

INCIDENCE OF FROSTBITE AND AMBIENT TEMPERATURE IN FINLAND, 1986-1995.

A national study based on hospital admissions.

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ABSTRACT

Objectives. The association of frostbite with ambient temperature in Finland is not known. The present study determined the incidence of frostbite and its association with sex, age and ambient temperature in a nationwide sample.

Study design. The first admissions of all patients (n=1,275) admitted to hospital in Finland during the period 1986-1995 with frostbite as a principal or secondary diagnosis were associated with ambient temperature on the day of admission.

Results. The incidence of frostbite was 2.5 per 100,000 inhabitants, it was higher in males than females and increased linearly with age. The annual incidence of frostbite started to rise at below -15°C and was considerable at under -20°C, particularly in northern Finland. However, the daily incidence increased most in the urban area of Helsinki.

Conclusion. In the north, the main factor is the large number of cold days in the year. The daily incidence may be affected by urban lifestyle, possibly fashion, and inability to protect oneself against the cold.

Keywords. Frostbite, Epidemiology, Temperature

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Anyone who is exposed to harsh winter conditions over a long period of time can suffer from frostbite. It is said to be most common in middle-aged men (1) and in persons suffering from mental disorders or alcoholism (1, 2). Factors increasing the risk of frostbite include wind, previous frostbite, disturbance of the peripheral circulation, smoking and alcohol intoxication (1, 3-6). Minor frostbites are rarely admitted to hospital but severe cases, often with gangrene, require hospital treatment.

Since the incidence of frostbite in Finland is not known, we surveyed the hospital records of all persons admitted to hospital in this country for frostbite during the period 1986-1995 and determined its incidence, association with sex, age, ambient temperature and predisposing conditions. We also compared the incidence of frostbite and its association with temperature between the northern and southern parts of Finland, and separately in the Helsinki metropolitan area.

MATERIAL AND METHODS

Study population

The sample comprised all patients admitted to hospital in Finland in 1986-1995 who had frostbite as their principal or secondary diagnosis (ICD-8 / ICD-9 codes 9910-9913). The data were collected from the nationwide hospital discharge register maintained by the National Research and Development Centre for Welfare and Health since 1967 which covers all public and private hospitals in this country. Each

Table 1.
Distribution of
the frostbite cases
by sex and age

Age (yr)	Males	Females	Both sexes	N	%
	N	N			
0-9	8	3		11	0.9
10-19	87	19		106	8.3
20-29	154	10		164	12.9
30-39	134	21		155	12.2
40-49	205	31		236	18.5
50-59	191	16		207	16.2
60-69	162	18		180	14.1
70-79	110	31		141	11.1
80+	44	31		75	5.9
Total	1095	180		1275	100.0

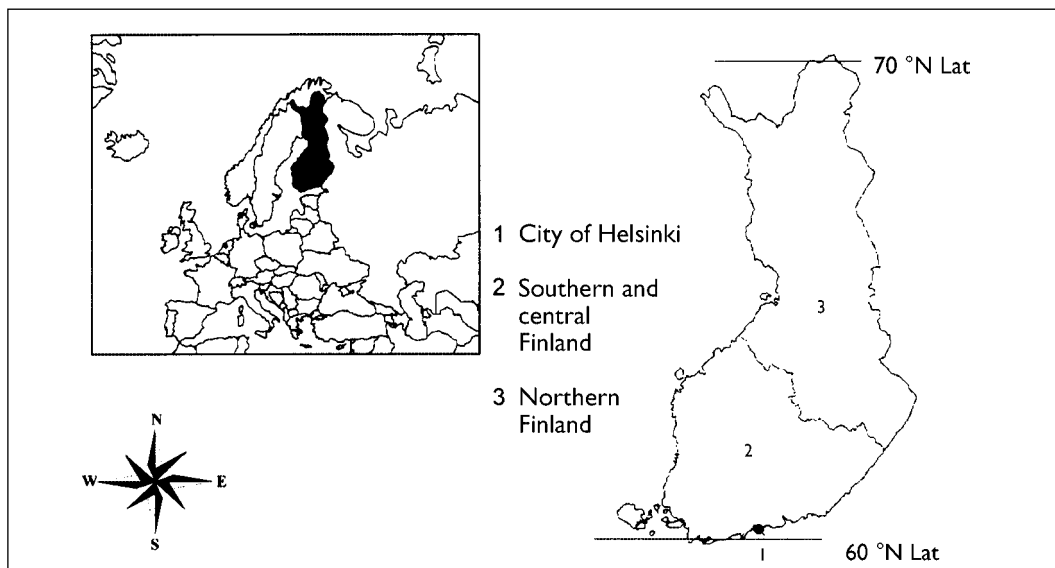
record included information on one to three diagnoses (ICD N-codes), sex, age, place of residence, length of hospital stay and place of occurrence of the injury. It was also known how many times the patient had been admitted for frostbite; only the first admissions were included. A total of 1,275 such patients were identified. The incidence of frostbite was plotted against age and ambient temperature, by sex and area. In this analysis, a restriction was made to those 1,212 patients who were admitted during October through May, since patients admitted in summer time could have sustained their frostbite well before their admission.

The three study areas (Fig. 1) were formed by merging hospital districts (22 in number). The areas were: (1) the Helsinki metropolitan area, (2) southern and central Finland and (3) northern Finland. The total population of Finland in 1990 was 5,016,894, of which 10 % lived in the Helsinki area, 68 % in southern and central and 22 % in northern Finland.

Climatic data

The lowest daily temperature on the day of admission recorded at the weather station closest to the patient's hospital was taken to represent the temperature in which the frostbite had been sustained. Mean day-time temperatures in each hospital district were obtained by averaging the temperatures recorded at the weather station closest

Fig. 1. Regional division of Finland used in the present study.



Diagnosis	N	%
Only frostbite injury	889	69.6
Cardiovascular disease	63	4.9
Alcoholism or alcohol intoxication	68	4.3
Mental disorder (excluding alcohol-related)	41	3.2
Musculoskeletal disease	39	3.1
Diabetes	32	2.5
Chilblains	23	1.8
Respiratory disease	19	1.5
Hypothermia	18	1.4

est to the central hospital of that district at 8 a.m., 2 p.m. and 8 p.m. Mean day-time temperatures were classified to form the intervals < -20 °C, -20 to -16 °C, -15 to -11 °C, -10 to -6 °C, -5 to -1 °C and 0 to +4 °C, and the numbers of days falling to each interval in each district in an average year were averaged over the larger areas shown in Fig. 1. The day-time temperatures were based on the period 1961-1990 in order to decrease the annual temperature variation. This has no effect on the temperature differences between the areas.

Definition of incidence

To obtain the incidence figures, the counts of patients summed over the whole period by sex and age (0-9, 10-19,...,70-79, 80+) were divided by the respective mean populations during the same period and multiplied by 100,000. The incidence of frostbite was expressed firstly as annual figures (they were affected by the number of cold days in the year), and secondly, as daily figures which had been divided by the number of days in each temperature category in each region. The latter figure was used to compare the incidence between different areas having different numbers of cold days in the year.

RESULTS

Characteristics of the patients

The majority of the patients (86 %) were men. The mean age was 48.5 years (SD 20.2 years); it was 47.6 years (19.4) in males and 53.8 years (23.7) in females. The greatest numbers of cases were seen in

Table 2.
Percentage of frostbite as the only diagnosis and percentages of secondary diagnoses among 1275 cases admitted to hospital for the first time for frostbite, 1986-1995.

the age group 40-49 years, but in females there was a second peak among those aged 70 years and over (Table 1). 14 % of the patients had been treated in university hospitals, 38 % in central or regional hospitals, 10 % in military hospitals, 23 % in local health centres and 15 % in other hospitals.

In 86 % of the cases frostbite was the principal diagnosis and in 19 % the second or third diagnosis (in some cases the patient had two different frostbite diagnoses). In 889 patients out of 1,275 (70 %) frostbite was the only diagnosis; 5 % also had a diagnosis of cardiovascular disease, 3 % mental disease, 4 % alcohol-related condition, and a small number of patients had other diagnoses (Table 2). An alcohol-related diagnosis was more rare in Helsinki (2.7 % of the cases) than in Southern and Central (5.6 %) or Northern Finland (5.8 %). Frostbite affected the feet in 61 % of the diagnosed cases, the hands in 34 %, the face in 5% and other parts of the body in 6 %. The hospital stay averaged 19 days, but varied depending on whether the frostbite was in the face (9 days), hand (18 days) or foot (21 days).

Annual incidence of frostbite by sex, age and area

In males, the annual incidence of frostbite increased by age in an almost linear fashion (Fig. 2). In females, the age trend was very weak, with only some rise beyond the age of 70 years. The incidence was higher in males than in females at all ages, the male excess growing with age, up to 5-fold at the upper end of the age scale.

The annual incidence of frostbite over the whole country averaged 2.5/100,000 inhabitants but it was nearly twice as high in northern Finland (3.9/100,000) than in southern and central Finland (2.8/100,000), the Helsinki area being intermediate (2,8/100,000).

Duration of winter and the number of cold days by area

The duration of winter (temperature <0°C) in northern Finland was 150-200 days, and the mean temperature was below -20°C for some 12-30 days/year, whereas the figures for southern and central Finland were 100-150 days/year and 1-12 days/year, and those for the City of Helsinki were 120 days/year and 2 days/year, respectively.

Incidence of frostbite and temperature

Figure 3 summarizes the climatic pattern and the numbers of cases by month. The number of patients was highest in January (the coldest

month), February and December, fairly high in spring (March to May) and late autumn (November), and some cases were seen in summer and early autumn (June to September).

The average annual incidence of frostbite increased with declining ambient temperature on the day of admission, starting from the range of -6 to -10°C ; it increased particularly steeply in northern Finland but less so in other areas (Fig. 4). In northern Finland the incidence was 4-fold at temperatures below -20°C compared with temperatures -0 to -5°C , and below -20°C it was 3 times higher than in other areas.

However, the daily incidence adjusted for the number of days in each temperature category was only slightly higher in northern Finland than in southern and central Finland, and by far the highest incidence was seen in the city of Helsinki (Fig.5). The latter area also showed the steepest increase in the incidence with declining temperature, particularly at temperatures lower than -15°C . Below -20°C the incidence was 4 times higher in the city of Helsinki than elsewhere.

DISCUSSION

The incidence of frostbite and contributing factors

The incidence of hospital-treated frostbite in Finland has not been previously published, except for one small study focusing on upper extremities (7). Our estimate of the annual incidence was 2.5/100,000,

Fig. 2.
Average annual incidence of frostbite per 100,000 inhabitants, by age and sex.



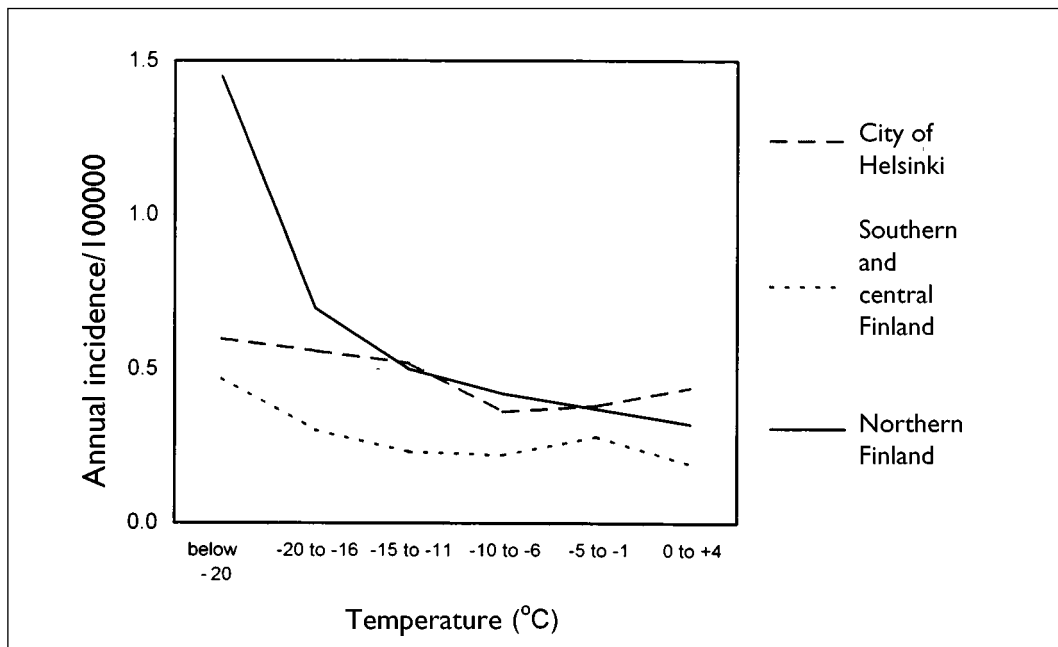


Fig. 3. Monthly numbers of frostbite cases in 1985-1996 (N=1275) and monthly mean temperatures in southern Finland (Helsinki) and northern Finland (Oulu) in 1961-1990.

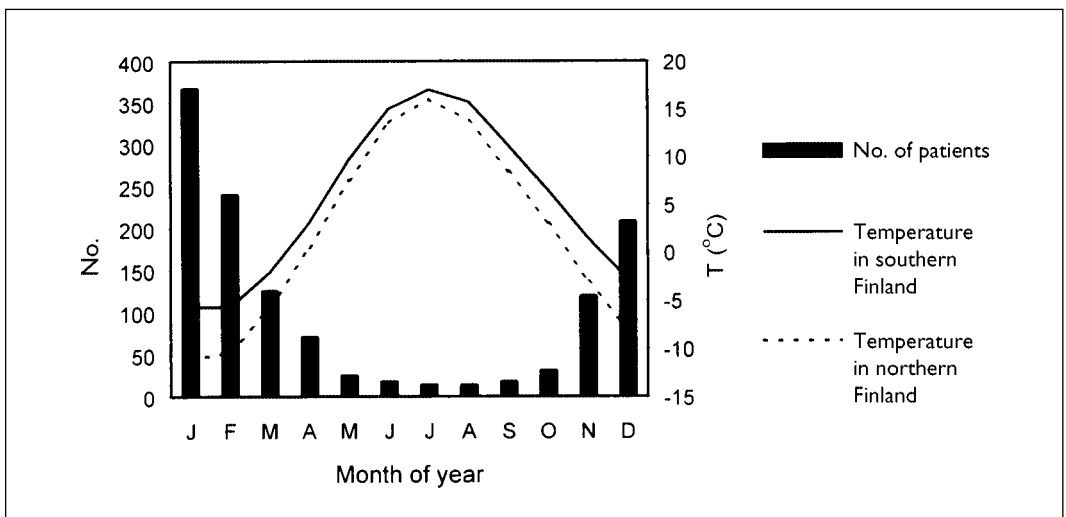
which can be regarded as fairly reliable, since the national hospital discharge register covers more than 95 % of all hospital-treated cases, and 96 % of injury diagnoses in this register match with the diagnoses in the hospital records (8, 9). A small proportion of actual frostbites may have been admitted under other diagnoses, but no validity study has been performed to confirm this. In Finland, frostbites are reportedly common, since a questionnaire survey revealed 13 % of the general population to suffer frostbite every year, of which however only 1-2 % are of blister severity (10). Injuries requiring hospital treatment are even more rare but can lead to severe consequences such as amputation of a limb or a part of it, persistent function limitation or disability. The incidence of 2.5/100,000 found here is actually higher than the figures of 1.0-1.6/100,000 for Canadian referral hospitals (11-13).

Our results differ from those reported by others in some respects. Firstly, the most severe cases of frostbite, especially those leading to amputation, are said to involve alcohol abuse (7). Thus Kappes and Mills, for example, noted that a large number of their patients with frostbite were alcoholics, and Conway et al. reported that 27 % of all frostbite injuries in Alaska involved alcohol abuse (2, 14). Secondly,

as much as 60 % of patients treated in hospital for frostbite have been reported to suffer from mental disorders (15). In the present sample which covered a national population and a wide range of latitudes, we saw only 3% of frostbite cases to have a mental and 4 % an alcohol-related diagnosis, 70 % of cases having frostbite as their only diagnosis. Because our result is based on hospital discharge register, it is possible that all alcohol, mental and other diagnoses have not recorded. There can be a delay between the freezing time and admission time also. Because of this the patient is not longer under the influence of alcohol when admitted to hospital.

The incidence of frostbite was much higher in males than females, which may be explained by males working in the cold more often than females (10). We also found an increase in the incidence of frostbite with advancing age, a finding not previously reported. There is no similar increase in times spent in the cold by people at different ages (10). It is still true that the most typical case of frostbite in this population was a male aged 40-49 years. Reasons for the rising incidence with age remain unknown, but impaired circulation, worse general health and frailty could be entertained. In any case, our finding has obvious implications regarding health education among the elderly.

Fig. 4.
Average annual incidence of
frostbite per 100,000
inhabitants by temperature
category and region in Finland.



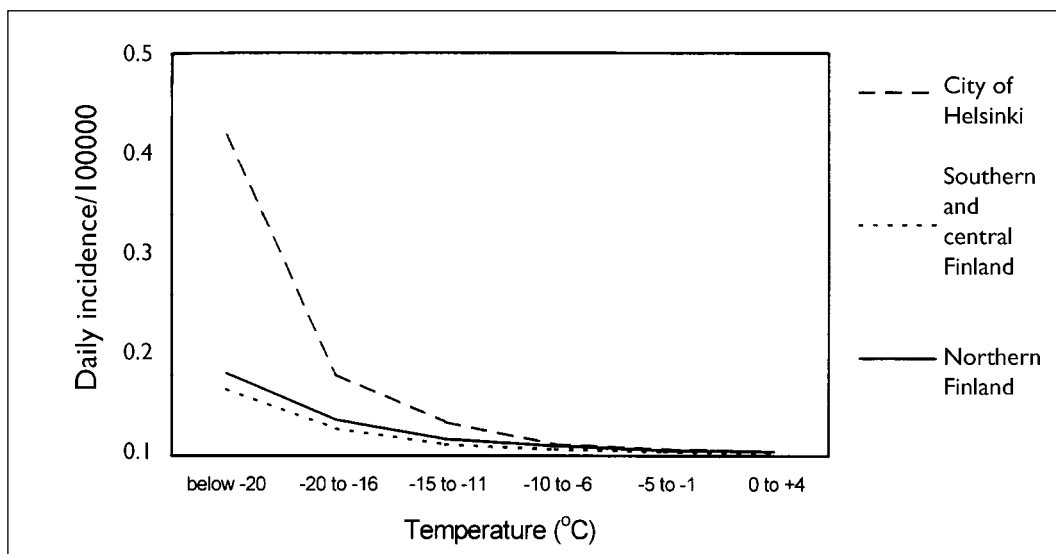
Association with ambient temperature and region

The annual incidence of frostbite increased with falling ambient temperature, especially in northern Finland. The areal difference is explained by the greater number of cold days in the north. This is in line with a previous survey of young Finnish men, which noted a lifetime incidence of superficial frostbite to be 1.5-fold in northern Finland compared with other parts of the country, and that of blister frostbite to be twice as high (16). The incidence of frostbite has also been found to be 1.4-1.9 times greater in the northern parts of the Finnish reindeer husbandry area (67°N-70°N) than in the more southern parts (65°N-66°N) (5).

According to Sinks et al., occupational cold injuries (60 % of which are frostbites) increase considerably at temperatures below -18°C (17). The present results indicate that the incidence of frostbite increases at temperatures below -20°C, and even at below -15°C in the city of Helsinki. The daily incidence in Helsinki when the temperature falls below -20°C is 0.4 cases per 100,000 inhabitants, which, given the population of the capital, means approximately two frostbite cases per day. In Helsinki, the incidence was actually four-fold compared with that in other, more rural parts of Finland.

The incidence of frostbite requiring hospital treatment in Helsinki was 2.8 cases/100,000 persons, which is 1.4 times greater than elsewhere in southern and central Finland. We have earlier noted a lower

Fig. 5. Average daily incidence of frostbite requiring hospital treatment per 100,000 inhabitants by temperature and region in Finland.



self-reported lifetime incidence of at least blister-type frostbite in Helsinki males (11%) than in males of northern Finland (18%) (10). The differences in lifestyle and capability to manage cold-related risks between the residents of Helsinki and those in other parts of the country may explain the relatively high incidence of hospital-treated frostbite in Helsinki.

According to Pinzur and Weaver, the frostbite injuries requiring medical treatment recorded in urban areas in the United States typically occur among the homeless and the poor (15). Homeless individuals make up about 0.5% of the population of Finland, and in Helsinki, as the largest city, about 1% of the inhabitants are homeless (unpublished information from Helsinki city statistical office). Alcohol abuse is also relatively more common there than in other parts of the country. Alcohol-related diagnoses were, however, very infrequent among the present frostbite cases, especially in Helsinki. It is therefore possible that many detrimental factors accumulate in Helsinki, thus increasing the number of severe frostbites.

The results obtained in the Finrisk-97 survey indicated that people living in the greater city of Helsinki and in other towns do not dress as warmly as people living in smaller urban communities or rural areas (10, 18). It may also be that city dwellers are more inclined to follow fashion trends. It is possible that people in Helsinki do not recognize the effect of cold weather as well as do those in the rural areas of Finland, so that they may be incapable of protecting themselves sufficiently. This may be one reason for the higher incidence of serious frostbite injuries in Helsinki.

CONCLUSIONS

We found an increase in the incidence of frostbite starting already at temperatures below -15 -10°C , particularly in the City of Helsinki. We did not find any evidence of middle-aged men being at higher risk than others, although their numbers were greatest, rather the risk of suffering frostbite increased with age. This suggests that the factors predisposing to frostbite are less well known than has been previously considered, and we therefore recommend more detailed studies to determine the underlying individual, social and environmental factors.

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