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## **The Impact of Sauna Use on the Cardiovascular System in Healthy and Cardiologically Burdened Individuals: A Literature Review**

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### **Abstract**

**Introduction:** As a popular way to relax, the sauna is used by many people. The safety of sauna use and the possible benefits of sauna attendance are the subject of scientific research. One of the most studied aspects is the impact and safety assessment of sauna use on people with

cardiovascular diseases. In addition to the effects of the traditional Finnish sauna, the effectiveness of Waon therapy, which is a type of dry infrared sauna that was invented for the treatment of people with cardiovascular diseases, was analysed.

**Aim of the study:** Analysis of the available scientific research on the effects of traditional Finnish sauna and infrared sauna (so-called Waon) on the cardiovascular system in healthy people and those with cardiovascular diseases such as heart failure, coronary heart disease, hypertension.

**Methods:** Review of the literature available in PubMed, Google Scholar and Cochrane Library databases by searching with keywords such as 'sauna', 'Finnish bath', 'waon', 'waon therapy', 'heart failure', "chronic heart failure", 'hypertension', 'cardiovascular system'.

**Conclusion:** Conventional Finnish sauna and Waon therapy are interventions with proven positive effects on the cardiovascular system in many studies. The results show that these interventions help to lower blood pressure, improve vascular function, increase myocardial perfusion, induce a reduction in symptoms associated with heart failure and improve exercise tolerance in this patient group. Patients with heart failure are a large group that could potentially benefit from the use of sauna and especially Waon therapy, although there are studies showing that sauna can also protect healthy individuals from future hypertension.

**Keywords:** sauna, finnish bath, waon, heart failure, chronic heart failure, hypertension, cardiovascular system

## **Introduction**

### *Epidemiology*

Cardiovascular diseases (CVD) are the most common cause of death worldwide. The leading cause of death is ischaemic heart disease and ischemic stroke. CVD is recognised as the largest and priority health problem globally [1,2]. The high number of deaths is caused, among other things, by inadequate control of hypertension symptoms. Treatment of hypertension is one of the most important interventions for the prevention of stroke, myocardial infarction, renal failure and others [3].

Heart failure occurs in approximately 2% to 4% of the population in the European and North American population, but the prevalence increases to a dozen percent after the age of 60 [4]. Another worrying health trend is the increase in the number of patients with heart failure [5,6].

It has been estimated that 1 in 4 people in the US will develop heart failure, which is an alarmingly high number, especially as more and more cases are being reported among younger people [5].

### *Finnish bath*

This is the most common type of dry sauna, with an average humidity of about 10 to 20 % and an air temperature usually between 70 and 100 degrees Celsius. The temperature is highest near the ceiling, while it is coolest near the floor. The interior is usually made of unpainted wood (e.g. pine). During a sauna session, the participant stays in a sitting or lying position on wooden benches. A single sauna session usually does not last longer than 20 minutes [7,8].

### *Waon therapy*

Waon therapy is an infrared sauna invented in Japan in the late 20th century that does not require the use of water. The session usually lasts 15 minutes and the temperature in the cabin is 60 degrees Celsius. After leaving the cabin, the person undergoing the treatment then goes to rest (usually in bed, as the heated body must be covered with a blanket or duvet after leaving). The sauna was developed for the treatment of people with cardiovascular diseases. It is a difference from the Finnish sauna in that it has a lower temperature, usually a different heat source (the Finnish sauna is usually heated with a stove) and that Waon is usually used therapeutically rather than commercially [8,9].

## **Methodology**

The review was based on publications available in PubMed, Google Scholar and Cochrane Library databases. The literature search was conducted using keywords such as sauna, Finnish bath, waon, heart failure, chronic heart failure, heart, hypertension, cardiovascular system. When reviewing the literature, we paid most attention to studies with high scientific value, such as meta-analyses and randomised controlled trials (RCTs). We focused mainly on issues related to chronic heart failure, coronary artery disease and the effects of sauna on cardiovascular physiology in healthy persons and cardiac patients. We devoted a lot of attention to analysing the effectiveness of the Waon, an infrared-heated sauna, which is primarily dedicated to cardiac patients.

### **Effects of sauna on the cardiovascular system**

In a study on asymptomatic individuals with at least one cardiovascular risk factor, the intervention was a single 30-minute use of a Finnish sauna with a temperature of about 72 degrees Celsius and 10-20% humidity. Participants mainly suffered from dyslipidaemia and

hypertension and the average participant was overweight. The effects of the sauna on arterial stiffness, blood pressure parameters and left ventricular ejection time (LVET) were tested. Participants were examined before the sauna session, immediately after leaving the sauna and then after spending 30 minutes at room temperature. Immediately after leaving the sauna, there was a reduction in arterial stiffness parameters (Pulse Wave Velocity (PWV) 9.8 m/s. vs. 8.6 m/s,  $p < 0.001$ ), a decrease in systolic (SBP) and diastolic blood pressure (DBP) by 7 mmHg, a decrease in mean arterial pressure (MAP) by 5.8 mmHg, an increase in heart rate by an average of 15 beats per minute and a significant decrease in LVET by an average of 29 ms. In addition, there was a short-term reduction in augmentation index (AIx), indicating a temporary increase in arterial elasticity. Parameters whose reduced values relative to baseline persisted after rest were PWV, SBP, MAP, LVET. The above indicate a beneficial effect of a single, short-term use of the sauna [10]. Another study that assessed how attending a sauna 4 times a week for 8 weeks would affect the blood vessels showed no significant effect of this intervention on the vessels. There were no important changes in brachial artery flow-mediated dilation or changes in large artery stiffness [11]. An intervention was carried out among risk-factor-burdened men and women with a sedentary lifestyle to test the effects of exercise (including aerobic exercise) and exercise with a 15-minute session in a sauna after a workout on cardiovascular parameters. The sauna group had better results than the exercise-only group. They gained improved cardiorespiratory fitness as measured by a greater increase in maximal oxygen uptake, a greater decrease in SBP and a reduction in cholesterol, indicating that the additional sauna attendance may carry extra health benefits [12]. Among a population of healthy, young men, a single 15-minute session in a 100-degree Celsius sauna resulted in a transient increase in heart rate (HR), a shortening of LVET and an increase in sympathetic and decrease in parasympathetic nervous system activity. These changes persisted, for a short period of time, and mostly normalised within 6 hours, indicating, among other things, that a healthy organism can adapt to sauna conditions and a short-term single exposure did not cause adverse effects [13]. In a study on patients with allergic rhinitis, there was also an increase in sympathetic activity, as shown by the heart rate variability (HRV) analysis [14]. Among healthy seniors, an experiment was conducted in which one of the parameters assessed was changes in function checked by Flow-Mediated Dilation (FMD), which assesses whether a blood vessel dilates adequately when there is an increase in blood flow, which is dependent on nitric oxide, among other things. This study did not demonstrate an effect of the sauna stay on changes in FMD values [15].

## **Chronic heart failure**

In a meta-analysis of the effects of sauna on patients with cardiovascular disease published in 2018, there was no effect on blood pressure values, but there was a significant reduction in brain natriuretic peptide (BNP) levels, a small increase in ejection fraction (EF), a reduction in cardiovascular events and a significant reduction in cardiopulmonary ratio (CTR). The above indicate that sauna use has a positive effect on people with cardiovascular disease, but despite the promising results, further research is needed [16]. Among patients with chronic heart failure III or IV in the NYHA classification, the use of 15-20 minute sessions in a 60-degree Celsius sauna applied three times a week for a period of four weeks resulted in lower levels of norepinephrine and endothelin, but other aspects analysed, such as improvement in NYHA score and increased treadmill training time, did not reach statistical significance. An unquestionable advantage, was the good tolerability and high safety profile of this intervention in the patient group studied. This study unfortunately had a very small study group of 9 patients [17]. In another study on patients meeting NYHA criteria II and III, who used a sauna with a temperature of 60 degrees Celsius every day for 15 minutes for 2 weeks. The majority of patients undergoing the intervention achieved an increase in the percentage Flow-Mediated Dilation (FMD) score, with no change in nitroglycerin-induced dilation and a significant decrease in BNP levels. Patients in the study group furthermore achieved a reduction in discomfort (including a decrease in oedema), a decrease in SBP, and a decrease in CTR. Although the study group was only 20 patients, the results of the study are very promising, especially as the patients did not report adverse effects [18]. A very interesting one was conducted on a population of men with heart failure and coronary artery disease, in which the effect of a short stay in a sauna at 80 degrees Celsius and soaking the body in water at 12 degrees Celsius immediately after leaving the sauna was investigated. There was a significant decrease in SBP and increase in HR during the sauna stay due to heat-induced vasodilation and an increase in SBP and HR upon exposure to cold water among all participants. Those with heart failure and a control group of healthy people achieved an increase in cardiac output. None of the participants in the study experienced adverse effects, suggesting that the intervention used appears to be safe, but due to the small study group, further studies need to be conducted to prove this [19]. In a meta-analysis of the effects of sauna use on people with heart failure or other cardiovascular disease, it was shown that immediately after leaving the sauna, participants experienced a statistically significant decrease in SBP, DBP, an increase in HR. In the longer term, after one month, an increase in left ventricular ejection fraction, a persistent decrease in

SBP and DBP, a decrease in BNP and, very importantly, patients achieved clinical improvements in exercise tolerance were noted [20].

### **Coronary artery disease**

In a study of the effects of Waon therapy on myocardial perfusion in a population of patients with chronically occluded coronary arteries and ischaemia, daily 15-minute participation in Waon therapy over an 8-week period resulted in satisfactory outcomes. After the intervention, there was an improvement in myocardial perfusion scintigraphy scores (there was a reduction in summed stress score and summed difference score, indicating an improvement in myocardial blood supply), a statistically significant improvement in Flow-Mediated Dilatation (FMD) measured on the brachial artery from  $4.1 \pm 1.3\%$  to  $5.9 \pm 1.8\%$  and an increase in mean Treadmill Exercise Test time from  $430 \pm 185$  s to  $511 \pm 192$  s ( $p < 0.01$ ). The above changes were not observed in the control group, which did not have the intervention implemented. The data obtained indicate an improvement in myocardial perfusion and physical performance in this group of patients. The results are very positive and further research is fully warranted as Waon therapy may be of great benefit in this group of patients [21].

### **Arrhythmias**

Among patients with chronic heart failure (CHF), the effect of sauna on the occurrence of ventricular arrhythmias has been tested. In a study on patients with symptoms corresponding to NYHA classifications II and III, it was tested how 15-minute sessions in a 60-degree Celsius sauna 5 times a week for a fortnight would affect. After leaving the sauna, they rested covered with a blanket for 30 minutes. In the intervention group, all patients had a reduction in the daily number of premature ventricular contractions (PVCs) compared to the control group ( $848 \pm 415$  vs  $3,097 \pm 1,033/24$  h,  $p < 0.01$ ). There was also a significant reduction in ventricular tachycardia episodes compared to the control group. Before the intervention, 80% of the participants experienced ventricular tachycardia and after the intervention only 20% of them with statistical significance, showing that sauna can have a positive effect on arrhythmia symptoms in patients with heart failure [22].

### **Arterial hypertension**

Researchers from Montreal published a study on people with non-pharmacologically treated hypertension in which two study groups were used. One study group had 2 eight-minute sauna sessions implemented, while the other study group had to perform aerobic training, up to 75% of their maximum heart rate, before going to the sauna. In both study groups, through the

measurement of short-term heart rate variability (HRV), a short-term increase in sympathetic nervous system tone was noted compared to the no-task control group, which normalised within 15 to 120 minutes [23]. The greatest reductions in SBP, DBP and MAP values were noted in those who exercised and additionally used the sauna. Heart rate (HR) values were higher in the study groups than in the control group; in addition, there was a decrease in stroke volume (SV), an increase in cardiac output and a decrease in peripheral vascular resistance in the study groups, but these effects were more pronounced in the group that had the two interventions implemented, demonstrating the positive effects of both training and sauna on the cardiovascular system [24]. A study in Finland investigated whether regular sauna use could affect the occurrence of hypertension among men. Frequent sauna use, 4 to 7 times a week, was shown to reduce the risk of hypertension by 46% compared to those who used the sauna once a week, and was statistically significant. Using the sauna only 2 to 3 times a week was also proven to probably carry a positive effect, but statistical significance was not obtained. In view of the fact that the mean follow-up period was 24.7 years with the number of men being 1,621, the results obtained seem convincing and reliable [25]. In another study, frequent sauna use both 2-3 times and 4-7 times per week as well as sessions lasting more than 19 minutes were proven to be associated with a reduced risk of sudden cardiac death, death from coronary heart disease and overall mortality. Frequent sauna use was protective against heart disease, but further research to confirm these findings is needed [26]. A Swedish study called MONICA, published in 2024, showed that people who used saunas regularly, at least once a month, were less likely to be diagnosed with hypertension, which is likely due to, among other things, the aforementioned vasodilation of blood vessels, decreasing peripheral vascular resistance [27]. Another study, found that after a 15-minute sauna session, there was a decrease in SBP and DBP in both men and women, but a greater average decrease in SBP was scored by men than women (- 6.8 mmHg vs. - 3.4 mmHg) and older participants over 34 years of age (-1.4 mmHg vs. -7.6 mmHg) [28].

## **Stroke**

In a study assessing whether Finnish sauna use can affect the occurrence of stroke, it was shown that the sauna can reduce the risk of ischaemic stroke, but has no effect on the occurrence of cerebral haemorrhagic stroke. Among Finnish sauna bathers, those using the sauna 4 to 7 times a week had the lowest risk, as they had up to 61% lower risk of ischaemic stroke than those using only once a week, indicating that frequent sauna use is highly effective in the prevention

of ischaemic stroke [29]. Further research on this topic is warranted, given that ischaemic stroke is the second cause of death from cardiovascular disease [1,2].

## **Waon therapy**

### *Chronic heart failure*

Chronic heart failure (CHF) is a condition that can be treated with waon therapy. In a study on patients classified NYHA II to IV, with a reduced left ventricular ejection fraction (LVEF) <50%, it was found that a combination of standard pharmacological therapy and participation in a total of 10 waon therapy sessions over a two-week period, resulted in an improvement in patients' NYHA classifications, lower SBP and DBP. A very beneficial effect was a reduction in cardiothoracic ratio (57.2±8.0% to 55.2±8.0% ( $p < 0.0001$ ), a reduction in BNP levels (542±508 pg/ml to 394±410 pg/ml) and an increase in LVEF maintaining statistical significance [30]. In a Japanese randomised controlled trial (RCT), the effect of Waon therapy on lowering BNP in patients with CHF was investigated. It was managed to achieve a significant reduction in BNP levels in the Waon group, in addition to an improvement in NYHA classification, and a decrease in cardiothoracic ratio. In addition, patients' physical performance improved in the present study in the form of increased distance in the 6 Minute Walk Test (6MWT) [31]. The results of the above studies indicate that Waon therapy is satisfactorily effective among patients with CHF [30,31].

Japanese researchers asked whether Waon therapy could improve outcomes in CHF patients using only drug treatment? They found that after 60 months of follow-up, the Waon therapy group did not have a lower mortality rate than the pharmacological treatment group, but Waon patients were less frequently re-hospitalised due to exacerbation of disease symptoms (31.3% vs. 67.7%) and had a 38% reduction in cardiac events compared to the control group, suggesting that the implementation of Waon therapy has significant benefits for patients with CHF [32]. In another study, the effects of Waon therapy on autonomic nervous system function were assessed. It was shown that, as a result of its use, parasympathetic activity is increased and sympathetic activity is decreased, which may improve the outcome of patients with CHF [33]. In another study published in 2020, Waon therapy was also shown to increase parasympathetic stimulation and have a positive effect on autonomic nervous system function [34].

### *Effects of Waon therapy on blood vessels*

The effectiveness of Waon therapy was also tested on patients with peripheral arterial disease and intermittent claudication. A 6-week period of attending Waon therapy 5 times a week



resulted in a reduction in pain intensity compared to the control group using only pharmacotherapy, an increase in distance in the 6MWT test (from  $149 \pm 104$  m to  $230 \pm 154$  m ( $p < 0.01$ ), a significant increase in ankle-brachial pressure index (ABPI) values indicating an improvement in peripheral blood supply to the limbs, an increase in the presence of CD34+ cells in the blood that may promote angiogenesis. The results are satisfactory and more research should be conducted in this area. As the study group consisted of only 11 patients, despite the excellent results, it is difficult to draw certain conclusions [35].

### *Pulmonary hypertension*

A study on patients with chronic obstructive pulmonary disease (COPD) who received 20 sessions of Waon therapy has been published. A reduction in SBP and DBP, improvement in right ventricular systolic function, a decrease in pulmonary artery pressure during physical activity from a value of  $64.0 \pm 18.0$  mmHg to a value of  $51.3 \pm 13.1$  mmHg after therapy, improvement in exercise tolerance and, importantly, improvement in quality of life as measured by the St. George's Respiratory Questionnaire (SGRQ) were observed. This indicates the need for further research into the inclusion of Waon therapy as an additional treatment in patients with COPD [36].

### **Conclusion**

Cardiovascular diseases are a very serious or even the most significant health problem worldwide, responsible for the largest number of deaths. The search for potential risk factors or interventions that may improve patient outcomes and function is the topic of many research papers.

Due to the prevalence and widespread access to sauna use, studies investigating the effects of sauna use on the cardiovascular system have been established. With the available scientific data, it can be concluded that the sauna appears to be a safe intervention for the cardiovascular system, emphasising that most of the studies analysed refer to dry saunas such as the Finnish sauna or Waon.

Staying in a sauna lowers arterial pressure - especially SBP - and some studies indicate that it has the effect of reducing arterial stiffness, reducing LVET, a short-term increase in heart rate. There are studies where there has been a reduction in cholesterol levels and a positive effect on autonomic nervous system balance.

Very satisfactory results were obtained in patients with chronic heart failure (CHF). In addition to a reduction in clinical symptoms (e.g. reduced peripheral oedema and improved physical

performance), some studies have found improved myocardial performance among these patients in lowering BNP levels and reducing cardiopulmonary index, improved LVEF, sustained reduction in SBP and DBP. In the treatment of patients with CHF, Waon therapy has great potential, as patients undergoing Waon therapy have achieved very good results in terms of improvement in NYHA classification severity of symptoms, reduction in SBP and DBP, significant reduction in BNP, improvement in physical performance, reduction in cardiothoracic ratio and reduction in cardiac events. In addition, Waon is dedicated to therapeutic targets and could hypothetically be incorporated into the equipment of cardiology departments or cardiac rehabilitation units.

Promising results have been obtained in patients with coronary artery disease, as Waon Therapy has been able to improve myocardial perfusion. However, not enough studies have been produced to be certain of the efficacy of this therapy in patients with coronary artery disease. With the good results of the initial studies, further studies should be conducted in the future, as this is a very large target group of patients who could potentially benefit from this method. Another interesting area where Waon therapy could potentially be applied more widely is in patients with peripheral arterial diseases, but the use of Waon therapy in this condition is poorly studied.

In addition to the sauna's effect on lowering SBP and DBP, regular and frequent sauna use probably reduces the risk of hypertension, suggesting that sauna use may be a prophylactic intervention against the onset of hypertension.

It is also very important to note that in the vast majority of studies, both the Finnish sauna and the Waon sauna did not cause significant and dangerous side effects in the experimental participants.

Future research should focus on proving the effectiveness of Waon therapy in the treatment of CHF. If further studies confirm the existing knowledge, Waon therapy may become a more popular and recognised method for the treatment of heart failure in Europe. In addition, investigators should continue to study the effectiveness of the sauna in the treatment of coronary artery disease and peripheral arterial diseases, as there is a deficit of trials on patients with these conditions.

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Conceptualization: Anita Ptak, Michał Szyc

Methodology: Michał Szyc, Anita Ptak

Software: Michał Szyc

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Formal analysis: Michał Szyc, Anita Ptak

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