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Sauna bathing is inversely associated with dementia and Alzheimer's disease in middle-aged Finnish men

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Abstract

Background: there are no previous studies linking repeated heat exposure of sauna and the risk of memory diseases. We aimed to investigate whether frequency of sauna bathing is associated with risk of dementia and Alzheimer's disease.
Setting: prospective population-based study.
Methods: the frequency of sauna bathing was assessed at baseline in the Kuopio Ischaemic Heart Disease population-based prospective cohort study of 2,315 apparently healthy men aged 42–60 years at baseline, with baseline examinations conducted between 1984 and 1989. Hazard ratios (HRs) with 95% confidence intervals (CIs) for dementia and Alzheimer's disease were ascertained using Cox-regression modelling with adjustment for potential confounders.
Results: during a median follow-up of 20.7 (interquartile range 18.1–22.6) years, a total of 204 and 123 diagnosed cases of dementia and Alzheimer's disease were respectively recorded. In 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 low-density lipoprotein cholesterol, compared with men with only 1 sauna bathing session per week, the HR for dementia was 0.78 (95% CI: 0.57–1.06) for 2–3 sauna bathing sessions per week and 0.34 (95% CI: 0.16–0.71) for 4–7 sauna bathing sessions per week. The corresponding HRs for Alzheimer's disease were 0.80 (95% CI: 0.53–1.20) and 0.35 (95% CI: 0.14–0.90).
Conclusion: in this male population, moderate to high frequency of sauna bathing was associated with lowered risks of dementia and Alzheimer's disease. Further studies are warranted to establish the potential mechanisms linking sauna bathing and memory diseases.

Keywords: *Older people, dementia, Alzheimer's disease, prospective study, epidemiology*

Introduction

Although there is a direct correlation between ageing and the incidence of dementia, its risk factors and pathogenesis are not fully understood and various possible preventive strategies are still under investigation. A multifactorial aetiology has been proposed and pathways notably implicated include inflammation, haemodynamic and vascular function [1, 2]. Evidence from observational studies suggests that poor vascular function (as indicated by arterial stiffening) and vascular diseases maybe associated with worse cognitive performance and dementia [3–5]. Given this, there remains a possibility that improved circulatory function may be linked to better cognitive outcomes. Sauna bathing, an activity linked to relaxation and well-being, is associated with better haemodynamic function, leads to skin sweating-induced fluid loss and increase in heart rate [5, 6]; and has been suggested to be associated with a better cardiovascular and circulatory function, especially among patients with chronic heart failure [7–11]. Previous studies have also shown that heat exposure of sauna bathing is associated with lower blood pressure [12, 13]; however, some of these reports were based on limited study designs. We have recently shown that regular sauna bathing is associated with reduced risks of fatal cardiovascular diseases and all-cause mortality [14]. The relationship between sauna bathing and dementia is however not known. Thus, the aim of this prospective study was to investigate the association

between frequency of sauna bathing and the risk of dementia and Alzheimer's disease.

Methods

Study population

This study was designed to investigate risk predictors for atherosclerotic cardiovascular outcomes in a population-based sample of men from eastern Finland. Subjects comprised a randomly selected sample of 3,433 men aged 42–60 years who resided in Kuopio or its surrounding rural communities [15]. Of those invited, 2,682 (83%) participated in the study, and those with complete information on sauna bathing were included (N = 2,327). Twelve men who did not use sauna were excluded, leaving 2,315 men for the analyses [14]. Baseline examinations were conducted between March 1984 and December 1989. The study was approved by the research ethics committee of the University of Eastern Finland, Kuopio, Finland. Each participant gave written informed consent.

Assessment of sauna bathing habits

A traditional Finnish sauna has dry air (10–20%) with relatively high temperature. The recommended temperature for sauna is usually from 80°C to 100°C at the level of the bather's face [16]. Humidity is temporarily increased by throwing water on the hot rocks of sauna heater. The use of sauna bathing was assessed by a self-administered questionnaire based on weekly sauna sessions, duration and temperature. The assessment represents a typical sauna use during the week. The temperature in sauna room was measured using a thermometer in and was also self-reported. The questionnaires were checked by an experienced nurse at the time of baseline examination [14].

Assessment of baseline characteristics

A subject was defined as a smoker if he had ever smoked on a regular basis and pack-years were defined. Resting blood pressure was measured between 8:00 and 10:00 AM with a random-zero sphygmomanometer. Alcohol consumption was assessed using the Nordic Alcohol Consumption Inventory [17]. Body mass index (BMI) was calculated as the ratio of weight in kilograms to the square of height in metres. The collection of blood specimens and the measurement of serum lipids, lipoproteins, creatinine and glucose have been described previously [17]. Diabetes was defined as a fasting blood glucose level ≥7.0 mmol/l or clinical diagnosis of diabetes with dietary, oral or insulin treatment. The use of medications, medical history and the level of physical activity were assessed by self-administered questionnaires. Physical activity (kcal/day) was computed by multiplying the duration and intensity of each physical activity by body weight and was assessed using a 12-month physical activity questionnaire described in detail previously [17]. Briefly, this detailed quantitative questionnaire deals with the most common leisure-time physical activities of middle-aged Finnish men (conditioning physical activity, e.g. walking, skiing, bicycling, swimming, rowing and ball games; and non-conditioning physical activity, e.g. crafts, repairs, building, gardening, hunting and fishing) and enables the assessment of all components of physical activity [18]. Prevalent coronary heart disease was defined as either a previous myocardial infarction, angina pectoris or the use of nitroglycerin for chest pain once a week or more frequently. Socio-economic status is a summary index that combines measures of income, education, occupation, occupational prestige, material standard of living and housing conditions, all of which were assessed with self-reported questionnaires [14].

Ascertainment of outcomes

All dementia and Alzheimer's disease cases that occurred from study enrolment through 2013 were included. There were no losses to follow-up given the complete follow-up of the Finnish population using personal identification codes. In the Kuopio Ischemic Heart Disease risk factor study, participants are under annual monitoring for incident dementia cases and cardio-metabolic outcomes [14, 17]. Data on outcome events were obtained by record linkage to the national computerised hospitalisation registry, which covers every hospitalisation in Finland. The diagnoses of memory diseases were coded according to the International Classification of Diseases Codes. In addition, sources of information on dementia outcomes were also based on a comprehensive review of hospital records, inpatient physician claims data and medico-legal reports. An independent committee of researchers reviewed all potential cases of dementia to obtain a consensus on the diagnosis and aetiology.

Statistical analysis

For all analyses, natural logarithm ($\log_e$) transformed values of non-normal distributed variables were used. Descriptive data are presented as means (SDs) for continuous variables and numbers (percentages) for categorical ones. Analyses of the associations between sauna bathing, dementia and Alzheimer's disease involved Cox-regression modelling. Hazard ratios (HRs) with confidence intervals (CIs) were estimated per frequency of sauna bathing with adjustment for potential confounders selected on the basis of their previously established role as risk factors [14]. Two-sided analyses were performed using SPSS version 18.0 (IBM Corp., Armonk, NY, USA) and CIs are presented at the 95% level.

Results

Baseline characteristics of the study population are shown in Table 1. During a median follow-up of 20.7 (interquartile range 18.1–22.6) years, a total of 204 newly diagnosed dementia and 123 Alzheimer's disease cases were recorded; only 4 dementia cases and 6 Alzheimer disease cases were defined at time of death. Of all men with diagnosed outcome events, 124 men with dementia and 67 men with

Alzheimer's disease died during the follow-up period, respectively. A total of 601, 1,513 and 200 participants reported having a sauna bath once a week, 2–3 times and 4–7 times per week, respectively. The numbers (proportions in each group) of dementia cases were 59 (10%), 137 (9%) and 8 (4%) respectively in the three frequency groups of sauna bathing. The corresponding numbers (proportions) of Alzheimer's disease cases were 34 (6%), 84 (6%) and 5 (3%), respectively.

Table 1. Baseline characteristics of the study participants (N = 2,315)

Characteristic, unit	Mean (SD)
Age, years	53.1 (5.1)
BMI, kg/m^2	26.9 (3.5)
Cigarette smoking, pack-years[a]	8.4 (16.5)
Alcohol consumption, g/week	74.2 (121.3)
Serum total cholesterol, mmol/l	5.91 (1.07)
Serum LDL cholesterol, mmol/l[b]	4.04 (1.01)
Serum HDL cholesterol, mmol/l[b]	1.29 (0.30)
Serum triglycerides, mmol/l	1.28 (0.82)
Systolic blood pressure, mmHg	134 (16)
Fasting plasma glucose, mmol/l	5.3 (1.2)
Physical activity, kcal/day[c]	372 (357)
Socio-economic status[d]	8.4 (4.2)
Clinical conditions	n (%)
Smokers	699 (30.1)
Type 2 diabetes	118 (5.1)
Coronary heart disease	554 (23.9)
Heart failure[e]	174 (7.5)
Cardiomyopathy[e]	47 (2.1)
Cerebrovascular stroke	64 (2.7)
Regular use of cardiovascular medication	*n* (%)
Antihypertensive medication	502 (21.7)
Medication for dyslipidaemia	24 (1.0)
β-Blockers	407 (17.6)
Acetylsalicylic acid	167 (7.2)

Number of participants with available information on sauna frequency and duration.

[a]Pack-years denote the lifelong exposure to smoking, which was estimated as the product of years smoked and the number of tobacco products smoked daily at the time of examination.

[b]LDL denotes low-density lipoprotein and HDL denotes high-density lipoprotein.

[c]Physical activity (kcal/day) was computed by multiplying the duration and intensity of each physical activity by body weight. Physical activity was assessed using the 12-month physical activity questionnaire.

[d]Socio-economic status is a summary index that combines measures of income, education, occupation, occupational prestige, material standard of living and housing conditions, all of which were assessed with self-reported questionnaires.

[e]Diagnosis is based on clinical findings and symptoms and/or echocardiography.

After adjustment for age, compared with men with only 1 sauna bathing session per week, the HR of dementia was 0.77 (95% CI: 0.57–1.04) for 2–3 sauna bathing sessions per week and 0.38 (95% CI: 0.18–0.80) for 4–7 sauna bathing sessions per week. The corresponding HRs for Alzheimer's disease were 0.80 (95% CI: 0.54–1.2) for 2–3 sauna bathing sessions per week and 0.41 (95% CI: 0.16–1.07) for 4–7 sauna bathing sessions per week.

In a multivariable analysis adjusted for baseline age, alcohol consumption, BMI, systolic blood pressure, smoking status, Type 2 diabetes, previous myocardial infarction, resting heart rate and serum low-density lipoprotein cholesterol, there was a 66% risk reduction (HR: 0.34) of dementia and 65% (HR: 0.35) risk reduction of Alzheimer's disease when sauna bathing 4–7 times a week was compared with subjects having 1 sauna session per week (Table 2). After additional adjustment for physical activity and socio-economic status, the respective associations between sauna bathing and the risk of memory diseases (HR 0.34, 95% CI: 0.16–0.71, P = 0.004 for dementia and HR 0.35, 95% CI 0.16–0.90, P = 0.029 for Alzheimer's disease) remained similar for men with 4–7 sauna bathing sessions per week.

Discussion

In this population-based study of middle-aged Finnish men, we found a strong inverse association between frequency of sauna bathing and the risk of dementia and Alzheimer's disease, which was independent of known risk factors.

Although the pathogenesis of dementia has not been completely elucidated, current evidence suggests a multifactorial aetiology, with impaired cardiovascular function, inflammation and oxidative stress as being the major contributors in its pathogenesis [4]. Our results are therefore biologically plausible as regular sauna bathing is associated with improved vascular endothelial function [8], which also leads to reduced inflammation. Additionally, sauna bathing

Table 2. HRs of dementia and Alzheimer's disease according to frequency of sauna bathing

Frequency of sauna bathing (number of subjects)	Dementia (N = 204)		Alzheimer's disease (N = 123)	
	HR (95% CI)	P value	HR (95% CI)	P value
Age adjusted				
1 time/week (601)	1.00 (reference)		1.00 (reference)	
2–3 times/week (1,513)	0.77 (0.57–1.04)	0.090	0.80 (0.54–1.20)	0.278
4–7 times/week (201)	0.38 (0.18–0.80)	0.011	0.41 (0.16–1.07)	0.069
Multivariable adjusted[a]				
1 time/week (601)	1.00 (reference)		1.00 (reference)	
2–3 times/week (1,513)	0.78 (0.57–1.06)	0.109	0.80 (0.53–1.20)	0.278
4–7 times/week (201)	0.34 (0.16–0.71)	0.004	0.35 (0.14–0.90)	0.030

[a]HRs (95% CIs) are adjusted for age, body mass index, systolic blood pressure, serum low-density lipoprotein cholesterol, smoking, alcohol consumption, previous myocardial infarction, Type 2 diabetes and resting heart rate.

may be beneficial in the reduction of high systemic blood pressure and elevated pulse pressure, which are also well-known risk factors for dementia [12, 19]. Skin blood flow usually increases leading to a higher cardiac output with an increased body temperature during sauna bathing. Heart rate may increase from 100 up to 150 beats per minute during sauna bathing [13, 20, 21], although there is no active function of skeletal muscles during the sauna bathing, which is in contrast to the training response experienced during physical activity. Indeed, it has been shown that weight loss achieved during intense physical exercise is more favourable in athletes than that achieved through the effects of sauna [22]. The increase in heart rate during sauna bathing is due to reaction to the heat stress.

Overall, our results indicate that sauna bathing in addition to being a relaxing lifestyle habit, remains a potential additional strategy which can be used in improving cardiovascular function [4], and subsequently prevent or delay the development of neurogenerative diseases such as dementia. However, these results are still early and further studies are needed to replicate these findings in different populations.

Strengths of the current study include the rigorous measurement of baseline risk factors, the large and homogeneous community-based sample and the long-term follow-up without missing data on outcomes. The prospective nature of our study done in apparently healthy individuals at baseline also offsets some of the biases attributed to reverse causality. We adjusted for a comprehensive panel of lifestyle and clinical factors. There are limitations that deserve consideration. Ascertainment of outcomes relied a lot on hospitalisation discharge codes, potentially missing cases that would have seen on an outpatient basis only. However, this is unlikely given that information on outcomes was also retrieved from a comprehensive review of hospital records, inpatient physician claims data and medico-legal reports. In addition, owing to the complete follow-up system of the Finnish population using personal identity codes, there were no losses to follow-up. We acknowledge that the generalisation of our findings is limited by the study population, which consisted of middle-aged Finnish men; these results should be confirmed in other groups including different age groups, other nationalities and women. Our results based on Finnish sauna bathing with an average temperature of 80° C, cannot be directly applied to steam rooms and hot tubs, which may operate at a lower temperature than a typical Finnish sauna [14]. Though many potential confounders were measured and adjusted for to ensure the validity of our key results, there remains potential for residual confounding as with all observational studies. It is possible that underlying diagnosed or undiagnosed diseases may have effect on sauna bathing habits. However, we adjusted for key covariates such as prevalent histories of diabetes and coronary heart disease to minimise these biases.

We did not have data on repeat assessments of sauna habits to enable us to assess the long-term associations (i.e. correction for regression dilution). We had only a one-time questionnaire-based assessment of the frequency and duration of sauna bathing during a typical week. While there is a possibility that our assessment based on baseline measurements could under-estimate the association between sauna habits and risk of dementia; this may not be considerable given that we used average sauna habits based on weekly sauna sessions. It is possible that sauna bathing habits might have changed during follow-up due to probable changes in health habits or other disease of participants occurring over the long period of time, which may have introduced some biases in our results. However, it is unlikely that this would have any considerable effect on the main findings, given that sauna bathing is a tradition and embedded in the culture in Finland and accessible for almost everyone. Secondly, we adjusted for several relevant confounders. Third, given that sauna bathing is a commonly used relaxing habit in the Finnish population, this suggests that the correlation between measured sauna habits taken several years apart is anticipated to be high and therefore analysis using baseline assessments is unlikely to considerably under-estimate the associations. Nevertheless, our results should still be interpreted with caution.

In conclusion, this report provides promising results from the first prospective study that shows sauna bathing to be a potential protective lifestyle factor for common memory diseases in middle-aged Finnish men. Our results suggest that sauna bathing, an activity which promotes relaxation and well-being, may be a recommendable intervention to prevent or delay the development of memory diseases in healthy adults. However, well-designed intervention studies are needed to confirm our results in different population settings.

Key points

- Regular sauna bathing is suggested to be protective of fatal cardiovascular disease and all-cause mortality. However, the association with risk of dementia has not been previously investigated.
- There is a strong inverse association between regular sauna bathing habits and the risk of dementia and Alzheimer's disease in middle-aged Finnish men.
- Sauna bathing, an activity that promotes relaxation and well-being, may be a recommendable intervention to prevent or delay the development of memory diseases in healthy adults. Further study is however needed.

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Conflicts of interest

None.

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