Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Systematic Impact of climate change on birth outcomes: Systematic Literature Review

Thivhulawi Malwela

thivhulawi.malwela@univen.ac.za

University of Venda

Rolivhuwa Sibongile Millet Mudau

University of Venda

Maria Sonto Maputle

University of Venda

Systematic Review

Keywords:

Posted Date: March 8th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-8960982/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

Background

Climate change is increasingly recognized as a critical factor influencing public health, particularly affecting vulnerable populations like pregnant individuals and newborns. Emerging evidence suggests that climate-related factors significantly impact birth outcomes. This integrated literature review synthesizes existing studies to explore how temperature fluctuations affect maternal and neonatal health outcomes. This Review aims to investigate the impact of climate change on birth outcomes.

Methods

An integrative review method will be utilized in this study. The search process for this review will be conducted in electronic databases, namely Google Scholar, PubMed, CINHL, and Scopus. Keywords such as "high temperature," "low birth weight," "pregnancy outcomes," "premature," and "stillbirth" will be used to search for relevant studies related to the impact of climate change on birth outcomes. The literature reviewed will be limited to publications from 2020 to 2025. Only papers written in English will be considered, and those in other languages will be excluded. After assessment, data were extracted, and 53 articles were selected as being relevant to the study.

Ethics and dissemination:

Ethical approval is not required for this study. This integrative literature review will evaluate existing research on the impact of seasonal ambient temperature on infant birth weight in a selected hospital in the Vhembe district. The findings could inform future research examining the relationship between ambient temperature and infant birth weight.

Systematic review registration : PROSPERO CRD420251160752.

Background

Climate change is becoming a significant factor in causing negative pregnancy outcomes worldwide. These outcomes include preterm births, low birth weights, stillbirths, autism, cleft palates, and heart problems. Vulnerable populations, particularly pregnant mothers and the elderly, especially those with low socioeconomic status, are the most affected [1–7].

High ambient temperatures have a notable impact on human health, particularly for Black mothers compared to White mothers [8–13]. Research indicates that mothers who face pregnancy complications are more likely to be exposed to high temperatures during the early weeks of pregnancy, which can lead to higher neonatal mortality rates in babies born with such complications [5, 14, 15], including maternal mortality and morbidity [16, 17].

[18] discovered that exposure to high ambient temperatures is linked to an increase in the head circumference of newborns. Mothers exposed to heat more frequently tended to give birth to babies with larger head circumferences compared to those exposed to cooler temperatures. Both extreme heat and cold can lead to adverse effects during pregnancy, as noted by [19–24]. circumference was particularly linked to temperature ranges exceeding 30°C during the third trimester of pregnancy, according to [25, 26].

The highest incidence of complications occurred during the first trimester of pregnancy after exposure to high ambient temperatures, which also affected fetal weight, as reported by [27–29]. According to [30], pregnancy complications do not occur only in the summer; they can happen in every season. The difference lies in the incidence rate and how many people are affected each season. Long-term exposure to high ambient temperatures has been linked to various health conditions, such as heart disease, mental illness, educational challenges, and respiratory problems [31]. HIV-positive mothers appear to be particularly affected compared to those who are HIV-negative [32]. When the body experiences high temperatures, it undergoes a cold thermoregulation process to combat the heat [33, 34]. If this process fails, the body may become dehydrated, reducing blood flow to the placenta [35].

The pathophysiology related to high ambient temperature exposure and its effects on birth outcomes is not yet fully understood. One animal study suggests that high temperatures can lead to dehydration, specifically, a loss of body fluids due to excessive sweating. Dehydration may cause blood to thicken, resulting in reduced blood flow to the placenta. This condition can trigger the release of oxytocin, a hormone responsible for initiating labor [36, 37].

Several studies have indicated that various types of stress can lead to overactivation of the hypothalamic-pituitary-adrenal (HPA) axis, which plays a crucial role in the release of corticotropin and cortisol. These hormones are responsible for stimulating early labor contractions, potentially resulting in premature delivery [38].

Weight gain during pregnancy can pose additional challenges for the body when it comes to heat regulation. When temperatures rise, the fetus needs to adapt to the heat. As a result, the fetus may release excess heat into the mother's body through metabolic processes, contributing to maternal heat stress [39].

Extreme heat exposure makes pregnant women more susceptible to heat stress, as their bodies struggle to manage the increased heat. This situation significantly elevates the risk of premature labor. Overall, heat exposure can have adverse effects on pregnant women and their health. A reduction in physical activity leads to a noticeable decrease in appetite and increased sleepiness, as highlighted by [2, 40]. This shift has a significant negative impact on the developing baby inside the uterus, as demonstrated by [41]. Consequently, we observe a rise in admissions to healthcare facilities due to neonatal complications, as noted by [42]. Furthermore, mothers often face sleep disturbances, particularly during the third trimester of pregnancy, as indicated by [43, 44].

High temperatures do not significantly impact mothers from different backgrounds and characteristics [45]. However, heat exposure is linked to reduced birth weight, especially manifesting during the second trimester of pregnancy [46]. Pregnancy complications such as newborn jaundice, hearing loss, and infections tend to be most common among mothers in their first trimester. These complications include reduced fertility and an increased risk of miscarriage. If these issues are not addressed, it may lead to future pregnancies resulting in unhealthy children and poor maternal health [43].

Another complication may be oligohydramnios. Oligohydramnios is a marker of fetal compromise and elevated risk of injury [47]. It can derive from both abnormalities (i.e., renal disease) and uteroplacental insufficiency and may be impacted by maternal hydration status [47].

Additionally, mothers may experience gestational diabetes, pregnancy-induced hypertension, pre-eclampsia, spontaneous abortion, and postpartum depression. Some studies have also reported impairments in neurodevelopment and a rise in waterborne diseases [48, 49, 50, 51, 52, 53, 54, 55]. As a result of these complications, many young women are becoming increasingly afraid of pregnancy and motherhood [56, 57].

A study conducted by [58] found that high ambient temperatures are more likely to affect high-income countries compared to middle- and low-income countries. This is attributed to a lack of seriousness regarding health issues in these regions, leading to mothers experiencing adverse pregnancy effects such as premature birth, low birth weight, spontaneous abortion, and stillbirth.

Some studies have recorded an association between high temperatures and stillbirth delivery, as noted by [59],[60], which state that exposure to high temperatures is linked to neonatal abnormalities. Most studies that confirmed these effects were conducted on animals rather than humans, although some focused on human populations. These complications are primarily observed during the third trimester of pregnancy, as [61] stated.

[40] focused on singleton mothers who work on farms to meet their basic needs in villages that experience high temperatures during the hot season. These mothers are more likely to face adverse pregnancy outcomes, such as premature births, low birth weight, stillbirths, and small gestational age, which are often the result of fetal growth restrictions. This phenomenon is supported by findings from [8, 43, 62, 63, 64, 65, 66].

Primary Objectives

This review's main objective was to assess the relationship between ambient temperature and birth outcomes, such as stillbirth, low birth weight, and premature delivery.

Specific objective

The objective was to investigate the impact of climate change on birth outcomes. This helped identify ways to reduce the impact of extreme ambient temperatures on vulnerable populations.

Methods

Protocol and registration

The systematic review adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocols (PRISMA-P 2020) guidelines. These guidelines were recommended because they helped to identify research gaps and facilitated the collection of all necessary information at once [(68)]. A PRISMA checklist was provided in a Word document for this systematic review. This protocol was based on a previously published systematic review protocol that was submitted to PROSPERO (CRD420251160752).

Eligibility Criteria

The eligibility criteria for this study followed the outlined specifications. The inclusion criteria were based on studies that examined the impact of climate change on birth outcomes, specifically focusing on women exposed to extreme ambient temperatures during their pregnancy. This included adverse pregnancy effects such as low birth weight, prematurity, and stillbirth. Only studies published between 2020 and 2025 will be considered.

Types of Studies

A systematic review was conducted on the impact of climate change on birth outcomes, focusing on various study designs, including cohort studies, cross-sectional studies, retrospective chart reviews, and crossover studies. All studies discussing the relationship between climate change and birth outcomes were included, while those unrelated to climate change and child health were excluded. Additionally, only articles published in English between 2020 and 2025 were considered, excluding any that were written in other languages.

Population interest

Only studies that investigate the effects of extreme ambient temperatures on birth outcomes will be included in the review. This included research on pregnancy complications such as premature delivery, low birth weight, stillbirth, and maternal complications faced by pregnant mothers due to exposure to extreme temperatures.

Intervention/Exposure

Pregnant mothers exposed to extreme ambient temperatures during pregnancy will not undergo any interventions that will be reviewed.

Comparator

All articles that included mothers who faced pregnancy adverse effects as a result of heat exposure.

Outcomes

The primary aim of the review was to examine the relationship between climate change and birth outcomes, specifically premature delivery, low birth weight, and stillbirth. Prematurity occurs when delivery happens before 37 weeks of pregnancy, while low birth weight and stillbirth are classified in cases after 37 weeks. Both primary and secondary outcomes will be considered in this analysis.

Primary Outcomes

The primary outcome of the impact of climate change on birth outcomes is premature delivery. Premature delivery can be classified as follows: extremely premature (less than 28 weeks), very premature (28–30 weeks), moderately premature (32–33 weeks), and late premature (34–36 weeks). All of these deliveries occur before 37 weeks of pregnancy[69–72].

Secondary Outcomes

Low birth weight refers to babies born after 37 weeks of pregnancy whose weight does not align with their gestational age [73]. This includes stillborn babies who died during labor within the normal delivery period [74], as well as babies affected by intrauterine growth restriction, meaning they are not growing adequately inside the uterus [75].

Settings

The review focused on the studies examining the impact of climate change on birth outcomes published from Jan 2020 to dec 2025, without geographical restrictions

Exclusion Criteria

Studies focusing on normal deliveries without complications will be excluded from this systematic review. Studies published before 2020 will not be considered, including all studies discussing the impact of climate change on animals and plants.

Information source and search strategies

A literature search was conducted using Google Scholar, PubMed/Medline, CINHL, and Scopus to identify studies related to the impact of climate change on birth outcomes. The search focused specifically on studies published between 2020 and 2025 and limited to those written in English. The

publication keywords used to find relevant articles included "low birth weight," "stillbirth," "prematurity," and "pregnancy outcomes."

Study Selection

All studies identified through the database were assessed for duplicates, which were then removed. The titles and abstracts were thoroughly reviewed to determine whether they fit the criteria for inclusion in the current review, while others were excluded. The remaining studies were fully evaluated based on inclusion and exclusion criteria, and all relevant studies were included in the review.

Data collection process

For the data collection process of the systematic review, the following form was utilized and pre-tested on a sample of included articles. The data collected consists of the author's name, year of publication, and country. We focused on complications related to climate change during the pregnancy period, as well as the statistical methods that will be used. In the event of any disagreements or conflicts between M.M.S and T.M, these will be resolved through discussions with M.R.S.M. If there is any missing data, we will try to contact the primary author to obtain the necessary information.

Risk of bias in individual studies

The risk of bias was evaluated by two reviewers using a risk bias assessment tool that is suitable for the study design, such as the Critical Appraisal Skills Programme (CAPS) [(42)]. This tool is recommended because it helps to minimize bias and misinterpretation of information, allowing for the identification of flaws, including the exaggeration of data. It is particularly beneficial for new qualitative research.

Data synthesis and analysis

For this review, data synthesis and analysis will be conducted using narrative synthesis.

Narrative synthesis

Due to differences in study design, exposure assessment, and birth outcomes in most of the reviewed literature on climate change, extreme ambient temperatures have been associated with adverse pregnancy effects such as premature delivery, low birth weight, and stillbirth. These complications predominantly occur in mothers who were exposed to extreme temperatures during pregnancy.

The majority of results from various studies indicate that exposure to extreme ambient temperatures negatively impacts the developing fetus, leading to these adverse pregnancy effects. Although the studies employed different methods, they yielded similar results, suggesting consistent findings across different research approaches. Each study's risk of bias will also be assessed.

Confidence in cumulative evidence

The cumulative evidence determines the impact of climate change on birth outcomes, which include wildfires, droughts, floods, and extreme ambient temperatures. Birth outcomes are associated with

premature delivery, low birth weight, and stillbirth.

Expected outcomes

Most studies have examined climate change and its effects on birth outcomes. It has been found that exposure to extreme ambient temperatures is associated with adverse pregnancy effects such as premature delivery, low birth weight, and stillbirth. These conditions can lead to maternal complications, including dehydration. Many of the affected mothers come from low socio-economic backgrounds, where access to healthcare facilities and cooling resources during hot seasons is limited. The primary aim of this review is to compile data from published studies on the impact of climate change on birth outcomes.

Dissemination

The report for the systematic review protocol will adhere to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. This systematic review and its protocol will form part of Mudau's MSc research dissertation, with T. Malwela serving as the main supervisor and M.S. Maputle as the co-supervisor.

Declarations

Dissemination

The report for the systematic review protocol will adhere to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. This systematic review and its protocol will form part of Mudau's MSc research dissertation, with T. Malwela serving as the main supervisor and M.S. Maputle as the co-supervisor.

Authors Contributions

M.RSM and TM designed the study, conceived the idea, and drafted the systematic review protocol, which was revised with input from M.SM. The search strategies were developed by M.RSM and TM, who also conducted the study section. TM and M.RSM oversee data extraction, and all co-authors edited and approved the final manuscript.

Funding

There was no funding for this study.

Conflict/Competing Interest/Disclosure

The authors have no conflict of interest to declare

There was no participant involved, so ethical approval and consent were not applicable.

References

1. Dehdashti B, Bagheri N, Amin MM, Hajizadeh Y. 2020. Impacts of climate changes on pregnancy and birth outcomes: A review. International Journal of Environmental Health Engineering, 9(1), p.24.
2. Bátiz LF, Illanes SE, Romero R, del Valle Barrera M, Mattar CN, Choolani MA, Kemp MW. 2022. Climate change and preterm birth: A narrative review. Environmental Advances, 10, p.100316.
3. Hajdu T, Hajdu G. 2021. Temperature, climate change, and birth weight: evidence from Hungary. Population and Environment, pp.1–18.
4. Zhang Y, Ye T, Yu P, Xu R, Chen G, Yu W, Song J, Guo Y, Li S. Preterm birth and term low birth weight associated with wildfire-specific PM2. 5: a cohort study in New South Wales, Australia during 2016–2019. Environ Int. 2023;174:107879.
5. Conte Keivabu R, Cozzani M. Extreme heat, birth outcomes, and socioeconomic heterogeneity. Demography. 2022;59(5):1631–54.
6. Kutz J. Effect of Temperature and Weather Shocks on Health at Birth. Evidence from the US; 2023.
7. Rubio-Cabañez M. 2024. The stratified effect of extreme temperatures on birth weight: the role of energy prices. *Population and Environment*, *46*(4), p.24.
8. Ha S, Abatzoglou JT, Adebiyi A, Ghimire S, Martinez V, Wang M, Basu R. 2024. Impacts of heat and wildfire on preterm birth. Environmental Research, 252, p.119094.
9. Wooten BA. 2023. Extreme Temperature and Adverse Birth Outcomes for Black and White Women in North Carolina (Master's thesis, The University of North Carolina at Chapel Hill).
10. Cil G, Kim J. Extreme temperatures during pregnancy and adverse birth outcomes: Evidence from 2009 to 2018 US national birth data. Health Econ. 2022;31(9):1993–2024.
11. Cho H. Ambient temperature, birth rate, and birth outcomes: evidence from South Korea. Popul Environ. 2020;41(3):330–46. 10.1007/s11111-019-00333-6. Epub 2019 Dec 2. PMID: 32214579; PMCID: PMC7089350.
12. Brimicombe C, Jackson D, Mungatia A, Sulaiman Z, Monthaler T, Wieser K, Otto IM, and HIGH Horizons study group., 2025. The influence of heat exposure on birthneonatal outcomes in Mombasa, Kenya: a pooled time series analysis. J Clim ChangeHealth, p.100409.
13. Rocque RJ, Beaudoin C, Ndjaboue R, Cameron L, Poirier-Bergeron L, Poulin-Rheault RA, Fallon C, Tricco AC, Witteman HO. Health effects of climate change: an overview of systematic reviews. BMJ open. 2021;11(6):e046333.
14. Syed S, O'Sullivan TL, Phillips KP. 2022. Extreme heat and pregnancy outcomes: a scoping review of the epidemiological evidence. International journal of environmental research and public health, 19(4), p.2412.
15. Dalugoda Y, Kuppa J, Phung H, Rutherford S, Phung D. 2022. Effect of elevated ambient temperature on maternal, foetal, and neonatal outcomes: a scoping review. International Journal of Environmental Research and Public Health, 19(3), p.1771.

16. Witsoe M, Mickelson K, Kang P, Dinh S, Samantha K, Brittany D, Sai-Anmisha D. p, Zhou g, Nguyen j, 2025. Climate pollution and maternal health: investigating the impact of temperature and ozone on birth outcomes in Phoenix, Arizona,(2076–3298). Apr2025, vol.12 issue 4, p118.13p.
17. Andrian L. 2023. On the health impact of climatic shocks: how heatwaves reduce birthweight in sub-Saharan Africa, December 2023,v 49,iss.49.iss.4, pp 737–69.
18. Essers E, Granés L, Delaney S, Ballester J, Santos S, Petricola S, Yang TC, Fernández-Somoano A, Bereziartua A, Ballester F, Tardón A, Vrijheid M, Lertxundi A, McEachan RRC, El Marroun H, Tiemeier H, Iñiguez C, Guxens M. Ambient air temperature exposure and foetal size and growth in three European birth cohorts. Environ Int. 2024;186:108619. 10.1016/j.envint.2024.108619. Epub 2024 Apr 1. PMID: 38603813.
19. Khodadadi N, Dastoorpoor M, Khanjani N, Ghasemi A. Universal Thermal Climate Index (UTCI) and adverse pregnancy outcomes in Ahvaz, Iran. Reprod Health. 2022;19(1):33. 10.1186/s12978-022-01344-7. PMID: 35109854; PMCID: PMC8811963.
20. Shankar K, Hwang K, Westcott JL, Saleem S, Ali SA, Jessani S, Patel A, Kavi A, Somannavar MS, Goudar SS, Hibberd PL, Derman RJ, Hoffman M, Wylie BJ, Goldenberg RL, Thorsten VR, McClure EM, Krebs NF. Associations between ambient temperature and pregnancy outcomes from three south Asian sites of the Global Network Maternal Newborn Health Registry: A retrospective cohort study. BJOG. 2023;130(3):124–33. 10.1111/1471-0528.17616. Epub 2023 Aug 15. PMID: 37581948; PMCID: PMC10843605.
21. Cheng P, Peng L, Hao J, Li S, Zhang C, Dou L, Fu W, Yang F, Hao J. Short-term effects of ambient temperature on preterm birth: a time-series analysis in Xuzhou, China. Volume 28. Environmental Science and Pollution Research; 2021. pp. 12406–13.
22. Ren M, Wang Q, Zhao W, Ren Z, Zhang H, Jalaludin B, Benmarhnia T, Di J, Hu H, Wang Y, Ji JS. Effects of extreme temperature on the risk of preterm birth in China: A population-based multi-center cohort study. The Lancet Regional Health–Western Pacific; 2022. p. 24.
23. Huang Q, Pan X, Yan S, Sun, Zhonghan LY, Yuan J, Ye Y, Lv C, Wang R. Song Maternal exposure to ambient temperature and risk of preterm birth in Chengdu, China, from 2017–2020: a cohort study[. BMC Public Health]. 2025;25(1):299.
24. Yu G, Yang L, Liu M, Wang C, Shen X, Fan L, Zhang J. 2023. Extreme temperature exposure and risks of preterm birth subtypes based on a Nationwide survey in China. Environmental Health Perspectives, 131(8), p.087009.
25. Amiel Castro RT, Marti B, Mmbaga BT, Siegfried T, Bernauer T, Ehlert U. 2024. Adverse Weather Conditions can have Negative Effects on Birth Outcomes: Evidence from a birth registry cohort in Tanzania. *medRxiv*, pp.2024-01.
26. Reddam A, Mujtaba MN, Tuholske C, Kaali S, Ayuurebobi K, Wylie BJ, Medgyesi DN, Boamah-Kaali E, Baccarelli AA, Agyei O, Chillrud SN. 2025. Prenatal exposure to heat and humidity and infant birth size in Ghana. *Environmental Research*, *266*, p.120557.

27. Rancière F, Wafo O, Perrot X, Momas I. Associations between heat wave during pregnancy and term birth weight outcomes: The PARIS birth cohort. Environ Int. 2024;188:108730. 10.1016/j.envint.2024.108730. Epub 2024 May 9. PMID: 38776654.
28. Le K, Nguyen M. The impacts of temperature shocks on birth weight in Vietnam. Popul Dev Rev. 2021;47(4):1025–47.
29. Basagaña X, Michael Y, Lensky IM, Rubin L, Grotto I, Vadislavsky E, Levi Y, Amitai E, Agay-Shay K. 2021. Low and high ambient temperatures during pregnancy and birth weight among 624,940 singleton term births in Israel (2010–2014): an investigation of potential windows of susceptibility. Environmental Health Perspectives, 129(10), p.107001.
30. McElroy S, Ilango S, Dimitrova A, Gershunov A, Benmarhnia T. Extreme heat, preterm birth, and stillbirth: A global analysis across 14 lower-middle income countries. Environ Int. 2022;158:106902. 10.1016/j.envint.2021.106902. Epub 2021 Oct 6. PMID: 34627013.
31. Brink N, Lakhoo DP, Solarin I, Maimela G, von Dadelszen P, Norris S, Chersich MF, Climate and Heat-Health Study Group. Impacts of heat exposure in utero on long-term health and social outcomes: a systematic review. BMC Pregnancy Childbirth. 2024;24(1):344. 10.1186/s12884-024-06512-0. PMID: 38704541; PMCID: PMC11069224.
32. Caniglia EC, Abrams J, Diseko M, Mayondi G, Mabuta J, Makhema J, Mmalane M, Lockman S, Bernstein A, Zash R, Shapiro R. Seasonality of adverse birth outcomes in women with and without HIV in a representative birth outcomes surveillance study in Botswana. BMJ Open. 2021;11(9):e045882. 10.1136/bmjopen-2020-045882. PMID: 34479931; PMCID: PMC8420660.
33. Yam YLJ. Body temperature and its regulation. Anaesth Intensive Care Med. 2024;25(8):584–8.
34. Cramer MN, Gagnon D, Laitano O, Crandall CG. 2022. Human temperature regulation under heat stress in health, disease, and injury. *Physiological reviews*.
35. Natarajan S, Murugavel AM, Palanisamy S, Deepa S. Complications in Pregnant Women. Predicting Pregnancy Complications Through Artificial Intelligence and Machine Learning. IGI Global; 2023. pp. 245–59.
36. Veenema RJ, Hoepner LA, Geer LA. 2023. Climate change-related environmental exposures and perinatal and maternal health outcomes in the US. *International Journal of Environmental Research and Public Health*, *20*(3), p.1662.
37. Yüzen D, Graf I, Diemert A, Arck PC. 2023. Climate change and pregnancy complications: From hormones to the immune response. *Frontiers in Endocrinology*, *14*, p.1149284.
38. Zangeneh FZ, Hantoushzadeh S. 2023. The physiological basis with uterine myometrium contractions from electro-mechanical/hormonal myofibril function to the term and preterm labor. Heliyon, *9*(11).
39. Hamburg-Shields E, Mesiano S. The hormonal control of parturition. Physiol Rev. 2024;104(3):1121–45.
40. Bonell A. 2023. Climate change, maternal health and birth outcomes: how does environmental heat affect pregnancy and birth outcomes in The Gambia? (Doctoral dissertation, London School of

Hygiene & Tropical Medicine).

41. Samuels L, Nakstad B, Roos N, Bonell A, Chersich M, Havenith G, Luchters S, Day LT, Hirst JE, Singh T, Elliott-Sale K. Physiological mechanisms of the impact of heat during pregnancy and the clinical implications: review of the evidence from an expert group meeting. Int J Biometeorol. 2022;66(8):1505–13.
42. Bekkar B, DeNicola N, Girma B, Potarazu S, Sheffield P. Pregnancy and newborn health - heat impacts and emerging solutions. Semin Perinatol. 2023;47(8):151837. 10.1016/j.semperi.2023.151837. Epub 2023 Oct 10. PMID: 37838485.
43. Wang L, Zhang C, Di J, Wang Q, Ren M, Huang A, Chen S, Zhao W, Hu H, Wang A, Di Q. Increased risk of preterm birth due to heat exposure during pregnancy: Exploring the mechanism of fetal physiology. Sci Total Environ. 2024;931:172730.
44. Lo YTE, Vosper E, Higgins JPT, Howard G. Heat impacts on human health in the Western Pacific Region: an umbrella review. Lancet Reg Health West Pac. 2023;42:100952. 10.1016/j.lanwpc.2023.100952. PMID: 38022710; PMCID: PMC10652124.
45. Cho H. Ambient temperature, birth rate, and birth outcomes: evidence from South Korea. Popul Environ. 2020;41(3):330–46. 10.1007/s11111-019-00333-6. Epub 2019 Dec 2. PMID: 32214579; PMCID: PMC7089350.
46. Le K. Heat Exposure and Birth Weight. Rev Econ. 2024;75(2):139–62.
47. Song Y, Zhang F, Lin G, Wang X, He L, Li Y, Zhai Y, Zhang N, Ma G. 2023. A study of the fluid intake, hydration status, and health effects among pregnant women in their second trimester in China: A cross-sectional study. *Nutrients*, *15*(7), p.1739.
48. Lin J, Yang Y, Nuermaimaiti A, Ye T, Liu J, Zhang Z, Chen Y, Li Q, Wu C, Liu B, Xu R, Xia Y, Xiang J. Impact of ambient temperature on adverse pregnancy outcomes: a birth cohort study in Fuzhou, China. Front Public Health. 2023;11:1183129. 10.3389/fpubh.2023.1183129. PMID: 37483924; PMCID: PMC10359494.
49. Rekha S, Nalini SJ, Bhuvana S, Kanmani S, Vidhya V. A Comprehensive Review on Hot Ambient Temperature and its Impacts on Adverse Pregnancy Outcomes. J Mother Child. 2023;27(1):10–20. 10.34763/jmotherandchild.20232701.d-22-00051. PMID: 37368943; PMCID: PMC10298495.
50. Papadiochou A, Diamanti A, Metallinou D, Georgakopoulou VE, Taskou C, Kagkouras I, Sarantaki A. Impact of Climate Change on Reproductive Health and Pregnancy Outcomes: A Systematic Review. Cureus. 2024;16(8):e68221. 10.7759/cureus.68221. PMID: 39347228; PMCID: PMC11439441.
51. Paulsen CP, Bandak E, Edemann-Callesen H, Juhl CB, Händel MN. 2023. The effects of exercise during pregnancy on gestational diabetes mellitus, preeclampsia, and spontaneous abortion among healthy women—a systematic review and meta-analysis. *International Journal of Environmental Research and Public Health*, *20*(12), p.6069.
52. Jenkinson B, Charlton V, Hardiman L, Limmer A, McKenzie M, Ura AL, Bonner C, Lawler S, Middleton P, Mishra G, Doust J. Women's health and healthcare experiences in the years after gestational diabetes or hypertensive disorders of pregnancy. BMC Pregnancy Childbirth. 2025;25(1):1–13.

53. Mendola P, Ha S. Beyond the infant in your arms: effects of climate change last for generations. Fertil Steril. 2022;118(2):224–9. 10.1016/j.fertnstert.2022.06.007. Epub 2022 Jul 2. PMID: 35791979.
54. Veras MM, Saldiva PHN. Impact of air pollution and climate change on maternal, fetal and postnatal health. J Pediatr (Rio J). 2024 Nov 22:S0021-7557(24)00140-2. 10.1016/j.jped.2024.10.006. Epub ahead of print. PMID: 39581563.
55. Dumbuya S, Chabinga R, Ferede MA, Saber M. Climate change impacts on maternal health and pregnancy outcomes in Africa. J Water Health. 2024;22(11):2113–31. 10.2166/wh.2024.254. Epub 2024 Oct 15. PMID: 39611672.
56. Smith DM, Sales J, Williams A, Munro S. Pregnancy intentions of young women in Canada in the era of climate change: a qualitative auto-photography study. BMC Public Health. 2023;23(1):766. 10.1186/s12889-023-15674-z. PMID: 37098525; PMCID: PMC10127979.
57. Thiede BC, Ronnkvist S, Armao A, Burka K. Climate anomalies and birth rates in sub-Saharan Africa. Clim Change. 2022;171(1):5.
58. Lakhani S, Ambreen S, Padhani ZA, Fahim Y, Qamar S, Meherali S, Lassi ZS. Impact of ambient heat exposure on pregnancy outcomes in low- and middle-income countries: A systematic review. Womens Health (Lond). 2024 Jan-Dec;20:17455057241291271. PMID: 39500870; PMCID: PMC11539105.
59. Sexton J, Andrews C, Carruthers S, Kumar S, Flenady V, Lieske S. Systematic review of ambient temperature exposure during pregnancy and stillbirth: Methods and evidence. Volume 197. Environmental research; 2021. p. 111037.
60. Haghighi MM, Wright CY, Ayer J, Urban MF, Pham MD, Boeckmann M, Areal A, Wernecke B, Swift CP, Robinson M, Hetem RS. 2021. Impacts of high environmental temperatures on congenital anomalies: a systematic review. International journal of environmental research and public health, 18(9), p.4910.
61. Dimitrova A, Dimitrova A, Mengel M, Gasparrini A, Lotze-Campen H, Gabrysch S. 2024. Temperature-related neonatal deaths attributable to climate change in 29 low-and middle-income countries. Nature communications, 15(1), p.5504.
62. Wesley SR, Gallo M, Apata T, Dis JV, Hollenbach SJ. Impact of Endocrine-Disrupting Chemicals, Climate, and Air Pollution on Pregnancy Outcomes: A Scoping Review. Semin Reprod Med. 2024 Dec;18. 10.1055/s-0044-1800961. Epub ahead of print. PMID: 39694048.
63. Fan W, Zlatnik MG. Climate Change and Pregnancy: Risks, Mitigation, Adaptation, and Resilience. Obstet Gynecol Surv. 2023;78(4):223–36. 10.1097/OGX.0000000000001116. PMID: 37043299; PMCID: PMC10508966.
64. Nyadanu SD, Dunne J, Tessema GA, Mullins B, Kumi-Boateng B, Bell ML, Duko B, Pereira G. Maternal exposure to ambient air temperature and adverse birth outcomes: An umbrella review of systematic reviews and meta-analyses. Sci Total Environ. 2024;917:170236. Epub 2024 Jan 24. PMID: 38272077.

65. Cushing L, Morello-Frosch R, Hubbard A. Extreme heat and its association with social disparities in the risk of spontaneous preterm birth. Paediatr Perinat Epidemiol. 2022;36(1):13–22.
66. Son JY, Choi HM, Miranda ML, Bell ML. Exposure to heat during pregnancy and preterm birth in North Carolina: Main effect and disparities by residential greenness, urbanicity, and socioeconomic status. Volume 204. Environmental research; 2022. p. 112315.
67. Wong EC, Maher AR, Motala A, Ross R, Akinniranye O, Larkin J, Hempel S. Methods for identifying health research gaps, needs, and priorities: a scoping review. J Gen Intern Med. 2022;37(1):198–205.
68. Mawolle GG. 2022. *The Prevalence and Factors Associated with Premature Birth Among Post-Delivery Women in Mbeya Region: An Analytical Cross-Sectional Study* (Master's thesis, University of Dodoma (Tanzania).
69. Ismail AQT. 2023. *Exploring the relationship between care provided and clinical outcomes for preterm babies born between 27–31 weeks of gestation in England* (Doctoral dissertation, University of Leicester).
70. Koteswari P, Lakshmi PA, Yaseen M, Sultana S, Tabassum A, Soumya P, Kawkab A. Preterm birth: causes and complications observed in tertiary care hospitals. Cell Mol Biomedical Rep. 2022;2(4):202–2012.
71. NDAGIJIMANA PC. 2022. *Reducing prolonged hospital stay for moderate and late premature babies in Neonatal Intensive Care Unit (NICU) of Kabgayi district Hospital* (Doctoral dissertation, University of Rwanda).
72. Dhungana R, Dhungana A, Fassl B, Judkins A, Tomlin B, Shakya DV, Chalise M. Determinants of low birth weight in newborns at a referral hospital in western Nepal: an unmatched case-control study. BMC Pediatr. 2025;25(1):1–11.
73. Tsakiridis I, Giouleka S, Mamopoulos A, Athanasiadis A, Dagklis T. Investigation and management of stillbirth: a descriptive review of major guidelines. J Perinat Med. 2022;50(6):796–813.
74. Bagga N, Panigrahay N, Maheshwari A. Extra-uterine growth restriction in preterm infants. Newborn. 2022;1(1):67–73.

Figures

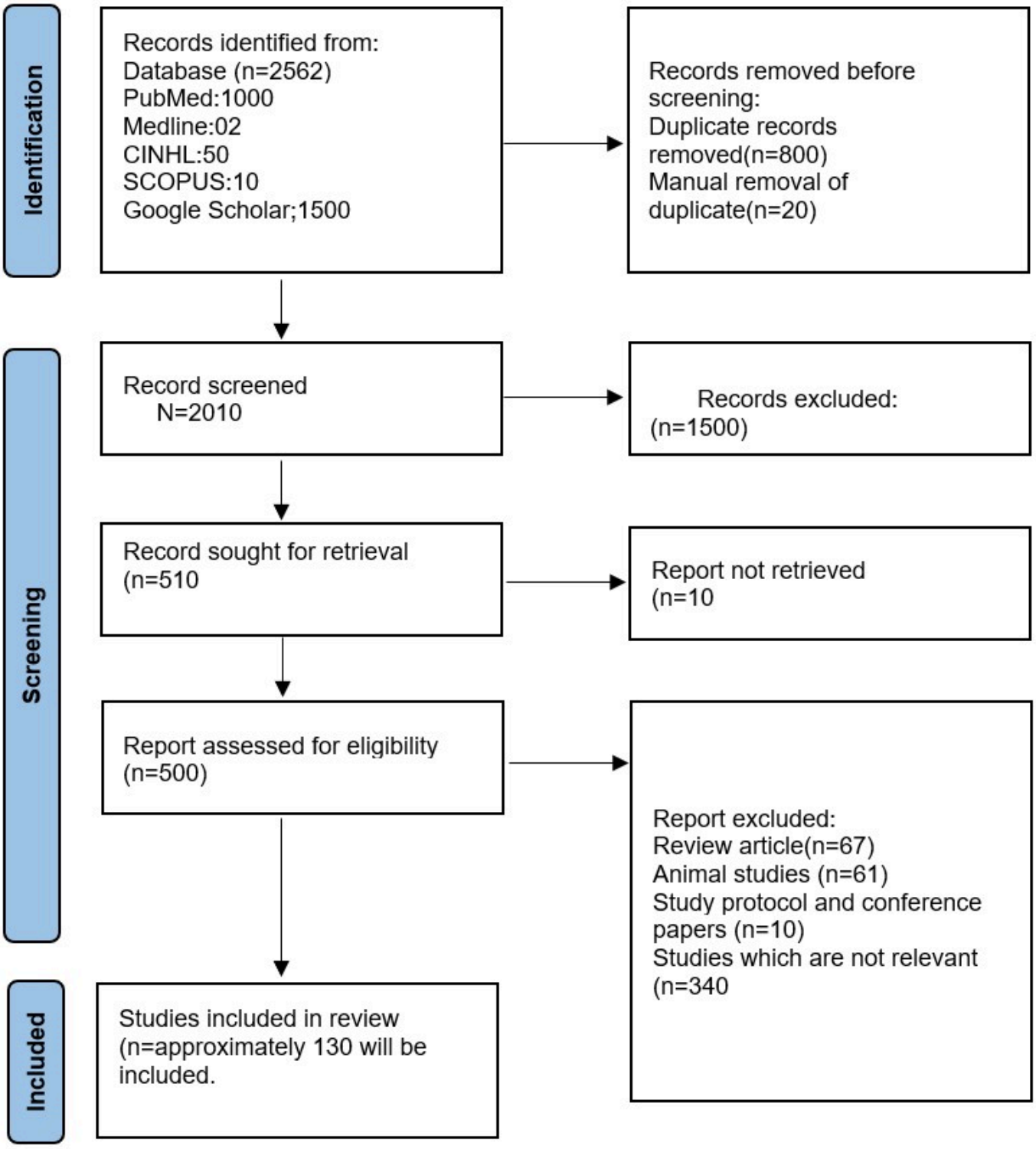


Figure 1

The PRISMA (Preferred Reporting Items for Systematic Review) flowchart for study selection, including preliminary results