

# Climate change and climatic variation impact on chronic oedemas: a protocol for a systematic review

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## Key words

Chronic oedema, climatic variation impact, climate change, international perspectives, literature review, lymphoedema, symptom variation and linkage, systematic review

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## Abstract

Chronic oedema is a significant problem worldwide and results in substantial burden on the health service and can be a major burden on the quality of life for those impacted by this disease. Primary management techniques involve ongoing use of compression garments and bandaging. However, patients report that higher temperatures and increased humidity result in an exacerbation of symptoms and increased difficulty complying with these treatment recommendations. With global temperatures predicted to rise up to 2.5 degrees over the coming years, these problems will continue to intensify. Understanding how the climate and climatic variations impact on symptoms of chronic oedema will enable improved treatment and management recommendations to improve health outcomes for people. Before commencing detailed investigations into this topic, it is essential to understand what research has already been completed and where the current gaps in knowledge are. In that light, a detailed systematic review of the literature is an essential first step. It is often hard to determine the best strategies for a systematic review so the full details of what we did is presented here to help others undertaking this task.

**C**hronic oedema is a significant problem worldwide and results in substantial burden on the health service. In the UK alone, it is estimated to impact 6 in every 1000 people (National Lymphoedema Partnership, 2019) and up to 28.75 per 1,000 for those aged 85 or older (Moffatt et al, 2017). Todd (2013) suggests that the prevalence is likely to be significantly higher than this as the condition is not always well diagnosed and patients don't always seek assistance for swollen limbs, and it is therefore under-reported. There are substantial financial costs associated with management of chronic oedema. Community based management involves skin care, external pressure (bandaging or garments), exercise and massage / manual lymphatic drainage. In addition, acute infections requiring hospital admission occur frequently.

Furthermore, it has a major impact on quality of life with one study reporting 80% of patients had taken time off work

as a direct result of their oedema as well as experiencing a negative ability to function socially and physically, with subsequent emotional distress (Moffatt et al, 2003).

With many of these conditions impacting the function of the lymphatic system, the terms lymphoedema and chronic oedema have been known to be used interchangeably (National Lymphoedema Partnership, 2015; Piller et al, 2017; Keeley, 2018).

Chronic oedema is primarily managed through ongoing use of compression garments, bandaging and manual lymphatic drainage. However, higher temperatures and increased humidity result in additional discomfort and may, therefore, lead to reduced compliance with these treatment recommendations resulting in increased swelling and poorly controlled symptoms (Piller, 2015). Indeed, this has been shown through analysis of cellulitis, a common complication of chronic oedema, where there was a marked increase (up to 34.8%) of hospital admissions in summer months compared to the cooler winter months

(Peterson et al, 2017; Hsu et al, 2019). Similarly, a study of the effect of seasonal variations in climate and upper-limb measures in a healthy population produced statistically significant increase in arm size in spring compared to summer and winter (Matthews and Gordon, 2010). It was suggested that the varying temperatures and humidity levels were responsible for this finding. Understanding the impact of climatic variations on the chronic oedema population is critical to ensuring best management techniques and effectiveness of interventions.

The issue of rising temperatures as a result of climate change is well understood with scientists predicting a 1.5–2.5% increase in average temperatures across the globe by 2050 (US Global Change Research Program, 2017).

These climatic changes present a challenge for human health and wellbeing, particularly in areas of already warm to hot climates. Increased temperatures contribute to more heart attacks, strokes,

accidents, and heat exhaustion as well as increased human stress and reduced work capacity (Costello et al, 2009; Hughes and McMichael, 2011; McMichael et al, 2012; Kjellstrom et al, 2017). Understanding these changes and the predicted impact on specific conditions will enable us to be proactive in the treatment and management strategies and thereby reduce risk and improve health outcomes.

This systematic review will consider seasonal variations in climate, as well as differences in climatic conditions between regions. It is often hard to determine the best strategies for a systematic review so the full details of what we did is presented here to help others undertaking this task.

### OBJECTIVES

The objective of this study was to systematically review the literature for evidence about the impact climatic conditions on chronic oedema. The secondary aim was to provide direction for further research into understanding environmental and climatic influences on chronic oedema to enable recommendations for treatment and management.

### METHODS

The review included both quantitative and qualitative studies that made connections between the climate and clinical presentation of chronic oedema. Preliminary searches of the data suggested that there are very few published articles matching this criterion, therefore, all study types were considered.

Studies were included that examined the general population (adult and/or children) who have chronic limb oedema as a result of primary or secondary lymphoedema, lipoedema, elephantiasis, vascular insufficiency, trauma-related oedema or any other condition that results in an imbalance between capillary drainage and lymphatic filtration. We focused on studies that made connections with specific environmental/climatic conditions or seasonal variations on presentation of chronic limb oedema, within and between geographical locations.

Exclusion criteria included articles that were not a primary study and studies published before 2000. In addition, lymphatic filariasis, a parasitic infection that is spread by mosquitos infected with

**Table 1.** MEDLINE (Ovid) search strategy.

1	(climate change or microclimate or climatic or climate or season* or subtropic* or desert or cold weather or cold climate or monsoon or humid or humidity or weather or season* or wet season).mp.
2	((dry or hot or heat or tropic* or environment or geograph*) adj3 (climate or temperat*)).mp.
3	exp Climate/ or exp Climate Change/ or Meteorological Concepts/
4	1 or 2 or 3
5	(lymphedema or lymphoedema or chronic oedema or chronic edema or podoconiosis or elephantiasis or lymphatic or filariasis or cellulitis or lipoedema or lipedema or lipohyperdystrophy or endocrine dysfunction or vascular insufficiency).mp.
6	lymphedema/ or breast cancer lymphedema/ or elephantiasis/ or elephantiasis, filarial/ or non-filarial lymphedema/
7	edema/ or edema, cardiac/
8	Cellulitis/
9	Lipedema/
10	or/5-9
11	4 and 10
12	(mice or rats or monkey or resus).mp.
13	11 not 12

worm larvae (Lourens and Ferrell, 2019), and podoconiosis, mineral particle-induced inflammation caused by long-term exposure to red clay soils (Deribe et al, 2018), were only included if the study discussed how the disease is influenced by climatic variations.

The definition described by the National Lymphoedema Partnership (2015) on the International Lymphoedema Framework was used to guide this investigation. "Chronic oedema is a term used to describe a group of conditions characterised by the presence of swelling within tissues of the body, caused by the accumulation of excess fluid within the interstitial space of the affected area". While chronic oedema generally refers to the presence of swelling for 3 months or longer, some conditions will be known to have long-lasting implications and, therefore, may be considered chronic earlier than 3 months (Bianchi et al, 2012; Piller et al, 2017; Moffatt et al, 2019).

### Comparators

There were no direct comparators as 'climatic variations' were considered as one element, however, if the literature indicated significant potential comparison types, such as humidity, air flow, temperature,

geographical location etc then eligibility was revisited for comparisons.

### Information sources

Literature search strategies were developed using medical subject headings (MeSH) and text words related to chronic oedema and climate. We searched all health databases including MEDLINE (via Ovid), CINAHL, Informit health Database Collection, Emcare (via Ovid), PubMed, PsycINFO, Web of Science, ProQuest, Ageline, Scopus, Eldis, REHABDATA, Trip, OT Seeker, PEDro, GreenFILE, and Best Practice. We also searched the Cochrane Library. The electronic database search was supplemented by searching for research through other sources, including Google Scholar and Grey Literature. Additionally, PROSPERO was searched for ongoing or recently completed systematic reviews.

To ensure literature saturation, we scanned the reference lists of included studies or relevant reviews identified through the search. We also searched the authors' personal files to make sure that all relevant material had been captured.

### Search strategy

Both qualitative and quantitative studies

were sought. No study design or language limits were imposed on the search, although only studies in languages other than English that can be translated adequately using Google Translate were included.

The search strategy was developed in MEDLINE with input from the project team and University research librarians experienced in systematic review searching. Once finalised, it was adapted to the syntax and subject headings of the other databases.

Table 1 details the authors' search strategy for MEDLINE (Ovid interface) and Epub.

### Data management

Literature search results were uploaded to Covidence (<https://www.covidence.org/home>), an internet-based software programme that facilitates collaboration among reviewers during the study selection process. The team developed, and test screening questions based on the inclusion and exclusion criteria.

### Selection process

Two review authors independently screened the titles and abstracts yielded by the search against the inclusion criteria. Full articles for all titles that appear to meet the inclusion criteria or where there is any uncertainty, were obtained. Review authors then screened the full text articles and decided whether these met the inclusion criteria. The authors recorded the reasons for excluding studies.

Neither of the review authors were blind to the journal titles or to the study authors or institutions, however, they were blind to each other's decisions until both voted. Reviewers resolved disagreements by discussion, and one of two arbitrators adjudicated unresolved disagreements.

### Outcomes

The primary outcome was the connection between geographical location/climate and presentation of chronic limb oedema. The clinical outcomes to be considered are disease progression/changes, compliance with treatment and management recommendations, diagnoses, population statistics (i.e. % of diagnoses per region), quality of life and infection rates. Cellulitis, as a known common complication of chronic oedema, was also considered.

Environmental connections considered were adverse weather events, seasonal

variations, climate related to geographical location, topical conditions, such as temperature, humidity, rainfall etc, perceived temperature and adaptive comfort.

Outcomes were collected as reported, with the exception of quality of life, which was collected only if associated with validated tools. Due to possible variation in disease definitions over time, we extracted definitions of outcomes as reported in individual studies. Articles reported in any language were included if they could be adequately translated into English using Google Translate.

Where possible, we used the Thom Discomfort Index to gauge a level of human discomfort based on climatic conditions (Angouridakis and Makrogiannis, 1982; Rusanescu et al, 2020). Additionally, the Köppen-Geiger climate classification was used to identify climatic regions (Peel et al, 2007).

The main outcomes were presented in a summary of findings table.

### Risk of bias in individual studies

To facilitate the assessment of possible risk of bias for each study, we customised the Covidence tools based on the Crowe Critical Appraisal Tool (CCAT), which covered the preliminaries, introduction, design, sampling, data collection, ethical matter, results and discussion. A judgement as to the possible risk of bias on each of the domains was made and scored from 1–5. Scores were added for a total overall score. For each domain in the tool, we commented on the procedures undertaken for each study. If there was insufficient detail reported in the study, we judged the risk of bias as “unclear”. Judgements were made by two review authors. Disagreements were resolved first by discussion and then by consulting a third author for arbitration.

### Data synthesis

A meta-analysis mixed methods synthesis was applied to identify themes and characteristics of the identified studies. Information was presented in text and tables to summarise and explain the qualities and findings of the included studies.

### Conclusion

Chronic oedema is a major clinical problem world wide and presents significant economic cost as well as distressing physical, psychological and social well-being effects

on the individual (Guest et al, 2015; Moffatt et al, 2019; Wound Care People, 2019). Current management techniques involve compression garments, bandaging and manual lymphatic drainage but compliance with these recommendations is challenging in areas of warm to hot temperatures (Piller, 2015). With climate and health being intrinsically linked (McMichael et al, 2008) it is not possible to consider the issue of chronic limb oedema management without also considering the influence of the climate.

Understanding the impact of climatic variations on chronic oedema symptoms, therefore, is critical to ensuring best management techniques and effectiveness of interventions. Climate change has been shown to have several direct and indirect influences on human health. In particular, we are seeing an increase in adverse weather events and an increase in average temperatures (Hughes and McMichael, 2011). This systematic review considered seasonal variations in climate, as well as differences in climatic conditions between regions and the correlation this presents for chronic limb oedema.

Results from this systematic review were published in 2021 (Witt et al, 2021) and provided direction for further research into the impact of climate on chronic limb oedema. In turn, this provided essential evidence to support treatment recommendations and subsequently improved patient outcomes based on environmental conditions.

### Registration

In accordance with the guidelines, our systematic review protocol was registered with the International Prospective Register of Systematic Reviews (PROSPERO) on 28/05/2020 (registration ID 163160).

### Collaboration

We invite others interested in this significant area of impact to contact the corresponding author to explore ways and means of further collaborative effort in this area. Please contact Susan Witt at [susan.witt@flinders.edu.au](mailto:susan.witt@flinders.edu.au) if you are interested.

### Conflict of Interest

The authors report no conflict of interest.

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