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Urban Heats Islands, Rising Temperatures, and Their Effects on Global Public Health: A Narrative Review

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Abstract
***Background**: The Urban Heat Island (UHI) phenomenon, caused by rapid urbanization and changes in surface characteristics, significantly impacts public health, particularly in densely populated urban areas. UHI leads to higher temperatures in urban regions compared to rural areas, especially during heatwaves, which are further exacerbated by climate change. This study aims to assess the health risks associated with increasing temperatures and the effects of Urban Heat Islands (UHI).*
***Method:** The method employed in this systematic review involves utilizing secondary data from articles published in international journals. The search was conducted using databases such as Google Scholar, Science Direct, and PubMed, focusing on articles from the last five years (2020-2024).*
***Results**: This review identified 20 relevant articles highlighting various health issues related to UHI, including cardiovascular disorders, respiratory problems, mental health issues, and increased mortality rates, particularly among the elderly and populations with pre-existing health conditions.*
***Conclusion**: These findings emphasize the urgent need for urban planning strategies to mitigate UHI effects, such as increasing green spaces and improving urban infrastructure to protect public health.*

***Keywords**: Public health, Temperature increase, Urban heat island.*

INTRODUCTION

The rapid urbanization, population growth, and anthropogenic activities significantly impact the urban thermal environment. The high density of buildings and road surfaces in urban areas absorbs more solar heat compared to vegetation in rural areas, leading to an increase in surface and air temperatures. Changes in surface characteristics, coupled with the reduction of vegetation that plays a role in natural cooling processes, make urban environments warmer than their surrounding areas, especially during heatwaves.[1] Natural factors such as global warming further exacerbate the situation; climate change increases average temperatures, making heatwaves more likely. The combination of natural heatwaves and rising temperatures due to urbanization creates extreme temperature conditions in urban areas.[2] This phenomenon is known as the Urban Heat Island (UHI), where temperatures in urban areas are higher than those in the surrounding rural areas.[3] UHI occurs due to the differences in surface characteristics between urban and rural areas. Buildings, roads, and other infrastructure in urban areas absorb and retain more heat than vegetation and open land in rural areas.[4] This temperature disparity can range from 5°C to 7°C, with urban areas being significantly warmer than their suburban counterparts, depending on the season and month.[5]

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Research indicates that UHI contributes to 69-70% of heat-related deaths.[6] Extreme temperatures, both hot and cold, can have serious impacts on human health, particularly increasing the risk of cardiovascular and respiratory diseases. In severe cases, extreme temperatures can lead to chronic illness and even death.[7] During the summer of 2022 in Europe, mortality due to heatwaves nearly reached 70,000.[8] Studies have shown that UHI significantly increases the risk of respiratory diseases, cardiovascular issues, and mental health disorders among urban residents, especially in city centers and areas with heavy traffic.[9] Prolonged heat exposure can worsen pre-existing conditions such as cardiovascular and respiratory problems. Furthermore, the UHI effect increases air pollution, particularly particulate matter and ground-level ozone, which can further exacerbate respiratory illnesses.[10]

The UHI problem is further exacerbated by climate change. Areas that already have a high risk will face more severe health challenges, necessitating more comprehensive health protection strategies. Additionally, heat patterns tend to spread from city centers to surrounding areas, increasing health threats for residents in broader regions.[11] Research in cities like Colombo indicates that severe heat stress conditions, such as heatstroke, can occur during the summer, particularly in rapidly expanding cities with poor heat management.[12]

Unfortunately, to date, there has been no inclusive mitigation action from the relevant parties to address the impacts of heatwaves. Public health may become a casualty if there is no clear follow-up regarding this condition. This systematic review aims to examine the potential health risks posed by increased heat with specific patterns, such as UHI and rising temperatures in urban areas. It is hoped that this writing can be used for policy determination or other actions related to mitigation and adaptation measures against the impacts of climate change and UHI.

METHOD

This study employs a systematic review method to summarize and collect previous research using secondary data from published articles in international journals. A systematic review is a type of systematic review that requires a level of rigor equivalent to that of primary research. The content section must present a clear and logical rationale for the reader.[13] Article searches were conducted using online article databases, including Google Scholar, Science Direct, PubMed, Semantic Scholar, and Springer Link. The keywords used can be found in Table 1.

Table 1. Keywords Used to Search for Articles

No	Keywords
1	"Urban Heat Island" AND "Human Health" AND “Morbidity”
2	(“Heat Wave” OR “Urban Heat”) AND “Human Health”
3	("Urban Heat Island" OR "UHI") AND "Morbidity"
4	"Urbanization" AND "Temperature Increase" AND "Diseases"
5	“Urban Heat" AND ("Morbidity" OR "Mortality")
6	"Urban Heat Island" AND "Health Outcomes" AND "Heat Stress"

The analysis method uses PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses). PRISMA is a method designed to enhance the reporting of systematic reviews and meta-analyses. With this method, the transparency, completeness, and accuracy of reporting can be demonstrated. This method serves as an important framework for conducting systematic reviews, ensuring that reports are comprehensive and facilitating decision-making based on information. The indicators used for literature recording include the author and title, research location, article review, and impact/risk. To limit article selection and avoid selection bias, the inclusion and exclusion criteria to be used can be found in Table 2.

Table 2. Inclusion and Exclusion Criteria Used to Filter Articles

Inclusion Criteria	Exclusion Criteria
Articles published within the last 5 years (2020 – 2024)	Articles whose research findings are less focused on the impacts of heat increases on human health
Articles that are fully accessible (full text articles)	Non-original research (not direct research, e.g., SLR, meta-analysis, etc.)
Articles that discuss the impacts and risks of urban heat increases on health issues	

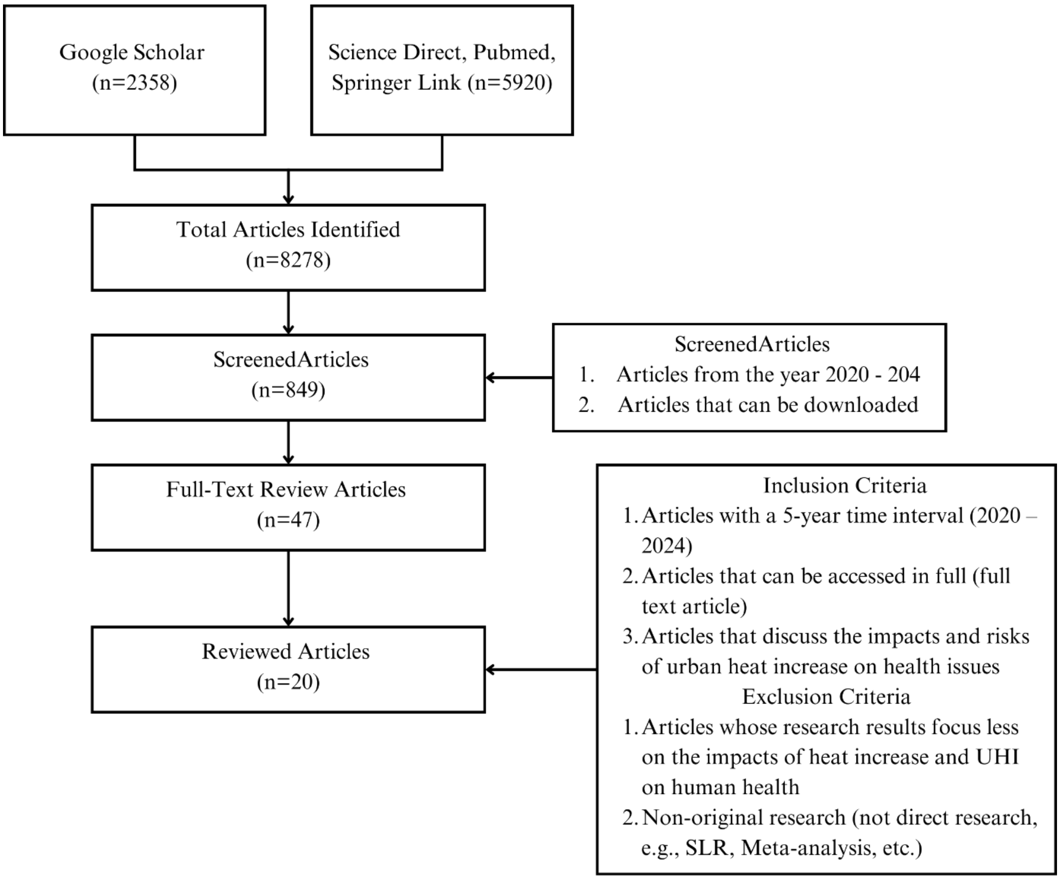

Figure 1. PRISMA Flowchart

RESULT

A total of 47 articles were found that met the criteria; however, only 20 articles fulfilled the inclusion criteria by specifically discussing the impacts of UHI and increased heat on health issues. The synthesis of the reviewed articles indicates that the health impacts caused by UHI and urban heat increases include cardiovascular disorders, respiratory disorders, psychological disorders, psychosomatic disorders, diabetes, immune system disorders, effects on vulnerable groups/people with pre-existing conditions, and, most severely, an increased risk of mortality. These impacts predominantly occur under conditions of moderate to extreme UHI and heat increases. For a more comprehensive overview, the synthesis results of the 20 articles can be found in Table 3.

DISCUSSION

After reviewing the articles, the authors summarize information regarding the main findings and research results. Data on location, a brief overview, and impacts and effects were manually extracted from the articles. Furthermore, the authors examine the impacts of increasing heat and UHI, with indicators of health issues due to UHI and rising temperatures, impacts on morbidity, and extending to impacts on mortality.

Table 3. Synthesis Results of the Articles

No.	Author/Year	Country/City	Title	Objective	Design Study and Method	Population	Subject of Study (Sample size)	Result
1	Nasrin Aghamohammadi et al. (2021)	Kuala Lumpur, Malaysia	Environmental heat-related health symptoms among community in a tropical city	To assess the impact of urban heat on PPP (physical, psychosomatic, psychological) health symptoms and identify related symptom clusters.	Cross-sectional survey with structured questionnaire and continuous PET-based microclimate monitoring.	Urban residents within 500m of monitoring stations, exposed to outdoor heat.	1,160 respondents via clustered random sampling.	Heat stress was significantly associated with psychosomatic pain ($p = 0.016$), anxiety ($p = 0.022$), and somatization ($p = 0.041$). No significant link was found with physical illnesses or depressive symptoms. Findings emphasize the mental and psychosomatic burden of urban heat in tropical settings, especially among populations with high outdoor exposure.
2	Kanghyun Lee et al. (2022)	Cincinnati, USA	Effects of Urban Landscape and Sociodemographic Characteristics on Heat-Related Health Using Emergency Medical Service Incidents	To examine how urban landscape and social vulnerability affect heat-related illnesses and emergency responses.	Spatial-statistical analysis using GIS, census data, and emergency health call records (EMS data).	Urban residents in Toronto, assessed by neighborhood units (census tracts).	140 neighborhoods analyzed using multivariate regression models.	The health impacts of heat are most severe in environments characterized by high-density built-up areas, limited green open spaces, and high social vulnerability (e.g., low-income elderly populations). Tree canopies and park access serve as protective factors. Spatial clustering reveals health inequities influenced by urban form and sociodemographic factors, highlighting the importance of integrating urban greening and equity into climate adaptation strategies.

Table 3. Synthesis Results of the Articles

No.	Author/Year	Country/City	Title	Objective	Design Study and Method	Population	Subject of Study (Sample size)	Result
3	Cuerdo Vilches et al. (2023)	Spain	Impact of urban heat islands on morbidity and mortality in heat waves: Observational time series analysis of Spain's five cities	To investigate how land use/land cover (LULC) changes influence outdoor thermal conditions and heat-related health symptoms.	GIS-based LULC analysis, remote sensing, thermal indices (PET), and structured surveys.	Urban residents across areas with differing LULC typologies.	1,011 participants surveyed in relation to local thermal and land use data.	Respondents living in high-density built-up areas experienced significantly higher PET levels and greater incidence of heat-related symptoms such as fatigue, headaches, and irritability. Strong correlations were found between impervious surfaces, low vegetation cover, and thermal discomfort. The study underscores the need for climate-sensitive urban planning that enhances green infrastructure to mitigate health risks from LULC-induced heat stress.
4	Nanayakkara et al. (2023)	China dan Sri Lanka	Analysis of Urban Heat Island Effect, Heat Stress and Public Health in Colombo, Sri Lanka and Shenzhen, China	To assess urban heat island (UHI) effects, heat stress exposure, and public health risks using spatial-tech tools.	Remote sensing (LST), GeoAI, spatial clustering, and risk mapping integrating census and health data.	Urban populations in Colombo District analyzed via spatial units.	Over 550 Grama Niladhari Divisions (GNDs) analyzed spatially; health data linked to temperature profiles.	Spatial analysis revealed intensified UHI zones strongly correlated with increased heat-related hospital admissions and vulnerable populations (elderly, low-income). High-risk areas lacked green spaces and showed poor thermal resilience. The study highlighted GeoAI as a powerful tool for early warning and health risk prediction in urban heat stress planning.

Table 3. Synthesis Results of the Articles

No.	Author/Year	Country/City	Title	Objective	Design Study and Method	Population	Subject of Study (Sample size)	Result
5	Janice Y. Ho et al.(2023)	Hongkong	Urban Heat Island Effect-Related Mortality Under Extreme Heat And Non-Extreme Heat Scenarios: A 2010–2019 Case Study In Hong Kong	To quantify excess mortality linked to UHI during extreme heat in Asian megacities.	Time-series analysis of mortality, temperature, and satellite-derived UHI data (MODIS); stratified by demographic and geographic variables.	Urban populations exposed to UHI and extreme heat in selected megacities.	Daily mortality data from 4 cities, spanning multiple years; demographic breakdown included.	UHI amplified heat-related mortality risk, especially during prolonged heatwaves. Elderly and low-income populations were most affected. Cities with low tree cover and high-density development showed higher mortality burdens. UHI effect accounted for up to 22.5% of excess deaths during peak events. Authors emphasize integrating urban climate adaptation with public health resilience strategies.
6	Wang et al. (2020)	Beijing and Tianjin	Urban heat island circulations over the Beijing-Tianjin region under calm and fair conditions	To investigate UHI-induced circulations and their implications on air temperature and regional airflow.	Regional climate modeling (WRF model), combined with satellite and observational data to simulate UHI circulations.	Metropolitan populations affected by mesoscale heat and air circulation dynamics.	Simulations covered regional climate dynamics with varied urbanization scenarios.	UHI circulations intensified near-surface temperatures and altered regional wind patterns, promoting heat stagnation in urban cores. Effects were strongest in high-density zones and during summer. These circulations also influenced pollution transport and potentially exacerbated heat-related health risks, indicating a need for integrated urban–atmospheric planning.

Table 3. Synthesis Results of the Articles

No.	Author/Year	Country/City	Title	Objective	Design Study and Method	Population	Subject of Study (Sample size)	Result
7	Yifang Dai et al. (2022)	Tianjin, China	Spatiotemporal Mechanism Of Urban Heat Island Effects On Human Health—Evidence From Tianjin City Of China	To explore how UHI impacts human health across space and time using environmental and health datasets.	GIS-based spatiotemporal analysis linking UHI metrics, land cover, and health records over time.	Urban residents in various districts of Tianjin.	Citywide grid-based analysis using remote sensing and hospital data.	UHI exposure was significantly linked to increased outpatient visits for heat-related symptoms, especially during summer. Health risks were unevenly distributed, with higher exposure in low-vegetation and high-built-up areas. Vulnerable groups included the elderly and those in densely populated zones. Authors recommend enhancing green infrastructure and heat surveillance systems for urban health resilience.
8	Huanchun Huang et al. (2020)	China	Spatio-Temporal Mechanism Underlying The Effect Of Urban Heat Island On Cardiovascular Diseases	To explore the spatiotemporal pattern and mechanism of UHI's impact on CVD mortality.	Remote sensing, landscape pattern index analysis using Landsat and meteorological data (1984–2017).	Urban population of Beijing.	Data from 95 weather stations and CDC CVD mortality data.	UHI significantly contributed to a 28.8% increase in CVD mortality over 33 years. The affected areas expanded spatially outward from the city center, showing three evolution stages: concentric growth, axial expansion, and regional filling. Landscape fragmentation and heat severity were highest in the southern and central regions. Elderly were most vulnerable. Mechanisms included elevated heart stress, dehydration, blood viscosity, and ozone-related inflammation. The study recommends green urban planning and early warning systems for thermal health hazards.

Table 3. Synthesis Results of the Articles

No.	Author/Year	Country/City	Title	Objective	Design Study and Method	Population	Subject of Study (Sample size)	Result
9	Chaston et al. (2022)	Sydney, Australia	Mortality Burden of Heatwaves in Sydney, Australia Is Exacerbated by the Urban Heat Island and Climate Change: Can Tree Cover Help Mitigate the Health Impacts?	To assess how UHI and climate change intensify mortality risks during heatwaves.	Statistical mortality modeling integrating temperature records, UHI mapping, and climate projections.	Residents of Sydney, with focus on high-risk areas.	Time-series analysis of excess deaths across urban regions.	Heatwaves were associated with a significant rise in mortality, with UHI amplifying death rates in western Sydney—up to 2.3 times higher than cooler areas. Vulnerable groups included the elderly and people with pre-existing conditions. Projected climate scenarios suggest a growing burden unless heat mitigation policies are enforced. Authors urge targeted urban planning to reduce health inequalities under future climate extremes.
10	Santamouris et al. (2020)	USA	Increasing Green Infrastructure in Cities: Impact on Ambient Temperature, Air Quality and Heat-Related Mortality and Morbidity	To evaluate current urban heat management practices and explore gaps in policy, health preparedness, and heat mitigation strategies.	Narrative review and comparative policy analysis using secondary data from heat management programs in U.S. cities.	Urban populations in U.S. cities vulnerable to extreme heat.	Case studies from major U.S. cities with varied socio-environmental contexts.	Heat health impacts are unequally distributed, with marginalized populations disproportionately affected. Although cities have heat action plans, many lack inter-agency coordination, real-time warning systems, and equity-driven responses. The study calls for integrated strategies combining urban planning, social services, and public health to reduce vulnerability under rising climate stress.

Table 3. Synthesis Results of the Articles

No.	Author/Year	Country/City	Title	Objective	Design Study and Method	Population	Subject of Study (Sample size)	Result
11	Arifwidodo et al. (2020)	Bangkok, Thailand	Urban heat stress and human health in Bangkok, Thailand	To investigate perceived health impacts of urban heat stress and propose urban planning solutions.	Quantitative household surveys combined with GIS mapping and microclimate measurements.	Residents in urban and peri-urban districts of Bangkok.	350 respondents; stratified by income and location.	Heat stress was perceived as a major health issue, especially among low-income groups in poorly ventilated housing. Symptoms included dehydration, fatigue, and dizziness. Spatial analysis revealed stronger effects in built-up, low-greenery areas. Authors recommended increasing urban vegetation, enhancing housing design, and improving public awareness through education and policy interventions.
12	Mirzaei et al. (2020)	Isfahan, Iran	Urban Heat Island Monitoring and Impacts on Citizen's General Health Status in Isfahan Metropolis: A Remote Sensing and Field Survey Approach	To assess UHI intensity and its health impacts on residents' general well-being.	Field temperature monitoring (17 points) + health surveys analyzed via GIS.	Citizens residing in urban and suburban districts of Dezful.	383 individuals surveyed using GHQ-28 and UHI exposure data.	Urban areas exhibited up to 9°C higher temperatures than suburban zones. Increased UHI intensity correlated with elevated levels of anxiety, somatic complaints, and social dysfunction based on GHQ scoring. Vulnerable populations included women and low-income groups. Authors called for integrated heat mitigation strategies including green infrastructure, building modifications, and public health campaigns.

Table 3. Synthesis Results of the Articles

No.	Author/Year	Country/City	Title	Objective	Design Study and Method	Population	Subject of Study (Sample size)	Result
13	Bu et al. (2024)	China	The synergistic effect of high temperature and relative humidity on non-accidental deaths at different urbanization levels	To assess joint effects of temperature and humidity on all-cause and cause-specific mortality.	Multi-city time-series analysis using distributed lag nonlinear models (DLNM) and meta-regression.	Urban residents across 14 diverse Chinese cities.	Mortality and meteorological data from 2010–2016.	High temperature combined with high humidity significantly increased all-cause and cardiovascular mortality. The effect was more pronounced in cities with humid subtropical climates. Elderly and people with CVD were the most vulnerable. Findings underscore the need for city-specific heat-health warning systems that account for both temperature and humidity as compounding risk factors.
14	Hao Tian et al. (2021)	China	Effects of high-frequency temperature variabilities on the morbidity of chronic obstructive pulmonary disease: Evidence in 21 cities of Guangdong, South China	To evaluate how short-term temperature variability influences mortality across different causes.	Nationwide time-series analysis using distributed lag nonlinear models (DLNM) and Bayesian meta-analysis.	Residents across 130 counties with various climatic and demographic profiles.	Daily mortality data from 2013–2018 for multiple causes of death.	Short-term temperature variability (e.g., diurnal range and day-to-day shifts) significantly elevated mortality risks, particularly for cardiovascular, respiratory, and stroke-related deaths. Elderly and people in low socioeconomic areas were most vulnerable. Findings suggest that variability, not just mean heat, is a key risk factor. Climate-health strategies should integrate daily variability indicators into early warning systems.

Table 3. Synthesis Results of the Articles

No.	Author/Year	Country/City	Title	Objective	Design Study and Method	Population	Subject of Study (Sample size)	Result
15	Jia et al. (2024)	China	Population heat exposure risk from the perspective of urban heat island spatial expansion in China during 2005–2020	To assess population heat exposure risk linked to spatial expansion of UHI during urbanization.	Remote sensing analysis (MODIS LST), urban expansion modeling, and heat exposure risk mapping (2000–2020).	Urban and peri-urban populations across 340 Chinese cities.	Multi-temporal spatial dataset covering 340 cities over 20 years.	Rapid UHI spatial expansion increased population heat exposure by 154.9% nationwide. High-risk clusters were concentrated in economically developed and densely populated regions. Disparities were observed between cities with similar climates but differing in land-use management. Study highlights the urgency of integrating heat exposure assessment into sustainable urban development and climate resilience policies.
16	Dong et al. (2014)	Beijing, China	Assessing Heat Health Risk for Sustainability in Beijing's Urban Heat Island	To develop a comprehensive heat health risk assessment framework in UHI context.	Combined remote sensing (LST), census data, health records, and spatial multi-criteria evaluation (MCE) in GIS.	Urban residents of Beijing at the sub-district scale.	18 districts assessed using spatial indicators of exposure, sensitivity, and adaptive capacity.	High heat health risks were concentrated in older urban districts with high population density, elderly populations, and limited vegetation. The spatial model effectively identified priority areas for targeted interventions. Authors suggested integrating green infrastructure, early warning, and community-based adaptation into sustainable urban planning to mitigate future risks.

Table 3. Synthesis Results of the Articles

No.	Author/Year	Country/City	Title	Objective	Design Study and Method	Population	Subject of Study (Sample size)	Result
17	Cleland et al.. (2023)	USA	Urban heat island impacts on heat-related cardiovascular morbidity: A time series analysis of older adults in US metropolitan areas	To quantify how UHI influences heat-related cardiovascular hospitalizations among older adults.	Time-series analysis (2001–2017) using Medicare data, satellite-derived UHI metrics, and Poisson regression modeling.	Adults aged ≥65 years residing in 105 urban U.S. counties.	Over 41 million cardiovascular hospitalization records.	UHI significantly increased the risk of heat-related cardiovascular hospitalizations during extreme heat days, especially in high-density, low-canopy areas. The strongest associations were observed among individuals ≥75 years, Black populations, and those with pre-existing conditions. Authors advocate for targeted heat-health adaptation, particularly in structurally disadvantaged neighborhoods.
18	Simpson et al.. (2024)	London	Estimated mortality attributable to the urban heat island during the record-breaking 2022 heatwave in London	To estimate excess deaths linked to UHI and assess the mitigating role of urban vegetation.	Multi-city ecological analysis using satellite LST data, mortality registries, and counterfactual modeling.	Residents of 85 major European cities.	Daily mortality and environmental data over summer months (June–August).	UHI contributed to ~4.3% of summer mortality across cities. Up to 6,700 premature deaths could be prevented annually by increasing urban vegetation to cover at least 30% of city areas. The study strongly recommends large-scale urban greening to reduce UHI intensity and heat-related mortality.

Table 3. Synthesis Results of the Articles

No.	Author/Year	Country/City	Title	Objective	Design Study and Method	Population	Subject of Study (Sample size)	Result
19	Sara Lopes de Moraes et al.. (2022)	Sao Paulo Brazil	The potential burden from urbanisation on heat-related mortality in Sao ˜ Paulo, Brazil	To estimate heat-related mortality attributable to ongoing urban expansion in São Paulo.	Scenario-based modeling using remote sensing (LST), demographic projections, and mortality risk functions.	Urban population of São Paulo, projected through 2050.	City-level spatial-temporal datasets and population forecasts.	Under high urbanization scenarios without mitigation, heat-related mortality could rise by 139% by 2050. Informal settlements and low-income neighborhoods face the highest risk due to poor infrastructure and low vegetation. Incorporating green spaces, reflective materials, and climate-sensitive planning is vital to reduce future health burdens.
20	Predrag Ignjačević et al. (2024)	Europe	Climate-induced mortality projections in Europe: Estimation and valuation of heat-related deaths	To estimate future heat-related deaths in Europe and quantify their economic burden under climate scenarios.	Integrated assessment modeling combining RCP-based climate projections, mortality functions, and economic valuation (VSL approach).	General population of 27 EU countries projected to 2100.	Projections based on regional temperature trends and demographic forecasts.	By 2100, annual heat-related mortality in Europe could reach 132,000 deaths under high emission scenarios, with economic losses up to €1.2 trillion/year. Southern and Eastern Europe face the steepest increases. Mitigation scenarios (RCP2.6) reduce both death toll and economic burden substantially. Authors stress urgent adaptation and emission reduction policies.

Health Issues Due to UHI and Rising Temperatures

Based on the review findings, the exposure to and effects of rising temperatures and UHI on health include cardiovascular disorders, respiratory disorders, mental health issues, psychosomatic disorders, diabetes, immune system disorders, effects on vulnerable groups or those with pre-existing conditions, and mortality. A clearer overview can be seen in Table 4.

Table 4. Categories of Health Issues Caused by UHI

No	Effect Category	Article Number	Percentage
1	Effects on vulnerable groups/individuals with pre-existing conditions	2,5,8,10,13,14,15,16,17,18,19	65%
2	Psychological disorders	1,2,3,4,5,7,11,12,13,15	50%
3	Cardiovascular disorders	1,3,6,7,8,10,13,16,17	45%
4	Mortality	5,9,10,13,15,18,19,20	40%
5	Respiratory disorders	6,7,10,12,13,14,16	35%
6	Psychosomatic disorders	1,2,4,7,11,12,16	35%
7	Diabetes	10,17	10%
8	Immune system disorders	3,11	10%

Based on the explanation from Table 4, it is known that the impact of UHI and increased heat is most severe on the rise in morbidity among vulnerable groups, psychological disorders, and cardiovascular disorders. Meanwhile, the lowest exposure impacts are diabetes and immune disorders. The conditions of heat and associated health issues have drastically increased among vulnerable groups such as the elderly and those with low socioeconomic status.[18] UHI and temperature have a significant impact on the population aged over 75 years. This is evidenced by the low mortality rates in areas with low UHI exposure, which increase in areas with high UHI exposure, along with rising morbidity in areas with moderate UHI levels.[17] Heat-related health issues, combined with non-communicable diseases, increase the health burden in urban areas, particularly among low- and middle-income communities. This group is expected to face a significantly higher health risk.[21] High temperatures contribute directly to excess mortality, especially among vulnerable groups such as the elderly and those with pre-existing health conditions.[24]

In vulnerable groups with pre-existing conditions, morbidity and mortality are driven by multiple physiological pathways. Older adults often experience thermoregulatory dysfunction—a diminished ability to lower body temperature—along with reduced cardiovascular reserves and impaired sweat gland function, making them more susceptible to heat-related complications.[31] Heat exposure also induces peripheral vasodilation (the widening of blood vessels near the skin surface to dissipate heat). As a result, blood pressure drops, forcing the heart to work harder. Among individuals with hypertension or heart failure, this condition poses an increased risk of morbidity and mortality.[31]

The conditions of UHI and rising temperatures play a significant role in health issues such as heat stress.[26] Residents living in areas affected by UHI experience significant psychological pressure. The resulting problems include anxiety, sleep disturbances, social functioning issues, and depression.[23] Furthermore, heat stress leads to mood changes; projections in the reviewed research indicate that individuals experiencing continuous heat stress are negatively affected in terms of life satisfaction due to emotional disturbances.[22] If UHI and rising temperatures are experienced by vulnerable groups, there is a risk of increasing mental disorders, rising morbidity in dementia cases, and even causing stress.[9]

The effects of stress and psychological disorders operate through a complex mechanism. Research indicates that individuals exposed to heat are more likely to experience central fatigue, sleep disturbances, and difficulties in maintaining energy homeostasis. Populations such as outdoor workers, the elderly, and women have been reported to suffer more frequently from cardiopulmonary and psychosomatic disorders.[32] This mechanism is initiated by chronic heat exposure, which subsequently leads to stress-related conditions such as anxiety, insomnia, and mild depression. Over time, these impacts may develop into somatic disorders, including persistent fatigue, pain, or digestive problems.

Not only does it impact mental health, but more severely, UHI and rising urban temperatures pose a risk of increased morbidity related to cardiovascular diseases. Extreme heat conditions significantly elevate the risk of hospitalization for cardiovascular diseases, with a particularly high risk increase of 2.4% in areas with high UHI impact.[28] This condition can be exacerbated when UHI and rising temperatures are combined with high humidity levels.[24] Prolonged exposure to high temperatures increases the inflammatory response in the body, which poses a risk of coronary heart disease.[19]

The impact of UHI on cardiovascular and respiratory problems results from interconnected and compounding effects. The physiological mechanism underlying cardiac issues can be triggered by the activation of the hypothalamic–pituitary–adrenal (HPA) axis and the sympathetic nervous system, which induces peripheral vasodilation. This, in turn, increases cardiac output and the heart's workload. Such responses elevate the risk of myocardial ischemia, particularly among individuals with pre-existing heart conditions.[33] Meanwhile, respiratory problems such as airway inflammation are driven by the production of proinflammatory cytokines, including IL-6, IL-8, and TNF-α. These cytokines activate mast cells and neutrophils, resulting in excessive mucus secretion, mucosal edema, and narrowing of the bronchial lumen.[34]

The Impact of UHI and Rising Temperatures on Increased Mortality

The impact of UHI and rising temperatures on mortality is designated as a separate discussion. This is due to its connection with the risk of death. While morbidity focuses on the increased impact of diseases in the body or a decline in quality of life, mortality refers to the ultimate consequence, or death. Therefore, this section explicitly discusses the findings from the review of articles regarding the impact of UHI and rising temperatures on the risk of mortality.

The risk of death significantly increases in areas classified with extreme heat, high heat, and moderate heat conditions. The risk of death is nearly doubled compared to areas exposed to low UHI.[17] In Australia, it is known that there is an average of 117.3 deaths per year correlated with heat effects. Heatwaves that exceed specific thresholds have a significant relationship with the burden or risk of mortality.[20] The risk of death has a direct and significant impact on vulnerable groups such as the elderly and individuals with chronic diseases.[24]

The mortality impact of UHI can be exacerbated in vulnerable groups. Pregnant women exposed to the effects of UHI in urban areas are at a risk of experiencing premature births approximately 1.2 times for every 5 °C increase in temperature.[35] The percentage of elderly mortality due to high UHI exposure is found to be higher, particularly among those aged over 75 years.[36] More vulnerable populations face increased risks when temperatures exceed median range values or during heightened UHI or extreme heat conditions.[37] Similar results were found in Silveira's study,[38] indicating that older adults (≥65 years) and women are more vulnerable to the risk of death due to the impacts of heatwaves, particularly related to cardiovascular issues. The effects of UHI and rising temperatures significantly increase the risk of mortality, especially among vulnerable groups such as the elderly and individuals with chronic diseases. Therefore, there is a need for better mitigation and adaptation efforts to protect vulnerable populations from extreme heat exposure.

Mitigation Actions

To reduce the negative impacts of UHI and rising temperatures, effective mitigation efforts are needed. Mitigation actions can be implemented both technically and systematically. One technical effort is to utilize land located outside urban boundaries, which serves as a buffer zone to reduce UHI effects. These areas can include forests, fields, and parks that have the ability to absorb heat, enhance air circulation, and provide cooling effects for the surrounding areas.[39] In another study, efforts can be made by implementing green and blue infrastructure in urban land. Maximizing the management of green spaces and water resource management in urban areas can reduce the impacts of rising temperatures and UHI.[40] However, there is still a lack of longitudinal studies addressing UHI issues, which hinders long-term analysis of UHI's impact on public health. Furthermore, more research is needed to examine UHI's effects in developing countries in Southeast Asia, where regional climatic differences may influence UHI impacts.

CONCLUSION

UHI and rising temperatures in urban areas pose various health risks, both directly and indirectly. The most significant increase in morbidity is found in cardiovascular disorders, mental health issues, and an increased risk of pre-existing diseases among vulnerable groups. The most severe impact of rising temperatures and UHI, whether directly or indirectly, is death. Directly, this can be caused by extremely high heat conditions, while indirectly, it affects vulnerable groups that already have pre-existing health conditions. Mitigation efforts that can be implemented include the management of green spaces, open water areas in urban regions, and the provision of green land in surrounding areas as buffers to reduce heat in urban areas. Furthermore, the impact of UHI and rising temperatures in Southeast Asia, particularly Indonesia, requires further study, considering that there are still few studies assessing the direct impacts of UHI and rising temperatures on public health issues. Moreover, the climate and humidity conditions in tropical areas are higher.

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