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### Sauna use associated with reduced risk of cardiac, all-cause mortality

*Date:* February 23, 2015

*Source:* The JAMA Network Journals

*Summary:* A sauna may do more than just make you sweat. A new study suggests men who engaged in frequent sauna use had reduced risks of fatal cardiovascular events and all-cause mortality, according to a new article.

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#### FULL STORY

A sauna may do more than just make you sweat. A new study suggests men who engaged in frequent sauna use had reduced risks of fatal cardiovascular events and all-cause mortality, according to an article published online by *JAMA Internal Medicine*.

Although some studies have found sauna bathing to be associated with better cardiovascular and circulatory function, the association between regular sauna bathing and risk of sudden cardiac death (SCD) and fatal cardiovascular diseases (CVD) is not known.

Jari A. Laukkanen, M.D., Ph.D., of the University of Eastern Finland, Kuopio, and coauthors investigated the association between sauna bathing and the risk of SCD, fatal coronary heart disease (CHD), fatal CVD and all-cause mortality in a group of 2,315 middle-aged men (42 to 60 years old) from eastern Finland.

Results show that during a median (midpoint) follow-up of nearly 21 years, there were 190 SCDs, 281 fatal CHDs, 407 fatal CVDs and 929 deaths from all causes. Compared with men who reported one sauna bathing session per week, the risk of SCD was 22 percent lower for 2 to 3 sauna bathing sessions per week and 63 percent lower for 4 to 7 sauna sessions per week. The risk of fatal CHD

events was 23 percent lower for 2 to 3 bathing sessions per week and 48 percent lower for 4 to 7 sauna sessions per week compared to once a week. CVD death also was 27 percent lower for men who took saunas 2 to 3 times a week and 50 percent lower for men who were in the sauna 4 to 7 times a week compared with men who indulged just once per week. For all-cause mortality, sauna bathing 2 to 3 times per week was associated with a 24 percent lower risk and 4 to 7 times per week with a 40 percent reduction in risk compared to only one sauna session per week.

The amount of time spent in the sauna seemed to matter too. Compared with men who spent less than 11 minutes in the sauna, the risk of SCD was 7 percent lower for sauna sessions of 11 to 19 minutes and 52 percent less for sessions lasting more than 19 minutes. Similar associations were seen for fatal CHDs and fatal CVDs but not for all-cause mortality events.

"Further studies are warranted to establish the potential mechanism that links sauna bathing and cardiovascular health," the study concludes.

### Editor's Note: Health Benefits of Sauna Bathing

In a related Editor's Note, Rita F. Redberg, M.D., of the University of California, San Francisco, and editor-in-chief of *JAMA Internal Medicine*, writes: "Although we do not know why the men who took saunas more frequently had greater longevity (whether it is the time spent in the hot room, the relaxation time, the leisure of a life that allows for more relaxation time or the camaraderie of the sauna), clearly time spent in the sauna is time well spent."

### Story Source:

Materials provided by **The JAMA Network Journals**. Note: Content may be edited for style and length.

### Journal Reference:

1. Tanjaniina Laukkanen, Hassan Khan, Francesco Zaccardi, Jari A. Laukkanen. **Association Between Sauna Bathing and Fatal Cardiovascular and All-Cause Mortality Events.** *JAMA Internal Medicine*, 2015; DOI: 10.1001/jamainternmed.2014.8187

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Frequent Sauna Bathing Has Many Health Benefits

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## Frequent sauna bathing may protect men against dementia, Finnish study suggests

*Date:* December 16, 2016

*Source:* University of Eastern Finland

*Summary:* Frequent sauna bathing may reduce the risk of dementia, suggests a recent study in Finland. In a 20-year follow-up, men taking a sauna 4-7 times a week were 66% less likely to be diagnosed with dementia than those taking a sauna once a week. The association between sauna bathing and dementia risk has not been previously investigated.

### FULL STORY



The more frequently saunas were taken, the lower was the risk of dementia, found investigators.

*Credit: © bravissimos / Fotolia*

Frequent sauna bathing can reduce the risk of dementia, according to a recent study carried out at the University of Eastern Finland. In a 20-year follow-up, men taking a sauna 4-7 times a week were 66% less likely to be diagnosed with dementia than those taking a sauna once a week. The association between sauna bathing and dementia risk has not been previously investigated.

The effects of sauna bathing on the risk of Alzheimer's disease and other forms of dementia were studied in the Kuopio Ischaemic Heart Disease Risk Factor Study (KIHD), involving more than 2,000 middle-aged men living in the eastern part of Finland. Based on their sauna-bathing habits, the study participants were divided into three groups: those taking a sauna once a week, those taking a sauna 2-3 times a week, and those taking a sauna 4-7 times a week.

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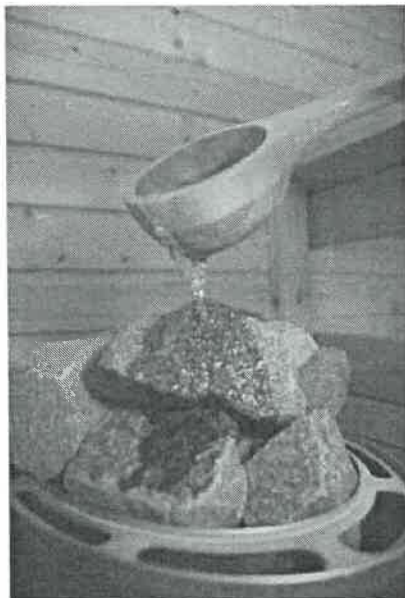
## Frequent sauna bathing reduces risk of stroke

*Date:* May 3, 2018

*Source:* University of Eastern Finland

*Summary:* Frequent sauna bathing is associated with a reduced risk of stroke, according to a new international study.

### FULL STORY



Frequent sauna bathing reduces the risk of stroke.

*Credit: UEF*

Frequent sauna bathing is associated with a reduced risk of stroke, according to a new international study. In a 15-year follow-up study, people taking a sauna 4-7 times a week were 61% less likely to suffer a stroke than those taking a sauna once a week. This is the first prospective large-scale study on this topic, and the findings were reported in *Neurology*.

Stroke is one of the leading causes of disability worldwide, placing a heavy human and economic burden on societies. The reduced risk associated with sauna bathing was found by a team of scientists from the Universities of Eastern Finland, Bristol, Leicester, Atlanta, Cambridge and Innsbruck.

The findings are based on the population-based Kuopio Ischaemic Heart Disease Risk Factor (KIHD) study and involved 1,628 men and women aged 53 to 74 years living in the eastern part of Finland. Based on their frequency of taking traditional Finnish sauna baths (relative humidity 10-20%), the study participants were divided into three groups: those taking a sauna once a week, those taking a sauna 2-3 times a week, and those taking a sauna 4-7 times a week.

The more frequently saunas were taken, the lower was the risk of stroke. Compared to people taking one sauna session per week, the risk was decreased by 14% among those with 2-3 sessions and 61% among those with 4-7 sessions. The association persisted even when taking into account conventional stroke risk factors, such as age, sex, diabetes, body mass index, blood lipids, alcohol consumption, physical activity and socio-economic status. The strength of association was similar in men and women.

Previous results from the KIHD study at the University of Eastern Finland have shown that frequent sauna bathing also significantly reduces the risk of cardiovascular and all-cause mortality. According to the researchers, mechanisms driving the association of sauna bathing with reduced stroke may include a reduction in blood pressure, stimulation of immune system, a positive impact on the autonomic nervous system, and an improved cardiovascular function. In a recent experimental study, the same group of scientists also showed that sauna bathing has acute effects on the stiffness of the arterial wall, hence influencing blood pressure and cardiac function parameters.

#### Story Source:

Materials provided by **University of Eastern Finland**. *Note: Content may be edited for style and length.*

#### Journal Reference:

1. Setor K. Kunutsor, Hassan Khan, Francesco Zaccardi, Tanjaniina Laukkanen, Peter Willeit, Jari A. Laukkanen. **Sauna bathing reduces the risk of stroke in Finnish men and women.** *Neurology*, 2018; 10.1212/WNL.0000000000005606 DOI: 10.1212/WNL.0000000000005606

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University of Eastern Finland. "Frequent sauna bathing reduces risk of stroke." ScienceDaily. ScienceDaily, 3 May 2018. <[www.sciencedaily.com/releases/2018/05/180503101635.htm](http://www.sciencedaily.com/releases/2018/05/180503101635.htm)>.

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## Scientists uncover why sauna bathing is good for your health

*Date:* January 5, 2018

*Source:* University of Eastern Finland

*Summary:* Scientists in Finland have shown that sauna bathing is associated with a variety of health benefits. Using an experimental setting this time, the research group now investigated the physiological mechanisms through which the heat exposure of sauna may influence a person's health. Their latest study with 100 test subjects shows that taking a sauna bath of 30 minutes reduces blood pressure and increases vascular compliance, while also increasing heart rate similarly to medium-intensity exercise.

### FULL STORY

Over the past couple of years, scientists at the University of Eastern Finland have shown that sauna bathing is associated with a variety of health benefits. Using an experimental setting this time, the research group now investigated the physiological mechanisms through which the heat exposure of sauna may influence a person's health. Their latest study with 100 test subjects shows that taking a sauna bath of 30 minutes reduces blood pressure and increases vascular compliance, while also increasing heart rate similarly to medium-intensity exercise.

Previously, the research group has published findings from a population-based study indicating that regular sauna bathing is associated with a reduced risk of coronary diseases and sudden cardiac death, hypertension and Alzheimer's disease and dementia. Frequent sauna bathing has also been associated with a reduced risk of respiratory diseases and lower CRP levels.

The experimental study carried out in the Sauna and Cardiovascular Health project provides new insight into changes that take place in the human body during and after having a sauna. The study analysed the effects of a 30-minute sauna bath in 100 test subjects. In particular, the objective was to analyse the role of vascular compliance and reduced blood pressure in the health benefits caused by sauna bathing.

Vascular compliance was measured from the carotid and femoral artery before sauna, immediately after sauna, and after 30 minutes of recovery. These vascular compliance measurements carried out in the experimental study constitute a new assessment method in a sauna setting.

Immediately after 30 minutes of sauna bathing, test subjects' mean systolic blood pressure reduced from 137 mmHg to 130 mmHg, and their diastolic blood pressure from 82 mmHg to 75 mmHg. Furthermore, their systolic blood pressure remained lower even after 30 minutes of sauna bathing. Test subjects' mean carotid-femoral pulse wave velocity, which is an indicator of vascular compliance, was 9.8 m/s before sauna, decreasing to 8.6 m/s immediately after. During sauna bathing, test subjects' heart rate increased similarly to medium-intensity exercise, and their body temperature rose by approximately 2°C. The findings shed light on the physiological mechanisms through which health benefits, which have been observed at the population level and are caused by the heat exposure of sauna, may develop.

The findings on the effects of sauna bathing on the human body were published in the *Journal of Human Hypertension*, and the findings relating to the carotid-femoral pulse wave velocity measurements were published in the *European Journal of Preventive Cardiology*. The study was funded by the Finnish Funding Agency for Innovation, Tekes, and it was carried out by Professor Jari Laukkanen's research group at the University of Eastern Finland. The project partners were Harvia Ltd., Velha Ltd., Pihlajalinna, Fintravel Ltd. and the Finnish Sauna Culture Association. The test subjects were 100 clients of the Pihlajalinna health care service provider. Their background information was collected by extensive surveys and interviews, and their physical health was measured by a clinical exercise test. The study was carried out in experimental saunas provided by the sauna stove and sauna heater manufacturer Harvia Ltd. The experimental sauna setting was a careful simulation of the way people in Finland take a sauna in their own homes.

Research indicates that regular physical exercise and a healthy lifestyle promote cardiac health and prevent disease, but not all of the risk and protective factors are yet known. The benefits of regular sauna bathing on cardiac health observed in the population-based study can, according to this experimental study, be explained by the fact that sauna bathing reduces blood pressure and increases vascular compliance. However, further research data from experimental settings relating to the physiological mechanisms of sauna bathing that promote cardiac health is still needed.

#### Story Source:

Materials provided by **University of Eastern Finland**. *Note: Content may be edited for style and length.*

#### Journal References:


1. Tanjaniina Laukkanen, Setor K. Kunutsor, Francesco Zaccardi, Earric Lee, Peter Willeit, Hassan Khan, Jari A. Laukkanen. **Acute effects of sauna bathing on cardiovascular function**. *Journal of Human Hypertension*, 2017; DOI: 10.1038/s41371-017-0008-z
2. Earric Lee, Tanjaniina Laukkanen, Setor K Kunutsor, Hassan Khan, Peter Willeit, Francesco Zaccardi, Jari A Laukkanen. **Sauna exposure leads to improved arterial compliance: Findings from a non-randomised experimental study**. *European Journal of Preventive Cardiology*, 2017; 25 (2): 130 DOI: 10.1177/2047487317737629

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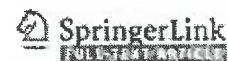
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Eur J Epidemiol. 2018 Mar;33(3):351-353. doi: 10.1007/s10654-017-0335-y. Epub 2017 Dec 5.

## Sauna bathing and systemic inflammation.

Laukkanen JA<sup>1,2</sup>, Laukkanen T<sup>3</sup>.

### Author information

### Abstract

We aimed to investigate whether frequency of sauna bathing is associated with the levels of serum C-reactive protein. C-reactive protein is a leading blood marker of systemic inflammation. The study consisted of 2084 men (42-60 years) without acute or chronic inflammation. A total of 533 (25.6%), 1368 (65.6%), and 183 (8.8%) participants reported having a sauna bath once a week, 2-3 times, and 4-7 times per week; mean serum C-reactive protein levels were 2.41 (standard deviation 2.91), 2.00 (2.41), 1.65 (1.63) mmol/L, respectively. In a multivariable analysis adjusted for baseline age, body mass index, systolic blood pressure, smoking, type 2 diabetes, previous myocardial infarction, and serum low density lipoprotein cholesterol, alcohol consumption and physical activity, there was a significant inverse association between the frequency of sauna bathing and the level of C-reactive protein. Further studies are warranted to investigate the relationship between sauna bathing and systemic inflammation.

**KEYWORDS:** C-reactive protein; Epidemiology; Sauna bathing

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# Sauna Bathing and Risk of Psychotic Disorders: A Prospective Cohort Study

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## Significance of the Study

- Sauna bathing has numerous health benefits including the promotion of mental well-being and relaxation; however, its association with mental disorders is unknown. In this new study, frequent sauna bathing was strongly associated with a reduced risk of psychotic disorders. These new findings add to emerging evidence that frequent sauna therapy could reduce the risk of several acute and chronic health conditions.

## Keywords

Sauna · Mental health · Psychosis · Risk factor · Cohort study

## Abstract

**Objective:** Sauna bathing has been suggested to promote mental well-being and relaxation, but the evidence is uncertain with respect to mental disorders. We aimed to assess the association of frequency of sauna bathing with risk of psychosis in the Kuopio Ischemic Heart Disease prospective population-based study. **Subjects and Methods:** Baseline sauna bathing habits were assessed in 2,138 men aged 42–61 years who had no history of psychotic disorders. Participants were classified into three groups based on the frequency of sauna bathing (once, 2–3, and 4–7 times per week). **Results:** During a median follow-up of 24.9 years, 203 psychotic disorders were recorded. A total of 537, 1,417, and

184 participants reported having a sauna bath once a week, 2–3 times, and 4–7 times per week, respectively. In Cox regression analysis adjusted for age, compared to men who had 1 sauna session per week, the hazard ratio (95% confidence intervals) of psychosis for 4–7 sauna sessions per week was 0.23 (0.09–0.58). In a multivariable model adjusted for several risk factors and other potential confounders, the corresponding hazard ratio was 0.21 (0.08–0.52). The association was similar after further adjustment for total energy intake, socioeconomic status, physical activity, and C-reactive protein (0.22 [0.09–0.54]) and was unchanged on additional adjustment for duration of a sauna session and temperature of the sauna bath (0.23 [0.09–0.57]). **Conclusion:** Our study suggests a strong inverse and independent association between frequent sauna bathing and the future risk of psychotic disorders in a general male population.

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## Introduction

Psychosis is triggered by other conditions such as schizophrenia, schizoaffective disorders, delusional disorders, neurodegenerative disorders, and major depressive disorders. Psychotic disorders are serious mental disorders, with a lifetime prevalence of approximately 3% in the general population [1]. Although a relatively rare condition, psychosis is a severe disabling sickness and associated with high health costs and reduced life expectancy [2]. Though very little is known about its etiology, psychosis is regarded as a multifactorial disorder which is determined by genetic and biological factors as well as environmental stressors [3]. Factors associated with low socioeconomic status (SES) such as low education and income levels, unemployment, and being unmarried, widowed, or divorced have been found to be linked to an increased risk of psychotic disorders [4–6]. Compelling evidence also suggests that psychosocial factors such as stress, depression, and anxiety are strongly implicated in the development of psychotic disorders [7–10]. Evidence suggests that these factors act in a cumulative way to increase the risk of psychosis [11]. Psychosis is also a very common feature in people suffering from Alzheimer's disease [12].

Sauna bathing, an activity linked to relaxation and well-being, which is commonly used and readily available in Nordic countries especially [13], has been linked with numerous health benefits which include improvement in the pain and symptoms associated with musculoskeletal diseases, treatment of chronic headache and reduced risk of respiratory diseases, hypertension, cardiovascular disease, stroke, and mortality [14–16]. Frequent sauna bathing has also been shown to be associated with a reduced risk of dementia and Alzheimer's disease [17] and reduces the symptoms of depression [18]. Other passive heat therapies such as Waon therapy, infrared saunas, and whole-body hyperthermia have also been shown to relieve stress and improve the symptoms of psychiatric disorders such as depression and anxiety [18–20].

Given the strong relationship between psychotic disorders and factors such as stress, depression, anxiety, and dementia, as well as emerging evidence on the beneficial effects of sauna bathing or thermal therapy on these factors or outcomes, we hypothesized that sauna bathing may be linked to improved mental health. In this context, we aimed to assess the association of frequency of sauna bathing with the risk of psychosis, using a population-based cohort of 2,138 men who were free from any apparent mental illness at baseline.

## Methods

### *Study Design and Participants*

The study population comprised a randomly selected representative sample of middle-aged men aged 42–61 years who were recruited into the Finnish Kuopio Ischemic Heart Disease (KIHD) risk factor study. Details of recruitment methods, ethical permissions, and assessment of risk markers and sauna bathing have been described in a previous report [16]. Briefly, subjects were a randomly selected sample of 3,433 men who resided in the town of Kuopio or its surrounding rural communities. Of those invited, 2,682 volunteered to participate in the study and those with complete information on sauna bathing were included ( $n = 2,327$ ). Baseline examinations were conducted between March 1984 and December 1989. Only 12 men did not use sauna at all and were excluded from the analysis. Men with a history of use of antipsychotic medication were excluded at baseline ( $n = 52$ ). The final dataset analyzed comprised 2,138 men with complete information on sauna exposure, relevant covariates, and psychosis outcome. The investigation was concordant with the principles outlined in the Declaration of Helsinki and its future amendments. The study protocol was approved by the Research Ethics Committee of the University of Eastern Finland and each participant gave written informed consent.

### *Assessment of Covariates and Exposure*

Participants were instructed to fast overnight, abstain from alcohol consumption for at least 3 days, and to keep away from smoking for at least 12 h prior to blood specimen collections. The cholesterol contents of serum lipoprotein fractions and triglycerides were measured enzymatically (Boehringer Mannheim, Germany) [16]. High-sensitivity serum C-reactive protein was assessed with an immunometric assay (Immulite High Sensitivity C-Reactive Protein Assay; DPC, Los Angeles, CA, USA). Participants completed a self-administered health and lifestyle questionnaire for the assessment of age, smoking, alcohol consumption, level of physical activity, SES, baseline diseases, and medication history. The energy expenditure of physical activity was assessed using the validated KIHD 12-month leisure time physical activity history questionnaire [14]. Adulthood SES was assessed as a combined measure of income, education, occupation, occupational prestige, material standard of living, and housing conditions, all of which were assessed with self-reported questionnaires. Values for SES ranged from 0 to 25, with a higher value indicating lower levels of SES. Alcohol consumption was assessed using the Nordic Alcohol Consumption Inventory. History of type 2 diabetes was defined as having a clinical diagnosis of diabetes and regular treatment with diet, oral hypoglycemic agents or insulin therapy, fasting plasma glucose  $\geq 7.0$  mmol/L, or according to self-reports. History of coronary heart disease (CHD) was based on a previous myocardial infarction, angina pectoris, the use of nitroglycerin for chest pain once a week or more frequently, or chest pain. Resting blood pressure was measured between 8 and 10 a.m. with a random zero sphygmomanometer. The weekly frequency of sauna bathing sessions, duration of sessions and temperature of the sauna room were assessed using self-administered questionnaires. The assessment represented typical sauna bathing habits during the week. The questionnaires were checked by an experienced nurse at the time of baseline examination.

**Table 1.** Baseline characteristics of overall study participants and according to frequency of sauna bathing

Characteristic	Sauna bathing (sessions per week)				<i>p</i> value for heterogeneity
	overall ( <i>n</i> = 2,138)	1 ( <i>n</i> = 537)	2–3 ( <i>n</i> = 1,417)	4–7 ( <i>n</i> = 184)	
<i>Questionnaire/prevalent conditions</i>					
Age at survey, years	53.1 (5.1)	53.4 (5.0)	53.2 (5.0)	51.5 (5.7)	<0.001
Alcohol consumption, g/week	31.4 (6.4–88.4)	32.3 (7.2–96.0)	30.1 (6.3–84.4)	39.2 (8.0–114.0)	0.036
Total energy intake, kJ/day	9,862 (2,534)	9,559 (2,471)	9,898 (2,532)	10,474 (2,621)	<0.001
Socioeconomic status	8.29 (4.24)	8.45 (4.27)	8.31 (4.21)	7.63 (4.26)	0.071
History of diabetes	76 (3.6)	26 (4.8)	48 (3.4)	2 (1.1)	0.05
Current smokers	647 (30.3)	190 (35.4)	424 (29.9)	33 (17.9)	<0.01
History of CHD	510 (23.9)	134 (25.0)	343 (24.2)	33 (17.9)	0.135
<i>Physical measurements</i>					
BMI	26.8 (3.5)	26.8 (3.5)	26.7 (3.4)	27.9 (4.2)	<0.001
SBP, mm Hg	134 (17)	135 (18)	133 (16)	135 (17)	0.095
DBP, mm Hg	88 (10)	89 (11)	88 (10)	90 (12)	0.093
Physical activity, kJ/day	1,223 (662–2,022)	1,136 (568–1,830)	1,238 (682–2,038)	1,510 (701–2,362)	0.003
<i>Lipid markers</i>					
Total cholesterol, mmol/L	5.90 (1.07)	5.87 (1.11)	5.93 (1.06)	5.79 (0.97)	0.209
HDL-C, mmol/L	1.30 (0.30)	1.27 (0.28)	1.31 (0.31)	1.33 (0.31)	0.021
Triglycerides, mmol/L	1.11 (0.81–1.57)	1.13 (0.79–1.60)	1.10 (0.81–1.55)	1.10 (0.78–1.61)	0.916
<i>Metabolic and inflammatory markers</i>					
Fasting plasma glucose, mmol/L	5.32 (1.15)	5.43 (1.41)	5.27 (1.05)	5.31 (1.09)	0.026
Serum creatinine, $\mu$ mol/L	89.6 (13.7)	88.7 (14.9)	89.6 (12.7)	92.1 (16.5)	0.02
High-sensitivity CRP, mg/L	1.24 (0.69–2.34)	1.46 (0.71–2.85)	1.19 (0.67–2.25)	1.21 (0.75–2.09)	<0.001

Values are mean (SD) or *n* (%) or median (IQR). BMI, body mass index; CHD, coronary heart disease; CRP, C-reactive protein; DBP, diastolic blood pressure; HDL-C, high-density lipoprotein cholesterol; IQR, interquartile range; SD, standard deviation; SBP, systolic blood pressure.

#### Ascertainment of Outcomes

We included all psychotic disorders that occurred from study enrollment through to 2013. Data on hospitalization due to a psychotic disorder were ascertained by computer linkage to the National Hospital Discharge Register. All participants (using Finnish personal identification codes) are under continuous annual monitoring for incident psychotic cases and cardiometabolic outcomes, including incident cases. An independent committee of researchers reviewed all potential cases of psychosis to obtain a consensus on the diagnosis. Diagnoses of psychotic disorders were made according to ICD-9 (290–299) and ICD-10 (F00–F09 and F20–F29) codes. Follow-up for incidence of psychotic disorders was conducted using record linkage with the files of the population-based countrywide Finnish Hospital Registry.

#### Statistical Analysis

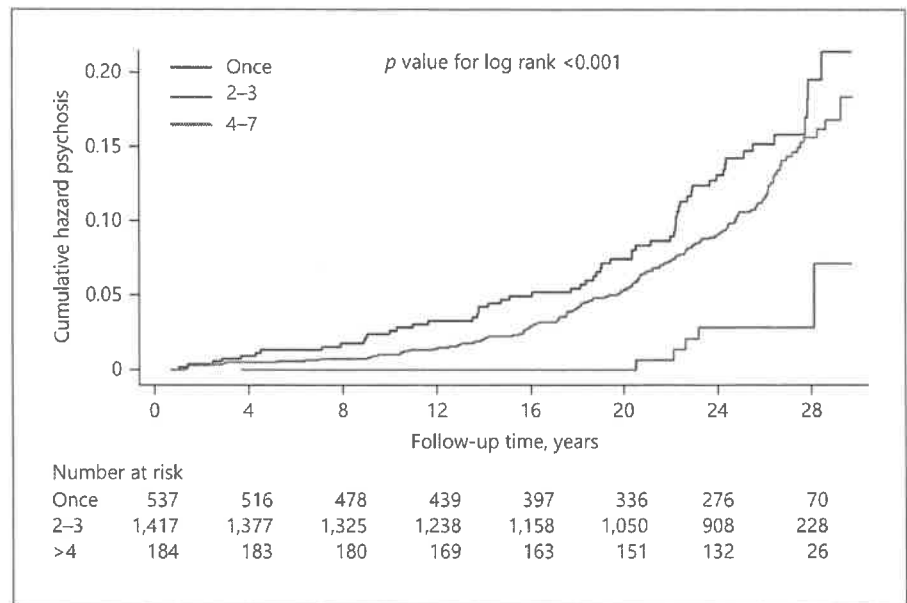
Descriptive data are presented as means (standard deviation, SD) or medians (interquartile range, IQR) for continuous variables and percentages for categorical variables. Hazard ratios (HRs) with 95% confidence intervals (CIs) for psychosis were calculated using Cox proportional hazard models, after confirmation of the assumptions of the proportionality of hazards. Participants were classified into three groups based on the frequency of sauna bathing (1, 2–3,

and 4–7 times per week), to maintain consistency with previous reports [15, 16]. HRs were progressively adjusted for (i) age (model 1); (ii) plus body mass index (BMI), smoking status, history of diabetes and CHD, years of education, total cholesterol, and alcohol consumption (model 2); (iii) plus total energy intake, SES, physical activity, and high-sensitivity serum C-reactive protein (model 3); and (iv) plus duration of a sauna session and temperature of sauna bath (model 4). Covariates were selected based on their potential as confounders as a result of their known associations with outcomes and observed associations with the exposure using the available data and evidence from previous research. A *p* value <0.05 was considered statistically significant. Statistical analyses were performed using Stata version 14 (Stata Corp., College Station, TX, USA).

## Results

### Baseline Characteristics

A summary of baseline characteristics of overall study participants and according to the group of weekly frequency of sauna bathing is shown in Table 1. The mean



**Fig. 1.** Cumulative Kaplan-Meier curves for psychosis during follow-up according to the frequency of sauna bathing per week.

(SD) age was 53.1 (SD, 5.1) years. The median (IQR) frequency of sauna baths and duration of a single sauna session was 2 sessions/week (IQR, 1–3) and 15 min (IQR, 10–15), respectively, with the mean temperature being 79.0°C (SD, 9.6). Participants with the highest frequency of sauna bathing of 4–7 times per week were younger, had higher BMI, lower SES, were more physically active, and consumed more alcohol compared with the participants in the other groups. In this study population, a total of 537, 1,417, and 184 participants reported having a sauna bath once a week, 2–3 times, and 4–7 times per week, respectively.

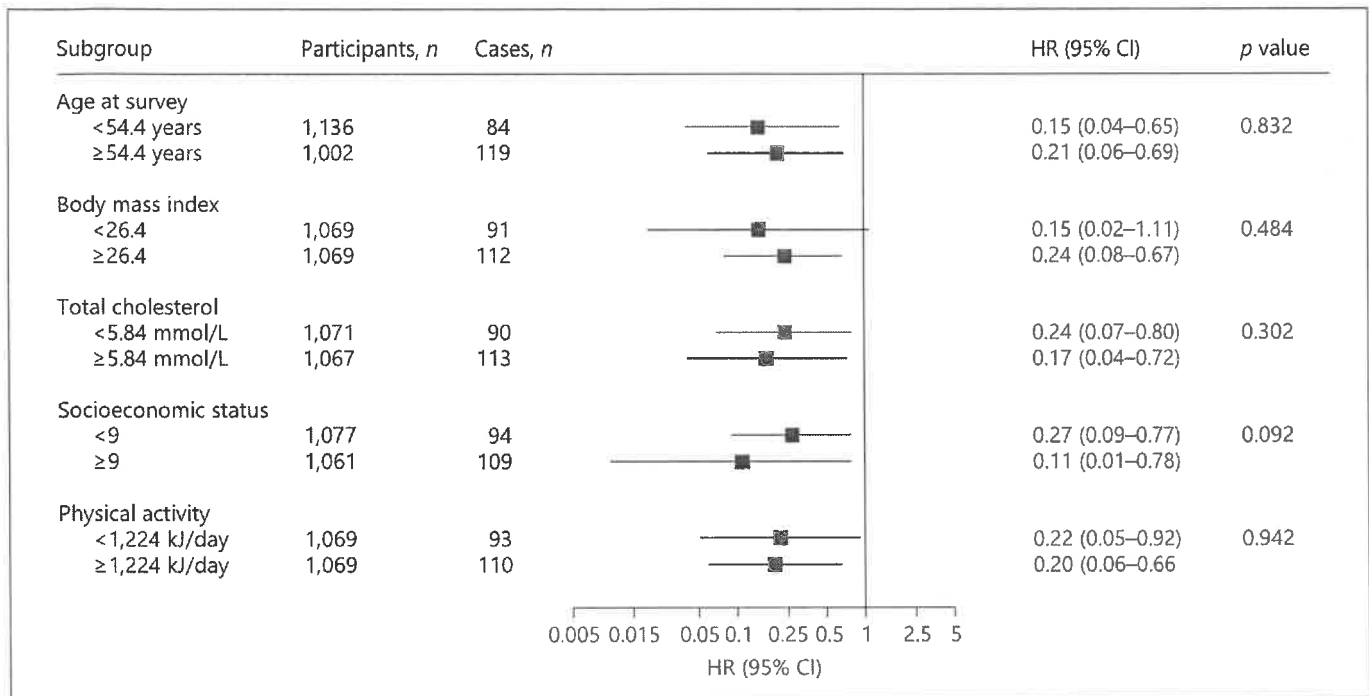
#### *Sauna Bathing and Risk of Psychosis*

During a median follow-up of 24.9 years (IQR, 18.5–27.1), 203 hospital-diagnosed psychotic disorders were recorded. Rates of psychotic disorders per 1,000 person-years of follow-up across the three frequency groups of sauna bathing (1, 2–3, and 4–7 times per week) were 8.1 (95% CI 6.1–10.8), 7.4 (95% CI 6.1–9.0), and 2.8 (95% CI 1.4–5.7), respectively. Cumulative hazard curves demonstrated a lower risk of a psychotic disorder among men who took 4–7 sauna bathing sessions per week compared to the other two groups ( $p < 0.001$  for log rank test; Fig. 1). Compared to men who had only 1 sauna session per week, the age-adjusted HR (95% CI) for psychosis was 0.23 (95% CI 0.09–0.58) for men with 4–7 sauna bathing sessions per week. In further analysis adjusted for several conventional risk factors (age, BMI, smoking status, history of diabe-

tes and CHD, years of education, total cholesterol, and alcohol consumption), the corresponding association was 0.21 (95% CI 0.08–0.52). The association was minimally attenuated on additional adjustment for other potential confounders and remained the same on further adjustment for duration of a single sauna session and temperature of the sauna bath (0.23 [95% CI 0.09–0.57]) (Table 2). In further analysis that additionally excluded men who were on antidepressants ( $n = 19$ ), the corresponding adjusted HRs for men who took 4–7 sauna bathing sessions per week (compared to 1 sauna session per week) were 0.24 (95% CI 0.09–0.59), 0.21 (95% CI 0.08–0.53), 0.22 (95% CI 0.09–0.55), and 0.23 (95% CI 0.09–0.58), respectively. The association between frequency of sauna bathing and risk of psychosis was not significantly modified by any clinically relevant characteristic (Fig. 2).

#### **Discussion**

In this prospective evaluation of the association between frequency of sauna bathing and risk of psychosis, our results showed a strong inverse association between frequency of sauna bathing and future risk of psychosis in men with no previous history of mental illness at baseline. The association remained consistent after excluding men who were taking antidepressants. The association was independent of several potential confounders and not modified by clinically relevant characteristics.



**Fig. 2.** Association of frequency of sauna bathing with psychosis in clinically relevant subgroups. CI, confidence interval; HDL-C, high-density lipoprotein cholesterol; HR, hazard ratio; HRs are adjusted for age, body mass index, smoking status, history of diabe-

tes, prevalent coronary heart disease, years of education, total cholesterol, and alcohol consumption; hazard ratios are reported comparing 4–7 sauna sessions per week with 1 sauna session per week; \* *p* value for interaction; cutoffs used are median values.

**Table 2.** Association of frequency of sauna bathing and risk of psychosis

Frequency of sauna bathing (sessions per week)	Model 1		Model 2		Model 3		Model 4	
	HR (95% CI)	<i>p</i> value	HR (95% CI)	<i>p</i> value	HR (95% CI)	<i>p</i> value	HR (95% CI)	<i>p</i> value
Once	ref		ref		ref		ref	
2–3	0.76 (0.56–1.03)	0.082	0.78 (0.57–1.06)	0.113	0.80 (0.59–1.09)	0.158	0.81 (0.59–1.11)	0.190
4–7	0.23 (0.09–0.58)	0.002	0.21 (0.08–0.52)	0.001	0.22 (0.09–0.54)	0.001	0.23 (0.09–0.57)	0.002

CI, confidence interval; HR, hazard ratio; ref, reference; Model 1, adjusted for age; Model 2, model 1 plus body mass index, smoking status, history of diabetes, prevalent coronary heart disease, years of education, total cholesterol, and alcohol consumption; Model 3, model 2 plus total energy intake, socioeconomic status, physical activity, and high-sensitivity C-reactive protein; Model 4, model 3 plus duration of a single sauna session and temperature of sauna bath.

To the best of our knowledge, the prospective association between sauna bathing and the risk of psychotic disorders has not been previously investigated and therefore it is difficult to directly compare our study findings to previous evidence. However, there is evidence to suggest that other types of passive heat therapy such as infrared saunas and Waon therapy improve the mood and reduce depression as well as fatigue, anxiety, and stress [18, 19].

A number of studies have also shown that sauna exposure is associated with a reduced risk of several adverse health outcomes [14–16].

The etiology of psychosis is multifactorial and has been reported to result from an interplay between genetic, lifestyle and environmental factors [21]. Although the protective role of sauna bathing in the development of psychosis is not known, we propose several plausible

mechanistic pathways. Frequent sauna baths enhance relaxation, pleasure and well-being, thereby reducing negative feelings and the anxieties and stresses of everyday life, which are also triggers for psychotic symptoms [7–10]. Sauna bathing is also associated with an opportunity to create friendships, which decrease feelings of isolation, a factor implicated in the development of psychosis [22]. There is evidence suggesting a strong link between elevated hypothalamus-pituitary-adrenal activity and psychosis [23]. Patients with psychotic disorders manifest increased hypothalamus-pituitary-adrenal activity, which is characterized by increased levels of circulating hormones such as cortisol (main stress hormone) and adrenocorticotropin [24]. It is known that agents or illnesses (e.g., Cushing's syndrome) that increase the release of cortisol induce or exacerbate psychotic symptoms [23]. Indeed, several studies have shown that sauna bathing induces hormonal changes which include lowering levels of cortisol by as much as 10–40% [25, 26]. Oxidative stress is believed to be involved in the pathophysiology of stress disorders such as chronic fatigue syndrome as well as psychotic disorders [27]. Evidence also suggests that antioxidant depletion and increased oxidative stress are related to the extent of symptoms in chronic fatigue syndrome [28]. Repeated sauna or passive heat therapy reduces levels of markers of oxidative stress [29] and may protect against psychosis via reduction in oxidative stress.

Our findings from hot Finnish sauna bathing with an average temperature of 79 °C cannot be directly applied to other types of passive heat therapy such as steam rooms, warm water therapy, Waon therapy, and infrared saunas which may operate at lower temperatures; however, similar pathways may be involved. We could not ascertain as to whether the protective effect of sauna on psychotic symptoms is due to the time spent in the hot room, the leisure of a life that allows for more relaxation time, the camaraderie of the sauna, or other biological mechanisms; however, previous evidence in addition to the current findings suggest that sauna bathing, in addition to being a relaxing lifestyle habit, could be used to maintain mental health and well-being. The current study adds to the emerging evidence that sauna bathing has a wide range of health benefits beyond its widely accepted use for relaxation and pleasure.

The results should however be interpreted with caution as our analyses focused on all types of psychotic disorders, including those that are mainly due to memory disorders such as Alzheimer's disease and dementia. The view of sauna as an indicator of SES is indeed stronger and more common in other cultures and countries than

in Finland. Although we adjusted for SES, it is not possible to completely exclude that sauna is not an indicator of economic, familial, or working traits. These results could in part be explained by divergent educational background, economic facilities, family engagement, or "attention" to lifestyle among people reporting different sauna use. Also, we did not have data on familiarity as regards mental disorders, use of drugs such as cannabis or an indicator of social deprivation, which may be related to risk of psychosis. There is also a possibility that the findings could be due to "reverse causation," whereby some men were already at risk of developing psychosis at study entry and therefore did not have frequent sauna baths. However, we minimized this bias by excluding study participants who were on antipsychotic medications. The results also remained the same in sensitivity analysis that excluded men on antidepressants.

In the interpretations of our findings, these factors should be considered along with the broad and compelling body of evidence on the beneficial physiological changes of sauna bathing. Other limitations of our study include (i) the inability to examine associations in some subgroups such as smoking status, history of prevalent disease such as diabetes or CHD, due to the limited number of cases in some categories of the exposure and (ii) the inability to generalize the results to women, and therefore it is unknown whether the physiological and psychological benefits of frequent sauna bathing are also applicable to women and older individuals. Furthermore, it was not possible to correct for regression dilution bias which may have underestimated the associations demonstrated, as sauna habits during a typical week were assessed only once. Due to potential changes in the health status of participants over the long period of observation, it is possible that sauna bathing habits may also have changed during follow-up; however, any changes may be minimal as sauna habits are fairly stable in this Finnish population. Finally, we were unable to assess the association between sauna bathing and risk of psychosis when comparing people who used sauna versus those who did not use sauna at all, because of the small numbers who did not use sauna at all. Indeed, a majority of Finnish people are accustomed to having sauna baths at least once per week, as it is a tradition [26].

## Conclusion

In this study, frequent sauna bathing is strongly associated with decreased risk of psychosis in a middle-aged male population. The present study adds to emerging ev-

idence that frequent passive heat therapy such as sauna bathing could reduce the risk of several acute and chronic health conditions. Sauna bathing is a recommendable habit as it is a well-tolerated and safe activity for most healthy people and even in patients with stable cardiac disease [13]. Potential contraindications include acute infections, unstable angina pectoris, recent myocardial infarction, or severe aortic stenosis [13]. In addition, people with schizophrenia may need to be cautious when taking sauna baths, as evidence suggests that such populations may exhibit dysregulation of body temperature [30]. Further well-conducted research work is needed to confirm the current findings and to understand the mechanisms underlying the observed relationship between sauna bathing and psychosis risk.

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### Statement of Ethics

The study protocol (143/97) has been accepted by the University of Eastern Finland and Research Ethics Committee Hospital District of Northern Savo, Finland.

### Disclosure Statement

The authors have no conflicts of interest to declare.

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