PUBLIC HEALTH RESEARCH

Heatwave Impact on Mortality and Morbidity and Associated Vulnerable Factors: A Systematic Review Protocol

Fadly Syah[1], Rozita Hod[1*], Norfazilah Ahmad[1], Mazni Baharom[1] and Fredolin Tangang[2]

[1]Department of Community Health, Faculty of Medicine, Universiti Kebangsaan Malaysia, 56000 Cheras, Kuala Lumpur, Malaysia.
[2]Centre for Earth Sciences and Environment, Faculty of Science and Technology, Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia.

**For reprint and correspondence: Assoc. Prof. Dr. Rozita Hod, Department of Community Health, Faculty of Medicine, Universiti Kebangsaan Malaysia, 56000 Cheras, Kuala Lumpur, Malaysia.*

Email: rozita.hod@ppukm.ukm.edu.my

ABSTRACT

Introduction Heatwave can increase the risk for heat-related illnesses and mortality. Many studies showed certain population are vulnerable to heatwave such as elderly, children and low-income households. However, the findings were inconsistent. This study aims to identify the effect of heatwave on the mortality and morbidity and associated vulnerability factors.

Methods Five electronic databases (Pubmed, Ebsco Host, WOS, OVID Medline and Scopus) will be the primary searching tools to retrieve relevant literatures. An additional searching tool (Google Scholar) will be used to seek for grey literatures. Selection of literature will be based on the inclusion criteria (empirical full-text article, English language and published between 2010-2021). Two authors will be assigned in each step of the process, starting from screening of the title, abstract and full text based on the inclusion criteria, data extraction and quality appraisal. Mixed-Method Appraisal Tool (MMAT) will be utilized to assess the quality of selected articles. Meta-analysis, thematic analysis and narrative approach will be the option used to describe the findings. This study protocol is registered under PROSPERO (CRD42021232847).

Conclusions This study presents a reliable and valid systematic review process that identifies a comprehensive evidence-based information on impacts of heatwave on human health especially upon the vulnerable groups.

Keywords Heatwave - mortality - morbidity - population health.

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INTRODUCTION

The significant impact of climate change on Earth is the increased global temperature, referred to as global warming. There are numerous climate and extreme weather events due to global warming, such as heatwaves, heavy rainfall, drought, and other extreme weather.[1, 2] The Intergovernmental Panel on Climate Change (IPCC) had reported that heatwaves have become more common over the last 50 years.[3]

The heatwave is proven to harm our health. It can result in two outcomes which are mortality and morbidity. A heatwave can be very significant and often disastrous, as shown by the large number of heat-related deaths reported across Europe in July and August 2003 and by the Russian Federation in July and August 2010.[3] Given the devastating impact of the heatwave events, many studies had tried to understand the vulnerability factors among the population.[4-7]

Various factors influence the vulnerability of the population on heatwaves. Vulnerability conceptualization comprises of two elements: exposure to heat and people's sensitivity.[8] Human exposure to heat is influenced by the indoor conditions (e.g. orientation of house and windows, ventilation, and heat protection measures) and outdoor (e.g. physical factors and processes such as radiation, elevation, wind, and land) temperature.[8] Meanwhile, people's sensitivity refers to the individual factors that may influence the adaptive capacity and coping mechanism with extreme weather, such as heatwaves. The adaptive ability is determined by the demographic characteristics such as (age, gender, family status), health status (pre-existing illness), access to resources, risk perception, support and information, and mobility.[9, 10]

Several studies have shown strong association of the impact of heatwaves on mortality and morbidity. As an example, study done by Cheng et al[11] showed that heatwave exposure increased the overall mortality by 28%. A study in Tehran showed the non-external cause of death increases significantly during heatwaves.[12] A study done by Astrom et al[13] projected that cardio-respiratory-related admission would be three times higher in 2021-2050.

The vulnerable groups, such as the elderly, infants, and people with pre-existing chronic conditions, will face more severe effects from the heatwave's events.[12, 14-16] Elderly is one of the most vulnerable group due to the decline of efficiency in body temperature regulation as they age.[17] Cardiovascular diseases will be compromised with heatwaves exposure. The underlying pathophysiologic mechanism on the relation of heat stress and cardiovascular disease, such as increased red and white cell counts in the circulation, leads to increased blood viscosity, the release of platelet into the bloodstream, and reduced plasma volume.[18] Thus, it is essential to recognize these vulnerable groups for early preventive measures.

Research question

This systematic review aims to answer the following questions:

1. What is the impact of heatwaves on mortality and morbidity?
2. What is the underlying cause for the vulnerability on each mortality and morbidity impact?

METHODS

Protocol and Registration

The protocol is registered in the PROSPERO (CRD42021232847). The protocol's structure and final review is based on the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) guideline.19

Patient and Public Involvement

Not applicable as this is a systematic review protocol.

Eligibility Criteria

i. Types of Study

This systematic review will include all published empirical data articles (original study) of observational study designs (cohort, case– control, cross-sectional and ecological time series) that evaluated the impact of heatwaves on mortality and morbidity and associated vulnerability factors.

ii. Inclusion criteria:

- It is an original study.
- Used heat wave as the main exposure of interest and included a clear definition of heat wave.
- Used mortality and/or morbidity as the main health outcome.
- Studied the associated vulnerability factors between heat waves and mortality/morbidity.

iii. Types of exposure

We will include studies that defined heatwaves in their studies and evaluate the impacts of heatwaves on health. The exposures are defined as:

- Measures or variation of health impact (mortality and morbidity) with the event of heatwaves
- Measures of vulnerability factors which refers the specific characteristics of the population that associated either mortality or morbidity in the event of heatwaves.

Searching strategy

We will systematically conduct a comprehensive literature search using various databases (Pubmed,

Ebscohost, WOS, Ovid Medline, Scopus). Selected articles will be based on the inclusion and exclusion criteria. The Medical Subject Heading (MeSH) terms and free-text terms will be used for comprehensive search strategy. The search term will be based on the PICo process and using a Boolean operator for each selected database. P (Population/Problem): Heatwave; I (Intervention/Issue): Vulnerability; Co (Context): mortality and morbidity. The keyword used were "heatwave" OR "global warming" OR "climate change" "hot weather" AND "vulnerability" OR "susceptible" OR "exposed" OR "prone" OR "disadvantaged" OR "disadvantage" OR "risk" AND "mortality" OR "death" OR "fatal" OR "lethality" OR "morbidity" OR "heat-related illness" OR "hospital admission" OR "hospitalization" OR "heat stress" OR "cardiovascular" "respiratory" OR "renal disease". Additional sources will be obtained from the reference list from all selected studies included in the inclusion criteria and Google Scholar (grey literature).

Selection of studies

There will be three phases of selecting the articles: screening of title, then abstract and finally, the full-text review. Two review authors will perform the screening for potential eligible studies (inspect title and abstract, full text or both). All studies that met the inclusion criteria will be included in the study. The third author will help to resolve any disagreement.

Data extraction

The review authors will develop a standardized data extraction tool to record the relevant information from the articles. Two review authors will extract the data from each selected article independently. The relevant information includes the necessary bibliographic information (title, author, journal name, and year of publication), characteristics of the study (study design, methodology, country of the study, study objectives, heatwave definition, and sample size), main findings (vulnerable factors on heatwave impact on mortality and morbidity) and the study limitations. The third author will help to resolve any disagreement.

Quality assessment

The Mixed Method Appraisal Tool (MMAT) will be used to evaluate the selected articles' quality.20 The MMAT comprised of two screening questions and 25 criteria for the critical appraisal of systematic mixed-method reviews, including quantitative, qualitative, and mixed-method studies based on empirical data. There were five study designs categorized in the MMAT: qualitative, quantitative randomized controlled trials, quantitative non-randomized, quantitative descriptive, and mixed methods study. Each criterion's scoring was based on a categorical scale (yes, no and cannot tell). The maximum score of each criterion is 7 points, where studies with MMAT Score 1-4 will be classified as low quality, 4-5 considered as moderate and 6-7 will be ranked high quality. Two authors will independently assess the study quality for each study according to the criteria incorporated by MMAT. There will be a discussion with the third reviewer if any disagreement happens.

Strategy for data synthesis

The systematic review will be using a mixed-method approach on each selected article. It encompassed two parts of data analysis (quantitative analysis and qualitative analysis).

First, the quantitative analysis will include all the quantitative data and quantitative part from mixed-method studies. The findings obtained, such as statistical outcome (ie., odd ratio, mean differences, and 95% confidence) intervals from this quantitative analysis will be thoroughly described. If appropriate with available data, results from comparable groups of studies will be pooled into statistical meta-analysis using Review Manager software from the Cochrane Collaboration. If the data not available for meta-analysis, findings will be presented in narrative form.

In the qualitative analysis, the findings of qualitative studies and qualitative parts of mixed-method studies will be analysed using a qualitative thematic analysis to describe the findings. A meta synthesis will be performed using the GRADE-CERQual method. If the data not available for meta-synthesis, findings will be presented in narrative form.

The selected articles will be divided into two groups (mortality and morbidity outcomes from the impact of heatwaves). The vulnerability factors of each mortality and morbidity group will be described separately. Both quantitative and qualitative findings from the selected articles will be merged using a narrative approach for the overall results.

Publication bias will be assessed by using funnel plot examination and rank-correlation test.

DISCUSSION

This systematic review will be the latest article that we know that review both mortality and morbidity vulnerability factors in one paper. This systematic review potentially will provide the latest and comprehensive information on the vulnerability factor for the heatwave impact either on mortality or morbidity.

Extreme heat events such as heatwaves have long threatened human health. Exposure to heatwaves is associated with increased hospital admissions especially cardiorespiratory disorders.[6, 21] Heat related illnesses (HRIs) also significantly

increase the mortality.[7,22] However, not everyone is equally at risk from heatwave exposure. Some of the vulnerable groups such as elderly people,[11] low-income populations[23] and people with existing chronic medical conditions[24] will have severe impact compared to the healthy populations. These vulnerability factors are inter-related and vary depending on many factors. Thus, identification of the vulnerable groups is crucial for control and mitigation of the diseases.

All this information will help the healthcare sector identify the population's vulnerability risk factors in their respective area. The findings can be used as guidelines for top managers and stakeholders to control and mitigate the disease. Our research implications will suggest future research priorities and outline the remaining uncertainties and knowledge gap in the area.

The strength of this study will be a clear and comprehensive approach to the systematic review process. This systematic review will be the latest evidence available that study the vulnerability of both mortality and morbidity impact from heatwaves.

Meanwhile, the limitation of this study will be the restriction to English language article. Some of the non-English articles might contain important information on this study topic. Bias from the author's judgment also can be a limitation for this systematic review.

CONCLUSION

This study protocol provided a reliable and valid process for systematic to establish a deeper and solid understanding of the impacts of heatwave on human health, as well as identifying the vulnerable groups.

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