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ARTICLE

Sauna habits/bathing and changes in lower urinary tract symptoms – Tampere Ageing Male Urologic Study (TAMUS)

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ABSTRACT

Objective: To evaluate the effect of sauna bathing on lower urinary tract symptoms (LUTS) in a Finnish population-based cohort.

Methods: A mail survey was sent to a population-based cohort of 50-, 60-, and 70-year-old men in 1994 followed by repeat questionnaires in 1999 and 2004. The evaluation of ten different types of LUTS was based on Danish Prostatic Symptom Score (DAN-PSS-1). The weekly frequency of sauna bathing was assessed in the first questionnaire and divided into three subgroups (0–1, 2, and $\geq$3). The prevalence, incidence, and remission rate of each LUTS was assessed based on the initial and follow-up assessments. In addition, the mean DAN-PSS-1 symptoms score, medication for LUTS, and operative treatment were determined at each time-point. Chi-square test, a linear-by-linear test, and binary logistic regression analysis were used to assess statistical significance.

Results: The population-based cohort included initially 3,163, men of whom 1,306 (41.3%) responded to all three questionnaire rounds and were included in the analysis. There was no clear association between sauna bathing frequency and prevalence of the nine LUTS, nor with incidence and remission rates. The only exception was feelings of incomplete emptying, with lower prevalence associated with frequent sauna bathing. There were no clear differences in the medications or operations for LUTS by sauna bathing habits.

Conclusion: Based on our results, sauna bathing does not affect LUTS development or natural history in the long-term.

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KEYWORDS
Sauna; lower urinary tract symptoms; LUTS; urology; cohort

Introduction

Saunas are a very important part of the Finnish culture. According to Statistics Finland, there were 2.3 million saunas in Finland with 5.5 million people in 2018. Other Nordic countries and Russia also have vivid sauna cultures, like many other countries in the world, but with distinct differences in the role of the sauna in lifestyle. The Finnish passion to sauna has influenced research, with abundant studies on the possible health benefits and disadvantages of sauna bathing.

In a sauna, water is applied to hot rocks on a stove to create steam. Finnish saunas are less humid than many other saunas, with relative humidity about 10–20%. Temperature in a Finnish sauna is typically from 80 to 100 °C. Generally, people sit in a sauna for 5–20 minutes at a time, possibly several times with intervals involving a cold shower or water plunge [1]. Such a temperature challenge with distinct physiological effects affecting the autonomic nervous and endocrine system, as well as blood pressure could also have a bearing on lower urinary tract symptoms (LUTS).

Numerous studies have been performed concerning various effects of sauna on the human body over the years. Review articles on dry 'Finnish' type sauna bathing have also been published. A review concluded that regular Finnish sauna bathing may provide beneficial effects particularly on cardiovascular and rheumatological diseases [2]. Another review suggested that sauna bathing may be linked to a reduction in the risk of vascular diseases, neurocognitive diseases, pulmonary diseases, and many other conditions such as arthritis, headache, and flu [3]. Neither of the reviews made any recommendations of optimal sauna bathing practices. The exact mechanism of the effects of sauna bathing on diseases and conditions has not been identified, though multiple different pathways have been proposed to be involved.

In urology, impaired spermatogenesis was demonstrated after sauna exposure was reversed by discontinuation of sauna exposure at 6 months [4].

To our knowledge, an association between LUTS and sauna bathing has not been investigated earlier. The purpose of our study was to investigate if saunas affect the course of LUTS among men.

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Materials and methods

This report is a part of the Tampere Aging Male Urologic Study (TAMUS). The study started in 1994 with a mail survey sent to men aged 50, 60 or 70 years and residing in Tampere or 11 surrounding municipalities. LUTS were evaluated at 5-year intervals and, for this study, three consecutive surveys were used covering a follow-up time of 10 years. In all three surveys, a reminder round was sent to men who did not respond to the initial one after 3 months. The study cohort comprised only men who had completed all three questionnaires.

To evaluate sauna bathing habits, the frequency (times per week) of bathing in a sauna was asked in the baseline questionnaire. For the analysis, sauna bathing frequency was divided to three subgroups: from none to one sauna bathing per week, twice per week or three or more times per week.

LUTS were evaluated using the modified Danish Prostatic Symptom Score (DAN-PSS-1) questionnaire. The questionnaire included ten symptoms: hesitancy, dysuria, feeling of incomplete emptying, post-micturition dribble, increased daytime frequency, nocturia, urgency, stress incontinence, urge incontinence and mixed incontinence. In other words, the study questionnaire did not include questions concerning slow stream or straining in the original DAN-PSS-1 questionnaire. Individual symptoms had four response options scaled as no symptom, mild symptom, moderate symptom and severe symptom. LUTS were evaluated in all questionnaires as well as demographic characteristics.

The presence of each LUTS was divided into two groups: asymptomatic versus symptomatic. Men were classified as asymptomatic if they reported no or mild symptoms and as symptomatic with moderate or severe symptoms. In our opinion, this division was clinically relevant. The proportions of symptomatic men were assessed at the beginning of the study and also at 5-year and 10-year time-points. The sauna bathing frequency was defined based on the 1994 questionnaire.

In the analysis, we estimated the incidence and remission risks for each LUTS according to sauna bathing times per week were evaluated by comparing symptom status at baseline to follow-up questionnaires at 5 and 10 years. Furthermore, LUTS were evaluated by calculating the mean DAN-PSS symptoms severity score (bother score was not used) for every ten symptoms according to sauna bathing times per week in every time point. The questionnaire also covered usage of the medications for LUTS and operative treatment for benign prostate hyperplasia and the treatments were also analyzed in relation to frequency of sauna bathing. Two-sided chi-square tests, a linear-by-linear test, and binary logistic regression analysis were used to assess the statistical significance of associations between study variables. SPSS (Statistical Package for Social Sciences) version 26.0 was used in the data analysis.

The Tampere University Hospital Committee for Research Ethics reviewed the study protocol (tracking number #99050).

Results

The response proportion in the baseline survey was 65%, as 2,064 out of 3,163 men in the target population responded to the initial questionnaire in 1994. In 1999, the response proportion was 75%, with 2,133 responders out of 2,837 eligible men and at 10 years, in 2004, it was 76%, with 1,905 participants out of 2,516 men. For this study, only men participating at all three questionnaire rounds were included. As compared participation proportions between sauna bathing groups, the percentages of men who answered all three questionnaires from men who answered the sauna bathing question in the initial questionnaire were 61% in the 0–1-times per week group, 71% in the 2-times per week group, and 74% in the 3+-times per week group. Therefore, the final study cohort included 1,306 men.

Most men in the study had a sauna once or twice per week, and less than 100 men had a sauna four or more times per week. Younger men had a slightly higher frequency of sauna bathing and single men used a sauna less than those cohabiting. The mean ages in different sauna bathing groups varied between 58.7 and 55.4 years. Previous diagnoses, medication for LUTS, or operations for benign prostatic hyperplasia were not associated with sauna bathing frequency (Table 1).

No material differences were found by sauna bathing frequency in the prevalence of the nine types of LUTS at baseline or after 5 or 10 years. However, an association was observed with feeling of incomplete emptying, as the proportion of symptomatic men was almost twice as high among men sauna bathing only 0–1 times per week compared to men sauna bathing three or more times (Table 2).

Incidence and remission rates of ten different LUTS were compared by sauna bathing frequency. Incidence and remission rates were comparable across sauna bathing groups, with variation in incidence and remission rates by symptom. No meaningful differences in LUTS were found by sauna bathing frequency. However, as the numbers of cases for incidence and remission were low, the statistical power was limited.

Mean symptom scores were also evaluated by sauna bathing habits, with the mean scores at baseline and at 5-year and 10-year follow-up. The mean symptom scores were slightly lower in men with frequent sauna bathing at baseline, with a similar difference persisting also at 5 and 10 years (Table 3). Feeling of incomplete emptying was the only symptoms showing a meaningful relationship with sauna bathing frequency, as 95% confidential intervals of the mean scores for men with the most and least frequent sauna bathing did not overlap.

Medication of LUTS and surgery for benign prostatic hyperplasia at baseline, as well as at 5 and 10 years, were analyzed in relation to sauna bathing frequency (Table 4). Overall, frequent sauna bathing showed some association with less medications and fewer operations at baseline and the difference increased in follow-up. However, the number of men treated for LUTS was small, and no statistically significant difference between sauna bathing groups was observed.

Table 1. Demographic characteristics of study participants according to sauna bathing frequency (times per week) at baseline.

	Sauna bathings per week								
	0–1		2		3 or more		Total		
	(519)		(561)		(226)		(1,306)		
Number of men	*n*	%	*n*	%	*n*	%	*n*	%	*p*-value
Age									
70	129	24.9	104	18.5	18	8.0	251	19.2	<0.01
60	192	37.0	231	41.2	85	37.6	508	38.9	
50	198	38.2	226	40.3	123	54.4	547	41.9	
Mean age (years)	58.7		57.8		55.4				
Marital status									
Married or cohabiting	392	75.5	484	86.3	207	91.6	1083	82.9	
Bachelor, divorced, widow	126	24.3	77	13.7	19	8.4	222	17.0	<0.01
Unknown	1	0.2	0	0.0	0	0.0	1	0.1	
Education									
Elementary school	227	43.7	288	51.3	100	44.2	615	47.1	0.07
Intermediate stage	155	29.9	156	27.8	66	29.2	377	28.9	
College	81	15.6	81	14.4	39	17.3	201	15.4	
University	52	10.0	36	6.4	18	8.0	106	8.1	
Unknown	4	0.8	0	0.0	3	1.3	7	0.5	
Previously diagnosed medical conditions and surgical procedures									
Diabetes	41	7.9	28	5.0	12	5.3	81	6.2	0.12
Elevated blood pressure	145	27.9	174	31.0	56	24.8	375	28.7	0.19
Coronary arterial disease	92	17.7	85	15.2	27	11.9	204	15.6	0.13
Neurological disease	10	1.9	12	2.1	6	2.7	28	2.1	0.82
Stroke	12	2.3	9	1.6	5	2.0	26	2.0	0.68
Surgery for benign prostate hyperplasia	16	3.1	9	1.6	5	2.2	30	2.3	0.27
Medication for LUTS	12	2.3	6	1.1	3	1.3	21	1.6	0.25

In logistic regression analysis, the frequency of sauna bathing was not associated with medication or surgery after adjustment for age.

Discussion

Sauna bathing has been shown to influence several medical conditions [2,3]. To our knowledge, no previous studies have evaluated the relation between the sauna bathing and LUTS. In our study, we found no long-term effect of sauna bathing habits on the development or natural history of LUTS. Only one symptom, feeling of incomplete emptying, showed an inverse association with the frequency of sauna bathing.

The possible mechanism of how sauna bathing may relieve different conditions is not known. One theory is that the positive effect of sauna bathing is attributable to increased nitric oxide (NO) bioactivity [3]. This theory is of urological interest, as a specific phosphodiesterase type 5 (PDE-5) inhibitor is used as a medication for erectile dysfunction and its mechanism is based on enhanced nitric oxide (NO)-mediated vasodilation in the corpus cavernosum through inhibition of cyclic guanosine monophosphate breakdown [5]. One PDE-5 inhibitor, tadalafil, has a long half-life with daily dosage. Tadalafil is also used to relieve male LUTS and its effect on LUTS is independent of erectile dysfunction [6]. PDE-5 has been demonstrated in the lower urinary tract and inhibition of PDE-5 decreases smooth muscle cell proliferation in the prostate, relaxes smooth muscle in the prostate and bladder neck, thus increasing perfusion of the lower urinary tract [7]. Based on these theories, sauna bathing could credibly be associated with LUTS.

The warm environment in the sauna could cause muscles to relax also in the pelvic region and that could influence LUTS. Increased temperature could cause increasing peripheral blood flow and in the pelvic region increased blood flow may cause changes in LUTS. Sauna bathing could affect neurological activity as sauna bathing is considered to have a mind relaxing effect. In the sauna, increased sweating could influence fluid balance and reduce the production of urine that could reduce especially storage symptoms of LUTS. As stated above, none of these mechanisms have been scientifically detected.

In our study, the weekly frequency of sauna bathing did not affect the proportion of symptomatic men or the incidence or remission rates at baseline, or 5-year or 10-year follow-up. Some of the ten evaluated symptoms were uncommon, as our criteria for symptomatic men were defined as only moderate and severe symptoms reflecting clinically relevant LUTS, but ignored minor changes.

There was a tendency toward lower mean symptom score among men with more frequent sauna bathing, but the differences in mean scores were small and not statistically significant except for the feeling of incomplete emptying. Evaluation of mean symptom scores could be more sensitive than the other used analyses, as it also encompasses minor changes in symptoms.

The proportions of men treated with medication for LUTS or surgery for benign prostatic hyperplasia showed suggestive differences between sauna bathing groups. The difference was demonstrated at the initial study round and the difference was accentuated at 5- and 10-year follow-up. In our population-based study treatment for LUTS was relatively uncommon and the small number of events reduced the statistical power.

We assessed the weekly sauna bathing frequency only at baseline. We assumed that sauna bathing habits would remain constant throughout the follow-up or the changes would not affect the differences between the subgroups.

Table 2. Symptomatic men according to sauna bathing times per week.

	Sauna bathings per week								Statistical significance	
	0–1		2		3 or more		Total			
Symptom	*n*	%	*n*	%	*n*	%	*n*	%		
Number of men	519		561		226		1,306		*p* (Pearson chi-square)	*p* (Linear-by-linear)
Hesitancy										
Baseline	36	7.0	24	4.3	12	5.3	72	5.6	0.16	0.19
5 years	38	7.5	49	8.8	15	6.7	102	7.9	0.53	0.95
10 years	49	9.8	56	10.1	11	5.0	116	9.1	0.06	0.09
Dysuria										
Baseline	8	1.5	4	0.7	6	2.7	18	1.4	0.10	0.50
5 years	6	1.2	2	0.4	3	1.3	11	0.9	0.24	0.80
10 years	11	2.2	13	2.4	7	3.2	31	2.4	0.74	0.49
Feeling of incomplete emtying										
Baseline	53	10.3	40	7.2	17	7.6	110	8.5	0.17	0.12
5 years	61	12.0	54	9.8	14	6.3	129	10.0	0.06	0.02
10 years	99	19.8	101	18.4	27	12.2	227	17.9	0.04	0.02
Post-micturition dribble										
Baseline	79	15.3	83	15.0	30	13.3	192	14.8	0.76	0.51
5 years	128	25.3	154	27.9	54	24.4	336	26.3	0.51	0.95
10 years	136	27.3	161	29.3	58	25.9	355	27.9	0.59	0.90
Increased daytime frequency										
Baseline	56	10.8	58	10.5	21	9.3	135	10.4	0.83	0.57
5 years	38	7.4	30	5.4	18	8.0	86	6.6	0.28	0.91
10 years	48	9.5	46	8.3	14	6.3	108	8.4	0.34	0.15
Nocturia										
Baseline	18	3.5	12	2.2	7	3.1	37	2.8	0.42	0.54
5 years	32	6.2	23	4.2	12	5.3	67	5.2	0.31	0.38
10 years	60	11.9	51	9.3	19	8.5	130	10.2	0.24	0.11
Urgency										
Baseline	12	2.3	7	1.3	1	0.4	20	1.5	0.13	0.04
5 years	71	14.0	68	12.2	29	12.9	168	13.0	0.68	0.55
10 years	99	19.7	104	18.8	39	17.5	242	18.9	0.78	0.48
Urgency incontinency										
Baseline	3	0.6	1	0.2	0	0.0	4	0.3	0.32	0.14
5 years	6	1.2	11	2.0	5	2.2	22	1.7	0.49	0.25
10 years	19	3.8	20	3.6	8	3.6	47	3.7	0.99	0.88
Stress incontinency										
Baseline	3	0.6	1	0.2	0	0.0	4	0.3	0.33	0.14
5 years	4	0.8	2	0.4	1	0.4	7	0.5	0.62	0.44
10 years	11	2.2	6	1.1	3	1.4	20	1.6	0.34	0.26
Mixed incontinence										
Baseline	6	1.2	2	0.4	1	0.4	9	0.7	0.26	0.17
5 years	4	0.8	3	0.5	2	0.9	9	0.7	0.82	0.99
10 years	18	3.6	7	1.3	3	1.4	28	2.2	0.02	0.02

Possible changes in sauna bathing habits over time could introduce misclassification, with possible attenuation of the differences.

One shortcoming in our study was that we did not have a zero-sauna bathing group. This was due to the fact that only 18 men reported that they did not sauna bath at all. These men were added to the group of men sauna bathing once a week.

Sauna bathing habits can vary considerably. We did not know how many minutes men were in the sauna, whether they had several heat exposures or what they did afterwards. In other words, sauna bathing was not standardized, but it is not in real life either.

There were some baseline differences by sauna bathing habits. Frequent sauna bathers were somewhat younger (mean age 3.3 years younger than the least frequent group) and more often married or cohabiting. Frequent sauna bathers might be healthier, but no clear differences were seen in baseline medical conditions between the sauna bathing groups.

In follow-up, LUTS increased in frequency and severity with age, albeit less changes were found in the mean scores of proportions of symptomatic men for dysuria and increased daytime frequency than the other LUTS, in line with other studies [8–10]. Also, fluctuation in LUTS was observed as reported earlier [11,12].

Despite our largely null findings, we could not entirely exclude a potential association between sauna bathing and LUTS. Sauna bathing could have beneficial effects in some cases, such as prostatitis, which is common in Finland with a possible involvement of a cold climate [13]. In clinical practice, warm treatment comparable to sauna bathing has been used with clear relief in some cases, but no effect in others. In fact, our findings offer support for a beneficial effect of sauna bathing in feelings of incomplete emptying, a typical symptom in prostatitis. The 5-year interval used in our study also precludes assessment of any possible short-term effect of sauna bathing.

Conclusions

In our study, sauna bathing showed no association with LUTS at baseline or at 5- or 10-year follow-up, with the

Table 3. DAN-PSS-1 mean symptom scores according to sauna bathing frequency.

	Sauna bathings per week					
Symptom	0–1		2		3 or more	
Number of men	519		561		226	
Hesitancy	Symptom mean score	95% CI	Symptom mean score	95% CI	Symptom mean score	95% CI
Baseline	0.57	(0.51–0.63)	0.51	(0.46–0.57)	0.57	(0.49–0.66)
5 years	0.61	(0.56–0.67)	0.61	(0.55–0.66)	0.56	(0.48–0.65)
10 years	0.65	(0.59–0.71)	0.66	(0.61–0.72)	0.54	(0.46–0.62)
Dysuria						
Baseline	0.25	(0.21–0.29)	0.24	(0.20–0.28)	0.22	(0.15–0.28)
5 years	0.23	(0.19–0.27)	0.22	(0.18–0.25)	0.22	(0.16–0.28)
10 years	0.24	(0.20–0.29)	0.24	(0.20–0.28)	0.26	(0.19–0.33)
Feeling of incomplete emptying						
Baseline	0.43	(0.37–0.50)	0.36	(0.30–0.42)	0.35	(0.27–0.44)
5 years	0.64	(0.57–0.70)	0.56	(0.50–0.62)	0.49	(0.40–0.58)
10 years	0.85	(0.77–0.92)	0.83	(0.76–0.90)	0.67	(0.57–0.76)
Post-micturition dribble						
Baseline	0.84	(0.78–0.90)	0.80	(0.74–0.86)	0.73	(0.64–0.82)
5 years	0.90	(0.82–0.97)	0.92	(0.85–0.99)	0.87	(0.77–0.98)
10 years	1.00	(0.93–1.07)	0.95	(0.88–1.02)	0.93	(0.83–1.04)
Increased daytime frequency						
Baseline	0.63	(0.57–0.69)	0.57	(0.51–0.63)	0.51	(0.42–0.60)
5 years	0.47	(0.41–0.53)	0.45	(0.40–0.50)	0.44	(0.35–0.52)
10 years	0.59	(0.53–0.65)	0.53	(0.48–0.59)	0.42	(0.34–0.51)
Nocturia						
Baseline	0.58	(0.53–0.63)	0.57	(0.52–0.61)	0.48	(0.40–0.56)
5 years	0.69	(0.64–0.74)	0.64	(0.59–0.69)	0.57	(0.49–0.65)
10 years	0.90	(0.85–0.96)	0.85	(0.80–0.90)	0.83	(0.75–0.91)
Urgency						
Baseline	0.38	(0.33–0.43)	0.36	(0.31–0.40)	0.30	(0.24–0.37)
5 years	0.86	(0.80–0.92)	0.85	(0.79–0.90)	0.85	(0.77–0.94)
10 years	0.99	(0.93–1.05)	1.02	(0.97–1.07)	0.95	(0.86–1.05)
Urgency incontinency						
Baseline	0.15	(0.12–0.19)	0.15	(0.12–0.18)	0.13	(0.09–0.18)
5 years	0.23	(0.19–0.27)	0.24	(0.20–0.28)	0.18	(0.12–0.24)
10 years	0.39	(0.34–0.44)	0.39	(0.34–0.44)	0.34	(0.26–0.42)
Stress incontinency						
Baseline	0.10	(0.07–0.12)	0.08	(0.06–0.10)	0.06	(0.03–0.09)
5 years	0.11	(0.08–0.14)	0.09	(0.06–0.12)	0.08	(0.04–0.11)
10 years	0.17	(0.13–0.21)	0.16	(0.13–0.20)	0.13	(0.07–0.19)
Mixed incontinence						
Baseline	0.13	(0.09–0.16)	0.08	(0.06–0.11)	0.09	(0.05–0.12)
5 years	0.08	(0.06–0.11)	0.08	(0.05–0.10)	0.07	(0.03–0.10)
10 years	0.19	(0.14–0.24)	0.13	(0.10–0.17)	0.13	(0.08–0.18)

Table 4. Treatment of LUTS according to sauna bathing frequency.

	Sauna bathings per week								Statistical significance	
	0–1		2		3 or more		Total			
Number of men	*n* 519	%	*n* 561	%	*n* 226	%	*n* 1,306	%	*p* (Chi square)	*p* (Linear by linear)
Medication for LUTS										
Baseline	12	2.3	6	1.1	3	1.3	21	1.6	0.25	0.19
5 years	34	6.6	27	4.8	11	4.9	72	5.5	0.41	0.25
10 years	68	13.1	59	10.5	18	8.0	145	11.1	0.10	0.03
Surgery for benign prostate hyperplasia										
Baseline	16	3.1	9	1.6	5	2.2	30	2.3	0.27	0.27
5 years	23	4.4	20	3.6	6	2.7	49	3.8	0.48	0.23
10 years	32	6.2	35	6.2	7	3.1	74	5.7	0.19	0.16

possible exception of feeling of incomplete emptying. In clinical practice this should be interpreted as sauna bathing did not have a long-term effect to LUTS. The study protocol did not allow assessment of short-term effects of sauna bathing.

Disclosure statement

Teuvo L. J. Tammela is a paid consultant to the companies Astellas, Amgen and Jansen-Cilag. Anssi Auvinen gets paid Lecture fees by Amgen and Janssen. The other authors report no potential conflict of interest.

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