

**Table 2.5 Cohort studies of workers in the rubber industry and digestive tract cancer**

Reference, location, name of study	Cohort description	Exposure assessment	Organ site (ICD code)	Exposure categories	No. of cases/deaths	Relative risk (95% CI)*	Adjustment factors	Comments
Stomach								
Chen et al (1997), PR China	7808 workers (5010 men, 2798 women) employed >1 year in 3 factories, through 1972	Work history and payroll data from company records	Stomach	<i>Men</i> Tire material handling	10	<b>SIR</b> 2.1 ( $p<0.05$ )	Results stratified by smoker/non-smoker	Local reference. Cancer incidence data obtained from company records and confirmed through hospital of diagnosis
Li and Yu (2002b), PR China	Case-cohort study; 1598 workers (934 men, 664 women) employed >1 year in a rubber manufacturing plant from 1973-1995; sub-cohort of 188 workers, frequency-matched by year of birth within 10 years; vital status 100%	Work history from company records and questionnaire; jobs coded in 4 categories, cumulative exposure years	Stomach	<i>Annual income</i> Medium Low <i>Job category and years</i> Inner tire tube 1-19 20-45 Milling, etc. 1-19 20-45	23 5 36 1 1 36 2 12	<b>RR</b> Trend ( $p=0.004$ ) 2.4 (1.0-5.8) 5.2 (1.4 -18.9) 1.5 (0.2-14.3) 1.7 (0.2-15.4) 0.5 (0.1-2.8) 1.3 (0.6-2.8)	Work groups, gender and income; not adjusted for smoking, RR for smokers >20 pack-years: 1.3 (0.4-3.8)	Reference category is non-exposed

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Mundt <i>et al</i> (1999), Germany	2871 female workers employed >1 year in 5 rubber plants and actively employed from 1976-1980; mortality follow up 1976-91; vital status 99%; cause of death 94%	Work history reconstructed from archived cost center codes. Classified into 6 work areas by type and stage of manufacturing process	Stomach	Overall <i>Year of hire</i> <1950 1950-59 ≥1960	7 1 1 5	<b>SMR</b> 1.6 (0.6-3.2) 1.0 0.7 2.5 (0.8-5.9)		Local reference.
Weiland <i>et al.</i> (1996); Weiland <i>et al.</i> (1998); Straif <i>et al.</i> (1998); Straif <i>et al.</i> (1999); Straif <i>et al.</i> (2000a); Straif <i>et al.</i> (2000b), Germany	8933 German male workers aged <85 years, employed >1 year in 5 rubber plants from 1950-1981; mortality follow up 1981-91; vital status 99%; cause of death 97%	Retrospective semi-quantitative exposure reconstruction of nitrosamines, asbestos, talc and carbon black using individual work histories and limited IH air measurements; low exposure workers were employed <0.5 year in high/medium exposures, high exposure were employed >10 years in high exposures	Stomach	Overall  <i>Asbestos/talc</i> Low Medium High	44  16 15 13	<b>SMR</b> 1.2 (0.9-1.6) <b>HRR</b> 1.0 1.9 (0.9-4.0) 3.9 (1.2-12.6)	HRR adjusted for age and all other exposures; 10-year lagging;	Local reference

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Neves <i>et al.</i> (2006), Sao Paulo, Brazil	9188 male workers from 743 rubber manufacturing companies employed from 1975-1985; mortality follow-up 1990-2000; vital status 83%; cause of death 81%	Classification by company size, type of rubber industry, occupational title, and qualification, obtained from union records	Stomach	<i>Company size</i> Large Medium Small	17	<b>RR</b> 1.0 1.2 (0.8-1.7) 3.5 (2.6-4.7)	Age, time since first employment, total duration of employment in rubber industry; 10-year lagging	Internal comparisons
Straughan and Sorahan (2000); Dost <i>et al.</i> (2007), United Kingdom BRMA health research project II	8651 workers of 41 rubber manufacturing plants (7561 men, 1090 women) employed >1 year during 1982-1991, office workers were excluded; mortality and incidence follow-up 1983-2004; vital status 98%	Workers considered exposed if employed in rubber manufacture; period from hire as surrogate for cumulative exposure	Stomach	Men Women  Men Women	4 0  10 0	<b>SMR</b> 0.9 (0.2-2.2) 0 <b>SRR</b> 1.4 (0.7-2.5) 0	Stratification by industry sector (tire manufacture or general rubber goods)	Local reference
Wilczyńska <i>et al.</i> (2001), de Vocht <i>et al.</i> (2009), Poland	17636 workers (11582 men, 6054 women) employed >3 months during 1950-95 in a rubber tire plant; mortality follow-up 1950-2001; vital status 97%; cause of death 88%	JEM for exposure to aromatic amines, inhalable aerosols and rubber fumes from a database of exposure data for the European rubber industry	Stomach	<i>Men</i> Overall Maintenance department	43 19	<b>SMR</b> 0.9 (0.7-1.2) 1.3 (0.8-2.0)	5-year lagging, gender-specific analyses	No increase in risk with exposure to aromatic amines and inhalable aerosol

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<b>Oesophagus</b>								
Chow <i>et al.</i> (1995), Sweden	Men employed in 1960; cancer incidence follow-up 1961-79; 2394 oesophageal cancer cases, 96% histologically confirmed	Employment information (industry and occupation) from 1960 census	Oesophagus	Employed in rubber Employed in vulcanizing shops	15 9	<b>SIR</b> 1.4 ( $p>0.05$ ) 4.7 ( $p<0.01$ )	Geographic region	National reference
Weiland <i>et al.</i> (1996); Weiland <i>et al.</i> (1998); Straif <i>et al.</i> (1998); Straif <i>et al.</i> (1999); Straif <i>et al.</i> (2000a); Straif <i>et al.</i> (2000b), Germany	8933 German male workers aged <85 years, employed >1 year in 5 rubber plants from 1950-1981; mortality follow up 1981-91; vital status 99%; cause of death 97%	Retrospective semi-quantitative exposure reconstruction of nitrosamines, asbestos, talc and carbon black using individual work histories and limited IH air measurements; low exposure workers were employed <0.5 year in high/medium exposures, high exposure were employed >10 years in high exposures	Oesophagus	Overall <i>Nitrosamines</i> Low Medium High	13 13	<b>SMR</b> 1.2 (0.9-1.6) <b>HRR</b> 1.0 2.7 (0.7-11.5) 9.1 (2.1-38.8) $p<0.05$	HRR adjusted for age and all other exposures; 10-year lagging;	Local reference

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Szeszenia-Dabrowska <i>et al</i> (1991), Szeszenia-Dabrowska <i>et al</i> (1995), Szymczak <i>et al.</i> (2003), Poland	11342 workers (5472 men, 5870 women) employed >1 year during 1945-85 in a rubber footwear plant; mortality follow up until 1997	Occupational history from company records	Oesophagus	Men	17	<b>SMR</b> 1.7 (1.0-2.8)		National reference
Straughan and Sorahan (2000); Dost <i>et al.</i> (2007), England and Wales and Scotland, UK, BRMA health research project II	8651 workers of 41 rubber manufacturing plants (7561 men, 1090 women) employed >1 year during 1982-1991, office workers were excluded; mortality and incidence follow-up 1983-2004; vital status 98%	Workers considered exposed if employed in rubber manufacture; period from hire as surrogate for cumulative exposure	Oesophagus	Men	6	<b>SMR</b> 1.1 (0.4-2.3)	Stratification by industry sector (tire manufacture or general rubber goods)	Local reference
				Women	0	<b>SRR</b> 0		
Chen <i>et al</i> (1997), Shanghai, China	7808 workers (5010 men, 2798 women) employed >1 year in 3 factories, through 1972	Work history and payroll data from company records	Rectum	Men		<b>SIR</b>	Results stratified by smoker/non-smoker	Local reference. Cancer incidence data obtained from company records and confirmed through hospital of diagnosis
				Tire building/tire storage	4	4.8 ( $p<0.05$ )		
				Women				
				Tire building	6	3.4 ( $p<0.05$ )		

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Szeszenia-Dabrowska <i>et al</i> (1991), Szeszenia-Dabrowska <i>et al</i> (1995), Szymczak <i>et al.</i> (2003), Poland	11342 workers (5472 men, 5870 women) employed >1 year during 1945-85 in a rubber footwear plant; mortality follow up until 1997	Occupational history from company records	Colon	Men	19	<b>SMR</b> 1.8 (1.1-2.8)		National reference
			Rectum and anus	Women	24	1.7 (1.1-2.5)		
Neves <i>et al.</i> (2006), Sao Paulo, Brazil	9188 male workers from 743 rubber manufacturing companies employed from 1975-1985; mortality follow-up 1990-2000; vital status 83%; cause of death 81%	Classification by company size, type of rubber industry, occupational title, and qualification, obtained from union records	Upper digestive tract	<i>Company size</i> Large Medium Small Changed size	14	<b>RR</b> 1.0 2.3 (1.7-3.2) 2.5 (1.8-3.5) 3.9 (3.0-5.1)	Age, time since first employment, total duration of employment in rubber industry; 10-year lagging	Internal comparisons
Taeger <i>et al.</i> (2007), west Germany	9597 workers (8,210 men, 1,387 women) employed in 13 rubber manufacturing facilities during 1981-2000; mortality follow-up 1982-2000, censored at age 85 years	Workers considered exposed if employed in rubber manufacture	Oral cavity	Men	1	<b>SMR</b> 1.6 (0.04-8.9)	Gender-specific analyses	Local reference; no bladder cancer deaths observed

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Wilczyńska et al. (2001), de Vocht <i>et al.</i> (2009), Poland	17636 workers (11582 men, 6,054 women) employed ≥3 months during 1950-95 in a rubber tire plant; mortality follow-up 1950-2001; vital status 97%; cause of death 88%	JEM for exposure to aromatic amines, inhalable aerosols and rubber fumes from a database of exposure data for the European rubber industry	Digestive organs and peritoneum (150-159)	<i>Women</i>	27	<b>RR</b>	5-year lagging, gender-specific analyses	Overall risk estimate not reported.
				<i>Quartiles</i>				
				Aromatic amines				
				I				
				II				
III								
IV								
						1.0		
						4.5 (1.4-15.1)		
						2.0 (0.5-7.6)		
						1.5 (0.4-5.5)		

HRR-hazard rate ratio, OR-odds ratio, RR-relative risk, SIR-standardized incidence ratio, SMR-standardized mortality ratio, SRR-standardized rate ratio