Pharmacophore, 13(6) 2022, Pages: 84-89

Pharmacophore

ISSN-2229-5402

Journal home page: http://www.pharmacophorejournal.com

Pharmacophore
an International Journal
ISSN 2229-5402

THE ROLE OF COLD EXPOSURE ON ISCHEMIC HEART DISEASE: A SYSTEMATIC REVIEW

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ARTICLE INFO

Received:
19 Sep 2022
Received in revised form:
07 Dec 2022
Accepted:
09 Dec 2022
Available online:
28 Dec 2022

Keywords: Cold exposure, Ischemic heart disease, Coronary artery disease, Systematic review

ABSTRACT

The primary aim of this systematic review is to examine the published research on the connection between cold exposure and ischemic heart disease (IHD). We conducted a systematic search through PubMed, Web of Science, Science Direct, EBSCO, and the Cochrane library. Using Rayyan QCRI, study articles were first screened by title and abstract before a full-text analysis was implemented. A total of six studies with 281979 patients were included. We comprised various cold events, including cold work environments among workers, cold spells, usual cold exposure, and prolonged extreme cold. Two studies reported that cold exposure among workers and the general population increases the risk of mortality rate due to myocardial infarction (MI). In CAD patients, prolonged severe cold exposure worsens coronary events (signs and symptoms). This comprehensive review indicated that exposure to the cold increased the risk of MI-related death in both workers and the general population. Furthermore, continuous exposure to extremely cold conditions makes coronary events worse in people with CAD.

To Cite This Article: Sabah ZU, Alarim RAO, Alarim MAO. The Role of Cold Exposure on Ischemic Heart Disease: A Systematic Review. Pharmacophore. 2022;13(6):84-9. https://doi.org/10.51847/Z8ksWSnevd

Introduction

Ischemic heart disease is defined by decreased cardiac blood flow, which throws off the balance between the oxygen supply and demand in the myocardium [1-3]. Most typically, coronary artery disease (CAD), caused by atherosclerotic spasm or blockage of the epicardial coronary arteries, or microvascular dysfunction, is the underlying clinical mechanism. As a result, the terms IHD and CAD are frequently used interchangeably. IHD is a chronic, progressive disorder, although it can change or even start as an unstable state at any time, usually due to an acute atherothrombotic event brought on by plaque erosion or rupture. Numerous clinical manifestations are caused by the dynamic nature of the CAD process, but the most straightforward classifications are chronic coronary syndromes (CCS) and acute coronary syndromes (ACS) [4, 5].

Although cardiovascular disease mortality is declining, it is still the leading cause of death throughout the world [6]. Across the US, CAD accounts for around 30% of all fatalities over 35 years and causes more than 1.7 million deaths annually in Europe, accounting for 20% of all deaths. Over the past ten years, age-standardized death rates for CAD have decreased by 30% to 60% in high-income and many middle-income nations. The prevalence of the cardiovascular disease varies significantly between nations still [7, 8].

A complex, immunoinflammatory disease of the arteries, atherosclerosis is fueled by lipids. The process by which lipids penetrate the intima and atherosclerotic plaque forms in the coronary arteries is accelerated by risk factors such as smoking, hypertension, diabetes mellitus, male gender, and inflammation. The imbalance between oxygen demand and supply in the myocardium caused by reduced blood flow in the coronary arteries as a result of atherosclerotic luminal constriction and endothelial dysfunction leads to ischemia. Primary or induced coronary artery vasospasm, deficient microcirculation or arteriolar dysregulation, coronary emboli, reduced coronary perfusion due to hypotension, decreased blood oxygen levels, and significantly increased myocardial oxygen consumption are nonatherosclerotic causes of myocardial ischemia (e.g., severe aortic stenosis, tachyarrhythmia) [9].

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Approximately 40% of patients with symptomatic coronary artery disease (CAD) have angina pectoris that is triggered by exposure to cold environments [10]. Furthermore, recent findings indicate that myocardial infarction and sudden cardiac death are more likely in regions of extreme cold. Two potential explanations for the decrease in ischemia threshold when exposed to low temperatures include an increase in peripheral vascular resistance, which raises myocardial oxygen demand, and disruptions in coronary artery vasomotion [11, 12].
There are data on how more extreme environmental cold exposure affects the ischemia threshold in the general population and CAD patients, including how extreme cold exposure affects the ischemic threshold even in people who do not have cold-induced angina. This systematic review aims mainly to investigate the published literature on the role of cold exposure in IHD.

Materials and Methods

This systematic review was carried out in accordance with established best standards (Preferred Reporting Items for Systematic Reviews and Meta-Analyses, PRISMA).

Study Design
This was a systematic Review.

Study Duration
From August to September 2022.

Study Condition
This review investigates the role of exposure to cold in ischemic heart conditions among the general population and patients with cardiovascular risks.

Search Strategy
To find the relevant literature, a thorough literature search was carried out in five main databases, including PubMed, Web of Science, Science Direct, EBSCO, and Cochrane Library. The English language was our only option, and the specifications of each database were taken into consideration. The following keywords, which were converted into Mesh terms in PubMed, were used to find the right studies; Cold exposure," "Cold spells," "Cold environment," "Ischemic heart disease," "Coronary artery disease," "Angina pectoris," "IHD," and "CAD." The necessary keywords were linked with the Boolean operators "OR" and "AND". The search yielded English-language publications with full text, freely accessible articles, and human trials.

Selection Criteria

Inclusion Criteria
The subjects were chosen for addition founded on their applicability to the research, which has the following criteria; male or female patients who were exposed to cold events and underwent a risk of IHD.

Exclusion Criteria
We discarded all further papers, ongoing research, and analyses of completed studies that did not concentrate on one of these topics.

Data Extraction
To check for duplicate search strategy results, we employed Rayyan (QCRI) [13]. By imposing a set of inclusion/exclusion criteria on the combined search results, the researchers were able to determine the relevance of the titles and abstracts. The reviewers read the entirety of the papers' texts that met the criteria for inclusion. The authors discussed dispute resolution. The qualified study was incorporated using a created data extraction form. The authors extracted data about the study titles, authors, study year, study designs, population type, participant number, mean age, gender, type of cold event, and main outcomes.

Strategy for Data Synthesis
To provide a qualitative summary of the included study components and outcomes, summary tables created from the data collected from the relevant studies were created. After data extraction for the systematic review, the best strategy to use the data from the included study articles was chosen. Studies that met the full-text inclusion criteria but did not provide any data on the targeted objects were excluded.

Results and Discussion

Search Results
A total of 390 study articles resulted from the systematic search, and then 42 duplicates were removed. Title and abstract screening were conducted on 348 studies, and 277 studies were excluded. 71 reports were sought for retrieval, and only 9

articles were not retrieved. Finally, 62 studies were screened for full-text assessment; 39 were excluded for wrong study outcomes, 10 for unavailable data on the relation between cold exposure and IHD, and 7 for the wrong population type. Six eligible study articles were included in this systematic review. **Figure 1** displays a summary of the study selection process.

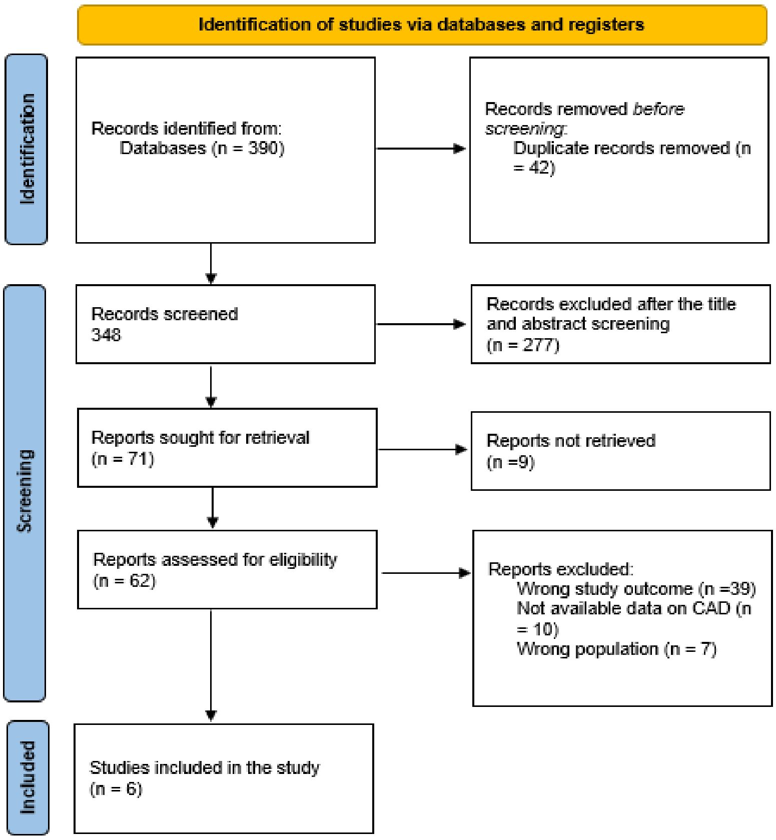

Figure 1. Summarises the research selection process using a PRISMA flowchart.

Characteristics of the Included Studies

A total of 6 studies were included in this review, with 281979 participants exposed to cold events and at IHD risk. The included population ranged from middle-aged participants to the elderly. Four studies were cohort studies [14-17], one was a prospective cohort study [18], and one was a descriptive study [19]. Cold work environments among workers [18], cold spells [14], extreme cold [15], usual cold exposure [16], prolonged extreme cold [19], and cold periods [17] are reported cold events. Three studies included CAD patients [15, 16, 19], and one included patients following MI [16]. Two studies reported that cold exposure among workers and the general population increases the risk of mortality rate due to MI [14, 18]. In CAD patients, prolonged severe cold exposure worsens coronary events (signs and symptoms) [15, 16, 19]. Another worldwide analysis has demonstrated that coronary events are increased during cold periods, especially in warm climates [17].

Table 1. A summary of characteristics of the included study articles.

Study	Country	Study designs	Population type	Participants (n)	Male (n)	Mean age	Type of cold event	Main findings
Pettersson *et al.*, 2020 [18]	Sweden	Prospective cohort	Workers	194501	NA	NA	Cold work environment	There is a link between working in the cold and a higher mortality rate from MI.
Davídkovová *et al.*, 2014 [14]	Czech Republic	Cohort study	General population	NA	NA	0-64	Cold spells	The impacts of winter cold spells were primarily seen in AMI mortality. Regardless of age group or gender, cold-related deaths are primarily linked to acute cardiac events. This is most likely because cold stress causes changes in blood coagulation that lead to thrombosis.

Meyer *et al.*, 2010 [15]	Canada	Cohort study	CAD patients	13	13	67.4±6.6	Extreme cold	Regardless of the existence or absence of anginal symptoms or a history of cold-induced angina, exercise testing in patients with CAD who have CAD results in a decreased ischemia threshold when exposed to extreme cold (-20°C).
Kudaiberdieva *et al.*, 2003 [16]	Turkey	Cohort study	CAD patients	25	25	50.8 ±8.1	Cold exposure	Through the stimulation of vasoconstriction and ischemia, exposure to cold in CAD patients was linked to abnormalities in the function of the left ventricle's myocardium, as seen by a delay in relaxing, worse stiffness, and decreased contractility.
Gumabay *et al.*, 2018 [19]	Philippines	Descriptive cohort study	CAD patients	30	12	41-64	Prolonged extreme cold exposure	Extreme cold presents a threat to CAD and can exacerbate the condition. This is distinguished by the appearance of the primary symptoms and signs brought on by prolonged exposure to extremely low temperatures.
Barnett *et al.*, 2005 [17]	Worldwide	Cohort analysis	General population	87410	70527	35-65	Cold periods	Particularly in warm climes, rates of coronary events increased during relatively cold periods.

Cardiovascular disease and mortality are more common worldwide during the winter season [20-22] or in association with extended periods of extremely low temperatures (cold spells) [23, 24]. This review is limited by the lack of data on the relationship between cold exposure and the risk of IHD as well as it is only a qualitative review.

We found that cold exposure among workers and the general population increases the risk of mortality rate due to MI [14, 18]. In CAD patients, prolonged severe cold exposure worsens coronary events [15, 16, 19]. Two previous studies were consistent with our findings [25, 26].

Both global [27] and national [28, 29] research have indicated that cold-related mortality exceeds the adverse effects of heat. Contrary to popular belief, the majority of temperature-related mortality occurs at milder non-optimal levels [27]. This is because the majority of bad health consequences are not exclusively associated with cold extremes.

According to one theory, being exposed to low temperatures causes a rapid release of catecholamines, which in turn causes increases in platelet aggregability, vasomotor tone, hemodynamic parameters, and other hematological and endothelial parameters. When a person comes from warm indoor to cold circumstances, the resultant increase in heart workload and oxygen consumption may precipitate an ACS [30, 31].

In healthy individuals, a sudden drop in temperature or its seasonal impacts increase cardiovascular strain due to physiologic reactions intended to preserve thermal balance. However, in those with cardiovascular disorders, including altered neural system, cardiac, and circulatory function, these may be made worse [32].

More research on cold exposure in forms, intensities, and durations that are similar to those people could experience in their daily lives is necessary, given the present knowledge. This area of study is crucial at this time since the epidemiology of the world's population is changing significantly. Cardiovascular illnesses are predicted to become more common, are known to be climate-sensitive [33], and are most prevalent among the elderly [22]. Additionally, it is hypothesized that, in addition to global warming, climate change may lead to an increase in extreme weather occurrences [34], which could make it harder for people to be prepared. The projected increasing proportion of suboptimal temperatures and the fact that the health impacts of cold outweigh those of heat [27] provides additional rationale for future research into vulnerable populations.

Conclusion

This systematic review demonstrated that exposure to the cold increases the risk of MI-related death in both workers and the general population. Additionally, prolonged exposure to extreme cold exacerbates coronary events in CAD patients. Further research investigations are required to quantitatively assess the risk of cold exposure among variable population types.

Acknowledgments: Many thanks to Dr. Zia Ul Sabah; Assistant Professor of Cardiology, Department of Medicine, King Khalid University Abha and Consultant Cardiologist PFKCC, for her continuous help, support and encouragement to complete this work.

Conflict of interest: None

Financial support: None

Ethics statement: None

References

1. Ghaffar FA, Redzuan AM, Makmor-Bakry M. Effectiveness of Sildenafil in Pulmonary Hypertension Secondary to Valvular Heart Disease: A Systematic Review and Meta-Analysis. Arch Pharm Pract. 2021;12(3):55-65.
2. Gholizadeh B, Zadeh FJ, Nabavi SS, Moradi-Joo E, Baghaei S. The Relationship between Quality of Life and Mental Health in Patients with Heart Failure. Entomol Appl Sci Lett. 2021;8(3):60-6.
3. Vagabov IU, Kafarov ES, Zenin OK. Variants of Blood Supply to Kidney Segments According to 3D Anatomical Analysis. Entomol Appl Sci Lett. 2021;8(1):60-5.
4. Jensen RV, Hjortbak MV, Bøtker HE. Ischemic heart disease: an update. InSeminars in nuclear medicine 2020 May 1 (Vol. 50, No. 3, pp. 195-207). WB Saunders.
5. Knuuti J, Revenco V. 2019 ESC Guidelines for the diagnosis and management of chronic coronary syndromes. Eur Heart J. 2020;41(5):407-77.
6. Lozano R, Naghavi M, Foreman K, Lim S, Shibuya K, Aboyans V, et al. Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010. Lancet. 2012;380(9859):2095-128.
7. Benjamin EJ, Virani SS, Callaway CW, Chamberlain AM, Chang AR, Cheng S, et al. Heart disease and stroke statistics—2018 update: a report from the American Heart Association. Circulation. 2018;137(12):e67-492.
8. Townsend N, Wilson L, Bhatnagar P, Wickramasinghe K, Rayner M, Nichols M. Cardiovascular disease in Europe: epidemiological update 2016. Eur Heart J. 2016;37(42):3232-45.
9. Falk E. Pathogenesis of atherosclerosis. J Am Coll Cardiol. 2006;47(8S):C7-12.
10. Ikäheimo TM. Cardiovascular diseases, cold exposure and exercise. Temperature (Austin, Tex.), 2018;5(2):123-46. doi:10.1080/23328940.2017.1414014
11. Peták F, Kovács BN, Agócs S, Virág K, Nyári T, Molnár A, et al. Seasonal changes in proportion of cardiac surgeries associated with diabetes, smoking and elderly age. Plos one. 2022;17(9):e0274105. doi:10.1371/journal.pone.0274105
12. Gronlund CJ, Sullivan KP, Kefelegn Y, Cameron L, O'Neill MS. Climate change and temperature extremes: A review of heat-and cold-related morbidity and mortality concerns of municipalities. Maturitas. 2018;114:54-9. doi:10.1016/j.maturitas.2018.06.002
13. Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A. Rayyan—a web and mobile app for systematic reviews. Syst Rev. 2016;5(1):1-0.
14. Davídkovová H, Plavcová E, Kynčl J, Kyselý J. Impacts of hot and cold spells differ for acute and chronic ischaemic heart diseases. BMC Public Health. 2014;14(1):1-1.
15. Meyer P, Guiraud T, Curnier D, Juneau M, Gayda M, Nozza A, et al. Exposure to extreme cold lowers the ischemic threshold in coronary artery disease patients. Can J Cardiol. 2010;26(2):e50-3.
16. Kudaiberdieva G, Timuralp B, Ata N, Unalir A, Gorenek B, Cavusoglu Y, et al. Cold exposure and left ventricular diastolic performance in coronary artery disease. Angiology. 2003;54(2):187-93.
17. Barnett AG, Dobson AJ, McElduff P, Salomaa V, Kuulasmaa K, Sans S. Cold periods and coronary events: an analysis of populations worldwide. J Epidemiol Community Health. 2005;59(7):551-7.
18. Pettersson H, Olsson D, Järvholm B. Occupational exposure to noise and cold environment and the risk of death due to myocardial infarction and stroke. Int Arch Occup Environ Health. 2020;93(5):571-5.
19. Gumabay EM, Ramirez RC, Dimaya JM, Beltran MM. Adversity of prolonged extreme cold exposure among adult clients diagnosed with coronary artery diseases: a primer for recommending community health nursing intervention. Nurs Open. 2018;5(1):62-9.
20. Song X, Wang S, Hu Y, Yue M, Zhang T, Liu Y, et al Impact of ambient temperature on morbidity and mortality: an overview of reviews. Sci Total Environ. 2017;586:241-54.
21. Naser N, Kulic M, Dilic M, Dzubur A, Durak A, Pepic E, et al. The cumulative incidence of stroke, myocardial infarction, heart failure and sudden cardiac death in patients with atrial fibrillation. Med Arch. 2017;71(5):316-9. doi:10.5455/medarh.2017.71.316-319
22. Liu J, Varghese BM, Hansen A, Zhang Y, Driscoll T, Morgan G, et al. Heat exposure and cardiovascular health outcomes: a systematic review and meta-analysis. Lancet Planet Health. 2022;6(6):e484-95. doi:10.1016/S2542-5196(22)00117-6
23. Ryti NR, Mäkikyrö EM, Antikainen H, Hookana E, Junttila MJ, Ikäheimo TM, et al. Risk of sudden cardiac death in relation to season-specific cold spells: a case–crossover study in Finland. BMJ Open. 2017;7(11):e017398.
24. Ratwatte P, Wehling H, Kovats S, Landeg O, Weston D. Factors associated with older adults' perception of health risks of hot and cold weather event exposure: A scoping review. Front Public Health. 2022;10:4274. doi:10.3389/fpubh.2022.939859
25. Ikäheimo TM. Cardiovascular diseases, cold exposure and exercise. Temperature. 2018;5(2):123-46.
26. Pettersson H, Olsson D, Järvholm B. Occupational exposure to noise and cold environment and the risk of death due to myocardial infarction and stroke. Int Arch Occup Environ Health. 2020;93(5):571-5. doi:10.1007/s00420-019-01513-5

27. Gasparrini A, Guo Y, Hashizume M. Mortalité attribuable au froid et à la chaleur: Analyse multi-pays. Environ Risques Sante. 2015;14(6):464-5.
28. Zhang Y, Wang S, Zhang X, Hu Q, Zheng C. Association between moderately cold temperature and mortality in China. Environ Sci Pollut Res. 2020;27(21):26211-20. doi:10.1007/s11356-020-08960-5
29. Berko J. Deaths attributed to heat, cold, and other weather events in the United States, 2006-2010. US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics; 2014.
30. Kuzmenko NV, Tsyrlin VA, Pliss MG, Galagudza MM. Seasonal dynamics of myocardial infarctions in regions with different types of a climate: a meta-analysis. Egypt Heart J. 2022;74(1):1-3. doi:10.1186/s43044-022-00322-5
31. Terner Z, Long A, Reviriego-Mendoza M, Larkin JW, Usvyat LA, Kotanko P, et al. Seasonal and Secular Trends of Cardiovascular, Nutritional, and Inflammatory Markers in Patients on Hemodialysis. Kidney360. 2020;1(2):93-105. doi:10.34067/KID.0000352019
32. Çağlak S. Evaluation of the Effects of Thermal Comfort Conditions on Cardiovascular Diseases in Amasya City, Turkey. J Public Health. 2022:1-0. doi:10.1007/s10389-022-01773-5
33. Li X, Zhang Y, He Y, Li KX, Xu RN, Wang H, et al. J-shaped association between serum albumin levels and long-term mortality of cardiovascular disease: Experience in National Health and Nutrition Examination Survey (2011–2014). Front Cardiovasc Med. 2022;9. doi:10.3389/fcvm.2022.1073120
34. Schneider A, Rückerl R, Breitner S, Wolf K, Peters A. Thermal control, weather, and aging. Curr Environ Health Rep. 2017;4(1):21-9.