

**Table 2.13. Cohort studies of benzene and Hodgkin's disease**

Reference, location	Cohort description	Exposure assessment	Organ site (ICD code)	Exposure categories	No. of cases/deaths	Relative risk (95% CI)	Adjustment for potential confounders	Comments
McCraw et al. (1985) USA	All white male employees at an oil refinery for at least one day between 1973–1982, and retirees alive as of 1973; total 3976	No exposure assessment was performed	HD 201	None	2	(SMR) 2.0 (0.2-7.2)		Comparison population Surveillance, Epidemiology and End Results, white men.
Wong (1987), USA	4602 men chemical workers from 7 plants occupationally exposed to benzene for at least 6 months 1947–1975, and 3074 workers from the same plants not exposed to benzene	Jobs with exposure to benzene classified as continuous and intermittent exposure. Tasks classified by occupational hygienists, with level of exposure assigned from exposure measurements.	HD 201	Benzene continually exposed <180 ppm-months 180–719 ppm-months ≥ 720 ppm-months	0 1 1	(SMR) - 1.9 2.4		

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Dagg <i>et al.</i> , (1992), USA	Cohort study of 14 074 employees of two petroleum refineries who worked at least a year 1950–1980, followed through 1986.	Only first and last jobs coded. No exposure determination performed	HD 201	None	8	(SMR) 0.9 (0.4-1.7)		No differences by duration of employment or in two different refineries.
Tsai <i>et al.</i> , (1993), USA	Cohort 4585 workers at two refinery and petrochemical plants who worked more than 6 months before or after January 1 1973 and followed through 1989.	No exposure determination performed	HD 201	None	2	(SMR) 2.0 (0.2-7.2)		
Honda <i>et al.</i> , (1995), USA	Cohort of 9796 white men who had worked at a petroleum manufacturing plant for 6 months 1942–1989 and followed to January 1 1990.	No exposure determination performed	HD 201	None	9	(SMR) 1.0 (0.5-2.0)		

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Collingwood <i>et al.</i> , (1996), USA	Cohort of 4855 refinery workers employed for a minimum of 1 year 1946–1979, and followed through 1987.	No exposure determination performed	HD 201		2	(SMR) 0.6 (0.0-2.1)		
Satin <i>et al.</i> , (1996), USA	Cohort of 17 844 petroleum refinery workers, employed 1937–1983, followed through 1987	No exposure determination performed	HD 201		18	(SMR) 1.4 (0.8-2.2)		Referent Texas general population.
Tsai <i>et al.</i> , (1996), USA	9720 employees who had worked at least 3 months 1948–1989 in a petrochemical refinery and chemical plant complex	Workers assigned to refinery (5019) or chemical plant (3988) according to longest duration job. No benzene exposure determination performed	HD 201	Refinery Chemical plant	4 0	(SMR) 1.4 (0.4-3.5) -		

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Lyngé <i>et al.</i> , (1997), Denmark, Norway, Sweden, Finland	Cohort of gasoline service station workers (16 524 men, 2445 women), followed through 20 years by linkage to national cancer registries	Service station occupation identified from the 1970 censuses of each country	HD 201	Men	10	(SIR) 1.0 (0.5-1.8)		Estimated average level of exposure to benzene below 1 mg/m <sup>3</sup>
				Women	0	-		
Nilsson <i>et al.</i> , (1998), Sweden	Cohorts of men Swedish seamen, age 20-64, identified through the 1960 (13 499) and 1970 (11 290) censuses, cases identified by linkage to the Swedish cancer register, 1961-79 and 1971-87, respectively (5 and 7 HD).	Details of service on ships from the Swedish Registry of Seamen. Ship classified as chemical or product tanker, crude oil tanker, other	HD 201	1960 cohort		(OR)		Nested case-control analysis. 3-5 controls per case randomly selected among men in the same 5 year age stratum classified as seamen in the same national census and confirmed to be alive at the time of the diagnosis of the case
				Chemical or product tanker	0	-		
				Crude oil tanker	0	-		
				1970 cohort				
Chemical or product tanker	3	3.0 (0.4-22.5)						
Crude oil tanker	0	-						

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Pukkala (1998), Finland	Cohort of 7512 men and 1942 women employed in one group including oil refinery, and chemical manufacturing; follow-up by linkage with the Finnish cancer registry 1971–1994.	No estimate of exposure to benzene	HD 201	Employed at least 3 months during 1967-1982	7	(SIR) 1.4 (0.5-2.8)		
Consonni <i>et al.</i> , (1999), Italy	Cohort of 1583 workers employed 1949–1982 in an oil refinery and followed through May 1991.	No estimate of exposure to benzene	HD 201		2	(SMR) 1.5 (0.2-5.4)		

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Divine <i>et al.</i> (1999a) USA	24 604 white men who worked at selected refinery, petrochemical, and research establishments at least one day between 1947–1977; employed at these for a cumulative total >5 years; still employed on the end date of the study	Complete work history of all jobs held at the participating factories	HD 201	Employed: Ever before 1950 1950 and after	17 12 5	(SMR) 1.0 (0.6-1.6) 0.9 (0.5-1.6) 1.1 (0.4-2.6)		
Wong <i>et al.</i> , (2001a) USA	Cohort of 7543 petroleum refinery workers (91% men) employed for at least 1 year, 1945–1996, followed to 1996	No exposure determination performed	HD 201	Men workers	3	(SMR) 0.6 (0.1-1.8)		
Wong <i>et al.</i> , (2001b) USA	Cohort of 3328 petroleum refinery workers employed for at least 1 year, 1959–1997, followed to 1997	No exposure determination performed	HD 201		1	(SMR) 0.5 (0.0-2.6)		

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Sorahan <i>et al.</i> , (2002), United Kingdom	Cohorts of 29 630 oil refinery and 16 480 petroleum distribution workers, first employed after 1 January 1946 who had worked for at least a year, followed 1951–1998 by linkage with national files	No exposure determination performed	HD 201	Refinery workers Distribution workers	13 14	(SMR) 0.6 (0.3-1.1) 1.2 (0.7-2.0)		
Collins <i>et al.</i> (2003), USA	Hourly workers (4172 men and 245 women) employed at a chemical manufacturing plant from 1940-1977 and followed to 1997	Work histories, sampling measurements and industrial hygienists assessments	HD 201	Benzene cumulative exposure ppm-years		(SMR)		
				0	1	0.5 (0.0-2.8)		
				<1	1	1.7 (0.0-9.7)		
				1-6	0	0.0 (0.0-6.7)		
				>6	0	0.0 (0.0-6.6)		

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Lewis <i>et al.</i> , (2003), Canada	Cohort of 17 230 men and 8062 women employed for at least a year of a petroleum company hired between 1964 and 1994 linked to national mortality and cancer incidence databases to 1994.	Estimates of similar exposure groups based upon job title and location by industrial hygienists	HD 201	Men Women	11 3	(SIR) 1.05 (0.5-1.9) [0.9]		No specific estimates of benzene exposure
Bloemen <i>et al.</i> , (2004), USA	Workers exposed to benzene at a chemical plant; 2266 workers (94% men) Followed for up to 30 years.	Job-titles were assigned to exposure categories by an industrial hygienist, based on industrial hygiene measurements.	HD 201	Benzene exposed workers	2	(SMR) 1.0 (0.1-3.6)		



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Huebner <i>et al.</i> , (2004), USA	All employees of two refinery/petrochemical plants (Baton Rouge 6941 men, Baytown 6241 men) active in 1970 or hired between 1970–1982 with at least 1 month of employment at the facility and followed through 1997	No exposure determination performed	HD 201	Hired before 1950		(SMR)		
				Baton Rouge	0	-		
				Baytown	1	[0.7]		
				Hired in 1950 or later				
				Baton Rouge	0	-		
			Baytown	0	-			
Sorahan <i>et al.</i> , (2005), United Kingdom	Cohort of 5130 men and 384 women followed for mortality, 1968–2002, and incidence 1971–2001 by linkage to national files.	Occupational exposure to benzene 1966/67 or earlier; as reported by 233 employers	HD 201	All benzene exposed workers	3	(SMR) 1.1 (0.2-3.2)		
					2	(SIR) 0.4 (0.0-1.5)		

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Swaen <i>et al.</i> , (2005), The Netherlands	Cohort of 311 workers on the production of Caprolactam, 1951–1968 followed to January 2001	Benzene used in the production of caprolactam (Nylon 6 monomer) indoors, exposure estimates by expert judgement.	HD 201	All workers	1	(SMR) 3.7 (0.0-18.8)		