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Cancer incidence by living area, social class and occupation

by Lyly Teppo, MD¹

TEPPO L. Cancer incidence by living area, social class and occupation. *Scand J Work Environ Health* 10 (1984) 361—366. The variation in the incidence of cancer between geographic areas and socio-economic classes is outlined. In many instances the differences in the incidence can be attributed to differences in life-style factors such as smoking, diet, sexual habits, and the reproductive history of women. The role of smoking as an explanator of the variation in the risk of lung cancer between occupational groups is emphasized.

Key terms: epidemiology, colon cancer, lung cancer, smoking.

Social class, education, religion, occupation, and living area are important risk indicators of cancer. However, they are not direct risk factors. In other words, social class, education, occupation, and residence determine the life-style which leads to different carcinogenic exposures — what people eat; how much they smoke; how much alcohol, and what kind, they drink; what kind of carcinogenic dusts and chemicals they are exposed to at workplaces; what kind of reproductive history women have; etc. In this paper I first give examples of the geographic variation in the incidence of cancer and explain what is known or suggested to be behind these variations. Second, I refer to studies in which social class and education have been used as background variables and to the message obtained from these analyses. Finally, I briefly discuss occupation as a risk indicator of cancer.

Geographic variation in the risk of cancer

The variation in the age-adjusted incidence rate of selected common cancers in the world is shown in table 1. More than tenfold differences are encountered in many instances. Admittedly, many low rates are based on rather inaccurate data, but it is quite clear that substantial international variation exists in the risk of cancer.

Even within the Nordic countries, which have much in common as regards their history, culture, religion, and everyday way of life, and all of which have a well-functioning population-based nationwide cancer registration system, there are marked differences in the incidence of many cancers (table 1). The

risk of lung cancer among Finnish males (highest) is fivefold that of males in Iceland (lowest). A much smaller variation exists among females, the rate being highest in Denmark. The incidence of testis cancer in Denmark is five times the rate in Finland, and the incidence of thyroid cancer in females in Iceland is five times the corresponding risk in Denmark (12).

The variation in the incidence of cancer between populations suggests — besides possible shortcomings in the coverage of registration — differences in the exposure to risk factors of cancer (9). For instance high rates of primary liver cancer in Africa have been attributed to exposure to aflatoxins and possibly to hepatitis B virus. Burkitt's lymphoma, also common in African populations, is associated with the Epstein-Barr virus, as is probably also nasopharyngeal carcinoma in Southeast Asia and elsewhere. Extremely high rates of esophageal cancer in Central Asia and Northern Iran have not been satisfactorily explained although diet deficient in some protective elements (vitamins?) has been suggested. Alcohol consumption seems to play an important role in the etiology of esophageal cancer in France and in some parts of Southern Africa, where the incidence and mortality rates are high (9).

Many cancers show high rates among well-developed affluent populations in Europe and North America (table 1). These include cancers of the lung, colon, prostate, breast, and endometrium, while the risk of stomach cancer is rather low in these populations. Trends in cancer incidence seem to support these cross-sectional findings. The risks of cancers that are particularly common in the Western world are, in general, increasing, whereas the risks of those associated with a lower standard of living are decreasing in these areas (8). Many risk differentials and trends are likely to be reflections of similar differentials and trends in the risk factors related to smoking and diet.

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Table 1. Age-adjusted ("world standard population") incidence rates (per 100 000) for selected cancers in different parts of the world [Rates for all areas except Iceland taken from Waterhouse et al (15) and those for Iceland from Waterhouse et al (14)]

Area	Lung (Males)	Prostate	Stomach (Males)	Colon (Males)	Breast (Females)	Corpus uteri	Thyroid (Females)	Melanoma (Females)
Denmark	51.8	23.6	17.1	19.0	58.8	13.0	1.4	6.2
Finland	74.4	27.2	29.3	8.3	40.1	10.9	3.9	3.8
Iceland	16.3	26.7	43.0	12.3	49.5	12.0	15.0	3.6
Norway	25.4	38.9	20.6	14.3	49.6	11.0	4.4	9.1
Sweden	23.8	44.4	18.3	16.3	55.2	13.0	3.8	5.7
German Democratic Republic	59.0	18.1	30.3	10.7	37.4	14.3	1.6	2.7
United Kingdom, Birmingham	79.9	18.6	22.1	16.3	56.4	9.4	1.2	2.5
Israel (Jews)	29.3	15.5	19.0	13.9	59.9	9.9	6.3	6.1
United States, Connecticut	60.9	42.7	11.1	32.3	77.9	21.3	4.3	5.4
Colombia, Cali	19.5	22.3	46.3	4.5	33.2	4.3	6.2	1.5
China, Shanghai	51.2	0.8	55.7	6.7	19.6	3.8	7.4	0.4
Japan, Miyagi	25.5	4.9	88.0	8.3	17.5	2.0	2.7	0.3

LUNG CANCER, males

Figure 1. Age-adjusted ("world standard population") incidence rates (per 100 000) for lung cancer (males) in Finland by hospital district in 1970-1979 (Finnish Cancer Registry).

Cancer maps from individual countries have demonstrated substantial geographic differences in the risk of cancer within one and the same population. In the United States, Norway, and Finland the incidence of melanoma of the skin is higher in the southern parts of the countries than in the north; this distribution agrees with the hypothesis that exposure to sun-

light is an important risk factor for melanoma (4). Lung cancer is the most common in the eastern and northeastern parts of Finland (figure 1), lip cancer in northern Finland, and colon and breast cancers in the south and southwestern parts of Finland. The geographic pattern of the risk of lung and lip cancers follows that of the smoking habits, while colon and breast cancers, known to be associated with higher social class and standard of living, are concentrated in the well-developed and more urbanized parts of the country (13). One has to remember that before any conclusions can be drawn from cancer maps, differences in the diagnostic facilities and in the accuracy of registration within the country must be ruled out. And, even then, many maps with risk differences do not give direct hints to the detection of the risk factors behind them.

In Utah in the United States, and especially in Utah county, the mortality rate of colon and rectum cancer is lower than that of the total United States. This well-known finding has been associated with the proportion of Mormons in the populations, who differ from other Americans as regards their personal habits, eg, diet. In this case the geographic variation in the incidence of cancer can be linked with life-style factors through religion (6).

But administrative geographic areas do not tell the whole truth. Most areas are heterogeneous. They include both urban centers and more or less remote rural areas. Table 2 shows the urban:rural ratio of the incidence of several cancers in Finland and Norway. It can be concluded that the degree of urbanization is an important indicator of the risk of cancer.

A municipality-based geographic analysis in Finland

There are some 450 municipalities in Finland, the populations of which vary from a few hundred (small islands) to half a million (Helsinki); the mean is about 10 000. According to the data obtained in the national censuses of 1950 and 1970, each municipality is characterized by numerical values of a number

of different background variables describing urbanization and socioeconomic level, such as mean income per person, proportion of people in the highest social class, mean dwelling space per inhabitant, and family size. The municipalities have been grouped into four to five classes according to each of these variables. Within each group the age-adjusted incidence rates of different cancers were calculated adding both the cases and the populations together by age groups (13).

As an example of the results obtained, some data for colon cancer are presented. All variables showed a positive association between urbanization and well-being on one hand, and risk of colon cancer on the other. When the municipalities were grouped into five classes according to the mean income per person in the municipality [the scale ranging from 1 (lowest income) to 5 (wealthiest municipalities)], a consistent correlation was seen. The higher the mean income per person, the higher also the incidence of colon cancer (figure 2).

However, the urban-rural status of the municipality must also be taken into account. Figure 3 shows that the association between the mean income per person and colon cancer risk is positive within both small towns and rural areas and that income is sufficient in explaining the variation in the incidence of colon cancer without an additional "urban factor."

A similar exercise for breast cancer showed that, when the mean family size in the municipality increases (which means that well-being decreases), the risk decreases. On the other hand, when the mean income per person, proportion of people in the highest

social classes, proportion of those with eight or more years of schooling, or the proportion of those having central heating in their homes increases, the incidence of breast cancer also increases. There is nothing basically new in these findings, but analyses of this kind

Table 2. Urban:rural ratio of the age-adjusted incidence rates for selected cancers in Finland in 1975–1979 (Finnish Cancer Registry, unpublished), and in Norway in 1973–1977 (15).

Sites	Finland	Norway
<i>Males</i>		
Lip	0.66	0.64
Esophagus	1.00	1.95
Stomach	0.97	1.03
Colon	1.70	1.35
Larynx	1.32	1.68
Lung	1.05	1.84
Prostate	1.20	1.16
Testis	1.29	1.12
Kidney	1.47	1.38
Skin, melanoma	0.94	1.47
Soft tissues	1.21	1.28
Multiple myeloma	1.07	0.92
All sites	1.12	1.25
<i>Females</i>		
Esophagus	0.83	1.00
Stomach	1.00	1.10
Colon	1.23	1.23
Lung	1.78	1.77
Breast	1.36	1.23
Cervix uteri	1.22	1.29
Corpus uteri	1.24	0.92
Ovary	1.12	1.05
Kidney	1.32	1.14
Skin, melanoma	1.02	1.18
Thyroid	0.94	0.91
Soft tissues	1.03	0.93
Multiple myeloma	0.98	0.85
All sites	1.19	1.16

CANCER OF THE COLON / INCOME

Figure 2. Age-adjusted ("world standard population") incidence rates for colon cancer in Finland (1955–1974) in five groups of municipalities classified by the mean income per person in the municipality in 1968 (13). (1 = lowest income, ie, poorest municipalities; 5 = highest income, ie, wealthiest municipalities)

CANCER OF THE COLON ♂

Figure 3. Correlation between the mean monthly income per inhabitant in 1968 and the incidence of colon cancer (males) in Finland, 1955–1974. Both rural municipalities and small towns were divided into four groups according to the mean monthly income (13).

give a much more straightforward picture of the association between the socioeconomic status and risk of breast cancer than simple geographic maps.

Socioeconomic status as a risk indicator of cancer

Studies on the level of individuals are more powerful than geographic or ecological analyses in the search for risk factors of cancer. In Cali (Colombia) those who belong to the lowest socioeconomic class have the lowest risk of colon cancer and many hormone-

dependent cancers, and those in the higher classes also experience a distinctly higher risk (table 3). A similar study was done in Finland. Cancer registry data for several cancers were linked with census data on education, social class, and occupation. Standardized incidence ratios (SIR) were calculated, the ratio for the total population being defined as the unit (table 4). For colon and breast cancers, high ratios were seen among managerial and clerical workers and employers, whereas workers and farmers had a lower risk. It appears that both colon cancer and breast cancer occur particularly in upper social classes, although the risk factors of these two tumor types are to a great extent different — breast cancer is related to reproductive history, colon cancer to dietary factors (although dietary hypotheses have been presented also for breast cancer).

Cancer of the cervix uteri shows an opposite trend, a high risk being found among those in low socioeconomic classes (table 4). Farmer's wives are an exception; it is always difficult to put farmers or their wives in the right place in socioeconomic groupings. The variation in the risk of cervical cancer by socioeconomic class is probably accounted for by differences in sexual habits. Although breast cancer and cervix cancer behave quite differently in this analysis on the level of individuals, these two cancers have exactly similar ecological patterns, ie, both are common in urban well-developed areas. One may con-

Table 3. Age-adjusted (1973 census population for Cali) incidence rates of selected cancers by socioeconomic class in Cali, Colombia, 1971–1975 (2).

Cancer	Socioeconomic class		
	High	Middle	Low
<i>Females</i>			
Breast	27.3	17.6	12.3
Endometrium	3.6	3.7	2.0
Ovary	7.4	6.3	5.6
Colon	2.7	3.0	0.9
<i>Males</i>			
Prostate	11.8	9.9	7.6
Colon	3.0	2.2	1.8

Table 4. Standardized incidence ratios for selected cancers in persons aged 30–69 years in different socioeconomic classes in Finland, 1971–1975 (11). (Whole population = 1.00)

Socioeconomic class	Lung (Males)	Lip (Males)	Colon (Females)	Breast (Females)	Cervix uteri	Melanoma (Males)
Farmers	0.72***	1.53**	0.64***	0.80***	0.65***	0.77
Other self-employed	0.86*	0.56	0.86	0.99	0.86	0.57
Employers	0.59***	0.66	1.24	1.16	0.69	1.26
Managerial	0.36***	0.23***	1.23	1.50***	0.45***	1.47*
Secretarial	0.61***	0.49***	1.25*	1.26***	0.90	1.31
Skilled workers	1.05	0.86	0.82*	0.90***	1.30***	1.04
Unskilled workers	1.13*	1.15	0.93	0.87**	1.51***	0.67

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.

Table 5. Observed and expected numbers of male lung cancer cases (35–69 years of age) and standardized incidence ratios for the main occupational categories, by sex, in Finland in 1971–1975. In addition, the prevalence of smoking in 1968 is given for each category (10).

Main occupational category	Observed	Expected	Standardized incidence ratio	Prevalence of smoking (%)
Technical, scientific, humanistic and artistic work	175	317	0.55***	37
Administrative, managerial and clerical work	151	235	0.64***	44
Sales work	129	171	0.76***	47
Agriculture, forestry and fishing	1 213	1 367	0.89***	46
Transport and communication work	302	315	0.96	52
Services	175	163	1.07	58
Mining and quarrying	42	20	2.08***	..
Manufacturing work	1 775	1 373	1.29***	61
Economically inactive	2 719	1 606	1.69***	..

*** $p < 0.001$, .. not analyzed.

clude that breast cancer is a disease of wealthy people in towns, whereas cervical cancer is a disease of poor people in urban environments (3).

Education and social class are strongly associated. On the basis of the social class distribution of the risk of colon cancer, one can expect high risks among those with long education. These high risks are exactly what was found. Similarly, those who had gone to school for eight years or less showed the highest risks of cervical cancer (11). Lip cancer among males had an identical pattern, but the variation was even more pronounced. In Finland, lip cancer is a very rare disease among urban males in higher social classes (5).

Occupation as a risk indicator of lung cancer

There is extensive literature on the occupational risk factors of cancer (1). Several occupational exposures have been shown to be carcinogenic, and among those exposed these risk factors can be of great importance. However, many life-style factors are associated with occupation, and in many instances they may be more relevant than the possible occupational exposures themselves. Consider for instance the following example of the importance of smoking as an explanatory factor for the variation in lung cancer risk by occupation (10).

In a study conducted by the Finnish Cancer Registry the incidence of lung cancer was calculated in different occupational categories, and an attempt was made to determine to what extent the observed variation might be attributable to differences in smoking habits. The series consisted of 6 700 male patients, 35 to 69 years of age, with lung cancer diagnosed in Finland in 1971–1975 and reported to the Finnish Cancer Registry. The Registry data of these patients was supplemented by a code on occupation recorded in the Finnish national census in 1 January 1971, ie, before the diagnosis of lung cancer had been made. These cases were tabulated by occupational group and age. The corresponding expected numbers of cases were calculated on the basis of the occupation and age-specific numbers of person-years at risk in 1971–1975, produced by the Central Statistical Office of Finland for the whole Finnish population, and the age-specific incidence rates of lung cancer among the economically active male study population.

The standardized incidence ratio was highest (2.08) for mining and quarrying (table 5). Other groups with a high ratio within the main category of "manufacturing" (SIR 1.29) were unskilled construction workers (SIR 1.80), construction metal workers (SIR 1.47), and joiners (SIR 1.42). Forestry workers constituted a high-risk group (SIR 1.46) within the category "agriculture, forestry and fishing." All high-risk groups do hard physical, and mostly outdoor, work. Moreover, these workers in general belong to lower socioeconomic strata.

Low standardized incidence ratios were encountered among priests (SIR 0.18), lawyers (SIR 0.31), teachers (SIR 0.36) and physicians (SIR 0.37), who belong to the main category "technical, scientific, humanistic and artistic work," and among administrators (SIR 0.47). In other words, academic professions with a long education leading to higher socioeconomic strata were associated with a low risk of lung cancer.

The occupational carcinogenic exposures are of course much more prevalent among the aforementioned high-risk occupations, but often only a limited number of workers in the mostly heterogeneous groups are exposed. The prevalences of smoking within the main occupational categories in Finland were available as a result of an interview study carried out in 1968 (7). The gradient in the prevalence of current smokers seems to be similar to that found for the standardized incidence ratio of lung cancer, ie, low prevalence in the low-risk academic professions (37 %) and administration (44 %) and high prevalence in manufacturing (61 %) and services (58 %), in which also the risk of lung cancer is high. Hence, a positive association was found between smoking and the risk of lung cancer. It can be calculated that a major proportion of the variation observable in the standardized incidence ratio of lung cancer between the main occupational categories can be explained by the variation in the prevalence of smoking.

Three conclusions can be drawn. First, it appears that data on lung cancer risk by occupation (or by any other parameter) is only of limited applicability if information on smoking habits is lacking. For the second, smoking is the most important factor explaining the occupational variation in the risk of lung cancer. And third, if all occupational groups could reduce their smoking to the level found among the academic profession, which is quite a realistic goal, 52 % of the lung cancer cases diagnosed in 1971–1975 in Finland would have been prevented.

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