

Table 2.1. Cohort studies of iron and steel founding workers and cancer

Reference, location, name of study	Cohort description	Exposure assessment	Organ site (ICD code)	Exposure categories	No. of cases/deaths	SMR (95% CI)*	Adjustment for potential confounders	Comments
Koskela <i>et al</i> (1976) Finland	A cohort of 3876 male foundry workers formed from a random sample among 15 401 men from 20 foundries, employed 1950 to 1972. All men employed more than three years and a random sample of those with shorter employments were included. Work histories were obtained from the companies. Mortality was followed up to 1973.	Employment duration. Occupational title groups Dustiness and CO exposure coded as low/high	Lung	Entire cohort	21	151 [94-231] [127] [61-233] [186] [93-334] [276] [119-544] [3.3] [0.9] [2.3] [1.1]	No smoking data. Internal contrast in risk not likely to be caused by smoking	Mortality reference rates were obtained from the general Finnish population.
				Exposed <5 years	10			
				Exposed ≥5 years	11			
				Exposed >5 years and dust = high >5 years <i>employment:</i>	8			
				Molders and coremakers	5			
				Casters and furnacemen	1			
Fettlers	3							
Laborers	1							
Gibson <i>et al</i> (1977) Canada	A cohort of 1542 steel mill workers included all workers (men?) employed in 1967, aged 45 and over, and employed for at least five years prior to 1967. The cohort was followed for mortality 1967-1976. Death rates were obtained for the area of Toronto. The plant started to operate in 1912	Foundry (439) / not foundry (1103)	Lung	Foundry workers Not foundry	21 11	2.55 (1.55-3.82) 0.66 (0.33-1.19)	A smoking survey in 1973 showed no difference in smoking habits between foundry and non-foundry workers	

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Decoufle & Wood (1979) USA	2 861 male foundry workers, employed for >1 year at the plant and >1 month in the foundry from 1938 to 1967. Followed for mortality 1938 to 1967.	Employment duration, employment before 1938	Respiratory cancer	Ever employed	29	[126] [84-180]	Race, age and calendar year	Expected numbers of deaths were derived from the general US population. No smoking data available [A low overall mortality was noted especially among non-whites (SMR = 0.65)]
			ICD7 160-165	employed >5 years	12	[128] [66-223]		
				employed >5 years before 1938	8	[200] [86-394]		
Digestive cancer	Ever employed	30	[90] [60-129]	ICD7 150-158	employed >5 years	17	[117] [68-188]	
	employed > 5 years before 1938	14	[189] [103-317]					
Tola <i>et al</i> (1979) Finland	A cohort of 3425 male foundry workers employed >1 year between 1918 and 1972 at 13 iron foundries, followed for mortality through 1976.	10 occupational groups were assigned PAH exposure levels measured in 1976	Lung	Entire cohort	51	PMR 144 [108-198]	No smoking data available. Internal contrast in risk not likely to be caused by smoking.	A nested case-control study showed significantly increased risk among floor molders and casters. No ORs were given. A non-significant excess of lung cancer was present among those with PAH-exposure "high" vs "low"

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Egan-Baum <i>et al</i> (1981) USA	Proportional mortality investigated among members of the death benefit program of the International Molders and Allied Workers Union. The study comprised 3013 males who had been members of the union in 1961 and died between 1971 and 1975		Lung	All union members White males Black males	224 39	PMR 144 [126-164] 176 [125-241]		No smoking data available A nested case-control analysis by foundry type had low numbers and gave no firm conclusion regarding lung cancer risk and foundry type
Silverstein <i>et al</i> (1986) USA	A proportional mortality analysis of 278 deaths among male workers employed >10 years at a foundry	Department	Lung	All men, Whites Non-whites White males ever smokers never smokers	28 3 23 4	PMR 148 (104-210) 85 (17-249) 159 (108-233) 96 (24-244)		The distribution of deaths among the foundry workers was compared to the general US population. For analysis of lung cancer PMR among smokers, comparison was made with smokers among USA veterans.

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Sitas <i>et al</i> (1989) South Africa	An analysis of proportional mortality among 419 deaths occurring 1961-83 among white male members of the Iron Moulders Society of South Africa.	Occupational titles: journeymen and production molders	Lung	<65 age >65 age	13 15	PMR 84 [0.45-1.44] 171 [0.96-2.83]		The distribution of causes of deaths in the general white male population was used for reference.
Andjelkovich <i>et al</i> (1990) USA	8147 men and 627 women employed for at least 6 months 1950-1979 in a gray iron foundry (which started operation in 1928 and closed in 1987) were followed for mortality 1950-1984.	Work histories specifying job title and department from company records. Duration of foundry employment	Lung (162)	Foundry employment White men Non-white men	[139] 72 67	[127 (107-150)] 123 (96-154) 132 (102-167)	Indirect adjustment using group level [automotive worker]	No positive trend with increasing duration of employment. Data indicated that the excess among whites but not among non-whites could be explained by tobacco smoking [crude method to assess the influence of tobacco smoking]
Andjelkovich <i>et al</i> (1992) USA	Further analysis of cohort study by Andjelkovich <i>et al.</i> (1990)	Analysis of mortality by work area	Lung	Core making Melting Molding Finishing Service and maintenance Pattern making	19 6 36 29 43 6	101 64 132 151* 142* 138 * p<0.05		No consistent pattern with duration within work areas

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Moulin <i>et al.</i> (1993) France	Stainless steel producing company. 4227 workers employed for >3 years between 1968 and 1984 included, followed for mortality 1968 to 1986.	Work area, duration, time since first employment	Lung	Entire cohort Foundry area In foundry area >30 years	39 11 6	132 (94-180) 229 (114-409) 324 (119-705)		A survey of smoking habits performed among those in employment 1986 (24% of the cohort) showed a slightly higher percentage of smokers among the SS plant workers, than in the national average. This could not explain the high lung cancer rate in the foundry workers.
			Stomach	Entire cohort	7	92 (37-190)		
Andjelkovich <i>et al.</i> (1994) USA	A case-control-study nested within the cohort reported by Andjelkovich <i>et al.</i> (1992). Follow up for mortality extended to 1989. 220 lung cancer cases and 2200 matched controls selected from the cohort. Information on smoking habits was obtained for 71%	Exposure to formaldehyde and silica classified by occupational hygienist; cumulative exposure calculated	Lung	Silica: Q2 vs Q1 Q3 vs Q1 Q4 vs Q1 Formaldehyde ever vs never		OR 1.27 (0.78-2.06) 0.97 (0.56-1.68) 0.91 (0.52-1.58) 1.31 (0.83-2.07)	Smoking	

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Sorahan <i>et al</i> (1994) UK.	10 438 male production workers employed for >1 year at 10 steel foundries in UK 1946-65, followed for mortality 1946-1990.	Employment duration Foundry area	Lung	Entire cohort	551	146 (134-158)		National mortality rates were used to calculate SMRs. Earlier follow-up of this cohort by Sorahan & Cooke (1989) and Fletcher & Ades (1984) No smoking histories available. Other tobacco-related cancers were not in excess
				Years in foundry and fettling shop				
				0	157	1		
				>0-5	185	1.21 (0.98-1.51)		
				>5-15	129	1.44 (1.13-1.82)		
				>15	80	1.26 (0.95-1.67)		
			Trend per unit of employment		1.11 (1.02-1.21)			
			Stomach	Entire cohort	124	134 (111-160)		
				Years in foundry and fettling shop				
				0	37	1		
>0-5	48	1.31 (0.84-2.04)						
>5-15	28	1.34 (0.81-2-20)						
>15	11	1.04 (0.52-2.21)						
Trend per unit of employment		1.07 (0.89-1.29)						

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Andjelkovich <i>et al</i> (1995) USA	A cohort of 3 929 men potentially exposed to formaldehyde between 1960 and 1989, selected from the cohort earlier reported by Andjelkovich <i>et al.</i> (1990, 1992). 2032 men not exposed to formaldehyde were selected from the same cohort. The cohort was followed for mortality 1960 – 1989. Information on smoking obtained from survey: response rate 65% in exposed and 55% in unexposed group	Exposure to formaldehyde and silica classified by occupational hygienist; cumulative exposures calculated	Lung	Silica: Q2 vs Q1 Q3 vs Q1 Q4 vs Q1 Formaldehyde: exposed vs unexposed		RR 2.34 (0.68-10.7) 3.41 (1.16-14.5) 3.98 (1.41-16.6) 0.71 (0.43-1.21)		Poisson regression was limited to those with known smoking habits The contradictory finding to those by Andjelkovich <i>et al.</i> (1994) explained by the authors on potential overmatching in the case-control study
Xu <i>et al</i> (1996) PR China	Proportionate mortality was investigated for 8 887 deaths among iron and steel workers at a large plant.	Occupational title and department	Lung Stomach	Foundry workers 68 25		PMR 1.2 (1.0-1.6) 1.0 (0.6-1.4)		No smoking data were available

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Rodríguez <i>et al</i> (2000) Spain	All workers employed at an iron and steel producing plant between 1952 and 1995, around 24490 subjects. Cases and controls were selected among males who had worked at least 13 months at the plant. 144 lung cancer cases from 1973 and onwards identified. 558 controls free from lung cancer and alive at time of sampling selected based on incidence density sampling	Work histories obtained from company medical records and payrolls, and smoking histories from company medical records	Lung	Ever employed at:		OR	Smoking	Nested case-control analysis
				Coke batteries	9	1.06 (0.46-2.44)		
				Blast furnace	16	2.55 (1.25-5.21)		
				Steel mill	15	1.30 (0.63-2.66)		
				Lamination	33	1.00 (0.60-1.66)		
				Foundry (steel)	10	1.64 (0.69-3.91)		
				Maintenance furnace	3	0.82 (0.23-2.89)		
				Coke-byproducts	2	0.55 (0.10-2.99)		
				Others	87	1.00		

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Adzersen <i>et al</i> (2003) Germany	A cohort of 17708 workers from 37 iron foundries, employed >1 year 1950-1985. The cohort was followed for mortality 1951-1993.	Duration of employment	Lung	Entire cohort	322	[127] [114-142]		Expected numbers were calculated from national mortality statistics for Western Germany. Group-level smoking data obtained from a national microcensus in 1978 indicated that the observed excess of lung cancer could be explained by smoking
				Duration of employment				
				1-10 years	159	[130] [110-152]		
				10-19 years	77	[117] [93-147]		
				20-29 years	60	[128] [98-165]		
30+ years	26	[142] [93-208]						
			Liver	Entire cohort no trend with duration	28	[226] [150-326]		
			Stomach	Entire cohort	70	[76] [59-96]		

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Hoshuyama <i>et al</i> (2006) PR China.	A cohort of 121 846 male iron and steel production workers employed > 6 months and employed 1980-01-01 were followed for mortality 1980-1993. This plant had earlier been studied by Xu <i>et al</i> (1996)	Exposure (yes/no) to 15 agents, e.g. silica, iron dust, asbestos and PAH, were linked to longest job held by a job exposure matrix. There were 836 workshops and 1583 job titles.		All exposed blue collar workers vs general population		SMR		Reference rates for mortality from the general population of the area and an internal group of unexposed blue-collar workers. No specific analysis was reported for the foundry department of the plant. No smoking data were available [The working group noted that the discrepant results from external and internal analyses of the cohort, as well as the crude exposure assessment limited the conclusions]
			Lung		750	96 (88-102)		
			Stomach		321	86 (77-96)		
				Internal analysis PAH and one dust		SRR		
		Lung		74	208 (162-266)			
		Stomach		24	187 (134-261)			