

Benefits and Risks of Sauna Bathing

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Although sauna bathing causes various acute, transient cardiovascular and hormonal changes, it is well tolerated by most healthy adults and children. Sauna bathing does not influence fertility and is safe during the uncomplicated pregnancies of healthy women. Some studies have suggested that long-term sauna bathing may help lower blood pressure in patients with hypertension and improve the left ventricular ejection fraction in patients with chronic congestive heart failure, but additional data are needed to confirm these findings. The transient improvements in pulmonary function that occur in the sauna may provide some relief to patients with asthma and chronic bronchitis. Sauna bathing may also alleviate pain and improve joint mobility in patients with rheumatic disease. Although sauna

bathing does not cause drying of the skin—and may even benefit patients with psoriasis—sweating may increase itching in patients with atopic dermatitis. Contraindications to sauna bathing include unstable angina pectoris, recent myocardial infarction, and severe aortic stenosis. Sauna bathing is safe, however, for most people with coronary heart disease with stable angina pectoris or old myocardial infarction. Very few acute myocardial infarctions and sudden deaths occur in saunas, but alcohol consumption during sauna bathing increases the risk of hypotension, arrhythmia, and sudden death, and should be avoided. *Am J Med.* 2001;110:118–126. ©2001 by Excerpta Medica, Inc.

SAUNA bathing, which has been a tradition in Finland for thousands of years, has become increasingly popular in the United States (1–4). In this article, we review the benefits and risks of sauna bathing for healthy adults and children, as well as for patients with coronary heart disease, hypertension, congestive heart failure, lung disease, rheumatic disease, and skin disease.

METHODS

We searched four databases using search words “sauna,” “Finnish bath,” and MeSH term “Baths, Finnish.” The databases were Medline (1966 to 2000, n = 336 documents in English or German), Embase (1974 to 2000, n = 61), Biosis Previews (1970 to 2000, n = 135), and Medic (1978 to 2000, n = 6). We supplemented our search by examining citations in the articles. Of the 271 documents that provided information on the chosen topics (sauna and the cardiovascular system, lungs, rheumatic diseases, skin, hormones, reproductive system, and children), we excluded case reports, letters, and comments, and included all original studies and reviews, giving a total of 130 references.

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THE SAUNA (FINNISH BATH)

Unlike the Turkish bath, the sauna (or Finnish bath) has dry air and a high temperature (4). The basic modern sauna is an unpainted, wood-paneled room with wooden platforms and a rock-filled electric heater. The walls are made of spruce or pine, and the benches are made of obeche, spruce, or aspen because these types of wood are less hot to sit on. The size of a sauna is at least 3 m² to encourage the correct balance between heat, humidity, and ventilation. The recommended temperature is 80°C to 100°C at the level of the bather’s face and 30°C at floor level (5). The air has a relative humidity of 10% to 20% (40 to 70 g of water vapor per kg of air; Figure 1) (5,6). Humidity is temporarily increased by throwing water on the hot rocks of the sauna heater. Drainage is provided on the sauna floor. A good sauna has efficient ventilation (Figure 2); the air should change 3 to 8 times per hour (5). The usual ritual consists of several short stays (5 to 20 minutes) in the sauna, interspersed with cooling-off periods, and followed by oral intake of fluids (7,8).

SAUNA AND THE CARDIOVASCULAR SYSTEM

Cardiovascular Effects

The cardiovascular effects of sauna bathing have been reviewed earlier (7,9–12) and are summarized in Table 1. Skin temperature increases rapidly to about 40°C (5,9,13,14), whereas the increase in rectal temperature depends on heat exposure (15–17). Sweating begins quickly and reaches its maximum at about 15 minutes,

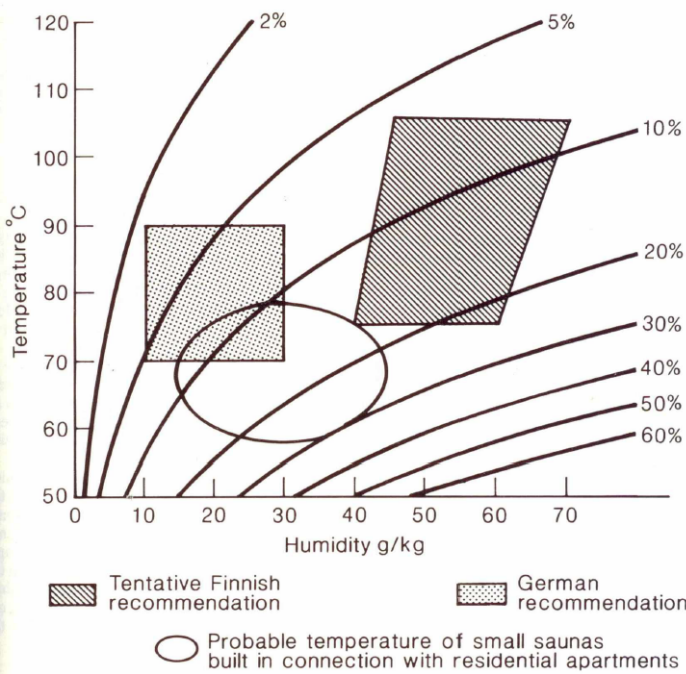


Figure 1. The recommended sauna temperature (t_s) is between 80°C and 100°C. The recommended humidity (X_a) is between 40 and 70 g of water vapor per kg of air, with relative humidity (φ) between 10% and 20%. From Leppäluoto J (6), with permission.

with an average total secretion of 0.5 kg (6,9,18). Skin blood flow is increased from 5% to 10% so it becomes 50% to 70% of the cardiac output, while blood flow to internal organs decreases (12). Cardiac output is increased by 60% to 70% in relation to the increase in heart rate (10,12,19), while cardiac stroke volume does not change (12,19). The effect of sauna bathing on blood pressure is variable (Table 1). Frequent sauna bathing improves heat tolerance and reduces the magnitude of the changes (17).

Sudden exposure to cold after sauna bathing activates the sympathetic nervous system and causes constriction of cutaneous blood vessels. The cardiovascular changes associated with cold exposure are generally opposite to those of sauna bathing: the heart rate decreases and stroke volume and the diastolic and systolic blood pressure increase (20–22). The workload of the heart is increased (20–22). Within a few hours after sauna bathing or cold exposure, these cardiovascular differences are no longer present (7,11,12).

Sudden Death and Coronary Heart Disease

Very few sudden deaths take place during or after sauna bathing. Of all sudden deaths (6,175) in Finland within 1 year, only 102 (1.7%) occurred within 24 hours of the sauna bath. One third of these were accidental, due to consumption of alcohol or drowning; the majority of the nonaccidental deaths were due to acute myocardial infarction in which alcohol intake was an important contributing factor (23). Another study examined all autopsied cases of sudden death (2,606) during a 1-year period in Finland and found that only 67 (2.6%) were nonacci-

dental deaths that occurred during or after sauna bathing; the main cause of death was coronary heart disease (24).

Epidemiologic studies show that very few acute myocardial infarctions occur during sauna bathing. Of 1,631 acute heart attacks or sudden coronary deaths that occurred during a 16-month period in Helsinki, Finland, ischemic symptoms began or the death occurred within 3 hours of sauna bathing in only 29 (1.8%) (25). In a large prospective study of 12,310 Finnish men and women 30 to 59 years old, there were 77 sudden coronary deaths during the 6-year follow-up period but only 2 of these occurred in saunas (26).

Experimental studies suggest that sauna bathing is well tolerated by patients with stable coronary heart disease and that their acute cardiovascular changes are similar to those of healthy subjects (27–34). In most (27,31,33,34) but not all (35) studies, patients had fewer and more moderate ischemic changes on the electrocardiogram (ECG) and fewer ectopic beats during sauna than during exercise. In 16 patients, nuclear scintigraphic imaging showed an asymptomatic transient perfusion defect during sauna bathing that was greater than at rest but smaller than during exercise (31). The authors concluded that this indicated myocardial ischemia during sauna bathing, but an accompanying editorial (36) suggested that the perfusion deficits may not have indicated myocardial ischemia, as none of the patients had ECG changes in the sauna but all had ST-segment depressions during exercise testing. Luurila (27,28) observed the sauna bathing habits of 102 consecutive patients after acute myocardial infarction. Most men took sauna regularly before the infarction and 80 men restarted sauna bathing an average of 7 weeks after the infarction (range 3 to 24 weeks) (27). At 10-year follow-up, only 2% reported chest pain during sauna whereas 60% had chest pain during normal daily life (28).

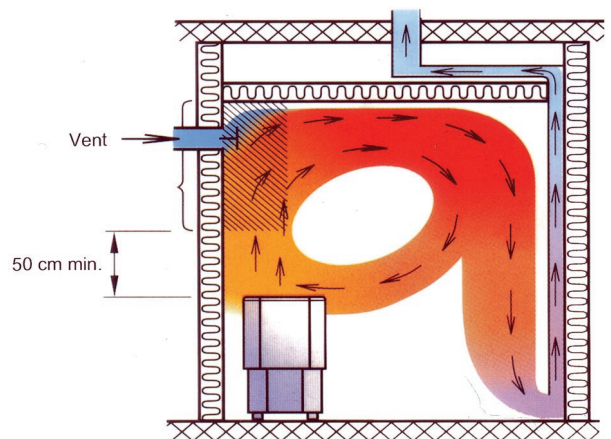


Figure 2. Mechanical ventilation is recommended for indoor saunas. The vent for incoming fresh air should be at least 50 cm above the sauna heater and the vent for outgoing air should be located on the opposite wall under the sauna benches.

Table 1. Acute Physiological Effects of Sauna Bathing

| Effect | Direction | Magnitude | References |
|-------------------------------|-----------|---|--------------------------------|
| Skin temperature | ↑ | Within a few minutes up to 40°C | (5,9,13,14) |
| Rectal temperature | ↑ | By 0.2°C at 72°C for 15 minutes | (15) |
| | | By 0.4°C at 92°C for 20 minutes | (16) |
| | | By 1.0°C at 80°C for 30 minutes | (17) |
| Sweating | ↑ | Sweat is secreted at a rate of 0.6 to 1.0 kg/hour at 80° to 90°C, with an average total secretion of 0.5 kg during a typical sauna bath | (6,9,18) |
| Skin blood flow | ↑ | From 5%–10% to 50%–70% of cardiac output (from about 0.5 to 7 L/minute) | (12) |
| Blood flow to internal organs | ↓ | Renal blood flow is decreased by 0.4 L/minute Splanchnic blood flow is decreased by 0.6 L/minute | (12) |
| Blood flow to muscles | ↓ | By 0.2 L/minute | (12) |
| Heart rate | ↑ | Up to 100 beats per minute during moderate sauna bathing in accustomed subjects | (9,27,29,31,49,83,115) |
| | | Up to 150 beats per minute during intense sauna bathing or in unaccustomed subjects | (20,35,83,116) |
| Cardiac output | ↑ | From 5–6 L/minute up to 9–10 L/minute | (10,12,19) |
| Cardiac stroke volume | | Unchanged | (12,19) |
| Systolic blood pressure | | Unchanged | (17,20,27,49,83) |
| | | Or decreased by 8 to 31 mm Hg | (19,21,29,31,35) |
| | | Or increased by 9 to 21 mm Hg | (20,27,83,116,117) |
| Diastolic blood pressure | | Unchanged | (27,31) |
| | | Or decreased by 6 to 39 mm Hg | (17,19–21,29,35,49,83,116,117) |

↑ = increased; ↓ = decreased.

Sauna bathing was not associated with reinfarction or sudden death (27,28). Winterfeld et al (29,30,32) studied the effects of regular sauna bathing as part of a rehabilitation program. Biweekly sauna bathing for 3 months increased the left ventricular ejection fraction by 7% to 8% in 19 men (32) and lowered the blood pressure in 114 men after coronary bypass surgery (29). Similar results were seen after a 3-year period (30). Patient selection criteria in these nonrandomized studies were not described.

Alcohol Consumption

Drinking alcohol while sauna bathing can create serious health risks and should be avoided (37). Alcohol consumption increases the risk of hypotension and fainting in the sauna (38), as well as the risk of arrhythmia (39,40) and sudden and hyperthermia death, especially in people with coronary heart disease (23,24,41–43). Almost all (221 of 228) hyperthermia deaths in Finland from 1970 to 1986 took place in saunas and were considered accidents (43). Most of the victims were middle-aged men, 84% were under the influence of alcohol, and 27% had cardiovascular disease. Of the 158 sudden deaths occurring in saunas in the province of Uusimaa (population 1.1 million) in Finland between 1976 and 1983, 80% of the victims were men and alcohol intake was a contributing factor in one third of the cardiovascular deaths and half of the accidental deaths (41).

Hypertension

Most patients with essential hypertension tolerate sauna bathing well, and their hemodynamic changes are similar to those of healthy subjects (19,29,30,44). Winterfeld et al (29,30,44) investigated the effects of regular sauna bathing on blood pressure and found that a 3-month period of biweekly sauna bathing lowered mean blood pressure from 166/101 to 143/92 mm Hg in 46 hypertensive patients (44) and from 162/110 to 139/92 mm Hg in 180 patients (29). Similar results were seen after a 3-year period (30). However, these studies were not randomized, and patient selection criteria were not described.

Only a few studies have examined the effects of antihypertensive drugs during sauna bathing in healthy (45–47) and hypertensive subjects (48). A double-blind crossover study of 11 hypertensive patients found that atenolol reduced the increase in heart rate and decreased systolic blood pressure during sauna bathing, whereas diltiazem and placebo did not (48).

Chronic Heart Failure

Sauna generally has been contraindicated for patients with chronic heart failure. However, sauna was well tolerated and improved hemodynamics in patients with chronic heart failure after a single sauna exposure in 32 patients (49) and after a 4-week period of sauna bathing (5 days per week) in 56 patients (50). Left ventricular

ejection fraction increased from $24\% \pm 7\%$ to $31\% \pm 9\%$ and left ventricular end-diastolic dimension decreased from 66 ± 6 mm to 62 ± 5 mm after the 4-week period (50). The sauna used in these investigations was not a typical (Finnish) sauna but an experimental infrared-ray dry sauna in which the temperature was relatively low (60°C), and the patients stayed in the supine position. Larger randomized studies need to be performed to confirm the findings.

Cardiovascular Contraindications

Severe aortic stenosis, unstable angina pectoris, and recent myocardial infarction are contraindications to sauna bathing (28,51). Decompensated heart failure and cardiac arrhythmia are relative contraindications (28,51). Although sauna bathing by patients with a history of stroke or transient ischemic attacks has not been studied, it should be avoided until the condition stabilizes. Elderly persons prone to orthostatic hypotension should be cautious in the sauna because a decrease in blood pressure may cause syncope, usually just after sauna (51).

SAUNA AND DRUGS

Vanakoski et al (52,53) have reviewed the effects of heat exposure on the pharmacokinetics of drugs. The effects of hyperthermia on the absorption, distribution, and elimination (54) of orally administered drugs were shown to be minor in studies with propranolol (47), captopril (47), midazolam (55,56), ephedrine (55), and tetracycline (57). Increased skin blood flow during sauna did, however, enhance the systemic absorption of transdermally administered nitroglycerin (58) and nicotine (59). The absorption of subcutaneously administered rapid-acting soluble insulin was improved in men with insulin-dependent diabetes (60), whereas the absorption of intermediate-acting amorphous insulin was not changed during sauna bathing (61).

SAUNA AND THE LUNGS

Sauna bathing decreases pulmonary congestion and increases the vital capacity, tidal volume, minute ventilation, and forced expiratory volume of the lungs (9,62). Patients with asthma or chronic bronchitis report that sauna bathing improves their breathing (62). Twelve patients with obstructive pulmonary disease who took sauna as a part of their rehabilitation program also demonstrated improved lung function (63). Other data, however, reveal no such changes (64,65). Studies by Ernst et al (66) and Einenkel (67) suggest that regular sauna bathing may reduce the incidence of acute respiratory infections, but sauna should be avoided during the acute phase of an infection (62). Obeche (a type of wood used to make

sauna benches) sometimes causes contact urticaria (68,69), allergic rhinitis, and asthma (70) in sauna builders. Studies indicate that the high incidence of lung cancer in Finland is attributable to smoking habits and occupational exposure and not to sauna bathing (71,72).

SAUNA AND RHEUMATIC DISEASE

Sauna bathing has been used as thermal therapy to treat pain and other symptoms of rheumatic disease, although clinical studies are limited. In studies based on interviews of 70 patients (73) and 119 patients (74) with rheumatoid disease, 40% to 70% of participants reported that sauna bathing alleviated pain and improved joint mobility. Approximately half of the patients experienced exacerbated pain on the day after sauna bathing but reported that this pain could often be prevented by a cool shower after the sauna bath (73,74). Sauna bathing relieved pain in 22 of 74 subjects with chronic neuropathic pain and had no effect in 44 (73,75). The mechanisms by which sauna alleviates rheumatic and neuropathic pain are not known.

SAUNA AND THE SKIN

In general, sauna bathing is harmless for the skin. Repeated stays in the sauna (30 minutes 4 times per day for 7 days) cause no withering of the skin and no change in transepidermal water loss (76,77). Although sauna bathing is seldom used as a therapy for skin disease, it may benefit patients with psoriasis by helping to keep skin lesions free of thick scales (77). In some atopic subjects and patients with cholinergic urticaria, sauna bathing may cause intense itching of the skin (77). Contact urticaria related to the use of birch sprig whisks during sauna bathing (an old tradition in Finland) is rare (78). It may be possible to acquire fungal infections of the feet from the floor of the washing room (79), but the acquisition of sexually transmitted diseases via sauna bench surfaces is highly unlikely (76,80).

SAUNA AND HORMONAL CHANGES

Sauna bathing activates the sympathetic nervous system, the renin-angiotensin-aldosterone system, and the hypothalamus-pituitary-adrenal hormonal axis. The hormonal changes related to sauna use are summarized in Table 2. Changes in the endocrine system are brief and reversible, with no permanent effects (81).

SAUNA AND THE REPRODUCTIVE SYSTEM

Fertility

Sauna bathing does not influence fertility. In men, serum concentrations of testosterone and gonadotropins do not

Table 2. Short-Term Hormonal Changes during Sauna Bathing*

| Hormone | Change | References |
|----------------------------------|----------------------------|---------------------|
| Adrenocorticotrophic hormone | Unchanged | (82,83,86,87,121) |
| | Increased 2- to 5-fold | (83,85,119,121,122) |
| Aldosterone | Increased 3- to 6-fold | (16,123) |
| Angiotensin II | Increased 3-fold | (123) |
| Arginine vasopressin | Increased 1.5- to 2-fold | (16,124) |
| Atrial natriuretic peptide | Increased 1.5- to 3-fold | (16,125) |
| Beta-endorphin | Increased 2- to 3-fold | (83,85,121,122,126) |
| Cortisol | Unchanged | (86) |
| | Increased 1.5- to 3-fold | (83,119,120,122) |
| | Decreased by 10% to 40% | (82,83) |
| Epinephrine | Unchanged | (83,118) |
| | Increased 2- to 3-fold | (86,119) |
| Follicle-stimulating hormone | Unchanged | (82,84) |
| Glucose | Unchanged | (127,128) |
| | Increased by 5% | (129) |
| Growth hormone | Increased 2- to 5-fold | (15,83,85,87,127) |
| Growth hormone releasing hormone | Increased 4-fold | (15) |
| Insulin | Unchanged | (127,128) |
| Luteinizing hormone | Unchanged | (82,84,85) |
| Norepinephrine | Increased 2- to 4-fold | (81,83,86,118,119) |
| Prolactin | Increased 2- to 10-fold | (82–87) |
| Renin activity | Increased 1.5- to 2-fold | (16,123,127) |
| Testosterone | Unchanged | (82,83) |
| Thyroid hormone | Unchanged | (82,87) |
| | Increased 1.2-fold | (129) |
| Thyroid-stimulating hormone | Unchanged | (82,87,130) |
| | Increased 1.2- to 1.8-fold | (129) |

* Hormone levels returned to normal within a few hours.

change even after repeated sauna use (82–85). Prolactin concentration increases temporarily in both men and women during sauna bathing (82–87). A few studies have reported decreased sperm count or decreased sperm movement after sauna bathing (88–90). Finnish men, however, have high sperm counts (91,92), and the time to pregnancy (a sensitive indicator of fertility) is shorter in Finland than in Britain (93), suggesting that the heat of the sauna does not reduce fertility.

Pregnancy

Two studies have generated public anxiety about the safety of sauna bathing during pregnancy (94,95). In a retrospective study of 63 mothers with anencephalic children, 2 of the mothers had taken sauna (95). A prospective follow-up study examining the effects of heat exposure during pregnancy in 23,491 women found that of 49 babies born with neural tube defects, 2 of the mothers had been to sauna (94). The relative risk of sauna bathing was 1.8 (95% confidence interval [CI]: 0.4 to 7.9) (94).

Other studies suggest that sauna bathing during pregnancy is not associated with an increased risk of congenital malformations. Almost all mothers in Finland take the sauna regularly during pregnancy, but the incidence of central nervous system defects in Finland is among the

lowest in the world (96,97). Saxén et al (98) interviewed the mothers of 100 consecutive children born with central nervous system defects and 202 born with orofacial defects from 1978 to 1980 and equal numbers of matched controls. Nearly all (99%) had taken the sauna regularly; thus, there were no differences in the sauna habits of the case and control mothers (98). In another study, Tikkanen et al (99) interviewed the mothers of all 573 infants born with cardiac malformations in 1982 to 1984, as well as 1,055 randomly selected controls and reported no association between sauna bathing and cardiovascular anomalies (99).

Experimental studies suggest that moderate sauna bathing is safe during the uncomplicated pregnancies of healthy women who are accustomed to sauna (97,100). Vähä-Eskeli et al (100–107) reported some differences in hormonal responses during a 20-minute sauna bath at 70°C (100,102–104), but these changes did not have any major effect on fetal heart rate reactivity, uterine contractions (100,101,103), or uterine and umbilical artery blood flow (100,105). These pregnancies continued to term, and the newborns were healthy (100,101,105). In hypertensive pregnant women (108), however, uterine vascular resistance increased during sauna bathing, sug-

gesting that sauna bathing should be discontinued during high-risk pregnancies.

SAUNA AND CHILDREN

Healthy children who are accustomed to sauna bathing tolerate it well when their parents supervise bathing time and temperature. In Finland, children typically take sauna once per week with their parents, who adjust the conditions according to each child's reaction (109). Children usually have shorter sauna baths (5 to 10 minutes) than their parents and sit on the lower bench where the temperature is not as hot (110).

Jokinen et al (111–114) studied the effects of sauna bathing in 81 healthy children (aged 2 to 15 years) during a 10-minute sauna bath at 70°C. Most respiratory (111), hormonal (111,112), and cardiovascular (111,113) changes were similar to those of adults. The ability to maintain stroke volume, however, was impaired, especially in younger children (aged 2 to 5 years) who had the greatest increase in heart rate (113). Cardiac output was increased in older but not in younger children (113). Systolic and diastolic blood pressures did not change during sauna bathing but dropped immediately afterward, and 2 children fainted (113). Although there were no significant ST-segment depressions, 3 children had extrasystoles (114). One 5-year-old girl with a wandering pacemaker had a 3.3-second sinus arrest, suggesting that heat stress may be risky for children with disorders of the sinoatrial node (114).

SUMMARY

For most healthy people, as well as for most patients with stable coronary heart disease, sauna bathing is well tolerated and safe. The physiological (Table 1) and hormonal (Table 2) changes that occur during sauna bathing are transient. Sauna bathing does not cause drying of the skin (76,77). The effects of hyperthermia on the pharmacokinetics of several orally administered drugs are minor (47,54–57). Sauna bathing does not lower fertility in men or women (91–93) nor is it harmful in moderation for healthy women with uncomplicated pregnancies (98–100). Healthy children who are accustomed to sauna bathing tolerate it well (111). Sauna bathing has also been shown to be safe for most coronary patients with stable angina pectoris or prior myocardial infarction (27–34). The risks of myocardial infarction (25), coronary death (26), and sudden death (23,24) are lower during sauna bathing than during other daily activities.

Sauna bathing may also have therapeutic value. Some studies have suggested that regular sauna bathing may lower the blood pressure in patients with hypertension

(29,30,44) and increase the left ventricular ejection fraction in patients with chronic heart failure (49,50). Sauna bathing may also improve lung function in patients with obstructive pulmonary disease (62,63) and alleviate pain in patients with rheumatic disease (73,74). Although sweating may increase itching in patients with atopic dermatitis, patients with psoriasis may experience some relief (77). Larger randomized studies are needed to establish the clinical relevance of these findings.

Sauna bathing is contraindicated during high-risk pregnancies (100,108) and for patients with unstable angina pectoris, recent myocardial infarction, and severe aortic stenosis (28,51). Decompensated heart failure and cardiac arrhythmia are relative contraindications. Some studies have reported ECG changes, ectopic beats, and perfusion defects suggestive of myocardial ischemia in patients with coronary heart disease, but these occur less frequently during sauna bathing than during exercise (27,31,33,34). Blood pressure may decrease after sauna, sometimes resulting in syncope (19). **Alcohol intake while sauna bathing can create serious health risks and should be avoided.**



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