

*Cognitive Vitality Reports® are reports written by neuroscientists at the Alzheimer's Drug Discovery Foundation (ADDF). These scientific reports include analysis of drugs, drugs-in-development, drug targets, supplements, nutraceuticals, food/drink, non-pharmacologic interventions, and risk factors. Neuroscientists evaluate the potential benefit (or harm) for brain health, as well as for age-related health concerns that can affect brain health (e.g., cardiovascular diseases, cancers, diabetes/metabolic syndrome). In addition, these reports include evaluation of safety data, from clinical trials if available, and from preclinical models.*

## Sauna

### Evidence Summary

Frequent sauna use is associated with significantly reduced risks for mortality, cardiovascular disease, stroke, and dementia. It may improve vascular endothelial function, reduce inflammation, and reduce blood pressure.

**Neuroprotective Benefit:** Frequent sauna use is associated with a large reduction in dementia risk, based on a single observational study. Benefits may be attributed to improved vascular endothelial function, and reduced inflammation and blood pressure.

**Aging and related health concerns:** Frequent sauna use is associated with significantly reduced risks for all-cause mortality, cardiovascular mortality, and stroke. It decreases blood pressure and inflammation, while improving vascular endothelial function.

**Safety:** Sauna use is generally safe for healthy individuals. But numerous contraindications exist (e.g., orthostatic hypotension, unstable coronary artery disease, etc.) and alcohol should not be consumed before or during sauna use.

<b>Availability:</b> Some gyms and fitness clubs have saunas. Sauna set-ups can also be purchased for a home.	<b>Dose:</b> Finnish men who used a sauna 4-7 times per week had significantly reduced risk of all-cause mortality, cardiovascular disease mortality, stroke, and dementia compared to those who used it once per week.	<b>Chemical formula:</b> N/A <b>MW:</b> N/A
<b>Half life:</b> N/A	<b>BBB:</b> N/A	
<b>Clinical trials:</b> Numerous open-label and controlled clinical trials of fewer than 100 patients.	<b>Observational studies:</b> Most observational studies are based on a cohort of over 2,000 middle-aged Finnish men (Kuopio Ischaemic Heart Disease Study).	

**What is it?** Sauna bathing has been a tradition in Finland for thousands of years and is typically used for relaxation and wellness. Finnish sauna bathing involves sitting in high temperature (80-100°C) with dry air for a brief period ([Laukkanen et al., 2018](#)). Sauna bathing is often done intermittently, with each stay lasting between 5 to 20 minutes followed by short periods in a colder environment (e.g., cold shower or a short stay in ice-cold water) ([Heinonen and Laukkanen, 2018](#)). Recent evidence suggests that sauna use has several health benefits, including the reduction in risk for cardiovascular disease, stroke, neurodegenerative diseases, pulmonary diseases, rheumatic diseases, and mortality ([Laukkanen et al., 2018](#)). The protective effects of the Finnish sauna may reflect life-long habits, which usually begin very early in the childhood, as children who are as young as 6 months old are gradually introduced to the sauna. Protective health benefits by shorter term sauna interventions later in life are not well-established.

**Neuroprotective Benefit:** Frequent sauna use is associated with a large reduction in dementia risk, based on a single observational study. Benefits may be attributed to improved vascular endothelial function, and reduced inflammation and blood pressure.

*Types of evidence:*

- 1 observational study

Human research to suggest prevention of dementia, prevention of decline, or improved cognitive function?

In a prospective population-based study of 2,315 healthy Finnish men aged 42-60 years old who were followed up for an average of 20.7 years, compared with those whose sauna use was once per week, the hazard ratio (HR) for dementia was 0.78 (95% CI, 0.57 to 1.06) for 2-3 times per week and 0.34 (95% CI, 0.16 to 0.71) for 4-7 times per week, based on a multivariable analysis adjusted for age, alcohol consumption, body mass index, systolic blood pressure, smoking status, type 2 diabetes, previous myocardial infarction, resting heart rate and serum LDL cholesterol ([Laukkanen et al., 2017](#)). The corresponding HRs for Alzheimer's disease were 0.80 (95% CI, 0.53 to 1.20) for 2-3 times per week and 0.35 (95% CI, 0.14 to 0.90) for 4-7 times per week. After additional adjustment for physical activity and socio-economic status, the respective associations between sauna bathing and the risk of neurocognitive diseases remained similar for men whose sauna use was 4-7 times per week when compared with once per week users (HR=0.34, 95% CI, 0.16 to 0.71, p=0.004 for dementia; HR=0.35, 95% CI, 0.16 to 0.90, p=0.029 for Alzheimer's disease).

Human research to suggest benefits to patients with dementia:

None available.

Mechanisms of action for neuroprotection identified from laboratory and clinical research:

The precise mechanisms through which sauna use produces neuroprotective effects have not been empirically tested. However, there are several theoretical mechanisms. The beneficial effects of sauna use have been linked to its effects on circulatory, cardiovascular, and immune functions ([Laukkanen et al., 2018](#)). Regular sauna bathing is associated with improved vascular endothelial function, which also leads to reduced inflammation ([Laukkanen et al., 2017](#)). Additionally, sauna use leads to reduction of high blood pressure and elevated pulse pressure. Therefore, sauna use may decrease dementia risk by reducing its risk factors.

APOE4 interactions: Unknown.

**Aging and related health concerns:** Frequent sauna use is associated with significantly reduced risks for all-cause mortality, cardiovascular mortality, and stroke. It decreases blood pressure and inflammation, while improving vascular endothelial function.

*Types of evidence:*

- 6 controlled clinical trials
- 8 open-labeled clinical trials
- 7 observational studies
- Numerous literature reviews

**Caveats:** The vast majority of studies have been carried out in Finland, where most homes have a built-in sauna. Most of the studies have been in men. Many of the studies have also been observational, so there may be confounding factors such as BMI/obesity in that people with less insulating fat may be able to tolerate the higher temperatures for longer. However, many of these caveats have been addressed in observational studies that controlled for numerous variables ([Heinonen and Laukkanen, 2018](#)) as well as in controlled studies where effects on blood pressure and other biomarkers were observed.

**Mortality:** SIGNIFICANTLY LOWER RISK FOR ALL-CAUSE MORTALITY, SUDDEN CARDIAC DEATH, FATAL CORONARY HEART DISEASE, AND FATAL CVD WITH FREQUENT SAUNA USE.

In a prospective cohort study of 2,315 middle-aged men from Eastern Finland (42-60 years old) who were followed up for a median of 20.7 years, compared to men who used the sauna once per week, the hazard ratio (HR) for all-cause mortality was 0.76 (95% CI, 0.66 to 0.88;  $p < 0.001$ ) for men who used it 2-3 times per week and 0.60 (95% CI, 0.46 to 0.80;  $p < 0.001$ ) for men who used it 4-7 times per week, after statistical adjustment for age, body mass index, systolic blood pressure, serum LDL cholesterol level, smoking, alcohol consumption, previous myocardial infarction, type 2 diabetes mellitus, cardiorespiratory fitness, resting heart rate, physical activity, and socioeconomic status ([Laukkanen et al., 2015](#)).

After adjustment for the risk factors listed above, compared to men who used the sauna once per week, the hazard ratio (HR) for sudden cardiac death was 0.78 (95% CI, 0.57 to 1.07) for men who used it 2-3 times per week and 0.37 (95% CI, 0.18 to 0.75) for men who used it 4-7 times per week. Similarly, an inverse association was found between sauna session duration and risk of sudden cardiac death. Compared with men having a sauna bathing session of less than 11 minutes, the adjusted HR for sudden

cardiac death was 0.93 (95% CI, 0.67 to 1.28) for sauna bathing sessions of 11-19 minutes and 0.48 (95% CI, 0.31 to 0.75) for sessions lasting more than 19 minutes ( $p=0.002$ ).

Participants with a higher frequency of sauna use per week also had a lower risk of fatal coronary heart disease and cardiovascular disease mortality: the HR for fatal coronary heart disease events was 0.77 (95% CI, 0.60 to 0.99) for those using the sauna 2-3 times per week and 0.52 (95% CI, 0.31 to 0.88) for those using it 4-7 times per week, respectively ( $p<0.005$ ). Correspondent estimates for cardiovascular disease mortality were 0.73 (95% CI, 0.59 to 0.89) and 0.50 (95% CI, 0.33 to 0.77) ( $p<0.001$ ). Likewise, significant inverse associations were found between duration of sauna bathing and coronary heart disease ( $p=0.007$ ) and cardiovascular disease ( $p=0.03$ ) mortality.

In a more recent study of the same cohort, 2,277 Finnish middle-aged men were followed for a median of 26.1 years ([Kunutsor et al., 2018](#)). Comparing high (3-7 times per week) versus low (2 or fewer times per week) frequency of sauna use, the HRs for cardiovascular and all-cause mortality were 0.74 (95% CI, 0.59 to 0.94) and 0.84 (95% CI, 0.72 to 0.97), respectively. Compared to low cardiorespiratory fitness (measured by respiratory gas analyses) and low sauna use frequency, the HRs of cardiovascular disease mortality for high cardiorespiratory fitness and high sauna use frequency; high cardiorespiratory fitness and low sauna use; and low cardiorespiratory fitness and high sauna use were 0.42 (95% CI, 0.28 to 0.62), 0.50 (95% CI, 0.39 to 0.63), and 0.72 (95% CI, 0.54 to 0.97), respectively. For all-cause mortality, the corresponding HRs were 0.60 (95% CI, 0.48 to 0.76), 0.63 (95% CI, 0.54 to 0.74), and 0.78 (95% CI, 0.64 to 0.96), respectively. Cardiorespiratory fitness and frequency of sauna bathing were independently associated with reduced mortality risk; a combination of good cardiorespiratory fitness and frequent sauna bathing showed the greatest survival benefits. However, objectively measured cardiorespiratory fitness remained a stronger indicator of cardiovascular and all-cause mortality outcomes than sauna use frequency.

In a study that included women, the same Kuopio Ischaemic Heart Disease Study cohort of 1,688 participants (51.4% of whom were women) were followed up for a median of 15 years and cardiovascular disease mortality decreased linearly with increasing sauna use per week ([Laukkanen et al., 2018](#)). In age- and sex-adjusted analysis, compared with participants who used the sauna once per week, HRs (95% CIs) for cardiovascular disease-related mortality were 0.71 (0.52 to 0.98) and 0.30 (0.14 to 0.64) for participants with sauna use 2-3 times and 4-7 times per week, respectively. After adjustment for established cardiovascular risk factors, potential confounders including physical activity, socioeconomic status, and incident coronary heart disease, the corresponding HRs (95% CIs) were 0.75 (0.52 to 1.08) and 0.23 (0.08 to 0.65), respectively. The duration of sauna use (minutes per week) was



inversely associated with cardiovascular disease-related mortality in a continuous manner. Higher frequency and duration of sauna bathing were each strongly, inversely, and independently associated with fatal cardiovascular events in middle-aged and elderly men and women.

Sauna bathing may confer its protective effects on cardiovascular disease and all-cause mortality via several mechanisms and these include improvement in cardiovascular function, reduction in systemic blood pressure, increased cardiac output as a result of increased body temperature, improvement in endothelial function, increase in left ventricular ejection fraction, and reductions in oxidative stress ([Kunutsor et al., 2018](#); [Laukkanen et al., 2018](#)). Other effects of regular sauna bathing which might contribute to its risk reduction of mortality include positive alterations of the autonomic nervous system, reduced levels of natriuretic peptides, and improved arterial stiffness and intima media thickness. Sauna-induced elevated heart rate (often up to 100-150 beats per minute) increases myocardial workload and oxygen demand similarly to physical exercise ([Zaccardi et al., 2017](#)).

***Stroke:*** SIGNIFICANTLY REDUCES RISK WITH FREQUENT AND LONG-TERM SAUNA USE.

In a prospective cohort study (Kuopio Ischemic Heart Disease study) of 1,628 Finnish men and women aged 53-74 years old without a history of stroke, compared to people who used the sauna once per week, the age- and sex-adjusted HR (95% CI) for stroke was 0.39 (0.18-0.83) for participants who used the sauna 4-7 times per week ([Kunutsor et al., 2018](#)). After further adjustment for cardiovascular risk factors and other potential confounders, the corresponding HR (95% CI) was 0.39 (0.18-0.84) and this remained persistent after additional adjustments for physical activity and socioeconomic status (HR=0.38; 95% CI, 0.18 to 0.81). The association between frequency of sauna bathing and risk of stroke was not modified by age, sex, or other clinical characteristics. The association was similar for ischemic stroke but modest for hemorrhagic stroke, which could be due to the low incidence (n=34). This long-term follow-up study suggests that middle-aged and elderly men and women who frequently use the sauna have a substantially reduced risk of new-onset stroke.

Mechanistic pathways thought to underlie the beneficial effects of sauna use on cardiovascular outcomes include reduction in systemic blood pressure, positive alteration of the autonomic nervous system, positive effects on circulating lipid profiles, and reductions in oxidative stress, arterial stiffness, carotid intima media thickness, and peripheral vascular resistance ([Kunutsor et al., 2018](#)). Sauna use is also considered to be relaxing and stress-relieving.



***Hypertension:*** BENEFIT.

In a controlled clinical trial of 16 patients with untreated hypertension, people in the sauna intervention group (85-90°C; relative humidity of 50-60%; two 8-minute stays followed by a cold-water showering) showed a significantly decreased systolic blood pressure during the second minute of the first sauna compared with baseline ([Gayda et al., 2012](#)). In untreated hypertensive patients, exercise followed by a sauna session had positive effects on short-term systolic blood pressure and 24-hour ambulatory blood pressure (systolic blood pressure), whereas sauna alone had no effects on the latter.

In an open-label trial of 102 people with at least one cardiovascular risk factor, a single sauna session of 30 minutes (temperature, 73 °C; humidity, 10-20%) significantly reduced mean carotid-femoral pulse wave velocity (mean  $\pm$  SD; from 9.8 $\pm$ 2.4 m/s before sauna to 8.6 $\pm$ 1.6 m/s immediately after sauna;  $p < 0.0001$ ), systolic blood pressure (from 137 $\pm$ 16 to 130 $\pm$ 14 mmHg;  $p < 0.0001$ ), and diastolic blood pressure (from 82 $\pm$ 10 to 75 $\pm$ 9 mmHg;  $p < 0.0001$ ) ([Laukkanen et al., 2018](#)). Systolic blood pressure after 30 minutes of recovery remained lower compared to pre-sauna levels.

In a prospective cohort study (Kuopio Ischaemic Heart Disease study) of 1,621 men without hypertension at baseline who were followed up for a median of 24.7 years, compared to people who used the sauna once per week, the HR for incident hypertension was 0.76 (95% CI, 0.57 to 1.02) for men who used the sauna 2-3 times per week and 0.54 (95% CI, 0.32 to 0.91) for men who used the sauna 4-7 times per week, based on a Cox regression analysis adjusted for baseline age, smoking, body mass index, and systolic blood pressure ([Zaccardi et al., 2017](#)). The corresponding hazard ratios were similar after further adjustment for glucose, creatinine, alcohol consumption, heart rate, family history of hypertension, socioeconomic status, and cardiorespiratory fitness: 0.83 (95% CI, 0.59 to 1.18) and 0.53 (95% CI, 0.28 to 0.98), respectively. Regular sauna bathing is associated with a reduced risk of hypertension, which may be one of the mechanisms underlying the decreased cardiovascular risk associated with sauna use.

***Heart/vascular function:*** MIXED/BENEFIT.

In an open label study of 12 patients with chronic heart failure, 13 patients with coronary artery disease, and 12 healthy controls, two consecutive Finnish sauna (80°C) exposures followed by a final neck-down cold-water immersion (12°C) resulted in significantly increased cardiac output and heart rate in all groups except for patients with coronary artery disease ([Radtke et al., 2016](#)). Systolic blood pressure during sauna decreased significantly in all groups ( $p < 0.05$ ). Cold-water immersion significantly

increased systolic blood pressure in all groups ( $p < 0.05$ ). Acute exposure to Finnish sauna and cold-water immersion caused hemodynamic alterations (increased low frequency/high frequency ratio of heart rate variability) in chronic heart failure patients similarly to control subjects and did not induce an excessive increase in adrenergic activity or complex arrhythmias.

In a pilot open-label study of 20 healthy young men (20-30 years old), Finnish sauna bath ( $3 \times 10$  minutes,  $90^{\circ}\text{C}$  with 10 minute-breaks) upregulated circulating endothelial progenitor cells ( $\text{CD45}^{+}/\text{CD309}^{+}$  cells) immediately after the sauna bath, though it did not reach statistical significance ([Donndorf et al., 2015](#)). Furthermore, sauna bathing tended to increase endothelial progenitor cell colony-forming capacity. It remains to be seen whether larger effects would be observed in older people with greater cardiovascular risk factors.

In an open-label study of 102 people with at least one cardiovascular risk factor, a single 30-minute sauna session (mean temperature:  $73^{\circ}\text{C}$ ) resulted in an increase in a blood biomarker of heart failure (N-terminal pro-B-type natriuretic peptide) from 46.0 ng/L before sauna exposure to 50.5 ng/L immediately after sauna (median change, +12.00%;  $p < 0.001$ ) and remained elevated at 30-min post-sauna (median change from pre-sauna to post-30-min sauna, +13.93%;  $p < 0.001$ ) ([Kunutsor et al., 2018](#)). While counterintuitive, it is possible that with repeated sauna use, there is a hormetic effect such that baseline B-type natriuretic peptide (BNP) levels decrease, as has been shown in a randomized controlled trial of a 10-day Waon therapy that involves a far-infrared ray sauna ([Tei et al., 2016](#)).

In an open-label study of 93 people with cardiovascular risk factors, a single sauna session for 30 minutes (temperature,  $73^{\circ}\text{C}$ ; humidity, 10-20%) resulted in a resting heart rate that was lower at the end of recovery (68/min) compared to pre-sauna (77/min) ([Laukkanen et al., 2019](#)). A sauna session transiently diminished the vagal component, whereas the cooling down period after sauna decreased low frequency power ( $p < 0.001$ ) and increased high frequency power in heart rate variability ( $p < 0.001$ ), favorably modulating the autonomic nervous system balance. A session of sauna bathing induces an increase in heart rate, but during the cooling down period, heart rate variability increased which indicates the dominant role of parasympathetic activity and decreased sympathetic activity of the cardiac autonomic nervous system.





***Cholesterol/Triglycerides:*** DECREASED.

In an open-label study of 16 young men (20-23 years old), 10 sauna sessions in a Finnish sauna every 1 or 2 days (mean temperature,  $90\pm 2^{\circ}\text{C}$ ; humidity 5-16%; three 15-minute stays followed by 2-minute cool-down) across 3 weeks significantly decreased total and LDL cholesterol, with a gradual return to baseline levels during the first and second week after the sauna intervention ([Gryka et al., 2014](#)). A statistically significant decline in the level of total cholesterol compared to the initial value ( $4.50\pm 0.66$  mmol/L, 174 mg/dL) was reported directly after the first sauna session ( $4.38\pm 0.62$  mmol/L, 169 mg/dL,  $p=0.007$ ), and then before ( $4.25\pm 0.47$  mmol/L, 164 mg/dL,  $p=0.044$ ) and after the last session ( $4.16\pm 0.54$  mmol/L, 160 mg/dL,  $p=0.015$ ) as well as 24 hours after the last sauna session ( $4.18\pm 0.41$  mmol/L, 161 mg/dL,  $p=0.02$ ). Total cholesterol levels in the first and the second week after completion of the sauna intervention were at a lower level ( $4.26\pm 0.45$  mmol/L and  $4.37\pm 0.56$  mmol/L, or 164 and 161 mg/dL) compared to the baseline level. A statistically significant decrease in LDL levels was observed in blood samples taken before ( $2.52\pm 0.43$  mmol/L, 97.5 mg/dL,  $p=0.013$ ) and after the 10th sauna session ( $2.44\pm 0.42$  mmol/L, 94.3 mg/dL,  $p=0.007$ ), 24 hours ( $2.43\pm 0.35$  mmol/L, 94 mg/dL,  $p=0.01$ ), and a week after completion of the sauna intervention ( $2.47\pm 0.40$  mmol/L, 95.5 mg/dL,  $p=0.03$ ). In the second week after completion of the sauna sessions, LDL levels remained lower than the baseline value ( $2.57\pm 0.43$  mmol/L, 99.3 mg/dL), though this was not statistically significant. A significant decline in triacylglycerols was also found directly after the 1st and 24 h directly after the 10th sauna session.

***Inflammation:*** DECREASED CRP WITH FREQUENT LONG-TERM SAUNA USE.

In a cross-sectional analysis of the Kuopio Ischaemic Heart Disease Study cohort of 2,084 Finnish men, people who used the sauna once a week, 2-3 times per week, and 4-7 times per week had mean serum C-reactive protein levels of 2.41 (SD=2.91), 2.00 (SD=2.41), 1.65 (SD=1.63) mmol/L, respectively ([Laukkanen and Laukkanen, 2018](#)). In a multivariable analysis adjusted for baseline age, body mass index, systolic blood pressure, smoking, type 2 diabetes, previous myocardial infarction, serum low density lipoprotein cholesterol, alcohol consumption, and physical activity, the significant inverse association between the frequency of sauna bathing and the level of C-reactive protein remained.

In a cross-sectional and longitudinal analyses of the Kuopio Ischaemic Heart Disease Study cohort of 2,269 Finnish men who were followed up for 11 years, baseline analysis showed that sauna use 4-7 times per week (compared with once per week) was associated with lower high-sensitivity C-reactive protein (hsCRP;  $-0.84$  mg/L; 95% CI,  $-1.55$  to  $-0.14$ ;  $p=0.019$ ); lower fibrinogen ( $-0.07$  g/L; 95% CI,  $-0.15$  to  $0.02$ ;



$p=0.112$ ); and lower leukocyte count ( $-0.28 \times 10^9/L$ ; 95% CI,  $-0.51$  to  $-0.06$ ;  $p=0.015$ ) after multivariable adjustment. In the longitudinal analysis (values after 11 years), the corresponding estimates were  $-1.66$  mg/L (95% CI,  $-3.13$  to  $-0.19$ ;  $p=0.027$ );  $-0.16$  g/L (95% CI,  $-0.31$  to  $-0.02$ ;  $p=0.031$ ); and  $-0.49 \times 10^9/L$  (95% CI,  $-0.85$  to  $-0.14$ ;  $p=0.007$ ) respectively ([Kunutsor et al., 2018](#)). In this population-based prospective cohort study, frequent sauna sessions significantly decreased levels of inflammatory markers at baseline and at the 11-year follow-up.

**Immune function:** DECREASED INCIDENCE OF COMMON COLDS WITH FREQUENT LONG-TERM SAUNA USE.

In a controlled clinical trial of 50 healthy volunteers, the group that used a sauna once or twice a week (8-12 min sitting or lying in the sauna room at 80-95°C at air humidity of 10-30 g/m<sup>3</sup> followed by 15 minutes of cooling with cold water and resting at room temperature, repeated 2-3 times) for 6 months had significantly fewer episodes of the common cold compared to the control group that abstained from sauna use ([Ernst et al., 1990](#)). During the last three months of the study period, the incidence was roughly halved compared to controls (9 vs 23). The mean duration and average severity of common colds did not differ significantly between the groups. The mechanisms by which sauna bathing could prevent common colds are not known. Hyperthermia induces DNA-synthesis and increases immunoglobulins and leukocytes in the blood, changes which might contribute to increased protection against viral infections.

In a randomized controlled single-blind trial of 157 patients with a newly acquired common cold (within 24 hours), inhalation of hot sauna air 3 minutes per day for 3 days did not result in a significant difference in overall symptom severity over 7 days when compared with the control group that inhaled dry air at room temperature for the same amount of time ([Pach et al., 2010](#)). Thus, regular sauna use may prevent people from catching a cold, but it does not appear to improve symptoms once they acquire a cold.

**Oxidative stress:** POTENTIAL BENEFIT.

In an open-label comparison study of 25 healthy male volunteers, single whole-body cryostimulation and dry sauna procedures induced an increase in antioxidant activity (superoxide dismutase and glutathione peroxidase for cryostimulation and superoxide dismutase and catalase for sauna) ([Sutkowy et al., 2015](#)). The superoxide dismutase activity was higher after cryostimulation than after dry sauna. It

is not clear if this increase in antioxidant activity is due to the induction of reactive oxygen species production during the cold- and heat-induced stress.

***Exercise endurance:*** POTENTIAL BENEFIT.

In a small cross-over clinical trial of 6 male distance runners, 3 weeks of post-training sauna (~30 minutes in a humid sauna at  $89.9 \pm 2.0^\circ\text{C}$  across  $12.7 \pm 2.1$  sessions) produced a maximum heart rate of  $140 \pm 11$  beats/min, a minimum diastolic pressure of  $42 \pm 6$  mmHg and a minimum systolic pressure of  $114 \pm 3$  mmHg ([Scoon et al., 2007](#)). Relative to control, sauna bathing increased run time to exhaustion by 32% (90% confidence limits, 21 to 43%), which is equivalent to an enhancement of approximately 1.9% (1.3 to 2.4%) in an endurance time trial of a 5 km run. Plasma and red-cell volumes increased by 7.1% (5.6 to 8.7%) and 3.5% (-0.8% to 8.1%) respectively, after sauna relative to control. Change in performance had high correlations with change in plasma volume (0.96, 0.76 to 0.99) and total blood volume (0.94, 0.66-0.99), but the correlation with change in red cell volume was weaker (0.48, -0.40 to 0.90). Three weeks of post-exercise sauna bathing produced an enhancement of endurance running performance, possibly by increasing blood volume. The effects of sauna bathing on performance and blood volumes need to be validated with a larger number of people.

***Obesity:*** POTENTIAL HARM WITH PROLONGED SAUNA SESSIONS.

In an open-label study of 45 young sedentary and overweight men, four 10-minute sauna stays (temperature,  $90\text{--}91^\circ\text{C}$ ; relative humidity, 14-16%) with four 5-minute cool-down breaks (e.g., cold showers) resulted in some deleterious cardiovascular adaptations ([Podstawski et al., 2019](#)). Although the sauna intervention resulted in a reduction in body mass (0.65 kg), elevated heart rate values did not return to baseline values, suggesting that 5-minute cool-down breaks were not long enough for participants whose heart rate and blood pressure values exceeded the recommended norm during successive sauna sessions (observed during the third and fourth sauna stays). The elevations in heart rate and blood pressure were strongly correlated with body mass, BMI, percent body fat, body fat mass, and visceral fat level.

**Safety:** Sauna use is generally safe for healthy individuals. But numerous contraindications exist (e.g., orthostatic hypotension, unstable coronary artery disease, etc.) and alcohol should not be consumed before or during sauna use.

*Types of evidence:*

- 1 controlled clinical trial
- 1 open-label clinical trial
- 4 observational studies
- 5 literature reviews

**General recommendations for healthy adults:** Drinking plenty of water before and after a sauna bath is a good practice. Alcohol consumption before or during the sauna should be avoided ([Olsson, 2018](#)). When you experience symptoms that may be related to low blood pressure, such as dizziness or visual impairment, get up slowly and leave the sauna.

**Clinical trial results:** In a small controlled clinical trial of 16 patients with untreated hypertension, two 8-minute sauna stays (with an intervening 1-2 minutes of cold-water showering) did not result in any adverse effects ([Gayda et al., 2012](#)). However, in an open-label study of 45 young sedentary and overweight men, four 10-minute sauna stays (temperature: 90-91°C; relative humidity: 14-16%) with four 5-minute cool-down breaks (e.g., cold showers) resulted in some deleterious cardiovascular adaptations ([Podstawski et al., 2019](#)). Despite the cool-down breaks, the elevated heart rates did not return to baseline values, suggesting that 5-minute breaks were not long enough for participants whose heart rate and blood pressure values exceeded the recommended norm during successive sauna bathing. Sauna sessions lasting 40 minutes could be excessive and dangerous to the health of men who are considerably overweight.

**Contraindications:** Contraindications include prolonged, or unstable angina-type chest pain, myocardial infarction, or other severe cardiac events within the past 4-8 weeks, severe orthostatic hypotension and severe aortic stenosis, acute infectious diseases with fever, rheumatoid arthritis in the acute inflammatory phase, and certain skin conditions, such as cholinergic urticaria, abrasions, and oozing rashes ([Kukkonen-Harjula and Kauppinen, 2006](#)).

People who have low blood pressure or those who have a tendency to faint need to be careful when using a sauna. Individuals with orthostatic hypotension should be cautious because blood pressure can drop rapidly just after sauna bathing ([Zaccardi et al., 2017](#)). Generally, antihypertensive medications

taken immediately before sauna use is not advisable, because it can amplify the hypotensive effects (especially on diastolic pressure) after the sauna.

During uncomplicated pregnancies, sauna use neither appears to harm the fetus nor the mother ([Kukkonen-Harjula and Kauppinen, 2006](#)). On the other hand, the resistance to the blood flow in the uterine artery was increased in toxemic patients subjected acutely to sauna-like thermal challenge, while no such event was recorded in normal controls. In severe toxemia, the fetal compensation mechanisms may be at their maximum at room temperature, and the heat exposure might compromise the availability of oxygen to the fetus. Therefore, pregnant mothers suffering from toxemia are advised to avoid sauna use.

**Drug interactions:** Based on a literature review, as sauna bathing increases cutaneous blood flow, it may increase the absorption of transdermally-administered drugs ([Kukkonen-Harjula and Kauppinen, 2006](#)). The use of transdermal glyceryl trinitrate (nitroglycerin) and nicotine patches increased plasma drug concentrations in healthy subjects after sauna bathing. Insulin absorption from a subcutaneous injection site in diabetics was also enhanced during bathing.

Generally, antihypertensive medications taken immediately before sauna use is not recommended as it can amplify the hypotensive effects (especially on diastolic pressure) after the sauna.

**Deaths related to sauna bathing:** RARE; OFTEN ASSOCIATED WITH ALCOHOL.

Based on an analysis of forensic autopsy documents of deaths related to sauna in Finland from 1990 to 2002, the annual rate of death occurring while in a sauna was less than 2 per 100,000 inhabitants ([Kenttämies and Karkola, 2008](#)). About half (51%) of the cases were determined to be natural deaths and exposure to heat was the cause of death in 25%. The majority of natural deaths were attributed to various cardiovascular diseases; ischemic heart disease was the underlying cause of death in 63% of the natural deaths. Overall, 50% of all cases were under the influence of alcohol. Alcohol consumption can also enhance the risk for hypotension and fainting in the sauna, as well as the risk of arrhythmia, hyperthermia, and sudden death, especially in people with coronary heart disease ([Hannuksela and Ellahham, 2001](#); [Kukkonen-Harjula and Kauppinen, 2006](#)).

In a similar study carried out in Sweden from 1992-2003, 77 deaths were identified, of whom 82% were men and most were middle-aged ([Rodhe and Eriksson, 2008](#)). In 69 cases, the blood alcohol concentration was determined; 49 (71%) of these tested positive, often with high concentrations. In 65 cases, a major disease/state that could explain death was identified; 34 (44%) of these deaths were related to alcohol and 18 (23%) were cardiovascular. Other causes of death were drowning during a

cool-off swim, carbon monoxide poisoning, oxygen deprivation, amphetamine intoxication, and burn injuries. In 13 cases, the cause of death remained undetermined. Among the cases, all but 2 were found alone, suggesting that bathing alone is a risk factor.

In a 2018 retrospective analysis of sauna deaths in Korea, of the 103 deaths reported, 76 (73.8%) had a blood alcohol concentration above 0.08% ([Yang et al., 2018](#)). In individuals with no alcohol detected in their blood, the cause of death may be attributed to heart disease, such as ischemic heart disease.

**Sources and dosing:** Some gyms and fitness clubs have saunas. Sauna set-ups can also be purchased for a home. Finnish sauna bathing involves exposure to high temperature (80-100°C) with dry air for 5 to 20 minutes at a time, followed by short periods in colder environment (e.g., cold shower or a short stay in ice-cold water) ([Laukkanen et al., 2018](#); [Heinonen and Laukkanen, 2018](#)). Finnish men who used a sauna bath 4-7 times per week had significantly reduced risk of all-cause mortality, cardiovascular disease mortality, stroke, and dementia compared to those who used it once per week ([Kunutsor et al., 2018](#); [Kunutsor et al., 2018](#); [Laukkanen et al., 2018](#); [Laukkanen et al., 2017](#)).

**Research underway:** According to [ClinicalTrials.gov](#), there are 7 clinical trials ongoing testing sauna bathing as an intervention. These studies are testing the efficacy of sauna interventions in coronary artery disease, arrhythmias, fluid overload in dialysis complications, chronic renal failure, dehydration in judo athletes, and post-fire rehabilitation of firefighters.

#### Search terms:

Pubmed, Google: Sauna

- + dementia, + Alzheimer's, + meta-analysis, + clinical trial, + cardiovascular

Websites visited for sauna:

- [Clinicaltrials.gov](#) (7)
- DrugAge (o)
- Geroprotectors (o)
- [Drugs.com](#)
- [WebMD.com](#)



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