ORIGINAL ARTICLE

Cutaneous melanoma: hints from occupational risks by anatomic site in Swedish men

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Aims: To improve knowledge of the epidemiology of melanoma by comparing occupational risks of cutaneous melanoma (CM) by anatomic site in Swedish workers.
Methods: Male workers employed in 1970 and living in the country in 1960 were followed up from 1971 to 1989 using the Swedish Registers of Death and Cancer. A more specifically exposed subcohort included men reporting the same occupation in 1960 and 1970. For each location, occupational risk ratios (RRs) were extracted from Poisson regression models adjusted by age, period, town size, and geographical area. To diminish the influence of socioeconomic factors, intrasector analyses, comparing only jobs belonging to the same occupational sector, were performed. Risk patterns for different locations were compared.
Results: High RRs for different sites were found among workers exposed to UV sources (dentists, physiotherapists, and lithographers), and sun exposed workers (harbour masters, and lighthouse/related work). Risk excesses were seen in fur tailors, tanners/fur dressers, patternmakers/cutters, electrical fitters/wiremen, telephone/telegraph installers/repairmen, and some glass/pottery/tile workers. Results for lower and upper limbs were significantly correlated but somewhat independent of those found in thorax, the most frequent location. Correlation between head/neck and thorax was moderate. Specific risk excesses were found for rolling mill workers in head/neck, for chimney sweeps in upper limbs, and for aircraft pilots/navigators/flight engineers in lower limbs.
Conclusions: High RRs in the trunk among occupations with UV exposure from artificial sources suggest an effect not restricted to exposed sites. An unusual distribution of cases and RRs in chimney sweeps, rolling-mill, or glass/pottery/tile workers suggests local effects of exposures. The not previously reported risk excess in this job and in fur related processes, and the RR in electrical fitters and telephone/telegraph installers deserve further investigation. Disparities between locations, as RRs in thorax and limbs, may reflect differences in aetiological mechanisms.

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Although melanoma is one of the neoplasms with higher increases of incidence in the past 20 years, especially in fair skinned populations,[1] its aetiology remains poorly understood. Familial cases represent only 4–15%,[2] reflecting the fact that environmental factors are the most probable aetiological agents. Even among subjects with germline mutations in the CDKN2A gene, which are the most common cause of inherited susceptibility, the penetrance presents a geographical variation in agreement with rates observed in the general population.[3] Thus, environmental factors might also have an important role in familial melanoma. Nowadays, sun exposure is the only generally acknowledged aetiological agent,[4] complemented with the increased susceptibility that some cutaneous and pigmentary characteristics confer to sunburn,[5] which have been recently associated with certain melanocortin-1 receptor polymorphisms.[6] Sunlamps and sunbeds have also been related to the occurrence of this neoplasm.[7 8]

Differences in exposure or skin contact with harmful agents, including UV sources, might be linked, not only with the risk of the disease, but also with the anatomic site where it appears. Melanoma is more frequently found in covered parts of the body, not usually exposed to sunlight. Both sexes have a different site distribution: while the trunk is the most common location in men, legs are the primary site in women, and this different pattern is consistent in countries with large variation in latitude.[9] Differences in trends by site have also been described.[10–13] Some anatomic locations depict specific epidemiological features, such as a predominance of lentigo malignant melanoma and an older age at diagnosis in the head and neck.[14] These differences have been related to patterns of sun exposure,[15–17] or with a site dependent susceptibility of melanocytes.[18] Others have suggested the existence of different pathways that could be related with anatomic site.[19 20]

Occupational settings present a large variation in environmental exposures by anatomic site; consequently, comparison of anatomic risk distributions might be a source of hypothesis about the aetiology of this neoplasm. This approach led some authors to suggest that the increased risk of melanoma in white collar workers, particularly in office jobs,[21 22] and its preference for normally covered sites, could be due to the effect of intermittent sun exposure.[4 23 24] Recently the Association of Swiss Cancer Registries[25] has included melanoma by site in its global analysis of cancer per occupation. However, their data source is a pool of several registries with different occupational classifications and they use as reference all registered cases, which could underestimate effects in jobs highly exposed to carcinogens.

Our main objective is to study in a more comprehensive way the relation between occupation and melanoma in men by giving a comparative view of occupational risks of this neoplasm by sites within a whole country. The high rate of

Abbreviations: CM, cutaneous melanoma; RR, risk ratio; UV, ultraviolet; PCBs, polychlorinated biphenyls

Main messages

- Some occupations, such as electrical fitters, show a general risk excess of cutaneous melanoma, suggesting the existence of general promoting factors, while others have only site specific excesses, suggesting local effects of exposures.
- If occupational exposure to artificial UV devices increases the risk of cutaneous melanoma, its effect is not limited to exposed sites.
- Disparities between locations, such as RRs in thorax and limbs, may reflect differences in aetiological mechanisms.

Policy implications

- The not previously reported excess risk found in fur related processes, and in glass/pottery/tile works, should be further investigated

incidence of melanoma in Sweden[26] and the availability of a large historical cohort[27] make this country an ideal candidate for this analysis. This is a more homogeneous population, and the restriction imposed on all members of the cohort of being present in both the 1960 and 1970 censuses assures their residence in the country for at least 10 years.

The relation between total melanoma and occupation has already been studied in Sweden with a related cohort[28] and with our material, although with a shorter follow up period[29] or in the context of a general study relating occupation and all types of cancer.[30 31] None of these has focused on site specific analysis, nor has taken into account some of the main confounders already described for this country,[32] such as urban/rural distribution (probably a proxy of travel habits to sunny countries),[33] and geographical distribution (reflecting environmental UV exposure). Socioeconomic class has not been considered in these previous studies, despite its well known relation with melanoma,[22 34 35] which is thought to reflect lifestyle differences.

Our study presents site specific job title relative risks adjusted by town size and geographical distribution, and is based on comparisons within occupational sectors, to compare people with a more homogeneous socioeconomic status. We have also compared site risk distributions in order to determine any disparities or similarities between locations that could point to possible aetiological differences.

METHODS

The base population for this historical cohort was made up of Swedish men gainfully employed at the time of the 1970 census, present in the 1960 census, and still alive and aged 25–64 years on 1 January 1971. The cohort included 1 890 497 men followed up until the end of 1989, and, inside it, a subcohort including only those with the same occupation in both the 1960 and 1970 censuses, comprising 755 728 men.

Information was drawn from two linked data sets: (1) the Swedish Cancer Environment register, providing information on incident cases and including a number of demographic variables from the 1960 and 1970 censuses, which was used to compute specific rate numerators; and (2) a background population register comprising all individuals in the 1970 census, with information on occupation and residence in 1970, occupation in 1960, and, if applicable, date of death. This register was used to calculate specific rate denominators. The record linkage between these two registers has been described in detail elsewhere.[36] Melanoma was coded 190 in the International Classification of Diseases (7th revision). The fourth digit specifies anatomic site. All head and neck melanomas have been analysed together. It must be taken into account that cutaneous melanomas with multiple sites or non-specified location are included in the global melanoma data but not in the site analysis. They made up 0.7% and 10.6% of all registered melanomas respectively.

Person-years in each of 278 occupations were accumulated from 1971 until the date of death or up to the end of 1989. The overall person-time that each worker contributed to the study was allocated to the corresponding cells of the variables of stratification. These were occupation, county and size of town of residence in 1970, five year age classes, and the following calendar periods: 1971–75, 1976–80, 1981–85, and 1986–89. Occupation, town size, and county, drawn from the 1970 census, were regarded as fixed variables, while age and period were time dependent. Clayton's algorithm[37] was used in calculating the exact number of person-years.

Occupation was classified according to the Nordic Classification of Occupations.[36] Every occupation is represented by a three digit number. The first digit refers to one of 10 major occupational sectors (0–9), where higher numbers indicate manual occupations and lower numbers non-manual occupations, often requiring longer education and associated with a higher socioeconomic status. Expected cases were calculated for each occupation using the age-period specific rates for the whole cohort as referent. They were initially used to calculate age-period standardised incidence ratios (SIR).

On the assumption that the observed number of cases was distributed in each stratum as a Poisson variable, log-linear Poisson models were fitted to estimate risk ratios (RRs). First, the classification of Swedish counties into low, medium, or high risk for melanoma was carried out using a Poisson model adjusted by sex, age, period, occupational sector, and town size, and taking as reference the incidence for the whole country. Counties were grouped into three intervals according with their RRs: <0.85, 0.85–1.15, or >1.15 (see fig 1).

For each sector and occupation, RRs by site, adjusted by town size and geographical area, were calculated using log-linear Poisson models. Town size was included as a confounder since it showed a positive correlation with melanoma risk. In these models, the number of expected cases was introduced as an offset.[37] As the expected numbers were computed based on the age and period specific reference rates, RRs were likewise age and period adjusted.

Occupations with at least five observed cases of total cutaneous melanoma were analysed. Each occupation was compared only with others within the same occupational sector. In general, RRs for different sectors in the cohort and subcohort showed a socioeconomic gradation, with risk excesses in sectors 0–III (white collar workers), reduced risks in production sectors, mining, and agriculture, and an intermediate position for sectors VI (transport & communication) and IX (services), though in head/neck this gradation was not so evident. For this reason, we preferred this intrasectorial approach in order to contrast people with a more homogeneous socioeconomic status, though it might underestimate risks if there is any relevant exposure shared by workers in the whole sector (that is, sun exposure in agriculture). Production sectors (sectors VII and VIII) were treated as a single category.

These analyses were also repeated for all cases with the subcohort reporting the same occupation in the 1970 and in 1960 censuses, a more specifically exposed group which has

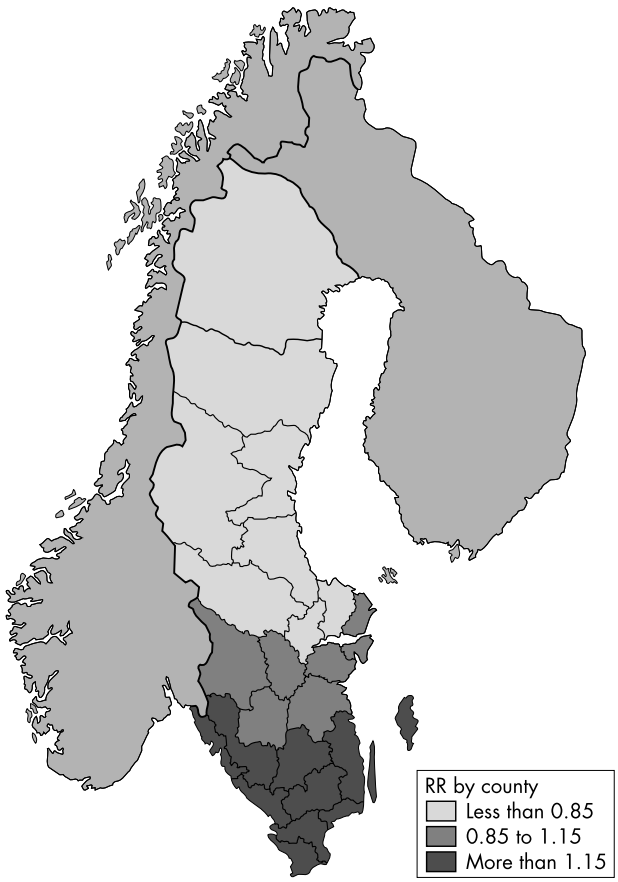

Figure 1 Distribution of risk by county adjusted by sex, age, period, occupational sector, and town size. Whole cohort.

been used mainly to check the consistency of the results found in the general cohort; however, the uneven reduction of the cohort that this restriction implies has several consequences: (1) a lower number of cases by job title, which reduces the statistical power or even makes it impossible to compute the risk in some jobs; (2) the absence of people in jobs which did not exist or were uncommon in men in 1960 (that is, systems analysts and programmers, or nurses), or in occupations with a lower stability (that is, those implying a promotion, such as staff officers); and (3) a slightly different composition of sectors between the subcohort and the cohort.

Logarithms of occupational RRs obtained with the whole cohort were subsequently used to asses similarities and differences in the risk pattern across different locations, using for each comparison all occupations with two or more cases in both locations considered. Results are presented graphically, highlighting occupations with high RRs and those with discrepant RRs for different sites. Pairwise site agreement was tested using Spearman's correlation coefficient.

RESULTS

During follow up, 6187 cases of cutaneous melanoma were found in the whole cohort and 2816 in the subcohort. Thorax and upper limbs accounted for 51% and 12% of the cases respectively in both. Head and neck melanomas were slightly more frequent in the subcohort (12% *v* 14%) and lower limbs in the general cohort (11% *v* 9%).

Tables 1 and 2 show age, period, town size and geographically adjusted intrasectorial RR by job title for all melanomas in the cohort and subcohort, and by sites in the cohort respectively. All occupations with a minimum of five cases in all melanomas and (a) RR $\geqslant$1.5 for global cutaneous melanoma, or (b) a minimum of three cases and RR $\geqslant$2 in any site, regardless of its statistical significance, are reported. For comparison purposes, all job titles fulfilling the established criteria were included in both tables. However, those jobs with less than three cases in all the specific sites are only reported in table 1. A higher cut-off has been used for specific sites as higher risks were also expected given the lower number of cases. Due to the complementary character of the information that cohort and subcohort analyses provide, the results of both approaches will be discussed together.

Risks in job titles not included in any of the tables are available, as well as RR using as reference the whole male working population, and can be provided on request. As expected, in this last analysis, a substantial proportion of occupations with increased RR belonged to sectors 0–III.

All cutaneous melanoma (table 1)

In general, results in the whole cohort and in the 60–70 subcohort were quite consistent. Significant increases of risks over 50% in the cohort (13 jobs) and/or in the subcohort (13 jobs) were found in 20 job titles if all cases are considered. In sectors 0–III it should be noted the risk excess found in certain health professions (dentists and physiotherapists/occupational therapists). Librarians/archivists and curators, composers/musicians, and insurance agents had significant RRs only in the subcohort analysis, while an excess of risk in university teachers was found in the cohort analysis alone. Well driller was the only job with increased RR in sector V. In several jobs comprising harbour workers, mostly from sector VI, there was also a significant RR (forwarding/shipping agents, harbour masters, and lighthouse/lock operators/ferry and harbour service assistants), while post office clerks had a consistent but lower RR. Of special interest within production sectors (VII and VIII) can be considered some occupations within textile industry, such as fur tailors and tanners/fur dressers, patternmakers/cutters, and leather good makers. It is also noteworthy that electrical fitters and wiremen, and telephone-telegraph installers and repairmen depicted a significant increased incidence. Another interesting result was the risk excess within the glass/pottery/tile industry, with an important, consistent, and significant RR in non-specified workers, and high and nearly significant RRs for glass formers/cutters. Additionally, truck/conveyor operators and typographers/lithographers had consistent high risks in both the cohort and the subcohort. In sector IX, catering supervisors had significant RRs only in the subcohort analysis, while risk excess among prison/reformatory officials was found in the whole cohort.

Head and neck (table 2)

A significant RR >2 was found in 10 job titles in the cohort analysis. Despite socioeconomic adjustment, most of the high risk jobs belonged to sectors 0–III (chemists, university teachers, ministers/priests, composers/musicians, social workers, bank employees, forwarding/shipping agents, and commercial travellers). Within blue-collar workers, only patternmakers and cutters, rolling-mill workers, non-specified glass/pottery/tile workers, and truck/conveyor operators had a statistically significant RR.

Thorax (table 2)

In six job titles, there was a significant RR >2 in the cohort, and in other three occupations a significant but lower RR was also found. Six of these nine jobs belonged to sectors V–VIII, thus showing a predominance of blue-collar occupations in this site after intrasectorial adjustment.

Table 1 Occupational risk of global cutaneous melanoma in Swedish men (whole cohort and subcohort)

	All cutaneous melanoma							
	Complete cohort				60–70 subcohort			
			Intrasectorial				Intrasectorial	
Occupational titles	C	SIR	RR	95% CI	C	SIR	RR	95% CI
SECTOR 0: Professional & technical work								
011 Chemists	13	129	1.00	0.58 to 1.72	6	207	1.46	0.65 to 3.26
012 Physicists	7	93	0.71	0.34 to 1.49	2	154	1.19	0.30 to 4.76
021 Veterinarians	6	242	1.94	0.87 to 4.34	5	263	2.16	0.90 to 5.21
023 Agricultural researchers/advisors	10	161	1.32	0.71 to 2.46	7	269	2.02	0.96 to 4.27
024 Forestry researchers/advisors	6	182	1.62	0.73 to 3.62	2	167	1.38	0.34 to 5.55
032 Dentists	***26***	***197***	***1.50***	***1.02 to 2.21***	***22***	***222***	***1.55***	***1.01 to 2.37***
045 Medical technicians	12	142	1.09	0.62 to 1.92	3	143	0.98	0.31 to 3.04
047 Physiotherap. & occupational therap.	**6**	**199**	**1.62**	**0.73 to 3.61**	**4**	**571**	**4.21**	**1.58 to 11.26**
050 Principals, headmasters	19	122	0.98	0.62 to 1.54	7	152	1.12	0.53 to 2.37
051 University. higher education teachers	***39***	***202***	***1.51***	***1.10 to 2.08***	8	182	1.22	0.60 to 2.45
052 Teachers in theoretical subjects	**79**	**159**	**1.25**	**1.00 to 1.57**	25	149	1.02	0.69 to 1.53
057 Educational methods advisors	15	158	1.21	0.73 to 2.01	0			
061 Ministers, priests	27	158	1.35	0.92 to 1.99	22	169	1.37	0.89 to 2.11
071 Judges & other lawyers in courts of law	10	187	1.40	0.75 to 2.61	7	233	1.57	0.75 to 3.32
073 Lawyers in private practice	9	202	1.51	0.79 to 2.91	6	200	1.34	0.60 to 3.01
074 Corporation & organisation lawyers	6	217	1.63	0.73 to 3.63	2	250	1.73	0.43 to 6.95
087 Composers & musicians	14	192	1.45	0.86 to 2.46	***12***	***293***	***1.96***	***1.11 to 3.48***
092 Social workers	22	181	1.43	0.94 to 2.17	6	261	1.81	0.81 to 4.05
093 Librarians, archivists, & curators	10	138	1.04	0.56 to 1.94	***8***	***381***	***2.65***	***1.32 to 5.33***
SECTOR II: Bookkeeping & clerical work								
290 Secretaries, typists, & related workers	15	174	1.39	0.83 to 2.33	3	333	2.49	0.79 to 7.92
292 Bank employees (general bank work)	23	160	1.21	0.79 to 1.85	8	200	1.41	0.68 to 2.95
294 Forwarding & shipping agents	***33***	***236***	***1.79***	***1.25 to 2.56***	***13***	***265***	***1.97***	***1.13 to 3.44***
296 Insurance raters, claims adjusters	20	186	1.48	0.94 to 2.32	9	265	1.88	0.92 to 3.82
SECTOR III: Sales work								
311 Insurance representatives & agents	16	194	1.57	0.95 to 2.58	***10***	***256***	***2.07***	***1.09 to 3.91***
313 Advertising salesmen	24	141	1.07	0.71 to 1.62	8	222	1.74	0.85 to 3.54
SECTOR IV: Agriculture, forestry, & fishing								
403 Forestry managers & supervisors	16	67	0.98	0.59 to 1.63	11	71	1.10	0.59 to 2.04
431 Fishermen	10	62	0.72	0.38 to 1.35	8	63	0.68	0.34 to 1.39
SECTOR V: Mining & quarrying								
502 Well drillers, diamond drillers	***6***	***154***	***3.64***	***1.35 to 9.82***	2	150	3.60	0.65 to 20.03
SECTOR VI: Transport & communications								
601 Ship deck officers	15	134	1.26	0.75 to 2.12	8	115	1.06	0.52 to 2.15
611 Ship deck and engine-room crew	10	100	0.98	0.52 to 1.83	3	73	0.70	0.22 to 2.18
621 Aircraft pilots, navigators, & flight engin.	6	176	1.83	0.82 to 4.11	4	190	1.94	0.72 to 5.26
641 Harbour masters	***6***	***284***	***2.70***	***1.20 to 6.04***	2	250	2.59	0.64 to 10.43
644 Road traffic supervisors	17	109	1.13	0.69 to 1.83	2	69	0.68	0.17 to 2.76
651 Post-office clerks	**20**	**160**	**1.60**	**1.02 to 2.51**	**10**	**200**	**2.08**	**1.10 to 3.91**
662 Messengers	25	114	1.05	0.70 to 1.58	5	139	1.29	0.53 to 3.14
671 Lighthouse, lock operat., harbour serv.	***7***	***237***	***2.85***	***1.35 to 6.01***	3	231	2.74	0.88 to 8.60
SECTORS VII & VIII: Production								
701 Textile workers	27	129	1.37	0.94 to 2.01	19	148	1.40	0.89 to 2.22
711 Tailors & dressmakers	6	92	1.03	0.46 to 2.30	4	83	0.84	0.32 to 2.25
712 Fur tailors	***9***	***332***	***3.49***	***1.81 to 6.73***	***7***	***350***	***3.41***	***1.62 to 7.18***
715 Patternmakers & cutters	***11***	***196***	***2.05***	***1.13 to 3.71***	6	182	1.70	0.76 to 3.80
726 Leather goods makers	5	159	1.74	0.72 to 4.19	4	250	2.48	0.93 to 6.62
731 Furnacemen	16	68	1.01	0.62 to 1.66	7	93	1.32	0.62 to 2.78
733 Rolling-mill workers	12	89	1.37	0.77 to 2.42	5	116	1.72	0.71 to 4.16
738 Other metal processing work	10	107	1.51	0.81 to 2.82	3	150	2.11	0.68 to 6.56
741 Precision toolmakers	17	97	1.11	0.69 to 1.79	6	118	1.26	0.56 to 2.81
743 Opticians	5	165	1.85	0.77 to 4.46	1	53	0.54	0.08 to 3.84
744 Dental technicians	6	131	1.47	0.66 to 3.27	6	158	1.63	0.73 to 3.63
756 Construction smiths	20	89	0.92	0.59 to 1.43	8	94	0.82	0.41 to 1.64
761 Electrical fitters & wiremen	**129**	**111**	**1.37**	**1.15 to 1.64**	***92***	***128***	***1.50***	***1.21 to 1.86***
766 Telephone & telegraph instal. & repair	***20***	***129***	***1.56***	***1.00 to 2.42***	2	118	1.30	0.32 to 5.20
768 Other electrical & electronic work	13	90	1.08	0.63 to 1.87	2	80	0.92	0.23 to 3.69
798 Other brick & concrete work	27	101	1.20	0.82 to 1.75	6	122	1.25	0.56 to 2.80
801 Typographers, lithographers	**69**	**129**	**1.40**	**1.10 to 1.78**	**52**	**136**	**1.37**	**1.03 to 1.81**
811 Glass formers & cutters	6	141	1.55	0.69 to 3.45	2	83	0.93	0.23 to 3.71
819 Non-spec. glass, pottery, & tile work	***12***	***192***	***2.31***	***1.31 to 4.09***	**4**	**308**	**3.59**	**1.34 to 9.62**
853 Tanner & fur dressers	6	185	2.04	0.91 to 4.55	***5***	***263***	***2.65***	***1.09 to 6.41***
875 Truck & conveyor operators	**64**	**116**	**1.44**	**1.12 to 1.84**	***16***	***150***	***1.72***	***1.05 to 2.82***
881 Packers	12	69	0.82	0.46 to 1.44	0			
SECTOR IX: Services & military work								
904 Prison & reformatory officials	***18***	***218***	***2.00***	***1.24 to 3.22***	4	133	1.01	0.37 to 2.72
911 Catering supervisors	18	171	1.53	0.95 to 2.46	***8***	***296***	***2.25***	***1.11 to 4.56***
921 Waiters and waitresses	9	123	1.05	0.54 to 2.04	7	184	1.36	0.64 to 2.92
933 Chimney sweeps	6	120	1.09	0.48 to 2.43	6	150	1.11	0.49 to 2.51
943 Launderers & dry-cleaners	6	90	0.77	0.35 to 1.74	3	91	0.65	0.21 to 2.04
945 Coaches, horse trainers	5	171	1.55	0.64 to 3.75	2	286	2.07	0.51 to 8.36
946 Photographers	11	118	1.03	0.57 to 1.88	7	125	0.92	0.43 to 1.96

C, cases; SIR, age-period standardised incidence ratio; RR, age-period-town size geographically adjusted intrasectorial risk ratio; CI, confidence interval. All occupations with a minimum of 5 cases in all cases and (a) RR ⩾1.5 for global cutaneous melanoma in the cohort or subcohort, or (b) a minimum of 3 cases and RR ⩾2 in any of the sites in the cohort, regardless of its statistical significance are reported. Italicised job titles have more than 5 cases, RR over the established threshold for all cases (1.50) and $p<0.05$. Bold text indicates only $p<0.05$. No occupation fulfilled the selected criteria in sector I (administrative and managerial work).

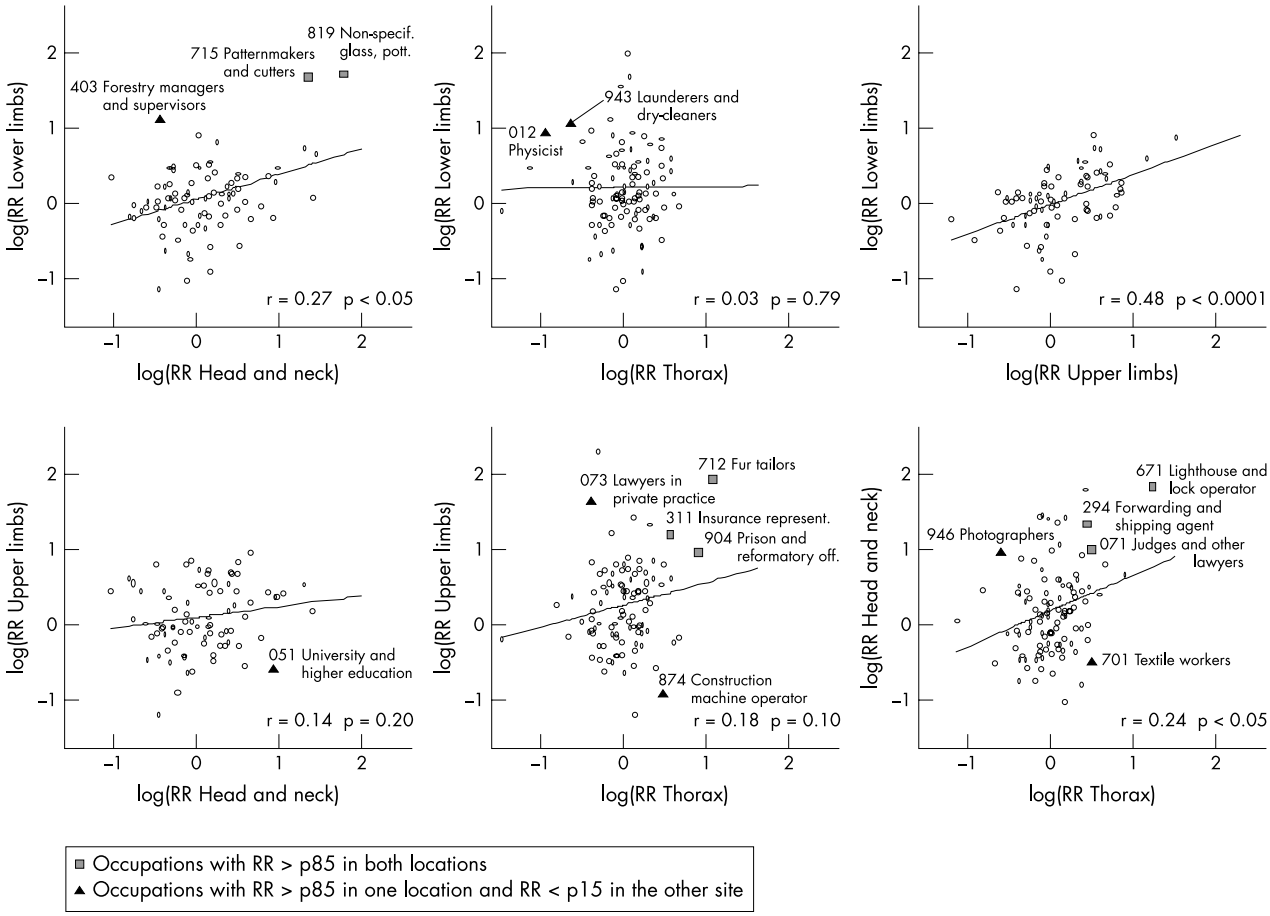

Figure 2 Linear regression and Spearman correlation coefficients between sites. All occupations with two or more cases in both locations are considered.

Veterinarians had a marked increase of risk, and a significant risk excess was also found in dentists, well drillers, harbour masters, lighthouse/lock operators/harbour service assistants, fur tailors, electrical fitters/wiremen, typographers/lithographers, and prison/reformatory officials.

Upper limbs (table 2)

In six job titles there was a statistically significant RR >2 in the cohort (teachers in theoretical subjects, lawyers in private practices, insurance agents, other brick/concrete work, typographers/lithographers, and chimney sweeps). Electrical fitters and wiremen had a slightly lower excess of risk, which also achieved statistical significance.

Lower limbs (table 2)

Only four job titles had significant increases of risk in this location, and all of them had very high RRs: forestry manager and supervisors, aircraft pilots/navigators/flight engineers, pattern makers/cutters, and non-specified glass/pottery/tile work. Almost significant high RRs were also found in precision toolmakers, packers, and launderers/dry cleaners.

Estimation of error due to chance

Table 3 shows an estimation of expected significant associations with RR >1 due to chance by site and analysis, assuming two tailed $\alpha = 0.05$. We also report the number of observed significant associations and those over the established threshold (1.5 for all cases and 2 for the sites). In general, between a third and a quarter of the statistically significant results might be due to chance. The use of a cut-off point should increase specificity of our results, even though RR also critically depends on the number of exposed workers. The importance of our findings should, however, be judged in the light of the available knowledge.

Correlations of results by sites

Figure 2 shows pairwise comparisons between occupational log(RR) per site. In each graph, those occupations with discordant risks (logRR <percentile 15 in one site and logRR >percentile 85 in the other) as well as jobs with increased risk (logRR >percentile 85 for both locations) are signalled. The absence of significant correlation of thorax with either lower or upper limbs is noteworthy. A significant correlation of 0.48 was found between upper and lower limbs, which increased to 0.54 when the analysis was restricted to occupations fulfilling the criteria used for inclusion in table 2. Head/neck had low but significant correlation with thorax and lower limbs, but not with upper limbs.

DISCUSSION

For many authors, a progressive change from predominantly occupational to predominantly recreational patterns of sun exposure is the most likely cause of the increasing incidence of melanoma in Caucasian populations.[9] However, and in accordance with our results, some workers are at increased risk of cutaneous melanoma, and the occupational pattern is not exactly the same in different sites. Holiday travel and leisure time activities cannot account for all the variability of risks found between occupations and their distribution per site. Westerdahl and colleagues[33] did not find differences in

Table 2 Occupational risk of cutaneous melanoma by anatomic site in Swedish men (whole cohort)

	Head and neck				Thorax				Upper limbs				Lower limbs			
			Intrasectorial				Intrasectorial				Intrasectorial				Intrasectorial	
Occupational titles	C	SIR	RR	95% CI	C	SIR	RR	95% CI	C	SIR	RR	95% CI	C	SIR	RR	95% CI
SECTOR 0: Professional & technical work																
011 Chemists	***5***	***460***	***4.21***	***1.72 to 10.27***	6	115	0.88	0.39 to 1.97	1	78			0			
012 Physicist	0				2	51	0.38	0.09 to 1.52	1	104			3	322	2.62	0.83 to 8.23
021 Veterinarians	0				***6***	***472***	***3.87***	***1.73 to 8.64***	0				0			
023 Agricultural researchers/advisors	1	132			6	188	1.58	0.71 to 3.54	1	129			2	284	2.36	0.58 to 9.54
024 Forestry researchers/advisors	0				4	234	2.19	0.82 to 5.85	1	243			1	258		
032 Dentists	4	244	2.19	0.81 to 5.91	**17**	**251**	**1.95**	**1.20 to 3.15**	2	122	0.84	0.21 to 3.37	2	130	0.97	0.24 to 3.90
045 Medical technicians	0				7	162	1.27	0.60 to 2.67	0				3	325	2.47	0.79 to 7.75
050 Principals, headmasters	5	255	2.38	0.97 to 5.81	7	86	0.70	0.33 to 1.48	4	206	1.54	0.57 to 4.16	3	180	1.45	0.46 to 4.54
051 University, higher education teachers	***6***	***286***	***2.53***	***1.11 to 5.75***	19	191	1.46	0.93 to 2.31	2	81	0.56	0.14 to 2.27	3	123	0.84	0.27 to 2.63
052 Teachers in theoretical subjects	7	129	1.16	0.54 to 2.48	32	123	0.98	0.69 to 1.40	***17***	***272***	***2.04***	***1.24 to 3.36***	13	215	1.70	0.96 to 3.00
057 Educational methods advisors	1	95			7	142	1.09	0.52 to 2.29	3	251	1.83	0.59 to 5.74	3	267	2.05	0.65 to 6.41
061 Ministers, priests	***7***	***290***	***2.89***	***1.33 to 6.26***	11	129	1.12	0.62 to 2.04	4	188	1.51	0.56 to 4.10	1	53		
071 Judges & other lawyers in courts of law	2	306	2.70	0.67 to 10.93	6	221	1.65	0.74 to 3.69	1	148			0			
073 Lawyers in private practice	1	169			2	88	0.66	0.16 to 2.63	***4***	***725***	***5.20***	***1.93 to 14.02***	0			
074 Corporation & organisation lawyers	0				3	208	1.52	0.49 to 4.74	1	290			0			
087 Composers & musicians	***4***	***451***	***4.11***	***1.52 to 11.13***	6	161	1.21	0.54 to 2.71	1	109			0			
092 Social workers	***4***	***297***	***2.69***	***1.00 to 7.28***	8	128	1.01	0.50 to 2.02	3	194	1.45	0.46 to 4.54	3	202	1.61	0.51 to 5.03
093 Librarians, archivists, & curators	1	95	0.83	0.12 to 5.96	4	111	0.83	0.31 to 2.23	1	111			2	252	1.89	0.47 to 7.62
SECTOR II: Bookkeeping & clerical work																
290 Secretaries. typists & related workers	1	97			8	181	1.36	0.67 to 2.77	1	92			3	297	2.19	0.68 to 7.08
292 Bank employees (general bank work)	***6***	***361***	***4.05***	***1.67 to 9.81***	10	139	0.98	0.52 to 1.86	3	160	1.19	0.37 to 3.85	3	162	1.09	0.34 to 3.52
294 Forwarding & shipping agents	***6***	***360***	***3.74***	***1.54 to 9.09***	16	222	1.57	0.94 to 2.63	4	226	1.70	0.61 to 4.76	5	305	2.10	0.83 to 5.34
296 Insurance raters. claims adjusters	2	155	1.56	0.37 to 6.57	11	198	1.47	0.80 to 2.71	0				2	164	1.17	0.28 to 4.85
SECTOR III: Sales work																
311 Insurance representatives & agents	0				10	232	1.79	0.95 to 3.37	***4***	***389***	***3.26***	***1.19 to 8.96***	2	221	1.84	0.45 to 7.53
313 Advertising salesmen	2	110	0.95	0.23 to 3.88	13	147	1.06	0.61 to 1.86	3	140	1.04	0.32 to 3.31	3	145	1.04	0.33 to 3.34
SECTOR IV: Agriculture, forestry, & fishing																
403 Forestry managers & supervisors	2	68	0.63	0.15 to 2.59	6	48	0.84	0.37 to 1.92	1	34			***5***	***195***	***3.07***	***1.16 to 8.15***
431 Fishermen	1	46			4	49	0.61	0.23 to 1.66	1	50			3	172	2.30	0.69 to 7.64
SECTOR V: Mining & quarrying																
502 Well drillers, diamond drillers	1	216			***4***	***199***	***5.13***	***1.42 to 18.54***	0				0			
SECTOR VI: Transport & communications																
601 Ship deck officers	1	72			7	122	1.04	0.49 to 2.20	3	213	2.10	0.65 to 6.78	1	78		
611 Ship deck and engine-room crew	0				6	117	1.05	0.47 to 2.37	3	233	2.44	0.76 to 7.86	0			
621 Aircraft pilots, navigators, & flight engin.	0				2	110	1.04	0.26 to 4.21	0				***3***	***749***	***7.45***	***2.28 to 24.27***
641 Harbour masters	0				***5***	***465***	***4.22***	***1.74 to 10.24***	0				0			
644 Road traffic supervisors	1	51			10	124	1.20	0.64 to 2.26	4	205	2.34	0.85 to 6.49	2	117	1.18	0.29 to 4.87
651 Post-office clerks	2	131	1.52	0.37 to 6.26	9	140	1.31	0.67 to 2.54	3	190	2.02	0.63 to 6.47	1	71		
662 Messengers	3	85	0.89	0.27 to 2.88	11	103	0.91	0.50 to 1.68	6	222	2.22	0.94 to 5.25	3	130	1.12	0.34 to 3.62
671 Lighthouse, lock operat, Harbour serv.	2	502	6.24	1.51 to 25.85	***5***	***331***	***3.48***	***1.43 to 8.46***	0				0			

Table 2 Continued

Occupational titles	Head and neck				Thorax				Upper limbs				Lower limbs			
			Intrasectorial				Intrasectorial				Intrasectorial				Intrasectorial	
	C	SIR	RR	95% CI	C	SIR	RR	95% CI	C	SIR	RR	95% CI	C	SIR	RR	95% CI
SECTORS VII & VIII: Production																
701 Textile workers	2	66	0.62	0.15 to 2.49	16	154	1.62	0.98 to 2.65	5	193	2.21	0.91 to 5.38	2	89	0.96	0.24 to 3.88
711 Tailors & dressmakers	0				6	189	2.10	0.94 to 4.70	0				0			
712 Fur tailors	1	292			***4***	***286***	***2.95***	***1.10 to 7.87***	**2**	**588**	**6.79**	**1.69 to 27.38**	1	338		
715 Patternmakers & cutters	***3***	***405***	***3.88***	***1.24 to 12.13***	3	105	1.08	0.35 to 3.36	1	143			**3**	**489**	**5.40**	**1.72 to 16.91**
726 Leather goods makers	0				3	187	2.03	0.65 to 6.29	1	254			0			
731 Furnacemen	2	64	0.89	0.22 to 3.61	8	66	1.01	0.50 to 2.04	4	135	2.20	0.81 to 5.96	0			
733 Rolling-mill workers	***5***	***285***	***4.27***	***1.74 to 10.46***	4	59	0.91	0.34 to 2.44	1	59			2	131	1.95	0.48 to 7.90
738 Other metal processing work	2	158	2.07	0.51 to 8.34	3	64	0.91	0.29 to 2.82	1	86			1	98		
741 Precision toolmakers	2	96	1.03	0.25 to 4.13	7	78	0.88	0.42 to 1.85	3	135	1.67	0.53 to 5.24	4	197	2.48	0.92 to 6.69
743 Opticians	0				3	191	2.13	0.69 to 6.63	1	260			1	273		
744 Dental technicians	0			to	4	168	1.86	0.70 to 4.97	1	173			1	185		
756 Construction smiths	3	109	1.04	0.33 to 3.25	9	78	0.79	0.41 to 1.52	5	176	2.05	0.84 to 4.98	2	77	0.87	0.22 to 3.52
761 Electrical fitters & wiremen	15	113	1.26	0.75 to 2.12	**64**	**107**	**1.32**	**1.02 to 1.69**	**19**	**129**	**1.74**	**1.09 to 2.78**	16	117	1.53	0.92 to 2.55
766 Telephone & telegraph instal. & repair	1	60			8	100	1.21	0.60 to 2.42	1	50			1	53		
768 Other electrical & electronic work	2	115	1.30	0.32 to 5.22	6	81	0.97	0.43 to 2.17	0	0			3	179	2.27	0.73 to 7.10
798 Other brick & concrete work	5	155	1.67	0.69 to 4.04	8	58	0.68	0.34 to 1.37	***6***	***178***	***2.30***	***1.02 to 5.17***	3	97	1.23	0.39 to 3.85
801 Typographers, lithographers	6	93	0.94	0.41 to 2.11	**37**	**136**	**1.45**	**1.04 to 2.02**	***13***	***193***	***2.35***	***1.34 to 4.15***	7	111	1.31	0.61 to 2.80
819 Nontospec. glass, pottery, & tile work	***5***	***578***	***5.96***	***2.45 to 14.51***	4	127	1.53	0.57 to 4.08	0	0			***3***	***434***	***5.49***	***1.75 to 17.24***
875 Truck & conveyor operators	**12**	**173**	**1.93**	**1.08 to 3.44**	31	110	1.37	0.96 to 1.96	7	101	1.33	0.63 to 2.81	4	63	0.81	0.30 to 2.17
881 Packers	1	41			5	57	0.68	0.28 to 1.63	1	46			4	212	2.66	0.99 to 7.14
SECTOR IX: Services & military work																
904 Prison & reformatory officials	2	219	1.93	0.47 to 8.02	***11***	***255***	***2.46***	***1.33 to 4.54***	3	287	2.60	0.80 to 8.40	0			
911 Catering supervisors	1				8	147	1.34	0.66 to 2.73	2	152	1.40	0.34 to 5.78	3	256	1.78	0.55 to 5.72
921 Waiters and waitresses	0				5	132	1.10	0.45 to 2.70	1	108			3	351	2.54	0.78 to 8.27
933 Chimney sweeps	0				1	39			**3**	***473***	***4.60***	***1.42 to 14.88***	2	338	2.41	0.58 to 9.96
943 Launderers & dry-cleaners	1	115			2	58	0.52	0.13 to 2.09	0				3	415	2.98	0.93 to 9.57
945 Coaches, horse trainers	1	303			3	199	1.89	0.60 to 5.93	0				0			
946 Photographers	3	279	2.62	0.81 to 8.49	3	62	0.54	0.17 to 1.70	2	169	1.45	0.35 to 6.00	2	179	1.34	0.33 to 5.53

C, cases; SIR, age-period standardised incidence ratio; RR, age-period-town size-geographically adjusted intrasectorial risk ratio; CI, confidence interval. All occupations with a minimum of 5 cases in all cases and (a) RR ⩾1.5 for global cutaneous melanoma in the cohort or subcohort, or (b) a minimum of 3 cases and RR ⩾2 in any of the sites in the cohort, regardless of its statistical significance are reported. Italicised job titles have ⩾3 cases, RR over the established threshold for the sites (2.00) and $p<0.05$. Bold text indicates only $p<0.05$. No occupation fulfilled the selected criteria in sector I (administrative and managerial work).

Table 3 Estimation of observed and expected associations due to chance by site and analysis

	All cases				Head & neck				Thorax				Upper limbs				Lower limbs			
	Total*	Ex	ob	thr	Total†	ex	ob	thr	Total†	ex	ob	thr	Total†	ex	Ob	thr	Total†	ex	ob	thr
Cohort	168	4.2	21	12	77	1.9	13	10	153	3.8	12	6	83	1.9	7	6	82	2.1	4	4
Subcohort	112	2.8	14	11																

*Number of occupations with more than five cases in all cases, i.e. number of comparisons done.
†Number of occupations with more than five cases in all cases and three cases in this site, i.e. number of comparisons done.
ex, number of expected significant RRs >1 for two tailed $\alpha = 0.05$; ob, number of observed significant RRs >1; thr, number of observed significant RRs over the threshold signalled (1.5 for all cases and 2 for the sites).

travel habits to south Europe between Swedish patients with different site locations. Furthermore, the use as reference group of people working in its own professional sector for each job title should at least partially control confounding due to those factors, which are highly related with socio-educational status.

Population occupational studies such as ours imply multiple comparisons, which might produce a certain number of spurious significant associations, the so-called mass significance phenomenon. We have tried to quantify this source of error, and in table 3 we provide an estimation of expected associations due to chance by site and analysis, together with the real number of associations obtained. However, we have also taken into account several considerations to weight the plausibility of the associations found. First, consistency between cohort and subcohort analysis results has been valued, because, though highly related, both analyses have been done separately. Second, more credit has been given to high RRs found in jobs with quite similar occupational exposures. Finally, those results already highlighted in the literature are specifically discussed.

For all cutaneous melanoma, our results show, in the first place, a significant risk excess in the cohort and subcohort analyses for all cases in dentists. Higher incidences than expected by chance for dentistry have been found in pooled SIR of Nordic countries and individually in Norway, Sweden, and Denmark,[30] Switzerland,[25] England,[38] and the USA.[39] Typographers/lithographers had also consistent and significant excess. Printers have been associated with melanoma in the combined analysis of incidence in four northern European countries—including Sweden.[30] Swiss cancer registers[25] described a significant OR of 1.6 for all printers, and 1.7 for the subcategory including lithographers. In a more specific way, Nielsen and colleagues[40] found a significant RR of 3.4 in their study of incidence in a cohort of Danish lithographers. Increases in melanoma mortality in printers have been reported in the USA and France.[41 42] It could be hypothesised that these associations might be attributed to the use of artificial sources of UV radiation in these two jobs,[43] which could also account for the high RR for physiotherapists in the subcohort. However, this possible explanation cannot justify the negative results in other jobs with known exposure to UV radiation,[43] such as welders. Site distribution of risk does not clarify this hypothesis. For sun exposure, Chen and colleagues[44] found that a history of sunburn at an anatomic site was specifically related to the development of malignant melanoma at that particular site. The most commonly accepted intermittent sun exposure theory also points towards this site specificity, more than to a general ''solar circulating factor'' which would increase global melanoma risk.[45] If an analogous effect were expected for other UV sources, it must be noted that workers exposed are usually dressed; thus exposure occurs mainly in head and neck, or upper limbs if short sleeves are worn. Our data show a non-significant high risk in the head and neck for dentists and a significant excess in upper limbs in lithographers/typographers, but in both jobs there is also an unpredicted significant increase in the thorax. For Swiss printers including lithographers,[25] a significant OR for lower limbs, and a high, though non-significant OR in the head/neck and thorax has been reported, while four out of five of Danish lithographers' melanomas were situated in the trunk. However, as the relation between sun and melanoma is not yet clarified, it is possible that UV effects from solar or non-solar sources could be both local and general.

Harbour masters, and lighthouse and related workers, who could be intermittently sun exposed, had a significant global excess of risk, with high RR in the thorax and head/neck. Similar results were observed in truck/conveyor operators.

Of special interest are the non-previously reported increased risks in fur tailors (both in the cohort and in the subcohort for all cutaneous melanomas, as well as in thorax, and upper limbs), and in tanners and fur dressers. Fur tailors are exposed to trichloroethylene, which was related to an excess of melanoma in a Canadian case-control study;[46] an increased incidence was also found in a Californian community where drinking water was contaminated with ammonium perchlorate and trichloroethylene.[47] However, the fact that both steps in the manufacture of furs have significant excesses of incidence points to common substances used by both jobs, and rests of dyes or chemicals used by fur dressers, still present in the fur at its tailoring process, could be mobilised with the high temperatures of ironing. We also found a higher risk of melanoma in patternmakers/cutters, with a significant RR >2 for all cases, head/neck, and lower limbs.

It is interesting to point out that electrical fitters/wiremen had a consistent increased incidence in each site; though only in the thorax and upper limb does it achieve statistical significance. High risks in electrical workers, with[48] or without socioeconomic adjustments,[46 48–50] have been reported. This risk excess has been related to polychlorinated biphenyl (PCB) exposure through skin contact, and a dose-response effect has been described,[51] although others have failed to find a clear trend. The generalised effect in all sites found in our data could point towards an exposure affecting the whole body, for example, cloth contamination by PCBs, but other explanations have also been proposed. Telephone/telegraph installers and repairman presented a high global RR, with a non-significant small increase in thorax. Some authors have found a relation between electromagnetic fields (EMF) and melanoma,[52 53] which could explain the results in these latter occupations. However, there is not yet enough scientific evidence to support this association.[54]

A very high RR in non-specified glass/pottery/tile workers has been found in global data, head/neck, and lower limbs. This job title might include crystal glassmakers and some glass blowers, and decorating glass and artistic glaziers. Interestingly glass formers/cutters had nearly significant high risks if all melanomas are considered. Furthermore, another glass industry occupation (glass/ceramic kilnmen), not included in the tables as it only had four cases of melanoma, also showed non-significant risk excess for global melanoma, accompanied by a significant RR of 3.18 in the thorax. These results have not been previously reported, not even in a

former study of mortality in the Swedish glass industry.[55] Their work environment is highly complex, and workers come into close contact with a variety of potentially hazardous agents, including metals such as arsenic and lead in art glass.[56]

The head/neck is generally considered to be a chronically sun exposed site, and presents a higher proportion of lentigo malignant melanoma,[14 57] whose most widely accepted risk factor is long term cumulative UV radiation.[58] Thus, higher risks in this site could be expected for outdoor workers; in fact, a risk excess in such occupations as construction workers,[59] or farmers[25] has been reported. Our data, in contrast, show a clear majority of indoor jobs, mostly belonging to high socioeconomic sectors. We do not have a specific hypothesis to explain the high RR in university teachers, priests, composers/musicians, or social workers. Intrasectorial variation in the frequency of travel to foreign countries would perhaps justify these results; however, this would not explain why they failed to show clearer risk excess for other locations. High risk of all cutaneous melanoma has been previously reported in teachers and priests or other religious workers in Norway and Finland[30] or in Switzerland,[25] but socioeconomically adjusted estimators, only provided in the last study, did not confirm this excess. Several studies have suggested a higher risk of melanoma for chemical workers,[30 60] though in our study it was mainly limited to head and neck. Finally, raised risk of melanoma in rolling mill workers has been previously found.[61]

Chimney sweeps had increased incidence in upper limbs, and a high, though not significant RR in lower limbs. In this occupation five of six cases are not located in the thorax, which might suggest skin contact with a harmful agent. The Swiss study[25] did not find any melanoma cases in this occupation.

In lower limbs, it is noteworthy that a high RR is found in aircraft pilots/navigators/flight engineers. Flight crews have been repeatedly associated with an excess of melanoma, and usually with high risk estimators.[38 62–64] A recent meta-analysis reported a combined, socioeconomically adjusted RR among male pilots for melanoma mortality of 1.97.[65] Despite this, no estimation of risk by site has been published, and usually information about anatomic location is scarce. This risk excess has been mainly attributed to sunbathing in sunny destinies, as UV exposure on the flight deck is negligible.[66] Other alternative occupational factors, such as melatonin disturbances or radiation dose have been proposed, since risk increases with hours of flight.[62 63] However, if their risk was mainly focused on legs, it could be related to clothing habits, as they might be more prone to wear short trousers than other workers, favouring intermittent sun exposure. Forestry managers/supervisors also had a non-previously reported significant RR of 3 in the lower limbs. The use of the global cohort as a reference did not substantially modify these results, signalling that they are not probably due to a privileged socioeconomic status within their sector.

Being the most frequent location, results in the thorax mostly mirrored those found for all sites combined, with some exceptions, such as the significant RR observed in veterinarians. As in our study, Goodman and colleagues[39] found a significant risk excess in this site for indoor/outdoor and outdoor workers after adjusting for training level and birth place. In general, it is difficult to think of local occupational exposures occurring preferentially in the thorax, which is usually a cloth covered site, but those factors with a global promoting effect for melanoma should also show their effect at this location, which represents 32% of the whole skin surface.[67]

Correlation coefficients showed that, globally, the pattern of risk was different in thorax and limbs, while upper and lower limbs results were significantly correlated. This curious finding could perhaps be explained by more similar patterns of occupational—or non-occupational—exposure to agents increasing risk of melanoma, including UV radiation. An alternative explanation could be the site specific differences in susceptibility to melanoma[18] or the existence of two site related different pathways for this neoplasm[19 20] that some authors have proposed, with the skin of both limbs in men being considered more alike than that of the trunk.

Of interest is the fact that the head and neck failed to correlate with the upper limbs, but showed a significant small correlation with the thorax and lower limbs.

In summary, a high incidence among dentists and printers/lithographers in the trunk only supports the aetiological role of occupational artificial sources of UV radiation if their effect is presumed not to be restricted to exposed sites. High RRs in certain locations and the unusual site distribution of cases found in occupations such as chimney sweeps, or rolling-mill or non-specified glass/pottery/tile workers could hint towards agents with a local effect. A generalised increase of risk in electrical fitters and high RR in telephone/telegraph installers, as well as the not previously reported risk excess of melanoma in glass/tile/pottery workers and in fur related processes requires further investigation. Regarding site correlation, different patterns might be due to an uneven distribution of exposures or to site differences in susceptibility.

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