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Authors' Affiliation:

¹University Clinical Hospital in Poznań, Przybyszewskiego 49, 60-355 Poznań, Poland

²Medical University of Gdańsk, Marii Skłodowskiej-Curie 3a, 80-210 Gdańsk, Poland

*Corresponding author:

Tomasz Czapiewski
University Clinical Hospital in Poznań, Przybyszewskiego 49, 60-355 Poznań, Poland;
Email: t.czapiewski98@gmail.com

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Finnish Sauna Bathing in Cardiovascular Health: Mechanistic Insights, Mortality Benefits, and Safety Considerations for At-Risk Populations

Wiktor Szymajda¹, Tomasz Czapiewski^{1*}, Maksymilian Szymczak¹, Lidia Żyła¹, Aleksandra Trojańska²

ABSTRACT

Finnish sauna bathing, a traditional practice involving dry heat exposure, is associated with significant cardiovascular benefits, especially in lowering the risk of hypertension and reducing cardiovascular disease mortality. Longitudinal cohort studies demonstrate that frequent sauna use (4–7 sessions/week) lowers incident hypertension risk by 47% (HR: 0.54, 95% CI: 0.32–0.91) and reduces sudden cardiac death risk by 63% (HR: 0.37, 95% CI: 0.18–0.75) via mechanisms including enhanced endothelial nitric oxide bioavailability, peripheral vasodilation, and improved autonomic regulation. Synergistic interactions with cardiorespiratory fitness further enhance the benefits, with high fitness levels combined with frequent sauna use being associated with 69% lower cardiovascular disease (CVD) mortality. Mechanistically, acute sauna exposure induces plasma volume redistribution (70% cutaneous blood flow increase) and chronic adaptations such as heat shock protein upregulation, reducing oxidative stress and arterial stiffness. Despite these benefits, sauna bathing poses risks for specific cardiovascular populations: unstable angina, recent myocardial infarction (<3–6 months), and severe aortic stenosis are absolute contraindications due to hemodynamic instability, while decompensated heart failure and orthostatic hypotension necessitate caution. Clinical trials highlight transient myocardial ischemia in 93% of stable coronary artery disease patients during sauna use, underscoring the need for individualized protocols. This review synthesizes evidence supporting sauna therapy as a non-pharmacological adjunct for cardiovascular health while emphasizing safety considerations in high-risk cohorts.

Keywords: sauna, Finnish sauna, cardiovascular diseases

1. INTRODUCTION

Sauna bathing, also known as the Finnish bath or dry sauna is an activity that has been practiced widely in Finland for thousands of years. It has also gained

popularity as a form of therapy and relaxation in other parts of the world (Hannuksela & Ellahham, 2001). According to evidence from epidemiological studies and clinical trials, frequent Finnish sauna bathing has been associated with numerous health benefits, particularly in relation to cardiovascular and respiratory health. Regular sauna bathing has been linked with a decreased risk of developing hypertension and other vascular diseases (Kukkonen-Harjula and Kauppinen, 2006; Laukkanen et al., 2015). There are different forms of passive heat therapy that are widely practiced, including infrared sauna, Waon therapy and Turkish baths. However this review only covers the effects of the dry sauna, since they have been studied and researched most thoroughly. The exact mechanisms and physiology responsible for the overall beneficial effects of saunas have yet to be fully investigated, as have the long-term results of clinical trials involving regular sauna use (Zaccardi et al., 2017).

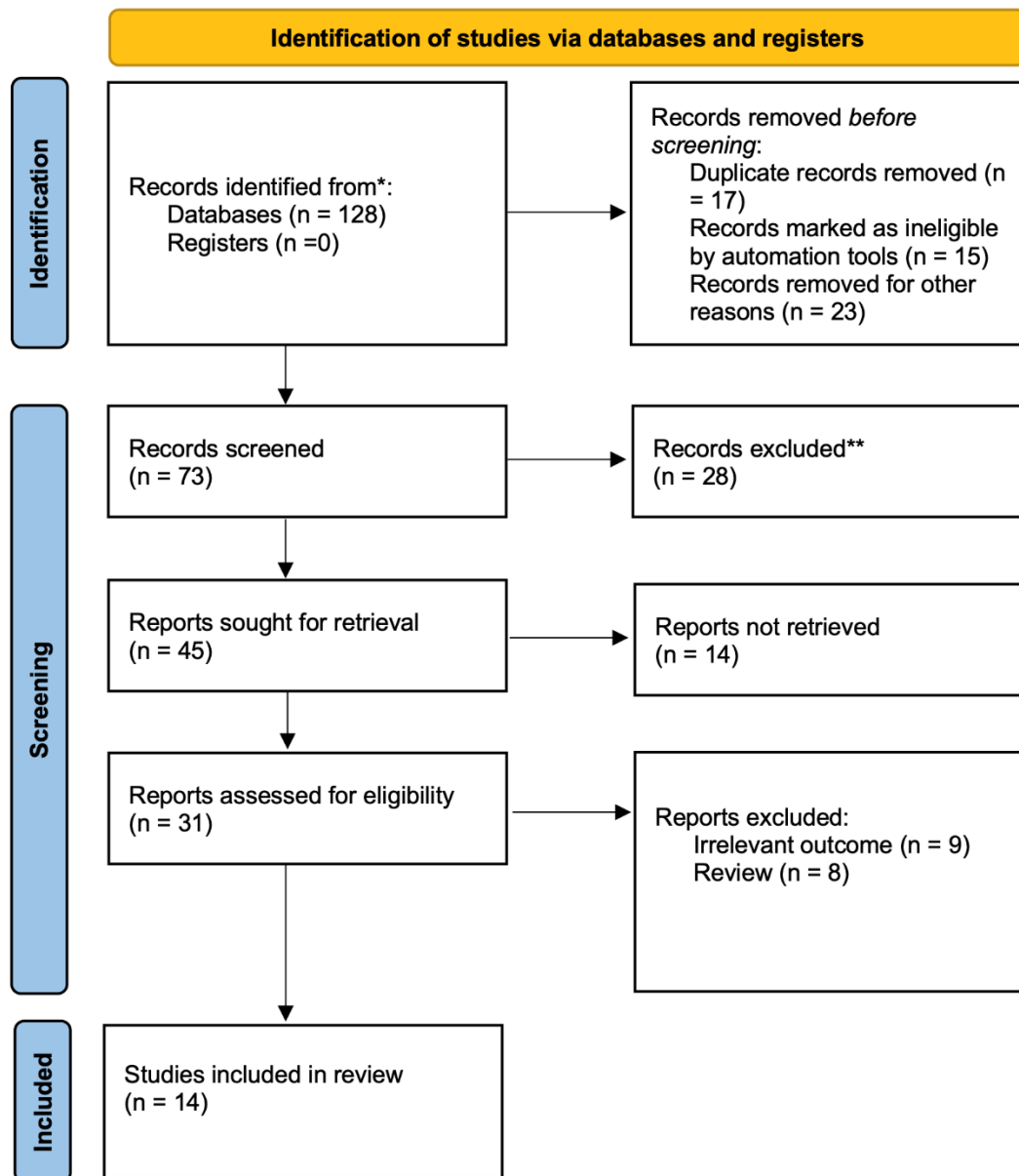


Fig 1: PRISMA flow diagram of selected studies

2. REVIEW METHOD

The review is an analysis of literature from available sources, including databases such as PubMed, Google Scholar, and ScienceDirect. The search was performed between April and May 2024. During the research, we considered only articles in English that used Medical Subject Headings and keywords; the identification and screening process of the studies is presented in Figure 1. Literature review

included studies published between 1999 and 2024, with a particular emphasis on research from the past 10–15 years to ensure relevance and timeliness. All selected studies were evaluated and approved by the co-authors.

3. RESULTS AND DISCUSSION

A Finnish sauna is traditionally made from high-quality, heat- and moisture-resistant wood, such as spruce, cedar or aspen. The interior features benches at different heights, allowing users to choose their preferred heat intensity. The sauna is heated by a stove, either wood-burning or electric, that warms stones placed on top. The typical temperature inside a Finnish sauna range from 80°C to 100°C (176°F to 212°F), with humidity levels kept low, usually between 5% and 20%. Pouring water over the hot stones briefly increases humidity, creating a burst of steam known as *löyly*, while the environment remains predominantly dry. A typical sauna session involves several short stays in the hot room each lasting 10–20 minutes, interspersed with cooling periods (e.g. a cold shower, swimming or resting at room temperature). The whole experience lasts up to an hour. The number of sessions ranges based on the users' preference, commonly 2 to 3 times a week (Hannuksela and Ellahham, 2001; Laukkanen et al., 2018; Radtke et al., 2016).

Beneficial Effects of Sauna Bathing on Cardiovascular Health and Systolic Blood Pressure

The cardioprotective benefits of regular sauna bathing have been highlighted by emerging evidence from longitudinal cohort studies, particularly in terms of reducing hypertension and lowering the risk of cardiovascular disease (CVD) mortality. Zaccardi et al., (2017) found that frequent sauna use can significantly reduce the risk of incident hypertension in middle-aged men. Over a median follow-up of 24.7 years, participants engaging in 4–7 weekly sauna sessions exhibited a 47% reduced hazard of hypertension (HR: 0.54, 95% CI: 0.32–0.91) compared to those with one session weekly, independent of traditional risk factors such as BMI, smoking, and baseline systolic blood pressure (SBP). This protective effect has been attributed to sauna-induced vasodilation, which acutely reduces peripheral vascular resistance and may promote long-term vascular remodeling (Zaccardi et al., 2017). These findings are consistent with the result of physiological studies indicating that passive heat therapy improves endothelial function. This is achieved by enhancing nitric oxide bioavailability and reducing oxidative stress, thus lowering SBP (Brunt et al., 2016).

Large prospective cohort studies have further elucidated the connection between sauna bathing and cardiovascular mortality. Laukkanen et al., (2015) reported an inverse, dose-dependent relationship between how often people used saunas and how likely they were to experience fatal cardiovascular disease (CVD) events. Compared to infrequent users, men who attended 4–7 weekly sessions had a 63% lower risk of sudden cardiac death (SCD) (hazard ratio (HR): 0.37, 95% confidence interval (CI): 0.18–0.75) and a 50% lower risk of fatal cardiovascular disease (CVD) (HR: 0.50, 95% CI: 0.33–0.77). These benefits were mediated through multiple pathways, including improved autonomic regulation, evidenced by increased vagal tone and reduced sympathetic activity, as well as favorable modulation of inflammatory markers such as C-reactive protein. Moreover, sauna bathing's hemodynamic effects—characterized by increased heart rate and cardiac output akin to moderate-intensity exercise, may enhance cardiovascular reserve and arterial compliance, contributing to long-term SBP reduction (Kunutsor et al., 2024; Laukkanen et al., 2023).

Synergistic interactions between sauna use and cardiorespiratory fitness (CRF) further amplify cardiovascular benefits. A cohort study conducted in 2018 found that individuals with high CRF who used the sauna 3–7 times per week experienced a 69% lower risk of SCD (HR: 0.31, 95% CI: 0.16–0.63) compared to those with low CRF and infrequent sauna use. This interplay suggests that sauna bathing may augment the cardioprotective effects of physical activity by promoting similar adaptive responses, such as improved endothelial function and reduced left ventricular afterload (Laukkanen et al., 2018). Notably, the combination of high CRF and frequent sauna use was associated with greater reductions in SBP than either factor alone, highlighting its potential as an adjunctive non-pharmacological intervention for hypertension management.

Recent investigations have also explored sauna bathing's role in attenuating the cardiovascular risks associated with elevated SBP. A cohort analysis from 2023 revealed that men with high SBP (≥ 140 mmHg) who used the sauna infrequently (≤ 2 sessions/week) were 81% more likely to die from CVD (HR: 1.81, 95% CI: 1.39–2.36) than normotensive individuals who used the sauna frequently. Strikingly, high SBP combined with frequent sauna bathing (3–7 sessions/week) showed an attenuated risk (HR: 1.52, 95% CI: 1.06–2.16), suggesting that regular sauna use may partially offset the adverse prognostic effects of hypertension (Laukkanen et al., 2023). This cardioprotective effect may stem from sauna-induced hemodynamic adaptations, including sustained post-sauna hypotension and improved arterial elasticity, which counteract the pathological vascular stiffness characteristic of chronic hypertension (Lee et al., 2018).

Mechanistically, sauna bathing exerts multifaceted effects on the cardiovascular system. Acute sessions induce plasma volume redistribution, increasing cutaneous blood flow by up to 70% and reducing central blood volume, which stimulates a compensatory

decrease in systemic vascular resistance (Crandall and González-Alonso, 2010). Repeated exposure can lead to chronic adaptations, such as the upregulation of heat shock proteins, which enhance endothelial resilience and reduce oxidative stress (Sutkowy et al., 2014). Additionally, sauna use modulates the autonomic nervous system by increasing parasympathetic activity post-cooling, which stabilizes heart rate variability and mitigates arrhythmic risk (Radtke et al., 2016). Together, these mechanisms contribute to the observed reductions in SBP and CVD morbidity.

Adverse Effects and Contraindications of Finnish Sauna Bathing in Cardiovascular Populations

Finnish sauna bathing, while generally safe for healthy individuals, poses specific risks for patients with cardiovascular diseases due to hemodynamic stressors inherent to thermal exposure. Absolute contraindications include unstable angina pectoris, recent myocardial infarction (<3–6 months), and severe aortic stenosis, as these conditions may precipitate acute ischemia or hemodynamic collapse during heat-induced tachycardia and peripheral vasodilation. Patients with decompensated heart failure face heightened risks from fluid shifts and preload reduction, which may exacerbate pulmonary congestion and systemic hypoperfusion (Blum and Blum, 2007; Hannuksela and Ellahham, 2001; Kukkonen-Harjula and Kauppinen, 2006). Although stable coronary artery disease (CAD) patients typically tolerate sauna sessions, myocardial perfusion imaging reveals transient ischemia in up to 93% of asymptomatic individuals during heat exposure, suggesting subclinical demand-supply mismatches despite clinical stability (Giannetti et al., 1999).

Orthostatic hypotension post-cooling poses syncope risks, particularly in elderly patients or those on antihypertensives/diuretics, with acute systolic blood pressure reductions of 10–15 mmHg commonly observed. Concurrent alcohol consumption exacerbates arrhythmogenic and hypotensive risks due to impaired vasoregulation and electrolyte imbalances, warranting strict avoidance. Relative contraindications include poorly controlled arrhythmias and hypertrophic cardiomyopathy with outflow obstruction, where tachycardia may compromise diastolic filling. While sauna use is permissible in stable CAD and chronic compensated heart failure, sessions should be limited to ≤20 minutes at ≤90°C, with gradual cooling and hydration to mitigate adverse events (Blum and Blum, 2007; Hannuksela and Ellahham, 2001). Clinicians must tailor their recommendations to individual patients, prioritising education on recognising symptoms and the importance of avoiding rapid exertion after a sauna session. Key research findings were presented in Table 1.

Table 1: Summary of key research findings on finnish sauna bathing and cardiovascular health

| Study / Authors | Population / Setting | Sauna Frequency | Main Findings |
|---|-----------------------------------|-----------------------|---|
| Zaccardi et al., 2017 | Middle-aged men | 4–7 times/week | 47% lower risk of hypertension (HR: 0.54, 95% CI: 0.32–0.91) vs. 1x/week; effect independent of BMI, smoking, SBP. Attributed to vasodilation and improved endothelial function. |
| Laukkanen et al., 2015 | Middle-aged men | 4–7 times/week | 63% lower risk of sudden cardiac death (HR: 0.37), 50% lower risk of fatal CVD (HR: 0.50) vs. infrequent use; mediated by improved autonomic regulation and reduced inflammation. |
| Laukkanen et al., 2018 | Adults with varying fitness (CRF) | 3–7 times/week | 69% lower risk of sudden cardiac death (HR: 0.31) in high CRF + frequent sauna users vs. low CRF + infrequent users; synergistic effect with exercise. |
| Laukkanen et al., 2023 | Men with high SBP (≥140 mmHg) | ≤2 vs. 3–7 times/week | Infrequent sauna: 81% higher CVD mortality risk (HR: 1.81); frequent use attenuates risk (HR: 1.52). Regular sauna reduces adverse impact of hypertension. |
| Brunt et al., 2016; Kunutsor et al., 2024 | Physiological studies | - | Sauna improves endothelial function, increases nitric oxide, lowers oxidative stress and SBP—effects similar to moderate exercise. |

4. CONCLUSION

There is accumulating evidence that Finnish sauna bathing is a viable intervention for improving cardiovascular outcomes, particularly by reducing systolic blood pressure (SBP) and the risk of hypertension. The cardioprotective effects result from haemodynamic adaptations, including enhanced endothelial function, arterial compliance, and autonomic balance, that mimic the effects of moderate-intensity exercise. Crucially, frequent sauna use attenuates the prognostic risks of elevated SBP, with high-risk individuals demonstrating 30% lower CVD mortality when engaging in regular sessions. However, there are still strict contraindications for patients with unstable cardiovascular conditions, as thermal stress could cause ischaemia or haemodynamic collapse. Clinicians should advocate for personalised regimens that prioritise gradual cooling and hydration, as well as avoiding alcohol. Future randomized controlled trials are imperative to establish causality, optimize temperature-duration thresholds, and validate protocols in diverse populations, including those with implantable cardiac devices. Until then, sauna bathing should be included in lifestyle recommendations for reducing cardiovascular risk, depending on the individual's risk level and their level of education.

Author's Contributions

Conceptualization: Wiktor Szymajda

Methodology: Tomasz Czapiewski

Resources: Lidia Żyła, Aleksandra Trojańska

Data Curation: Maksymilian Szymczak

Writing - Original Draft Preparation: Tomasz Czapiewski

Writing - Review & Editing: Wiktor Szymajda, Aleksandra Trojańska

Visualization: Maksymilian Szymczak

Supervision: Lidia Żyła

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Informed consent

Not applicable.

Ethical approval

Not applicable.

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Conflict of interest

The authors declare that there is no conflict of interest.

Data and materials availability

All data associated with this study will be available based on the reasonable request to corresponding author.

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