

Cancer mortality of Swiss men by occupation, 1979—1982

by

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ABSTRACT

MINDER CE, BEER-PORIZEK V. Cancer mortality of Swiss men by occupation, 1979—1982. *Scand J Work Environ Health* 1992;18 suppl 3;27 p.

Results of a study of male cancer mortality are presented by occupation. The data base consisted of the 1979—1982 mortality register and 1980 census data from Switzerland. In a novel approach, a linked subset of death certificates and census records was used to correct the numerator-denominator bias of standardized mortality ratios and their confidence intervals. Agricultural occupations exhibited low cancer mortality (exception: stomach cancer). Electricians suffered excess mortality from cancer of several sites. Foundry and chemical workers had elevated mortality risks for digestive tract cancers. Other metal workers suffered from high mortality from cancers of the respiratory organs. Construction workers were subject to high mortality from cancers of the upper digestive tract and lungs. Innkeepers, cooks, and owners or managers of guest houses had high rates of cancers of the digestive system. Occupations using combustion-powered equipment suffered from excess lung cancer mortality. In general the results of the study agree with those of several other studies.

Key terms: etiologic hypotheses, health surveillance, long-term occupational risk, mortality data quality assessment, numerator-denominator bias, occupational cancer, occupational mortality, quality of occupational coding, use of linked data sets.

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INTRODUCTION

Unlike some other European countries, Switzerland has no tradition of publishing data on occupation and mortality. To our knowledge the last comprehensive publication (1) appeared in 1916 in connection with the fight against tuberculosis. A publication with selected occupational mortality risks appeared in 1959 (2). In recent years, however, there has been a resurgence of interest in occupational diseases, and consequently in studies of occupational mortality. For reasons of size and reliability of registration, the study presented in this report was restricted to cancer and occupation. It is known, for instance, that cancer is registered fairly reliably on Swiss death certificates (3, 4).

A methodologically new feature of this study is the use of information from a linked sample in order to correct statistically the numerator-denominator bias

resulting from occupational misclassification. Standardized mortality ratios and their confidence intervals have been corrected for classification errors on the death certificate.

The objective of this study was to identify areas for further research and to draw the attention of national authorities to areas in need of regulation (eg, prevention and workmen's compensation). This report is intended to document the present situation with regard to occupation and cancer mortality in Switzerland. It also tries to contribute pertinent data to the field of occupation and cancer mortality. Comparisons with the literature are made where feasible. In particular, it was of interest to compare the results of this overview with those obtained in similar overviews in the United States (state of Washington), England and Wales, and Denmark (5–7).

SUBJECTS AND METHODS

The data

The data consisted of the death certificates of all Swiss men who died in the period from 1979 to 1982 at the age of 30 years or over. The population at risk was determined with the use of the occupational classification of the 1980 census records (census date 1 December 1980). The occupational classification on the death certificate (8) is a less precise version of the Swiss census classification of 1970. It was used to determine the occupation of the men who had died. This same classification was applied to the 1980 Swiss census. It differs however to some extent from classifications used in other countries and does not agree with the International Standard Classification of Occupations. Deaths and persons at risk were grouped into five-year intervals. As in other reports (5, 6, 9), only the primary cause of death was used. The cancers were classified according to table 1 (10).

Quality of diagnoses

The two columns "retrieval fractions" in table 1 give measures of the quality of the cancer categories used. High fractions indicate diagnoses of high quality on the death certificates, and low fractions represent

diagnoses of poor quality. Retrieval fractions were computed from a set of 4008 death certificates of patients dying of cancer in a hospital and matched through their hospital records. These data constituted all linkable hospital cancer deaths recorded in 1979 by the Swiss hospital association in its diagnostic statistics. The association included roughly one-third of all Swiss hospitals. The RDH (RDH = retrieval fraction of death certificates in hospital records) is the percentage of death certificates for which the primary cause of death was found in the matching hospital records, while the RHD (RHD = retrieval fraction of hospital diagnoses on death certificates) is the percentage of hospital main diagnoses found on the matching death certificates.

If any cancer was noted on the death certificate, there was a greater than 95% chance that a cancer, though not necessarily the same kind, would be found in the corresponding hospital record (all cancer RDH > 95%). The same pertained to cancers in the hospital record being found on the death certificate (all cancer RHD > 95%). For each of the major cancers (as defined in table 4 in the Results section) the retrieval fraction was at least 77%, indicating reasonable agreement between the hospital records and the death certificates.

Table 1. Cancer categories.

Description	ICD-8 code ^a	Retrieval fractions ^b		Autopsy or operation ^c (%)
		RDH (%)	RHD (%)	
Malignant neoplasms				
Mouth and pharynx ^d	140—149	85	78	57
Esophagus ^d	150	88	93	50
Stomach ^d	151	88	90	59
Colon ^d	153	80	88	69
Rectum ^d	154	77	84	69
Liver and gallbladder	155, 156	82	83	67
Pancreas ^d	157	83	93	66
Larynx	161	65	65	57
Lung and bronchi ^d	162	91	97	47
Other respiratory organs	160, 163	86	49	64
Bones and connective tissues	170, 171	67	58	69
Skin	172, 173	72	81	59
Breast	174	92	98	57
Prostate ^d	185	89	97	48
Bladder ^d	188	92	92	63
Other urinary organs	189	88	95	68
Leukemia ^d	204—207	94	95	37
Other blood and lymph organs ^d	200—203, 208—209	87	92	53
Brain	191, 225	81	82	67
Secondary without localization	196—199	68	30	34
Other malignant neoplasms	152, 158, 159, 181, 186, 187, 190, 192—195	67	65	55
Benign neoplasms				
	210—224, 226—239	26	14	31

^a From reference 10.^b RDH = retrieval fraction (% found) of primary cause on death certificates in corresponding hospital records, RHD = retrieval fraction of main diagnosis in hospital records on death certificates.^c Percentage of death certificates with autopsy or operation.^d Major cancers among men in Switzerland, 1979—1982.

Table 2. Variations in retrieval fractions by cause and social class — differences exceeding 15%.

Cancer	Retrieval fraction ^a	Highest value	Number with highest value	Social class for highest value ^b	Lowest value	Number with lowest value	Social class for lowest value ^b
Esophagus	RDH	100	11	III _m	85	17	IV + V
Colon	RDH	94	15	III _n	65	11	F
Liver and gallbladder	RDH	94	15	III _m	76	22	IV + V
Pancreas	RDH	100	10	F	79	23	IV + V
Pancreas	RHD	100	13	III _n	84	21	IV + V

^a RDH = retrieval fraction (% found) of the primary cause on death certificates in corresponding hospital records, RHD = retrieval fraction of main diagnosis in hospital records on death certificates.^b Adaptation of social classes I to V used by the Office of Population Censuses and Surveys in the United Kingdom to the Swiss situation (11), comprising the classes I to III_m, IV + V, and F (farmers).

An inspection of retrieval fractions by cause and broad age groups (15—64, 65—74, ≥ 75 years) showed that they varied little with age. Among those determined on the basis of more than 10 observations (105 out of a total of 132 fractions), only the RDH for “secondary tumors and tumors without localization” at age ≥ 75 years was more than 10% lower than the reported value of 68% in table 1. Due to the small numbers, the retrieval fractions by age groups for cancer of the larynx, other respiratory organs, and bones and connective tissues could not be assessed.

Causes of death with variations in retrieval fractions by social class [model for classification: England and Wales (11)] exceeding 15% are given in table 2. There was a tendency towards higher retrieval fractions in

higher social classes, but substantial differences were rare.

Regional variations in the retrieval fractions were larger and more consistent, the northwestern region showing high values and the western region showing low ones. It was, however, not clear whether regional peculiarities in the coding of death certificates or hospital records (or both) were responsible for the differences. These differences were particularly large for cancer of the colon, for which the lowest regional retrieval fraction was 62%, fully 19% below the overall one.

Aside from these approaches to statistical quality assessment, a further measure of diagnostic quality was used. The last column of table 1 shows the percentage of death certificates with an autopsy or operation, in-

dicating pathological verification from at least 37% (leukemia) up to 69%, depending on the cancer site.

Measures of mortality; quality of occupational description

The mortality measures used were the age-standardized mortality ratio (SMR) and the proportionate mortality ratio (PMR) supplemented by confidence intervals (appendices 1 and 2). While PMR values in themselves are not usually recommended as measures of risk (12, page 77), their advantage is that they are based on one source of occupational data only (ie, death certificates). In this report they were used whenever the discrepancies in the application of occupational classification between census and death certificates were so severe that the use of corrected SMR values was impossible. (See the later discussion.) Comparisons of several cause-specific PMR values for a given occupation with the corresponding SMR values may also give an indication of whether the SMR values are generally too high or too low.

To be able to evaluate the reliability of findings based on SMR values, we found it necessary to assess the agreement of occupational information on the census records and death certificates. For this purpose a novel approach was taken. Death certificates for a stratified random sample of 4000 men who died in 1981 were linked back to their census records by means of date of birth, marital status, place of residence, and citizenship community [the community in which the deceased person had (inherited) citizenship rights]. The documents of 76%, or 3058 men, could be linked (3). As this procedure had to be done manually, the cost of finding a case was the primary reason for nonlinkage. Differences in the definition of place of living be-

tween census and death registry and incompleteness of census records were the main factors influencing the chance of linkage. While nonresponse bias could not be entirely excluded, it was unlikely to be of importance.

For every occupation the concordances C_d (based on death certificates) and C_c (based on census records), as well as the correction factor K , were computed (appendix 2). Concordances are useful for quantifying the agreement of occupation between a death certificate and census occupation. If both C_d and C_c were high, say, above 75%, the occupation was coded reliably. When C_d was high and C_c was lower, the death certifiers had a broader definition than the census takers in assigning the occupation in question and vice versa. When, on the other hand, both C_d and C_c were low, there was little agreement between the death certificate and the census record regarding that particular occupation, and the results could not be trusted. Concordances by occupation are given in table 3. Occupations with a public role, like primary school teacher or physician, and those with a well-developed occupational identity, like painter, mason or railway engine driver, showed high concordances. For industrial or service occupations the concordances were generally lower. The observed concordances may not be indicative of the quality of occupational description over the longer periods of time required by the long latency periods of many cancers. However, a mixing of occupations over time will reduce observed relative risks of mortality so that observed risks tend to underestimate true risks.

An investigation of coding reliability by age using broad sociooccupational groups indicated stability up to the age of 80 years, except for qualified agricultural workers. The occupation of retired persons can thus be considered reliably coded.

Table 3. Concordances (C_c , C_d) and the correction factor^a (K) and its standard errors [se (K)] of occupations. (C_c = concordance based on data from the census records, C_d = concordance based on the death certificate data, SMR = standardized mortality ratio, PMR = proportionate mortality ratio)

Code ^b	Occupation	Number of death certificates	C_c (%)	C_d (%)	K	se(K)	Measure of mortality
<i>Agriculture, forestry</i>							
100	Farmers	86	80	81	1.02	0.05	SMR and PMR
111	Wine growers	5	50	40	0.80	0.36	PMR
112	Vegetable producers	25	62	48	0.77	0.15	SMR and PMR
122	Other farming occupations	37	50	49	0.98	0.14	SMR and PMR
140	Foresters	5	83	100	1.20	0.20	SMR and PMR
141	Forestry workers	6	31	33	1.08	0.47	PMR
145	Fishermen, hunters	3	100	67	0.67	0.27	PMR
<i>Mining</i>							
200—							
201	All mining workers	7	19	29	1.52	0.64	PMR

(continued)

Table 3. Continued.

Code ^b	Occupation	Number of death certificates	C _c (%)	C _d (%)	K	se(K)	Measure of mortality
<i>Food industry</i>							
212	Bakers	31	70	68	0.96	0.12	SMR and PMR
218	Butchers	17	54	47	0.88	0.18	SMR and PMR
216	Cheese makers	10	30	40	1.34	0.34	SMR and PMR
221	Other food processing	23	56	39	0.70	0.16	SMR and PMR
<i>Tobacco industry</i>							
240	Tobacco processing	—	..	..	..	..	PMR
<i>Textile industry</i>							
250	Spinners	5	16	20	1.27	0.78	PMR
253	Weavers	13	52	69	1.34	0.28	SMR and PMR
262	Other textile industry	43	53	21	0.40	0.10	SMR and PMR
270	Textile cutters	27	62	63	1.01	0.18	SMR and PMR
273	Other textile processing occupations	16	32	44	1.37	0.32	SMR and PMR
<i>Wood-working industry</i>							
304	Carpenters	10	47	50	1.05	0.28	SMR and PMR
306	Furniture makers	43	81	72	0.89	0.09	SMR and PMR
313	Other wood and cork processing	21	59	52	0.88	0.15	SMR and PMR
<i>Paper and graphic arts</i>							
330	Paper makers	10	19	10	0.52	0.21	PMR
340	Typesetters	31	68	74	1.09	0.17	SMR and PMR
341	Printers	22	23	46	1.95	0.46	SMR and PMR
345	Other graphic arts	32	48	72	1.51	0.22	SMR and PMR
<i>Leather industry</i>							
360	Occupations of leather processing	41	67	66	0.99	0.14	SMR and PMR
<i>Chemical industry</i>							
370	Chemical workers	26	55	31	0.56	0.15	SMR and PMR
380	Synthetics and rubber production	1	0	0	4.3	1.92	PMR
390	Stone and earth processing	61	61	38	0.62	0.12	SMR and PMR
<i>Glass, earth and stone industry</i>							
401	Glass workers	6	22	100	4.5	1.23	PMR
406	Other occupations stone and earth processing	6	0	0	0.33	0.23	PMR
<i>Metal industry</i>							
410	Foundry workers	48	73	35	0.49	0.09	SMR and PMR
426	Metal turners	15	39	40	1.02	0.28	SMR and PMR
456	Mechanics	83	62	54	0.88	0.08	SMR and PMR
472	Electricians	88	52	48	0.92	0.12	SMR and PMR
477	Other metal workers	70	50	60	1.21	0.08	SMR and PMR
485	Watchmakers	76	28	33	1.16	0.17	SMR and PMR
490	Jewellery makers	7	47	57	1.21	0.37	PMR
<i>Building trades</i>							
500	Masons	73	59	67	1.14	0.10	SMR and PMR
501	Floor tilers	2	100	50	0.50	0.35	PMR
509	Roofers	5	76	40	0.53	0.25	PMR
510	Plasterers	7	47	71	1.51	0.35	SMR and PMR
513	Miners (tunnel)	14	28	21	0.77	0.57	PMR
514	Construction laborers	65	21	25	1.18	0.14	SMR and PMR
515	Other building trades	84	37	26	0.71	0.09	SMR and PMR
520	Painters	81	82	77	0.93	0.07	SMR and PMR
524	Other painting occupations	4	14	50	3.52	1.04	PMR
530	Production workers	4	54	50	0.92	0.39	PMR
<i>Architects and engineers</i>							
600	Architects	22	86	27	0.32	0.11	PMR
601	Civil, machine and electrical engineers	53	88	17	0.19	0.06	PMR
610	Technicians	49	32	49	1.54	0.18	SMR and PMR
<i>Technical occupations</i>							
620	Technical managers	42	30	38	1.27	0.18	SMR and PMR
622	Laboratory assistants	2	24	100	4.25	1.08	PMR
624	Draftsmen	4	27	25	0.91	0.30	PMR
634	Excavator and crane operators	13	47	39	0.83	0.24	SMR and PMR
639	Other technical occupations	94	42	33	0.79	0.10	SMR and PMR
<i>Managers</i>							
640	Entrepreneurs, directors	72	46	40	0.88	0.09	SMR and PMR

(continued)

Table 3. Continued.

Code ^b	Occupation	Number of death certificates	C _c (%)	C _d (%)	K	se(K)	Measure of mortality
641	Chief officials	8	41	50	1.22	0.29	SMR and PMR
642	Association secretaries	..	..	..	..	..	PMR
<i>Employees, trade and commerce</i>							
650	Commercial and administrative employees	77	46	51	1.11	0.08	SMR and PMR
651	Bookkeepers, cashiers	9	32	33	1.04	0.28	SMR and PMR
653	Cost accountants	5	74	80	1.08	0.22	SMR and PMR
670	Merchant employees	7	8	14	1.72	0.44	SMR and PMR
<i>Sales occupations</i>							
673	Pharmacy assistants	1	100	100	1.00	0.00	SMR and PMR
678	Sales representatives	17	38	47	1.25	0.25	SMR and PMR
679	Gas station attendants	4	40	25	0.63	0.44	PMR
683	Other sales occupations	50	46	44	0.97	0.11	SMR and PMR
695	Service salesmen	6	25	33	1.36	0.43	PMR
<i>Transport occupations</i>							
700	Railway engine drivers	27	84	74	0.88	0.13	SMR and PMR
701	Tram and special railway conductors	13	100	38	0.38	0.13	PMR
703	Professional drivers	84	40	58	1.47	0.15	SMR and PMR
710	Station masters	37	48	46	1.05	0.30	SMR and PMR
712	Train conductors	18	61	50	0.82	0.18	SMR and PMR
715	Train attendants	22	34	32	0.92	0.21	SMR and PMR
720	Other railway occupations	22	50	41	0.82	0.13	SMR and PMR
721	Water traffic occupations	6	100	83	0.83	0.15	SMR and PMR
723	Air traffic occupations	2	7	50	7.03	4.63	PMR
730	Communications occupations	20	72	80	1.12	0.14	SMR and PMR
740	Other transport occupations	19	12	21	1.81	0.33	SMR and PMR
<i>Hostellery and restaurants</i>							
750	Innkeepers and hotel managers	78	73	55	0.76	0.09	SMR and PMR
751	Owners and managers of pensions	4	23	25	1.09	0.86	PMR
754	Waiters	15	23	27	1.16	0.41	PMR
759	Cooks	35	64	49	0.76	0.13	SMR and PMR
765	House servants	7	0	0	0.82	0.41	PMR
770	Other occupations in tourism	14	27	43	1.59	0.35	SMR and PMR
<i>Cleaning services</i>							
780	Chimney sweeps	8	100	88	0.88	0.12	SMR and PMR
784	Laundrymen	2	50	100	2.00	0.70	PMR
787	Other cleaning and maintenance occupations	43	39	56	1.43	0.18	SMR and PMR
790	Occupations of public hygiene	5	0	0	3.30	1.25	PMR
800	Hair dressers	28	84	68	0.81	0.12	SMR and PMR
<i>Law</i>							
815	Lawyers, notaries, judges, public prosecutors	32	59	50	0.85	0.19	SMR and PMR
820	Police officers	59	54	58	1.06	0.15	SMR and PMR
<i>Medicine</i>							
830	Physicians	36	100	92	0.92	0.05	SMR and PMR
831	Dentists, veterinarians, pharmacists	20	92	80	0.87	0.11	SMR and PMR
839	Hospital orderlies	13	100	85	0.85	0.10	SMR and PMR
<i>Scientists</i>							
850	Chemists	10	41	20	0.49	0.21	PMR
851	Natural scientists	2	100	50	0.50	0.35	PMR
854	Mathematicians	4	9	25	2.85	1.32	PMR
858	Writers, humanists	15	83	53	0.65	0.15	SMR and PMR
866	Other scientific occupations	5	0	0	0.38	0.27	PMR
<i>Artists</i>							
870	Painters, potters, musicians and actors	15	43	53	1.24	0.28	SMR and PMR
886	Other artists	25	61	44	0.72	0.15	SMR and PMR
<i>Teachers and clergy</i>							
900	University professors	3	20	67	3.40	1.58	PMR
901	Intermediate school teachers	26	60	77	1.29	0.17	SMR and PMR
903	Primary school teachers	19	89	79	0.89	0.11	SMR and PMR
913	Other occupations in educations	4	60	50	0.84	0.35	PMR
920	Ordained clergymen	13	64	77	1.20	0.32	SMR and PMR
923	Other clergy	4	..	0	..	..	PMR
<i>Not well classified</i>							
930	Not otherwise classified occupations	76	34	5	0.16	0.04	PMR
938	Laborers	88	22	3	0.16	0.04	PMR

^a See appendix 2 for the calculation of the correction factor.^b Taken from reference 8.

As a novel feature of this study, correction factors for the SMR values were computed for each occupation on the basis of the sample of 3058 linked records. The following situations arose however in which the computation or use of a correction factor was impossible: (i) due to small numbers the sample did not permit the calculation of either concordances or the correction factor (or both); (ii) there were low concordances; (iii) the correction factor may have been determined imprecisely. In table 3, both the correction factor and its standard error (see appendix 2) are given. Due to the difficulties mentioned, only PMR values are presented for certain occupations. This was the case when either the correction factor was below 0.5 or above 2.0 (indicating vastly different concordances, of which one at least was below 50%), or when its coefficient of variation exceeded 0.3 (indicating low precision due to a small linked sample). The limits were set arbitrarily, but inspection showed that among the excluded cases the correction produced confidence intervals for the SMR values so large as to make them uninformative. Approximate confidence intervals based on *corrected* SMR values (see appendix 2) were also computed and used in table 5 in the Results section.

Preliminary investigations using correction factors of sufficient quality, as has already been defined, showed that the corrected results were in substantially better agreement with the results from cohort and case-referent studies than the uncorrected results were. Thus the mortality even of some unreliably coded occupations could be assessed accurately.

Multiple testing

The intentions of this study were (a) health surveillance and (b) accumulation and comparison of results regarding occupation and cancer. For purpose a, one is interested in having few false negatives, even at the expense of some false positives. For purpose b, one wishes to recognize patterns. A fairly detailed pattern is preferable to an overly smoothed one. For these reasons, we maintain that the traditional approach of separate tests, not adjusted for multiplicity, is preferable to an approach adjusting for multiplicity. This latter approach needs to be followed, however, when a single prespecified hypothesis is being confirmed.

Presentation of results

The main results are summarized in table 5 in the Results section, showing all occupations with significantly raised or lowered SMR or PMR values for cancer. A full description of occupations is given in the text only; short forms are used in the table. In general, results with elevated risks and small numbers ($N < 5$) are presented only in the table. Discussion is only given in relation to the literature for findings with an N exceeding 4. For some occupations the results have not been presented because the study could not provide reliable results, mostly on account of small numbers. Appendix 3 contains a list of these occupations along with the reason for exclusion from the report.