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Temperature, Crime, and Violence: A Systematic Review and Meta-Analysis

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Background: Heat is known to affect many health outcomes, but more evidence is needed on the impact of rising temperatures on crime and/or violence.

Objectives: We conducted a systematic review with meta-analysis regarding the influence of hot temperatures on crime and/or violence.

Methods: In this systematic review and meta-analysis, we evaluated the relationship between increase in temperature and crime and/or violence for studies across the world and generated overall estimates. We searched MEDLINE and Web of Science for articles from the available database start year (1946 and 1891, respectively) to 6 November 2023 and manually reviewed reference lists of identified articles. Two investigators independently reviewed the abstracts and full-text articles to identify and summarize studies that analyzed the relationship between increasing temperature and crime, violence, or both and met *a priori* eligibility criteria. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines were used to extract information from included articles. Some study results were combined using a profile likelihood random-effects model for meta-analysis for a subset of outcomes: violent crime (assault, homicide), property crime (theft, burglary), and sexual crime (sexual assault, rape). This review is registered at PROSPERO, CRD42023417295.

Results: We screened 16,634 studies with 83 meeting the inclusion criteria. Higher temperatures were significantly associated with crime, violence, or both. A 10°C (18°F) increase in short-term mean temperature exposure was associated with a 9% [95% confidence interval (CI): 7%, 12%] increase in the risk of violent crime ($I^2 = 30.93\%$; eight studies). Studies had differing definitions of crime and/or violence, exposure assessment methods, and confounder assessments.

Discussion: Our findings summarize the evidence supporting the association between elevated temperatures, crime, and violence, particularly for violent crimes. Associations for some categories of crime and/or violence, such as property crimes, were inconsistent. Future research should employ larger spatial/temporal scales, consistent crime and violence definitions, advanced modeling strategies, and different populations and locations. https://doi.org/10.1289/EHP14300

Introduction

Violence and crime are worldwide problems and are currently on the rise.[1] While crime and violence are affected by complex, interconnected social, cultural, economic, and health systems,[2,3] extreme temperatures could be a contributing factor.[4–6] One study suggested that long-term temperature increases could contribute to 35,000 murders in the US over the next 90 years.[7] Many studies have provided evidence for the relationship between temperature and crime and/or violence, including elevated rates of violent crime,[6,8,9] assaults,[10–12] robberies,[13–15] property crime,[14,16,17] and sexual crime.[18–20] If high temperature is associated with crime and violence, rising overall temperatures and heat extremes from climate change could result in a larger public health burden than anticipated.

Previous studies identified different risk factors of sociodemographic variables (e.g., age, sex, race, income) that are related to crime rates in communities.[21,22] However, temperature may also play a role. Various hypotheses have been proposed to explain the association between temperature and crime and/or violence. First, the routine activity theory suggests that the weather affects an individual's activities, attracting people to public spaces and fostering social interactions, which might lead to criminal behavior.[17,23] The heat–aggression hypothesis posits that heat serves as a fundamental factor contributing to violence and crime. According to this theory, elevated temperatures induce physiological discomfort and intolerance in humans, thereby intensifying tendencies toward aggression.[24] Furthermore, the economic theory of rational criminal behavior posits that one compares the benefit of violating the law with the possible cost.[25] For instance, property crimes decreased as the daylight hours increased, likely due to the higher possibility of being witnessed or caught during the daytime.[26]

The temperature–crime relationship has been examined in many ways, comparing different seasons, years, months, and locations with studies in different cities and countries. Hsiang et al.[27] synthesized 60 studies regarding human conflict for time periods spanning from 10,000 BCE to the present day. Their meta-analysis estimated that one standardized deviation change in temperature was estimated to correspond to a 14% change in intergroup conflict and a 4% change in interpersonal violence.[27] However, comparing results among different studies is challenging, since most previous studies focused on the temperature–crime association for one city or one specific type of crime or violence. Previous studies on other impacts of heat indicate different associations by location and population.[28–30] Further, the definition of a particular type of crime or violent act may not be perfectly consistent across location, time, and study. A systematic analysis of the scientific evidence on how high temperature affects risk of crime and/or violence is needed to inform assessments of the health burden of climate change and to examine how impacts differ across location and population. Such information could also inform strategies (e.g., heat action plans) to address the public health burden of high temperatures and add communities in addressing crime and violence.

We conducted a systematic review and meta-analyses of epidemiological studies examining the relationship between increased

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temperatures and the risk of various types of crime and violence. Through this review, we seek to inform future research directions and policymakers with insights into the characteristics and potential magnitude of health effects arising from the interplay of temperature, crime, and violence.

Methods

Search Strategy

We conducted literature searches through Ovid MEDLINE (1 January 1946 to 6 November 2023) and Web of Science (1 January 1891 to 6 November 2023) databases for English-language papers. The specific search strategies are indicated in Table S1. A combination of terms related to crime or violence [e.g., homicide, burglary, intimate partner violence (IPV)] and increased temperature (e.g., extreme heat) were used for the literature search. See Table S1 for the full list of search terms. The reference lists of identified papers were examined for the studies published up through November 2023 and added to the list of potential studies.

This review was prospectively registered (PROSPERO CRD42023417295), and the systematic literature search was conducted with PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines.[31]

Inclusion and Exclusion Criteria

The studies included met the following inclusion criteria grouped according to the population–exposure–comparator–outcome (PECO) framework[32,33]:

- Population: human, population-based studies with no restriction on sex, age, or study location.
- Exposures: studies of short-term (daily) or long-term (monthly, yearly) temperature exposures, including maximum, mean, minimum, heat index, or extreme temperatures.
- Comparators: observational and analytical studies reporting the effect estimates [e.g., odds ratio (OR), relative risk (RR), percent change] by comparing the risk in different exposure levels (e.g., 75th percentile vs. 99th percentile, 1°C increase).
- Outcomes: studies reporting crime or violence, or both, such as robbery, gunshot, and sexual assault.
- Studies published in a peer-reviewed journal with full text available and written in English.

Studies with the following descriptions were excluded:

- Population: nonhuman studies (e.g., animal studies).
- Exposures: studies focused only on the seasonal effect of the outcome.
- Comparators: studies without direct comparative risk effect estimates.
- Outcomes: studies without assessment of human related crime or violence.
- Nonprimary studies (e.g., commentaries, books, or reviews) were excluded.

Study Selection and Data Extraction

The titles, abstracts, and full-text articles were independently reviewed by two investigators (i.e., dual-reviewed). Conflicts were resolved through discussion among the investigators. Investigators independently dual extracted the following data from each article at full-text screening: *a*) study information including the study location, study year, study design, statistical method, factors adjusted, mechanisms used to explain the relationship between the exposure and outcome, and the main findings; *b*) characteristics of the exposure used in the study, exposure method, and exposure as linear or nonlinear; and *c*) crime and/or violence outcomes considered, including the source of data on crime and/or violence, effect size [e.g., relative risk (RR)], uncertainty of the effect size [e.g., confidence interval (CI)], and risk increment [e.g., 1°C, interquartile range (IQR) increase]. All of the information was extracted directly from the publications, and there was no contact with the authors. Discrepancies were resolved through consensus after discussion with a third reviewer.

Study Quality Assessment

For each identified study, quality was assessed using risk of bias (ROB), which is an adapted tool of Office of Health Assessment and Translation (OHAT) Risk of Bias Rating Tool for Human and Animal Studies.[34] There are various methods to evaluate the risk of bias in observational studies, and the OHAT method is based on the Grading of Recommendations Assessment, Development and Evaluation (GRADE). The GRADE framework[35] is employed in experimental designs, particularly in randomized controlled trials, and penalizes observational study designs. However, studies on the association of temperature and crime and/or violence are observational in nature, not randomized controlled trials. OHAT is the revised version of the GRADE approach to include observational human studies. It could be independently applied to human data, particularly in the context of epidemiological studies.[36] In total, eight categories were assessed: Three key criteria (exposure assessment, outcome assessment, and confounding bias) and five other criteria (selection bias, attrition/exclusion bias, selective reporting bias, conflict of interest, and other sources of bias) were evaluated for each study. For each category, the risk was rated and graded (scale of 1 to 4 with higher score indicating higher risk of bias) based on the specific guidelines of the following design characteristics that were met [low risk of bias (score 1) if all conditions met, probably low risk of bias (score 2) if most of the conditions met, probably high risk of bias (score 3) if a few conditions met, and high risk of bias (score 4) if none of the conditions met]. Specifically, we considered the reliability of the exposure and outcome assessment (e.g., is the dataset from a reliable source) and the overall study design (e.g., did the study account for temporal trend, season, day of week, and other important confounders); selection bias (e.g., was the study population selected without bias and representative of the group); attrition/exclusion bias (e.g., did the study appropriately handle missing data); selective reporting bias (e.g., did the study report all of the study estimates); conflict of interest (e.g., what were the sources of funding); and other sources of bias. The specific details are shown in Table S2.

Statistical Analysis

Measures of the relationship between hot temperature and crime and/or violence from studies were combined using meta-analysis to obtain the summary estimates. We conducted a meta-analysis for each crime and/or violence category with five or more effect estimates.[33] The definition and the categorization of crime and violence are different by city/country and study. However, most studies grouped crime and violence into three broad categories: *a*) violent crime including aggravated assault, simple assault, robbery, murder, and homicide; *b*) property crime including burglary/trespassing, motor vehicle theft, and other types of theft; and *c*) sexual crime including rape, sexual assault, and intimate partner violence.[37–39] The specific details of the definition for each type of crime and/or violence differed by study location and the dataset used; however, when crime and violence was categorized into the three categories, the general characteristics and definition of crime and/or violence were similar. We reviewed all of the included studies with caution and extracted the outcomes with the most similarities among the studies: violent crime, property crime, assault, and homicide.

For the meta-analysis, we extracted the effect estimates from studies with *a*) the same type of crime or violent outcome, *b*) the same exposure (mean temperature), and *c*) effect estimates derived from a regression model adjusting for confounding variables. The point effect estimates were represented as the relative risk for a 10°C (18°F) increase, and the 95% confidence interval (CI) was derived. We converted Fahrenheit to Celsius temperature and calculated the estimated risk for 10°C (18°F) increase before converting into the relative risk. If the risk estimate compared two percentiles (e.g., 99th vs. 75th percentile) and the specific temperature value [e.g., 99th percentile as 30°C (86°F) and 75th percentile as 23°C (73.4°F)] is shown in the study, we calculated the estimated risk for a 10°C (18°F) increase accordingly. We considered studies examining temperature and crime and/or violence as a linear or nonlinear association. Studies reporting the effect estimates within a limited temperature range (e.g., crime or violence risk above a certain temperature) were excluded in the meta-analysis due to inability to compare between different temperature ranges.

The relative risks were combined using a profile likelihood random-effects model to account for variation among studies.[40] The statistical heterogeneity among studies was assessed using the I^2 statistic.[40] Studies not reporting a quantitative association between temperature and risk of crime or violence (e.g., beta coefficient, RR, and percent change in effect) were excluded from the meta-analysis.

Sensitivity analysis was conducted by excluding each study for each outcome to explore the robustness of the overall effect estimates for each temperature–violence and/or crime association. Forest plot and contour-enhanced funnel plots were generated to differentiate publication bias by examining the asymmetry of the funnel plot.[41] Also, the Egger's test of the intercept for statistical precision was conducted to assess publication bias,[42] where if there is no publication bias, the regression intercept is expected to be zero.

Analyses were performed in R studio (version 4.3.0). All significance testing was two-sided, and the results were considered statistically significant if $p < 0.05$.

Results

A total of 14,741 unique published papers were screened after removing the duplicates (6,724 papers from Ovid MEDLINE, 11,254 papers from Web of Science, and five additional records found by the reference lists). After we excluded the duplicates and then screened the titles and abstracts, 147 papers qualified for full-text screening (Figure S1). Excluded studies did not address crime or violence as the outcome, did not consider temperature in the study, or did not assess the relationship between temperature and crime and/or violence. In total, 83 studies were eligible for inclusion in our review and 25 studies were eligible for meta-analysis.

The basic characteristics of the included 83 studies are described in Table 1. Studies were mostly conducted in North America ($n = 39$, 46%), Asia ($n = 15$, 18%), and Africa ($n = 10$, 12%). Included studies mostly had study timeframes of 5 to 9 years ($n = 27$, 32%), and about 48% of the studies ($n = 40$) focused on a study period after 2010. Most of the studies explored a single city ($n = 41$, 49%) or considered multiple cities from one country ($n = 23$, 27%), and more than half of the study was based on the daily temporal scale ($n = 50$, 60%). Approximately 53% of the studies ($n = 44$) considered temperature as only the linear function when exploring the temperature–crime and/or violence relationship. More than half of the studies focused on violent crime ($n = 64$, 55%), followed by property crime ($n = 27$, 23%) and sexual crime ($n = 14$, 12%).

The geographical location and the specific crime and/or violence type are shown in Table 2. If the study had more than one study result (e.g., separate results from violent crime and property crime in one study), those findings were considered separately. Most of the study locations focused only on violent crimes [60% (6 out of 10 studies) of studies in Africa, 20% (3/15) of studies in Asia, 43% (3/7) of studies in Europe, 46% (18/39) of studies in North America, and 57% (4/7) of studies in Oceania], and most focused on a single city [30% (3/10) of studies in Africa, 46% (7/15) of studies in Asia, 57% (4/7) of studies in Europe, 56% (22/39) of studies in North America, and 57% (4/7) of studies in Oceania]. The detailed summary results for all 83 studies are summarized in Table S3. The majority of the included studies focused on all seasons throughout the year [96.3% (80/83)]. The spatial and temporal resolution of the exposure varied from hourly to annual. Most of the studies assessed daily exposures [59% (49/83)]. Annual temperature exposure was the most used exposure timeframe for studies with multiple cities or multiple countries. Modeled or satellite temperature exposure was used in 26.5% (22/83) of studies, whereas 73.5% (61/83) used monitoring stations (Table S3).

Table 1. Basic characteristics of the included studies on temperature and crime or violence ($n = 83$).

Study characteristics	*n* (%)
Temperature linearity	
Linear	44 (53.01)
Nonlinear	25 (30.12)
Both (linear and nonlinear)	5 (6.02)
Not mentioned	9 (10.84)
Crime and/or violence type[a]	
Violent crime	64 (55.17)
Property crime	27 (23.28)
Sexual crime	14 (12.06)
Other[b]	11 (9.48)
Length of study	
<5 years	14 (16.87)
5–9 years	27 (32.53)
10–14 years	14 (16.87)
15–19 years	9 (10.84)
≥20 years	17 (20.48)
Else[c]	2 (2.41)
Median year of the study period	
<1990	7 (8.43)
1990–1999	12 (14.46)
2000–2009	22 (26.51)
≥2010	40 (48.19)
Else[c]	2 (2.41)
Spatial scale	
Multicity from one country	23 (27.71)
Multicity from multicountry	12 (14.46)
One city	41 (49.39)
One country	7 (6.02)
Temporal scale	
Daily	50 (60.24)
Weekly	1 (1.20)
Monthly	17 (20.48)
Quarterly	1 (1.20)
Annual	14 (16.87)
Study continent	
Africa	10 (12.05)
Asia	15 (18.07)
Europe	7 (8.43)
North America	39 (46.98)
Oceania	7 (8.43)
South America	1 (1.20)
Other[d]	4 (4.82)

[a]If a single study addressed multiple types of crime and/or violence, each was counted separately.
[b]Other crime and/or violence types (e.g., civil war, angry tweets, political violence).
[c]E.g., different study periods by city/country or different temporal scales (monthly, daily).
[d]Other study continents where there are multiple countries spanning multiple continents analyzed for the study.

Table 2. The geographical location and specific crime and/or violence used as outcomes for the included studies ($n = 83$).

Study continent	Number of studies	Total crime	Violent crime	Property crime	Sexual crime	Other[a]
Africa	10	1	8	2	2	3
Multicity, multicountry	5	0	3	0	0	2
Single country	1	0	1	0	0	0
Multicity, single country	1	0	1	0	0	0
Single city	3	1	3	2	2	1
Asia	15	2	12	8	3	4
Multicity, multicountry	1	0	1	0	0	0
One country	2	1	2	2	0	0
Multicity, single country	5	0	3	3	2	3
Single city	7	1	6	3	1	1
Europe	7	0	4	2	3	0
Multicity, multicountry	1	0	1	0	0	0
Single country	1	0	1	0	0	0
Multicity, single country	1	0	0	1	1	0
Single city	4	0	2	1	2	0
North America	39	3	31	16	6	7
Multicity, multicountry	1	0	1	0	0	0
Single country	2	0	1	0	0	2
Multicity, single country	14	0	11	8	4	3
Single city	22	3	18	8	2	2
Oceania	7	1	6	3	0	2
Single country	1	1	1	1	0	0
Multicity, single country	2	0	2	1	0	0
Single city	4	0	3	1	0	2
South America	1	0	1	0	0	0
One city	1	0	1	0	0	0
Other[b]	4	0	3	0	0	1

[a]Other crime and/or violence types (e.g., civil war, angry tweets, political violence).
[b]Other study continents where there are multiple countries spanning multiple continents analyzed for the study.

Most of the study results indicated a positive association between temperature and crime and/or violence (Table S4). Table S4 describes the included articles, divided into different types of crime and/or violence and summarizes the studies' findings for temperature–crime and/or violence associations. Most studies observed a positive relationship between violence/crime and temperature, and most of the positive associations were statistically significant. Most studies considered mean temperature for the exposure index, although other metrics such as maximum temperature were also examined. The most commonly studied type of crime and/or violence was homicide, for which 12 estimates (from eight studies) out of 19 estimates (from 12 studies) identified statistically significant positive results.[43–50] Eight studies investigated property crime in general, with different groupings of the various property crimes by study.[19,28,29,51–55] Burglary and rape were the most investigated crimes in the categories of property crime and sexual crime, respectively.

Among the included studies, there were a total of 188 study estimate results, and about 70% (132/188) of the quantitative study estimates indicated a positive relationship between temperature and crime with p-values of <0.05 (Table S5). Approximately 50% (93/188) of the included estimates were from North America, and about 63% (59/93) of those from North America showed a positive association between temperature and crime (p-value <0.05). Forty-nine estimates were from Asia, and more than 80% (40/49) showed positive results (p-value <0.05). Estimates from Africa (20/188) mostly focused on violent crimes (7/20) or conflicts (5/20).

The ROB assessment for the included studies is shown in Table S6 and Table S7. The heat map is shown in Table S6 for eight different categories (key criteria: exposure assessment, outcome assessment, and confounding bias; other criteria: selection bias, attrition/exclusion bias, selective reporting bias, conflict of interest, and other source of bias), mentioned in Table S2. ROB was scored with a scale of 1 to 4, with higher scores indicating higher risk of bias. The specific reasons and criteria for the grading are indicated in Table S7. Some studies had high risk of bias for exposure and outcome assessment categories. Various types of crime and/or violence was examined by the included studies. Some studies examined crime and/or violence as a grouped outcome (e.g., violent crime, property crime, sexual crime), and other studies examined a more specific type of crime and/or violence (e.g., homicide, burglary, intimate partner violence). Due to different exposure/outcome assessments, we grouped studies by the timeframe of the exposure: short-term (daily or weekly scale) exposure on an acute outcome (lag day 0) and long-term (monthly or yearly scale exposure) and an incident outcome.

Association between Crime and/or Violence and Temperature

There were eight studies focusing on the association between temperature and total crime in general.[16,29,52,54–58] The meta-analysis for the eight studies was not conducted due to variations in the total crime definitions, aggregating the violent crime and/or property crime as a whole. While looking at the individual study results, all of the study results indicated a positive relationship between total crime (aggregating various crimes in one category) and temperature. One study in Vietnam estimated a 10.1% (95% CI: 3.7, 16.8) increase in all crime types for a 5°C (9°F) increase in daily mean temperature from 2013 to 2019.[52] A study in Malaysia suggested a positive association between long-term temperature exposure and crime, and this was the only study looking at the long-term temperature exposure.[58] A 1°C (1.8°F) increase in monthly maximum temperature was associated with an additional 22.811 crime incidents per million people in Virginia, USA.[55]

The association between short-term temperature exposure (e.g., daily or monthly) and violent crime was assessed by 22 studies, and eight studies were included in the meta-analysis: five studies from the US,[9,45,51,59,60] one study from Vietnam,[52] one study from South Africa,[29] and one study from Taiwan.[53] The meta-analysis using the eight studies indicated that a 10°C (18°F) increase in short-term mean temperature was associated with violent crime risk [1.09 (95% CI: 1.07, 1.11), heterogeneity 30.93% I^2] compared to no

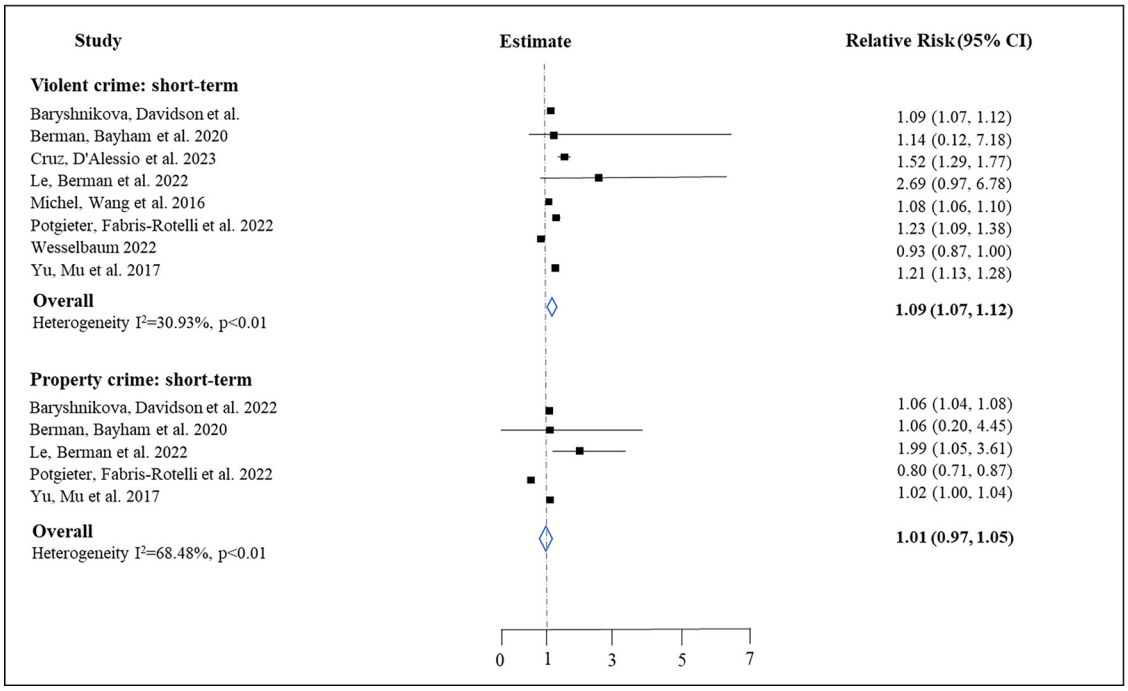

Figure 1. Meta-analysis of studies ($n = 83$) on the association between mean temperature (short-term: daily or weekly scale exposure) and violent and property crime. Crime or violence risk for 10°C (18°F) increase.

temperature increase (Figure 1). The pooled relative risk was robust to sensitivity analysis by excluding each effect estimate in turn (Table S8). The funnel plot (Figure S2A) and Egger's regression test ($p = 0.3279$) indicated statistically insignificant asymmetry. Many studies suggested a long-term relationship between temperature and violent crime. In St. Louis, a 0.56°C (1°F) increase in monthly temperature was associated with a 0.689% increase in violent crime[57]; and in Virginia, a 1°C (1.8°F) increase in average monthly maximum temperature was associated with an additional 1.146 violent crime incidents per million people.[55]

There were a total of 16 studies examining property crime, and five studies were included in the meta-analysis assessing the relationship between short-term temperature exposure (e.g., daily or monthly) and property crime.[28,29,51–53] The meta-analysis results using the five studies suggested that a 10°C (18°F) increase in short-term temperature exposure was associated with the risk of 1.01 (0.97, 1.05) for property crime (e.g., daily or monthly) (Figure 1). Statistically insignificant asymmetry was found by funnel plot (Figure S2B) and Egger's regression test ($p = 0.6772$). In the long-term temperature exposure (e.g., annual) and property crime relationship, an additional 16.235 per million events were associated with a 1°C (1.8°F) increase in monthly maximum temperature in Virginia, USA,[55] and 0.56°C (1°F) increase was associated with a 0.309% increase in property crime in St. Louis, Missouri.[57]

Three studies examined the association between sexual crime and temperature.[18,20,29] All of these studies focused on short-term temperature exposure, and most of the study results had a p-value of <0.05. One study found that a 1°C (1.8°F) increase in daily maximum temperature was associated with a 3.4% (95% CI: 2.8, 9.7) increase in sexual assault.[18]

Association between Specific Crime and/or Violence and Temperature

There were 21 studies examining the relationship between short-term temperature exposure and assault, of which eight studies were analyzed for meta-analysis assessing the short-term temperature exposure and assault.[12,44,53,60–64] The meta-analysis results including the eight studies suggest that a 10°C (18°F) increase in temperature was associated with a relative risk of 1.23 (0.91, 1.63) in assault (Figure 2). The pooled risk for the sensitivity analysis was robust (Table S8). The funnel plot is shown in Figure S3A and the Egger's regression test ($p = 0.2445$) exhibited statistically insignificant asymmetry. Eight studies focused on the association between long-term temperature exposure and assault.[7,10,55,57,65–68] When exploring the individual study results for the eight studies, a 1°C (1.8°F) increase in monthly maximum temperature was associated with an additional 1.257 and 5.43 events per million people in the rates of aggravated assault and simple assault, respectively, in Virginia.[55] Another study in the US found a 1°C (1.8°F) increase above the expected monthly temperature was associated with a 1.42% increase in monthly assault levels.[68] However, there are conflicting results from one study in the US, which found that for temperatures below 9.4°C (49°F), the assaults increased after temperatures decreased.[7] Different cities in British Columbia have examined both positive and negative associations between temperature and assault.[67]

A total of 20 studies assessed the relationship between homicide and temperature (10 studies for short-term temperature exposure and 10 studies for long-term temperature exposure).[9,10,43–50,57,68–73] For the meta-analysis to examine the effect of short-term temperature exposure (e.g., daily or monthly) and homicide, seven out of 10 studies were included.[9,43–47,49] Among the 10 studies examining long-term temperature exposure (e.g., annual) and homicide, five studies were included in the meta-analysis for the association of long-term temperature exposure and homicide.[10,48,50,72,73] We extracted seven effect estimates from the five studies; if a study included an effect estimate from more than one city or location or if the study results indicated the total effect, we used the aggregated effect for the meta-analysis. For the meta-analysis results, a 10°C (18°F) temperature increase was associated with an increased risk of homicide [1.12 (95% CI: 1.02, 1.22) and 1.34 (95% CI: 0.90, 1.68)

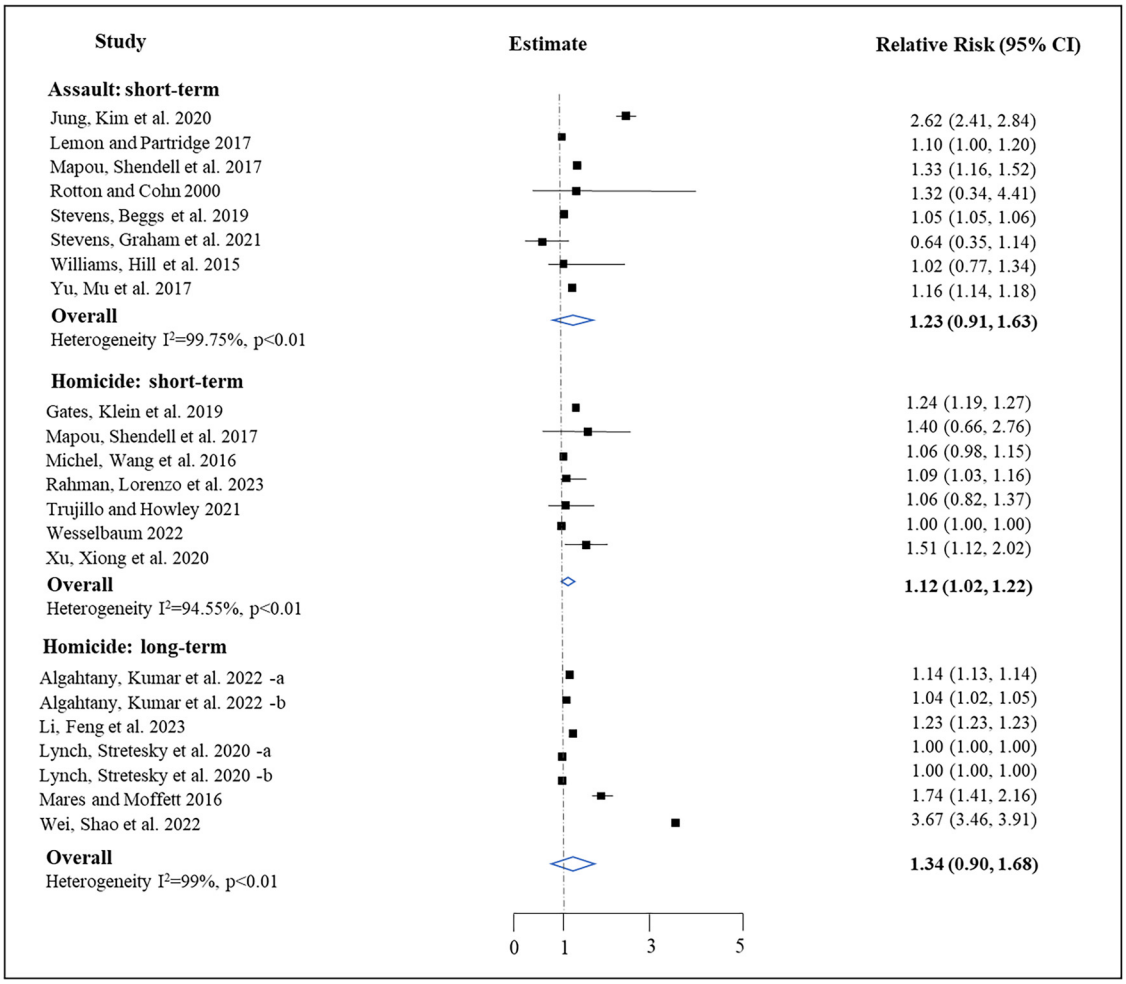

Figure 2. Meta-analysis of studies ($n = 83$) on the association between mean temperature (short-term: daily or weekly scale exposure and long-term: monthly or yearly scale exposure) and assault and homicide. Crime or violence risk for 10°C (18°F) increase.

for the short-term and long-term temperature exposure, respectively] (Figure 2). The robustness of the meta-analysis is shown in Table S8, which was similar for both short-term (ranging from 1.06 to 1.15) and long-term (ranging from 1.33 to 1.47) temperature exposure for the homicide outcome. There was a statistically insignificant asymmetry for Egger's regression test ($p = 0.163$ and $p = 0.1634$ for short-term and long-term, respectively), and funnel plots are shown in Figure S3B and Figure S3C.

Twenty-seven studies focused on other specific violent crimes including armed violence,[45,74–77] murder,[7–9,55,66] and robbery.[7,11,13–15,17,20,44,53,55,57,66–68,70,71,78–81] Most of the study results showed a positive relationship between temperature and these other violent crimes. Specifically, five studies explored the relationship between temperature and armed violence. The temperature-attributable risk of shootings was 6.85% (95% CI: 6.09, 7.46) for 100 US cities.[75] Studies showed a suggestive positive association between temperature and murder; in Virginia, a 1°C (1.8°F) increase in monthly maximum temperature was associated with an additional 0.027 events per million people.[55] There were conflicting study results for the relationship between temperature and robbery. There was a significant positive impact of temperature on robbery counts, and in Philadelphia,[13] an IQR increase in temperature was associated with a 12% (95% CI: −21, 59) increased risk of robbery in four US cities (Chicago, Houston, Philadelphia, and Seattle).[44] However, other studies found that an increase in monthly temperature was associated with reduced robbery,[55] and negatively associated below a temperature of 15°C (59°F).[7]

There were studies focusing on burglary, vehicle theft, theft, larceny, and arson for other property crimes. Fourteen studies focused on the association between temperature and burglary were included in this study.[7,15,17,44,53,55,57,66,68,70,71,79–81] One study in Virginia found that a 1°C (1.8°F) increase in monthly maximum temperature was associated with lower risk of robbery by 0.358 events per million people.[55] The maximum daily temperature and burglary were negatively associated with temperatures below 9.4°C (49°F); however, they were positively associated with temperatures above 9.4°C (49°F). A study in the US found that each degree Celsius increase above expected temperature was associated with a 0.73% increase in robbery.[68]

There were 10 studies on vehicle theft[7,16,44,53,55,57,66–68,70] with varying study results. Some studies found a positive relationship between temperature and vehicle theft; a 1°C (1.8°F) increase in monthly maximum temperature was associated with an additional 1.425 vehicle thefts per million people[55] and a 1°C increase above the mean temperature was associated with a 0.59% increase in motor vehicle theft.[68] A study conducted in four US cities indicated a negative association, a one IQR increase in temperature [18.6°C (33.48°F)] was associated with 0.26 (95% CI: 0.17, 0.39) times the risk of vehicle theft compared to no increase in temperature.[44] Eight studies on theft showed a mostly positive relationship[10,15,17,44,62,79,81,82]; study results

indicate that for every 1°C (1.8°F) increase in temperature, there were an estimated 23 more incidents of theft per month[62] and a risk ratio of 1.58 (95% CI: 1.17, 2.14) for every IQR increase in temperature [18.6°C (33.48°F)].[44] Other specific property crimes such as larceny[7,55,57,68,70] and arson[66,72,83] also were positively associated with temperature.

Rape was the most frequently studied sexual crime,[7,8,11,53,55,68,70–72] followed by intimate partner violence (IPV),[19,84,85] sexual assault,[10,66] and sexual offenses.[79] Most of the studies indicated a positive relationship between other sexual crimes and temperature. A 1°C (1.8°F) average monthly maximum temperature increase is expected to increase the number of rape incidents by 0.281 per million people,[55] with positive effect above a temperature of 21.1°C (70°F),[7] and a 1.5% increase in rape for each 1°C increase above the mean temperature level.[68] IPV prevalence was associated with a 4.49% (95% CI: 4.1, 4.78) increase for a 1°C (1.8°F) increase in annual mean temperature in South Asian countries.[85]

Other crimes and/or violence were also explored in the included studies: abduction,[66] criminal behavior led by alcohol abuse,[10] assault deaths,[86] break and enter,[16,67,82] conflict,[87–93] criminal arrest,[94] criminal damage,[79,81] domestic disputes,[82] domestic violence,[19,95,96] drug,[10] fraud,[62] interpersonal violence,[46] manslaughter,[7] minimal violent robbery (MVR),[11,71] mischief,[16] nonviolent crime,[52] police calls or fire calls,[97,98] political violence,[99] theft from vehicle,[16] angry tweet with violent behavior implied messages,[4,64] urban crime,[5] and violent mortality.[100]

Discussion

Based on our analysis of the 83 studies in this systematic review and meta-analysis, we have seen various association between temperature and different types of crime and violence, where most of the relationships have shown positive associations. Based on the meta-analysis results, increased temperature had a significantly positive relationship with violent crime, assault, and homicide across different study regions, time periods, and temperature ranges.

The World Health Assembly announced violence as a major public health issue in 1996.[101] In 2002, the World Health Organization (WHO) released the "World Report on Violence and Health," analyzing various types of violence and how they differ by cultural, social, and economic contexts.[102] Public health approaches to violence often focus on prevention by addressing potential factors that influence the likelihood of violence. Attention to violence prevention in the public health era has increased since the 1970s. The number of publications on violence increased by 550% comparing the 1970s to 1990s.[101] Recognizing violence as a health problem is based on the understanding that violent behavior arises from behavioral, biological, environmental, and social stressors.[103] Every interaction within the health care system is an opportunity to prevent violence and implement strategies to reduce and eliminate violence. Developing a public health model including the potential risk and protective factors (e.g., influence of environmental factors) affecting crime or violence among the individual or a certain population group is crucial. Currently, many countries focus on the immediate action after the crime or violence occurs,[104] whereas it needs to be accompanied with the primary prevention of crime or violence before it occurs. To fully understand the effect of crime or violence, various individual (e.g., age, sex), socioeconomic (e.g., income, cultural factors), and environmental (e.g., temperature, greenspace) factors could be the point for intervention. Incorporating all of these factors could help provide valuable guidance in reducing crime or violence.

The current study results could be explained through multiple theories. Within the same country, the association between temperature and crime and/or violence differed by city. Positive associations were observed for maximum daily temperature and frequency of violent crime occurring outdoors in Cleveland, Ohio,[59] as well as a positive relationship between daily maximum temperature and crime rates in Los Angeles, California.[19] However, in New York there was a negative relationship between mean hourly temperature and violent crime.[9] Different socioeconomic status and environmental settings may influence people's activity, prompting them to engage in outdoor activities or stay indoors. The study results shown in different regions could be related to different climate zones. Most of the study results for locations in Asia showed a positive association between temperature and crime or violence, which was not the case for most studies of other continents. The Asia study locations examined were Saudi Arabia,[10] Taiwan,[53] Vietnam,[52] Malaysia,[105] Tangshan,[71] and Beijing[14] from China, which are part of the tropical, subtropical, and humid climate zones. Studies from North America included cities in Canada[16,67,82,83] and the US,[4,5,8,9,15,17,19,28,44,45,47,49,51,55,57,59,60,68,70,72,74,75,77,80,81,97,98,106–109] which are mostly in temperate climate zones with only a few cities in humid subtropical climate zones (e.g., Dallas, Los Angeles). When examining the individual studies, the regions in tropical and humid climate zones (e.g., Saudi Arabia, Taiwan) have reported mostly positive associations between daily or monthly or annual mean temperature and crime, violence, or both (e.g., criminal arrest, homicide, assault, robbery, burglary), whereas studies focusing on countries from the temperate climate zones (e.g., some cities in the US and Canada) have shown positive, negative, or both relationships between daily or monthly or annual mean or maximum temperature and crime, violence, or both. These differences in estimated associations may partially be explained by the heat–aggression theory.[24] Furthermore, the comparatively low risk of property crime compared to other crimes could partially be explained by the economic theory of rational criminal behavior.[110] Property crimes may be less susceptible to impulse control and aggression compared to other crimes. However, further investigation is needed to explain the association between hot temperatures and specific crimes. Violence exists everywhere and affects human health directly and indirectly.[104,111] Our study results yield to several different explorations of the temperature and crime and/or violence relationship. Exposure to violence could vary by different life spans, different racial/ethnic characteristics, sex, and occupation. The US homicide rate is higher in black adults than in white adults,[112] low-income neighborhoods have a higher occurrence of crime compared to high-income neighborhoods,[113] and all ages from children[114] to the elderly[115] are exposed to violence. Some of these sociodemographic patterns also relate to environmental exposures, such as higher temperatures in urban settings due to the urban heat island effect, which is a phenomenon when the heat is accumulated within the urban areas and result in higher urban temperature compared to the surrounding rural area temperature.[116] Additionally, climate adaptations, such as the use of indoor air conditioning and the availability of public spaces, can influence the levels of environmental exposure experienced by an individual. Exposure to violence is associated with an increased risk of mental health issues, detrimental health-related behaviors (alcohol abuse), chronic diseases (hypertension, cancer, and stroke), and premature mortality.[117] Investigating the complex interplay of factors that could contribute to an increase in crime and violence risk is critical for future studies.[104,118] Previous studies have found that higher country-level income inequality has shown to be related to higher rates of homicide and self-reported assaults.[118] Also, other studies reported individual factors, such as underage smoking and drinking to be associated with violent behaviors.[119,120] However, there are limited studies considering diverse socioeconomic and environmental factors at both the individual and country levels which could potentially affect the incidence of crime and violence. Furthermore, focusing on the incidence among different types of crime or violence would result in a better understanding of the

complex dynamics influencing crime and violence and avoid misinterpretation of the results. The nature of crime and violence, and therefore the association between temperature and crime and/or violence, could differ by community or country. Interpretation biases should be considered while interpretating temperature and crime associations, as further research is needed to better understand these relationships.[121]

Our analysis included studies that examined the association between hot temperatures and crime, violence, or both for different timeframes of exposure: daily, weekly, or long term. Our study results indicate that increases in daily mean or maximum temperature are associated with higher incidences of violent crimes, which accounts for the near immediate reactions or actions from the preceding day temperatures. Notably, a majority of studies did not account for the day of the event, overlooking potential lag effects of temperature, which warrants further investigation. Recent research also focused on environmental hazards influencing individual criminal behavior in the short term,[122,123] yet there are limited studies examining hourly effects of temperature on crime. The high hourly variability of crime within a day could be influenced by the immediate physical environment, such as temperature or air pollution. Also, the long-term effects of temperature on crime and/or violence were explored in some studies. An ordinary least squares regression model with annual or monthly crime counts was used in some studies focusing on long-term effects.

Due to the limited availability of data on long-term temperature–crime relationships, the conclusions remain unclear. However, our results indicate that long-term temperature exposures are associated with higher risks of crime compared to short-term temperature exposures. This could be explained by the short-term exposures, including parts of the long-term effects, which might result in a smaller effect size compared to the long-term effects.[124] In contrast, the long-term effect reflects cumulative effects that increase the effects of highly exposed subgroup populations, such as those with disadvantaged characteristics.[125] This finding aligns with mortality studies that found different risk effects for long-term and short-term temperature exposures.[124,126,127] Most of the research done currently primarily focuses on the effects of short-term temperature exposures, but our evidence suggests that this approach may cause bias in the associated risks. While short-term temperature exposures have traditionally been the primary measure for assessing human health, our study highlights the importance of also considering long-term exposures.

The pathways through which temperature influences crime may differ between short-term and long-term exposures, although such a determination is beyond the scope of this study and was not illuminated by the identified studies. Most existing studies focused on the short-term effects of temperature on crime. Short-term temperature exposure can directly impact population behavior (e.g., more time indoors) and influence physiological responses to temperature (e.g., intolerance).[128] Conversely, there is limited evidence on how long-term temperature exposures affect crime. Regardless of the mechanism, the patterns of the association observed in this study and previous studies support the importance of long-term temperature exposure on human health. Recent reviews showed that long-term temperature exposure was associated with a wide range of adverse health outcomes.[126,129] To bridge the gap between short- and long-term temperature effects, future work should focus on comprehensive data collection, statistical methods analyzing the immediate and cumulative impacts, and various factors and mechanisms interacting with human health.

There are various factors influencing the temperature and crime and/or violence association. A study in Los Angeles, California, found higher rates of gun-related violent crimes and adverse health outcomes with a reduction in the use of outdoor park space.[130] Also, higher neighborhood crime rates were associated with increased odds of adverse pregnancy outcomes in Chicago.[131] Another study found that individuals exposed to gun violence had significantly higher levels of depression and suicidal ideation compared to those not exposed. The association between gun violence and depression was stronger among Latin persons and those of "other" races relative to white persons.[132]

Violence is not attributed to a single factor, but the causes are complex and occur at various levels. Violence prevention involves interaction between different sectors of society and organizations, and less is known about the potential impact of environmental conditions such as heat compared to other influences. The lack of largescale datasets regarding violence and crime hinders research, and many of the studies that we identified were based on single locations, although studies are needed across multiple locations as the weather conditions, populations, and socioeconomic and cultural systems impacting crime may differ.[101,104] Further, the definitions and categorizations of various types of violence differed across countries and cities, which challenges comparison of results.[101] Future studies regarding the prevention of violence and its contribution to health are needed.

This study had several strengths; this work included a comprehensive literature search with focused eligibility criteria, inclusion of studies from around the world, assessment of individual study quality and overall strength of evidence for each outcome, and use of adjusted estimates from individual studies to estimate overall associations. Also, the contour-enhanced funnel plot analysis suggests that the review was not subjected to publication bias in which studies with negative or null results were not included because they were not published. While the true impact of publication bias cannot be fully known, the identified studies include results that were not statistically significant with null or negative results.

This study has several limitations. Firstly, only articles in English were included, which might have excluded some studies. Second, several other factors could affect the temperature–crime relationship, such as race/ethnicity, socioeconomic factors, gender, and age, although fewer studies have been published on these relationships. Third, this review was limited in scope in terms of the types of violence and/or crime considered, and the meta-analysis included only assault from the various crime and violence outcomes. This was due to the different definitions of outcome, methods of exposure assessment, and risk estimates presented which may cause biased results.[133] The studies used different definitions and data sources for various crimes and violence, with some studies using government or police department data sources with a variety of formats and variables. Studies with insufficient information in calculating the risk for a 10°C (18°F) increase, different temperature metrics, or different assessment for exposure or outcome (e.g., daily, weekly, annually) could not be combined in meta-analysis. Considering these differences, the study results used in the meta-analysis were selected for the most commonly examined crime and/or violence categories and examined separately for short-term and long-term exposures. Violent crime, property crime, assault, and homicide are some of the most common crimes in the US and worldwide.[134] Specifically, for short-term exposure to temperature and crime, we assessed violent and/or property crime in general; most of the studies were from cities in the US and used the same definitions for crime and from other countries (Africa, Taiwan, and Vietnam) that applied the same category for defining violent and property crimes. For these studies, the temperature exposure was assessed through monitoring stations or modeled dataset on a daily scale. For long-term temperature and homicide, most of the studies were global with a definition of homicide from the World Bank,[135] and some studies were from Asia,

North America, and Europe using the annual exposure assessment. Different statistical methods were applied in the included studies; however, most used linear regression models and considered temperature as a linear function. Results were combined based on the change in the risk of crime and/or violence per 10°C (1.8°F) increase. Most of the studies considered temperature and crime and/or violence as a linear relationship; however, recent studies have shown nonlinear relationships. Some studies showed crime risk decreases in extreme heat and higher crime risks in moderate–high temperature levels.[52,136] Despite the similarities between studies combined in the meta-analysis, some heterogeneity could exist in the methods, outcomes, study populations, study locations, and the association between temperature and crime and/or violence. Location-specific studies for a range of different populations, locations, and types of exposures are needed. While we note that observed associations are statistically significant, such findings should be interpreted with caution given the known challenges of such assessments. Moreover, the study results do not suggest that violence is an extension of heat, resembling environmental determinism, but rather should be interpreted within the broader socioeconomic and demographic contexts.[137]

Conclusions

There exists heterogeneity in the results by different crime and violence types; however, the evidence leans toward a positive relationship between short-term increased temperature exposure and the crime or violence risk. Overall, increased short-term temperature exposure was significantly associated with increased violent crime, whereas the evidence was weak for property crimes. It is important to note several research gaps, notably the considerable disparities in the definition of different crime and violence categories across countries and cities, as well as variations in modeling approaches and study designs observed in prior studies. To advance our understanding of the influence of temperature on crime and violence in the context of climate change, more extensive research, conducted on geographically and temporally larger scales and encompassing multiple crime and violence types, is needed.

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References

1. United Nations. 2020. *A New Era of Conflict and Violence*. https://www.un.org/en/un75/new-era-conflict-and-violence#:~:text=Globally%2C%20the%20absolute%20number%20of,criminal%2C%20and%20international%20terrorist%20groups [accessed 19 September 2024].
2. Elliott D. 1997. Environmental factors contribute to juvenile crime and violence. In: *Juvenile Crime: Opposing Viewpoints*. Sadler AE, ed. New York, NY: Greenhaven Publishing, 83–89.
3. Ministry of Justice. 2009. Social risk factors for involvement in crime. https://www.beehive.govt.nz/sites/default/files/Social%20Risk%20Factors.pdf [accessed 19 September 2024].
4. Stechemesser A, Levermann A, Wenz L. 2022. Temperature impacts on hate speech online: evidence from 4 billion geolocated tweets from the USA. Lancet Planet Health 6(9):e714–e725, PMID: 36087602, https://doi.org/10.1016/S2542-5196(22)00173-5.
5. Hou K, Zhang L, Xu X, Yang F, Chen B, Hu W, et al. 2023. High ambient temperatures are associated with urban crime risk in Chicago. Sci Total Environ 856(pt 1):158846, PMID: 36122719, https://doi.org/10.1016/j.scitotenv.2022.158846.
6. Tiihonen J, Halonen P, Tiihonen L, Kautiainen H, Storvik M, Callaway J. 2017. The association of ambient temperature and violent crime. Sci Rep 7(1):6543, PMID: 28754972, https://doi.org/10.1038/s41598-017-06720-z.
7. Ranson M. 2014. Crime, weather, and climate change. J Environ Econ Manage 67(3):274–302, https://doi.org/10.1016/j.jeem.2013.11.008.
8. Gamble JL, Hess JJ. 2012. Temperature and violent crime in Dallas, Texas: relationships and implications of climate change. West J Emerg Med 13(3):239–246, PMID: 22900121, https://doi.org/10.5811/westjem.2012.3.11746.
9. Wesselbaum D. 2022. Violent crimes and homicide in New York city: the role of weather and pollution. J Forensic Leg Med 91:102430, PMID: 36099858, https://doi.org/10.1016/j.jflm.2022.102430.
10. Algahtany M, Kumar L, Barclay E. 2022. A tested method for assessing and predicting weather-crime associations. Environ Sci Pollut Res Int 29(49):75013–75030, PMID: 35641751, https://doi.org/10.1007/s11356-022-20440-6.
11. Shen B, Hu X, Wu H. 2020. Impacts of climate variations on crime rates in Beijing, China. Sci Total Environ 725:138190, PMID: 32464740, https://doi.org/10.1016/j.scitotenv.2020.138190.
12. Jung Y, Kim D, Piquero AR. 2020. Spatiotemporal association between temperature and assaults: a generalized linear mixed-model approach. Crime Delinquency 66(2):277–302, https://doi.org/10.1177/0011128719834555.
13. Sorg ET, Taylor RB. 2011. Community-level impacts of temperature on urban street robbery. J Criminal Justice 39(6):463–470, https://doi.org/10.1016/j.jcrimjus.2011.08.004.
14. Peng C, Xueming S, Hongyong Y, Dengsheng L. 2011. Assessing temporal and weather influences on property crime in Beijing, China. Crime Law Soc Change 55(1):1–13, https://doi.org/10.1007/s10611-010-9264-3.
15. Lynch MJ, Stretesky PB, Long MA, Barrett KL. 2022. The climate change-temperature-crime hypothesis: evidence from a sample of 15 large US cities, 2002 to 2015. Int J Offender Ther Comp Criminol 66(4):430–450, PMID: 33153330, https://doi.org/10.1177/0306624X20969934.
16. Linning SJ, Andresen MA, Brantingham PJ. 2017. Crime seasonality: examining the temporal fluctuations of property crime in cities with varying climates. Int J Offender Ther Comp Criminol 61(16):1866–1891, PMID: 26987973, https://doi.org/10.1177/0306624X16632259.
17. Cohn EG, Rotton J. 2000. Weather, seasonal trends and property crimes in Minneapolis, 1987–1988. A moderator-variable time-series analysis of routine activities. J Environ Psych 20(3):257–272, https://doi.org/10.1006/jevp.1999.0157.
18. McLean I. 2007. Climatic effects on incidence of sexual assault. J Forensic Leg Med 14(1):16–19, PMID: 16442330, https://doi.org/10.1016/j.jcfm.2005.12.001.
19. Heilmann K, Kahn ME, Tang CK. 2021. The urban crime and heat gradient in high and low poverty areas. J Public Econ 197:104408, https://doi.org/10.1016/j.jpubeco.2021.104408.
20. Schutte FH, Breetzke GD. 2018. The influence of extreme weather conditions on the magnitude and spatial distribution of crime in Tshwane (2001–2006). South African Geographical J 100(3):364–377, https://doi.org/10.1080/03736245.2018.1498384.
21. Hohl BC, Wiley S, Wiebe DJ, Culyba AJ, Drake R, Branas CC. 2017. Association of drug and alcohol use with adolescent firearm homicide at individual, family, and neighborhood levels. JAMA Intern Med 177(3):317–324, PMID: 28055064, https://doi.org/10.1001/jamainternmed.2016.8180.
22. DeLisi M, Alcala J, Kusow A, Hochstetler A, Heirigs MH, Caudill JW, et al. 2017. Adverse childhood experiences, commitment offense, and race/ethnicity: are the effects crime-, race-, and ethnicity-specific? Int J Environ Res Public Health 14(3):331, PMID: 28327508, https://doi.org/10.3390/ijerph14030331.
23. Glaeser EL, Sacerdote B, Scheinkman JA. 1996. Crime and social interactions. Q J Econ 111(2):507–548, https://doi.org/10.2307/2946686.
24. Anderson CA. 1989. Temperature and aggression: ubiquitous effects of heat on occurrence of human violence. Psychol Bull 106(1):74–96, PMID: 2667010, https://doi.org/10.1037/0033-2909.106.1.74.
25. Jacob B, Lefgren L, Moretti E. 2007. The dynamics of criminal behavior: evidence from weather shocks. J Human Resources 42(3):489–527, https://doi.org/10.3368/jhr.XLII.3.489.

26. Doleac JL, Sanders NJ. 2015. Under the cover of darkness: how ambient light influences criminal activity. Rev Econ Stat 97(5):1093–1103, https://doi.org/10.1162/REST_a_00547.
27. Hsiang SM, Burke M, Miguel E. 2013. Quantifying the influence of climate on human conflict. Science 341(6151):1235367, PMID: 24031020, https://doi.org/10.1126/science.1235367.
28. Baryshnikova N, Davidson S, Wesselbaum D. 2022. Do you feel the heat around the corner? The effect of weather on crime. Empir Econ 63(1):179–199, https://doi.org/10.1007/s00181-021-02130-3.
29. Potgieter A, Fabris-Rotelli IN, Breetzke G, Wright CY. 2022. The association between weather and crime in a township setting in South Africa. Int J Biometeorol 66(5):865–874, PMID: 35061073, https://doi.org/10.1007/s00484-022-02242-0.
30. Choi HM, Chen C, Son J-Y, Bell ML. 2021. Temperature-mortality relationship in North Carolina, USA: regional and urban-rural differences. Sci Total Environ 787:147672, PMID: 34000533, https://doi.org/10.1016/j.scitotenv.2021.147672.
31. Moher D, Shamseer L, Clarke M, Ghersi D, Liberati A, Petticrew M, et al. 2015. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. Syst Rev 4(1):1, PMID: 25554246, https://doi.org/10.1186/2046-4053-4-1.
32. Morgan RL, Whaley P, Thayer KA, Schünemann HJ. 2018. Identifying the PECO: a framework for formulating good questions to explore the association of environmental and other exposures with health outcomes. Environ Int 121(pt 1):1027–1031, PMID: 30166065, https://doi.org/10.1016/j.envint.2018.07.015.
33. Braithwaite I, Zhang S, Kirkbride JB, Osborn DP, Hayes JF. 2019. Air pollution (particulate matter) exposure and associations with depression, anxiety, bipolar, psychosis and suicide risk: a systematic review and meta-analysis. Environ Health Perspect 127(12):126002, PMID: 31850801, https://doi.org/10.1289/EHP4595.
34. National Toxicology Program. 2015. *OHAT Risk of Bias Rating Tool for Human and Animal Studies*. https://ntp.niehs.nih.gov/sites/default/files/ntp/ohat/pubs/riskofbiastool_508.pdf [accessed 14 September 2024].
35. Xie CX, Machado GC. 2021. Clinimetrics: grading of recommendations, assessment, development and evaluation (GRADE). J Physiother 67(1):66, PMID: 32859566, https://doi.org/10.1016/j.jphys.2020.07.003.
36. Boogaard H, Patton AP, Atkinson RW, Brook JR, Chang HH, Crouse DL, et al. 2022. Long-term exposure to traffic-related air pollution and selected health outcomes: a systematic review and meta-analysis. Environ Int 164:107262, PMID: 35569389, https://doi.org/10.1016/j.envint.2022.107262.
37. National Sexual Violence Resource Center. 2010. *Factsheet: What is Sexual Violence?* https://www.nsvrc.org/sites/default/files/Publications_NSVRC_Factsheet_What-is-sexual-violence_1.pdf [accessed 19 September 2024].
38. Federal Bureau of Investigation. 2010. *Violent Crime*. https://ucr.fbi.gov/crime-in-the-u.s/2010/crime-in-the-u.s.-2010/violent-crime [accessed 19 September 2024].
39. National Institute of Justice. 2024. *Property Crimes*. https://nij.ojp.gov/topics/crime/property-crimes [accessed 19 September 2024].
40. Hardy RJ, Thompson SG. 1996. A likelihood approach to meta-analysis with random effects. Stat Med 15(6):619–629, PMID: 8731004, https://doi.org/10.1002/(SICI)1097-0258(19960330)15:6<619::AID-SIM188>3.0.CO;2-A.
41. Light RJ, Pillemer DB. 1984. *Summing Up: The Science of Reviewing Research*. Cambridge, MA: Harvard University Press.
42. Egger M, Smith GD, Schneider M, Minder C. 1997. Bias in meta-analysis detected by a simple, graphical test. BMJ 315(7109):629–634, PMID: 9310563, https://doi.org/10.1136/bmj.315.7109.629.
43. Gates A, Klein M, Acquaotta F, Garland RM, Scovronick N. 2019. Short-term association between ambient temperature and homicide in South Africa: a case-crossover study. Environ Health 18(1):109, PMID: 31842901, https://doi.org/10.1186/s12940-019-0549-4.
44. Mapou AEM, Shendell D, Ohman-Strickland P, Madrigano J, Meng Q, Whytlaw J, et al. 2017. Environmental factors and fluctuations in daily crime rates. J Environ Health 80(5):8–22.
45. Michel SJ, Wang H, Selvarajah S, Canner JK, Murrill M, Chi A, et al. 2016. Investigating the relationship between weather and violence in Baltimore, Maryland, USA. Injury 47(1):272–276, PMID: 26233631, https://doi.org/10.1016/j.injury.2015.07.006.
46. Trujillo JC, Howley P. 2021. The effect of weather on crime in a torrid urban zone. Environ Behavior 53(1):69–90, https://doi.org/10.1177/0013916519878213.
47. Xu R, Xiong X, Abramson MJ, Li S, Guo Y. 2020. Ambient temperature and intentional homicide: a multi-city case-crossover study in the US. Environ Int 143:105992, PMID: 32738768, https://doi.org/10.1016/j.envint.2020.105992.
48. Li J, Feng C, Yang J. 2023. Climate attribution of interpersonal violence: international evidence. Environ Res 236(pt 2):116836, PMID: 37543128, https://doi.org/10.1016/j.envres.2023.116836.
49. Rahman MM, Lorenzo M, Ban-Weiss G, Hasan Z, Azzouz M, Eckel SP, et al. 2023. Ambient temperature and air pollution associations with suicide and homicide mortality in California: a statewide case-crossover study. Sci Total Environ 874:162462, PMID: 36858215, https://doi.org/10.1016/j.scitotenv.2023.162462.
50. Wei JC, Shao QW, Liu Y, Marinova D. 2022. Climate change and homicide: global analysis of the moderating role of information and communication technology. Weather Climate Soc 14(4):1025–1037, https://doi.org/10.1175/WCAS-D-22-0001.1.
51. Berman JD, Bayham J, Burkhardt J. 2020. Hot under the collar: a 14-year association between temperature and violent behavior across 436 U.S. counties. Environ Res 191:110181, PMID: 32971077, https://doi.org/10.1016/j.envres.2020.110181.
52. Le VTH, Berman JD, Tran QA, Wattenberg EV, Alexander BH. 2022. The effects of daily temperature on crime events in urban Hanoi, Vietnam using seven years of data (2013–2019). Int J Environ Res Public Health 19(21):013906, PMID: 36360786, https://doi.org/10.3390/ijerph192113906.
53. Yu C-H, Mu JE, Ding J, McCarl BA. 2017. Relationships between typhoons, climate and crime rates in Taiwan. Nat Hazards 89(2):871–897, https://doi.org/10.1007/s11069-017-2998-9.
54. Chambru C. 2020. Weather shocks, poverty and crime in 18th-century savoy. Explorations Economic History 78:101353, https://doi.org/10.1016/j.eeh.2020.101353.
55. Wu CYH, Lee HF, Liu H. 2020. Effect of temperature and precipitation change on crime in the metropolitan area in Virginia, USA. Asian Geographer 37(1):17–31, https://doi.org/10.1080/10225706.2019.1678046.
56. Churchill SA, Smyth R, Trinh TA. 2023. Crime, weather and climate change in Australia. Economic Record 99(324):84–107, https://doi.org/10.1111/1475-4932.12720.
57. Mares D. 2013. Climate change and crime: monthly temperature and precipitation anomalies and crime rates in St. Louis, MO 1990–2009. Crime Law Soc Change 59(2):185–208, https://doi.org/10.1007/s10611-013-9411-8.
58. Shah M. 2017. The effects of weather on crime rates in Malaysia. Int J Business Soc 18:263–270.
59. Cruz E, D'Alessio SJ, Stolzenberg L. 2023. The effect of maximum daily temperature on outdoor violence. Crime Delinquency 69(6–7):1161–1182, https://doi.org/10.1177/0011128720926119.
60. Rotton J, Cohn E. 2000. Violence is a curvilinear function of temperature in Dallas: a replication. J Pers Soc Psychol 78(6):1074–1081, PMID: 10870909, https://doi.org/10.1037//0022-3514.78.6.1074.
61. Lemon DJ, Partridge R, Pan-Dorset Cardiff Model team. 2017. Is weather related to the number of assaults seen at emergency departments? Injury 48(11):2438–2442, PMID: 28870621, https://doi.org/10.1016/j.injury.2017.08.038.
62. Stevens HR, Beggs PJ, Graham PL, Chang H-C. 2019. Hot and bothered? Associations between temperature and crime in Australia. Int J Biometeorol 63(6):747–762, PMID: 30830288, https://doi.org/10.1007/s00484-019-01689-y.
63. Williams MN, Hill SR, Spicer J. 2015. The relationship between temperature and assault in New Zealand. Climatic Change 132(4):559–573, https://doi.org/10.1007/s10584-015-1438-7.
64. Stevens H, Graham P, Beggs P, Hanigan I. 2021. In cold weather we bark, but in hot weather we bite: patterns in social media anger, aggressive behavior, and temperature. Environ Behavior 53(7):787–805.
65. Jung Y, Chun Y, Griffith DA. 2020. Temperature and assault in an urban environment: an empirical study in the city of Seoul, South Korea. Appl Geography 124:102340, https://doi.org/10.1016/j.apgeog.2020.102340.
66. Takahashi RYO. 2017. Climate, crime, and suicide: empirical evidence from Japan. Clim Change Econ 8(1):1750003, https://doi.org/10.1142/S2010007817500038.
67. Linning SJ, Andresen MA, Ghaseminejad AH, Brantingham PJ. 2017. Crime seasonality across multiple jurisdictions in British Columbia, Canada. Can J Criminology Criminal Justice 59(2):251–280, https://doi.org/10.3138/cjccj.2015.E31.
68. Mares DM, Moffett KW. 2019. Climate change and crime revisited: an exploration of monthly temperature anomalies and UCR crime data. Environ Behavior 51(5):502–529, https://doi.org/10.1177/0013916518781197.
69. Talaei A, Hedjazi A, Rezaei Ardani A, Fayyazi Bordbar MR, Talaei A. 2014. The relationship between meteorological conditions and homicide, suicide, rage, and psychiatric hospitalization. J Forensic Sci 59(5):1397–1402, PMID: 24635192, https://doi.org/10.1111/1556-4029.12471.
70. DeFronzo J. 1984. Climate and crime: tests of an FBI assumption. Environ Behavior 16(2):185–210, https://doi.org/10.1177/0013916584162003.
71. Hu X, Wu J, Chen P, Sun T, Li D. 2017. Impact of climate variability and change on crime rates in Tangshan, China. Sci Total Environ 609:1041–1048, PMID: 28787778, https://doi.org/10.1016/j.scitotenv.2017.07.163.
72. Lynch MJ, Stretesky PB, Long MA. 2020. Climate change, temperature, and homicide: a tale of two cities, 1895–2015. Weather Climate Soc 12(1):171–181, https://doi.org/10.1175/WCAS-D-19-0068.1.
73. Mares DM, Moffett KW. 2016. Climate change and interpersonal violence: a "global" estimate and regional inequities. Climatic Change 135(2):297–310, https://doi.org/10.1007/s10584-015-1566-0.
74. Reeping PM, Hemenway D. 2020. The association between weather and the number of daily shootings in Chicago (2012–2016). Inj Epidemiol 7(1):31, PMID: 32564771, https://doi.org/10.1186/s40621-020-00260-3.

75. Lyons VH, Gause EL, Spangler KR, Wellenius GA, Jay J. 2022. Analysis of daily ambient temperature and firearm violence in 100 US cities. JAMA Netw Open 5(12):e2247207, PMID: 36525273, https://doi.org/10.1001/jamanetworkopen.2022.47207.
76. Annan-Phan S, Ba BA. 2023. Hot temperatures, aggression, and death at the hands of the police: evidence from the U.S. J Urban Econ 142:103592, https://doi.org/10.1016/j.jue.2023.103592.
77. Ruderman D, Cohn EG. 2021. Predictive extrinsic factors in multiple victim shootings. J Prim Prev 42(1):59–75, PMID: 32671646, https://doi.org/10.1007/s10935-020-00602-3.
78. Schutte FH, Breetzke GD, Edlstein I. 2021. The relationship between temperature and crime on the cape flats of South Africa. Int J Criminal Justice Sci 16(1):127–145.
79. Field S. 1992. The effect of temperature on crime. Br J Criminology 32(3):340–351, https://doi.org/10.1093/oxfordjournals.bjc.a048222.
80. Schinasi LH, Hamra GB. 2017. A time series analysis of associations between daily temperature and crime events in Philadelphia, Pennsylvania. J Urban Health 94(6):892–900, PMID: 28687898, https://doi.org/10.1007/s11524-017-0181-y.
81. Towers S, Chen S, Malik A, Ebert D. 2018. Factors influencing temporal patterns in crime in a large American city: a predictive analytics perspective. PLoS One 13(10):e0205151, PMID: 30356321, https://doi.org/10.1371/journal.pone.0205151.
82. Castle Y, Kovacs J. 2023. Sizing up crime and weather relationships in a small Northern city. Can J Criminology Criminal Justice 65(1):60–79, https://doi.org/10.3138/cjccj.2022-0037.
83. Yiannakoulias N, Kielasinska E. 2016. The effect of temperature on arson incidence in Toronto, Ontario, Canada. Int J Biometeorol 60(5):651–661, PMID: 26362852, https://doi.org/10.1007/s00484-015-1059-x.
84. Sanz-Barbero B, Linares C, Vives-Cases C, González JL, López-Ossorio JJ, Díaz J. 2018. Heat wave and the risk of intimate partner violence. Sci Total Environ 644:413–419, PMID: 29981991, https://doi.org/10.1016/j.scitotenv.2018.06.368.
85. Zhu Y, He C, Bell M, Zhang Y, Fatmi Z, Zhang Y, et al. 2023. Association of ambient temperature with the prevalence of intimate partner violence among partnered women in low- and middle-income South Asian countries. JAMA Psychiatry 80(9):952–961, PMID: 37379013, https://doi.org/10.1001/jamapsychiatry.2023.1958.
86. Kim SE, Kim Y, Hashizume M, Honda Y, Kazutaka O, Hijioka Y, et al. 2023. Positive association of aggression with ambient temperature. Yale J Biol Med 96(2):189–196, PMID: 37396982, https://doi.org/10.59249/RXZX5728.
87. Bollfrass A, Shaver A. 2015. The effects of temperature on political violence: global evidence at the subnational level. PLoS One 10(5):e0123505, PMID: 25992616, https://doi.org/10.1371/journal.pone.0123505.
88. Maystadt J-F, Calderone M, You L. 2014. Local warming and violent conflict in North and South Sudan. J Economic Geography 15(3):649–671, https://doi.org/10.1093/jeg/lbu033.
89. O'Loughlin J, Linke AM, Witmer FD. 2014. Effects of temperature and precipitation variability on the risk of violence in sub-Saharan Africa, 1980–2012. Proc Natl Acad Sci USA 111(47):16712–16717, PMID: 25385621, https://doi.org/10.1073/pnas.1411899111.
90. O'Loughlin J, Witmer FDW, Linke AM, Laing A, Gettelman A, Dudhia J. 2012. Climate variability and conflict risk in East Africa, 1990–2009. Proc Natl Acad Sci USA 109(45):18344–18349, PMID: 23090992, https://doi.org/10.1073/pnas.1205130109.
91. Pacillo G, Kangogo D, Madurga-Lopez I, Villa V, Belli A, Läderach P. 2022. Is climate exacerbating the root causes of conflict in Mali? A climate security analysis through a structural equation modeling approach. Front Clim 4:849757, https://doi.org/10.3389/fclim.2022.849757.
92. Iyigun M, Nunn N, Qian N. 2017. *Winter is Coming: The Long-Run Effects of Climate Change on Conflict, 1400–1900*. Bonn, Germany: Institute of Labor Economics (IZA).
93. van Weezel S. 2019. Local warming and violent armed conflict in Africa. World Development 126:104708, https://doi.org/10.1016/j.worlddev.2019.104708.
94. Peng J, Zhan Z. 2022. Extreme climate and crime: empirical evidence based on 129 prefecture-level cities in China. Front Ecol Evol 10:1028485, https://doi.org/10.3389/fevo.2022.1028485.
95. Auliciems A, DiBartolo L. 1995. Domestic violence in a subtropical environment: police calls and weather in Brisbane. Int J Biometeorol 39(1):34–39, https://doi.org/10.1007/BF01320891.
96. Stevens HR, Graham PL, Beggs PJ, Hanigan IC. 2023. No retreat from the heat: temperature-related risk of violent assault is increased by being inside. Int J Urban Sci 28(1):124–139, https://doi.org/10.1080/12265934.2023.2209544.
97. Williams A, McDonogh-Wong L, Spengler JD. 2020. The influence of extreme heat on police and fire department services in 23 U.S. Cities. Geohealth 4(11):e2020GH000282, PMID: 33204929, https://doi.org/10.1029/2020GH000282.
98. Williams AA, Allen JG, Catalano PJ, Buonocore JJ, Spengler JD. 2020. The influence of heat on daily police, medical, and fire dispatches in Boston, Massachusetts: relative risk and time-series analyses. Am J Public Health 110(5):662–668, PMID: 32191522, https://doi.org/10.2105/AJPH.2019.305563.
99. van de Vliert E, Schwartz SH, Huismans SE, Hofstede G, Daan S. 1999. Temperature, cultural masculinity, and domestic political violence: a cross-national study. J Cross-Cultural Psych 30(3):291–314, https://doi.org/10.1177/0022022199030003002.
100. Otrachshenko V, Popova O, Tavares J. 2021. Extreme temperature and extreme violence: evidence from Russia. Economic Inquiry 59(1):243–262, https://doi.org/10.1111/ecin.12936.
101. Krug EG, Mercy JA, Dahlberg LL, Zwi AB. 2002. The world report on violence and health. Lancet 360(9339):1083–1088, PMID: 12384003, https://doi.org/10.1016/S0140-6736(02)11133-0.
102. Krug EG, Dahlberg LL, Mercy JA, Zwi AB, Lozano R, World Health Organization. 2002. *World Report on Violence and Health*. Geneva, Switzerland: World Health Organization.
103. Mercy JA, Rosenberg ML, Powell KE, Broome CV, Roper WL. 1993. Public health policy for preventing violence. Health Aff (Millwood) 12(4):7–29, PMID: 8125450, https://doi.org/10.1377/hlthaff.12.4.7.
104. Dahlberg LL, Krug EG. 2006. Violence a global public health problem. Ciênc Saúde Coletiva 11(2):277–292, https://doi.org/10.1590/S1413-81232006000200007.
105. Habibullah MS. 2017. The effects of weather on crime rates in Malaysia. Int J Business Soc 18(2):263–270.
106. Butke P, Sheridan SC. 2010. An analysis of the relationship between weather and aggressive crime in Cleveland, Ohio. Weather Climate Soc 2(2):127–139, https://doi.org/10.1175/2010WCAS1043.1.
107. Mares D. 2013. Climate change and levels of violence in socially disadvantaged neighborhood groups. J Urban Health 90(4):768–783, PMID: 23435543, https://doi.org/10.1007/s11524-013-9791-1.
108. Rotton J, Cohn EG. 2004. Outdoor temperature, climate control, and criminal assault: the spatial and temporal ecology of violence. Environ Behavior 36(2):276–306, https://doi.org/10.1177/0013916503259515.
109. Sommer AJ, Lee M, Bind M-AC. 2018. Comparing apples to apples: an environmental criminology analysis of the effects of heat and rain on violent crimes in Boston. Palgrave Commun 4(1):138, PMID: 31360534, https://doi.org/10.1057/s41599-018-0188-3.
110. Becker GS. 1968. Crime and punishment: an economic approach. J Political Econ 76(2):169–217, https://doi.org/10.1086/259394.
111. Magnani L. 2011. *Understanding Violence: The Intertwining of Morality, Religion and Violence: A Philosophical Stance*, vol 1. Berlin, Heidelberg: Springer-Verlag.
112. Sheats KJ, Irving SM, Mercy JA, Simon TR, Crosby AE, Ford DC, et al. 2018. Violence-related disparities experienced by black youth and young adults: opportunities for prevention. Am J Prev Med 55(4):462–469, PMID: 30139709, https://doi.org/10.1016/j.amepre.2018.05.017.
113. Kang S. 2016. Inequality and crime revisited: effects of local inequality and economic segregation on crime. J Popul Econ 29(2):593–626, https://doi.org/10.1007/s00148-015-0579-3.
114. Moffitt TE, Klaus-Grawe 2012 Think Tank. 2013. Childhood exposure to violence and lifelong health: clinical intervention science and stress-biology research join forces. Dev Psychopathol 25(4 pt 2):1619–1634, PMID: 24342859, https://doi.org/10.1017/S0954579413000801.
115. Rosen T, Makaroun LK, Conwell Y, Betz M. 2019. Violence in older adults: scope, impact, challenges, and strategies for prevention. Health Aff (Millwood) 38(10):1630–1637, PMID: 31589527, https://doi.org/10.1377/hlthaff.2019.00577.
116. Yang L, Qian F, Song D-X, Zheng K-J. 2016. Research on urban heat-island effect. Procedia Engineering 169:11–18, https://doi.org/10.1016/j.proeng.2016.10.002.
117. Gilbert LK, Breiding MJ, Merrick MT, Thompson WW, Ford DC, Dhingra SS, et al. 2015. Childhood adversity and adult chronic disease: an update from ten states and the District Of Columbia, 2010. Am J Prev Med 48(3):345–349, PMID: 25300735, https://doi.org/10.1016/j.amepre.2014.09.006.
118. Wolf A, Gray R, Fazel S. 2014. Violence as a public health problem: an ecological study of 169 countries. Soc Sci Med 104(100):220–227, PMID: 24581081, https://doi.org/10.1016/j.socscimed.2013.12.006.
119. Loeber R, Farrington DP. 1998. *Serious and Violent Juvenile Offenders: Risk Factors and Successful Interventions*. Thousand Oaks, CA: Sage Publications.
120. West DJ, Farrington DP. 1973. *Who Becomes Delinquent? Second Report of the Cambridge Study in Delinquent Development*. London, UK: Heinemann Educational.
121. Cane MA, Miguel E, Burke M, Hsiang SM, Lobell DB, Meng KC, et al. 2014. Temperature and violence. Nat Clim Chang 4(4):234–235, https://doi.org/10.1038/nclimate2171.
122. Burkhardt J, Bayham J, Wilson A, Berman JD, O'Dell K, Ford B, et al. 2020. The relationship between monthly air pollution and violent crime across the United States. J Environ Econ Policy 9(2):188–205, https://doi.org/10.1080/21606544.2019.1630014.
123. Berman JD, Burkhardt J, Bayham J, Carter E, Wilson A. 2019. Acute air pollution exposure and the risk of violent behavior in the United States. Epidemiology 30(6):799–806, PMID: 31430264, https://doi.org/10.1097/EDE.0000000000001085.
124. Shi L, Liu P, Wang Y, Zanobetti A, Kosheleva A, Koutrakis P, et al. 2016. Chronic effects of temperature on mortality in the southeastern USA using satellite-

based exposure metrics. Sci Rep 6(1):30161, PMID: 27436237, https://doi.org/10.1038/srep30161.
125. Hu J, Zhou M, Qin M, Tong S, Hou Z, Xu Y, et al. 2022. Long-term exposure to ambient temperature and mortality risk in China: a nationwide study using the difference-in-differences design. Environ Pollut 292(pt B):118392, PMID: 34678392, https://doi.org/10.1016/j.envpol.2021.118392.
126. Zanobetti A, O'Neill MS, Gronlund CJ, Schwartz JD. 2012. Summer temperature variability and long-term survival among elderly people with chronic disease. Proc Natl Acad Sci USA 109(17):6608–6613, PMID: 22493259, https://doi.org/10.1073/pnas.1113070109.
127. Shi L, Kloog I, Zanobetti A, Liu P, Schwartz JD. 2015. Impacts of temperature and its variability on mortality in New England. Nat Clim Chang 5(11):988–991, PMID: 26640524, https://doi.org/10.1038/nclimate2704.
128. Zanobetti A, O'Neill MS. 2018. Longer-term outdoor temperatures and health effects: a review. Curr Epidemiol Rep 5(2):125–139, PMID: 30416932, https://doi.org/10.1007/s40471-018-0150-3.
129. Zafeiratou S, Samoli E, Dimakopoulou K, Rodopoulou S, Analitis A, Gasparrini A, et al. 2021. A systematic review on the association between total and cardiopulmonary mortality/morbidity or cardiovascular risk factors with long-term exposure to increased or decreased ambient temperature. Sci Total Environ 772:145383, PMID: 33578152, https://doi.org/10.1016/j.scitotenv.2021.145383.
130. Han B, Cohen DA, Derose KP, Li J, Williamson S. 2018. Violent crime and park use in low-income urban neighborhoods. Am J Prev Med 54(3):352–358, PMID: 29338953, https://doi.org/10.1016/j.amepre.2017.10.025.
131. Mayne SL, Pool LR, Grobman WA, Kershaw KN. 2018. Associations of neighbourhood crime with adverse pregnancy outcomes among women in Chicago: analysis of electronic health records from 2009 to 2013. J Epidemiol Community Health 72(3):230–236, PMID: 29305526, https://doi.org/10.1136/jech-2017-209801.
132. Smith ME, Sharpe TL, Richardson J, Pahwa R, Smith D, DeVylder J. 2020. The impact of exposure to gun violence fatality on mental health outcomes in four urban U.S. settings. Soc Sci Med 246:112587, PMID: 31958617, https://doi.org/10.1016/j.socscimed.2019.112587.
133. Choi HM, Bell ML. 2023. Heat-mortality relationship in North Carolina: comparison using different exposure methods. J Expo Sci Environ Epidemiol 33(4):637–645, PMID: 37029251, https://doi.org/10.1038/s41370-023-00544-y.
134. van Dijk J, Nieuwbeerta P, Joudo Larsen J. 2022. Global crime patterns: an analysis of survey data from 166 countries around the world, 2006–2019. J Quant Criminol 38(4):793–827, https://doi.org/10.1007/s10940-021-09501-0.
135. World Bank Group. 2024. *Intentional Homicides (per 100,000 People)*. https://genderdata.worldbank.org/indicators/vc-ihr-psrc-p5/?gender=total [accessed 19 September 2024].
136. Heo S, Choi HM, Lee J-T, Bell ML. 2024. A nationwide time-series analysis for short-term effects of ambient temperature on violent crime in South Korea. Sci Rep 14(1):3210, PMID: 38331944, https://doi.org/10.1038/s41598-024-53547-6.
137. Raleigh C, Linke A, O'Loughlin J. 2014. Extreme temperatures and violence. Nat Clim Chang 4(2):76–77, https://doi.org/10.1038/nclimate2101.