Effect of cooling vests on physiological and perceptual responses: A systematic review protocol

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Protocol

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Abstract

Background: Human in hot environments are exposed to several risks and discomforts which seriously affect their physiological and mental workload. However, they are required to take frequent rest breaks to prevent heat strain when working in hot environments. The main objective of this study is to systematically summarize the literature about the effect of cooling vests on physiological and perceptual responses that might help research and practice in the future. **Inclusion criteria:** Studies in scientific journals and other databases, focusing on the effect of cooling vests on physiological and perceptual responses will be included.

Methods: Three main databases such as PubMed, Scopus, and Web of Science will be searched to find relevant literature on type of cooling vest and effects using subject headings and appropriate MeSH terms. Inclusion and exclusion criteria will be used for screening. Two authors will participate in all of the search stages including preliminary search, screening, quality assessment, data extraction, and data synthesis. We will limit our search to articles published in a peer review journal between 2000 and 2019. The protocol has been written according to PRISMA-P checklist. Three main databases such as PubMed, Scopus, and Web of Science will be searched to find relevant literature on type of cooling vest and effects using subject headings and appropriate MeSH terms. Inclusion and exclusion criteria will be used for screening. Two authors will participate in all of the search stages including preliminary search, screening, quality assessment, data extraction, and data synthesis. We will limit our search to articles published in a peer review journal between 2000 and 2019. The protocol has been written according to PRISMA-P checklist.

Objective: The aim of this systematic review is to investigate and compare the effect of different types of cooling vests on physiological and perceptual responses in order to choose the best one according to affecting factors.

PROSPERO Registration Number: CRD42019140820

Background

Outdoor workers, such as construction workers, miners, and hot processes in iron, steel, glass and rubber foundries, firefighters who perform highly intense physical activities, are exposed to heat stress, particularly in tropical and subtropical regions or countries (1-3). The combination of physical activities, high ambient temperatures and humidity may create excessive heat strain, which would effect on physical, subjective and physiological performance if preventive measures are not taken (2, 4). Various types of personal cooling (PC) garments have been developed to mitigate heat strain in users hot environmental occupations, e.g., fluid cooling garments (FCGs)(5) are using a system that circulates cold water or air through a tube-lined shirt or garment, phase change material garments (PCM) uses the latent heat storage of phase change materials (4), evaporative cooling garments (ECGs)(6) is another type of

cooling garments that large latent heat of water evaporation for cooling, and hybrid cooling garments(HBCUs) that combine two or more of cooling systems(7-9).

There are indices for represents the combined strains of the thermoregulatory, cardiovascular systems (e.g. physiological strain index (PSI) (10) and quantify perceptual responses (e.g. rating of perceived exertion (RPE, 6–20) (11), thermal sensation (0.0–8.0) (12), perceived thirst (1–7) (13), and muscle pain (0–10)(14)). Wearing microclimate cooling systems(MCSs) significantly increase physiological responses (core body temperature and sweating rate (-0.34 °C/h, -0.30 L/h respectively), and performance (+29.9%, effect size [EFS] =1.1) compared with no wearing MCSs (15). Also, another a meta-analysis showed that precooling (prior to exercise) has a moderate (d=0.73) effect on human performance and cooling during exercise has a positive effect on performance (d=0.76) in hot environmental (16). Although CVs have been extensively applied and proven as an effective design in the decrease or remove physiological parameters and improve performance in many occupational workers and other physical activity in workplaces with exposure to the extreme environment (15). Less attention has been focused on their perceptual responses. In this regard, thermal perceptions that are perceptual and subjective responses to heat stress should also be considered (17).

REVIEW QUESTIONS

The questions of this review are:

- How can affect the cooling vests on physiological responses?
- How can affect the cooling vests on perceptual responses?
- Are there any differences among types of CVs?
- Can use to the cooling vests induced decrease heat stress?

OBJECTIVES

Primary objectives

The primary objectives of this systematic review include:

- Investigating effect of CVs on human observational- perceptual responses, which will be particularly helpful for preventing of heat stress among workplaces populations
- Comparing the efficacy of different types of cooling vests in reducing physiological and perceptual responses in workplace.

Secondary objectives

- Investigating the effect of CVs on physiological responses human body.
- Investigating the effect of CVs on perceptual responses human body.
- Investigating the efficacy of types of CVs in heat stress reduction

Methods

This systematic review study will investigate existing documents with search phrases and terms including cooling vests, physiological response, and effect employing Mesh terms or synonyms related to search strategy. Web of Science, PubMed, Scopus, Cochrane Library and Google. This systematic review will be done using the suggested reporting items for systematic review and meta-analysis protocol (PRISMA-P) 2015(18). This protocol has been written based on the PRISMA Protocol Checklist and has been registered in the PROSPERO with the registration number: (CRD42019140820)

ELIGIBILITY CRITERIA

- Studies investigate types of CVs.
- Studies that Compare among of CVs.
- Studies investigating the Performance of types of CVs.
- Studies investigating the effect of CVs on physiological responses human body.
- The effect of CVs on perceptual responses human body.
- Studies with the English language.
- Studies investigating perceptual human responses.

EXCLUSION CRITERIA

- Studies about the effect of personal cooling on thermal manikins.
- Studies investigating the effect of personal cooling on spinal cord injury.
- Studies on the effect of personal cooling on cure infant or other diseases.
- Studies investigating on the modeling of personal cooling without human subjects' response.
- Studies with non-English language.

SEARCH STRATEGY

The aim of the search is to find both published and unpublished studies. A preliminary search of Pubmed was undertaken to identify articles on this subject. The text words contained in the titles and abstracts of relevant studies, and the Mesh terms used to describe the articles were used to develop a full search strategy (see Appendix 1). If we find other relevant keywords during our primary search, we will include in the search syntax. Also, the included studies reference will be searched for additional studies.

INFORMATION SOURCES

We will search PubMed, Scopus, and Web of Science. Other resources such as conference papers, books, thesis, research reports, and guidelines will also be investigated to find the gray literature. Conference papers will be searched via Scopus database. In order to find more related studies, the reference lists of included papers and the table of contents of key journals on the subject will also be investigated. Studies that were published between 2000 and 2019 will be included.

ARTICLE SCREENING

All searched studies will be exported in the EndNote software then duplicated records will be removed. Two informed authors will investigate them separately in order to identify relevant studies according to title, abstract and keywords. Then reviewers will investigate identified articles based on inclusion criteria for their full-text investigation. The included study lists of two reviewers will be compared and cases of disagreements will be resolved through discussion and consensus. In the case of unresolved disagreements between two reviewers, the entire research team will make the decision about the inclusion or exclusion of a study. More potential relevant documents will be identified through the extracted documents references and key journals. Also guidelines, standards and documents introducing models or tools will be reviewed to find more relevant factors.

SELECTION PROCESS

Using EndNote software identified studies will be classified and screened. Two reviewer authors will investigate them separately in order to identify relevant studies according to title, abstract and keywords. Then reviewers will investigate identified articles based on inclusion criteria for their full-text investigation. The included study lists of two reviewers will be compared and cases of disagreements will be resolved through discussion and consensus. In the case of unresolved disagreements between two reviewers, the entire research team will make the decision about the inclusion or exclusion of a study.

ASSESSMENT OF METHODOLOGICAL QUALITY

The methodological quality of the included documents will be assessed using a researcher-made quality assessment form. Two reviewers will evaluate each document quality using a checklist. In case disagreements were not resolved, a third reviewer would reassess the manuscripts.

Data extraction

After completing the process of searching literature, the full text of studies will be given to the reviewers. Then two data extraction forms will be used for data extraction. The first form will include general information of the included articles such as first author name, publication year, document type, study location, the methodology of research and findings. Another form will be used to identify the details of indicators and domains. The corresponding author will be contacted by email and ask authors to give full texts or data, in case of failing to access them. In the case of inaccessibility to the full text of articles, they will be excluded from the study.

Discussion

People most often required to perform prolonged periods of indoor and outdoor jobs under conditions frequently exposed to high heat and humidity (19). In recent years, personal cooling garments have been developed to ensure the user remains thermal comfort and thermoregulation when exposure to extreme environmental conditions during a long period of time (20). PC garments that in order to thermal comfort technologies offer a potentially low-cost solution toward mitigating energy use by HVAC systems (21). Numerous efforts have been made to reduce heat strain and human performance working underneath personal protective equipment (PPE) ensembles by applying various types of CVs such as liquid cooling, air cooling and phase changing material or ice. This types of equipment can affect physiological and perceptual responses in persons that use to these (22).

There is no consistent finding on the effectiveness of CVs on human subjective judgments and physiological responses to heat exposure. This may be because different studies administered the different type of supplements and they assessed the effects on different variations. The results of this systematic review could be helpful for occupational health services provider and experts to understand the best type of CVs supplement for users that frequently exposed to heat stress.

Abbreviations

CVs

Cooling Vests

PC

Passive Cooling

FCGs

fluid cooling garments

ECGs
evaporative cooling garments
HBCUs
hybrid cooling garments
PSI
physiological strain index
RPE
rating of perceived exertion
MCSs
Wearing microclimate cooling systems
MeSH
Medical Subject Headings
NNR
Number Needed to Read

Declarations

Ethics approval and consent to participate

Conflicts of interest

Not applicable

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

PH, AH, GM, FH, and HD designed the study and approved the project. PH and AH prepared the manuscript draft and all authors approved the final manuscript.

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Not applicable

References

1. Shirish A, Kapadia V, Kumar S, Kumar S, Mishra S, Singh G. Effectiveness of a cooling jacket with reference to physiological responses in iron foundry workers. *International journal of occupational safety and ergonomics*. 2016;22(4):487-93.
2. Itani M, Ouahrani D, Ghaddar N, Ghali K, Chakroun W. The effect of PCM placement on torso cooling vest for an active human in hot environment. *Building and Environment*. 2016;107:29-42.
3. Habibi P, Momeni R, Dehghan H. Relationship of environmental, physiological, and perceptual heat stress indices in Iranian Men. *International journal of preventive medicine*. 2015;6.
4. Kenny GP, Schissler AR, Stapleton J, Piamonte M, Binder K, Lynn A, et al. Ice cooling vest on tolerance for exercise under uncompensable heat stress. *Journal of occupational and environmental hygiene*. 2011;8(8):484-91.
5. Yang Y. Vacuum Desiccant Cooling for Personal Heat Stress Management: Université d'Ottawa/University of Ottawa; 2016.
6. Zhao Y, Yi W, Chan AP, Wong FK, Yam MC. Evaluating the physiological and perceptual responses of wearing a newly designed cooling vest for construction workers. *Annals of work exposures and health*. 2017;61(7):883-901.
7. Lu Y, Wei F, Lai D, Shi W, Wang F, Gao C, et al. A novel personal cooling system (PCS) incorporated with phase change materials (PCMs) and ventilation fans: an investigation on its cooling efficiency. *Journal of thermal biology*. 2015;52:137-46.
8. Itani M, Ghaddar N, Ghali K. Innovative PCM-desiccant packet to provide dry microclimate and improve performance of cooling vest in hot environment. *Energy Conversion and Management*. 2017;140:218-27.
9. Moran D, Pandolf K, Shapiro Y, Laor A, Heled Y, Gonzalez R. Evaluation of the environmental stress index for physiological variables. *Journal of thermal biology*. 2003;28(1):43-9.
10. Habibi P, Dehghan H, Rezaei S, Maghsoudi K. Physiological and perceptual heat strain responses in Iranian Veiled women under laboratory thermal Conditions. *Iran J Health Saf Environ*. 2012;1(4):172-76.
11. Borg G. Perceived exertion as an indicator of somatic stress. *Scand j rehabil med*. 1970;2:92-8.
12. Toner MM, Drolet LL, Pandolf KB. Perceptual and physiological responses during exercise in cool and cold water. *Perceptual and motor skills*. 1986;62(1):211-20.
13. Engell DB, Maller O, Sawka MN, Francesconi RN, Drolet L, Young AJ. Thirst and fluid intake following graded hypohydration levels in humans. *Physiology & behavior*. 1987;40(2):229-36.

14. Cook DB, O'connor PJ, Eubanks SA, Smith JC, Lee M. Naturally occurring muscle pain during exercise: assessment and experimental evidence. *Medicine and science in sports and exercise*. 1997;29(8):999-1012.
15. Chan AP, Song W, Yang Y. Meta-analysis of the effects of microclimate cooling systems on human performance under thermal stressful environments: potential applications to occupational workers. *Journal of Thermal Biology*. 2015;49:16-32.
16. Tyler CJ, Sunderland C, Cheung SS. The effect of cooling prior to and during exercise on exercise performance and capacity in the heat: a meta-analysis. *Br J Sports Med*. 2015;49(1):7-13.
17. Dehghan H, Habibi E, Habibi P, Maracy MR. Validation of a questionnaire for heat strain evaluation in women workers. *International journal of preventive medicine*. 2013;4(6):631.
18. Nassiri P, Monazzam MR, Golbabaie F, Dehghan SF, Rafieepour A, Morteza pour AR, et al. Application of Universal Thermal Climate Index (UTCI) for assessment of occupational heat stress in open-pit mines. *Industrial health*. 2017.
19. Mokhtari Yazdi M, Sheikhzadeh M. Personal cooling garments: a review. *The Journal of The Textile Institute*. 2014;105(12):1231-50.
20. Tong JK, Huang X, Boriskina SV, Loomis J, Xu Y, Chen G. Infrared-transparent visible-opaque fabrics for wearable personal thermal management. *ACS Photonics*. 2015;2(6):769-78.
21. Barr D, Gregson W, Sutton L, Reilly T. A practical cooling strategy for reducing the physiological strain associated with firefighting activity in the heat. *Ergonomics*. 2009;52(4):413-20.
22. Shamseer L MD, Clarke M, Ghera D, Liberati A, Petticrew M, Shekelle P, Stewart LA. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: elaboration and explanation. . *Bmj* 2015;2:7647.

Appendix I: Search Strategy

Pubmed search

#Insert name of database (insert name of the platform/service provider), e.g. MEDLINE (Ovid) #

Search conducted on #month, year#

Search	Query	Records retrieved
#1	("cooling vest"[tiab] OR (cooling[tiab] AND vest*[tiab]) OR "cooling garment"[tiab] OR (cooling[tiab] AND garment[tiab]) OR "passive cooling"[tiab] OR (passive[tiab] AND cooling[tiab]) OR "fluid cooled garment"[tiab] OR FCG*[tiab] OR "phase change material"[tiab] OR PCM*[tiab] OR "evaporate cooled garment"[tiab] OR ECG*[tiab] OR "vacuum desiccant cooling"[tiab] OR VDC[tiab] OR cloth*[tiab] OR "active cooling vest"[tiab]) AND ("physiological response"[tiab] OR (physiological[tiab] AND response*[tiab]) OR "perceptual response"[tiab] OR (perceptual[tiab] AND response[tiab]) OR "heart rate"[tiab] OR (heart[tiab] AND rate[tiab]) OR "core temperature"[tiab] OR (core[tiab] AND temperature[tiab]) OR "sweat rate"[tiab] OR (sweat[tiab] AND rate[tiab]) OR "skin temperature"[tiab] OR (skin[tiab] AND temperature[tiab]) OR "oral temperature"[tiab] OR (oral[tiab] AND temperature[tiab]) OR "PSI index" OR PSI OR "thermal comfort"[tiab] OR (thermal[tiab] AND comfort[tiab]) OR RPE[tiab])	4639
26 July 2019.		