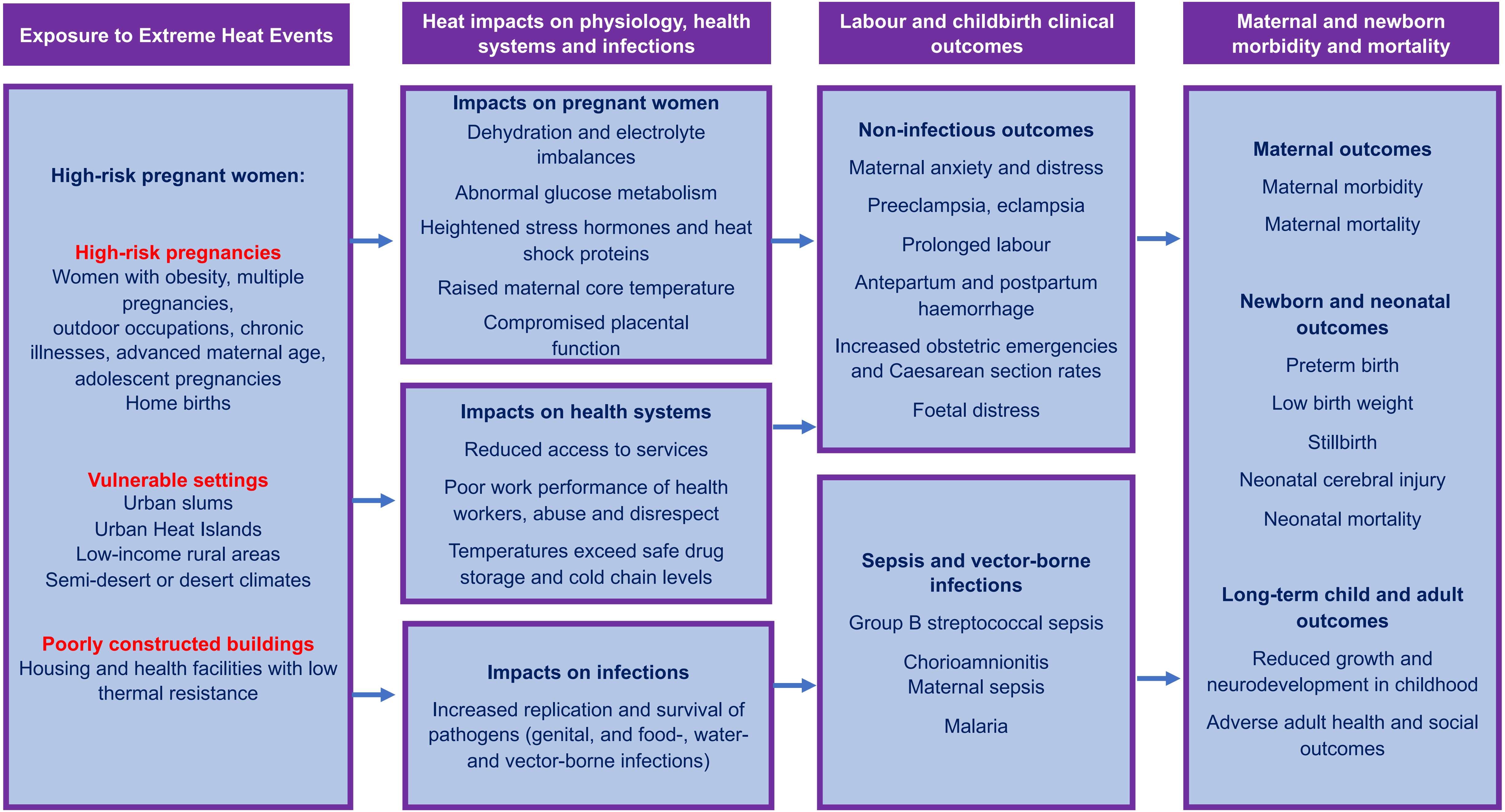
↑ convective & radiant heat loss (peripheral vasodilation)
↑ evaporative cooling (sweating)

FEBRILE RESPONSE

↓ convective & radiant heat loss (peripheral vasoconstriction)
Dangerous if coincides with parturition

Prof. Duncan Mitchell
Dr Robyn Hetem
Prof. Lois Harden

Exposure-outcome pathways



Framework based on evidence located in the systematic review led by WRHI (n=152 studies demonstrated adverse impacts of heat exposure on maternal and newborn health)

Exposure-outcome pathways (main evidence gaps)

Exposure to Extreme Heat Events

High risk pregnant women:

High-risk pregnancies
Women with obesity, multiple pregnancies,
outdoor occupations, chronic illnesses, advanced maternal age, adolescent pregnancies
Home births

Vulnerable settings
Urban slums
Urban Heat Islands
Low-income rural areas
Semi-desert or desert climates

Poorly constructed buildings
Housing and health facilities with low thermal resistance

→

Heat impacts on physiology, health systems and infections

Impacts on pregnant women

Dehydration and electrolyte imbalances

Abnormal glucose metabolism

Heightened stress hormones and heat shock proteins

Raised maternal core temperature

Compromised placental function

Impacts on health systems

Reduced access to services

Poor work performance of health workers, abuse and disrespect

Temperatures exceed safe drug storage and cold chain levels

Impacts on infections

Increased replication and survival of pathogens (genital, and food-, water- and vector-borne infections)

→

Labour and childbirth clinical outcomes

Non-infectious outcomes

Maternal anxiety and distress

Preeclampsia, eclampsia

Prolonged labor

Antepartum and postpartum haemorrhage

Increased obstetric emergencies and Caesarean section rates

Foetal distress

Sepsis and vector-borne infections

Group B streptococcal sepsis

Chorioamnionitis
Maternal sepsis

Malaria

→

Maternal and newborn morbidity and mortality

Maternal outcomes

Maternal morbidity

Maternal mortality

Newborn and neonatal outcomes

Preterm birth

Low birth weight

Stillbirth

Neonatal cerebral injury

Neonatal mortality

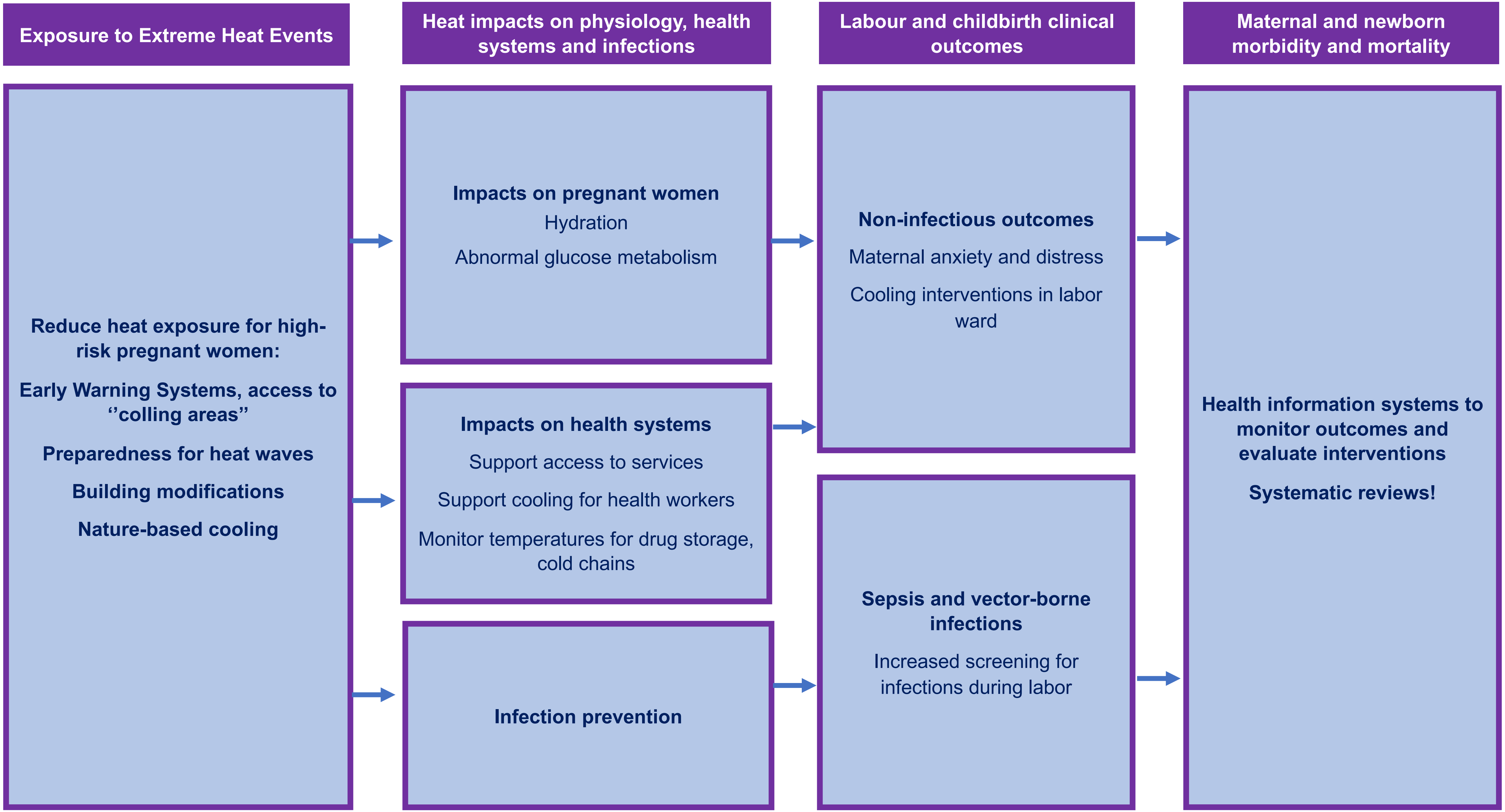
Long-term child and adult outcomes

Reduced growth and neurodevelopment in childhood

Adverse adult health and social outcomes

Framework based on evidence located in the systematic review led by WRHI (n=152 studies demonstrated adverse impacts of heat exposure on maternal and newborn health)

Interventions



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