Table 2.6. Summary of epidemiological studies of arsenic in drinking-water and lung cancer

Reference	Location	End-point	Exposure	No. of cases		Study outcome	Comments

Ecological studies

Taiwan

Reference	Location	End-point	Exposure	No. of cases		Study outcome	Comments
Chen *et al.* (1985)	84 villages on the SW coast	Mortality 1968–82, all ages	Area endemic for chronic arsenic toxicity (Blackfoot disease)	Men Women	332 233	Age- and sex-adjusted SMR (95% CI) 3.2 (2.9–3.5) 4.1 (3.6–4.7)	Mid-year population: 141 733 in 1968, 120 607 in 1982; national rate in 1968–82 used as the standard for SMR estimation
Chen *et al.* (1988a)	42 villages on the SW coast	Mortality 1973–1986, all ages	Average arsenic (1964–66) General population < 300 μg/L 300–600 μg/L ≥ 600 μg/L General population < 300 μg/L 300–600 μg/L ≥ 600 μg/L	Men Women		Age-standardized mortality rates per 100,000 19.4 35.1 64.7 87.9 9.5 26.5 40.9 83.8	899 811 person–years, rate per 100 000, age-standardized to 1976 world population
Wu *et al.* (1989)	42 villages on the SW coast	Mortality 1973–86, age ≥ 20	Average arsenic (1964–66) < 300 μg/L 300–600 μg/L ≥ 600 μg/L < 300 μg/L 300–600 μg/L ≥ 600 μg/L	Men Women	53 62 32 43 40 38	Age-adjusted mortality rates per 100,000 49.16 100.67 104.08 (*p* for trend < 0.001) 36.71 60.82 122.16 (*p* for trend < 0.001)	Men: 257 935 person–years; females, Women: 234 519 person–years; rate per 100 000 age-standardized to 1976 world population

Table 2.6. Summary of epidemiological studies of arsenic in drinking-water and lung cancer

Reference	Location	End-point	Exposure	No. of cases		Study outcome	Comments
Chen & Wang (1990)	Taiwan	Mortality 1972–83, all ages	National survey of 83 656 wells (1974–76); average arsenic for each of 314 precincts or townships	Men Women		*β (SE) from regression* 5.3 (0.9) 5.3 (0.7) *Percentiles of age-adjusted mortality rate/100 000 person–years*	Regression coefficient (β) estimates increase in age-adjusted mortality per 100 000 per 100 μg/L arsenic increase in water
				Men		25th 11.8 50th 16.2 75th 20.7	
				Women		25th 5.2 50th 7.4 75th 10.4	
Tsai *et al*. (1999)	SW Taiwan, 4 townships	Mortality 1971–94, all ages	Arsenic-exposed area	Men Women Men Women Men Women	699 471	SMR (95% CI) 2.6 (2.5–2.8) 3.5 (3.2–3.8) 3.1 (2.9–3.3) 4.1 (3.8–4.5)	Men: 1 508 623 person–years; Women: 1 404 759 person–years National rates in 1971–94 used as the standard for estimation of SMR Regional rates in 1971–94
South America							
Rivara *et al*. (1997)	Region II and VIII, northern Chile	Mortality 1976–92	Arsenic-contaminated Region II			Relative risk (95% CI) Region II versus region VIII 8.8 (8.1–9.5)	Population: 411 000 in Region II, 1 700 000 in Region VIII. Antofagasta (Region II) versus Region VIII.
Hopenhayn-Rich *et al*. (1998)	Córdoba Province, Argentina, 26 counties	Mortality 1986–91, age ≥ 20	County group: Low exposure Medium exposure High exposure Low exposure Medium exposure High exposure	Men Women	826 914 708 194 138 156	0.92 (0.85–0.98) 1.5 (1.4–1.6) 1.8 (1.6–1.9) 1.2 (1.1–1.4) 1.3 (1.1–1.6) 2.2 (1.8–2.5)	Population: low exposure, 341 547, medium exposure, 201 006; high exposure, 135 209; national rate in 1989 used as the standard for SMR estimation
Smith *et al*. (1998)	Region II, northern Chile	Mortality 1989–93, age ≥ 30	5-year intervals, 420 μg/L average	Men Women	544 154	SMR 3.8 (3.5–4.1) 3.1 (2.7–3.7)	National rates in 1991 used as the standard for estimation of SMR; arsenic concentration is population-weighted average for major cities or towns in Region II, 1950–74

2

Table 2.6. Summary of epidemiological studies of arsenic in drinking-water and lung cancer

Reference	Location	End-point	Exposure	No. of cases		Study outcome	Comments
Smith *et al*. (2006)	Antofagasta, northern Chile	Mortality 1989-2000	In utero & early childhood residence in Antofagasta, with arsenic levels > 800 µg/L	Born 1950-'57		SMR	SMRs for age at death 30-49; All regions outside of Region II used as the referent population.
				Men	52	8.2 (6.2-10.8)	
				Women	16	4.7 (2.7-7.7)	
				Born 1958-'70			
				Men	13	8.1 (4.3-13.9)	
				Women	3	2.9 (0.6-8.5)	
Marshall *et al*. (2007)	Region II, northern Chile	Mortality 1950-2000	High exposure (>800 µg/L) in 1958-1970.			RR (95% CI)	RR shown for comparison with Region V rates. Results shown for a sample of 3-yr periods between 1950 and 2000.
				Men	209		
				1983-'85	251	2.72 (2.29-3.23)	
				1986-'88	315	3.35 (2.84-3.94)	
				1989-'91	345	3.48 (3.00-4.03)	
				1992-'94	302	3.61 (3.13-4.16)	
				1995-'97		2.43 (2.11-2.79)	
				Women			
				1983-'85	40	1.77 (1.23-2.63)	
				1986-'88	66	2.52 (1.87-3.38)	
				1989-'91	92	3.26 (2.50-4.23)	
				1992-'94	91	2.54 (1.97-3.27)	
				1995-'97	121	2.97 (2.37-3.72)	
Australia							
Hinwood *et al*. (1999)	Victoria	Incidence 1982–91	Median arsenic concentration in drinking-water ranging 1–1077 µg/L	20		SIR (95% CI) 1.0 (0.9–1.1)	State rates in 1982–91 used as the standard for estimation of SIR
Cohort studies							
Chen *et al*. (1988b)	SW Taiwan	Mortality 1968–83	Area endemic for Blackfoot disease	28		SMR: 10.49 ($p < 0.001$) compared with national standard; 2.84 ($p < 0.01$) compared with regional standard	789 patients with Blackfoot disease followed from 1968 to 1984. National and regional rates in 1968–83 used as the standard for estimation of SMR

3

Table 2.6. Summary of epidemiological studies of arsenic in drinking-water and lung cancer

Reference	Location	End-point	Exposure	No. of cases		Study outcome	Comments
Tsuda *et al.* (1995)	Niigata Prefecture, Japan	Mortality, 1959–92, all ages	Arsenic level: < 0.05 mg/L 0.05–0.99 mg/L ≥ 1.0 mg/L Total	0 1 8 9		SMR 0.0 (0–2.4) 2.3 (0.1–13.4) 15.7 (7.4–31.0) 3.7 (1.8–7.0)	113 persons who drank from industrially contaminated wells in 1955–59, then followed for 33 years; rates in Niigata Prefecture in 1960–89 used as the standard for estimation of SMR
Chiou *et al.* (1995)	SW Taiwan; 4 neighbouring townships	Incidence 1986–93	Cumulative arsenic exposure (mg/L × year) < 0.1 0.1–19.9 ≥ 20 Average arsenic concentration (mg/L) < 0.05 0.05–0.70 ≥ 0.71	3 7 7 5 7 7		Relative risk (95% CI) 1.0 3.1 (0.8–12.2) 4.7 (1.2–18.9) 1.0 2.1 (0.7–6.8) 2.7 (0.7–10.2)	Incidence among a cohort of 2556 subjects (263 Blackfoot disease patients and 2293 healthy individuals) followed for 7 years
Lewis *et al.* (1999)	Millard County, UT, USA	Mortality	Arsenic in well-water, 3.5–620 µg/L	Men 28 Women 6		SMR 0.6 (0.4–0.8) 0.4 (0.2–0.95)	State rates in 1950–92 used as the standard for SMR estimation.
Nakadaira *et al.* (2002)	Niigata Prefecture, Japan	Mortality	Industrially contaminated well-water in the town of Nakajo	Men 7 Women 1 Total 8		Poisson probability distribution in men: 9.6 0/E = 11.01	86 patients with chronic arsenic poisoning. National rates in 1959–92 used as the standard for SMR estimation.
Chen *et al.* (2004)	Arseniasis-endemic areas of N.E. and S.W. Taiwan	Incidence	S.W. Taiwan: Median village level of well-water arsenic; N.E. Taiwan: Measured level from household measurement.	Avg As µg/L <10 10-99 100-299 300-699 ≥700	 27 31 17 18 26	RR (95% CI) 1.0 1.15 (0.7-1.9) 2.04 (1.1-3.8) 2.65 (1.5-4.8) 2.50 (1.4-4.4)	Incidence among combined cohorts of 2503 persons in SW Taiwan and 8088 persons in NE Taiwan followed for an avg of 8 yrs. Results adjusted for age at recruitment, sex, yrs education, alcohol habit. .

Table 2.6. Summary of epidemiological studies of arsenic in drinking-water and lung cancer

Reference	Location	End-point	Exposure	No. of cases	Study outcome	Comments
Case–control studies						
Chen *et al.* (1986)	SW Taiwan, 4 townships	Mortality	Duration of consumption of artesian well-water containing high levels of arsenic	76 cases 368 controls	Age- and sex-adjusted OR by years of consuming high-arsenic artesian well-water Never 1.00 1–20 years 1.26 21–40 years 1.52 > 40 years 3.39	OR calculated using subjects who never consumed artesian well-water as referent

Mantel-Haenszel χ^2 value: 8.49 ($p < 0.01$) |
| Ferreccio *et al.* (2000) | Northern Chile | Incidence 1994–96 | Individual ≥ 40-year average arsenic concentration from public water supply records during 1930–94 0–10 μg/L 10–29 μg/L 30–49 μg/L 50–199 μg/L 200–400 μg/L | 151 cases 419 matched hospital controls | Age- and sex-adjusted OR (95% CI)

1.0 1.6 (0.5–5.3) 3.9 (1.2–12.3) 5.2 (2.3–11.7) 8.9 (4.0–19.6) | OR calculated using subjects with average exposures of 0–10 μg/L as referent |

SMR, standardized mortality ratio; CI, confidence interval; SIR, standardized incidence ratio; OR, odds ratio