

Socioeconomic Groups and Cancer Risk at Death in the Swiss Canton of Vaud

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Data collected by the Cancer Registry of the Canton of Vaud, Switzerland, were used to estimate proportional mortality ratios (PMR) and mortality odds ratios (MOR) for various neoplasms according to social class and sector of occupation (agriculture versus others). Mortality ratios were elevated in lower social classes for cancers of the lung (MOR = 1.18 for social class IV or V vs I or II) and other sites strictly related to tobacco (mouth or pharynx, oesophagus and larynx; MOR = 1.70), and (though not significantly) for cancers of the stomach (MOR = 1.16) and uterus (MOR = 1.30 for cervix and 1.47 for corpus uteri). Furthermore, there was a strong negative social class gradient for thyroid cancer (a neoplasm with particularly elevated incidence and mortality in Switzerland), probably attributable to higher prevalence of iodine deficiency in lower social classes (MOR = 3.17). Positive social class gradients emerged for cancers of the intestines (MOR = 0.77 for social class IV or V), skin (MOR = 0.74) and prostate (MOR = 0.87). Agricultural workers showed decreased ratios for cancers of the lung (MOR = 0.75), cervix uteri (MOR = 0.72) and prostate (MOR = 0.80), and excess mortality from cancers of the upper digestive and respiratory sites (MOR = 1.22), stomach (MOR = 1.18), testis (MOR = 2.05) and lympho-haematopoietic neoplasms, particularly myeloma (MOR = 2.14).

Socioeconomic status has long been known to be one of the major determinants of the incidence of various neoplasms. Cancers of the stomach and cervix uteri, for instance, have consistently been found to be higher in lower social classes, whereas cancers of the breast or prostate tend to show positive social class gradients.¹⁻⁸

It is difficult to define and quantify the importance of specific occupational exposures and of various lifestyle correlates of socioeconomic status on subsequent cancer risk. Nonetheless, further reports on this topic are of general interest, since the socioeconomic determinants of cancer risk are known to differ in different countries and time periods. Thus, we present here the results, in terms of proportional mortality ratios and mortality odds ratios, on the relation between social class and mortality from major cancer sites on the basis of incident cases from the Cancer Registry of the Vaud Canton, Switzerland. The dataset was insufficient for

any evaluation of specific occupations, but meaningful analyses could be conducted (and are enclosed in the present report) for the whole of agriculture and forestry workers as compared with all other occupational sectors.

MATERIALS AND METHODS

The data were derived from the Vaud Cancer Registry datafile, which includes data concerning incident cases of malignant neoplasms in the Canton (whose population in 1980 was about 530,000 inhabitants).^{9,10} Information collected by the register includes general characteristics of the patient (age, sex), site and histological type of the tumour according to the standard International Classification of Diseases (ICD, Ninth Revision) and time of registration. Information on marital status, nationality and occupation is not collected at registration, but is abstracted from death certificates. Occupation is coded according to a detailed three-digit classification provided by the Swiss Federal Office of Statistics,¹¹ which is an adaptation of the International Classification of Occupations.¹²

Among the cancer deaths registered between 1977 and 1984 in the population aged 20 to 74, information on occupation was available for 4461 deceased cases

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(3099 males and 1362 females, 77% of all deceased cases, 81% of males and 70% of females), which constitute the material for these analyses.

Using these occupation codes, it is possible to define socioeconomic groups or social classes comparable to those adopted by the British Registrar General.¹³ Validation of this socioeconomic classification has been considered in a separate study, which showed satisfactory concordance between death certificate and Census data.¹⁴

In order to obtain meaningful numbers in each category, we grouped the six original social classes into three categories, including respectively the Registrar General's Social classes I and II (professional, managerial and intermediate), social classes III nM or III M (skilled occupations), and social class IV or V (partly skilled and unskilled occupations).

A total of 347 cases could not be classified in terms of social class, and were considered only for analyses related to occupational sector (agriculture versus others).

Observed numbers of deaths for each cancer were tabulated and compared with cause-specific expected numbers based on the proportional cancer mortality experience of the whole dataset, with adjustments for age (in five-year groups) and sex (where appropriate). Cancer proportional mortality ratios (PMRs) were calculated as the ratio of observed to expected deaths for each cancer.¹⁵⁻¹⁷ Standard errors of the PMRs were based on the Poisson distribution, and their statistical significance was determined by the chi-square test, comparing observed and expected numbers of deaths.

Age- and sex-adjusted mortality odds ratios (MORs)¹⁸ were computed from 2×2 tables including deaths for a defined neoplasm versus those from all other neoplasms. Estimates of the MORs were also derived from multiple logistic regression equations,^{19,20} with maximum likelihood fitting²¹ and including simultaneously terms for age, sex, social class, sector of occupation, nationality and marital status. Since age- and sex-adjusted MORs in no case were materially different from the corresponding PMRs, whereas multivariate estimates provided some additional information on the modifying effect of potential confounding factors, only the latter are given in the tables.

RESULTS

Absolute numbers of cases included in the present analyses for all cancer deaths and each of the 21 cancers or groups of cancers considered are given in Table 1 in separate strata of sex, age, social class and sector of occupation. Overall, there were 3099 males

and 1362 females for the agriculture versus other activities analyses, 2848 males and 1266 females for the social class analyses (since social class was undetermined for 347 individuals). By far the commonest cause of cancer death was lung (1010 cases), followed by intestines (442 cases), breast (280 cases) and prostate (244), whereas a total of 472 cancer deaths were due to various neoplasms of the upper digestive and respiratory tract.

Table 2 gives proportional mortality ratios according to social class in the two sexes separately, while Table 3 reports corresponding estimates for the two sexes combined for non-sexual neoplasms (and for the relevant sex for sexually related ones) both in terms of age- and sex-adjusted proportional mortality ratios and of multivariate mortality odds ratios.

Significant negative social class gradients (ie higher ratios in lower social classes) emerged for cancers of the mouth or pharynx, larynx and oesophagus, lung and thyroid: for these neoplasms, the pattern of trends in ratios was satisfactorily consistent for the two sexes, although the lowest ratio for female lung was observed in the intermediate class. Negative social class gradients (though non-significant) were evident for cancers of the stomach and uterus, too.

Significantly positive social class gradients were apparent for cancers of the intestines, skin (chiefly melanoma) and prostate. Ratios were significantly below unity for lower social classes for non-Hodgkin's lymphomas and significantly above unity in the upper social classes for myeloma, but the trends in ratios for these neoplasms were inconsistent.

Mortality odds ratios, derived from multiple logistic regression equations (including terms for nationality and marital status besides age and sex) give the estimated risk of cancer death for social class III and IV or V compared with social class I or II (reference category). The findings from this analysis are largely consistent with the age- and sex-adjusted proportional mortality ratios although, on account of the large standard errors of the estimate from the model, the tests for linear trend were significant only for cancers of the mouth or pharynx, larynx or oesophagus, lung and thyroid (elevated ratios in lower social classes), and for intestines (lower ratios for lower social classes).

Corresponding analyses (PMRs for males and females, PMRs and MORs for both sexes combined) for agriculture versus other occupations are reported in Table 4. Farmers and other workers in agriculture showed significant excess proportionate mortality for neoplasms of the upper digestive and respiratory tract, gallbladder and bile ducts, testis, myeloma and leukaemias, and significantly decreased ratios for lung,

TABLE 1 *Distribution of cancer deaths from the registry of the Swiss canton of Vaud according to type of cancer and selected variables.*

Type of cancer	Number of registered deaths according to									
	Sex		Age			Social class			Sector of occupation	
	M	F	<55	55-64	65-74	I or II (Highest)	III	IV or V	Agriculture	Other
Mouth or pharynx, oesophagus and larynx	409	63	124	184	164	101	199	131	60	412
Stomach	159	36	32	62	101	57	72	49	25	170
Intestines (chiefly colon and rectum)	283	159	62	124	256	161	159	88	49	393
Liver	82	18	11	36	53	31	37	24	11	89
Gallbladder	25	39	9	23	32	17	25	12	12	52
Pancreas	113	71	22	67	95	62	63	44	20	164
Lung	907	103	165	384	461	302	386	261	96	914
Skin (chiefly melanoma)	180	50	33	45	152	88	75	46	28	202
Breast	5	275	101	89	90	92	128	39	23	257
Cervix uteri	—	62	20	25	17	19	26	13	4	58
Corpus uteri	—	45	7	16	22	14	19	11	3	42
Ovary	—	101	32	30	39	31	45	17	9	92
Prostate	244	—	52	45	194	89	79	55	26	218
Testis	19	—	16	1	2	5	8	5	4	15
Bladder	147	27	23	5	99	48	73	39	18	156
Kidney	65	33	14	32	52	35	38	18	9	89
Brain and nervous system	75	37	47	31	34	41	41	22	10	102
Thyroid	11	9	6	6	8	3	9	7	2	18
Non-Hodgkin's lymphomas	77	46	25	43	55	42	51	20	14	109
Myeloma	35	18	5	19	29	22	10	10	11	42
Leukaemias	73	47	31	31	58	35	49	22	19	101
Total, all cancer deaths*	3099	1362	866	1445	2150	1403	1713	998	481	3980

*Including others and undefined

cervix uteri and prostate. Stomach cancer and non-Hodgkin's disease were above unity and corpus uteri neoplasms rates below unity in subjects working in agriculture, but these differences were not significant. Likewise, no appreciable difference was observed for other digestive sites, breast, ovary, urinary sites, brain and thyroid.

For the comparisons of agriculture versus other occupations, too, the findings for multiple logistic regression MORs were largely consistent with age- and sex-adjusted PMRs. Significantly elevated MORs for agricultural workers emerged for gallbladder, leukaemias and multiple myeloma, whereas the estimate was significantly below unity for lung cancer.

Finally, we repeated the same analyses for PMR and MOR computation after exclusion of lung cancer, since this neoplasm represented a large proportion of the comparison group and has a major recognized risk

factor in smoking.¹⁷ There were minor changes in the sense of increasing (or reducing) differences between social classes or occupational categories, but in no case were the estimated ratios materially modified. Thus, only estimates based on comparison with all (other) neoplasms were presented.

DISCUSSION

There are a number of problems in the interpretation of the analyses presented, chiefly due to the relatively small absolute numbers of cases with the consequent limited power to detect significant associations, and to the absence of reliable estimates of the population at risk in various occupational groups. Consequently, we had to rely on estimates of risk based on cancer PMRs and MORs. In general, the two methods provided consistent estimates, minor differences being restricted to a systematic tendency to underestimate

TABLE 2 Proportional mortality ratios† for selected cancer sites according to social class in the two sexes. Vaud, Switzerland, 1977-84.

Type of Cancer	Proportional mortality ratios in:					
	Males, social class			Females, social class		
	I or II (Highest)	III	IV or V	I or II (Highest)	III	IV or V
Mouth or pharynx, oesophagus and larynx	0.59	1.29	1.24*	0.78	1.25	1.07
Stomach	0.97	0.92	1.17	0.70	1.35	0.94
Intestines (chiefly colon and rectum)	1.29	0.89	0.82*	1.11	0.89	1.04
Liver	0.89	1.16	0.97	1.60	0.43	1.37
Gallbladder and biliary tract	1.29	0.74	1.06	0.69	1.37	0.90
Pancreas	1.12	0.84	1.07	1.12	0.77	1.25
Lung	0.90	1.04	1.07*	1.07	0.88	1.13
Skin (chiefly melanoma)	1.39	0.82	0.86	1.38	0.70	0.98
Bladder	0.84	1.26	0.90	0.70	1.09	1.39
Kidney	1.19	1.16	0.65	1.27	0.78	1.02
Brain and nervous system	1.44	0.75	0.82	0.91	1.24	0.89
Thyroid	0.45	0.85	2.19*	0.27	1.94	1.47
Non-Hodgkins lymphomas	1.39	0.94	0.69	0.81	1.45	0.67
Myeloma	2.31	0.49	0.73	1.51	0.36	1.88
Leukaemias	0.94	1.02	1.05	0.99	1.45	0.48

* $p < 0.05$ (for linear trend).

† Adjusted for age.

differences between occupational groups by the PMRs, obviously due to the fact that observed deaths from the cause under examination were included in the computation of expected ones (denominators) as well.¹⁵⁻¹⁸ A further advantage of MOR estimates was given by the applicability of standard methods of adjustment for covariates, ie logistic regression commonly utilized in the analysis of case-control studies.^{18,19}

Nonetheless, it should be stressed that these methods are in any case restricted to an estimate of risk of death in relative terms of comparison with deaths from all (other) cancer deaths, and hence they do not give information on the absolute risk of cancer death in a defined socioeconomic occupational group. Moreover, the fact that we utilized cancer deaths only, and not total mortality, further restricts the inference within the distribution of various cancers, preventing us from inferences on differential overall cancer mortality between various occupational groups, even in relative terms. For instance, total cancer mortality is known to be higher for lower social classes in several countries (ref 4 pp. 104-6), but in the present analysis was obviously constrained to unity. On the other hand, this should inherently correct the present analyses from biases due to the 'healthy worker effect', which

are known to produce spurious overestimates of the PMRs for cancer when total mortality is used as reference.^{15,17}

Bearing these cautions in mind, it is consequent that the present analysis should be considered preliminary work to generate hypotheses to be tested by further research, or to compare and verify mortality patterns previously reported from studies conducted in other countries.

It is thus interesting to find confirmation in the present dataset of lower mortality ratios in higher social classes for cancers of the lung and other sites strictly related to tobacco (mouth or pharynx, oesophagus and larynx). It is also likely that occupational exposures to carcinogens did play some role in determining these social class differences, at least for lung cancer.

Likewise, the negative social class gradients for cancers of the stomach and (cervix) uteri are largely recognized, as well as the positive gradients for intestinal neoplasms and for skin melanoma.¹⁻⁸

More controversial is the evidence for cancer of the prostate, which showed a positive social class gradient in the present dataset, as well as in various Scandinavian countries,⁷ among white Americans from Los Angeles County,²² in a case-control study from Italy²³ and in England and Wales in the earlier decades of the

TABLE 3 Proportional mortality ratios* and mortality odds ratios** for selected cancer sites according to social class. Vaud, Switzerland, 1977-84.

Type of cancer	Proportional mortality ratio for social class			Mortality odds ratio for social class		
	I or II (Highest)	III	IV or V	I or II (Highest)	III	IV or V
Mouth or pharynx, oesophagus and larynx	0.62	1.28	1.22†	1‡	1.70	1.70†
Stomach	0.91	0.99	1.13	1‡	1.05	1.16
Intestines (chiefly colon and rectum)	1.22	0.89	0.88†	1‡	0.79	0.77†
Liver	0.99	0.98	1.02	1‡	1.03	1.06
Gallbladder and biliary tract	0.89	1.11	0.98	1‡	1.22	1.18
Pancreas	1.12	0.81	1.12	1‡	0.83	1.03
Lung	0.91	1.02	1.07†	1‡	1.11	1.18†
Skin (chiefly melanoma)	1.39	0.79	0.88†	1‡	0.71	0.74
Breast‡	1.01	1.11	0.80	1‡	1.09	0.80
Cervix uteri	0.96	0.89	1.27	1‡	1.00	1.30
Corpus uteri	0.90	0.88	1.44	1‡	0.96	1.47
Ovary	0.96	1.13	0.98	1‡	1.05	0.99
Prostate	1.23	0.83	0.97†	1‡	0.77	0.87
Testis	0.86	1.06	1.15	1‡	1.32	1.46
Bladder	0.82	1.23	0.95	1‡	1.31	1.13
Kidney	1.22	1.00	0.74	1‡	0.91	0.73
Brain and nervous system	1.23	0.92	0.84	1‡	0.81	0.78
Thyroid	0.37	1.23	1.92†	1‡	2.19	3.17†
Non-Hodgkin's lymphomas	1.14	1.13	0.69	1‡	0.96	0.67
Myeloma	2.02	0.44	0.96	1‡	0.36	0.64
Leukaemias	0.96	1.19	0.86	1‡	1.11	0.91

* Adjusted for age and sex.

** Estimates from multiple logistic models including terms for age, sex, nationality and marital status.

† $p < 0.05$ (for linear trend).

‡ Reference category.

§ Only cases among women included.

current century,⁴ but not in more recent British data⁴ and on other American studies.^{6,24}

A finding deserving consideration in the present study (in spite of the rarity of the disease) is the strong negative social class gradient for thyroid cancer ratios, on account of the exceedingly high rates for this neoplasm in Switzerland.²⁵ Thus, although British,⁴ Swedish⁷ or American data²⁶ are not entirely consistent with these data (the only negative social class gradient being evident among British married women),⁴ it is conceivable that this apparent discrepancy is due to differences in the causes of the disease in various countries. More specifically, assuming that a considerable proportion of Swiss thyroid cancer deaths were due to iodine deficiency, it is conceivable that the deficit was more prevalent among lower social class individuals.

Among the interesting findings of the analyses of agricultural workers there are the decreased ratios for lung cancer (even more pronounced in females) and of the cervix uteri, which should be considered in relation

to known risk factors for these diseases (smoking and sexual habits, respectively). In contrast, agricultural workers showed excess mortality ratios for cancer of the stomach, gallbladder, of the upper digestive and respiratory sites, which are probably explainable in terms of differences in dietary habits, including alcohol.

This study showed reduced ratios for prostate cancer and elevated ones for cancer of the testis in agricultural workers. Although the latter association has already been reported,²⁷ the overall evidence concerning the relation between agricultural work and male genital tract neoplasms is as yet largely controversial.^{7,23,28-30}

More consistent data have been accumulated over the last few years on a possible association between lympho-haematopoietic neoplasms and agricultural work,^{29,31-36} which is confirmed in the present dataset. This association, which was previously reported from several^{7,28,37} (but not all) other studies has been tentatively explained in terms of the exposure to viruses or

TABLE 4 Proportional mortality ratios (PMR)* and mortality odds ratios (MOR)** for selected cancer sites among individuals occupied in agriculture. Vaud, Switzerland, 1977-84.

Type of cancer	Males	Females	Total	
	PMR	PMR	PMR	MOR
Mouth or pharynx, oesophagus and larynx	1.26†	1.18	1.25†	1.22
Stomach	1.09	1.65†	1.17	1.18
Intestines (chiefly colon and rectum)	1.09	0.87	1.03	1.01
Liver	0.78	2.09†	0.94	1.05
Gallbladder and biliary tract	1.90†	2.35†	2.14†	2.08†
Pancreas	1.07	0.93	1.03	1.11
Lung	0.85†	0.94†	0.82†	0.75†
Skin (chiefly melanoma)	1.08	0.83	1.04	1.05
Breast	—	0.99	—	0.95‡
Cervix uteri	—	0.77†	—	0.72
Corpus uteri	—	0.75	—	0.75
Ovary	—	1.04	—	1.11
Prostate	0.79†	—	—	0.80
Testis	1.83†	—	—	2.05
Bladder	0.83	1.33	0.88	0.89
Kidney	0.49†	1.84	0.83	0.83
Brain and nervous system	1.21	—	0.88	0.82
Thyroid	0.90	1.25	1.05	1.08
Non-Hodgkin's lymphomas	1.33†	0.73	1.13	1.14
Myeloma	1.50†	3.99†	2.10†	2.14†
Leukaemias	1.46	1.69	1.54†	1.52†

* Adjusted for age and sex (when appropriate).

** Estimates from multiple logistic models including terms for age, sex, nationality and marital status.

† $p < 0.05$.

‡ Only cases among women included.

chemicals (herbicides)³⁸ of agricultural workers, although no clear knowledge of the causes of these neoplasms is at present available.

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