

# The health impacts of climate change on outdoor workers in urban Vietnam: A systematic review of Vietnamese-language and Vietnam-based studies

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## APPENDIX: METHODOLOGICAL APPROACH

This systematic review follows a structured five-phase approach to identify and evaluate Vietnamese and Vietnam-based studies on the impact of climate change and extreme weather events on the health of outdoor workers in urban Asia. The review is guided by four research questions:

1. Which extreme weather events affect the health of outdoor workers in urban Asia?
2. What are the specific health impacts of climate change and extreme weather events on this workforce?
3. Which types of outdoor work and groups of workers are most vulnerable?
4. What coping and adaptation strategies have these workers adopted in response to climate change?

The process is designed to ensure the comprehensive coverage of relevant studies, systematic data extraction, and critical evaluation of the findings. The five-phase approach includes the development of search strings, development of inclusion and exclusion criteria, a pilot search and identification process, a full database search and screening, and data extraction.

### The development of search strings

Based on the research questions and PICO framework, a series of keywords were used to search for relevant Vietnamese language literature in the two areas of “climate change” and “health.” These search strings encompass topics related to Climate, Health, Employment, Society, Urban areas, and Asia (see Table A1). By incorporating these six filters, the systematic review comprehensively addresses the multifaceted nature of the topic, ensuring a thorough examination of the interconnected factors influencing the health impacts of climate change on precarious outdoor workers in urban Asia.

### The development of inclusion and exclusion criteria

The systematic review used specific inclusion and exclusion criteria to assess eligibility (see Table A2). It included Vietnamese academic papers and English ones based in Vietnam, original research, systematic reviews, scoping reviews, meta-analyses, and relevant grey literature like dissertations. The focus was on studies examining climate change and its health impacts on urban workers in Asia, including adaptation and mitigation effects. The excluded sources were those related to rural areas, non-Asian regions, indoor workers, and opinion pieces or popular media.

### The pilot search and identification

The review draws on three key academic databases in Vietnam: the EBSCO Discovery Service of the Central Library (HCM VNU Lib), the National Database on Science and Technology (MOST Pub Database), and Google Scholar. To ensure comprehensive coverage, the review also incorporated supplementary sources, including the *Vietnam Medical Journal*. A significant challenge encountered was the restrictive keyword limits imposed by Vietnamese databases. Google Scholar permits a maximum of 16 keywords, HCM VNU Lib 12, and MOST Pub Database only eight. Additionally, both HCM VNU Lib and MOST Pub Database lack full-text search capabilities, reducing the specificity of search queries. In response, the search terms were refined to focus on broader concepts—climate, health, employment, society, and urban areas—using a total of 15 keywords. Searches were divided into smaller groups, and results manually filtered to identify studies specific to urban areas in Asia. The search strategy was adapted to accommodate these database limitations (see Table A3).

### The full database search and screening

The process of searching, identifying, and screening documents was based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses

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Table A1: The Initial search strings

Filter	Main keywords		Vietnamese synonyms/ relevant keywords
	English	Vietnamese	
	climate	khí hậu	“Khí hậu” OR “thời tiết” OR “lũ lụt” OR “hạn hán” OR “nắng nóng” OR “nóng” OR “lạnh” OR “nóng lên toàn cầu” OR “bão” OR “gió mùa” OR “lượng mưa” OR “thích ứng” OR “giảm thiểu” OR “khí nhà kính” OR “lốc xoáy” OR “xói mòn bờ biển” OR “rủi ro” OR “thiên tai” OR “cháy rừng”
AND	health	sức khỏe	“Sức khỏe” OR “bệnh tật” OR “truyền nhiễm” OR “phúc lợi” OR “chất lượng cuộc sống” OR “tử vong” OR “tai nạn” OR “hạnh phúc” OR “bị thương” OR “bệnh viện” OR “tâm thần” OR “y tế” OR “cấp cứu” OR “đột quỵ” OR “kiệt sức” OR “chuột rút” OR “mang thai” OR “sốt” OR “mệt mỏi” OR “bong rứt” OR “căng thẳng” OR “đá”
AND	work	việc làm	“Công việc” OR “ngoài trời” OR “khuân vác” OR “xây dựng” OR “người bán hàng” OR “bán hàng rong” OR “người lái xe” OR “công việc ngoài trời”
AND	society	xã hội	“Giới tính” OR “tuổi tác” OR “thế hệ” OR “người già” OR “trẻ” OR “già” OR “nghèo đói” OR “loại trừ” OR “bấp bênh” OR “người di cư” OR “thiếu số” OR “dễ bị tổn thương” OR “phi chính thức” OR “bình thường” OR “hợp đồng” OR “thỏa thuận”
AND	urban	đô thị	“Thành phố” OR “thị trấn” OR “đô thị” OR “thị xã”
AND	Asia	châu Á	“Châu Á” OR “Việt Nam” OR “Trung Quốc” OR “Timor Leste” OR “Đông Timor” OR “Indonesia” OR “Philippines” OR “Campuchia” OR “Thái Lan” OR “Lào” OR “CHDCND Lào” OR “Myanmar” OR “Miến Điện” OR “Malaysia” OR “Brunei” OR “Brunei Darussalam” OR “Ấn Độ” OR “Sri Lanka” OR “Nepal” OR “Pakistan” OR “Bangladesh” OR “Bhutan” OR “Afghanistan” OR “Bắc Triều Tiên” OR “Cộng hòa Dân chủ Nhân dân Triều Tiên” OR “Mông Cổ”

[Source: The authors]

(PRISMA) (see **Figure 1**). Through our search strings, we identified 88 works related to the research topic, including research articles, books, and dissertations. After filtering these works based on the criteria listed in **Table 2**, by reviewing all titles, abstracts, and full texts, we retained eight documents for the systematic review.

**The data extraction**

After full-text screening, these eight studies were extracted into a structured Excel sheet, with rows representing individual papers and columns capturing key themes. The themes included Article reference, Methodology, Health impacts of weather extremes on outdoor workers, Types of weather-related health risks, Vulnerable outdoor work, Coping strategies, Policy recommendations, and Reflections. Each

theme was divided into sub-themes for detailed analysis. This tabular organisation facilitated easy comparison of paper summaries with the research questions, enabling efficient location of evidence for specific objectives (see **Table A4**).

**LISTS OF FIGURES**

**Figure 1. The flow diagram of screening process of included studies on the impacts of climate change on Asian urban outdoor workers’ health**

This PRISMA flow diagram outlines the systematic review process used to identify and include relevant studies. A total of 88 records were initially identified through database searches, including Google Scholar (67 records), HCM-VNU Library (11 records), and the MOST Publication Database (10 records). No ad-

**Table A2: The inclusion and exclusion criteria**

Criterion	Inclusion	Exclusion
Content	<ul style="list-style-type: none"> <li>- Research on climate/weather change and events and health impacts</li> <li>- With a focus on workers (especially outdoor workers) in urban Asia</li> <li>- Research on the impacts of climate change adaptation and mitigation on health/well-being</li> </ul>	<ul style="list-style-type: none"> <li>- Studies with a rural focus</li> <li>- Studies not in urban Asia</li> <li>- Indoor</li> </ul>
Types of literature	<ul style="list-style-type: none"> <li>- Original research papers (including qualitative studies and quantitative research)</li> <li>- Systematic literature reviews (including scoping reviews, rapid evidence assessments, meta-analyses, narrative analyses)</li> <li>- Relevant grey literature (dissertations and conference papers)</li> </ul>	<ul style="list-style-type: none"> <li>- Opinion pieces</li> <li>- Popular media (e.g. blogs, social media feeds and / or newspaper articles)</li> </ul>
Date of publication	- January 2000 – present (April 2024)	- Any research published before January 2000
Geography	- Studies from urban Asia	- Any research not from urban Asia
Language	<ul style="list-style-type: none"> <li>- Vietnamese-language</li> <li>- English-language research articles published in academic journals based in Vietnam</li> </ul>	- Other cases

[Source: The authors]

**Table A3: The final search strings**

Filter		Main keywords		Vietnamese synonyms and relevant keywords
		English	Vietnamese	
All main keywords were combined for searching in one string with synonyms and relevant keywords included.	AND	climate	khí hậu	“khí hậu” OR “thời tiết” OR “thiên tai”
	AND	health	sức khỏe	“sức khỏe” OR “bệnh” OR “triệu chứng”
	AND	work	việc làm	“làm việc ngoài trời” OR “lao động ngoài trời” OR “việc làm ngoài trời”
	AND	society	xã hội	“xã hội” OR “con người” OR “yếu thế”
Each word in this group was manually added along with the string of keywords above for searching.	AND	urban	đô thị	“đô thị” OR “thành phố” OR “thị xã”
	AND	Asia	Châu Á	“Châu Á” OR “Việt Nam” OR “Trung Quốc” OR “Timor Leste” OR “Đông Timor” OR “Indonesia” OR “Philippines” OR “Campuchia” OR “Thái Lan” OR “Lào” OR “CHDCND Lào” OR “Myanmar” OR “Miến Điện” OR “Malaysia” OR “Brunei” OR “Brunei Darussalam” OR “Ấn Độ” OR “Sri Lanka” OR “Nepal” OR “Pakistan” OR “Bangladesh” OR “Bhutan” OR “Afghanistan” OR “Bắc Triều Tiên” OR “Cộng hòa Dân chủ Nhân dân Triều Tiên” OR “Mông Cổ”

[Source: The authors]

Table A4: The data extraction framework: column groups and columns

Themes (column groups)	Sub-themes (columns)
Article reference	Author(s)
	Title
	Date (year)
	Journal / Source
	Full reference
Methodology and abstract	Abstract
	Summary of key findings and arguments
	Used methods
	Themes covered in depth
	Demographics of the sample
	Country of focus
Health impacts of weather extremes for outdoor workers	Health impacts – Type
	Health impacts – Severity
	Nature of societal vulnerabilities identified
	Impacts of climate adaptation/mitigation
Types of extreme weather impact on the health of outdoor workers	Extreme weather - Type and Forms
Forms of outdoor working that are most health exposed to weather extremes	Outdoor work – Types
	Outdoor work - Social groups
Coping strategies	What coping strategies are adopted to escape from weather extremes
	What coping strategies are adopted to adapt to weather extremes
Policy actions and recommendations	Actions
	Recommendations
Reflections	Gaps and limitations
	Suggestions for future research

[Source: The authors]

ditional records were sourced from external sources. After removing duplicates and screening titles and abstracts, 42 records were excluded, leaving 46 full-text articles for further assessment. Of these, 38 articles were excluded for being off-topic or miscellaneous types. Ultimately, 8 studies met the inclusion criteria. No additional studies were identified from reference lists.

Figure 2. The word cloud of key themes

This word cloud highlights the most frequent terms found in studies related to the health impacts of

climate change on outdoor workers. Larger words such as “workers,” “health,” “working,” “years,” and “heat” reflect the predominant focus on worker-related health issues, exposure to heat, and long-term working conditions. Other significant terms include “radiation,” “temperature,” “diseases,” and “factors,” indicating attention to environmental risks and their effects on occupational health. The variation in word size corresponds to the frequency of each term’s appearance across the reviewed studies, emphasising key themes such as heat stress, ultraviolet radiation, and the need for protective measures.

### Figure 3. The geographical research scope distribution of identified studies

This pie chart illustrates the percentage of geographical research scope across eight cities and provinces in Vietnam. The largest proportion is from Hanoi (30.8%), followed by Ho Chi Minh City and Hai Phong, each contributing 15.4%. Lang Son, Thai Nguyen, Quang Ninh, Can Tho, and Long An each account for 7.7% of the total. Different colours represent the locations: orange for Hanoi, green for Lang Son, light blue for Quang Ninh, purple for Thai Nguyen, blue for Hai Phong, peach for Ho Chi Minh City, yellow for Can Tho, and lavender for Long An. Percentages are indicated within each segment.

### Figure 4. The types and forms of extreme weather distribution

This pie chart illustrates the distribution of types and forms of extreme weather events identified in the systematic review. The largest portion, represented by 50.0% in blue, corresponds to heat-related phenomena, such as heat waves and high temperatures. Cold or extreme cold weather, shown in red, accounts for 25.0%. Meanwhile, bad weather in general, represented in yellow, and heavy rain, shown in green, each account for 12.5% of the reviewed literature.

### Figure 5. The health impacts on outdoor workers

This pie chart shows the percentage distribution of various health problems that outdoor workers suffered identified by the systematic review. Heat-related problems, such as heat stress and heatstroke, account for the largest portion (23.8%) of the reported health issues, shown in blue. Respiratory diseases (14.3% in red), dermatological diseases (14.3% in yellow), and

musculoskeletal problems (14.3% in green) are the next most commonly reported issues. Neuropsychiatric diseases, including vestibular disorders, make up 9.5%, shown in orange. Other health concerns, including traffic or occupational accidents (4.8%, light blue), digestion problems (4.8%, pink), heart-related problems (4.8%, cyan), urinary diseases (4.8%, teal), and dengue (4.8%, light green), are also highlighted but represent a smaller portion of the total health concerns.

### Figure 6. The outdoor workers' employment status distribution

This pie chart illustrates the employment status of outdoor workers identified in the systematic review. The majority, 75.0%, are formal workers, represented in green. Informal workers make up 12.5%, shown in red. Another 12.5%, indicated in yellow, are categorised as undefined. These results suggest that formal employment predominates within the surveyed population, while a smaller portion is engaged in informal work or remains undefined in terms of employment status.

### Figure 7. The word cloud of outdoor workers' coping strategies

This word cloud visualises key terms related to protective equipment mentioned in the identified studies, emphasising the prominence of personal protective measures. The largest words, such as "protective," "equipment," "personal," and "workers," highlight the central theme of occupational safety when working outdoors. Other notable terms like "clothing," "masks," "shoes," "gloves," and "hats" reflect essential protective gear commonly used in outdoor environments.