Cancer in printing workers in Denmark

Elsebeth Lynge, Bo Andreassen Rix, Ebbe Villadsen, Ib Andersen, Mogens Hink, Erik Olsen, Ulla Lucht Møller, Erik Silfverberg

Abstract

Objectives—To study the cancer incidence in printing workers in Denmark.

Methods—The cohort of 15 534 men and 3593 women working in the printing industry in 1970 were followed up for death, emigrations, and incident cancer cases until the end of 1987. Their cancer incidence was compared with that of all economically active people in Denmark. The smoking and drinking habits reported by members of the printing trade unions at a survey in 1972 were compared with habits reported by members of other trade unions.

Results—Lung, bladder, renal pelvis, and primary liver cancers were in excess among the printing workers. The excess risks of lung cancer among the factory workers in newspaper and magazine production, of bladder cancer in typographers in printing establishments, of renal pelvis cancer in typographers and lithographers, and of primary liver cancer among lithographers and bookbinders exceeded those expected based on the reported smoking and drinking habits.

Conclusion—Our results indicate, in line with a previous study from Manchester, that work with rotary letterpress printing was associated with an increased risk of lung cancer. The inconsistent results from studies on bladder cancer in printing workers may point to a risk confined to a certain subgroup. The sixfold risk of primary liver cancer in Danish lithographers warrants studies in other countries.

(*Occup Environ Med* 1995;52:738-744)

Keywords: cancer incidence; printing work

A survey of the material and substances used in the printing industry in Denmark in 1978 showed use of 2000 products, in which 300 chemicals were identified.¹ Among the chemicals, 26 are known or suspected carcinogens according to the classifications made by the International Agency for Research on Cancer² and the European Union.³ Data in the Danish National Register of Products show that 3124 products are used at present in the printing and related industries. Nearly 23% of these products contain one or more of 67 known or suspected carcinogens⁴ (PROBAS preliminary data, personal communication, 1994).

The use of chemicals in the printing industry

has caused concern both from the point of view of the working environment and from the point of view of waste water and chemical discharge from the printing shops. In Denmark, this has led to reviews of the industry, and the present study of cancer incidence in printing workers in Denmark was undertaken as part of this process.

Subjects and methods

The study includes all people aged 20-64 years, living in Denmark, and working in the printing and bookbinding industry on the census date 9 November 1970. These people were followed up for death and emigration for 17 years until 8 November 1987 by liaison with the Central Population Register. Incidence cancer cases diagnosed between November 1970 and October 1987 were identified by liaison with the Danish Cancer Register. The detailed liaison procedures for 1970-80 have been described previously,⁵ and the 1981-7 update followed the same procedures.

Occupation and industry were coded in the 1970 census only for people who were economically active. Occupation was coded according to a special Danish nomenclature. Industry was coded according to a modified version of the international standard industrial classification. Table 1 shows the groups included in the present analysis.

The person-years at risk were calculated for each person from 9 November 1970 until the date of discovery of a tumour, death, emigration, or 8 November 1987 whichever came first. The observed number of cancer cases and the person-years at risk were tabulated by 5-year age groups defined by age at the time of the census. The cancer incidences generated in the same way for all economically active people were used for calculating the expected number of cancer cases, and standardised incidence ratios (SIRs) were calculated by dividing the observed number of cancer cases by the expected number. Ninety-five per cent confidence intervals (95% CIs) were calculated under the assumption that the observed number of cancer cases followed a poisson distribution. Only data for cancer sites with five or more cases observed in the total group of printing workers were included in the tables.

Data on alcohol drinking and tobacco smoking in typographers, lithographers, and bookbinders were retrieved from the stored files from a labour market survey undertaken in Denmark in 1972.^{6,7} The study population consisted of stratified samples of 9231 mem-

Danish Cancer Society,
Strandboulevarden 49,
DK-2100 København Ø, Denmark
E Lynge
B A Rix
E Villadsen

National Institute of Occupational Health,
Lersø Parkallé 105,
DK-2100 København Ø, Denmark
I Andersen
E Olsen
U L Møller

Danish Work Environment Foundation,
Vermundsgade 38,
DK-2100 København Ø, Denmark
M Hink

The Graphic College of Denmark, Glentevej 67, DK-2400 København NV, Denmark
E Silfverberg

Correspondence to:
Dr E Lynge, Danish Cancer Society, Strandboulevarden 49, DK-2100 København Ø, Denmark.

Accepted 7 July 1994

Table 1 Number of men and women aged 20–64 years working in the printing industry in Denmark in 1970

Code	Occupation	Industry	Men	Women
35001 350	Typographer, type founder, stereotyper, printer, compositor, pressman	280 Printing establishments, job printing shops, etc	5690	81
35002 350	Typographer, as above	285 Newspapers, periodicals, magazine publishers	3140	45
35003 350	Typographer, as above	281 Lithographing establishments, offset printing, music engraving, copperplate printing, steel plate printing, screen printing	873	7
		282 Process reproduction, stereotyping and electrotyping establishments, phototype process firms, copying establishments.		
		283 Bookbinding, paper ruling, ledger manufacturing.		
		284 Book and art publishers, music publishing.		
35100 351	Lithographer, offset printer, copper plate engraver, tracer, lithographic printer, lithographic artist, screen printer	All industries	1618	37
35102 352	Photoengraver, etcher, phototype printer	All industries	853	10
35300 353	Bookbinder, paper ruler	All industries	1146	153
41400 414	Layer on girl	All industries	—	201
41500 415	Bookbinder's assistant (female)	All industries	—	1909
48227 480	Factory hand and other unskilled workers	280–285 Printing industry	2214	1150
Total			15534	3593

bers from 54 selected trade unions. The data collection was based on self administered questionnaires and the response rate was 75%.

Results

The printing and bookbinding industry in Denmark in 1970 in total employed 15 534 men. Of these 5690 men worked as typographers in printing establishments, and 3140 worked as typographers with newspapers and magazine publishers (table 1).

The total group of men had a significantly increased overall cancer incidence (observed 1095 *v* expected 946.41, SIR 1.16, 95%CI 1.09–1.23). Significantly increased risks were also seen for primary liver cancer (19 *v* 9.99, SIR 1.90, 95%CI 1.14–2.97), lung cancer (248 *v* 198.62, SIR 1.25, 95%CI 1.10–1.41), renal pelvis cancer (15 *v* expected 7.95, SIR 1.89, 95%CI 1.06–3.11), and bladder cancer (109 *v* 81.26, SIR 1.34, 95%CI 1.10–1.62). Risks of borderline significance were found for cancer of the oral cavity (observed 11, SIR 1.89), colon cancer (observed 80, SIR 1.24), and non-melanoma skin cancer (observed 148, SIR 1.17, table 2).

All the occupational subgroups, except the lithographers and bookbinders, had an increased overall cancer incidence. Several subgroups contributed to the excess risk of primary liver cancer, the risk being particularly high among the lithographers (observed 5 *v* expected 0.74, SIR 6.76, 95%CI 2.18–15.77). The excess risk of renal pelvis cancer was aggregated from a small number of cases in each of the subgroups. Typographers in printing establishments had a significantly increased risk of bladder cancer (40 *v* 26.83, SIR 1.49, 95%CI 1.06–2.03). Within the subgroup of factory workers in printing establishments 14 cases of bladder cancer were found (expected 8.79, SIR 1.59, 95%CI 0.87–2.67, data not shown in table 2).

Several subgroups also contributed to the excess risk of lung cancer. The risk was significantly increased in the factory workers in the printing industry (observed 60 *v* expected 42.57, SIR 1.46, 95%CI 1.12–1.87), and the main contribution here came from the factory workers in newspaper and magazine production (observed 26 *v* expected 12.89, SIR 2.02, 95%CI 1.32–2.96, data not shown in table 2). A borderline excess risk was found among photoengravers (15 *v* exp 8.88, SIR 1.69, 95%CI 0.94–2.79).

Typographers in newspaper and magazine production furthermore had significantly increased risks of gallbladder cancer (observed 5 *v* expected 1.47, SIR 3.40, 95%CI 1.10–7.94) and male breast cancer (3 *v* 0.38, SIR 7.89, 95%CI 1.59–23.07, data not shown in table 2).

A total of 3593 women were employed in the printing and bookbinding industry in Denmark in 1970. Of these 1909 were bookbinder's assistants and 1150 were factory workers (table 1).

The women in total had a significantly increased overall cancer risk (observed 284 *v* expected 241.77, SIR 1.17, 95%CI 1.04–1.32), lung cancer risk (32 *v* 18.45, SIR 1.73, 95%CI 1.19–2.45) and breast cancer risk (88 *v* 65.40, SIR 1.35, 95%CI 1.08–1.66), and a borderline excess risk of cervical cancer (observed 29, SIR 1.40, table 3). Other noteworthy findings were two cases of cancer of the tongue (one in a bookbinder and one in a layer on girl) two cases of laryngeal cancer, four cases of brain tumours, and two cases of multiple myeloma in the small group of layer on girls (data not included in table 3).

Table 4 shows the percentage of smokers among male members of selected trade unions in 1972, and the SIR values for lung cancer, bladder cancer, and renal pelvis cancer for men in these occupations in 1970–87. It can be seen that members of the unions of typo-

Table 2 Cancer incidence 1970–87 among men working in the printing industry in Denmark 1970

ICD-7	Typographer/ printing establishments 35001				Typographer/ newspapers/magazines 35002				Typographer/ all other 35003				Lithographer 35101			
	Obs	Exp	SIR	(95% CI)	Obs	Exp	SIR	(95% CI)	Obs	Exp	SIR	(95% CI)	Obs	Exp	SIR	(95% CI)
143–144 Mouth	4	1.89	2.12	0.57–5.42	4	1.36	2.94	0.79–7.53	1	0.20	5.00	0.07–27.82	0	0.47	—	—
145–148 Pharynx	3	2.51	1.20	0.24–3.49	3	1.80	1.67	0.33–4.87	2	0.26	7.69	0.86–27.77	0	0.64	0.00	—
150 Oesophagus	2	3.72	0.54	0.06–1.94	1	2.69	0.37	0.00–2.07	0	0.35	—	—	1	0.86	1.16	0.02–6.47
151 Stomach	10	13.99	0.71	0.34–1.31	9	9.77	0.92	0.42–1.75	3	1.30	2.31	0.46–6.74	1	3.13	0.32	0.00–1.78
153 Colon	30	21.44	1.40	0.94–2.00	19	14.95	1.27	0.76–1.98	4	2.03	1.97	0.53–5.04	4	4.81	0.83	0.22–2.13
154 Rectum	14	17.47	0.80	0.44–1.34	15	12.21	1.23	0.69–2.03	2	1.63	1.23	0.14–4.43	2	3.90	0.51	0.06–1.85
155-0 Liver	3	3.28	0.91	0.18–2.67	5	2.33	2.15	0.69–5.01	0	0.31	—	—	5	0.74	6.76	2.18–15.77
155-1 Gallbladder	2	2.13	0.94	0.11–3.39	5	1.47	3.40	1.10–7.94	0	0.20	—	—	0	0.47	—	—
157 Pancreas	8	10.15	0.79	0.34–1.55	8	7.14	1.12	0.48–2.21	0	0.94	—	—	1	2.27	0.44	0.01–2.45
160 Nose	2	1.04	1.92	0.22–6.94	1	0.71	1.41	0.02–7.84	1	0.11	9.09	0.12–50.58	0	0.25	—	—
161 Larynx	4	6.17	0.65	0.17–1.66	5	4.48	1.12	0.36–2.60	1	0.62	1.61	0.02–8.97	3	1.48	2.03	0.41–5.92
162-0,1 Lung	79	65.20	1.21	0.96–1.51	56	46.48	1.20	0.91–1.56	2	5.98	0.33	0.04–1.21	15	14.52	1.03	0.58–1.70
162-2 Pleura	2	1.55	1.29	0.14–4.66	3	1.09	2.75	0.55–8.04	0	0.15	—	—	0	0.36	—	—
177 Prostate	31	25.54	1.21	0.82–1.72	19	17.42	1.09	0.66–1.70	3	2.14	1.40	0.28–4.10	6	5.12	1.17	0.43–2.55
178 Testis	12	11.03	1.09	0.56–1.90	4	5.45	0.73	0.20–1.88	4	1.89	2.12	0.57–5.42	1	3.31	0.30	0.00–1.68
180* Renal cell carcinoma	7	8.30	0.84	0.34–1.74	4	5.85	0.68	0.18–1.75	1	0.84	1.19	0.02–6.62	1	1.96	0.51	0.01–2.84
180* Renal pelvis, ureter	6	2.63	2.28	0.83–4.97	4	1.85	2.16	0.58–5.54	0	0.25	—	—	2	0.59	3.39	0.38–12.24
181 Bladder	40	26.83	1.49	1.06–2.03	20	18.92	1.06	0.65–1.63	3	2.55	1.18	0.24–3.44	8	6.07	1.32	0.57–2.60
190 Melanoma	13	8.50	1.53	0.81–2.62	5	5.47	0.91	0.29–2.13	2	1.09	1.83	0.21–6.62	2	2.33	0.86	0.10–3.10
191 Other skin	48	42.22	1.14	0.84–1.51	39	29.25	1.33	0.95–1.82	4	4.36	0.92	0.25–2.35	12	10.07	1.19	0.62–2.08
193 Brain	10	11.50	0.87	0.42–1.60	7	7.45	0.94	0.38–1.94	1	1.44	0.69	0.01–3.86	5	3.03	1.65	0.53–3.85
194 Thyroid	2	1.23	1.63	0.18–5.87	0	0.76	—	—	0	0.15	—	—	1	0.32	3.13	0.04–17.39
197 Connective tissue	4	1.43	2.80	0.75–7.16	1	0.89	1.12	0.01–6.25	0	0.18	—	—	1	0.37	2.70	0.04–15.04
198 Metastases	7	4.66	1.50	0.60–3.10	1	3.28	0.30	0.00–1.70	3	0.46	6.52	1.31–19.06	0	1.08	—	—
199 Other and unspecified	3	2.29	1.31	0.26–3.83	4	1.60	2.50	0.67–6.40	1	0.23	4.35	0.06–24.19	0	0.53	—	—
200,202 Non-Hodgkin lymphoma	7	8.10	0.86	0.35–1.78	2	5.19	0.39	0.04–1.39	1	0.97	1.03	0.01–5.74	3	2.05	1.46	0.29–4.28
201 Hodgkin's disease	6	3.32	1.81	0.66–3.93	1	1.88	0.53	0.01–2.96	1	0.49	2.04	0.03–11.35	1	0.93	1.08	0.01–5.98
203 Multiple myeloma	4	3.50	1.14	0.31–2.93	5	2.42	2.07	0.67–4.82	0	0.33	—	—	0	0.79	—	—
204 Leukaemia	7	9.19	0.76	0.31–1.57	5	6.08	0.82	0.27–1.92	3	1.00	3.00	0.60–8.77	1	2.19	0.46	0.01–2.54
140–205 All malignant	359	317.26	1.13	1.02–1.25	252	217.04	1.16	1.02–1.31	44	32.38	1.36	0.99–1.82	70	74.67	0.94	0.73–1.18

*Subsites specified in Danish codes.

Table 3 Cancer incidence 1970–87 among women in the printing industry in Denmark 1970*

ICD-7	Typographer/lithographer/ photoengraver 35001–35102				Bookbinder 35300				Layer on girl 41400				Bookbinders' assistant 41500			
	Obs	Exp	SIR	(95% CI)	Obs	Exp	SIR	(95% CI)	Obs	Exp	SIR	(95% CI)	Obs	Exp	SIR	(95% CI)
151 Stomach	0	0.13	—	—	0	0.14	—	—	0	0.47	—	—	3	2.05	1.46	0.29–4.28
153 Colon	0	0.44	—	—	0	0.49	—	—	1	1.69	0.59	0.01–3.29	10	7.03	1.42	0.68–2.62
154 Rectum	1	0.24	4.16	0.11–23	0	0.25	—	—	1	0.90	1.11	0.01–6.18	1	3.69	0.27	0.00–1.51
157 Pancreas	0	0.14	—	—	0	0.16	—	—	0	0.61	—	—	1	2.39	—	—
162-0,1 Lung	0	0.50	—	—	2	0.57	3.51	0.39–12.67	3	1.85	1.62	0.33–4.74	13	8.13	1.60	0.85–2.73
170 Breast	1	2.21	0.45	0.01–2.52	3	2.32	1.29	0.26–3.78	8	5.43	1.47	0.63–2.90	48	30.63	1.57	1.16–2.08
171 Cervix uteri	2	0.81	2.47	0.30–8.91	3	0.78	3.85	0.77–11.24	5	1.52	3.29	1.06–7.68	12	10.16	1.18	0.61–2.06
172 Corpus uteri	0	0.40	—	—	0	0.47	—	—	1	1.58	0.63	0.01–3.52	4	6.79	0.59	0.16–1.51
175 Ovary	1	0.48	2.08	0.05–11.60	1	0.52	1.92	0.03–10.70	0	1.47	—	—	6	7.14	0.84	0.31–1.83
181 Bladder	0	0.14	—	—	0	0.17	—	—	1	0.59	1.69	0.02–9.43	2	2.41	0.83	0.09–3.00
190 Melanoma	0	0.36	—	—	0	0.34	—	—	0	0.56	—	—	5	4.32	1.16	0.37–2.70
191 Other skin	1	0.77	1.30	0.04–7.23	2	0.82	2.44	0.27–8.81	4	2.21	1.81	0.49–4.63	8	11.14	0.72	0.31–1.42
193 Brain	0	0.29	—	—	0	0.28	—	—	4	0.61	6.56	1.76–16.79	1	3.74	0.27	0.00–1.49
200, 202 Non-Hodgkin's lymphoma	0	0.13	—	—	0	0.14	—	—	1	0.38	2.63	0.03–14.64	1	1.89	0.53	0.01–2.94
140–205 All malignant	9	7.86	1.15	0.52–2.17	13	8.18	1.59	0.85–2.72	34	21.60	1.57	1.09–2.20	118	111.70	1.06	0.87–1.27

*Subsites specified in Danish codes.

graphers and lithographers did overall not have a smoking pattern that differed from that of the other selected groups. A few of the SIR values of the printing trades exceeded the values for other trades. This was the case for renal pelvis cancer in typographers (observed 10, SIR 2.11) and lithographers (observed 2, SIR 3.39), for bladder cancer in typographers in printing establishments (observed 40, SIR 1.49), and for lung cancer in the factory workers in newspaper and magazine production (observed 26, SIR 2.02).

Table 5 shows the percentage of male trade union members reporting daily drinking of beer, wine, or spirits in 1972, and the SIR value for primary liver cancer in 1970–87. Overall the printing groups did not report

drinking more frequently than other trade union members. The SIR values for primary liver cancer in lithographers (observed 5, SIR 6.76) and bookbinders (observed 2, SIR 2.67) clearly exceeded that of the other groups.

Discussion

TOBACCO SMOKING AND ALCOHOL DRINKING
Cancer of the lung and renal pelvis were in excess among the male printing workers in Denmark. These diseases are known to be related both to tobacco smoking and to chemical exposures at the work place.

Data on smoking habits among printing workers in Denmark around 1970 are available only from the 1972 labour market survey.

Photoengraver 35102				Bookbinder 35300				Factory worker/ all printing industry 48227				All groups			
Obs	Exp	SIR	(95% CI)	Obs	Exp	SIR	(95% CI)	Obs	Exp	SIR	(95% CI)	Obs	Exp	SIR	(95% CI)
1	0.29	3.45	0.05-19.19	0	0.44	—	—	1	1.16	0.86	0.01-4.80	11	5.81	1.89	0.94-3.39
0	0.39	—	—	0	0.58	—	—	2	1.48	1.35	0.15-4.88	10	7.66	1.31	0.62-2.40
2	0.53	3.77	0.42-13.62	1	0.86	1.16	0.02-6.47	4	2.39	1.67	0.45-4.28	11	11.40	0.96	0.48-1.73
2	1.92	1.04	0.12-3.76	1	3.20	0.31	0.00-1.74	7	8.69	0.81	0.32-1.66	33	42.00	0.79	0.54-1.10
2	2.94	0.68	0.08-2.46	6	4.87	1.23	0.45-2.68	15	13.34	1.12	0.63-1.85	80	64.38	1.24	0.99-1.55
2	2.39	0.84	0.09-3.02	5	3.98	1.26	0.40-2.93	16	11.04	1.45	0.83-2.35	56	52.62	1.06	0.80-1.38
0	0.46	—	—	2	0.75	2.67	0.30-9.63	4	2.12	1.89	0.51-4.83	19	9.99	1.90	1.14-2.97
0	0.29	—	—	1	0.48	2.08	0.03-11.59	1	1.33	0.75	0.01-4.18	9	6.37	1.41	0.64-2.68
2	1.39	1.44	0.16-5.19	2	2.32	0.86	0.10-3.11	10	6.43	1.56	0.74-2.86	31	30.64	1.01	0.69-1.44
1	0.15	6.67	0.09-37.09	0	0.23	—	—	1	0.61	1.64	0.02-9.12	6	3.10	1.94	0.71-4.21
3	0.90	3.33	0.67-9.74	1	1.43	0.70	0.01-3.89	6	3.98	1.51	0.55-3.28	23	19.06	1.21	0.76-1.81
15	8.88	1.69	0.94-2.79	19	14.99	1.27	0.76-1.98	62	42.57	1.46	1.12-1.87	248	198.62	1.25	1.10-1.41
0	0.22	—	—	0	0.35	—	—	3	0.95	3.16	0.63-9.23	8	4.67	1.71	0.74-3.38
4	3.15	1.27	0.34-3.25	8	5.75	1.39	0.60-2.74	11	16.46	0.67	0.33-1.20	82	75.58	1.08	0.86-1.35
4	1.67	2.40	0.64-6.13	3	2.12	1.42	0.28-4.13	5	3.18	1.57	0.51-3.67	33	28.65	1.15	0.79-1.62
2	1.20	1.67	0.19-6.02	2	1.90	1.05	0.12-3.80	3	5.09	0.59	0.12-1.72	20	25.14	0.80	0.49-1.23
0	0.36	—	—	0	0.60	—	—	3	1.67	1.80	0.36-5.25	15	7.95	1.89	1.06-3.11
3	3.70	0.81	0.16-2.37	10	6.12	1.63	0.78-3.01	25	17.07	1.46	0.95-2.16	109	81.26	1.34	1.10-1.62
3	1.33	2.26	0.45-6.59	2	1.85	1.08	0.12-3.90	1	4.05	0.25	0.00-1.37	28	24.62	1.14	0.76-1.64
10	6.02	1.66	0.80-3.06	11	9.58	1.15	0.57-2.05	24	25.23	0.95	0.61-1.42	148	126.73	1.17	0.99-1.37
1	1.73	0.58	0.01-3.22	0	2.51	—	—	9	5.90	1.53	0.70-2.90	33	33.56	0.98	0.68-1.38
0	0.18	—	—	0	0.26	—	—	2	0.60	3.33	0.37-12.03	5	3.50	1.43	0.46-3.33
0	0.21	—	—	0	0.31	—	—	2	0.69	2.90	0.33-10.47	8	4.08	1.96	0.84-3.86
0	0.66	—	—	1	1.06	0.94	0.01-5.25	2	2.90	0.69	0.08-2.49	14	14.10	0.99	0.54-1.67
0	0.32	—	—	0	0.52	—	—	4	1.41	2.84	0.76-7.26	12	6.90	1.74	0.90-3.04
1	1.17	0.85	0.01-4.76	2	1.77	1.13	0.13-4.08	6	4.26	1.41	0.51-3.07	22	23.51	0.94	0.59-1.42
0	0.50	—	—	1	0.68	1.47	0.02-8.18	2	1.32	1.52	0.17-5.47	12	9.12	1.32	0.68-2.30
0	0.48	—	—	1	0.79	1.27	0.02-7.04	1	2.17	0.46	0.01-2.56	11	10.48	1.05	0.52-1.88
3	1.28	2.34	0.47-6.85	1	2.04	0.49	0.01-2.73	5	5.21	0.96	0.31-2.24	25	26.99	0.93	0.60-1.37
62	44.18	1.40	1.08-1.80	77	71.31	1.08	0.85-1.35	231	189.57	1.22	1.07-1.39	1095	946.41	1.16	1.09-1.23

Factory worker/ all printing industry 48227				All groups			
Obs	Exp	SIR	(95% CI)	Obs	Exp	SIR	(95% CI)
3	1.83	1.64	0.33-4.79	6	4.62	1.30	0.47-2.83
4	6.37	0.63	0.17-1.61	15	16.02	0.94	0.52-1.54
5	3.36	1.49	0.48-3.47	8	8.44	0.95	0.41-1.87
4	2.24	1.79	0.48-4.57	5	5.54	0.90	0.29-2.11
14	7.40	1.89	1.03-3.17	32	18.45	1.73	1.19-2.45
28	24.81	1.13	0.75-1.63	88	65.40	1.35	1.08-1.66
7	7.46	0.94	0.38-1.93	29	20.73	1.40	0.94-2.01
7	6.24	1.12	0.45-2.31	12	15.48	0.78	0.40-1.35
8	6.16	1.30	0.56-2.56	16	15.77	1.01	0.58-1.65
2	2.22	0.90	0.10-3.25	5	5.53	0.90	0.29-2.11
4	2.94	1.36	0.37-3.48	9	8.52	1.06	0.48-2.01
10	9.24	1.08	0.52-1.99	25	24.18	1.03	0.67-1.53
6	2.82	2.13	0.78-4.63	11	7.74	1.42	0.71-2.54
3	1.54	1.95	0.39-5.69	5	4.08	1.23	0.39-2.86
110	92.43	1.19	0.98-1.43	284	241.77	1.17	1.04-1.32

Although this survey included more than 9000 people and has a response rate of 75%, the actual number of men was below 100 in most trades. The percentage of smokers in the trades included in the present analysis varied between 63% and 81%. This corresponds well with other data collected in Denmark in 1970 where the percentages of smokers were 68% for all men, 74% for skilled workers, and 75% for unskilled workers.⁸

Based on the comparison between the smoking habits reported in the 1972 survey and the SIR values for cancer of the lung, bladder, and renal pelvis, it seems reasonable to conclude that the excess risks of cancer of the renal pelvis in typographers and lithographers, lung cancer in the factory workers in

newspaper and magazine production, and bladder cancer in typographers in printing establishments are unlikely to be explained exclusively by excessive smoking.

Primary liver cancer was also in excess among the male printing workers in Denmark. Alcohol drinking is the most common cause of primary liver cancer in Denmark,⁹ and the excess risk of primary liver cancer in printing workers could therefore be related either to excessive alcohol drinking or to chemical exposures. The data on daily drinking habits reported in the 1972 survey showed no major difference between printers and men in other trades. Daily drinking is known to be a valid indicator in Denmark for total alcohol intake (Henrik Sælan, personal communication, 1995). In a small study printers were found to consume more alcohol than matched controls, but the average consumption was reported to be only 1.5 drinks a day.¹⁰ It therefore seems reasonable to conclude that the excess risk of primary liver cancer among lithographers and bookbinders is unlikely to be explained exclusively by excessive alcohol drinking.

LUNG CANCER

A cohort study of newspaper printers in Manchester¹¹ showed an excess risk of lung cancer among the unskilled workers but not among the skilled typographers. The unskilled machine assistants working with rotary letterpress printing had an SMR of 179 (95%CI 144-218), and a nested case-control study showed that the risk increased by number of years in the job. Exposure to ink mist was suggested to be the aetiological agent.¹²

Table 4 Smoking habits* among selected occupational groups of men in Denmark 1972, and incidence† of lung, bladder, and renal pelvis cancer 1970–87

	Typographer	Lithographer	Bookbinder	Electrician	Painter	Bricklayer	Metal worker	Postal worker	Unkilled worker
n	65	80	26	89	58	89	468	76	1193
Smoker:									
Yes %	66	70	81	63	71	70	68	72	74
No %	34	26	19	34	24	27	30	26	22
Unknown %	0	4	0	3	5	3	2	2	4
Smoking of cigarettes:									
≥ 20/day %	23	29	38	26	31	25	23	28	26
< 20/day %	22	21	23	28	19	17	25	24	24
None %	55	49	35	44	45	56	48	47	44
Unknown %	0	1	4	2	5	2	4	1	6
Lung cancer:									
Obs	137	15	19	133	239	252	1191	175	8271
SIR	1.16	1.03	1.27	1.26	1.41	1.28	1.33	1.13	1.17
95% CI	1.98–1.38	0.58–1.70	0.76–1.98	1.05–1.49	1.24–1.60	1.12–1.45	1.25–1.40	0.97–1.32	1.14–1.19
Bladder cancer:									
Obs	63	8	10	34	98	110	455	56	2887
SIR	1.30	1.32	1.63	0.76	1.41	1.36	1.23	0.89	1.01
95% CI	1.00–1.67	0.57–2.60	0.78–3.01	0.53–1.06	1.15–1.72	1.12–1.64	1.12–1.435	0.68–1.16	0.97–1.05
Renal pelvis cancer:									
Obs	10	2	0	5	7	11	49	5	280
SIR	2.11	3.39	—	1.16	1.04	1.39	1.35	0.82	1.00
95% CI	1.01–3.89	0.38–12.24	—	0.37–2.70	0.42–2.14	0.69–2.48	1.00–1.79	0.27–1.92	0.89–1.12

*Based on combination of answers to the two questions in a self administered questionnaire: "Do you smoke at work?" and "Do you smoke at home?"

†Based on the 1970 census population.

Table 5 Drinking habits* among selected occupational groups of men in Denmark 1972, and incidence† of primary liver cancer 1970–87

	Typographer	Lithographer	Bookbinder	Electrician	Painter	Bricklayer	Metal worker	Postal worker	Unkilled worker
n	65	80	26	89	58	89	468	76	1193
Drink daily:									
Yes %	31	37	15	33	38	45	28	29	27
No %	68	61	81	66	55	51	70	70	68
Unknown %	1	2	4	1	7	4	2	1	5
Primary liver cancer:									
Obs	8	5	2	6	12	10	46	10	364
SIR	1.35	6.76	2.67	1.11	1.41	1.01	1.01	1.27	1.03
95% CI	0.58–2.66	2.18–15.77	0.30–9.63	0.40–2.41	0.73–2.46	0.48–1.86	0.74–1.35	0.61–2.34	0.93–1.15

*Based on answer to the question in a self administered questionnaire: "Do you drink beer, wine, or spirits daily?"

†Based on the 1970 census population.

Newspaper printing workers have previously been found to have an excess risk of lung cancer in London (proportionate mortality ratio (PMR) 124 (95%CI 98–156)),¹³ New York (SMR 131 (95%CI 104–166)),¹⁴ Los Angeles (SMR 149 (95%CI 92–219))¹⁵ and Sweden (SIR 1.6 (95%CI 1.3–2.9)).¹⁷ Workers exposed to printing ink have been found to have an excess risk of dying from lung cancer at an early age in the United Kingdom (SMR 1.6 (95%CI 0.9–2.7)).¹⁸

Commercial pressmen from New York and New Jersey exposed to benzidine based colours have an excess risk of lung cancer (PMR 116 (95%CI 94–147))¹⁹ and so have photoengravers in Los Angeles (SMR 320 (95%CI 138–630)).¹⁶ Other studies of workers in the printing industry or of members of the printing workers' unions in general have shown both positive^{20–23} and negative^{24–28} results for lung cancer.

In Denmark, the change from rotary to offset letterpress in the production of newspapers took place around 1970. Measurements undertaken in Denmark in 1979²⁹ and 1986–7³⁰ showed dust concentrations for rotary letterpress of 1.1 mg/m³ and 1–4 mg/m³, respectively, and for offset letterpresses 0.28 mg/m³ and 0.1–0.7 mg/m³, respectively. In the rotary letterpresses measurements from 1986–7, 65%–90% of the dust was ink mist, whereas this was the case for only

25% of the dust in the offset measurement. Nose and throat irritation was in 1979 reported more frequently by a small sample of printing workers than by a group of matched controls, but there was no difference in pulmonary function.¹⁰ In newspaper printing in Denmark, the operation of the rotary letterpress machines was a typical job for the factory workers. It therefore seems reasonable to conclude that the observation of a doubled risk of lung cancer (observed 26, SIR 2.02) among the Danish factory workers in newspaper and magazine production is in line with the results from Manchester.

Photoengravers in Denmark also had an excess risk of lung cancer (observed 15, SIR 1.69). Around 1970 these people worked manually with a great variety of photochemicals as well as nitric acid, chromium VI compounds, and photoreactive acrylic systems.

BLADDER AND RENAL PELVIS CANCER

The number of cases is small in several of the studies on bladder cancer in printing workers. Significant excess risks have been found among workers exposed to ink mist from high speed presses in West Yorkshire, United Kingdom, OR 3.1 (95%CI 1.4–8.8),³¹ among printing machine operators in Missouri, United States, OR 3.1 (95%CI 1.1–8.9),³² and among workers in newspaper printing in Sweden, SIR 1.26 (95%CI 1.02–1.57).³³ Borderline excess risks have been found

among United States Government Printing Office workers, PMR 1.40 (95%CI 0.9–2.2),²⁵ workers with substantial exposure to printing and publishing in Montreal, Canada, OR 1.7 (90%CI 0.9–3.1),²² and men with high exposure to printing ink have an excess risk of dying from bladder cancer at an early age in the United Kingdom, SMR 5.0 (95%CI 1.0–25.8).¹⁸ Several studies have reported inconclusive results mainly due to small numbers.^{14 16 19–20 27 34–41}

It is remarkable, however, that there was no excess risk of bladder cancer in the large cohort study of printing workers from Manchester, SMR 77 (95%CI 43–126),¹¹ nor was the risk of bladder cancer increased among printers in the large United States National Bladder Cancer Study, OR 0.8 (95%CI 0.5–1.2).⁴²

These inconsistent results might be due to a risk of bladder cancer being concentrated in a subgroup of printing workers that vary in size between the studied populations.

PRIMARY LIVER CANCER

With the significant excess risk of primary liver cancer found among the printing workers in Denmark, SIR 1.90, it is remarkable that such significant excess risks have not been found in other populations. Borderline significant results have been found for commercial pressmen in New York and New Jersey exposed to benzidine based colours (SMR 1.67 (95%CI 0.87–3.20))¹⁹ and for United States Government Printing Office workers (PMR 1.47 (95%CI 0.9–2.5)).²⁵ There was no excess risk of primary liver cancer among the members of Manchester cohort,¹¹ the members of the Pressmen's Union in Los Angeles, United States,¹⁶ and among the printing workers in Sweden.⁴³ In Denmark lithographers were found to have an SIR value of 6.76 for primary liver cancer and this is unlikely to be caused by excessive alcohol consumption. Studies involving lithographers have not been conducted in other countries.

INFORMATION ON EXPOSURES

A study from Denmark based on pension scheme data also indicated an increased risk of primary liver cancer in the printing industry, and previous use of trichloroethylene and arsenic compounds were thought to be possible aetiological agents.⁴⁴ A Danish job exposure matrix (JEM), based on the American JEM,⁴⁵ and the 1978 survey of chemicals in the printing industry¹ classified the proportions of printers exposed to specified substances.⁴⁶ More than two thirds of the printers were classified as having direct exposure (skin or inhalation) for more than one hour a week to benzene, white spirit, and lead salts. Between one and two thirds were classified accordingly with direct exposure to soot, diethylene glycol, polyvinyl alcohol, mineral oil, and paraffin. Offset printers were classified with comparable exposures including exposures to hydroquinone and chromium compounds. Analysis of air samples from printing workshops in 1979 found high concentrations

of ethanol, isopropanol, ethyl acetate, and 1,1,1-trichloroethane.²⁹

Conclusion

In the present study the cancer incidence of all printing workers in Denmark was followed up over a 17 year period. Lung, bladder, renal pelvis, and primary liver cancer were in excess among the printing workers.

The doubled risks of lung cancer among the factory workers in newspaper and magazine production is unlikely to be explained by excessive smoking, and our results indicate, in line with a previous study from Manchester, that work with rotary letterpress printing was associated with an increased risk of lung cancer.

Typographers in printing establishments had a 1.5 increased risk of bladder cancer. The results for bladder cancer in printing workers are inconsistent across studies and this may point to a risk confined to a certain subgroup. Typographers and lithographers in Denmark also had an excess risk of cancer of the renal pelvis.

The sixfold risk of primary liver cancer in Danish lithographers is unlikely to be explained by excessive alcohol drinking and this result warrants studies in other countries.

Available data on exposures 25 years ago indicate significant exposures to solvents (benzene, white spirit, and alcohols).

We are indebted to Finn Gyntelberg and Lisbeth E Knudsen for comments on the manuscript. The study was financially supported by the Danish Cancer Society and the Danish Work Environment Fund.

- Andersen PE, Boserup B, Seedorff L, Sørensen F. *Chemical substances and products in the printing industry*. København: Københavns Universitet, Medicinsk-Kemisk Institut, 1979:1–92. (In Danish.)
- International Agency for Research on Cancer. *Some industrial chemicals. IARC Monographs on The Evaluation of Carcinogenic Risks to Humans. Vol 60*. Lyon: IARC, 1994: 1–560.
- EU-Council. Seventh amendment of directive 67/548/EEC on classification labelling and packaging of hazardous substances. *European Union Official Journal* 1992:L154/1. (Council directive 92/32/EEC.)
- Flyvholm M-A, Andersen P, Beck ID, Brandorff NP. PROBAS. The Danish Product Register Data Base—A national register of chemical substances and products. *Journal of Hazardous Material* 1992;30:59–69.
- Lynge E, Thygesen L. Occupational cancer in Denmark. Cancer incidence in the 1970 census population. *Scand J Work Environ Health* 1990;16:9–35.
- Arbejdsmiljøgruppen. *The work environment survey*. Copenhagen: The Danish National Institute of Social research, 1974:1–207. (In Danish.)
- Danish Data Archives. *The work environment survey*, 1973. Odense: Danish Data Archives, 1982:1–130.
- Nielsen PE, Zachø J, Olsen JA, Olsen CE. Changes in smoking habits in Denmark 1970–87. *Ugeskr Læger* 1988;150:2229–33. (In Danish.)
- Andersen IB, Sørensen TIA, Prener A. Increase in incidence of disease due to diagnostic drift: primary liver cancer in Denmark, 1943–85. *BMJ* 1991;302:437–40.
- Baelum J, Andersen I, Moelhave L. Acute and subacute symptoms among workers in the printing industry. *Br J Ind Med* 1982;39:70–5.
- Leon DA. Mortality in the British printing industry: a historical cohort study of trade union members in Manchester. *Occup Environ Med* 1994;51:79–86.
- Leon DA, Thomas P, Hutchings S. Lung cancer among newspaper printers exposed to ink mist: a study of trade union members in Manchester, England. *Occup Environ Med* 1994;51:87–94.
- Moss E, Scott TS, Atherley GRC. Mortality of newspaper workers from lung cancer and bronchitis 1952–66. *Br J Ind Med* 1972;29:1–14.
- Nicholson WJ, Seidman H, Hoas D, Selikoff IJ. *The mortality experience of New York newspaper pressmen, 1950–76*. New York: Environmental Science Laboratory, Mount

- Sinai School of Medicine, 1981.
- 15 Menck HR, Henderson BE. Occupational differences in rates of lung cancer. *J Occup Med* 1976;18:797-801.
 - 16 Paganini-Hill A, Glazer E, Henderson BE, Ross RK. Cause-specific mortality among newspaper web pressmen. *J Occup Med* 1980;22:542-4.
 - 17 Malke HSR, Gemne GA. Register-epidemiology study on cancer among Swedish printing industry workers. *Arch Environ Health* 1987;42:73-82.
 - 18 Coggon D, Pannett B, Acheson ED. Use of job-exposure matrix in an occupational analysis of lung and bladder cancers on the basis of death certificates. *J Natl Cancer Inst* 1984;72:61-5.
 - 19 Zoloth SR, Michaels DM, Villalbi JR, Lacher M. Patterns of mortality among commercial pressmen. *J Natl Cancer Inst* 1986;76:1047-51.
 - 20 Greenberg M. A proportional mortality study of a group of newspaper workers. *Br J Ind Med* 1972;29:15-20.
 - 21 Schoenberg JB, Stenham A, Mason TJ, Patterson J, Bill J, Altman R. Occupation and lung cancer risk among New Jersey white males. *J Natl Cancer Inst* 1987;79:13-21.
 - 22 Siemiatycki J. *Risk factors for cancer in the workplace*. Boca Raton, Ann Arbor, Boston, London: CRC Press, 1991:1-325.
 - 23 Bertazzi PA, Zocchetti C. A mortality study of newspaper printing workers. *Am J Ind Med* 1980;1:85-97.
 - 24 Lloyd JW, Decoufle P, Salvin LG. Unusual mortality experience of printing pressmen. *J Occup Med* 1977;19:543-50.
 - 25 Greene MH, Hoover RN, Eck RL, Fraumeni JF Jr. Cancer mortality among printing plant workers. *Environ Res* 1979;20:66-73.
 - 26 Coggon D, Pannett B, Osmond C, Acheson ED. A survey of cancer and occupation in young and middle aged men. I. Cancers of the respiratory tract. *Br J Ind Med* 1986;43:332-8.
 - 27 Williams RR, Stegens NL, Goldsmith JR. Associations of cancer site and type with occupation and industry from the third national cancer survey interview. *J Natl Cancer Inst* 1977;59:1147-85.
 - 28 Dunn JE Jr, Weir JM. A prospective study of mortality of several occupational groups. Special emphasis on lung cancer. *Arch Environ Health* 1968;17:71-6.
 - 29 Moelhave L, Baelum J. Pollution components in the air in graphic workshops. *Ugeskr Laeger* 1979;141:3187-92. (In Danish.)
 - 30 Wallstroem E, Hansen A, Eng K, Svendsen B. *Printing ink dust in printing work shops*. København: Arbejdsmiljøfondet, 1989:1-63. (In Danish.)
 - 31 Cartwright R. Occupational bladder cancer and cigarette smoking in West Yorkshire. *Scand J Work Environ Health* 1982;8(suppl 1):79-82.
 - 32 Brownson RC, Chang JC, Davis JR. Occupation, smoking, and alcohol in the epidemiology of bladder cancer. *Am J Publ Health* 1987;77:1298-300.
 - 33 Malke HSR, McLaughlin JK, Silverman DT, Ericsson JLE, Stone BJ, Weiner JA, et al. Occupational risks for bladder cancer among men in Sweden. *Cancer Res* 1987;47:6763-6.
 - 34 Claude JC, Frentzel-Beyme R, Kunze E. Occupation and risk of cancer of the lower urinary tract among men. A case-control study. *Int J Cancer* 1988;41:371-9.
 - 35 Cole P, Hoover R, Friedell GH. Occupation and cancer of the lower urinary tract. *Cancer* 1972;29:1250-60.
 - 36 Baxter PJ, McDowall ME. Occupation and cancer in London: an investigation into nasal and bladder cancer using the cancer atlas. *Br J Ind Med* 1986;43:44-9.
 - 37 Iscovich J, Castelletto R, Estève J, Munos N, Colanzi R, Corenel A, et al. Tobacco smoking, occupational exposure and bladder cancer in Argentina. *Int J Cancer* 1987;40:734-40.
 - 38 Vineis P, Magnani C. Occupation and bladder cancer in males: a case-control study. *Int J Cancer* 1985;35:599-606.
 - 39 Anthony HM, Thomas GM. Tumours of the urinary bladder: an analysis of the occupations of 1030 patients in Leeds, England. *J Natl Cancer Inst* 1970;45:879-95.
 - 40 Kabat GC, Dieck GS, Wynder EL. Bladder cancer in non-smokers. *Cancer* 1986;57:362-7.
 - 41 Steenland K, Burnett C, Osorio AM. A case-control study of bladder cancer using city directories as a source of occupational data. *Am J Epidemiol* 1987;126:247-57.
 - 42 Silverman DT, Levin LI, Hoover RN, Hartge P. Occupational risks of bladder cancer in the United States: I white men. *J Natl Cancer Inst* 1989;81:1472-80.
 - 43 McLaughlin JK, Malke HSR, Malke BK, Stone BJ, Ericsson JLE, Blot WJ, Weiner JA. Registry-based analysis of occupational risks for primary liver cancer in Sweden. *Cancer Res* 1987;47:287-91.
 - 44 Petersen KT, Doessing M, Olsen JH. *Occupational liver cancer in Denmark*. København: Arbejdsmiljøfondet, 1991:1-69. (In Danish.)
 - 45 Hoar SK, Morrison AS, Cole P, Silverman DT. An occupation and exposure linkage system for the study of occupational carcinogenesis. *J Occup Med* 1980;22:722-6.
 - 46 Olsen J, Skytthe A, Lyng E, Knudsen L, Svane O. *Development of a Danish job-exposure matrix*. København: Kraeftens Bekaempelse, 1986:1-5.7 (In Danish.)

Rejected manuscripts

From February 1994, authors whose submitted articles are rejected will be advised of the decision and one copy of the article, together with any reviewers' comments, will

be returned to them. The *Journal* will destroy remaining copies of the article but correspondence and reviewers' comments will be kept.