

DISCUSSION

General points

Since the mid-1980s there has been a growing interest in Switzerland in the question of occupational cancer. The present paper gives an overview of the relationship between occupation and cancer in Switzerland in the years 1979 to 1982. The main objective is to illustrate the Swiss situation and to compare it wherever possible with the circumstances in other countries. Furthermore, additional evidence of relationships which have already been observed between certain cancers and occupations is provided. Indications for new associations are given wherever possible.

Occupations and occupational groups

Agriculture, fishing and forestry work (100—145)

Our results concur with those of a Swedish (13), a Canadian (14), and an overview (15) study. None of

the cancers with elevated risks were of manifest occupational origin. There was some evidence, however, that dietary habits influence the risk of stomach cancer [parallel regional variations for men and women (16, page 25)], while the level of physical activity may explain the low SMR for colon cancer (17). The high mortality of wine growers from cancer of the esophagus was likely to be related to alcohol consumption.

Food industry (212—240)

In contradiction to the findings of other studies (18) “butchers and sausage makers” exhibited no elevated risk for lung cancer.

Textile industry (250—273)

Stomach cancer may be an occupation-related risk similar to what has been reported for England and Wales (6, page 112).

Wood working and furniture industry (304—313)

The pattern of excess cancer mortality observed for "carpenters" is compatible with that of exposure to tobacco smoke and alcohol, or to chemicals entering the body via the mouth or airways. A detailed analysis of the Swiss data for "furniture makers" (19, 20) showed that the respiratory cancers observed were evenly divided between sinonasal cancers and pleural mesotheliomas. The sinonasal cancer risk is undoubtedly occupational (19, 21, 22), whereas the mesothelioma risk is probably occupational (20, 23, 24).

Paper manufacturing and graphic industry (330—345, 624)

With regard to paper makers a report from the United States (25) has shown a nonsignificant increase in mortality from cancer of the rectum. Typesetters had excess carcinoma of the colon and urinary tract in one study (5, page 36) and of cancer of the pancreas in another (26).

Leather processing (360)

Lung cancer has been mentioned as an occupational risk in leather processing (27), but it was not found to be so in our study. The low rate for cancers of the urinary tract can also be found in other studies (28), but not unequivocally so (29, 30).

Chemical workers (370)

The high mortality from stomach cancer among chemical workers was astonishing, as most chemical workers live in urban surroundings, where stomach cancer is less frequent than in rural areas. High risks for stomach cancer have been observed for chemical workers elsewhere (6, page 135; 7, page 74). One study reported excess rates for leukemias and Hodgkin's disease among chemical workers (5, page 33); our data showed no excess risks for these diseases however. Glue production workers have shown excess risk for bladder cancer (7, page 80).

Occupations of stone and earth processing (390—406)

Contrary to some other findings (eg, those in reference 27), our data did not show any excess lung cancer mortality among occupations of stone and earth processing. Excess stomach cancer risk is, however, found in the literature. A Finnish study (31) confirmed the excess stomach cancer risk and also documented an excess risk of lung cancer. A recent Danish study (7, pages 74 & 77) confirmed an excess stomach cancer risk for mineral workers.

Foundry workers (410)

A detailed study of the mortality of foundry workers has shown that there was an excessive lung cancer risk for Swiss foundry workers in the 1950s and 1960s, which probably persists (32). High cancer risks for the lung and digestive tract among foundry workers are known from the literature (33, 34, 35).

Occupations of metal processing (426—456, 477)

The mortality pattern of excess respiratory and bladder cancer observed for mechanics and other metal workers is consistent both with findings for smoking and exposure to occupational carcinogens (36, 37, 38, 39). The high mortality from cancer of the bladder and rectum has been found in other studies, too (37, 40).

Electricians (472)

Due to the rather broad description on the Swiss death certificate, reliable comparisons with other findings were difficult for electricians. In the overview (6) done by the Office of Population Censuses and Surveys in the United Kingdom, electrical production workers showed excess death risks or excess registration for cancer of the esophagus, stomach, lung, and bronchi, and electrical engineers had a corresponding excess of cancer of the colon, prostate, and brain. In a report from Washington state in the United States (5), excess mortality from cancer of the pancreas, kidney, urinary bladder, and brain and lymphosarcoma was reported for electrical and electronic technicians; excess deaths from melanoma, cancer of the small intestine and brain and lymphosarcoma appeared for electrical engineers; and elevated mortality risks for melanoma, brain cancer, and acute leukemia, all with small numbers, were reported for electricians.

Jewellery making and watchmaking (485—490)

The excess mortality risk for "jewellery makers" could be occupational in that grinding wheel operators have been shown to experience an excess risk of laryngeal cancer (41).

Building trades (500—515)

The excess mortality of the building occupations from cancers of the mouth and pharynx, larynx, and esophagus was likely related to alcohol abuse. However, other risk factors may have been involved, since differential exposure to alcohol alone could hardly explain the magnitude of the observed excess risks. A possible contributing cause for laryngeal cancer is cement dust (42). With cancer of the lung and bronchi, the magnitude of the excess risks suggests factors in addition to smoking. Plausible are tar fumes for roofers (43) and solvent fumes for plasterers (27). The observed excess mortality from cancer of the stomach, bladder, blood-forming and lymphatic system, and secondary and ill-

defined and benign neoplasms cannot be linked easily to occupational exposures. Excess mortality from lung and stomach cancer has been found for construction workers in England and Wales (6, page 136) and Washington state (5, pages 27 & 37).

Painters (520, 524)

The elevated SMR values for cancers of the mouth and pharynx, lung and bronchi, and pancreas among painters may be explainable by excessive alcohol consumption and smoking. Nevertheless, it is plausible that occupational exposures play a part in the etiology of these types of cancer (27, 44, 45, 46). In England and Wales (6, page 136) and Washington state (5, page 43) painters showed excess mortality from lung cancer, and in Washington state they also had excess mortality from pancreatitis.

Entrepreneurs, directors and chief officials (640, 641)

As in our study, excess mortality from colon cancer among managers and owners or proprietors was found in England and Wales (6, page 138) and in Washington state (5, page 19).

Employees in trade and commerce, sales occupations (650—670, 678, 683—695)

At present one can only speculate as to the causes for high and low cancer risks for employees in trade and commerce and sales occupations — the literature provides little support. In American (5, pages 17, 19, 23 & 26) and British (6, page 139) studies, one finds excess risks for colon carcinoma and neoplasia of the blood-forming and lymphatic systems in sales occupations, but also for some types of cancer not appearing in the present study. Low mortality rates have rarely been reported.

Excavator and crane operators (634), professional drivers (703), gas station attendants (679)

The excess lung cancer mortality of operators of excavators and cranes, professional drivers, and gas station attendants may have been due to exposure to gasoline and diesel fumes or their combustion products, as has been suggested elsewhere (27, 47, 48, 49). In one study (6, page 140), English car mechanics, crane operators, bus and truck drivers, and garage owners showed elevated lung cancer risks, in another study (5, pages 20, 28, 29, 33, 34 & 44) in Washington state gas station attendants, tire recappers and rubber welders, general mechanics, and truck and tractor drivers similarly showed excess mortality from lung cancer.

The simultaneous occurrence of excess lung cancer mortality in these occupations strengthens the case for a relation to gasoline and diesel exhaust exposures, whereby there may be interaction effects with smoking.

Railroad occupations (700—701, 710—720)

An analysis of the Swiss mortality data over a 15-year period revealed an excess mortality from malignant neoplasia of hematopoietic and lymphatic tissues (ICD 200—207) for railway engine drivers (50). With regard to lung cancer, the Washington study (5, page 44) showed excess respiratory cancer for railroad shunting workers, along with many other types of cancer for various railroad occupations, while the study from England and Wales (6) showed no such risks.

Air traffic occupations (723)

Excessive (stress-induced) smoking is the likely explanation of the excess lung cancer mortality observed for air traffic occupations. A high lung cancer incidence has been found in Denmark among the larger group of transport occupations (7, page 78).

Innkeepers, hotel managers, cooks (750—759)

The absence of a lung cancer risk among innkeepers, hotel managers, and cooks was in contradiction to some recent findings (51). Milham (5, pages 46 & 47) and the study of the Office of Population Censuses and Surveys in the United Kingdom (6, page 137) showed elevated risks for cancer of the mouth and pharynx and the pancreas, as well as an excess risk for pancreatitis for innkeepers, barkeepers, and cooks. Abuse of alcohol and tobacco was certainly responsible for a large part of these cancer deaths, and passive smoking might have played a role. However, the etiology of cancer of the mouth and pharynx, liver and gallbladder, and larynx among cooks and innkeepers merits further investigation.

Cleaning services (780—787)

For chimney sweeps, exposure to soot is a likely cause of the excess lung cancer mortality (6, page 141).

Lawyers, notaries, judges and public prosecutors (815)

The reduced lung cancer mortality found among lawyers, notaries, judges, and public prosecutors in our study confirms similar results for Washington state (5, page 12) and Denmark (7, page 79).

Physicians, dentists, veterinarians, pharmacists and pharmacy assistants (830, 831, 673)

Both elevated colon cancer mortality and reduced lung cancer risk were also present for physicians, dentists, veterinarians, pharmacists and pharmacy assistants in Washington state (5, page 13) and Denmark (7, pages 75 & 79), but not in England and Wales (6, page 138). The low lung cancer mortality reflects the low rate of smoking among Swiss physicians (52).

Chemists (850)

Excess brain tumor mortality for chemists has been mentioned by Olin & Ahlbom (53). A detailed study has confirmed this risk for Swiss chemists (unpublished report).

Clergy (920—923)

English and Welsh clergy and members of religious orders have low overall cancer mortality (6, page 132). The results of our study were in agreement with the findings from Washington state (5, page 8), where it was reported that clergy have low mortality rates from lung cancer, but elevated PMR values for Hodgkin's and other diseases of the blood and lymphatic organs, except for leukemia, as well as for brain cancer.

Laborers (938)

Laborers in England and Wales showed respiratory problems (6, page 136), but little excess cancer. In Washington state (5, page 52), some high cancer risks were found. The concordance of the term "laborer" in different studies must, however, be questioned.

Confirmation of observations of other authors

With regard to previously observed relationships the present study confirms the high mortality from stomach cancer and the low mortality from cancer of the colon in farming occupations, the high rates of stomach cancer among chemical workers, the high rates of cancer of the upper respiratory tract for furniture makers, the high rates of esophageal and lung and bronchial cancer for foundry workers, and the high mortality rates from cancer of the upper respiratory, digestive and urinary tracts of construction workers.

Dubrow & Wegman (47) have suggested a relationship of occupations dealing with traffic and transportation and earth moving equipment to lung cancer. Such an association was observed once again in our study. It is hypothesized that these types of cancer are caused or promoted by exposure to hydrocarbons or their combustion products. Dubrow & Wegman (47) also mentioned cooks and innkeepers as a group which would merit an investigation for cancer risk. Our results point in the same direction. Further information on the Swiss situation can be found in reports by Schuler (54) with respect to colorectal cancer, by Schuler & Rüttner (55) and Schuler (56) as regards lung cancer, and by Gass (57) concerning broad occupational groups. The results of these studies must be assessed carefully with regard to both methodology and data quality.

Our data lend support to the hypothesis that physical activity reduces the risk of colon cancer, because the occupations with a high risk for this cancer were

sedentary, while the low-risk group consisted of occupations involving physical activity, chiefly walking (eg, train conductors, forestry workers, farmers, and other farming occupations) (58).

Mortality from skin cancer was high for some fairly prestigious occupations such as professional association and union secretaries and, marginally, lawyers and notaries. Low mortality was found for other farming occupations, masons, and laborers. The observation that upper socioeconomic occupations tend to have higher mortality from skin cancers is confirmed in the literature (9, 59, 60, 61). The low mortality of other farming occupations, masons, and laborers in Switzerland may be related to their larger proportion of persons with Mediterranean ancestry (recent immigration) and consequently better tanning ability. As a group, they have a lower risk of dying from skin cancer (62, 63).

Some general remarks

We observed that in Switzerland, as elsewhere, there are members of some occupations at the low end of the socioeconomic scale that seem to be at high risk of dying from cancer (eg, construction workers). On the other hand, there are some occupations, such as physicians, clergymen, and teachers, which are high on the socioeconomic scale and exhibit generally low cancer risks.

It is impressive to look at the patterns of cancer risks for related occupations and to observe that similar patterns emerge frequently. In our view such patterns add credibility to the results deduced from significant SMR or PMR values of single occupations.

In the framework of this study it is hazardous to draw conclusions about causative mechanisms. First, an observed common mortality pattern could be the result of a life-style common to members of the occupations compared. This is a likely possibility for cancers linked to the use of alcohol and tobacco. However, this mechanism is also likely to operate for a fraction of the cancers of the stomach, liver, and gallbladder, as well as for that of the pancreas. A second possible path of causation is by direct occupational exposure, for example, to airborne carcinogens, which then affect the upper respiratory tract, larynx, pharynx, lungs and bronchi, and, after absorption, the inner organs such as the pancreas, liver, bladder, and the like. The distinction between these two etiologic paths is very difficult in the present framework, as both may occur simultaneously. Special epidemiologic studies in which data on occupational exposure and life-style characteristics are collected separately for each individual are necessary to make this distinction.

On a methodological plane the present overview demonstrates the use of mortality statistics as an instrument for trend surveillance and etiologic research in the field of occupational health. This instrument can

be enhanced greatly by analyses of the quality and comparability of items retained by the component statistics (ie, death certificates and census records). Our analyses of the quality of occupational coding were based on a linked set of death certificates and census records of 3058 deaths among men in the year 1981. Similarly, we have investigated the quality of the causes of death on the Swiss death certificates with the aid of a set of linked death certificates and hospital records of 4008 hospital cancer deaths from the year 1979. The

results of both of these analyses have been applied to the calculations and conclusions of this report. Consequently, the risk estimates are more reliable than they would have been in the absence of these quality investigations. This increased reliability is evident from the many congruencies between the results of our classification-corrected analysis with the findings of studies from Denmark, England and Wales, and the United States (Washington state), even for less reliably coded occupations.

ACKNOWLEDGMENTS

We would like to thank Professor T Abelin and Dr G Schüler and two referees for their helpful comments on earlier drafts of this report. We are also much indebted to Dr R Gugelmann for helpful suggestions and Ms T Bietenholz for her expert typing and help with

the presentation.

This research was supported by the Swiss National Science Foundation, grant no 3.985—0.87. Publication costs were borne by the same grant and a grant from the Swiss Cancer League.

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APPENDIX 1

Approximate 95% confidence intervals for proportionate mortality ratios

With $PMR = X/F$, where X is the observed number of deaths and F is the expected number of deaths, the approximate confidence interval of the PMR at the 95% level is given by $100 \cdot L_1/F$, $100 \cdot L_2/F$ with:

$$L_1 = kx\{[1 - (1/9x)] - z_\alpha\sqrt{(1/9x)}\}^3,$$

$$L_2 = (x + z_\alpha^2/2) + z_\alpha^2\sqrt{(x/z_\alpha^2 + 0.25)}$$

and

$$k = 2.23, 1.07, 1.025, 1.013, 1.0075 \text{ for } x = 1, 2, 3, 4 \text{ and } 5,$$

otherwise $k = 1$ and $z_\alpha = 1.96$. These approximations are accurate to ± 1 in the third digit. For $x = 0$, the limits are 0 and $369/F$, respectively, for a 97.5% interval (upper tail area = 2.5%).

APPENDIX 2

Part 1: The correction factor and its variability

The table of this appendix shows the data layout for the computation of correction factors. The column totals contain fixed numbers because the sampling was done through the selection of a certain fixed number of death certificates by occupation at random. Under these conditions, a has a binominal distribution with parameters p_1 and $n = a + c$ and b has a binominal distribution with parameters p_2 and $m = b + d$:

$$a \approx \text{Bin}(p_1, n) \\ b \approx \text{Bin}(p_2, m),$$

and these two variates are independent. As the sample was weighted, a second table similar to the table of this appendix needs to be formed, multiplying each column by its weight (w_1 or w_2). The concordances are then given by:

$$C_d = w_1 a / [w_1 \cdot n] = a/n \quad (\text{basis: death certificates}), \\ C_c = w_1 a / [w_1 a + w_2 b] = a/[a + (w_2/w_1)b] \quad (\text{basis: census records}),$$

and the correction factor by:

$$K = [a + (w_2/w_1)b]/n = C_d/C_c.$$

These are reported in the text in table 3. With the use of the preceding distributional properties, one obtains

Table Basis for the computation of concordances and the correction factor for occupation A. (N = total number of linked pairs of death certificates and census records; a = number showing occupation A on both the death certificate and the census record; $a + c$ = number showing occupation A on the death certificate, fixed by sampling procedure; and $a + b$ = number showing occupation A on the census record, subject to sampling variation)

Occupation A	Death certificate		Total
	Present	Absent	
Census record			
Present	a	b	a + b
Absent	c	d	c + d
Total	a + c	b + d	N

the variance:

$$V(K) = [np_1(1 - p_1) + (w_2/w_1)^2 mp_2(1 - p_2)]/n^2,$$

which can be estimated by:

$$v = [(ac/n) + (w_2/w_1)^2 [bd/m]]/n^2.$$

The standard error of K is $se(K) = \sqrt{v}$, and the estimated coefficient of variation of K is given by:

$$vc(K) = se(K)/K.$$

Part 2: Approximate confidence intervals for corrected standardized mortality ratios

With the use of $\log(SMR) \approx \text{normal}$, it is straightforward to derive the following formula for an approximate confidence interval for the corrected SMR

(SMR_c): Define SMR as $100 \cdot X/E$, where E is the expected number of deaths and X is the observed number of deaths; SMR_c as $K \cdot SMR$ and z_α as the

$100 \cdot \alpha\%$ point of the standard normal distribution ($\alpha > 1/2$). Then the $100 \cdot (2\alpha - 1)\%$ -limits are as follows:

$$S_{1,2} = \text{SMR}_c \exp \left\{ -\left(\frac{1}{2}\right)u^2 \pm z_\alpha u \right\}; u^2 = 1/x + v/K^2 + v/xK^2.$$

This formula relies on the facts that, for any variate X with an existing mean and variance, $V(\log X) = VC^2$ and $E(\log X) = \log E(X) - \frac{1}{2}VC^2$ (VC^2 = coefficient of variation squared). These confidence intervals are used in table 5 of the text for corrected SMR values.

APPENDIX 3

Occupations not analyzed

Occupations not listed in table 5 of the Results section and the reasons for omission.

Code ^a	Occupation	Total number of deaths in 1979–1982	Reason ^b
112	Vegetable producers	1096	1
130	Fish breeders	105	2 → 145
143	Fishermen, hunters	70	2 → 145
200	Miners	9	3
201	Other mining occupations	74	1
218	Butchers	910	1
240	Tobacco processing	67	1
250	Spinners	52	1
260	Knitters	10	3
344	Etchers	—	3
371	Gas and gasoline refinery workers	8	3
380	Synthetic and rubber production	98	1
401	Glass workers	61	1
406	Other occupations in stone and earth processing	37	1
480	Watch makers	964	2 → 485
484	Other occupations, watch making	570	2 → 485
501	Floor tilers	99	1
513	Miners	105	1
530	Production workers	253	1
604, 608	Engineers except civil, machine and electrical	185	1
622	Laboratory assistants	174	1
658	Data-processing operators	10	3
660	Programmers	9	3
701	Tram and special railway conductors	130	1
707	Pilots	23	3
715	Train attendants	656	1
754	Waiters	116	1
763	Room servants	5	3
765	House servants	125	1
790	Occupations of public hygiene	77	1
800	Hairdressers	462	1
801	Other occupations of physical hygiene	22	3
811	Lawyers, notaries	410	2 → 815
813	Judges, public prosecutors	84	2 → 815
820	Police officers	942	1
831	Dentists, veterinarians, pharmacists	376	1
839	Hospital orderlies	207	1
844	Medical laboratory assistants	10	3
845	X-ray assistants	1	3
847	Other medical occupations	129	1
851	Natural scientists	51	1
900	University professors	101	1
940	Inadequate statement of occupation	238	4
990	Students	—	3
991	Persons without occupation	19	3

^a Taken from reference 8.

^b 1 = mortality experience not significantly divergent from that of the total population; 2 = combined into the category mentioned; 3 = not analyzed, too few deaths observed; and 4 = not analyzed, no interest.

24th international congress on occupational health

26 September — 1 October 1993, Nice (France)

On behalf of the International Commission on Occupational Health, the French Organizing Committee (OC 24 France), chaired by Dr Marianne Saux, and the scientific committee, chaired by Professor Jean-François Caillard, are organizing the 24th International Congress on Occupational Health, to be held in Nice, France, on 26 September — 1 October 1993. There will be key-note addresses, oral communications, posters, microsymposia, films, and an extensive exhibition on various aspects of occupational health. Simultaneous translation into French, English and Spanish will take place during the plenary sessions. Everyone working or interested in any sector of occupational and environmental health is invited to attend.

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