



## Original Research

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# Extreme Heat and Pregnancy: A Content Analysis of Heat Health Risk Communication by US Public Health Agencies

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## Abstract

**Objectives:** Exposure to extreme heat events increases the risk for negative birth outcomes, including preterm birth. This study sought to determine the presence and content of web-based heat health information for pregnant people provided by federal, state, and local government public health websites.

**Methods:** This website content analysis consisted of 17 federal, 50 state, and 21 city websites, and noted which of 25 recognized pregnancy heat health data elements were included. Data for the analysis were collected from March 12, 2022, through March 16, 2022.

**Results:** The search identified 17 federal websites, 38 state websites, and 19 city websites with heat health information. Within these, only seven websites listed pregnant people as a vulnerable or at-risk population, and only six websites provided information related to heat health specifically for pregnancy. Of the 25 themes recognized as important for pregnancy risk during extreme heat exposure, only 11 were represented within these 6 websites.

**Conclusion:** The presence of web-based pregnancy heat health information is infrequent and limited in content. Boosting web-based publication of extreme heat and pregnancy risks could mitigate negative maternal and child health outcomes.

## Significance

Extreme heat poses threats to population health, especially for vulnerable populations such as pregnant people. Extreme heat exposure is associated with increases in various adverse health outcomes impacting pregnancy. Given the risks, it is imperative to create access to heat health information focused on the risks during pregnancy. This study examined government websites that would be expected to communicate extreme heat risks and found insufficient information available about pregnancy-related risk. Public health departments and other entities need to increase awareness of extreme heat as a health risk during pregnancy and provide information in places where it can be publicly accessed.

## What Is Already Known on This Subject?

The scientific literature shows associations between extreme heat and adverse health outcomes during pregnancy. The public often lacks information about how to mitigate risks of pregnancy during extreme heat events.

## What This Study Adds?

Extreme heat is a significant health risk that has not been fully examined in public health. This paper identifies a research and practice gap in the delivery of pregnancy heat health information to the public through federal, state, and local government websites. Increasing communication around pregnancy heat health information has the potential to positively impact maternal and child health outcomes in the future.

In North America, the frequency of extreme ambient heat events—multiple-day episodes of temperature and/or humidity well above normal—is increasing<sup>1</sup> and expected to continue rising with climate change.<sup>2</sup> Extreme heat events experienced by a pregnant person may harm the developing embryo or fetus. Degree of risk is due to a combination of how elevated above normal the core body temperature may become and the time span of this elevation.<sup>3</sup>

A range of epidemiologic studies has found a relation between extreme ambient heat and poor birth outcomes. A well-studied outcome is the risk of preterm birth. A multi-site cross-

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sectional study of over 200 000 births examined the relation between local extreme heat events in early pregnancy and preterm birth.<sup>4</sup> Exposure to extreme heat events (above 90th percentile) during the first seven weeks of pregnancy was associated with an 11% greater relative risk of early preterm (less than 34 weeks) delivery. A systematic review<sup>5</sup> identified this and four other studies with acceptable methodology, and four of these five noted a relation between heat events and preterm birth.

Studies have also investigated the relation between extreme local extreme heat events and low birth weight. An American multi-site study examined low birth weight for full-term births with extreme heat events (95th percentile above normal temperatures). Exposure in the third trimester (but not first or second) was associated with a 30% greater relative risk of low birth weight.<sup>6</sup> A systematic review<sup>5</sup> identified this and two other studies with acceptable methodology, and all three noted a relation between heat events and low birth weight.

Prenatal exposure to extreme heat has also been associated with congenital heart defects. For a Quebec, Canada, cohort of mother/child pairs with an ultrasound assessment for cardiac heart defects, researchers determined those for whom the fetus, in early pregnancy (2 to 8 weeks post-conception), experienced local extreme heat events. The heart defect rate was 979.5 per 100 000 for those exposed to 10 or more days above 30 degrees, about 9% greater than the rate, and 878.9 per 100 000 for those with no days above 30 degrees.<sup>7</sup> In a multi-site longitudinal cohort study of infants with birth defects, that also included a matched control group, researchers examined the likelihood of congenital heart defects for mother/child pairs exposed to extreme heat events early in pregnancy (3 to 8 weeks post-conception). There were greater odds of a child having a ventricular septal defect across most regions of the United States, with odds ratios ranging from 2.2 to 3.2 for those with exposure to three or more extreme heat event days during spring or summer.<sup>8</sup> Along with these studies noting associations between heat events and preterm birth, low birth weight, and cardiac birth defects, other associations have been noted. These include neural tube defects,<sup>9</sup> stillbirth,<sup>10,11</sup> and placental abruption.<sup>12</sup>

These are all associational studies. Epidemiologically, it is a great challenge to attribute birth outcomes to specific causes. Due to the broad evidence, it may be warranted to believe that extreme heat is responsible for some degree of these outcomes. It is possible that extreme heat may contribute to death, such as the noted stillbirth association, and for the increased risk of early death associated with some of these outcomes, such as preterm birth. While the threat of extreme heat to pregnancy seems clear, the magnitude would be difficult to estimate.

Nonetheless, the risk of this largely preventable harm warrants a good policy response from the governmental entities tasked with protecting public health. The World Health Organization (WHO) and the World Meteorological Organization (WMO) have both suggested that heat health, generally, should be taken into consideration for public health programming.<sup>13</sup> It is additionally noted that pregnant and postpartum women have special needs during public health emergencies but have insufficient preparedness tools.<sup>14</sup> The degree that pregnancy is specifically highlighted and addressed in public health programming on extreme heat exposure is not known.

The threat posed by extreme heat is limited and uneven across public health agencies.<sup>15</sup> Of the four federal agencies responsible for addressing extreme heat events, the Centers for Disease Control and Prevention (CDC), The National Oceanic and Atmospheric

Administration (NOAA) National Weather Service (NWS), the US Department of Homeland Security (DHS), and the Environmental Protection Agency (EPA), only the NOAA NWS lists pregnant women as a vulnerable population.<sup>16</sup>

We have developed a multi-stage content analysis of a representative range of federal, state, and local government public health-related websites concerning heat health in order to assess the degree that pregnancy risk is included along with other heat risk topics and populations.

## Objectives

The objectives of this website content analysis were to (1) determine the degree that federal, state, and local government websites communicate pregnancy heat health information, and (2) determine what information, from a recognized set of relevant information components, is communicated on these websites.

## Methods

A website search and content analysis were conducted of federal, state, and city government websites ending in a “.gov” URL to assess the availability of heat health pregnancy information and guidance in the United States. A web search strategy was developed to detect websites for these jurisdictions that communicated heat health information. For each search result, the website was explored to resolution: either the heat/pregnancy topic was detected or not, within that website. When heat health information was provided by a jurisdiction about pregnancy, further content analysis was conducted to identify the type of information provided.

The data were collected ethically, and IRB was not obtained because research consisted of publicly available information.

### Federal Agency Data Collection

A review of the federal executive administration revealed several agencies addressing public health and/or weather. Also, a Google search was conducted with the search phrases “Federal Agency Extreme Heat” and “US Government Heat Information,” and the first 10 pages of results (the first 50 to 70 results) were examined. All federal websites with a “.gov” URL were included for review.

### State Public Health Agency Data Collection

The health department of each state was located. Minnesota and New Mexico did not have a .gov URL for a state health department, but each was found to have a population health website, which was included in this analysis. To find heat health information on each state’s health website, the search functions were used with the terms “Heat,” “Extreme Heat,” and “Heat Preparedness.” If the relevant information was not found using the first search term, the second and third terms were used. The first 25 populated results from each search were examined thoroughly by clicking on each link and then corresponding subsequent links. New Hampshire did not have a search bar, but an “A-Z topics” was listed, which was searched for “Heat,” “Extreme Heat,” “Injury Prevention,” and “Climate.” These were predetermined categories and were thought to be the best fit to find heat health information. A list of state agencies and the responses to the presence of heat health and pregnancy information on their websites are in Supplemental Information.

### City Public Health Agency Data Collection

A set of cities with large populations was selected based on the urban heat island effect and because larger cities would be expected to have the resources necessary, such as a city public health department web page or similar, for pregnant women to easily access. Urban heat island effect happens when the heat gained during the day from unshaded roads and buildings contributes to an increase in temperature approximately 15-20 degrees greater than surrounding areas.<sup>17</sup> Included were the top 10 most populous cities in the United States: New York, NY; Los Angeles, CA; Chicago, IL; Houston, TX; Phoenix, AZ; Philadelphia, PA; San Antonio, TX; San Diego, CA; Dallas, TX; and Austin, TX.<sup>18</sup>

Additionally, 12 cities were added that had an extreme heat attributable mortality rate at 2.0 or higher (per 100 000) according to The United States Environmental Protection Agency Office of Atmospheric Programs. These cities included Providence, RI (4.14); Hartford, CT (3.28); St. Louis, MO (3.17); Kansas City, MO (3.10); Buffalo, NY (2.78); Indianapolis, IN (2.61); Memphis, TN (2.48); Columbus, OH (2.45); Minneapolis, MN (2.32); Philadelphia, PA (2.19); Denver, CO (2.12); and Detroit, MI (2.12).<sup>17</sup>

Philadelphia, PA, appeared on both lists, therefore 21 cities were identified. Some cities identified are in areas that experience high heat regularly, whereas others are more accustomed to cooler weather, thus providing a variety of urban environments. The website for the health department of each city was identified by searching the city name and “health department” with Google search. All but three cities had their own pages for heat health. Los Angeles, CA, and Memphis, TN, referred to their county websites, and Providence, RI, referred to the state of Rhode Island website. A list of city agencies and the responses to the presence of heat health and pregnancy information on their websites are provided in Supplemental Information.

### Analysis

For each jurisdiction, the following questions were answered, based on the identified web page:

1. Is health information provided?
2. Are pregnant people mentioned as an at-risk or vulnerable population?
3. Is there heat health information specific to pregnant people?

The information for each of these three questions had to be either on the main landing page examined or within one link. If additional links had to be accessed, the information was not considered in the analysis. Tailored information was documented as either a headline or bolded text that said “pregnant women” or “pregnancy” with heat health information listed directly after or an explanation of why or what risks pregnant women could endure if exposed to an extreme-heat event. All heat health pregnancy information was copied into a data set for analysis.

With a data set of heat health pregnancy information from each jurisdiction, information was coded according to a previously published qualitative coding system regarding pregnancy and heat topics, which identified 21 distinct themes, developed from a set of municipality health advisory information.<sup>15</sup> For this analysis, four items were added to this set of 21, due to specific relevance in this analysis.

**Table 1.** Presence of Heat Health Information, Pregnancy as a Vulnerable Population, and Specific Pregnancy Heat Health Information, Federal Government Agency Websites

Federal Government Agency	HHIA*	PWV**	HHIP***
Centers for Disease Control and Prevention	Yes	No	No
FEMA	Yes	No	No
National Weather Service, National Oceanic Atmospheric Administration	Yes	Yes	Yes
U.S. Environmental Protection Agency	Yes	No	No
National Integrated Heat Health Information System	Yes	Yes	Yes
United States Office of Personal Management	Yes	No	No
US Department of Labor	Yes	No	No
Occupational Safety and Health Administration	Yes	No	No
U.S. Dept. of Health and Human Services Office of Community Services	Yes	No	No
Health and Human Services	Yes	No	No
U.S. Global Change Research Program	Yes	No	No
National Institute of Environmental Health Sciences	Yes	No	No
Homeland Security and Emergency Management	Yes	No	No
U.S. Department of Agriculture Forest Service	Yes	No	No
National Institute of Health, News in Health	Yes	No	No
National Library of Medicine, Medline Plus	Yes	No	No
<b>Total yes, present:</b>	<b>16/16</b>	<b>2/16</b>	<b>2/16</b>

\*HHIA: Heat health information provided.

\*\*PWV: Pregnant women listed as a vulnerable population.

\*\*\*HHIP: Heat health information provided to pregnant women.

### Results

The web search was conducted from March 12, 2022, through March 16, 2022. The search identified 17 federal websites, 38 out of 50 state websites, and 18 out of 21 city websites with heat health information and guidance. For all website content analysis data collection (federal, state, and city), the URL from the pages that were analyzed was saved and is available in Supplemental Information.

#### Federal Government Websites

There were 17 federal agency websites with at least one statement or reference to heat health information in general (Table 1). However, only two of these 17 listed “pregnant women” as a vulnerable or at-risk population: the National Weather Service (NWS) and the National Integrated Heat Health Information System (NIHHIS). These two federal agencies are also the only federal websites that provided heat health information specifically targeted for pregnant people.

The information provided by the NWS was published on their *Heat Safety* web page. The NWS listed “pregnant women” under the “vulnerable population” section and included a picture of a pregnant person in an infographic on the web page. Additionally, when examined against the 21 heat-pregnancy themes, the NWS mentioned two of the 21 themes: listing pregnant women as

**Table 2.** Federal, state, and city website coding for presence of any of 25 distinct pregnancy heat health management suggestions

Items Reviewed	NWS <sup>1</sup>	NIHHIS <sup>2</sup>	Ohio	L <sup>3</sup>	N <sup>4</sup>	D <sup>5</sup>	C <sup>6</sup>
*Pregnant women listed as vulnerable or at-risk	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Specific Heat-Health Information for PW							
Drink plenty of fluid/water	No	Yes	No	No	Yes	No	Yes
Avoid alcohol, caffeine, or sugary drinks	No	Yes	No	No	No	No	No
Eat light, cool, easily digestible meals	No	No	No	No	No	No	No
Stay cool	No	Yes	No	No	Yes	No	Yes
Spend time in AC	No	No	No	No	No	No	No
If no AC, take cool showers or bath	No	No	No	No	No	No	No
If no AC, use stove and oven less for cooler home	No	No	No	No	No	No	No
Using fans safely	No	No	No	No	No	No	No
Wear lightweight, light-colored, loose-fitting clothes	No	Yes	No	No	No	No	No
Wear a brimmed hat	No	No	No	No	No	No	No
Wear sunglasses	No	No	No	No	No	No	No
Wear sunscreen	No	No	No	No	No	No	No
Reapply sunscreen	No	No	No	No	No	No	No
Limit outdoor-activity to cooler times of the day	No	Yes	No	No	Yes	No	No
Eliminate outdoor activity if possible	No	Yes	No	No	Yes	No	No
Acclimate to heat slowly	No	No	No	No	No	No	No
Rest in shade	No	No	No	No	No	No	No
Avoid strenuous activities	No	No	No	No	Yes	No	No
*Why pregnant women are at risk	No	Yes	No	No	Yes	No	No
*Potential risks during pregnancy	Yes	Yes	No	No	Yes	Yes	No
Know signs and symptoms of heat-related illnesses	No	Yes	No	No	No	No	No
Actions when heat-related illness is suspected	No	No	No	No	No	No	No
*Call your doctor if you become ill	No	No	No	No	No	No	No

\*Indicates category added to original set of 21 from Zottarelli et al.<sup>15</sup>

NWS<sup>1</sup>: National Weather Service.

NIHHIS<sup>2</sup>: National Integrated Heat Health Information System.

L<sup>3</sup>: Los Angeles California, County of Los Angeles health Department.

N<sup>4</sup>: NYC Health.

D<sup>5</sup>: Detroit Health Department.

C<sup>6</sup>: Chicago, Illinois.

vulnerable or at risk and listing potential risks during pregnancy (Table 2).

The pregnancy heat health information provided by the NIHHIS was included on their *NIHHIS News & Updates* page. The main page did not include pregnant women under the “vulnerable population” section. However, the provided links were explored, and the second web page included “pregnant women” on its vulnerable population list and provided information regarding heat health and pregnancy. When examined for the 21 pregnancy heat health themes, this NIHHIS information included 10 of the 21 themes (Table 2): listing pregnant women as vulnerable or at risk; drinking plenty of fluid/water; avoiding alcohol, caffeine, or sugary drinks; staying cool; wearing lightweight, light colored, loose fitting clothes; limiting outdoor activity to cooler times of the day; eliminating outdoor activity if possible; providing information on why pregnant people are at risk; listing potential risks during pregnancy; and listing information on the signs and symptoms of heat-related illnesses.

The National Integrated Heat Health Information System was created in 2015 as part of a set of initiatives addressing the health threats of climate change. Partners include the CDC, Assistant Secretary for Preparedness and Response, Environmental Protection Agency, Federal Emergency Management Agency, National Institute for Occupational Safety and Health, Department of Veteran Affairs, Forest Service, National Park Service,

Department of Health and Human Services, National Institute of Environmental Health Sciences, Occupational Safety and Health Administration, and Substance Abuse and Mental Health Services Administration. So, while many of these agencies may not provide pregnancy heat health information individually, NIHHIS provides the opportunity for a coordinated presentation.

The CDC did not include pregnant people in their heat vulnerable populations list on their website nor did they provide specific heat health pregnancy information. However, the CDC does include some pregnancy heat health information in a linked, 20-page PDF, *Climate Change and Extreme Heat: What You Can Do to Prepare*. This PDF, attributed jointly to EPA and CDC, is accessed on the bottom of their Heat Information page, in a box labeled “Resources for Health Professionals.” In this PDF, in a section titled “Who is most at risk from extreme heat,” “pregnant women” are noted as being at risk.<sup>19</sup> Pregnant people are also represented in an infographic on page 13 of the PDF.

### State Government Websites

There were 38 states with heat health information (Table 3), but only one, Ohio, specifically noted “pregnant women” as an at-risk population. However, this information from Ohio was published in a web-posted news release PDF and was not on a designated heat-related web page. The news release provided a warning about

**Table 3.** Presence of Heat Health Information, Pregnancy as a Vulnerable Population, and Specific Pregnancy Heat Health Information, State Government Websites

State	Health Department Title	HHIA*	PWV**	HHIP***
AL	Alabama Department of Public Health	Yes	No	No
AK	Alaska Dept of Health and Social Services Div of Public Health	No	No	No
AR	Arizona Department of Health Services	Yes	No	No
AR	Arkansas Department of Health	Yes	No	No
CA	California Department of Public Health	Yes	No	No
CO	Colorado Department of Public Health & Environment	Yes	No	No
CT	Connecticut State Department of Public Health	Yes	No	No
DE	DHSS Division of Public Health	Yes	No	No
FL	Florida Health	Yes	No	No
GA	Georgia Department of Public Health	Yes	No	No
HI	Hawaii State Department of Health	No	No	No
ID	Idaho Department of Health and Welfare	No	No	No
IL	Illinois Department of Public Health	Yes	No	No
IN	Indiana Department of Health	Yes	No	No
IA	Iowa Department of Public Health	No	No	No
KS	Kansas Department of Health and Environment	No	No	No
KY	Kentucky Cabinet for Health and Fam Svs Dept for Public Health	Yes	No	No
LA	Louisiana Department of Health	Yes	No	No
ME	Division of Public Health Systems	Yes	No	No
MD	Maryland Department of Health	Yes	No	No
MA	Massachusetts Department of Public Health	Yes	No	No
MI	Michigan Department of Health and Human Services	Yes	No	No
MN	Minnesota Department of Health	Yes	No	No
MS	Mississippi State Department of Health	Yes	No	No
MO	Missouri Department of Health & Senior Services	Yes	No	No
MT	Montana Department of Public Health and Human Services	Yes	No	No
NE	Nebraska Department of Health and Human Services	Yes	No	No
NV	Dept of Health and Human Svs Div of Public and Behav Health	No	No	No
NH	New Hampshire Department of Health and Human Services	No	No	No
NJ	New Jersey Department of Health	Yes	No	No
NM	New Mexico Department of Health	Yes	No	No
NY	New York State Department of Health	Yes	No	No
NC	North Carolina Division of Public Health	Yes	No	No
ND	North Dakota Department of Health	No	No	No
OH	Ohio Department of Health	Yes	Yes	No
OK	Oklahoma State Department of Health	Yes	No	No
OR	Oregon Public Health Division	No	No	No
PA	Pennsylvania Department of Health	Yes	No	No
RI	State of Rhode Island Department of Health	Yes	No	No
SC	South Carolina Department of Health and Environmental Control	Yes	No	No
SD	South Dakota Department of Health	No	No	No
TN	Tennessee Department of Health	Yes	No	No
TX	Texas Department of State Health Services	Yes	No	No
UT	Utah Department of Health	No	No	No
VT	Vermont Department of Health	Yes	No	No
VA	Virginia Department of Health	No	No	No
WA	Washington State Department of Health	Yes	No	No
WV	West Virginia Department of Health & Human Resources	Yes	No	No
WI	Wisconsin Department of Health Services	Yes	No	No
WY	Wyoming Department of Health	Yes	No	No
<b>Total yes, present:</b>		<b>38/50</b>	<b>1/50</b>	<b>0/50</b>

\*HHIA: Heat health information provided.

\*\*PWV: Pregnant women listed as a vulnerable population.

\*\*\*HHIP: Heat health information provided to pregnant women.

**Table 4.** Presence of Heat Health Information, Pregnancy as a Vulnerable Population, and Specific Pregnancy Heat Health Information, City Government Websites

City, State	Name of Health Department	HHIA*	PWV**	HHIP***
Austin, TX	Austin Public Health	Yes	No	No
Buffalo, NY	Erie County, NY Department of Health	Yes	No	No
Chicago, IL	Public Health- City of Chicago	Yes	Yes	No
Columbus, OH	Columbus Public Health	Yes	No	No
Dallas, TX	Dallas County Health and Human Services	No	No	No
Denver, CO	Denver Public Health and Environment	Yes	No	No
Detroit, MI	Detroit Health Department	Yes	Yes	Yes
Hartford, CT	Hartford Health Department	Yes	No	No
Houston, TX	Houston Health Department	No	No	No
Indianapolis, IN	Marion County Public Health Department	No	No	No
Kansas City, MO	City of Kansas City, Missouri Health	Yes	No	No
Los Angeles, CA	County of Los Angeles Public Health	Yes	Yes	No
Memphis, TN	Shelby County Health Department	Yes	No	No
Minneapolis, MN	Minneapolis Health Department	Yes	No	No
New York, NY	NYC Health	Yes	Yes	Yes
Philadelphia, PA	City of Philadelphia Department of Public Health	Yes	No	No
Phoenix, AZ	Maricopa County Public Health	Yes	No	No
Providence, RI	Refer to State of Rhode Island	Yes	No	No
San Antonio, TX	San Antonio Metropolitan Health District	Yes	No	No
San Diego, CA	San Diego County Health & Human services Agency	Yes	No	No
St. Louis, MO	St. Louis City Emergency Management Agency	Yes	No	No
<b>Total yes, present</b>		<b>18/21</b>	<b>4/21</b>	<b>2/21</b>

\*HHIA: Heat health information provided.

\*\*PWV: Pregnant women listed as a vulnerable population.

\*\*\*HHIP: Heat health information provided to pregnant women.

excessive heat and provided recommendations for avoiding harm. While no states had heat health advisory information specific to pregnancy, 23 states either provided a link to or referenced the CDC's heat health information pages.

### City Government Websites

Of the 21 cities reviewed (Table 4), 18 provided at least one statement or reference to heat health information in general. Additionally, 12 cities either provided a link to or referenced the CDC's heat health information pages. Of the 18 that provided heat health information, four listed "pregnant women" as an at-risk group: Chicago, IL; Detroit, MI; Los Angeles, CA; and New York City, NY. While these 18 noted "pregnant women" among the at-risk populations, only two, New York City and Detroit, provided information that was specific regarding pregnant women. Detroit had links that directed users to the NWS heat health website and provided a brief explanatory statement. Los Angeles provided information on potential risks of heat but not why pregnancy puts people at additional risk.

When reviewed for any of the 21 pregnancy heat health content themes (Table 2), Chicago mentioned three: listing pregnant people as vulnerable or at risk, drinking plenty of fluid/water, and staying cool. Detroit mentioned two: listing pregnant people as vulnerable or at risk and listing potential risks during pregnancy. Los Angeles mentioned one: listing pregnant women as an at risk or vulnerable population. New York City mentioned eight: listing pregnant people as vulnerable or at risk, drinking plenty of fluid/water, staying cool, limiting outdoor activity to the cooler parts of the day, eliminating outdoor activity if possible, avoiding

strenuous activities, listing why pregnant people are at risk, and listing potential risks during pregnancy.

### Discussion

The CDC reported in 2016 that one strategy to prevent preterm birth and related complications is to "identify women at risk for preterm delivery and provide access to preventative treatments."<sup>20</sup> Extreme heat exposure, as a risk for preterm birth, is not well represented in government information and guidance. Along with more complete web-based pregnancy heat health information and guidance, another policy option would be to develop heat health pregnancy weather alerts. These could follow the Weather Forecast Office's guidelines already in place for other vulnerable populations, such as older adults. Yet another policy option would be for an agency, such as NIHHS, to develop and broadly disseminate a pregnancy heat health toolkit. This could help in ensuring the information is valid and credible and would create consistent messaging around heat health pregnancy information.

Extreme heat events pose a risk for a range of pregnancy-related health problems, including preterm birth, low birth weight, congenital cardiac defects, and others. We conducted this review of governmental websites to determine the degree that pregnancy heat health information and guidance are available on these websites.

This study found seven government websites (federal: NWS, NIHHS; state: Ohio; city: Los Angeles, New York City, Detroit, Chicago) that listed "pregnant women" as a vulnerable or at-risk population, and six (federal: NWS, NIHHS; city: Los Angeles, New York City, Detroit, Chicago) that provided heat health

information specific to pregnancy. In these six, 11 of 21 recognized pregnancy heat themes were represented.

Along with a low presence of heat health information among these websites, the range of information is quite limited. From our review, it is clear that the risk posed by extreme heat is significant during pregnancy. Information resources to mitigate this risk exist, especially as provided by NIHHS. However, this information should be more clearly and consistently communicated and widely broadcast in order to achieve heat health awareness, and to provide actions to be taken to reduce risk.

While these conclusions are well supported by this analysis, there are limitations to this study. One limit is the data collection period. Data were collected March 12, 2022, through March 16, 2022. Websites could have been updated as more current information is released on climate change, extreme heat information, and the effects on pregnancy. Additionally, this time is usually cooler in temperature for a majority of locations; content may be posted seasonally, to be relevant. Another limitation is that the analysis only looked at federal, state, and local government websites and did not consider other website types (such as WebMD) or other communication channels (such as provider education, printed material, weather alerts). Further studies could examine the presence of pregnancy heat health information and guidance from these additional avenues, and further research could also assess the degree that people of child-bearing age and health care professionals are aware of this information.

## Conclusion

Extreme heat poses a range of threats to population health, especially for some vulnerable populations including pregnant people. Increases in extreme heat events may translate into increases in preterm birth and the other noted adverse pregnancy outcomes. Therefore, access to comprehensive preparedness information regarding heat health and pregnancy should mitigate the negative effects that extreme heat can have on maternal and child health.

Boosting the presence and quality of web-based pregnancy heat health information and guidance, and developing other policy options, could reduce negative birth outcomes due to extreme heat exposure.

**Author contributions.** RS co-conceived the study, completed all data collection and analysis, and led the writing; LZ co-conceived the study, supervised data collection and analysis, and provided editing and feedback; PR assisted in writing and provided feedback; GW assisted in editing and provided feedback; and JH contributed to the organization of the study and provided feedback and oversight for the study.

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**Ethical standards.** IRB was not obtained because research consisted of publicly available information published on federal, state, and city websites.

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