

Mortality Studies Among Capacitor and Transformer Manufacturing Workers Exposed to PCBs, Grouped by Study Site

| Site | Reference | N | Study design | Eligibility criteria | Study dates | PCB Exposure (PCB type if stated) | Other exposure | Cohort deaths, ratio ^a (CI) | Hi exp = | Hi exp deaths, ratio [†] (CI) |
|---|--------------------------------|----------------------------|--------------|--|-------------|--|--|--|----------------------------|--|
| Canada, Ontario, transformer manufacture and repair | (Liss 1989) | 1073: 273 women 800 men | cohort | ≥ 1 year work 1960-1976 | -1985 | 1978 air samples 3-8 µg/m ³ | Benzene ca 45, SMR 1.2 (0.9-1.6) | 146, SMR 1.0 (0.8-1.1); | Men ever in high exp job | 24, SMR 0.8 (0.5-1.2); cancer 6, SMR 0.8 (0.3-1.9), lymph & hemat cancer 2 SMR 2.9 (0.3-12.4) |
| Canada, transformer manufacture | (Yassi et al. 1994) | 2222: all men | cohort | ≥ 1 month work 1946-1975 | -1989 | >27,000 gallons Askarels used in mfg | mineral oil, solvents | 63-171 ^b , SMR 0.7-1.1 (nss); cancer 18-36, SMR 0.8-1.2 (nss); GI ca 6-17, SMR 0.9-1.6 (nss); pancreas ca 5-11 SMR 2.9-7.6 (all ss) | Transformer assembly | 35, SMR 0.9 (0.6-1.2); cancer 11, SMR 1.4 (0.7-2.5); GI cancer 5, SMR 2.3 (0.7-5.3); pancreas cancer 4, SMR 9.8 (2.6-25) |
| Italy, Milan vicinity, capacitor manufacture | (Bertazzi et al. 1982) | 1310: 1020 women, 290 men | cohort | ≥ 6 months work 1946-1978 production dept. | 1978 | 1954 air samples 5200-6800 µg/m ³ , 1977 TWA air samples 48-275 µg/m ³ , surface wipes 0.2-159 µg/cm ² , dermal wipes 0.3-9.2 µg/cm ² , blood levels (n=67) 230.5±174.5 ppb 54% chlorine PCBs; 114.1 ±79.6 ppb 42% chlorine PCBs; use stopped 1979 | | 27, SMR 1.3 (0.9-1.9), ca 14, SMR 2.5 (1.4-4.2); lymph-hemat 4, SMR 4.4 (1.2-12.2) | | |
| | (Bertazzi et al. 1987) | 2100: 1556 women, 544 men | cohort | ≥ 1 week work 1946-1978 | 1982 | 1982 surface wipes 0.003-6.3 µg/cm ² , dermal wipes 0.09-1.5 µg/cm ² , blood levels (n=37) 202.8±111.7 ppb 54% chlorine PCBs; 42.9 ±34.7 ppb 42% chlorine PCBs | TCE | 64, SMR 1.2 (0.9-1.5), cancer 26, SMR 2.0 (1.3-2.9); lymph-hemat 7, SMR 3.0 (1.2-6.5); GI tract (men) 6, SMR 3.5 (1.3-8.1) | | |
| | (Tironi et al. 1996) | 1556: all women | cohort | ≥ 1 week work 1946-1980, production dept. | 1954-1982 | 1954 air samples 5200-6800 µg/m ³ , 1977 TWA air samples 48-275 µg/m ³ , surface wipes 0.2-159 µg/cm ² , dermal wipes 0.3-9.2 µg/cm ² , blood levels (n=67) 230.5±174.5 ppb 54% chlorine PCBs; 114.1 ±79.6 ppb 42% chlorine PCBs; use stopped 1980 | | 47, SMR 1.4 (1.0-1.8), cancer 19, SMR 1.2 (0.7-1.8); lymph-hemat 5, SMR 1.4 (0.5-3.3) | | |
| Sweden, capacitor manufacture | (Gustavsson et al. 1986) | 142: all men | cohort | ≥ 6 mo. work 1965-1978, Swedish | 1982 | 42% chlorination | | 21, RR 1.0 (0.6-1.5); cancer 7, RR 1.3 (0.5-2.7) | Capacitor filler, repairer | “no tendency toward increased mortality” |
| | (Gustavsson and Hogstedt 1997) | 242: all men | cohort | ≥ 6 mo. work 1965-1978 | 1965-1991 | Tasks IDd as low, med, hi PCB | | 56, SMR 1.2 (0.9-1.5); cancer 16, SMR 1.3 (0.8-2.2) | Impregnation & repair | 23, SMR 1.6 (1.0-2.3); cancer 7, SMR 1.9 (0.8-3.9) |
| USA, Illinois, capacitor manufacture | (Mallin et al. 2004) | 2885: 1707 women, 1178 men | cohort | At least 1 day in ≥ 1 quarter 1944-1977 | 1944-2000 | Arochlor 1254 1952-1956 Arochlor 1242 1954-1970 Arochlor 1016 1970-1979 | Chlorinated naphthalenes 1944-1981, di-2-ethylhexyl phthalate, 1979-1981 | 1546, SMR 1.01 (1.0-1.1); ca 347, SMR 1.10 (1.0-1.2); liver, biliary 14, SMR 2.38 (1.3-4.1); stomach 17, SMR 1.89 (1.1-3.1) | >5 yrs between 1952-1977 | Male stomach 3, SMR 3.09 (0.6-9.0); female intestine 9, 2.25 (1.0-4.3); female liver 4, SMR 5.57 (1.5-14.3) |

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| USA, Indiana, capacitor manufacture | (Sinks et al. 1992) | 3588: 846 women, 2742 men | cohort | ≥ 1 day work 1957-1977, known or presumed Caucasian, work history complete | 1957-1986 | 1977 air samples: zone 5 personal 94±68 µg/m ³ , area 76±52 µg/m ³ ; zone 3 area 59±19 µg/m ³ ; zone 2 area 48±13 µg/m ³ ; zone 1 area 16±15 µg/m ³ ; 1977 serum: only zone 5, 763±1117 ng/ml; only zone 3, 100±27 ng/ml; only zone 2, 121±61 ng/ml | 1,1,1-trichloroethane, TCE, MEK, toluene, xylene | 192, SMR 0.7 (0.6-0.8); cancer 54, SMR 0.8 (0.6-1.1); skin 8, SMR 4.1 (1.8-8.0); brain 5, SMR 1.8 (0.6-4.2) | ≥10 yrs work | Skin cancer 3, SMR 7.0 (1.4-23); brain cancer 3, SMR 4.8 (1.0-16) |
| USA, Massachusetts, New Bedford, capacitor manufacture | (Brown & Jones 1981) | 1599: 924 women 675 men | cohort | ≥ 3 mo. work 1946-1976, possible PCB exposure, no TCE exposure | -1976 | 1977 TWA personal air samples 170-1260 µg/m ³ , area samples 50-810 µg/m ³ | TCE exposure (at degreasers, 53-78 ppm) | 90, SMR 0.9 (0.7-1.1); cancer 26, SMR 1.0 (0.6-1.4); rectal 3, SMR 4.3 (0.9-14); liver 2, SMR 3.0 (0.3-13); cirrhosis 5, SMR 1.6 (0.5-3.9) | entire cohort | |
| | (Brown 1987) | 1607: 930 women, 677 men | cohort | ≥ 3 mo. work 1946-1977, possible PCB exposure, no TCE exposure | -1982 | 1977 TWA personal air samples 170-1260 µg/m ³ , area samples 50-810 µg/m ³ | Degreaser TCE exposure, 53-78 ppm | 179, SMR 1.0 (0.8-1.1); cancer 44, SMR 0.9 (0.7-1.2); rectal 3, SMR 2.7 (0.6-1.2); liver 4, SMR 3.3 (0.9-9.3) | entire cohort | Excess liver ca in women: 4, SMR 4.4 (1.2-12.3) |
| USA, New York, capacitor manufacture | (Brown & Jones 1981) | 968: 385 women, 583 men | cohort | ≥ 3 mo. work 1938-1976, possible PCB exposure, no TCE exposure | -1976 | 1977 TWA personal air samples 24-393 µg/m ³ , area samples 3-476 µg/m ³ | Degreaser TCE exposure, <35 - 321 ppm | 73, SMR 1.0 (0.8-1.2); cancer 13, SMR 0.8 (0.4-1.3); rectal 1, SMR 2.1 (0.0-17); liver 1, SMR 2.4 (0.0-20); cirrhosis 1, SMR 0.4 (0.0-3.4) | entire cohort | |
| | (Brown 1987) | 981: 383 women, 593 men | cohort | ≥ 3 mo. work 1938-1977, possible PCB exposure, no TCE exposure | -1982 | 1977 TWA personal air samples 24-393 µg/m ³ , area samples 3-476 µg/m ³ | Degreaser TCE exposure, <35 - 321 ppm | 116, SMR 0.9 (0.7-1.1); cancer 18, SMR 0.6 (0.3-0.9); rectal 1, SMR 1.2 (0.0-10); liver 1, SMR 0.7 (0.0-5.4) | entire cohort | |
| USA, Massachusetts, Pittsfield, transformer manufacture | (Greenland et al. 1994) | ~3500 death ever employed study | death certificate | Worked 1930s-1984, vested in pension fund, white male, job history available | 1969-1984 | Pyranol transformer oil | Trichlorobenzene, benzene, TCE, other solvents, machining fluids, asbestos, resin systems | 1821 all cause, 513 cancer, 33 pancreas cancer, 37 lymph-hematopoietic | Any vs. none | Liver-biliary OR 2.4 (0.6-9.7), lymphomas OR 3.3 (1.1-9.3) for PCB exposure |

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| USA, New York, capacitor manufacture | (Brown & Jones 1981) 968: | 385 women, 583 men | cohort | ≥ 3 mo. work 1938-1976, possible PCB exposure, no TCE exposure | -1976 | 1977 TWA personal air samples 24- 393 µg/m ³ , area samples 3-476 µg/m ³ | Degreaser TCE exposure, <35 - 321 ppm | 73, SMR 1.0 (0.8-1.2); cancer 13, SMR 0.8 (0.4-1.3); rectal 1, SMR 2.1 (0.0-17); liver 1, SMR 2.4 (0.0-20); cirrhosis 1, SMR 0.4 (0.0-3.4) | entire cohort | |
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| | (Taylor et al. 1988) | 6292: 2691 women, 3601 men | cohort | ≥ 3 months work 1946-1975 | -1980 | 1975 air samples geometric mean (GM) 679 µg/m ³ direct exposure areas; GM 260 µg/m ³ indirect exposure areas; 1977 air samples GM 310 µg/m ³ direct exposure areas; GM 27 µg/m ³ indirect exposure areas; 1977 personal air samples GM 168 µg/m ³ direct exposure areas | | 510, SMR 0.83 (0.76, 0.91); cancer 136, SMR 0.9 (0.8-1.1); GI cancer 44, SMR 1.3 (1.0-1.8); skin 3, SMR 1.0 (0.2-3.2); brain 1, SMR 0.2 (0.0-1.6); lymph-hemat 10, SMR 0.7 (0.3-1.3) | | |
| | (Kimbrough et al. 1999) 7075: | 3013 women, 4062 men | cohort | ≥ 3 months work 1946-1977 | 1946-1993 | Hi exp: Filling & impregnating 1975 air samples 227-1500 µg/m ³ | | 1195, SMR 0.8 (0.7-0.8); cancer 353, SMR 0.9 (0.8-1.0); rectal 10, SMR 1.3 (0.6-2.5); liver 5, SMR 0.9 (0.3-2.0) | Hourly workers | 966, SMR 0.9(0.8-0.9); ca 278, SMR 1.0 (0.8-1.1); rectal 7, SMR 1.2 (0.5- 2.6); liver 4, SMR 0.9 (0.2-2.4) |
| | (Kimbrough et al. 2003) 7075: | 3013 women, 4062 men | cohort | ≥ 3 months work 1946-1977 | 1946-1998 | Hi exp: Filling & impregnating 1975 air samples 227-1500 µg/m ³ | | 1654, SMR 0.9 (0.85-0.93); cancer 492 SMR 1.0 (0.9-1.1); rectal 12, SMR 1.3 (0.7-2.3); liver 9, SMR 0.8 (0.4-1.5) | Hourly workers | 1333, SMR 1.0 (0.9-1.0); ca 381, SMR 1.0 (0.9-1.2); rectal 8, SMR 1.2 (0.5- 2.4); liver 8, SMR 1.0 (0.4-1.9) |

a. Odds ratio (OR), standardized mortality ratio (SMR), or relative risk (RR).

b. Yassi used various eligibility criteria and calculated SMRs for each set.

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