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## Death in Sauna\*

**ABSTRACT:** Bathing in sauna is common in Finland, where there are approximately 2 million saunas among the population of 5.2 million. In this paper, deaths occurring while in a sauna in 1990–2002 in Finland were studied by analyzing police and forensic autopsy reports, death certificates, and toxicological results. The annual rate of death occurring while in a sauna was less than 2 per 100,000 inhabitants. Close to half (51%) of the cases were determined to be natural deaths and exposure to heat was the cause of death in 25%. Overall, 50% of all cases were under the influence of alcohol. The main conclusion is that death in the sauna is a rare event even in Finland where the frequency of sauna bathing is high. The role of alcohol as a risk factor has grown. The prevention of these deaths should focus on less drinking of alcohol and avoid leaving a drunken bather alone in the sauna.

**KEYWORDS:** forensic science, death, sauna, alcohol

Sauna is an essential part of Finnish life. In addition to bathing in sauna, until the early 20th century, children were born there, and after death, the deceased were washed there. These activities have been moved to other places in modern society, but the Finns continue to sweat, wash, and relax in sauna. There are approximately 2 million saunas in Finland, and of these 1.2 million are located in private homes. This is a considerable number with respect to the total population of 5.2 million in Finland (1). The Finns bathe in the sauna at least once a week and often even more frequently.

The temperature in the Finnish sauna varies from 80 to 100 degrees centigrade (176–212 °F). The source of heat is an oven covered with stones, which are heated either with electricity or burning wood in the furnace. The relative humidity is in an average 10% to 20%, which momentarily quickly rises when warm water is thrown on the hot stones. A good sauna is also provided with sufficient ventilation and a sewer system. Bathing in sauna usually lasts for a couple or several periods of 5–15 minutes. In between the bathers cool off by showering, swimming, and taking refreshments.

Bathing in sauna is supposed to have many healthful effects. It can relieve pain and stiffness of joints, improve breathing in chronic obstructive lung diseases, and also help in hypertension. There is a saying “sauna is a poor man’s pharmacy” (2).

On the other hand, sauna also includes risks to one’s health. Bathing in sauna is not recommended in the acute phase of ischemic heart disease or in connection with a severe aortic valve stenosis. The overall conclusion in many reviews has, however, been that bathing in sauna is safe and well tolerated in chronic heart diseases (3–6). Yet, there is one significant risk factor when bathing in sauna and that is alcohol. It has been noted to strengthen the decline of blood pressure in heat (7) and increase the risk of arrhythmias and sudden death (8).

This study looked specifically at deaths occurring in sauna. It not only describe fatal attacks of illnesses when bathing in sauna but also various external factors and circumstances that have led or contributed to death.

### Materials and Methods

Forensic autopsy documents from 1990 to 2002 in regions of Helsinki and its surroundings (Uusimaa and Eastern Uusimaa) in southern Finland and Kuopio in eastern Finland were reviewed. These regions have approximately 31% of the total population of the country. The criteria for including the case in the study was that the death scene was a sauna or a room in the immediate vicinity, such as a washroom, a dressing room, a swimming pool, or other space for cooling off.

The information was gathered from police reports and forensic autopsy reports, which include expert statements, death certificates, and results of forensic toxicological analysis.

A specific form for handling the data was made. The material was categorized according to the age and gender of the deceased and the site of the body in the sauna. Autopsy findings of diseases, forensic toxicological results of blood alcohol concentration (BAC, weight by volume, g/dL), carbon monoxide concentration in blood, and findings of pharmaceutical agents and narcotic drugs were registered. The causes of death, contributory factors, external circumstances, and manner of death were collected from the death certificates. The mortality rates per 100,000 inhabitants were determined. In comparison of age distribution, alcohol findings and individual parameters between the genders, the  $\chi^2$ -test was used.

### Results

#### *Age and Gender*

The study included 393 cases in which death occurred in the sauna or its immediate vicinity. A decreasing trend in the annual death rate in sauna was noted after the mid-1990s (Fig. 1). Two-thirds of the cases were male. Half (50%) of men were at the age of 50–69 years, whereas most (60%) of women were over 70 years of age (Fig. 2). This difference of ages between men and women was statistically significant ( $\chi^2 = 59.7, p < 0.00001$ ).

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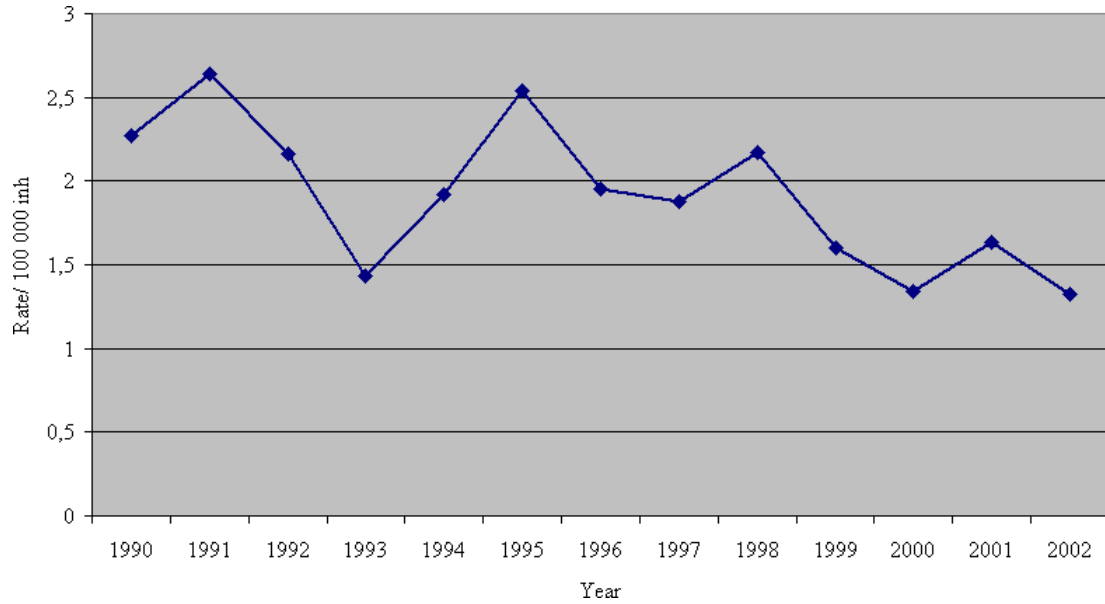


FIG. 1—Death rate in sauna/100,000 inhabitants.

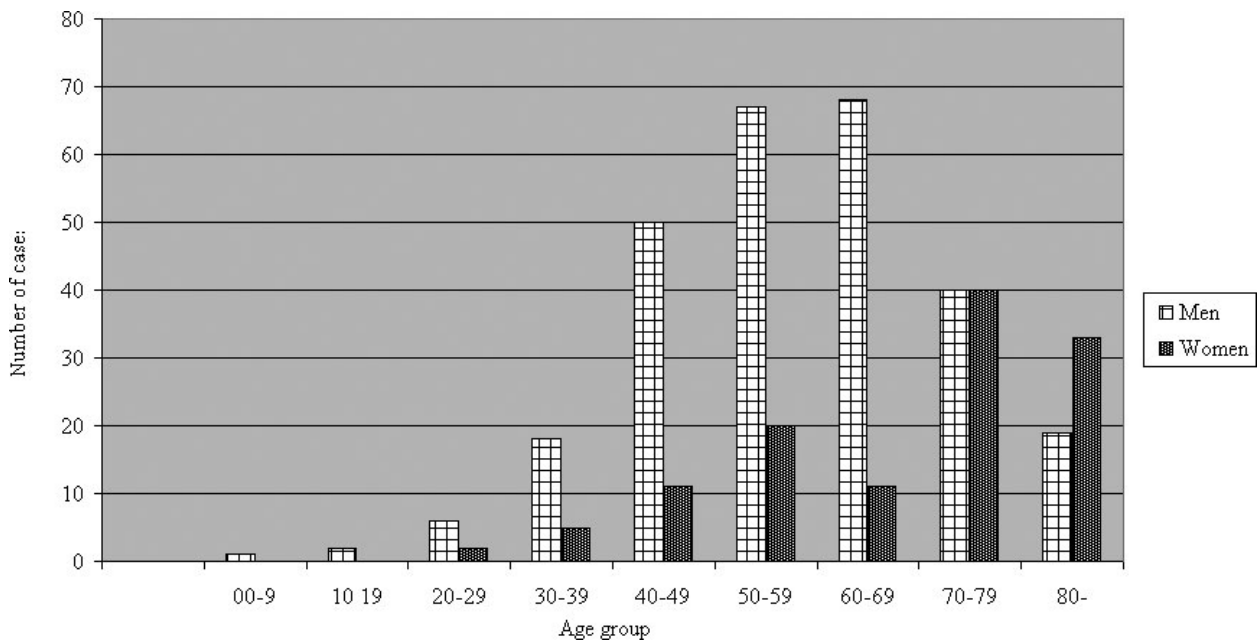


FIG. 2—Deaths in sauna by age and gender.

*Site of Death in Sauna*

The site of death was in most cases (78%) in the steam room, either on the benches or on the floor. In one case, the deceased was found collapsed on the hot stones of the oven. Almost one fifth (19%) of the cases died in the washing or dressing rooms or vestibules. In seven cases (1.8%) the body was found in a swimming pool close to the sauna.

*Manner of Death in Sauna*

Half (51%) of the cases were determined to be natural deaths at the autopsy. The figure was slightly higher in women (59%) than

in men (51%), whereas various accidents and suicides were more common in men. Eleven cases (2.8%) remained undetermined. Of all deaths in sauna, 27 (6.9%) were suicides (Table 1). Thirteen were hangings or suffocations, nine were shootings and three cases were self-poisonings (two by medicine and one by carbon monoxide). One suicide was committed by self-incision and one by electrocution from the electric oven.

*Natural Causes of Death*

The majority of natural deaths were attributed to various cardiovascular diseases (Table 2). Ischemic heart disease was the underlying cause of death in 63% of the natural deaths, and in 23% of

TABLE 1—Manners of death in sauna.

Manner of death	Men	Women	Total
Natural	130	72	202
Accidental	116	37	153
Suicide	19	8	27
Undetermined	6	5	11
Total	271	122	393

TABLE 2—Natural causes of death in sauna.

Underlying cause of death	Men	Women	Total
Ischemic heart disease	79	45	124
Other heart diseases	29	10	39
Cerebrovascular diseases	3	6	9
Other vascular diseases	3	3	6
Diabetes	2	1	3
Alcohol-related diseases	6	0	6
Nervous system diseases	2	1	3
Other diseases	6	6	12
All natural causes	130	72	202

these, autopsy findings also showed acute myocardial infarction. In one-third of the ischemic heart disease cases, exposure to the heat in the sauna was estimated to be a contributing factor.

The group of "other cardiac diseases" mainly consisted of various hypertrophic conditions, which were not defined more specifically. Just two cases of aortic valve stenosis, one case of myocarditis, and one of pericarditis were found. The material included nine acute cerebrovascular events: five subarachnoid hemorrhages, three cerebral infarctions, and one intracerebral hemorrhage. In addition, there were two cases of aortic dissection and four deaths from pulmonary embolism. Alcohol-related diseases refer to various illnesses that have resulted from chronic use of alcohol, such as alcoholic liver disease or pancreatitis. Deaths in sauna because of "other diseases" included cases of cancer, chronic respiratory diseases and acute infectious diseases (Table 2).

#### Deaths Caused by External Factors

The underlying cause of death was exposure to the heat in the sauna in 25% of all deaths. Furthermore, it was a contributing factor in another 25%. Alcohol intoxication was estimated to be the underlying cause of death in 34 cases (8.7%, of which majority (74%) were male. Blood-alcohol concentration (BAC) was on average 0.306 g/dL, the range being 0.169–0.401 g/dL. The greatest number (26 cases) of the deaths caused by alcohol poisoning took place in the steam room, and in 16 cases the heat was considered a contributing factor. There were six cases of carbon monoxide poisonings, five of them accidental and one suicide. In addition, two suicides by intake of medicines and two accidental heroin overdoses were found.

Various mechanical traumas caused 13 deaths. Most (10 cases) were suicides either by shooting (nine cases) or incision (one case). There were only three accidental falls with head or cervical injuries. In addition, burns caused four deaths, and of the five drowning cases, one was classified as undetermined and the others were accidents (Table 3).

#### The Role of Alcohol

According to the forensic toxicology reports, 50% of all cases had alcohol in their blood, and in 43% BAC exceeded 0.158 g/dL. There was a great difference between the genders: men had taken

TABLE 3—Deaths in sauna by external causes.

Underlying cause of death	Men	Women	Total
Heat	77	23	100
Alcohol poisoning	25	99	34
Carbon monoxide poisoning	6	0	6
Other poisoning	2	1	4
Mechanical injury	10	3	13
Burns	3	1	4
Drowning	3	2	5
Hanging/suffocation	8	6	14
Other injury	1	1	2
All external causes of death	136	46	182

alcohol twice as often as women (60% and 29%, respectively;  $\chi^2 = 33.3$ ,  $p < 0.00005$ ; Fig. 3). On the other hand, in approximately one third of the cases (35%), alcohol was not found in the forensic toxicological analysis. Even here the gender difference was clear: more than half the women (52%) were sober, whereas the corresponding figure for men was 27% ( $\chi^2 = 21.9$ ,  $p < 0.00005$ ). Information of alcohol was not available in 15% of the cases.

Of those who died of exposure to heat, 87% had alcohol in their blood. Men who died of hyperthermia were almost always (91%) intoxicated, and the percentage of intoxicated women was also high (78%). Moreover, almost one third (30%) of the suicide cases had alcohol in their blood; on the other hand, no alcohol was found in 41% of these suicide cases. In deaths by external causes other than heat or alcohol intoxication, alcohol was found in almost half of the cases (47%), whereas one third (32%) were sober (Fig. 4).

In natural deaths alcohol was found in 31%, BAC being on average 0.179 g/dL (range 0.021–0.422 g/dL). The cases with no alcohol were almost as numerous, their proportion being 32%. However, in natural death cases, information on alcohol was not available in 38%.

## Discussion

#### Validity of the Data

Death in the sauna is always an exceptional event even in Finland where sauna bathing is common. In Finland, the law on determination of the cause of death always requires a police investigation in these specifically mentioned cases (9). This most usually leads to a forensic autopsy. On the basis of the Finnish legislation and practice, it is most likely that the material in the present study includes practically all relevant cases in the mentioned area and time period. The proportion of forensic autopsies of all deaths has grown in Finland from 18% to 21% during the time period of this investigation (10). The corresponding information on deaths in the sauna is not available for the whole country. According to the official statistics over the present study period in Finland, there were altogether 448 cases (an average of 34 cases annually) in which the underlying cause of death was heat (1990–1995, ICD-9 code E900A), exposure to man-made or other heat (1996–2002, ICD-10 codes W92, X14, X19) (10–12). In Finland, these codes practically always refer to exposure to the heat in the sauna. Thus, at least in deaths due to exposure to heat in the sauna, the present data represent as much as 22% of the total number of such deaths in the whole country during the investigation time period.

The retrospective method used in this study, however, includes some limitations. The causes of death are based on background information and autopsy findings, and significance of various factors has been evaluated by forensic pathologists. These evaluations

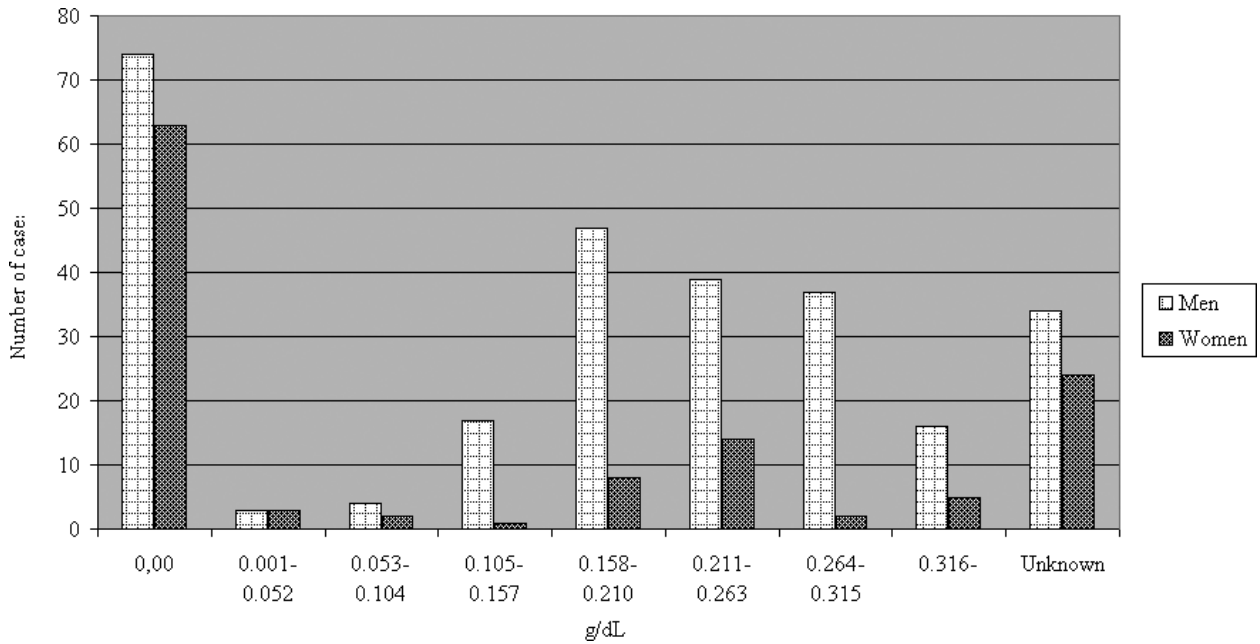


FIG. 3—Blood alcohol concentration (w/v, g/dL) in deaths in sauna.

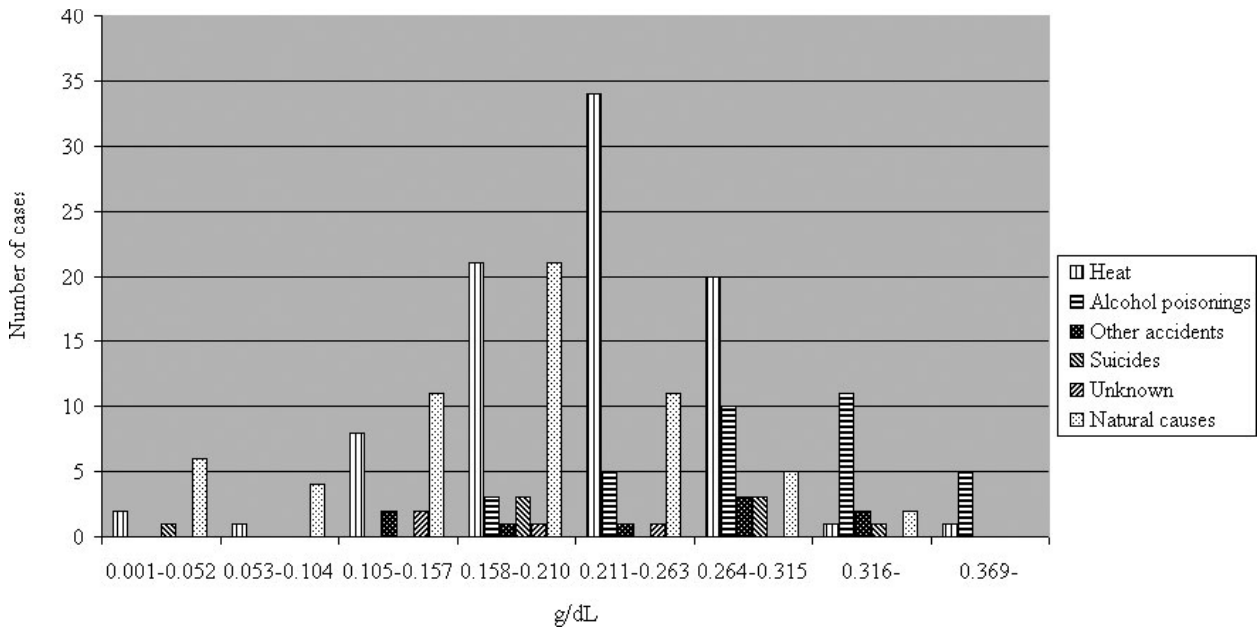


FIG. 4—Blood alcohol concentration (w/v, g/dL) in deaths by various causes in sauna.

have not been tested or re-considered by the method used in the present study. In some cases, for instance, deaths caused by hyperthermia, the diagnosis may be based on exclusion, and the diagnostic criteria may not have been totally uniform. On the other hand, most cases of death are based on evident morphological changes that can be verified in the autopsy, and therefore, despite these limitations, the major conclusions can be drawn from the data.

*Incidence of Deaths in Sauna*

The death rate in sauna remained low during the investigation period. There are very few earlier studies on the incidence of

deaths in the sauna. Vuori et al. (13) examined sudden deaths in connection with sauna bathing (during bathing to 24 h thereafter) in the whole country in 1970. They found 102 such cases out of 6175 sudden and unexpected deaths. This relatively high number during one year could be explained by the broad time definition up to 24 h. Of these cases, 82% were men, who were on average 44 years of age at death, while the average age of women was 50 years. Thus, according to the present data, the average age in sauna deaths has become higher compared with cases in 1970.

Penttilä (14) carried out a similar study to ours on the years 1976–1983 covering the same area in southern Finland as in our study. The annual number of deaths in sauna (on average 20) was

then the same as in our study with respect to Helsinki, Uusimaa, and Eastern-Uusimaa. The most evident difference applies to sex distribution: in 1976–1983 the proportion of women was 20%, whereas it has increased to 34% in our study.

#### *Site of Death in Sauna*

Most (78%) of the deaths in the sauna took place in the steam room. However, exposure to heat as an underlying cause of or a contributing factor to death was noted in half of the cases. In some of the deaths, the person likely died so suddenly that heat probably did not play an essential role. This may have been the case, e.g., in deaths caused by mechanical injuries. In some cases, such as in suicides by shooting, the police report indicated that the sauna had not been heated.

#### *Natural Causes of Death and Effects of Heat in the Sauna*

In our investigation, half of the cases (51%) were natural deaths. Similar results (46%) were obtained in 1976–1983 by Penttilä (14). The proportion of ischemic heart disease had, however, diminished from 78% in 1976–1983 to 63% in 1990–2002. The great role played by ischemic heart disease is not surprising, because the proportion of all deaths caused by ischemic heart disease is almost one third (10). This great proportion is understandable also because of the heat as a contributing factor. In a hot environment, physiological changes, such as increased heart rate, cardiac output, and noradrenalin secretion lead to elevated oxygen consumption of cardiac muscle. Moreover, hemoconcentration results from sweating and loss of body fluids and electrolytes enhances the risk of blood clotting (3,15,16). In these circumstances, the probability of coronary or other sudden cardiac or cerebrovascular events increases, especially in persons with chronic heart or vascular diseases. This is also supported by a clinical study, where significant ischemic changes occurred in persons with coronary disease in connection with sauna bathing, although these changes were not as pronounced as in physical exertion (17).

#### *Alcohol*

Our investigation shows that the role of alcohol in deaths in sauna has become more pronounced than before. Half of the deceased (50%) had alcohol in their blood, whereas the corresponding figure in 1976–1983 was 30% (14). This increase has taken place both in men and women. Alcohol is a significant risk factor in deaths in the sauna, especially for those whose underlying cause of death was heat. Kortelainen (18) found that 91% of men who died of heat in the sauna had alcohol in their blood in 1970–1986 in the whole country. In our investigation, the proportion of men was the same, but again, that of women has grown substantially from 59% to 78%.

In the present study, the gender distribution in the fatal alcohol intoxications was similar as in alcohol intoxication deaths in general, but among our cases, the mean BAC was 0.306 g/dL, whereas that in all fatal alcohol poisonings was 0.348 g/dL (19). The smaller concentrations in sauna may be due to the heat as an additional risk factor. Most fatal alcohol poisonings in our investigation had been exposed to heat. In individual cases, it was often difficult to estimate which factor, heat or alcohol, was more essential. In fatal alcohol intoxication, death may result from depression of the respiratory center in the central nervous system or from harmful effects of alcohol on cardiac function, such as arrhythmia (20). In a hot environment, the human organism tends to prevent

the rise of body temperature by increasing the loss of heat by intensifying the blood circulation of the skin and by sweating (3). If the exposure to heat is prolonged as a consequence of strong alcohol intoxication and passing out or fainting, the compensatory mechanisms of the cardiovascular system fail and death occurs. If the person also has heart disease, this may further contribute to the cardiovascular failure.

Although the role of alcohol as a risk factor in sauna deaths is important, fatal falls and burns are infrequent. Papp (21) has studied burns in the sauna treated in Kuopio University Hospital, Kuopio, Finland, during 1994–2000. The prevalence was only 7/100,000, and the mortality as low as 1.9%. On the other hand, a recent clinical study shows that the heat in sauna alone can cause severe tissue damage with rhabdomyolysis after only half an hour's exposure. Many of these cases had alcohol as a contributing factor and the mortality rate was high (22).

#### **Conclusions**

The main conclusion is that in respect to the frequency of saunas and sauna bathing, death in the sauna or in its near vicinity is rare in Finland, fewer than 2/100,000 inhabitants per year. Half of the cases were natural deaths. In deaths because of external causes in the sauna, the effect of heat and various poisonings were more common than burns or mechanical injuries. The proportion of women in sauna deaths has increased and the role of alcohol as a risk factor has grown. The prevention and control of deaths in the sauna should focus on less alcohol drinking or drinking afterwards. Furthermore, a drunken sauna bather should not be left alone in the sauna.

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