HEALTHY SAUNA

M Saari[1*], M-L Pallari[1], M Salonvaara[1], H Kääriäinen[1], H Viitanen[1], K Laitinen[2], I Humala[3], S Liski-Markkanen[3] and A Malin[3]

[1] Technical Research Centre of Finland (VTT), VTT Building and Transport, Finland
[2] University of Helsinki, Department of Public Health, Helsinki, Finland
[3] Work Efficiency Institute, Rajamäki, Finland

ABSTRACT
Finnish sauna is a traditional hot room for sweating, relaxing as well as mental and physical cleaning. Healthy Sauna field study produced the practical guidelines for a good, clean, comfortable and desirable sauna. We were relieved that no dangerous microbes or diseases were found in saunas. However, cleaning procedures, methods and materials should be further developed. Cooled ceramic seats in sauna are quite popular in swimming halls. The low temperature level (40 °C) offered the microbes very pleasant living conditions. Even cleaning had almost no effect on them. The traditional wooden seats were much cleaner than the ceramic ones. The surface temperatures of the wooden seats were typically 70 °C. Adequate ventilation and total drying once a day reduced the microbe level efficiently.

INDEX TERMS
Sauna, Ventilation, Thermal climate, Cleaning, Microbes

INTRODUCTION
There are more than 2 million saunas in Finland. Finland's population is 5 million. Almost all new apartments have their own sauna. Additionally all multi-storey apartment buildings have a couple of common saunas (house sauna). The swimming halls and sport centres have very heavily used saunas. New saunas are mainly electrically heated. Also wood heated sauna stoves are used especially in the countryside.

Traditionally we Finns think that a sauna is a clean and a hygienic place to be born and bathe. New generations of people and saunas, new habits and technology may have both good and bad effects on sauna. High humidity may cause hygienic problems in sauna. Also the economical pressures may reduce the budget of cleaning and maintenance. Adequate ventilation in saunas and in bathrooms is not an obviousness yet it is very important.

Healthy Sauna study tries to produce the practical guidelines for a good, clean, comfortable and desirable sauna. Guidelines are for the sauna owners, construction companies and product manufacturers as well as for official use.

METHODS
The target of the study was to determine the cleanliness, comfortableness, thermal and humidity conditions as well as the conditions of the structures. The subjects were nine common used saunas owned by the City of Helsinki. There were five saunas of the swimming halls, three saunas of multi-storey apartment buildings and one log house sauna in a camping area of Helsinki. Apartment saunas were excluded in this study.

* Contact author email: mikko.saari@vtt.fi

Main subtasks were

- classification of all saunas in Helsinki to estimate the business potential of Healthy Sauna
- study of structural condition
- study of cleaning procedures and staff interview
- enquiry of users
- operation of ventilation system
- monitoring of microbes on the floor and seats
- monitoring of temperature and humidity in saunas

In this paper we concentrated on the thermal climate, the ventilation rates and the microbes in two saunas during one week. Thermal climate, surface temperatures and ventilation rates were monitored continuously. Microbes were monitored two times (before use and after use) a day using agar-bowl and incubated at room temperature and in heating chamber for 7 days.

RESULTS

Figure 1 shows the measured average thermal climate during use in the saunas. The hatched area is an old recommendation for the temperature and the humidity in Finnish saunas. Both the temperature and the humidity were lower than recommended in most saunas.

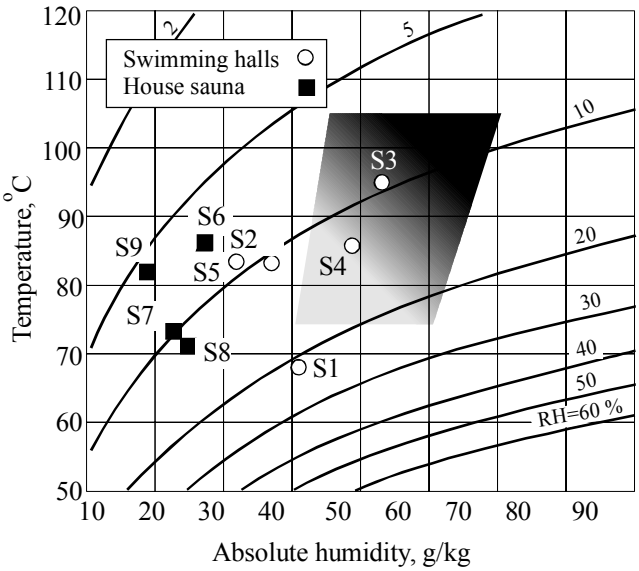

Figure 1. Measured average thermal climate in saunas. The shaded area is the recommendation for the temperature and the humidity in Finnish saunas. Dry bulb temperature (°C) and relative humidity RH (%) are measured at head height of sitting people (typically 170 - 200 cm above floor level).

Figure 2 shows the recommended location of the ventilation air inlet and outlet. There were mechanical supply and exhaust air ventilation systems with heat recovery in all swimming hall saunas. Air inlets and outlets were located as recommended. House saunas in multi-storey apartment buildings had a mechanical exhaust air ventilation system. Air outlets were located on the ceiling and inlets behind or under the stove. The log house sauna had a natural exhaust air ventilation system without an air inlet.

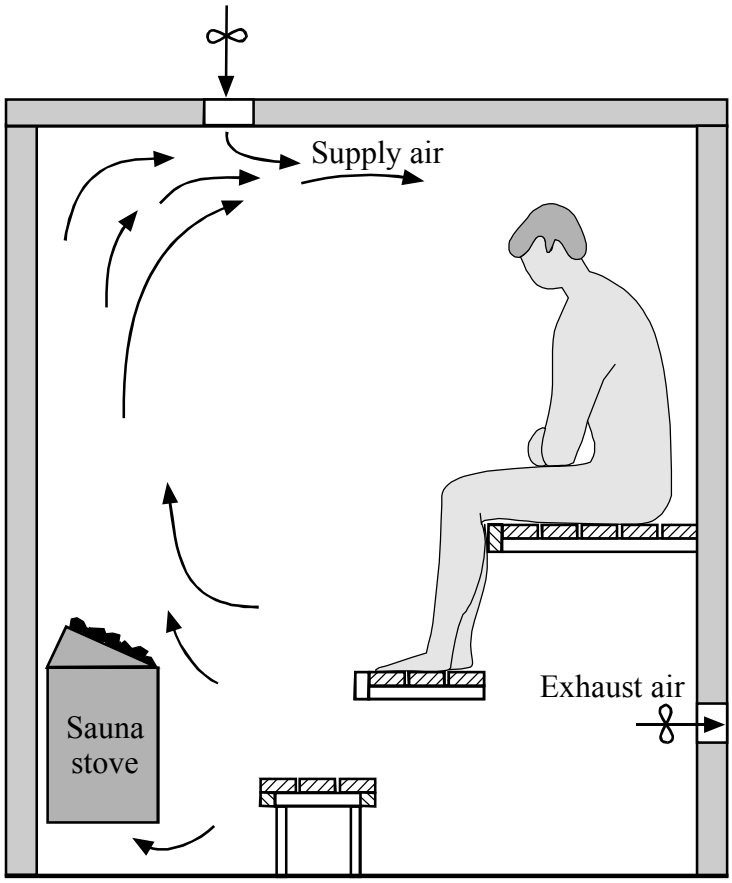

Figure 2. Recommended location of ventilation inlet and outlet. Inlet can be on the wall or on the ceiling above the stove. This arrangement confirms uniform temperature distribution in sauna and good air quality.

In Figure 3 the measured ventilation air flows in two swimming hall saunas A and B (table 1) are presented. Supply and exhaust air flows should be equal in the saunas. The best thermal climate is achieved when the exhaust air flow is a little bit smaller than the supply air flow (sauna B). Then air is flowing from sauna to bathroom. In sauna A unbalanced air flows were measured. Despite that the exhaust air flow was much higher than recommended; we had complaints of bad odours more than in other saunas.

Table 1. Definition of the saunas.

Property	*Sauna A*	*Sauna B*
Floor area	13 m²	11 m²
Height	2.6 m	2.2 m
Seat type	Ceramic seats	Wooden seats
Opening time	7 day per week, 13 hours per day	7 day per week, 15 hours per day
Users per day (average)	200	500

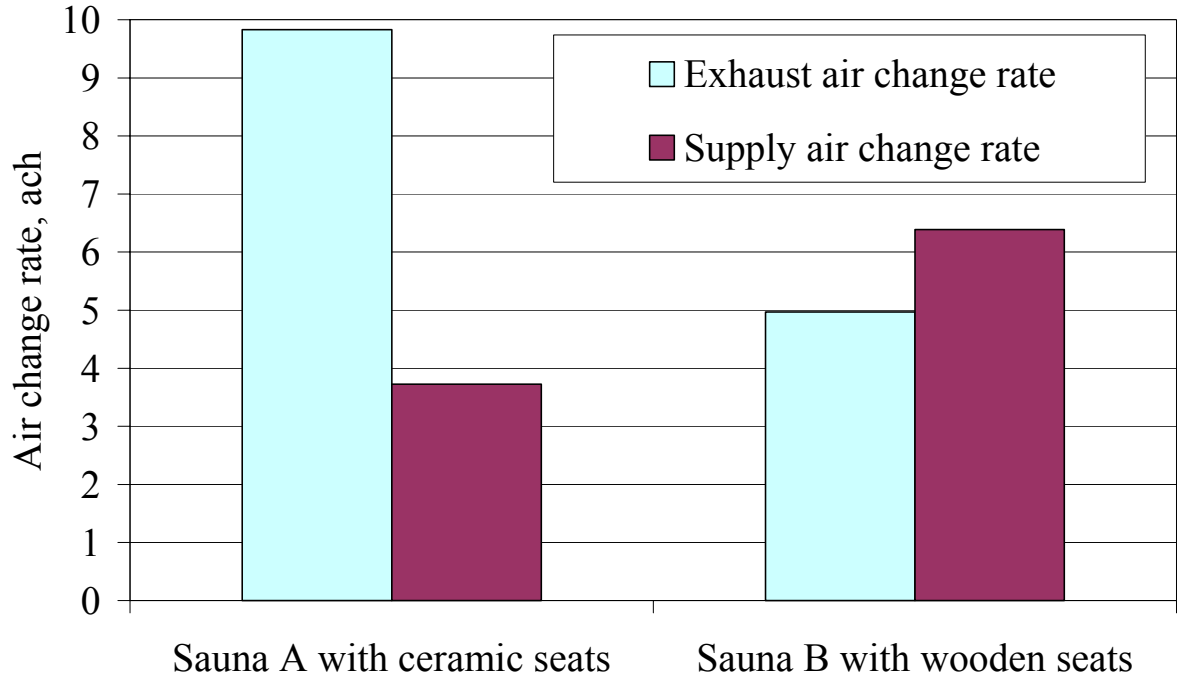

Figure 3. Measured ventilation air flows in saunas during use. Recommended air change rate is 5 - 6 ach (air change per hour).

Figure 4 shows the measured vertical distribution of the air temperature and the temperatures of the surfaces in two saunas. Sauna A had ceramic seats that were cooled by water circulation inside the seats. Swimming pool water is used for the cooling. Cooling is needed to guarantee the comfort. Surface temperatures of the ceramic seat were about 40 - 45 °C that caused continuous condensation. Sauna B had wooden seats. Surface temperatures of the wooden seat were about 60 - 70 °C and drying capability was very good. In the both saunas the temperature distribution was quite uniform.

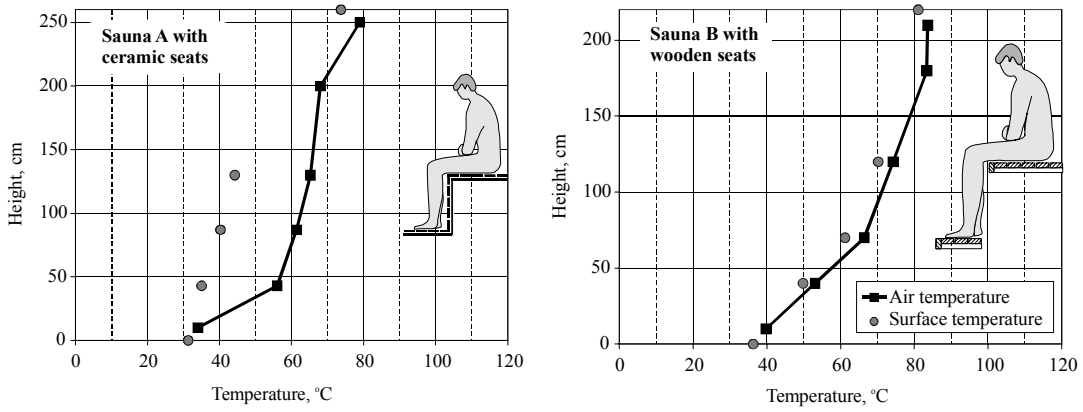

Figure 4. Measured vertical distribution of the air temperature and temperatures of the surfaces during use in sauna A and B. Sauna A had ceramic seats. Absolute humidity of the air was typically 30 - 45 g/kg. Sauna B had wooden seats. Absolute humidity of the air was typically 45 - 55 g/kg.

Figures 5 and 6 shows the measured one week average concentration of microbes (Table 2) in two previously mentioned saunas. Cleaning seemed to have almost no effect on microbes in the sauna with ceramic seats. No human pathogenic microbes were found. Typical microbes on the seats were Gram-positive *staphylococci* and Gram-positive *bacillus*. These bacteria do not cause any disease. On the floor there were Gram-negative *bacillus*. It may cause infection if the immunity to bacteria is very low.

Table 2. Classification of measured concentration of microbes (mainly bacteria).

Classification	cfu/bowl	cfu/cm²
1 low	less than 100	less than 4
2 moderate	100 - 1000	4 - 40
3 high	more than 1000	more than 40

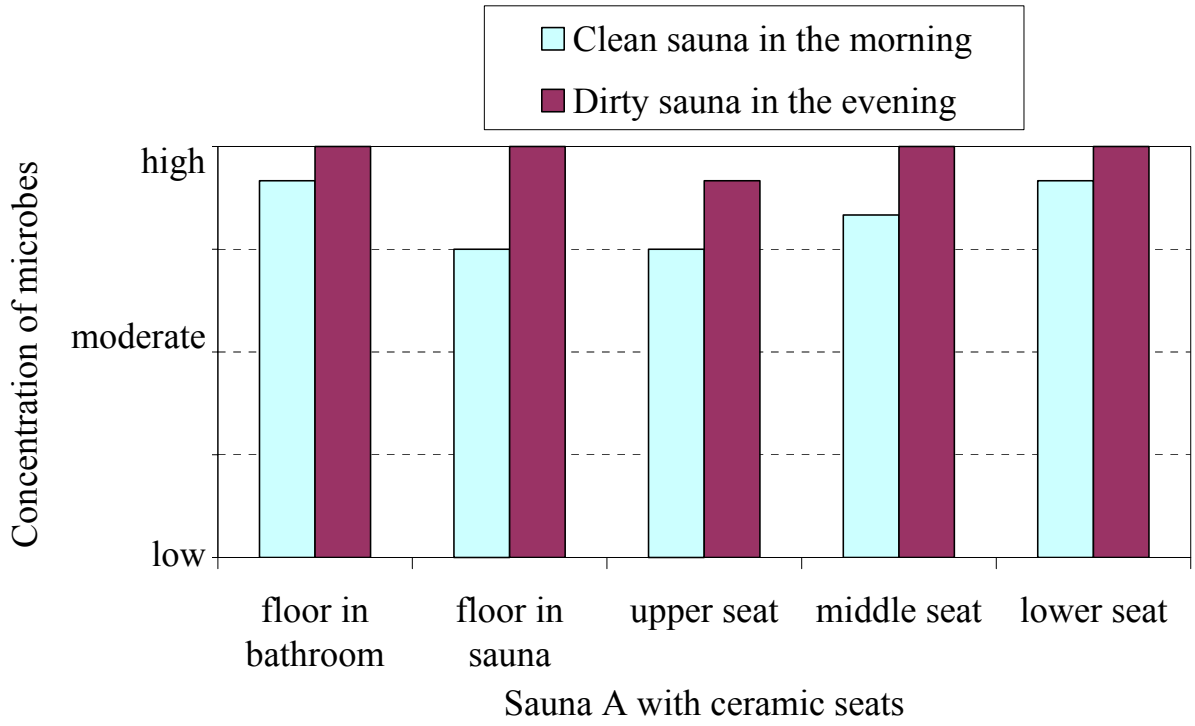

Figure 5. Measured concentration of microbes in sauna A.

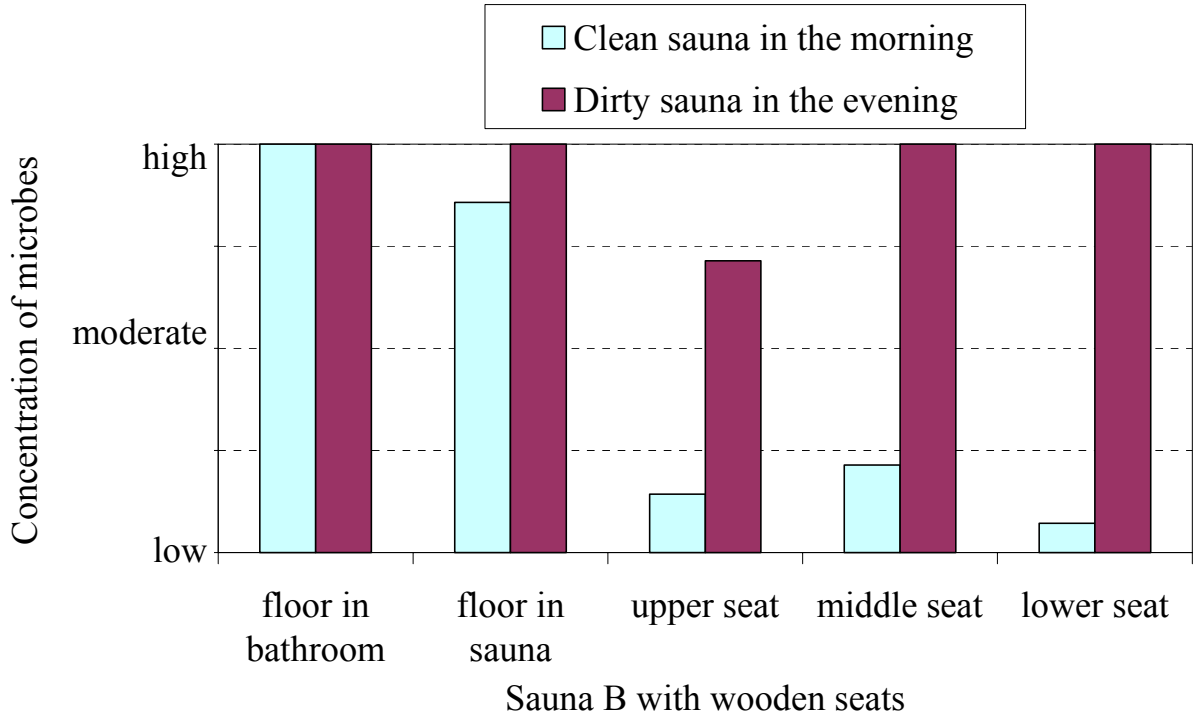

Figure 6. Measured concentration of microbes in sauna B.

CONCLUSIONS

The microbiological study shows that there were no dangerous microbes or diseases in saunas. However the hygienic level was very poor in saunas with ceramic seats. Low surface temperature increased the condensation and offered the microbes very pleasant living conditions. Cleaning seemed to have almost no effect on the high microbe concentration on ceramic seats. Wooden seats were cleaner.

ACKNOWLEDGEMENTS

The comparison study was conducted in co-operation with the Sauna research laboratory of VTT, University of Helsinki, Foundation of Finnish Sauna Research and Work Efficiency Institute. The study was funded by the City of Helsinki, Ministry of Environment, Foundation of Finnish Sauna Research, VTT, Finnish housing fair, Woodfocus Ltd, Farmos Ltd, Saunatec Ltd, Harvia Ltd, Vallox Ltd and National Technology Agency TEKES. This study was part of the national Healthy Building research program.

REFERENCE

Saari, M., Pallari, M.-L., Salonvaara, M., et al. 2002. Healthy Sauna. Practical guidelines for good, clean, comfortable and desirable sauna (in Finnish, English abstract). Technical Research Centre of Finland, Espoo, Finland. 100 p. (VTT Research Notes)