Occupation and malignant melanoma: a study based on cancer registration data in England and Wales and in Sweden

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Abstract

An analysis of the incidence of malignant melanoma according to occupation is presented using data from two national cancer registries. The data relate to 3991 cases of cutaneous malignant melanoma, 662 cases of ocular melanoma, and 179 cases of non-cutaneous, non-ocular melanoma in subjects aged 15-64 in England and Wales diagnosed from 1971 to 1978 and to 5003 cases of cutaneous malignant melanoma diagnosed from 1961 to 1979 in Sweden in subjects born between 1896 and 1940. Professional workers of both sexes in both countries experienced an excess incidence of cutaneous malignant melanoma. An excess of ocular melanoma and of non-cutaneous, non-ocular melanoma also existed for this group in England and Wales. Pharmacists, medical doctors, and dentists had a high incidence of cutaneous melanoma in both countries and were represented three times when listing the top 20 occupations in both countries and both genders. Combining the data from cutaneous malignant melanoma over both sexes and both registries the occupations with the highest incidence ratios (expressed as a percentage) were: airline pilots, incidence ratio (IR) = 273, (95% confidence limits 118-538); finance and insurance brokers IR = 245 (140-398); professional accountants IR = 208 (134-307); dentists IR = 207 (133-309); inspectors and supervisors in transport IR = 206 (133-304); pharmacists IR = 198 (115-318); professionals not elsewhere classified IR = 196 (155-243); judges IR = 196 (126-289); doctors IR = 188 (140-248); university teachers IR = 188

(110-302); and chemists IR = 188 (111-296). No particular exposure in the workplace seemed to link these groups and only a few worked in high technology environments. Many of the highest risk groups have in common a high level of education. In England and Wales and in Sweden this might correlate particularly with foreign travel and residence in childhood, when travel abroad was more unusual than it is now, but evidence on present and past exposure to sun by occupation is needed to clarify the reasons for the association.

The occurrence of malignant cutaneous melanoma has been linked to patterns of exposure to sun as well as to phenotypic factors, such as eye colour, complexion, or propensity to burn in the sun.¹ Malignant cutaneous melanoma is more common in the higher social classes, the better educated, and office workers than in other workers.²⁻⁵ The distribution of melanoma by occupational groups has been interpreted as resulting from differences in exposure to sun, notably the number of episodes of intermittent exposure, between these occupational groups.⁶

Specific occupational associations of melanoma have been reported.⁷⁻²³ Olsen and Jensen screening the Danish Cancer Registry for occupational clusters²³ found an excess of melanomas in occupations characterised as community, social, and personal services, in male workers in "communication," and in textile manufacturing.²³

It is not clear, however, whether occupational risk factors are involved in the occupational associations reported. It has been argued that the associations may have arisen by chance, since a large number of occupations have been examined in several studies.²⁴ On the other hand, other researchers have suggested that the findings are not entirely haphazard. Reynolds, in a review of occupation and melanoma, concluded that some occupationally related risk factor may exist in high technology occupations and environments.²⁵

The study reported here analysed and compared the occupational distribution of malignant melanoma in England and Wales and in Sweden and identified occupations with a high incidence of melanoma in both countries. Melanoma of the skin in the two countries and for men and women were analysed

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separately. In addition, data on ocular melanoma and on non-cutaneous, non-ocular melanoma from England and Wales were analysed.

Material and methods

The study was based on cases of malignant melanoma from the cancer registries of England and Wales and of Sweden. In England and Wales registered cases of malignant melanoma occurring in subjects aged 15–64 during the period 1971–8 were included. There were 3991 such cases of malignant cutaneous melanoma (ICD 8 = 172). In addition, 662 cases of ocular melanoma (ICD8 = 191) and 179 cases of non-cutaneous, non-ocular melanoma were studied. The histological types included for ocular and non-cutaneous, non-ocular tumours were all categories of melanoma in the Manual of Tumor Nomenclature and Coding, except lentigo maligna.²⁶ Information about occupation for men and women was that recorded at cancer registration and was coded according to the OPCS classification system.²⁷ Women were coded according to their own occupation.

In Sweden the cases of malignant melanoma were those incident during the period 1961–79. They were obtained from the Swedish Cancer Environment Registry—a linkage of the 1960 population census to the cancer registry of 1961–79.²⁸ The Swedish data were restricted to those born between 1896 and 1940 and included only cases of malignant cutaneous melanoma, giving a total of 5003 cases. Information about occupation was from the 1960 population census and coded according to the Nordic Classification

of Occupations.²⁹ Women were coded according to their own occupation.

The English and Welsh and the Swedish materials were initially analysed separately. Methods of calculating the ratio of observed to expected cases of melanoma for a particular occupation differed. For the England and Wales data, age adjusted proportional registration ratios (PRRs) were calculated. The PRR is a comparison of the proportion of all cancer which melanoma constitutes in a particular occupation with the corresponding proportion in all occupational groups combined, adjusting for age. For the Swedish data standardised registration ratios (SRR) were calculated. The SRR is a comparison of the number of observed cases in a particular occupation with the expected number, derived from the number of people at risk in that occupation at the beginning of the period, controlling for age and county of residence. Approximate 95% confidence limits were calculated for SRRs and PRRs according to the method of Rothman and Boice.³⁰

Results

Table 1 gives for England and Wales the PRRs for men by broad occupational orders for cutaneous melanoma, ocular melanoma, and non-cutaneous, non-ocular melanoma. Industrial and manual occupations generally had a lower incidence of cutaneous melanoma than expected whereas administrators and managers, professionals, clerical workers, sales workers, and the armed forces had an excess. Furthermore, the occupational groups with the high PRRs for cutaneous melanoma tended also to have

Table 1 Proportional registration ratios (PRRs) for melanoma by occupational order, men, England and Wales

Occupational order	Cutaneous melanoma			Ocular melanoma			Non-cutaneous, ocular non-melanoma		
	No of cases	PRR	(95% CL)	No of cases	PRR	(95% CL)	No of cases	PRR	(95% CL)
I Farmers, foresters, fishermen	69	101	(79–128)	16	94	(54–153)	3	95	(19–238)
II Miners, quarrymen	24	49	(31–73)**	9	67	(31–127)	2	83	(9–300)
III Gas, coke, chemical	12	60	(31–105)	4	85	(23–218)	1	113	(1–631)
IV Glass, ceramics	4	64	(17–164)	1	64	(1–356)	0	—	—
V Furnace, etc	16	76	(43–123)	2	37	(4–134)	0	—	—
VI Electrical, electronic	63	98	(75–125)	16	118	(67–192)	6	230	(84–588)
VII Engineering, etc	297	88	(78–99)**	71	91	(71–115)	17	117	(68–187)
VIII Woodworkers	41	86	(62–117)	17	155	(90–248)	2	96	(11–341)
IX Leather workers	7	92	(37–190)	2	102	(11–368)	0	—	—
X Textile workers	14	100	(55–168)	3	86	(17–252)	0	—	—
XI Clothing workers	5	61	(20–142)	2	93	(10–336)	0	—	—
XII Food, drink, tobacco	27	91	(60–132)	9	121	(55–230)	0	—	—
XIII Paper, printing	15	61	(34–101)	5	89	(29–208)	0	—	—
XIV Makers other products	20	105	(64–162)	1	22	(0–122)	2	236	(27–880)
XV Construction	78	88	(70–110)	15	73	(41–120)	3	77	(16–224)
XVI Painters, decorators	31	71	(48–101)	4	37	(10–95)*	0	—	—
XVII Drivers of stationary engines, etc	17	43	(25–69)**	5	51	(16–119)	2	111	(12–401)
XVIII Labourers, nec	95	53	(43–65)**	22	48	(30–73)**	7	83	(33–173)
XIX Transport, etc	169	82	(70–95)**	49	101	(75–134)	11	121	(60–230)
XX Warehousemen, etc	38	55	(39–75)**	23	126	(80–189)	5	151	(49–338)
XXI Clerical workers	210	137	(119–157)**	51	138	(103–181)*	5	72	(23–161)
XXII Sales workers	162	125	(106–146)**	37	125	(88–172)	7	123	(49–258)
XXIII Service, sport, etc	138	100	(84–118)	39	115	(82–157)	5	79	(25–188)
XXIV Admin and managers	199	163	(141–187)**	38	137	(97–188)	6	114	(42–248)
XXV Professional, etc	320	161	(144–180)**	50	127	(94–167)	13	162	(86–271)
XXVI Armed forces	38	181	(128–248)**	1	29	(0–162)	0	—	—

*p < 0.05.

**p < 0.01.

CL = Confidence limits.

Table 2 Occupational units with highest proportional registration ratios (PRRs) for cutaneous melanoma, England and Wales 1971-8

Occupational unit				
Code	Title	No of cases	PRR	(95% CL)
Men				
Twenty occupations with the highest PRR				
199	Work study, etc	7	363	(146-751)**
202	Metallurgists	3	318	(64-932)
117	Aircraft pilots, etc	4	291	(79-748)
115	Deck, engineering officers, etc	9	287	(131-546)*
149	Finance & insurance brokers, etc	12	280	(145-490)**
192	University teachers	9	265	(121-504)**
217	Professionals nec	14	254	(139-426)**
174	Local authority senior officials	7	248	(99-511)
210	Company secretaries, etc	5	227	(73-530)
213	Clergy, etc	12	224	(116-392)*
178	Personnel managers	5	221	(71-516)
195	Civil engineers, etc	17	213	(124-341)**
064	Fibre preparers	3	212	(43-622)
206	Authors, journalists, etc	12	210	(108-367)*
214	Judges, barristers, etc	10	200	(96-368)
205	Physical & bioscientists	8	197	(85-388)
212	Architects, etc	9	197	(90-375)
159	Restaurateurs	10	192	(92-354)
156	Hotel proprietors, etc	8	191	(82-377)
221	Armed forces (UK)	38	190	(134-261)**
Other occupations with PRR > 150 (p < 0.05)				
181	Medical practitioners	17	187	(109-299)*
211	Surveyors	16	187	(107-303)*
194	Teachers nec	26	174	(114-255)*
180	Managers nec	133	172	(144-204)**
193	Primary & secondary teachers	43	168	(122-223)**
150	Salesmen etc	25	161	(104-238)*
Women				
Twenty occupations with the highest PRR				
123	Inspectors etc, transport	2	435	(49-1570)
208	Painters, sculptors, etc	16	434	(248-706)**
201	Engineers nec	2	385	(44-1416)
182	Dentists	2	286	(32-1046)
184	Pharmacists	5	284	(92-663)
106	Railway linesmen	2	282	(32-1031)
217	Professionals nec	24	275	(176-410)**
191	Medical workers nec	8	267	(115-527)*
204	Chemists	2	250	(28-903)
005	Gardeners, groundsmen	3	242	(49-707)
150	Salesmen, etc	8	231	(99-456)
192	University teachers	2	222	(25-802)
181	Medical practitioners	11	215	(107-385)*
194	Teachers nec	48	215	(159-285)**
087	Printers	5	202	(65-472)
188	Physiotherapists	6	193	(71-421)
193	Primary & secondary teachers	135	183	(154-217)**
152	Police	2	168	(19-607)
089	Workers in rubber	2	164	(18-597)
178	Personnel managers	4	162	(44-416)

*p < 0.05.

**p < 0.01.

Occupations with <2 cases excluded.

raised incidence of ocular melanoma and of non-cutaneous, non-ocular melanoma. Data for women (not shown in the table) were based on smaller numbers but showed a roughly similar distribution. Although most manual occupations had low incidences of both cutaneous and non-cutaneous melanoma, this was not so for farmers and foresters, or for electrical and electronic occupations, for either type of melanoma.

As occupational orders are broad groupings, the data were divided into specific occupational units. Table 2 identifies for men and women the 20

occupations with the highest incidence of cutaneous melanoma in 223 occupational units in England and Wales. Table 3 shows similar data for the 299 occupational units in Sweden. Also listed are all other occupations with a significantly raised PRR or SRR greater than 150. Pharmacists, medical doctors, and dentists are listed three times. Male aircraft pilots and men in military work are listed in both countries. Chemists, judges, physiotherapists, university teachers, clergy, finance brokers, insurance clerks, and journalists were listed twice. In addition certain similar, but not identical, occupations were listed

Table 3 Occupations with high standardised registration ratios (SRRs) for cutaneous melanoma, Sweden 1961–79

Occupational unit				
Code	Title	No of cases	SRR	(95% CL)
Men				
Twenty occupations with the highest SRR				
654	Telephone operators	2	1203	(140–4510)*
942	Public baths staff	3	651	(131–1906)*
021	Veterinarians	6	494	(181–1079)**
013	Geologists, etc	4	374	(101–957)**
945	Jockeys, sportsmen, etc	3	367	(74–1082)
318	Auctioneers, valuers	2	359	(40–1312)
046	Pharmacists	5	345	(111–810)*
643	Rail station masters	17	284	(165–455)**
296	Clerks, insurance companies	11	269	(134–482)**
621	Air pilots, air machinists, etc	4	264	(71–678)
074	Public representatives/legal affairs	3	258	(52–756)
009	Technical occupations nec	2	257	(29–938)
292	Bank clerks	16	254	(145–413)**
071	Judges	6	243	(89–531)
091	Accountants	13	239	(127–409)**
312	Finance brokers	4	236	(64–606)
904	Prison guards	7	234	(94–482)
911	Housekeepers	11	230	(115–412)*
053	Teachers, O-level	41	229	(164–311)**
043	Nurse assistants	2	228	(26–830)
Other occupations with SRR > 150 (p < 0.05)				
290	Secretaries, typists	11	222	(111–400)*
011	Chemists	9	218	(100–415)*
052	Teachers, A-level	30	213	(144–304)**
032	Dentists	13	208	(110–350)*
031	Medical doctors	21	198	(123–300)**
085	Journalists, publishers	17	194	(113–310)*
118	Management nec	69	180	(140–239)**
201	Clerks, book keepers	50	167	(124–220)**
981	Military work	42	158	(114–200)**
Women				
Twenty occupations with the highest SRR				
003	Engineers, mechanical	2	445	(51–1641)
946	Photographers	6	426	(156–932)**
004	Chemical engineers	2	333	(37–1203)
301	Wholesale traders	2	325	(36–1183)
827	Dairy workers	4	296	(79–757)
948	Services nec	4	269	(72–692)
061	Clergy	5	233	(72–521)
032	Dentists	5	208	(67–486)
713	Hat makers, etc	10	199	(95–366)
738	Metal making nec	2	198	(22–714)
715	Clothing workers, cutters	14	192	(105–322)*
093	Librarians, etc	8	185	(80–365)
052	Teachers, A-level	21	178	(110–272)*
046	Pharmacists	5	175	(57–409)
297	Civil servants, insurance	4	175	(47–449)
095	Psychologists, etc	4	170	(46–436)
045	Laboratory assistants, etc	12	166	(86–290)
047	Physiotherapists	6	161	(59–351)
296	Clerks, insurance companies	9	160	(73–304)
203	Bank cashiers	5	156	(50–364)
Other occupations with SRR > 150 (p < 0.05)				
040	Nurses	59	151	(115–190)**

*p < 0.05.

**p < 0.01.

Occupations with <2 cases excluded.

more than once, among them teachers (other than university).

Table 4 lists the 10 occupations (men) with the highest incidence ratios for ocular melanoma, and for non-cutaneous, non-ocular melanoma in England and Wales. In women and for ocular melanoma only five occupations had PRRs greater than 150 based on at least two cases observed and for non-cutaneous, non-ocular melanoma there were six such occupa-

tions. No other occupations had a significantly raised PRR that was also greater than 150. Both conditions are relatively uncommon, and it may be seen that most of the PRRs were not significantly greater than 100. Teachers (nec) are listed three times and electrical engineers and commercial travellers twice.

As many of the high risk occupations are professional, table 5 shows more detail in this group by separating "professionals" (occupational order

Table 4 Occupations with highest PRRs for ocular melanoma, and for non-cutaneous, non-ocular melanoma, England and Wales, 1971-8

Occupational unit		No of cases	PRR	(95% CL)
Code	Title			
Men				
Ocular melanoma				
169	Athletes, sportsmen, etc	2	930	(105-3359)*
197	Electrical engineers	2	692	(78-2499)
199	Work study, progress engineers	2	551	(62-1989)
203	Technologists nec	2	418	(47-1511)
008	Coalmine workers above ground	3	416	(84-1216)
168	Launderers, dry cleaners, etc	2	397	(45-1433)
068	Weavers	2	392	(44-1416)
112	Labourers, glass and ceramics	2	377	(42-1360)
083	Makers of paper & paperboard	2	364	(41-1315)
167	Hairdressers, manicurists	3	361	(73-1056)
Non-cutaneous, non-ocular melanoma				
033	Sheet metal workers	4	860	(233-2226)**
195	Civil engineers, etc	2	635	(72-2329)
046	Pipe fitters, etc	2	585	(66-2124)
030	Electrical engineers	2	568	(64-2063)
120	Drivers of buses	2	336	(38-1223)
194	Teachers nec	2	334	(37-1203)
154	Publicans	2	329	(36-1183)
220	Technical & related, nec	2	314	(35-1126)
038	Machine tool setters, etc	2	231	(26-839)
148	Commercial travellers, etc	2	214	(24-776)
Women				
Ocular melanoma				
148	Commercial travellers	2	833	(94-3009)
163	Kitchen hands	6	319	(117-695)*
077	Clothing product makers	2	308	(35-1111)
156	Proprietors & managers	2	267	(30-963)
194	Teachers nec	6	259	(94-563)
Non-cutaneous, non-ocular melanoma				
213	Clergy, etc	2	952	(106-3438)*
003	Agricultural workers nec	2	606	(68-2188)
215	Social welfare workers, etc	3	492	(99-1437)
194	Teachers nec	4	435	(17-1113)
183	Nurses	8	165	(71-326)
076	Hand & machine sewers	4	162	(44-416)

* $p < 0.05$.Occupations with < 2 cases excluded.

XXV) into 12 subgroups of occupations, combining male and female data. All professional occupations tend to have a raised incidence of cutaneous melanoma and the relation does not appear to be specific to certain types of work. Teachers have a significantly raised incidence not only of cutaneous but also of ocular and non-cutaneous, non-ocular melanoma. The incidence of ocular and non-cutaneous, non-ocular melanoma is raised in the professional group as a whole but there were small numbers for analysis at occupational unit level.

Finally, to ascertain consistently raised risk across the two countries and genders, table 6 was obtained in the following way. All male and female occupations in England and Wales or in Sweden that had a SRR or a PRR greater than 150 for cutaneous melanoma were listed. Then for any occupation listed at least twice (any combination of gender and country) the data from both sexes from Sweden and from England and Wales were combined whenever possible. The "matching" of occupations was the most difficult aspect of this procedure. Finding such

a match was based on the short descriptions of occupations given in two references.^{27 29} In a few cases a Swedish or a British occupational title has been matched to a combination of occupations in the other country. For some occupational titles it was not possible to match a Swedish occupation to a British one. These could not be represented in this table.

The resulting risk estimates and 95% confidence intervals were calculated. Table 6 lists occupations in order of the resulting level of the incidence ratio if this ratio was both greater than 150 and significantly raised. The highest incidence ratio is in airline pilots, followed by finance and insurance brokers, professional accountants, dentists, inspectors and supervisors in transport, pharmacists, and then professional workers nec, judges, doctors, university teachers, and chemists.

Discussion

This study was based on a large number of cases drawn from two national cancer registries. Some occupations were identified as associated with a

Table 5 PRRs for cutaneous, eye, and non-cutaneous, non-ocular melanoma among occupational units within the occupational order of professionals, England and Wales, 1971-8

Occupational units	Cutaneous melanoma, men + women			Ocular melanoma, men + women			Cutaneous, non-ocular, men + women		
	Obs	PRR	95% CL	Obs	PRR	95% CL	Obs	PRR	95% CL
Doctors, dentists (181-182)	34	199	138-278**	3	108	22-316	1	147	2-818
Other medical (183-191)	176	122	104-141*	15	95	53-157	9	153	70-291
Teachers (192-194)	263	187	165-211**	32	177	120-248**	12	214	110-372*
Engineers (195-201)	51	159	118-209**	8	129	56-254	3	240	48-701
Scientists (202-205)	24	176	113-263*	5	215	69-503	0	0	0-
Technicians (219-220)	39	113	81-155	7	128	51-264	2	146	16-527
Authors, etc (206-208)	40	159	113-216**	3	81	16-237	3	298	60-877
Accountants, etc (209-210)	18	166	98-262	1	50	1-278	0	0	0-
Architects (211-212, 218)	44	148	107-199*	6	118	43-257	1	88	1-492
Clergy (213)	16	171	98-277	1	57	1-318	2	447	51-1641
Judges (214)	11	187	93-335	2	189	21-688	0	0	0-
Others (215-217)	67	198	153-252**	2	45	5-163	5	367	118-858*
All professional (181-220)	783	157	147-169**	85	124	99-153	38	190	134-261*

*p < 0.05.

**p < 0.01.

considerably higher incidence of cutaneous melanoma than national rates would lead one to expect. There are 11 such occupations with a near twofold or greater incidence and another ten with at least a 50% raised incidence when both countries and both genders are combined. Are these results due to chance, bias, or confounding? Or do they represent a true risk associated with these occupations? If the latter is the case are these risks due to differences in exposure to sun or phenotype or are there occupational or other risk factors?

Considering the methodological issues first: in studying a large number of occupations we would expect that some of these would, by chance alone, be associated with a high incidence, even if no occupationally associated risk exists. There is no way, however, of distinguishing a truly high incidence in a certain occupation from a chance one. Thus findings based on analysing a large number of occupations should not be dismissed solely on the

basis of the screening method applied. Rather, they need consideration in the light of a priori knowledge or hypotheses, based on previous studies, all of which were prone to the same influence from chance.³¹

The methods applied to estimate the expected number of cases in an occupation differed in the two countries—that is, calculation of PRRs based on cross sectional data in England and Wales and on SRRs based on follow up of cohorts in Sweden. Calculating SRRs or PRRs on the same data set in Britain has given similar results.³² When raised risks were found for an occupation in both the English and Welsh and the Swedish data in the present study the different methods used in the two countries decrease the likelihood that methodological artefacts explain the risks. Also, combining data from the two countries gives larger numbers and hence more stable estimates of risk associated with occupation.

Several medical or medically related occupations had a high incidence of cutaneous melanoma in the

Table 6 Malignant cutaneous melanoma in England and Wales and in Sweden. Number of cases and observed/expected (%) for selected occupations (see text for method of selection). Men and women combined. Listed in order of obs/exp-ratio

Occupation (UK/Sw-code)	E & W		Sweden		Both countries	
	Obs	PRR	Obs	SRR	Obs/exp	95% CL
Airline pilots (117/621)	4	282	4	265	273	118-538*
Finance and insurance brokers (149/312)	12	256	4	216	245	140-398*
Accountants, professional (209/091)	11	180	14	236	208	134-307*
Dentists (182/032)	6	207	18	208	207	133-309*
Inspectors, supervisors, transport (123/643)	8	136	17	271	206	133-304*
Pharmacists (184/046)	7	164	10	232	198	115-318*
Professional workers nec (217/021, 093, 094, 095, 098)	38	267	42	157	196	155-243*
Judges (214/071, 072, 073)	11	187	14	203	196	126-289*
Doctors (181/031)	28	197	22	179	188	140-248*
University teachers (192/051)	11	256	6	127	188	110-302*
Chemists (204/011)	8	168	10	206	188	111-296*
Salesmen, services, valuers, auctioneers (150/311, 312, 318)	33	174	16	196	181	134-239*
Surveyors (211/007)	16	178	6	176	177	111-268*
Armed forces (221/981)	40	183	42	158	169	135-210*
Physical and biological scientists (205/012, 013, 022, 023, 024)	10	189	14	155	167	107-249*
Primary & secondary school teachers (193/052, 053, 054, 055)	178	179	190	155	166	149-184*
Clergy (213/061)	16	171	19	157	163	113-227*
Authors, journalists (206/085)	13	137	20	182	161	111-227*
Managers nec (138, 174, 180/118)	173	155	73	170	159	140-180*
Clothing makers, cutters (077/715)	9	113	22	186	157	103-225*
Painters, sculptors and related (208/081, 082, 083)	21	302	13	84	152	105-213*

*p < 0.05.

**p < 0.01.

study data. A question is whether a "detection bias" exists that results in a higher number of melanomas being detected, diagnosed, and registered in these groups. This may be true to some extent but seems unlikely to account for any major part of their high incidence: firstly, because one might expect a detection bias to lead to higher apparent incidence in medical workers, particularly doctors, than in other professionals, but no such raised risk compared with professionals is apparent and, secondly, because the magnitude of the difference in risk between medical workers and others seems too large to explain in this way; the same argument applies, if anything more strongly, to the possibility that the twofold increased incidence in other occupational groups such as professional accountants or professional workers *nec* might be due to detection bias.

The possibility of confounding by phenotypic factors, known to be associated with cutaneous melanoma, deserves consideration. Although it seems unlikely to explain entirely the association of melanoma with higher social class occupations, the low representation of black people in these occupations presumably affects rates of melanoma to some extent in England and Wales. In Sweden there is a small proportion of black individuals in all classes and there would be no impact on differences between occupations. We could not exclude the possibility that the distribution of skin and eye colour in white people might vary by social class, although we have no information supporting such a hypothesis.

A high incidence of cutaneous melanoma, observed for several professional occupations in this study, has been reported in several other studies.^{23 21} It has been postulated that it may result from sun exposure habits, usually linked to affluence and the potential for going abroad for sun holidays among groups usually working indoors.

Reynolds, alternatively, suggested that there was also a high technology factor involved on the evidence of several engineering and chemical occupations reported to have high risks.²⁵ Polychlorinated biphenyls were early suggested as such a risk factor and it is known to affect melanocytes.^{7 33 34} Although several occupations working in laboratories or with chemicals in our study were at raised risk of melanoma, their risk was not in general higher than that of other occupations of similar social background but without technological or chemical exposures—for instance, lawyers and clergy.

The common feature of many of the high risk groups in the study appears to be rather their highly educated backgrounds: thus as well as raised risk in many affluent professional groups, there was also high risk for teachers and for clergy, who are not in general particularly affluent. It should be noted, however, that high risk occurs also in some affluent non-professional groups, and that inclusion of

occupations in the combined countries' overall analysis (table 6) depended on the availability of similarly categorised occupational descriptions in the two countries. Managers, of different types, were not classified according to the same principles in the two countries, and could not be matched.

The highest risk group in the combined England and Wales plus Sweden analysis (table 6) was airline pilots. Although ultraviolet levels external to an aircraft at high altitude would be expected to be much higher than outdoors at ground level, there is probably no important ultraviolet exposure to pilots when inside aircraft because of shielding by the window glass (A McKinlay, personal communication). Frequent flights abroad may, however, give British and Swedish pilots particular opportunity, compared with the general population, for intense recreational sun bathing in hot countries.

In this study clothing makers/cutters had an excess of melanomas and screening of data in the Danish Cancer Registry suggested textile workers as a risk group.²³ There is no other evidence that this group is prone to melanoma and so far as we know no causal agent suggested that could account for such a finding.

Earlier studies suggested oil refinery workers to be a risk group.^{10 12} We could not distinguish this group as such. It is part of the larger group of chemical production process workers *nec*, which did not display a raised incidence of melanoma in either country.

Electrical and electronics manufacturing work, earlier suggested to be linked to cutaneous ocular melanoma,^{4 18 19} was not associated with a high incidence of cutaneous melanoma, although an association with non-cutaneous, non-ocular melanoma may exist. Male electrical engineers tended to have a high incidence of both ocular and non-cutaneous, non-ocular melanoma, although in both types inevitably based on a small number of cases.

The high incidence of non-cutaneous, non-ocular melanoma among professional occupations is interesting because they are in areas not exposed to the sun. If cutaneous melanoma among professionals is caused by exposure to sun it is perhaps surprising to find an equally high or even higher incidence (in relative terms) of non-cutaneous, non-ocular melanoma for this group as a whole. Teachers are a case in point, with significantly raised incidences of cutaneous, ocular, and non-cutaneous, non-ocular melanoma. Interpretation of the latter category must be cautious, however: a group for which cutaneous melanoma was more common would probably also be more likely to have a secondary tumour to a melanoma of unknown primary location diagnosed as a non-cutaneous, non-ocular melanoma. Perhaps this would account for the distribution of non-cutaneous, non-ocular melanoma to some extent, although this should be regarded as an *ad hoc* hypothesis for the

moment. The alternative hypothesis is that the occupational distribution of non-cutaneous, non-ocular melanoma does in fact reflect the same aetiological factor, such as exposure to sun or some unknown factor.

In conclusion, several groups that showed pronounced consistent raised risk of melanoma in this study were linked by their professional occupation. Lifestyle rather than occupational hazards may be responsible for this excess, although one cannot rule out the possibility of an occupationally induced excess in small occupational groups. Not all of the occupational groups at high risk are affluent, and it is not clear whether their current sun exposure behaviour, at home or in travel abroad, differs importantly from that of other social groups. Their educational background seems a shared feature of several of the highest risk occupations. A possible common behavioural feature of these highly educated groups, however, may be linked to their family background and early experience. A history of having travelled abroad to hotter countries or having resided there in childhood, when foreign travel for Britons and for Swedes was more unusual and less easy than it is now, could be relevant.

This study was supported by a research fellowship to one of the authors (DV) from the Committee for Social Research of the Swedish Health Ministry (DSF).

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Accepted 24 July 1989