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The decreasing incidence rate and improvement in survival of laryngeal cancer patients in Finland are exceptions among western countries. A descriptive study of these trends was conducted including both nationwide population-based cancer registry data with 5 766 patients diagnosed in 1956–1995 and regional hospital-based data from Northern Finland, allowing classification into supraglottic and glottic cancers, with 353 patients diagnosed in 1976–1995. In Finland, the age-adjusted incidence rate among males decreased from 6.5 per 100 000 in 1956–1965 to 3.5 in 1986–1995, while in females the rate remained around 0.3 per 100 000. The rates in Northern Finland were slightly higher and the supraglottic to glottic incidence ratio diminished from 1.4:1 in 1976–1985 to 0.5:1 in 1986–1995. The 5-year relative survival rate improved in both Northern Finland and the whole country, most noticeably among males and the elderly. In the data from Northern Finland, the survival rate was more favourable in glottic (80%) than in supraglottic cancer (64%). Considering the marked decrease in the incidence of the less favourable supraglottic disease, the observed improvement in survival was small.

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The incidence of laryngeal cancer shows wide geographical variations (1). In developed countries, increasing trends have been observed in the past 20 years (2–5). Changes in the consumption of alcohol and tobacco, the two most important risk factors, are suggested to be responsible for this development (6–8). On the other hand, survival rates of laryngeal cancer have, in general, declined (1, 9), especially in Eastern Europe (1).

Finland is an exception in terms of both of these trends. The incidence is decreasing (10, 11). This decline has occurred mainly among males and in supraglottic cancer, leading to substantial changes in both the male to female ratio and subsite distribution of laryngeal cancer (10, 12). The shift from supraglottic to glottic cancer could be expected to improve survival, because glottic tumours are diagnosed at an earlier stage than supraglottic tumours (13). However, even though the survival rate for laryngeal cancer in Finland has, in contrast to many other western countries, improved steadily during the past few decades (14), the change has been unexpectedly small.

In this study we examined the epidemiology of laryngeal cancer in Finland, first by evaluating the trends in incidence and survival on the basis of nationwide population-based

cancer registry data in 1956–1995 with special emphasis on Northern Finland, where the incidence of laryngeal cancer is known to be higher than in other parts of the country (11). As the anatomical subsite of the tumour is not recorded in these data, we then gathered detailed information of laryngeal cancer cases from a hospital-based database in Northern Finland in 1976–1995 in order to determine the differences in incidence trends and survival between supraglottic and glottic cancer.

## MATERIAL AND METHODS

### *Nationwide data from the Finnish Cancer Registry*

The first part of the study included all patients with laryngeal cancer diagnosed in Finland between 1956 and 1995, and recorded in the nationwide population-based Finnish Cancer Registry, founded in 1952. All hospitals, pathological laboratories and practitioners are obliged to report to the Registry every cancer case that comes to their attention. Moreover, annual checks are made against the death certificates issued in the country. The Registry files are practically complete in terms of cancer cases diagnosed in Finland (15).

A total of 5 766 patients were reported to the Finnish Cancer Registry as having cancer of the larynx between 1 January 1956 and 31 December 1995. This interval was divided into four 10-year periods to detect time-related trends. At the Registry, the stage is coded into three categories on the basis of clinical notifications and pathologists' reports: localized (cancer limited to the larynx), regional (extending to regional lymph nodes), and distant (spreading beyond the larynx or with distant metastases). The stage was not known in 818 patients (14%). The incidence rates were adjusted for age to the world standard population.

Survival was measured using 5-year relative survival rates (RSR = ratio of observed to expected rates). The expected survival rates were obtained from population life tables (supplied by Statistics Finland) by age, sex and year of follow-up. The Relative Survival Analysis program (16) was used. A separate analysis was performed for patients who lived in the Oulu University Health Control Region (in this text referred to as 'Northern Finland'), which includes 87 municipalities in 5 Central Hospital Districts, covering Finland's two northernmost provinces, 50% of Finland's area, and approximately 14% of its population.

#### *Hospital-based data from Northern Finland*

The second part of the study included all patients with laryngeal cancer diagnosed and/or treated in the Oulu University Hospital between 1976 and 1995. According to data obtained from Statistics Finland, the population in the region increased from 668 000 in 1976 to 710 000 in 1995. Because the healthcare system in the area—as in the rest of Finland—is based on a general health insurance scheme, it provides equal access to medical and hospital services for everyone. Oulu University Hospital is the only tertiary referral center in the region (The Oulu University Health Control Region, 'Northern Finland') and practically all the laryngeal cancer patients from the study region are treated there. However, the number of new laryngeal cancer cases in Northern Finland in 1976–1995 amounted to 353 according to Oulu University Hospital records and 398 according to the Finnish Cancer Registry. Owing to this 11% dropout, hospital-based data are used only to characterize the patient series and in calculating incidence trends and survival in relation to anatomical subsite, because this variable is not recorded at the Cancer Registry.

Among the 353 patients in the hospital series, there were 9 cases of carcinoma in situ. In all cases the diagnosis was histologically verified. Data were collected on the following patient characteristics: age, sex, domicile, socioeconomic status, smoking, alcohol consumption, and duration of symptoms at the time of diagnosis. Tumour characteristics that were taken into account included histology, histological differentiation (grade), anatomical subsite (supraglottic, glottic or subglottic), and clinical stage ac-

ording to TNM classification (I–IV) (17). During the whole 20-year period, all data were uniformly collected by the same head and neck surgeon (K.H.).

Age-adjusted incidence rates and 5-year relative survival rates were calculated in relation to anatomical subsites. The calculations were made using the SPSS for Windows program version 9.0 and the Relative Survival Analysis program (16).

## RESULTS

### *Population-based data from the Finnish Cancer Registry*

From 1956–1965 to 1986–1995, the age-adjusted incidence rate in males in Finland decreased from 6.5 to 3.5 per 100 000 person years; in females, the rate remained unchanged (Table 1). The decrease took place mainly after the early 1970s and the relative decrease was more pronounced among males under 65 years of age. The incidence rates in all stages ('local', 'regional' and 'distant') showed a decreasing trend in males.

In Northern Finland, the trends were similar: between 1976–1985 and 1986–1995, the age-adjusted incidence rate in males decreased from 5.2 to 3.8 but did not change in females (Table 1). The decrease in males was, as throughout Finland, seen only in patients younger than 65 years. During the most recent 10-year period (1986–1995), the incidence rates in Northern Finland tended to be slightly higher than those in the whole of Finland. The decreasing trend in incidence rates in males was similar in all five of the university hospital regions in Finland (see Fig. 1.).

Throughout the country, the 5-year relative survival rate (RSR) among males increased slightly with time, from 57% in 1956–1965 to 62% in 1986–1995 whereas among females the RSR decreased (Table 2). The increase was most noticeable among patients aged 65 years or more at diagnosis (from 38% to 57%). RSR in patients with localized disease improved from 68% to 75%, whereas patients with non-localized cancer showed a decrease since the early 1970s. Regardless of time period, the most significant determinant of survival was disease stage, followed by age.

During the most recent period, the 5-year RSRs were more favourable in Northern Finland than in the country as a whole in both sexes and age groups (Table 2).

### *Hospital-based data from Northern Finland*

In males, the age-adjusted incidence rate of supraglottic disease decreased clearly from 1976–1985 to 1986–1995 (from 2.6 to 1.2 per 100 000), whereas for glottic disease an increase was observed (from 1.9 to 2.3). The opposite trends in the two major anatomical subsites among males resulted in a substantial change in the subsite distribution of the incidence rates: the supraglottic to glottic ratio diminished from 1.4 : 1 to 0.5 : 1. In females, the incidence rate remained unchanged for both main anatomical subsites: in supraglottic cancer it was 0.3 per 100 000 and in

**Table 1**

Trends in the age-adjusted incidence rate<sup>1</sup> of laryngeal cancer in Finland in 1956–1995 and in Northern Finland in 1976–1995 by sex, age and stage from the Finnish Cancer Registry

Subpopulation	Finland				Northern Finland	
	1956–1965	1966–1975	1976–1985	1986–1995	1976–1985	1986–1995
	(n = 1 453)	(n = 1 652)	(n = 1 420)	(n = 1 241)	(n = 206)	(n = 192)
Males (n = 5307)	6.5	6.4	4.7	3.5	5.2	3.8
Age						
0–64 years	4.9	4.5	2.8	1.9	3.4	1.9
65+ years	27.9	31.4	28.8	24.6	29.6	30.1
Stage						
Local	4.4	4.0	3.1	2.2	3.4	2.4
Regional	1.1	0.70	0.52	0.29	0.91	0.46
Distant	0.40	0.51	0.34	0.21	0.29	0.12
Unknown	0.60	1.2	0.74	0.80	0.60	0.82
Females (n = 459)	0.33	0.35	0.33	0.30	0.36	0.42
Age						
0–64 years	0.02	0.03	0.24	0.19	0.22	0.29
65+ years	1.7	1.4	1.5	1.7	2.3	2.1
Stage						
Local	0.24	0.22	0.22	0.18	0.26	0.25
Regional	0.05	0.02	0.05	0.05	0.09	0.08
Distant	0.02	0.04	0.02	0.02	–	0.03
Unknown	0.02	0.07	0.04	0.05	0.01	0.06

<sup>1</sup> Incidence rate per 100 000 person-years adjusted for age to the world standard population.

glottic cancer 0.1 per 100 000. In consequence, the proportion of women among patients with supraglottic disease increased from 11% to 20%. Only 3 subglottic tumours (0.8%) were diagnosed during the 20-year period.

Squamous cell carcinoma was the dominant histopathological diagnosis in both supraglottic and glottic cancer (99% and 93%, respectively) (Table 3). The disease stage was generally more advanced among patients with supraglottic cancer: 53% of patients with glottic cancer had stage I disease, whereas 61% of patients with supraglottic cancer had stage III–IV disease. Stage IV glottic tumours were rare.

The mean duration from first symptoms to diagnosis was approximately half a year in both glottic and supraglottic tumours. Practically all patients were smokers and 15% of both groups were heavy drinkers. Social background was similar in both categories but patients with glottic tumours came more often from an urban environment (Table 3).

During the whole 20-year study period the 5-year relative survival rate in this hospital-based series was 80% in glottic cancer and 64% in supraglottic cancer (Table 3).

## DISCUSSION

In the nationwide cancer registry data, a substantial decrease in the incidence rate of laryngeal cancer has taken place among males since the early 1970s. The decrease was seen in all five of the university hospital regions in Finland

and was more pronounced in males younger than 65 years of age. Among females, the incidence did not change. This trend is an exception among western countries: increasing incidences have been reported from Canada (2), Italy (3), Denmark (4), the United States (5), Great Britain, and Australia (6), especially among females. The observed

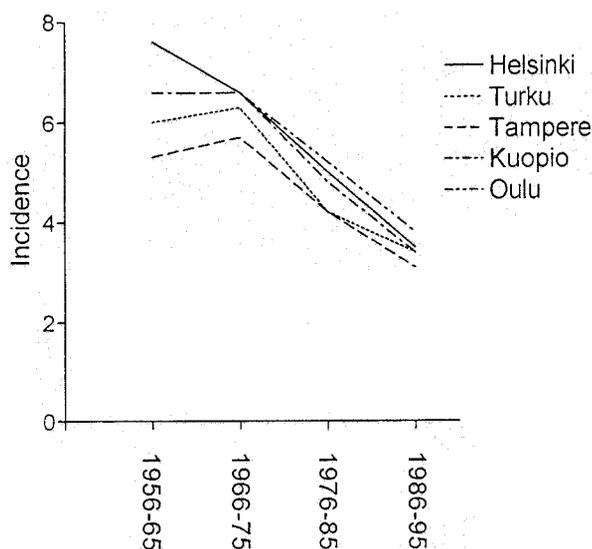


Fig. 1. Age-adjusted incidence rate (per 100 000) of laryngeal cancer in men in 1956–1995 in five University Hospital regions in Finland.

Table 2

Trends in the 5-year relative survival rate (RSR, %) for laryngeal cancer in Finland in 1956–1995 and in Northern Finland in 1976–1995 by sex, age and stage from the Finnish Cancer Registry

Subpopulation	Finland					Northern Finland	
	Overall	1956–1965	1966–1975	1976–1985	1986–1995	1976–1985	1986–1995
	RSR (n) <sup>1</sup>						
All patients	59 (5766)	57 (1453)	59 (1652)	61 (1420)	62 (1241)	61 (206)	67 (192)
Males	59 (5307)	57 (1358)	58 (1544)	60 (1295)	62 (1110)	60 (189)	66 (169)
Females	63 (459)	61 (95)	67 (108)	64 (125)	58 (131)	74 (17)	69 (23)
Patient age							
0–64 years	63 (3523)	61 (1092)	64 (1094)	65 (761)	65 (576)	70 (122)	69 (85)
65+ years	50 (2243)	38 (361)	46 (558)	55 (659)	57 (665)	45 (84)	64 (107)
Stage:							
Local	70 (3740)	68 (995)	68 (1025)	72 (946)	75 (774)		
Regional	36 (690)	34 (241)	43 (178)	38 (157)	29 (114)		
Distant	19 (518)	11 (92)	29 (195)	13 (123)	14 (108)		
Unknown	55 (818)	50 (125)	55 (254)	55 (194)	59 (245)		

<sup>1</sup> Total number of patients at the beginning of the follow-up.

decline among men in Finland is most likely attributable to a significant decrease in the proportion of male daily smokers in Finland between 1960 and 1981 (from 58% to 37%) (18). During the same period, smoking among females increased. Alcohol consumption per capita has increased markedly from the late 1960s (19), making changes in average drinking patterns a less plausible explanation for the trends detected. In the clinical series from Northern Finland, 96% of the patients were smokers and 15% were daily or heavy drinkers. An improvement was seen in relative survival, especially among males and the elderly. This also differs from findings in many European and North American countries, where there has been a decline in survival rates (1, 9).

Even though the incidence of laryngeal cancer among both males and females is higher in Northern Finland compared to the whole of the country, the observations from Northern Finland were essentially similar to those for the whole country: according to cancer registry data, the overall incidence decreased among males and remained unchanged among females. In the hospital-based data, the decrease among males was exclusively due to a 54% decline in the incidence of supraglottic cancer, which changed the supraglottic to glottic incidence ratio from 1.4:1 to 0.5:1. A similar trend has been documented previously in the Tampere region of Finland (10). Thus, one can conclude that the marked decrease in incidence of laryngeal cancer in Finland in men during the past few decades is largely attributable to the decreasing incidence of supraglottic cancer. In the comparable Cancer Registry-based analysis, the relative survival rates were slightly better in Northern Finland than those in the whole of Finland in all categories analysed. The reason for this difference remains speculative.

In the 20-year study period based on hospital data, the overall 5-year relative survival in Northern Finland was 64% in supraglottic and 80% in glottic cancer, giving a higher overall survival rate than that arrived at from the population-based analysis. Hence, there are probably some poor-outcome patients diagnosed in the region who are not treated in the University Hospital. The more favourable prognosis for glottic cancer is partly attributable to the larger proportion of patients with stage I disease (53% vs. 21%) and the rarity of stage IV disease (5% vs. 21%); glottic cancers are diagnosed at an earlier stage because of the delicate and crucial role of the glottis in voice formation, thus producing symptoms earlier (13). The observed decrease in the incidence of supraglottic cancer, the more fatal type of laryngeal cancer in men in the past few decades, explains to some extent the improvements seen in survival rates in males. Among females, this shift from supraglottic to glottic cancer has not taken place and, accordingly, no improvements in survival were seen, which is similar to the situation among both sexes in other developed countries. Thus, we believe that the exceptional improvement in survival in Finland is caused by a shift from supraglottic to glottic cancer among men.

In conclusion, we observed a decrease in the incidence of laryngeal cancer in males in Finland during the past two decades. In Northern Finland, we found that this was caused exclusively by a decrease in supraglottic cancer. We also noted a small but steady improvement in survival, especially among males and the elderly, which is likely to be caused by a decline in the proportion of supraglottic cancer, which has a poorer prognosis. The decrease in the laryngeal cancer incidence rate in males is probably attributable to the strong decrease in the prevalence of smoking in Finland.

**Table 3**

Patient characteristics and 5-year relative survival rates of laryngeal cancer in Northern Finland in 1976–1995 by anatomical subsite<sup>1</sup>

	Supraglottic (n = 170)	Glottic (n = 180)
Mean age (SD)	63 (9)	64 (12)
Male sex	145 (85%)	168 (93%)
Smoking	151 (98%)	163 (95%)
Heavy alcohol consumption <sup>2</sup>	12 (15%)	17 (15%)
Low socioeconomic status <sup>3</sup>	90 (65%)	96 (64%)
Urban domicile	75 (45%)	102 (58%)
Mean duration of symptoms (in months)	6	7
Histology		
Squamous cell carcinoma	162 (99%)	158 (93%)
Other <sup>4</sup>	2	12
Grade		
Well differentiated	33 (28%)	58 (46%)
Moderately well differentiated	56 (47%)	52 (42%)
Poorly differentiated	22 (18%)	7 (6%)
Indeterminate	9 (8%)	8 (6%)
Stage		
I	35 (21%)	94 (53%)
II	29 (17%)	30 (17%)
III	67 (40%)	43 (24%)
IV	36 (21%)	8 (5%)
Not staged	2	1
5-year relative survival rate (95% CI)	64% (55–73)	80% (71–88)

<sup>1</sup> Three patients (0.8%) with subglottic cancer were excluded to simplify the table.

<sup>2</sup> Defined as either daily or heavy drinking or alcoholism.

<sup>3</sup> Based on profession and employment status according to WHO (20).

<sup>4</sup> Including carcinoma in situ.

Percentages calculated among the subpopulations of patients with the data available.

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