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Mortality in a group of tar distillery workers and roofers

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Abstract *Objective*: A retrospective cohort mortality study was conducted to assess long-term health risk in a group of tar distillery workers and roofers in order to investigate the existence of carcinogenic effects related to the occupational exposures.
Methods: The study population consisted of 907 tar distillery workers and 866 roofers, employed at least one half-year between January 1947 and January 1980. This group was followed for mortality until January 1988. For the deceased workers the cause of death was provided by the Central Bureau of Statistics. The observed cause-specific mortality was compared with the expected cause-specific mortality calculated by means of the national mortality rates of The Netherlands.
Results: Mortality from cancer of the lungs and trachea was higher than expected in both groups, but not statistically significant. In addition the roofers had experienced an excess mortality rate from external causes.
Conclusions: The study provides some additional support for the carcinogenicity of coal tar exposures, but the findings were not statistically significant.

Key words Coal tar · roofers · Carcinogenicity · Epidemiology · Occupation

Introduction

During their work a great variety of workers are exposed to coal tar and coal tar derived products. Some examples of occupational groups of workers exposed to coal tar or coal tar fumes are coke oven workers, coal tar distillery workers, potroom workers at aluminium smelters and roofers. Evidence for a carcinogenic effect for most of these groups is substantial. In coke oven workers and coal gasification workers there is consistent evidence for a lung cancer risk (Costantino et al. 1995; Swaen et al. 1991). Tar distillery workers have only rarely been investigated (Maclaren et al. 1987). In France, however, no indication of an excess lung cancer mortality rate was found in a cohort of tar distillery workers (Moulin et al. 1988). Epidemiological studies of potroom workers in aluminium smelters consistently show excesses in lung cancer (Ronneberg et al. 1995; Spinelli et al. 1991; Tremblay et al. 1995).

The carcinogenic risks in roofers have been investigated on several occasions. In the classic epidemiological study carried out by Hammond et al. (1976) 6000 roofers or roofing-related workers were followed for mortality. Between 1960 and 1972, 121 roofers had died from lung cancer compared with an expected number of 86.25 [standardized mortality ratio (SMR) = 140.29]. In that same year Menck and Henderson (1976) reported an SMR of 500 for lung cancer mortality in roofers, based on 11 deaths.

Engholm et al. (1991) reported the results of a cohort study including 704 roofers. A relative risk of 3.6 for lung cancer incidence was noted based on four cases. Minder and Beer-Porizek (1992) conducted a proportionate mortality ratio (PMR) analysis by occupation in Switzerland. Among roofers an excess of mouth and pharynx cancer mortality was reported. No excess were reported for lung cancer mortality. Partanen and Bofetta (1994) conducted a meta-analysis of epidemiological studies on asphalt workers and roofers. A pooled estimate for the relative risk of lung cancer of 1.78 was calculated for the roofers.

In general it is quite complicated to investigate long term health effects of roofers. Roofers usually are employed by smaller regionally operating companies that are difficult to trace. Earlier epidemiological studies of roofers used union records or haphazard lists of roofers.

Upon a request by the company the feasibility of a retrospective cohort mortality study was evaluated. The

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request was triggered by public concern regarding its industrial emissions. It was thought that the perceived high incidence of cancer in the vicinity of the company was related to the emissions. In addition a haphazard inventory of disease in the workforce and pensioners suggested an unusual disease pattern. In order to clarify these issues the company made a request to have an epidemiological study conducted. The aim of the study was to investigate the cause of specific mortality patterns of their employees, including the roofers employed in the regional operations.

Materials and methods

The company under investigation consisted of a tar distillery and supporting workshops. Tar was bought from cokeries and distilled and from which a range of products was manufactured. During its existence the company had two tar distilleries, one of which is still in production. In order to develop a market for its roofing products, larger roofing companies were bought or established so that eventually the coal tar distilling company possessed a network of roofing companies covering most of The Netherlands. During the feasibility phase of the study it became clear that the personnel records had periodically been cleaned of pensioned or deceased workers. Thus this potential source for cohort identification, for company pension fund, could not be used. The obvious alternative for cohort identification was further investigated. The files of the company pension fund were searched and found in such a condition that they were assumed to be complete and usable for cohort selection. Closed files were stored in the basement. Employees of the pension fund could not recollect any destruction of closed files. Inspection of completeness was made in two ways. First, after the cohort identification process was completed key persons in the company were requested to inspect the cohort and report any former workers not included in the cohort. Based on hiring and release dates an estimate was made of the total workforce. This estimate was in agreement with earlier reported figures regarding company size. The cohort consisted of 1773 workers employed for at least one half-year between January 1947 and January 1980. Women were excluded since they formed only a small group and were mainly employed in office jobs and not on production sites. In addition workers with foreign nationality were excluded from the study, since no nationality-specific mortality rates are available and many workers left The Netherlands after termination of employment, which rendered it impossible to follow them for mortality. This number was quite small.

For all workers included in the study it was possible to determine if they worked in the tar distillery (including supporting workshops) or the local roofing companies. For most of the tar distillery workers a job history was available. This was only the case for 40% of the workers employed by the local roofing companies.

The total group was followed for mortality by means of the municipal population registries. The Dutch Central Bureau of Statistics was willing to provide the causes of death for the deceased workers. Because of the strict privacy laws in effect in The Netherlands the causes of death are only given for groups of persons and not for individuals. Causes of death were converted into the ninth revision of the International Classification of Diseases (ICD-9). The end date of the follow-up was set at January 1988.

Seventy-five (4.2%) former employees were not traceable through the municipal population registries. In the analysis these persons were included as being at risk until the day that they were lost to follow-up. A similar procedure was applied for the 14 workers (0.8%) who had emigrated before January 1988. From the 591 deceased workers 570 causes of death (96.4%) were traced through the Central Bureau of Statistics.

The statistical analysis consisted of the conventional person-time analysis, an indirect method of standardization to adjust for the specific effect of age distribution, time interval and duration of follow-up. Age-specific, period-specific and cause-specific mortality of the total Dutch male population were used as a source for comparison data. SMRs were calculated by dividing the observed number of deaths by the expected number and multiplying the outcome by 100. Confidence intervals of 95% were calculated according to the method proposed by Breslow and Day (1937).

Results

During the follow-up a total number of 49 375 person-years at risk were generated giving an average period of follow-up of 27.8 years. The first half-year of employment was not regarded as being at risk since one of the eligibility criteria was at least one half-year of employment. The average period of follow-up was 27.8 years excluding the first half-year of employment.

The total mortality in the cohort was slightly lower than expected based on national mortality rates (Table 1). A total of 591 workers had died compared with an expected number of 610.1. Such a ''healthy worker effect'' is often noted in retrospective cohort studies. The total cancer mortality was quite in agreement with the cancer mortality rates in the general population. 183 workers had died from neoplastic disease, compared with an expected number 183.2. From the seven main categories of causes of death only the external causes catagory (consisting of accidents, violence and suicide) differed substantially from the expected range.

The total cohort was stratified into distillery workers and roofers. The distributions of the causes of death for these groups are given in Table 2. This analysis by subcohort reveals that the lung cancer mortality is mainly confined to the roofers, with an SMR of 131.3. This is also true for the increased mortality rate from external causes, mainly consisting of accidental falls. Finally the roofers were subdivided according to their date of hire. The group hired prior to 1 January 1955 had experienced an SMR for lung cancer mortality of 129.8 (95% CI: 85.5–188.9). Roofers hired between 1 January 1955 and 1 January 1965 had an SMR for lung cancer of 153.8 (95% CI: 79.5–269.1). Only 137 roofers were hired after 1 January 1965. In this group no death from lung cancer was observed compared with an expected number of 1.1.

Discussion

In this cohort consisting of 1733 workers from a tar distillery and roofers some indications were found for the existence of occupationally related health risks. In the tar distillery workers as well as among the roofers an elevated lung cancer mortality was noted. The excess lung cancer mortality in the tar distillery workers was comparatively small and not statistically significant. In a similar study of 255 tar distillery workers Maclaren and Hurley (1987) observed an SMR of 160 for lung cancer

Table 1 Cause-specific mortality in 1773 workers of a coal tar distillery and local roofing companies. *Obs* observed, *Exp* expected, *SMR* standardized mortality ratio

	Obs	Exp	SMR	95% CI
Total mortality	591	610.1	96.9	89.2–105.0
I Infectious disease	3	6.0	49.9	10.0–145.8
II Neoplasm	183	183.2	99.9	86.0–115.5
III Heart and circulatory disease	233	266.1	87.6	76.7–99.6
IV Respiratory disease	46	42.3	108.7	79.6–145.0
V Digestive disease	13	19.9	65.2	34.7–111.5
VI Other causes	41	59.2	69.2	49.7–93.9
VII External causes[a]	51	33.4	152.6	113.6–200.7
Neoplasms:				
Mouth and pharynx	2	1.9	102.5	11.5–369.9
Oesophagus	5	3.0	164.0	52.9–382.8
Stomach and jejunum	21	20.6	102.1	63.2–156.1
Colon	8	10.7	74.6	32.1–147.0
Rectum	4	6.1	65.8	17.7–168.6
Liver	5	3.6	140.2	45.2–327.1
Pancreas	8	8.1	99.4	42.8–195.9
Larynx	1	1.7	59.1	0.8–328.6
Trachea and lung	87	70.3	123.8	99.1–152.7
Bone	1	0.7	150.2	2.0–835.4
Connective tissue	1	0.6	172.1	2.2–957.6
Skin	2	1.5	134.5	15.1–485.6
Prostate	10	12.5	80.2	38.4–147.6
Kidney	2	4.3	46.3	5.2–167.0
Bladder	5	6.3	80.0	25.8–186.7
Brain	0	3.1	–	–
Thyroid	1	0.4	258.4	3.4–1437.7
Hodgkin's disease	0	1.6	–	–
Other lymphomas	2	1.7	119.3	13.4–430.6
Multiple myeloma	1	2.5	40.4	0.5–224.9
Leukaemia	6	5.0	119.9	43.8–261.0
Non-malignant	2	0.8	256.7	28.8–927.0
Not specified	5	8.1	61.4	19.8–143.2
Other	4	2.6	153.7	41.3–393.4
Unknown	21			

[a] External causes includes deaths from accidents, violence and suicide

mortality. Although this figure is higher it is in the range of the observations in this study. However, the excess of bladder cancer mortality reported by Maclaren and Hurley is not reproduced in this study. In a similar study among 963 tar distillation workers conducted in France no indication for a lung cancer risk was reported (Moulin et al. 1988). However, in that study an excess for cancer of the buccal cavity and pharynx was observed, which was not seen in our study.

The lung cancer mortality excess among the roofers was more pronounced than in the tar distillery workers. Thirty nine deaths from lung cancer were observed as compared with an expected number of 29.7. Although these figures are not statistically significantly different from each other, it is quite plausible that the excess is occupationally related. In several other studies excesses of lung cancer mortality or morbidity among roofers have been observed. Dong et al. (1995) reported a PMR of 115 for lung cancer in British roofers after adjustment for age and social class. Currently there is some debate regarding a possible lung cancer risk in workers exposed to asphalt (Partanen et al. 1994). Hansen (1989) reported a statistically significantly increased SMR of 344 for lung cancer mortality in a cohort of workers exposed to bitumen fumes. However, two studies of highway maintenance workers including asphalt pavers did not report any excess of lung cancer mortality (Bender et al. 1989; Maizlish et al. 1988). Differences in composition between coal tar and asphalt and differences in application temperatures indicate that a lung cancer risk from asphalt fumes should be lower than that from coal tar fumes, if there is any difference at all.

This study provided only limited evidence for the existence of a lung cancer risk in roofers and distillation workers exposed to coal tar or coal tar-based products. Despite the substantial sample size, the SMR was not statistically significant from unity.

Unfortunately it was not possible to collect information on the smoking habits of the study sujects. Since it is known that smoking is more prevalent among the lower socio-economic classes (Vutuc et al. 1979, 1980), a confounding effect by smoking could not be ruled out. The results of this study are quite in agreement with the earlier study of roofers by Hammond et al. (1976), in which an SMR of 140 for lung cancer mortality was observed. However, the results of this study do not support the findings of Engholm et al. (1991) who reported a relative lung cancer risk of 3.6, based on only four cases. A confounding effect by smoking in roofers was also observed in the roofers studied by Dong et al. (1995).

Table 2 Cause-specific mortality in 907 tar distillery workers and 866 roofers

	Tar distillery				Roofers			
	Obs	Exp	SMR	95% Cl	Obs	Exp	SMR	95% Cl
Total mortality	297	347.5	85.5	76.0–95.8	294	262.6	112.0	99.5–125.5
I Infectious disease	1	3.4	29.2	0.4–163.6	2	2.6	77.3	8.6–277.7
II Neoplasm	102	104.7	97.4	79.4–118.3	81	78.4	103.3	82.0–128.4
III Heart and circulatory disease	119	152.1	78.2	64.8–93.6	114	114.0	100.0	82.5–120.1
IV Respiratory disease	20	24.7	80.9	49.4–125.1	26	17.6	147.8	96.5–216.5
V Digestive disease	3	11.3	26.7	5.3–77.6	10	8.7	115.0	55.0–211.4
VI Other causes	22	33.3	66.1	41.4–100.0	19	26.0	73.2	44.0–114.1
VII External causes[a]	19	18.0	105.6	63.5–164.8	32	15.4	207.6	142.1–293.4
Neoplasms:								
Mouth and pharynx	0	1.1	–	–	2	0.9	233.1	25.0–802.3
Oesophagus	1	1.7	58.1	0.8–327.3	4	1.3	301.7	82.8–787.8
Stomach and jejunum	11	11.7	94.4	46.9–168.2	10	8.9	112.3	53.8–206.6
Colon	5	6.1	81.7	26.4–191.3	3	4.6	65.2	13.1–190.6
Rectum	3	3.5	86.5	17.2–250.4	1	2.6	38.4	0.5–214.0
Liver	2	2.0	99.4	11.2–361.0	3	1.6	192.9	37.7–547.8
Pancreas	5	4.6	109.0	35.0–253.7	3	3.5	86.6	17.2–250.4
Larynx	0	1.0	–	–	1	0.7	135.9	1.9–794.8
Trachea and lung	48	40.6	118.2	87.2–156.8	39	29.7	131.3	93.4–179.5
Bone	0	0.4	–	–	1	0.3	335.6	4.4–1854.6
Connective tissue	1	0.3	310.6	4.4–1854.6	0	0.3	–	–
Skin	2	0.8	245.7	28.1–902.6	0	0.7	–	–
Prostate	9	7.3	122.7	56.3–234.1	1	5.1	19.5	0.3–109.1
Kidney	0	2.4	–	–	2	1.9	105.3	11.8–380.1
Bladder	2	3.6	55.0	6.2–200.6	3	2.6	114.7	23.2–337.1
Brain	0	1.7	–	–	0	1.4	–	–
Thyroid	1	0.2	465.1	6.5–2781.9	0	0.2	–	–
Hodgkin's disease	0	0.7	–	–	0	0.6	–	–
Other lymphomas	0	0.9	–	–	2	0.7	272.9	32.1–1031.6
Multiple myeloma	0	1.4	–	–	1	1.1	94.8	1.2–505.8
Leukaemia	3	2.8	106.7	21.5–313.1	3	2.2	136.9	27.4–398.4
Non-malignant	1	0.4	228.8	3.3–1391.0	1	0.3	292.4	4.4–1854.6
Not specified	4	4.6	86.5	23.4–222.6	1	3.5	28.4	0.4–159.0
Other	4	1.5	268.6	71.7–682.7	0	1.1	–	–
Unknown	11				10			

[a] External causes includes deaths from accidents, violence and suicide

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