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**Brief communication**

**Frequent sauna bathing may reduce the risk of pneumonia in middle-aged Caucasian men: the  
KIHD prospective cohort study**

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## ABSTRACT

*Objective:* Emerging evidence suggests sauna bathing to be linked with numerous health benefits. Having frequent sauna baths has been found to be associated with reduced risk of acute and chronic disease conditions. Sauna bathing may reduce the risk of respiratory diseases; however, the evidence is uncertain. We aimed to assess the association of frequency of sauna bathing with risk of pneumonia. *Methods:* Baseline sauna bathing habits were assessed by administration of questionnaires in a prospective cohort of 2,210 men aged 42-61 years. *Results:* During a median follow-up of 25.6 years, 375 hospital diagnosed cases of pneumonia were recorded. In age-adjusted analyses, the hazard ratios (HRs) 95% confidence intervals (CIs) of pneumonia were 0.67 (0.53-0.83) and 0.53 (0.34-0.84) for participants who had 2-3 and  $\geq 4$  sauna sessions per week respectively compared with participants who had  $\leq 1$  sauna session per week. After further adjustment for several major risk factors, the HRs were 0.69 (0.55 to 0.86) and 0.56 (0.35-0.88) respectively. The associations remained on additional adjustment for total energy intake, socioeconomic status, physical activity, and C-reactive protein, 0.72 (0.57 to 0.90) and 0.63 (0.39 to 1.00) respectively.

*Conclusions:* Frequent sauna baths is associated with reduced pneumonia risk in a middle-aged male Caucasian population.

Keywords: sauna; pneumonia; cohort study

## **1. Introduction**

Sauna bathing, a traditional activity mainly used for relaxation and pleasure in Finland[1] and increasingly being adopted in many populations,[2] may have therapeutic potential for adverse health outcomes. Sauna bathing has been used for the treatment and improvement of symptoms associated with several acute and chronic conditions such as rheumatic disease,[3] headache,[4] and skin diseases.[5] The beneficial effects of sauna bathing on long-term risk of vascular and non-vascular diseases have also been recently reported. Sauna bathing has been demonstrated to be associated with reduced risks of hypertension,[6] cardiovascular disease (CVD) outcomes,[7] dementia,[8] as well as mortality from all causes.[7]

Pneumonia is an inflammatory condition of the lung tissue commonly caused by bacteria or viruses and is a leading cause of mortality among the elderly, the young, and people with comorbid conditions.[9] Pneumonia is a global cause of approximately 4 million deaths annually.[9] Pneumonia is also associated with increased morbidity, reduced quality of life, and high healthcare costs. The annual global economic cost of community-acquired pneumonia has been estimated to be \$17 billion.[10] Smoking, excessive alcohol consumption, diabetes, asthma, chronic obstructive pulmonary disease (COPD), and other chronic conditions such as kidney and liver disease are major contributing risk factors for pneumonia.[10] Indeed, pneumonia is a preventable disease and constitutes a substantial public health burden globally.

Sauna bathing has been suggested to improve lung function, reduce the symptoms of lung disease, and may also reduce the incidence of acute and chronic respiratory conditions.[11-13] However, the effect of regular sauna bathing on the risk of pneumonia is uncertain. Using a population-based prospective cohort study comprising of 2,210 Caucasian men, we aimed to assess the prospective association between frequency of sauna bathing and the risk of pneumonia,

## **2. Materials and methods**

The Kuopio Ischemic Heart Disease (KIHD) risk factor study which has been previously described[8] was employed for this analysis. The KIHD study recruited a representative sample of middle-aged men aged 42-61 years from Kuopio and surrounding communities in eastern Finland between 1984 and 1989. The study protocol was approved by the ethical committee of the University of Eastern Finland. Baseline sauna habits were assessed by a self-administered questionnaire and details of measurements of risk markers have been described previously.[8] Pneumonia cases that occurred from study entry to 2014 were included and these were collected by data linkage to the National Hospital Discharge Register and a comprehensive review of hospital records. The diagnoses of pneumonia cases were made by qualified physicians based on the International Classification of Diseases codes used in clinical practice. Hazard ratios (HRs) with 95% confidence intervals (CIs) for pneumonia according to the frequency of sauna bathing ( $\leq 1$ , 2-3 and  $\geq 4$  times per week) were estimated using Cox proportional hazard models. All statistical analyses were conducted using Stata version 14 (Stata Corp, College Station, Texas).

## **3. Results**

The mean [standard deviation (SD)] age of study participants at study entry was 53 (5) years. The median frequency and mean temperature of sauna bathing were 2 (range, 0-7) times per week and 78.9 (SD, 9.6) °C respectively. Only 12 men did not use sauna at all. During a median (interquartile range) follow-up of 25.6 (17.6-27.8) years, 375 hospital diagnosed pneumonia cases were recorded. In age-adjusted analyses, the HRs of pneumonia were 0.67 (95% CI: 0.53 to 0.83) and 0.53 (95% CI: 0.34 to 0.84) for participants who had 2-3 and  $\geq 4$  sauna sessions per week respectively compared with participants who had  $\leq 1$  sauna session per week. After further adjustment for several risk factors (body mass index, smoking status, history of diabetes, prevalent history of coronary heart disease, history of asthma, history of chronic bronchitis, history of tuberculosis, years of education, and alcohol consumption), the HRs remained consistent. The HRs for 2-3 and  $\geq 4$  sauna sessions per week were attenuated, but the inverse associations

held on additional adjustment for total energy intake, socioeconomic status, physical activity, and C-reactive protein, 0.72 (95% CI: 0.57 to 0.90) and 0.63 (95% CI: 0.39 to 1.00) respectively (**Table**).

#### **4. Discussion**

Using a population-based prospective cohort of middle-aged Caucasian men, higher frequency of sauna bathing was observed to be independently associated with a reduced risk of pneumonia and which may be consistent with a graded dose-response pattern. The findings persisted after adjustment for several major risk factors for pneumonia. Inflammatory processes are well known to be involved in the pathogenesis of pneumonia.[14] Oxidative stress is also a common pathogenic mechanism underlying the development of inflammatory lung diseases such as pneumonia.[15] Sauna bathing may therefore influence the pathogenesis of pneumonia via reductions in oxidative stress.[16] Direct effects of sauna baths on the airways and lung tissue include improvement in ventilation and lung function and reduction in pulmonary congestion.[11] Sauna bathing seems to show great promise beyond its use for pleasure and relaxation and this includes a protective effect on several disease conditions.[8] Sauna bathing has a good safety profile and increasingly becoming widely used. Further robust research is needed to establish any potential true protective effects of sauna bathing on pneumonia and other disease conditions.

Strengths of the current study include its novelty, inclusion of men who were representative of the general population, long-term follow-up, and adjustment for several major risk factors for pneumonia. Limitations include inability to assess the association using people who did not use sauna baths as a reference group because only 12 people did not use sauna at all in the study population, lack of generalisation of findings to women and other ethnicities, lack of data on specific types of pneumonia, and the possibility of residual confounding due to the observational study design.

In conclusion, having frequent sauna baths is associated with a reduced risk of pneumonia in a middle-aged male Caucasian general population. Further research should explore the biological processes

underlying the relationship, replicate these findings, and address the therapeutic implications of sauna bathing on pulmonary diseases.

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Conflict of interest: None

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**Table.** Association of frequency of sauna bathing and risk of incident pneumonia

Frequency of sauna bathing (times/week)	Events/ Total	Model 1		Model 2		Model 3	
		HR (95% CI)	<i>P</i> -value	HR (95% CI)	<i>P</i> -value	HR (95% CI)	<i>P</i> -value
≤ 1	119 / 579	ref		ref		ref	
2-3	234 / 1,441	0.67 (0.53 to 0.83)	< 0.001	0.69 (0.55 to 0.86)	0.001	0.72 (0.57 to 0.90)	0.007
≥ 4	22 / 190	0.53 (0.34 to 0.84)	0.007	0.56 (0.35 to 0.88)	0.013	0.63 (0.39 to 1.00)	0.049
<i>P</i> -value for trend			0.0001		0.0004		0.0034

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, history of asthma, history of chronic bronchitis, history of tuberculosis, years of education, total cholesterol, and alcohol consumption

Model 3: Model 2 plus total energy intake, socioeconomic status, physical activity, and C-reactive protein