MAYO CLINIC

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REVIEW

Does the Combination of Finnish Sauna Bathing and Other Lifestyle Factors Confer Additional Health Benefits? A Review of the Evidence

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Abstract

Sauna bathing, a tradition deeply rooted in the Finnish culture, has been used for thousands of years for leisure, relaxation, and wellness. Sauna bathing is linked with substantial health benefits beyond its use for leisure and relaxation. Several observational and interventional studies suggest that regular or frequent sauna bathing reduces the incidence of vascular and nonvascular diseases, such as hypertension, cardiovascular disease, dementia, and respiratory conditions; may improve the severity of conditions such as musculoskeletal disorders, COVID-19, headache, and influenza; and increases the life span. The beneficial effects of sauna bathing on adverse outcomes have been linked to its blood pressure–reducing, anti-inflammatory, antioxidant, cytoprotective, and stress-reducing properties and its synergistic effect on neuroendocrine, circulatory, cardiovascular, and immune function. Evidence suggests that frequent sauna bathing is an emerging protective risk factor that may augment the beneficial effects of other protective risk or lifestyle factors, such as physical activity and cardiorespiratory fitness, or attenuate or offset the adverse effects of other risk factors, such as high blood pressure, systemic inflammation, and low socioeconomic status. This review summarizes the available epidemiologic and interventional evidence linking the combined effects of Finnish sauna bathing and other risk factors on vascular outcomes including cardiovascular disease and intermediate cardiovascular phenotypes, nonvascular outcomes, and mortality. We also discuss the mechanistic pathways underlying the joint contributions of Finnish sauna bathing and other risk factors on health outcomes, the public health and clinical implications of the findings, gaps in the existing evidence base, and future directions.

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Passive heat therapy is characterized by exposure to a high environmental temperature for a brief period. Although there are different types of passive heat therapy, which include Waon therapy, hot tubs, hydrotherapy, sanarium, and steam baths, the most commonly used and widely studied to date are the Finnish saunas. Sauna bathing is a tradition embedded in the Finnish culture and has been used for thousands of years for leisure, relaxation, and wellness; it is accessible to most people in Finland.[1,2] It is also commonly used in other Nordic countries. The typical hot and dry sauna is characterized by high temperatures (ranging from 80 to 100 °C), good ventilation, and dry air with relative humidity varying from 10% to 20%.[3] A sauna session may involve short stays of 5 to 20 minutes in the sauna room with intervals of cooling-off sessions that may involve swimming or cold showers. The duration of stay in the sauna room depends on the temperature and how comfortable the individual is.[4] On average, a typical Finnish person has a sauna bath at least once per week; the average habitual frequency is 2 or 3 sessions per week.[5-7]

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ARTICLE HIGHLIGHTS

- Finnish sauna bathing, a passive heat therapy characterized by exposure to a high environmental temperature for a brief period, is linked with myriad health benefits, particularly on the vascular system.
- Evidence suggests that frequent sauna bathing is an emerging protective risk factor that may potentiate the beneficial effects of protective risk factors, such as physical activity and cardiorespiratory fitness, or attenuate or offset the adverse effects of other risk factors.
- Interventional evidence shows that 8 weeks of regular sauna bathing sessions combined with exercise produces a mean reduction in systolic blood pressure of about 8 mm Hg.
- Frequent sauna bathing appears to offset the adverse impact of systemic inflammation, low socioeconomic status, and high systolic blood pressure on outcomes such as cardiovascular disease, pneumonia, chronic obstructive pulmonary disease, and mortality.
- Adding frequent sauna sessions will substantially augment the benefits of physical activity. For people who are unable to meet physical activity guidelines or are unable to exercise at all because of physical activity limitations, regular use of sauna may be an alternative lifestyle strategy to mitigate the risk of diseases due to other risk factors.

There is a growing body of robust research evidence linking sauna bathing with substantial health benefits, beyond its use for leisure and relaxation. Several observational and interventional studies suggest that regular or frequent sauna bathing reduces the risk of vascular and nonvascular diseases, such as hypertension,[8] cardiovascular disease (CVD) mortality,[6] sudden cardiac death,[6] stroke,[9] dementia,[10] venous thromboembolism,[11] all-cause mortality,[6] lung diseases,[12-14] and psychotic disorders[15]; improves the severity of musculoskeletal disorders (such as osteoarthritis, rheumatoid arthritis, and fibromyalgia),[16,17] COVID-19,[18] and lung conditions (such as asthma, chronic bronchitis, and chronic obstructive pulmonary disease [COPD])[18,19]; and extends the life span.[20] The beneficial effects of sauna bathing on adverse outcomes have been linked to its stress-reducing, anti-inflammatory, cytoprotective, and antioxidant properties and its synergistic effect on neuroendocrine, circulatory, cardiovascular, and immune function.[21]

Evidence suggests that frequent sauna bathing is such an emerging protective risk factor that may potentiate the beneficial effects of protective risk factors, such as physical activity and cardiorespiratory fitness (CRF),[5,22–24] or attenuate or offset the adverse effects of other risk factors.[13,25,26] Given the sparse and inconsistent evidence available, synthesizing the existing evidence will enable patients, practitioners, researchers, and policymakers to make appropriate interpretations, which can have an impact on public health and clinical practice. The aim of this review is to summarize the available epidemiologic and interventional evidence linking the combined effects of Finnish sauna bathing and other risk factors on vascular outcomes including intermediate cardiovascular phenotypes and nonvascular outcomes and mortality. We also sought to discuss the mechanistic pathways underlying the joint contributions of Finnish sauna bathing and other risk factors on health outcomes, public health implications of the findings, gaps in the evidence base, and future directions. Given that there are so many other types of passive heat therapies, which vary by relative humidity and their effects and typically operate at lower temperatures, we focused on Finnish saunas, which are the most widely studied and used and have the most consistent evidence of being beneficial for health. However, for the sake of completeness, we have included a brief section on the health benefits of other passive heat therapies. Furthermore, there are a number of reviews on the cardiovascular and other health benefits of other well-known passive heat therapies, such as Waon therapy and hydrotherapy.[27–29] Last, given the publication of a comprehensive review on the independent cardiovascular and other health benefits of Finnish sauna baths,[21] this review specifically focuses on

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the combined effects of Finnish sauna bathing and other risk factors or lifestyle activities on health outcomes.

METHODS

We sought randomized controlled trials (RCTs), non-RCTs, and observational study designs (prospective cohort, nested case-control, retrospective cohort, or case-control) of adult humans from MEDLINE and Embase from their inception until September 2022, with particular emphasis on Finnish sauna baths evaluated in combination with other risk or lifestyle factors. Search terms included *sauna bath, Finnish, joint association, joint contribution, additive interaction, multiplicative interaction, cardiovascular disease, coronary heart disease, sudden cardiac death, heart failure, hypertension, blood pressure, dementia, depression, pulmonary disease, mortality, lipids, natriuretic peptides, hormones, endothelial function, inflammation, oxidative stress, arterial stiffness, arterial compliance,* and *intima-media thickness*. Studies were restricted to those published in English.

POTENTIATING THE BENEFICIAL EFFECTS OF OTHER RISK FACTORS

Cardiovascular Outcomes and Mortality

Evidence from a number of observational epidemiologic studies suggests that the combination of frequent sauna bathing and other protective lifestyle factors may confer more protection on cardiovascular outcomes than each modality alone. In the evaluation of the Kuopio Ischemic Heart Disease (KIHD) prospective cohort study comprising 2277 middle-aged and older Finnish men who were followed up for a median period of 26.1 years, a combination of high CRF levels and frequent sauna bathing sessions conferred stronger protection on cardiovascular and all-cause mortality outcomes compared with high CRF or frequent sauna bathing alone.[5] In a follow-up study using the KIHD cohort, the combined effect of high CRF and frequent sauna baths was associated with a substantially lowered risk of future sudden cardiac deaths compared with high CRF or frequent sauna bathing alone.[22]

Intermediate Cardiovascular Phenotypes

Several interventional studies have reported on the combined effect of sauna bathing and exercise training or physical activity on intermediate cardiovascular phenotypes. In a pre-post interventional design in which 77 participants with at least 1 cardiovascular risk factor were exposed to 15 minutes of aerobic exercise on a cycle ergometer followed immediately by 15 minutes of sauna exposure, there were positive alterations in mean arterial pressure, pulse pressure, and augmentation index, which were retained after a 30-minute recovery period.[30] In a crossover study using matched durations to explore the hemodynamic changes of sauna exposure compared with a combination of aerobic exercise and sauna exposure in middle-aged participants with cardiovascular risk factors, both interventions elicited comparable acute hemodynamic alterations, such as reductions in blood pressure and mean arterial pressure.[31] In 16 patients with elevated blood pressure, Gayda et al[32] reported that exercise followed by a sauna session resulted in a significant decrease in daytime and 24-hour systolic blood pressure (SBP) as well as in total peripheral resistance. In 7 well-trained male cyclists who were exposed to 30 minutes of sauna (87 °C, 11% relative humidity) after daily training for 10 consecutive days, the combined intervention resulted in substantial expansion of plasma volume after 4 exposures.[33] In 27 healthy prehypertensive men who were exposed to sauna only, sauna after endurance exercise, sauna after strength exercise, or sauna after combined endurance and strength exercise, the combination of endurance and sauna provided the greatest reductions in blood pressure.[34] In a recent RCT comprising 47 middle-aged individuals with at least 1 traditional cardiovascular risk factor, 8 weeks of regular sauna bathing sessions combined with exercise produced substantially beneficial effects on CRF, SBP, and total cholesterol levels compared with

exercise training alone; the mean reduction in SBP was 8 mm Hg.[24]

Nonvascular Outcomes

In a follow-up evaluation of the KIHD study, a combination of high CRF levels and frequent sauna baths was found to be associated with a substantially lowered risk of future pneumonia compared with each modality alone.[23]

MITIGATING THE ADVERSE EFFECTS OF OTHER RISK FACTORS

Cardiovascular Outcomes and Mortality

In addition to augmenting the beneficial effects of other risk factors, frequent sauna exposure may mitigate the adverse effects of other risk factors. In a study that used the KIHD cohort to evaluate the independent and joint associations of socioeconomic status (SES) and frequency of sauna bathing with the risk of all-cause mortality, low SES was associated with an increased risk of mortality, whereas frequent sauna baths were associated with a decreased risk of mortality.[26] Joint association analysis found that the risk of mortality was increased in men with both low SES and low frequency of sauna bathing ($\leq$2 sessions per week), but the risk was mitigated in men with low SES who engaged in frequent sauna baths (3 or more sessions per week). Further analysis found the presence of additive and multiplicative interactions between SES and frequency of sauna bathing in relation to mortality risk; the association of both exposures combined (ie, low SES and low frequency of sauna bathing) with all-cause mortality risk exceeded the sum or product of their associations considered separately.[26] In another analysis of the KIHD study that evaluated the interplay between inflammation (as measured by high-sensitivity C-reactive protein [hsCRP]), sauna bathing, and all-cause mortality, the risk of mortality was increased in men with high hsCRP levels (>3 mg/L) and low frequency of sauna bathing, but the risk was offset in men with high hsCRP levels who were frequent sauna bathers.[35] Interaction analysis found that the association for the combination of high hsCRP and low frequency of sauna bathing with all-cause mortality risk exceeded the sum or product of their associations considered separately.[35] Frequent sauna baths have also been reported to mitigate the increased risk of cardiovascular and all-cause mortality in men with high SBP, with significant evidence of interactions existing between sauna bathing and SBP in relation to these outcomes.[36]

Nonvascular Outcomes

Evaluation of the independent and joint associations of hsCRP and sauna bathing with the risk of pneumonia using the KIHD cohort found that elevated levels of hsCRP were associated with an increased risk of pneumonia, whereas frequent sauna baths were associated with a decreased risk of pneumonia.[25] When both exposures were analyzed in combination, the risk of pneumonia was increased in men with high hsCRP and low frequency of sauna bathing, but the risk was attenuated to null in men with high hsCRP who took frequent sauna baths.[25] Frequent sauna baths have also been reported to offset the increased risk of pneumonia and COPD in men with low SES, with significant evidence of interactions existing between sauna bathing and SES in relation to these outcomes.[13,37]

HEALTH EFFECTS OF OTHER PASSIVE HEAT THERAPIES

Other passive heat therapies include Waon therapy, hot tubs/baths, hydrotherapy, sanarium, and steam baths (eg, hammam, Russian steam bath or banya); they vary by relative humidity but typically operate at lower temperatures. There is a good amount of literature regarding their beneficial effects on vascular and nonvascular health.

Waon therapy (which means "soothing warm therapy") is a form of thermal treatment in a far-infrared dry sauna maintained at a uniform temperature of 60 °C; it is the predominant passive therapy that is used for the treatment of heart failure in Japan. Patients remain in the sauna for 15 minutes and are then placed in a supine position on a

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bed outside the sauna where they are covered with blankets for 30 minutes.[27,28] In patients with heart failure, Waon therapy has been found to improve clinical symptoms, hemodynamic measures such as cardiac index and systemic and pulmonary resistance, cardiac and vascular endothelial function, exercise capacity, and quality of life; to increase ejection fraction and heart rate variability; and to decrease cardiac size, premature ventricular contractions, and sympathetic nervous activity.[27,28,38,39] Repeated sessions of Waon therapy reduce blood pressure in patients with hypertension[39,40] and relieve symptoms of peripheral artery disease, COPD, fibromyalgia, chronic pain, mild depression, and chronic fatigue syndrome.[27,28]

Hydrotherapy (also known as water therapy, aquatic therapy, pool therapy, and balneotherapy), which was widely used in ancient cultures including Egypt, China, and India, involves the use of water in any form (liquid, ice, steam) at varying temperatures and pressure to promote health or to treat diseases.[29,41] Hydrotherapy has been found to improve pain and is used for the management of heart failure, myocardial infarction, COPD, asthma, Parkinson disease, ankylosing spondylitis, osteoarthritis, rheumatoid arthritis, fibromyalgia, anorectal disorders, fatigue, anxiety, obesity, hypercholesterolemia, hyperthermia, and labor.[29] Although the mechanistic pathways underlying the beneficial effects of hydrotherapy are not well understood, evidence suggests that these effects are dependent on the temperature of the water.[29]

Steam baths, a form of hydrotherapy, operate at temperatures around 43 °C with a humidity level of 100%. In addition to the health benefits listed before, they have been found to produce significant reductions in blood pressure.[42] Hot tub bathing, which involves sitting in a hot tub with water up to the shoulders at temperatures ranging from 37.8 to 41.0 °C, is ingrained in the culture of Japan. It has been reported to reduce levels of cardiovascular risk factors (such as fasting glucose concentration, glycated hemoglobin level, blood pressure, and body weight), to improve sleep, and to increase general sense of well-being.[43–45] In a prospective study based on 30,076 participants aged 40 to 59 years with no history of CVD or cancer at baseline followed up from 1990 to 2009, having hot tub baths almost daily or every day vs 0 to 2 times per week was associated with risk reductions in cardiovascular outcomes ranging from 23% to 46%.[46]

A number of studies have also evaluated the effects of the combination of any of these other passive therapies (other than Finnish saunas) with other risk or lifestyle factors. In a study that evaluated the efficacy of the combination of Waon therapy and exercise training compared with Waon therapy alone in patients with heart failure, combination therapy significantly reduced levels of brain natriuretic peptide and increased exercise capacity.[47] In a clinical trial of overweight, community-dwelling middle-aged and older adults who were randomized to exercise, diet, and hot bathing intervention (group A), exercise and diet intervention (group B), hot bathing intervention (group C), and a control group (group D), twice weekly for 3 months, the exercise, diet, and hot bathing intervention group had significant improvements in anthropometric measures compared with the hot bathing intervention or control group only.[45]

MECHANISTIC PATHWAYS UNDERLYING THE COMBINED EFFECTS OF FINNISH SAUNA AND OTHER FACTORS

Evidence on the ability of frequent sauna bathing to augment the beneficial effects of other protective risk factors, such as physical activity and exercise training, suggests that sauna may work in synergy with these risk factors to produce a greater effect than each modality alone. Indeed, the protective effects of sauna bathing on adverse outcomes have been reported to be independent of physical activity and fitness levels[11,23,25]; furthermore, sauna bathing has been reported to interact with other risk markers, such as physical activity, CRF, and inflammation, in relation to some outcomes.[26,35] The physiologic responses and adaptations

elicited by a sauna bath have been reported to be similar to those produced by moderate- or high-intensity physical activity.[48,49] For instance, levels of norepinephrine induced by sauna exposure are similar to the levels induced by maximal physical activity.[50] Also, regular heat therapy (including Finnish saunas) produces blood pressure reductions that are similar to levels after physical activity or aerobic exercise training.[51,52] Our published review on the cardiovascular and other health benefits of Finnish sauna baths comprehensively discussed the mechanistic pathways underlying the protective effects of sauna bathing on various outcomes.[21] A review by Patrick and Johnson[20] has also discussed the body's physiologic responses to the heat stress from sauna and molecular mechanisms that drive these responses, which subsequently contribute to its health benefits. Briefly, predominant underlying pathways may include a combination of the following: blood pressure reduction[8]; reduction in systemic inflammation[53,54] and oxidative stress[54–56]; improvement in arterial stiffness and compliance and intima-media thickness[7,44,55,57,58]; overall improvement of the cardiorespiratory system[59] and cardiovascular function[3,4,60]; boosting of immune function[61,62]; positive stimulation of the autonomic nervous system,[63] which increases the production of norepinephrine and parasympathetic tone[64–66]; promotion of analgesic effects through stimulation of increased circulating levels of β-endorphins[67]; and direct effects on the airways and lung tissue by reducing pulmonary congestion and increasing ventilation[18] (Figure). Furthermore, sauna bathing is a stress reliever, and given that stress is a major contributing factor of most diseases,[68] frequent sauna bathing may prevent diseases by its ability to promote overall well-being and body relaxation. Large-scale prospective studies are needed to investigate which pathways or factors exert the most predominant protective roles.

Other postulated pathways that deserve further study include improvement in endothelial function and nitric oxide bioactivity[69–71]; hormonal stimulation, which includes increases in levels of plasma renin, cortisol, and growth hormone[72]; improvement in levels of blood-based vascular risk factors, such as circulating lipids, measures of glycemia, natriuretic peptides, cardiac troponin T, interleukins, and CRP[53,54,57,73,74]; facilitation of increased secretion of heavy metals, such as aluminum, cobalt, and lead, through sweating[75]; increased expression of heat shock proteins, which play important roles in many cellular processes, such as immune function and prevention of protein disorder and aggregation, subsequently providing protection against chronic diseases[20]; and enhancement in neurogenesis through increased expression of brain-derived neurotrophic factor.[76]

CLINICAL AND PUBLIC HEALTH IMPLICATIONS

The good safety profile of sauna bathing is well documented, and most people, including patients with stable CVD, are able to tolerate a typical hot and dry Finnish sauna.[21] These findings have implications for public health practice and have the potential to be translated into clinical practice. Habitual physical activity is well documented to have a protective effect on adverse health outcomes, including the promotion of longevity. Adding frequent sauna sessions will substantially augment the benefits of physical activity. Taking the overall evidence together, 3 to 7 sauna sessions per week with each session lasting about 15 to 20 minutes is associated with the most health benefits.[21] Combining this with physical activity guideline recommendations of at least 150 to 300 minutes of moderate-intensity physical activity or 75 to 150 minutes of vigorous-intensity physical activity per week[77–79] will substantially promote cardiovascular and overall health and longevity. For people who are unable to meet physical activity guideline recommendations[77–79] or are unable to exercise at all because of physical activity limitations, regular use of sauna may be an alternative lifestyle strategy to mitigate the risk of diseases due to other risk factors. There is evidence that the regular use of sauna alone elicits similar hemodynamic responses, such as blood pressure reduction,

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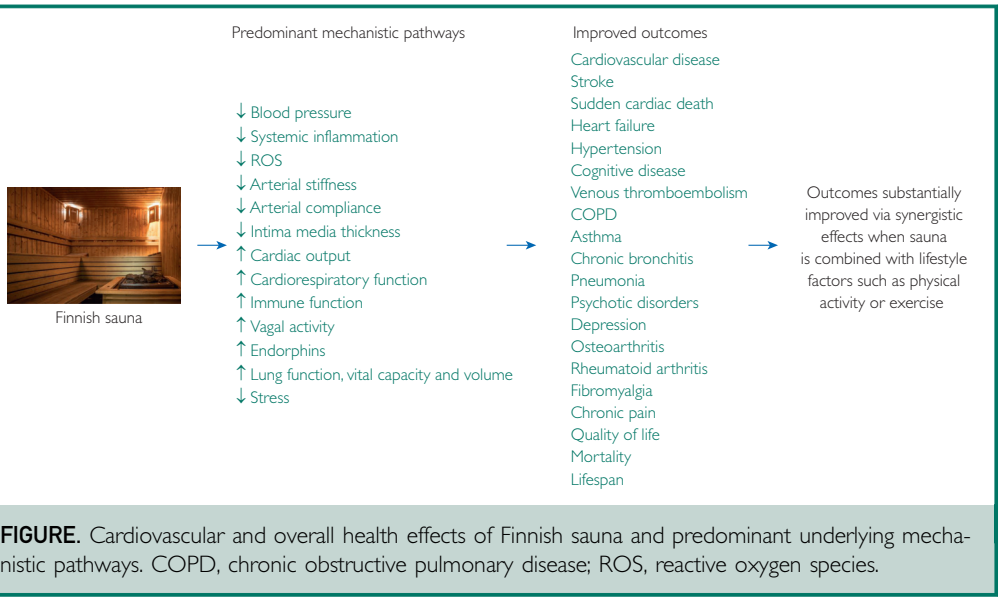

FIGURE. Cardiovascular and overall health effects of Finnish sauna and predominant underlying mechanistic pathways. COPD, chronic obstructive pulmonary disease; ROS, reactive oxygen species.

compared with a combination of exercise and sauna.[31] In our recent RCT, we found that 8 weeks of regular sauna bathing sessions combined with exercise produced a mean reduction in SBP of 8 mm Hg.[24] This is a substantial and clinically important reduction, given that exercise training alone produces mean reductions of about 4 mm Hg for SBP.[48] Furthermore, a reduction of 2 mm Hg in SBP could reduce mortality from stroke and vascular causes by 10% and 7%, respectively[80]; SBP reductions of 5 to 7 mm Hg among individuals with hypertension translate to a 20% to 30% reduced risk of CVD.[81]

FUTURE DIRECTIONS

The evidence on the cardiovascular and other health benefits of sauna is consistent, and its use should be promoted among the wider population. It has often been argued that sauna bathing is more accessible to people in Nordic countries as well as to people of high SES; hence, its public health impact and ability to be translated clinically may be limited in other populations. However, the steep increase in research outputs on the health benefits of saunas during the last decade has been accompanied by a proportionate global increase in the use of saunas as a lifestyle strategy. Most wellness centers and gyms have included saunas in their facilities. Nevertheless, despite the growing evidence on the health benefits of sauna use, definitive RCTs evaluating sauna use are very few, and there are many unanswered questions. A lot of the current evidence is based on the KIHD study (Table), a unique population-based long-term observational prospective cohort study that was designed to evaluate emerging and traditional risk factors for atherosclerotic cardiovascular end points and other related outcomes in eastern Finland.[82] Given the potential biases inherent in observational cohort studies, such as residual confounding due to errors in measured confounders and relevant unmeasured confounders, reverse causation, regression dilution bias, and inability to prove causation, caution is still needed in interpreting the findings.

Investigators are encouraged to conduct well-designed intervention studies to further provide more robust evidence on the health benefits of regular sauna use in combination with protective lifestyles such as physical activity and also to understand the pathophysiologic mechanisms underlying the protective effects. Furthermore, whether there are sex and age

TABLE. Key Studies That Have Evaluated the Combination of Finnish Sauna Bathing and Other Risk Factors[a]

Reference, year	Country	Study design	Exposures	Outcome (No. of events) or measures	No. of participants and population	Comparisons	Results or risk estimate[b] (95% CI)
Kunutsor,[5] 2018	Finland	Prospective cohort	Sauna bathing and CRF	CVD mortality (520)	2277 general population participants	High vs low FSB High vs low CRF High CRF—high FSB vs low CRF—low FSB	0.74 (0.59-0.94) 0.51 (0.41-0.63) 0.42 (0.28-0.62)
				All-cause mortality (1124)		High vs low FSB High vs low CRF High CRF—high FSB vs low CRF—low FSB	0.84 (0.72-0.97) 0.65 (0.57-0.75) 0.60 (0.48-0.62)
Kunutsor,[13] 2021	Finland	Prospective cohort	Sauna bathing and SES	Pneumonia (617)	2575 general population participants	High vs low FSB Low vs high SES Low SES—high FSB vs high SES—low FSB	0.76 (0.65-0.90) 1.29 (1.09-1.52) 1.01 (0.79-1.27)
Laukkanen,[22] 2018	Finland	Prospective cohort	Sauna bathing and CRF	SCD (226)	2291 general population participants	High vs low FSB High vs low CRF High CRF—high FSB vs low CRF—low FSB	0.67 (0.46-0.98) 0.48 (0.34-0.67) 0.31 (0.16-0.63)
Kunutsor,[23] 2021	Finland	Prospective cohort	Sauna bathing and CRF	Pneumonia (529)	2275 general population participants	High vs low FSB High vs low CRF High CRF—high FSB vs low CRF—low FSB	0.81 (0.68-0.97) 0.75 (0.61-0.91) 0.62 (0.48-0.80)
Lee,[24] 2022	Finland	RCT	Sauna and exercise	Blood pressure, CRF, and other cardiovascular risk markers	47 participants with low physical activity levels and at least 1 traditional cardiovascular risk factor	Sauna and exercise vs exercise vs control	Sauna combined with exercise had positive effects on SBP, CRF, and total cholesterol
Kunutsor,[25] 2022	Finland	Prospective cohort	Sauna bathing and hsCRP	Pneumonia (528)	2264 general population participants	High vs low FSB High vs normal hsCRP High hsCRP—high FSB vs normal hsCRP—low FSB	0.79 (0.66-0.95) 1.30 (1.04-1.62) 0.94 (0.69-1.29)
Kunutsor,[26] 2022	Finland	Prospective cohort	Sauna bathing and SES	All-cause mortality (1618)	2575 general population participants	High vs low FSB Low vs high SES Low SES—high FSB vs high SES—low FSB	0.85 (0.75-0.97) 1.31 (1.18-1.45) 1.07 (0.89-1.29)

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TABLE. Continued

Reference, year	Country	Study design	Exposures	Outcome (No. of events) or measures	No. of participants and population	Comparisons	Results or risk estimate[b] (95% CI)
Lee,[30] 2020	Finland	Pre-post intervention study	Sauna and aerobic exercise	Arterial stiffness and hemodynamic measures	77 participants with at least 1 cardiovascular risk factor	NA	Positive alterations on mean arterial pressure, pulse pressure, and augmentation index
Lee,[31] 2021	Finland	Crossover study	Sauna and aerobic exercise	Hemodynamic measures	72 participants with at least 1 cardiovascular risk factor	Aerobic exercise and sauna vs sauna	Similar reductions in hemodynamic measures—blood pressure and mean arterial pressure
Gayda,[32] 2012	Canada	Crossover study	Sauna and exercise	Blood pressure and central hemodynamic variables	16 patients with untreated hypertension	Exercise and sauna vs sauna	Decrease in SBP, mean blood pressure, and total vascular resistance
Stanley,[33] 2015	Australia	Pre-post intervention study	Sauna and exercise	Plasma volume and heart rate –based measures	7 well-trained male cyclists	NA	Expansion in plasma volume
Rissanen,[34] 2020	Finland	Intervention study	Sauna and endurance and strength exercise	Hemodynamic, plasma volume, and immunologic measures	27 healthy, slightly prehypertensive men	Sauna vs sauna and endurance exercise vs sauna and strength exercise vs sauna and endurance and strength exercise	Combination of endurance and sauna provided greatest reductions in blood pressure
Kunutsor,[35] 2022	Finland	Prospective cohort	Sauna bathing and hsCRP	All-cause mortality (1618)	2575 general population participants	High vs low FSB High vs normal hsCRP High hsCRP—high FSB vs normal hsCRP—low FSB	0.86 (0.76-0.97) 1.27 (1.13-1.44) 1.06 (0.81-1.40)
Laukkanen,[36] 2022	Finland	Prospective cohort	Sauna bathing and SBP	CVD mortality (744)	2575 general population participants	High vs low FSB High vs normal SBP High SBP—high FSB vs normal SBP—high FSB	0.80 (0.66-0.96) 1.48 (1.27-1.73) 1.21 (0.90-1.62)

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differences in the health benefits of sauna is uncertain as the majority of studies have been conducted in men who are middle-aged or older. Hence, studies are needed to clarify these uncertainties. Last, RCTs comparing the health benefits of Finnish sauna with other passive therapies are warranted. Specifically, given the substantial health benefits associated with hydrotherapy, a definitive trial that randomizes patients to Finnish sauna, hydrotherapy, exercise, or sham intervention would help address pertinent clinical questions.

CONCLUSION

Sauna bathing has traditionally been used for leisure and pleasure purposes. However, epidemiologic and interventional evidence suggests that regular sauna bathing is consistently linked with an array of health benefits and also increases the life span. The evidence suggests that frequent sauna bathing may augment the beneficial effects of protective risk factors, such as physical activity and fitness, or attenuate or offset the adverse effects of other risk factors. The effects of sauna are independent of physical activity; hence, when used in combination, it has the ability to exert substantial benefits compared with physical activity alone.

For people who genuinely cannot engage in physical activity, the use of sauna alone may be enough to confer beneficial health outcomes, given that some of the clinical effects of sauna are similar to those produced by moderate- or high-intensity physical activity. Definitive trials that make head-to-head comparisons of sauna and physical activity/exercise are also lacking and are urgently warranted.

POTENTIAL COMPETING INTERESTS

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TABLE. Continued

Reference, year	Country	Study design	Exposures	Outcome (No. of events) or measures	No. of participants and population	Comparisons	Results or risk estimate[b] (95% CI)
Kunutsor, 2022	Finland	Prospective cohort	Sauna bathing and SBP	All-cause mortality (1618)	2575 general population participants	High vs low FSB High vs normal SBP High SBP—high FSB vs normal SBP—high FSB	0.86 (0.76-0.98) 1.31 (1.18-1.45) 1.11 (0.90-1.35)

[a]CRF, cardiorespiratory fitness; CVD, cardiovascular disease; FSB, frequency of sauna bathing; hsCRP, high-sensitivity C-reactive protein; NA, not applicable; RCT, randomized controlled trial; SBP, systolic blood pressure; SCD, sudden cardiac death; SES, socioeconomic status.
[b]Based on fully adjusted analyses.

Abbreviations and Acronyms: **COPD,** chronic obstructive pulmonary disease; **CRF,** cardiorespiratory fitness; **CVD,** cardiovascular disease; **hsCRP,** high-sensitivity C-reactive protein; **KIHD,** Kuopio Ischemic Heart Disease; **RCT,** randomized controlled trial; **SBP,** systolic blood pressure; **SES,** socioeconomic status

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