

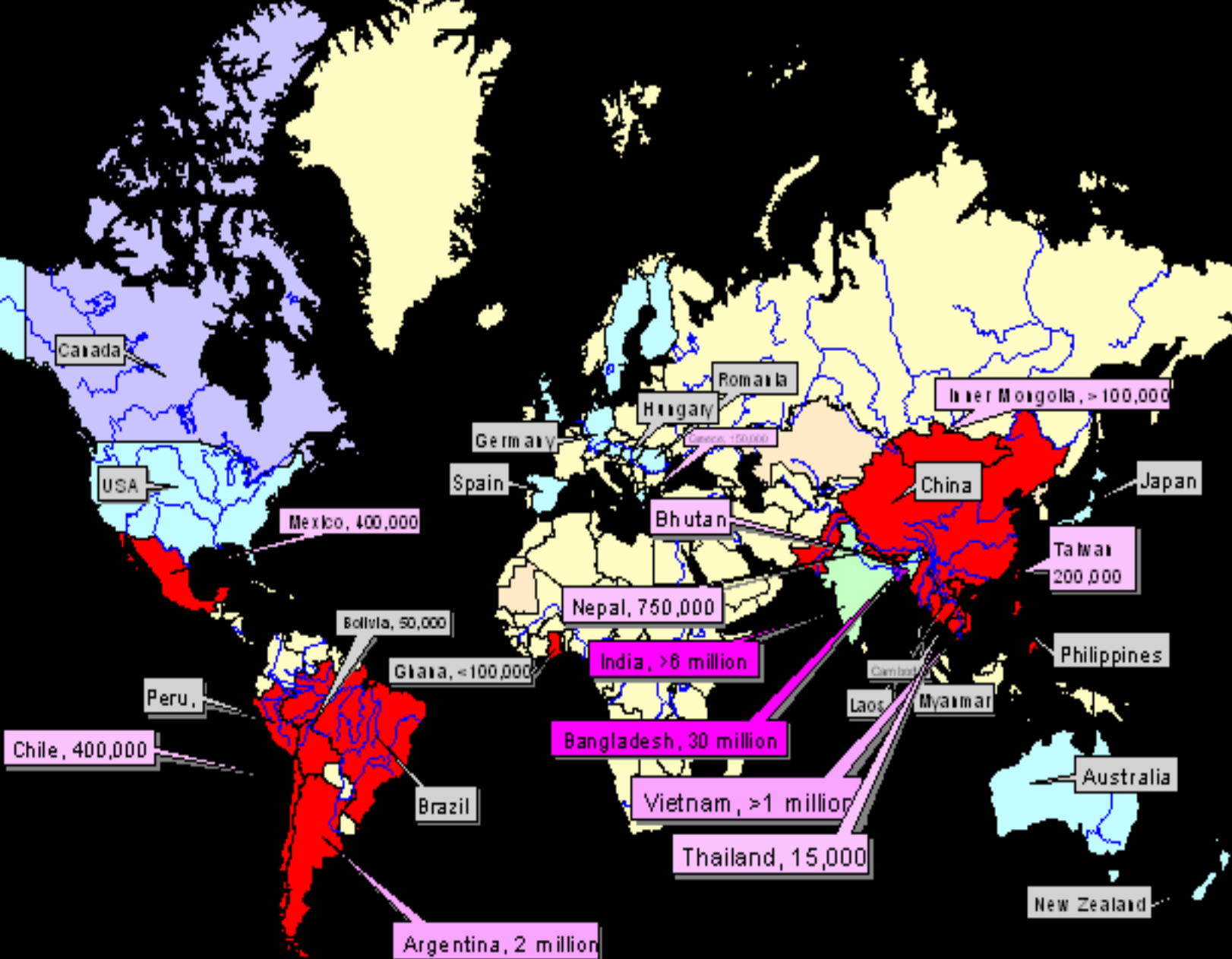
ARSENIC IN DRINKING WATER: HEALTH EFFECTS AND CURRENT ISSUES

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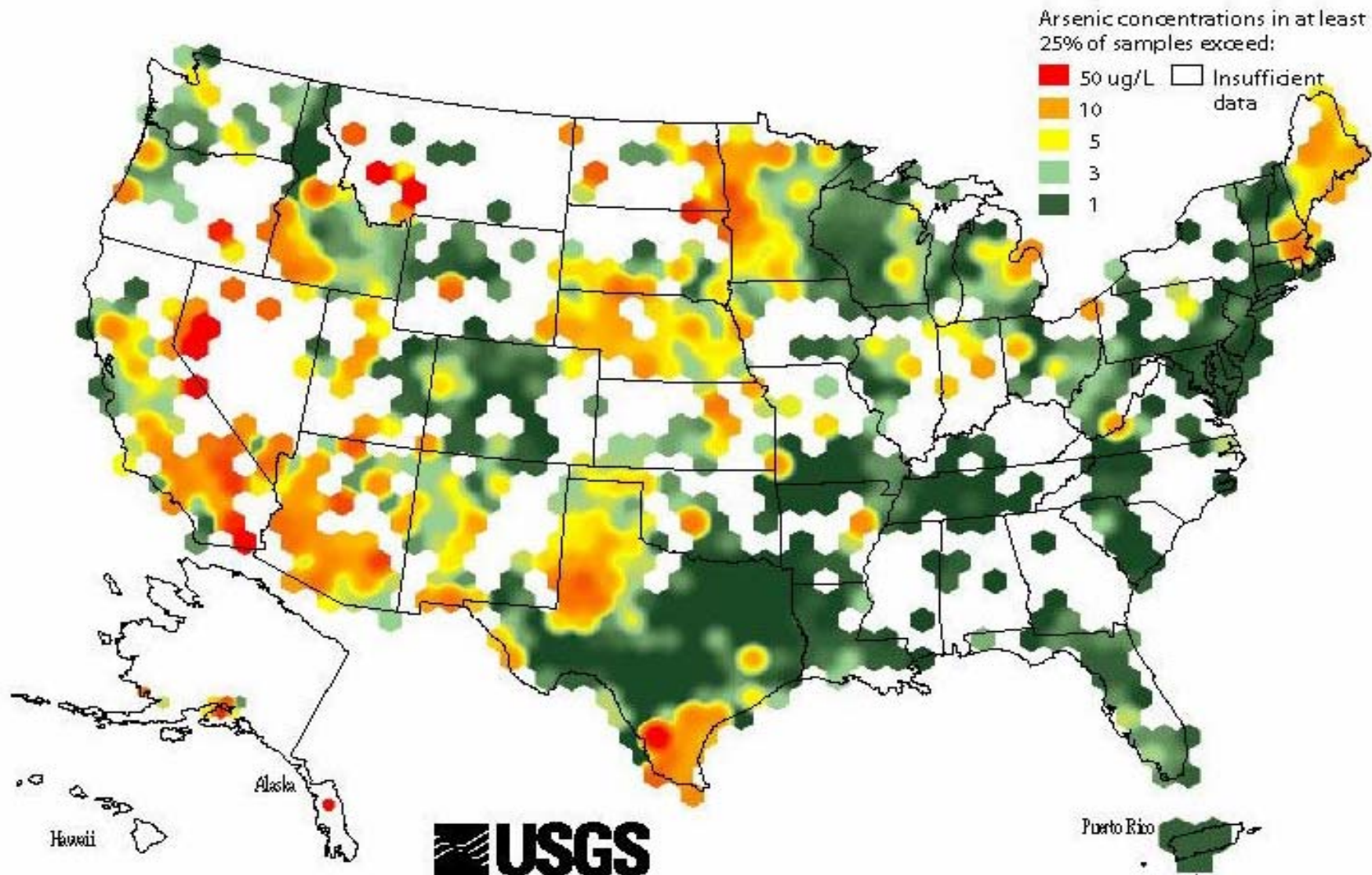
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WORLDWIDE ARSENIC EXPOSURE



Why Should You Care?

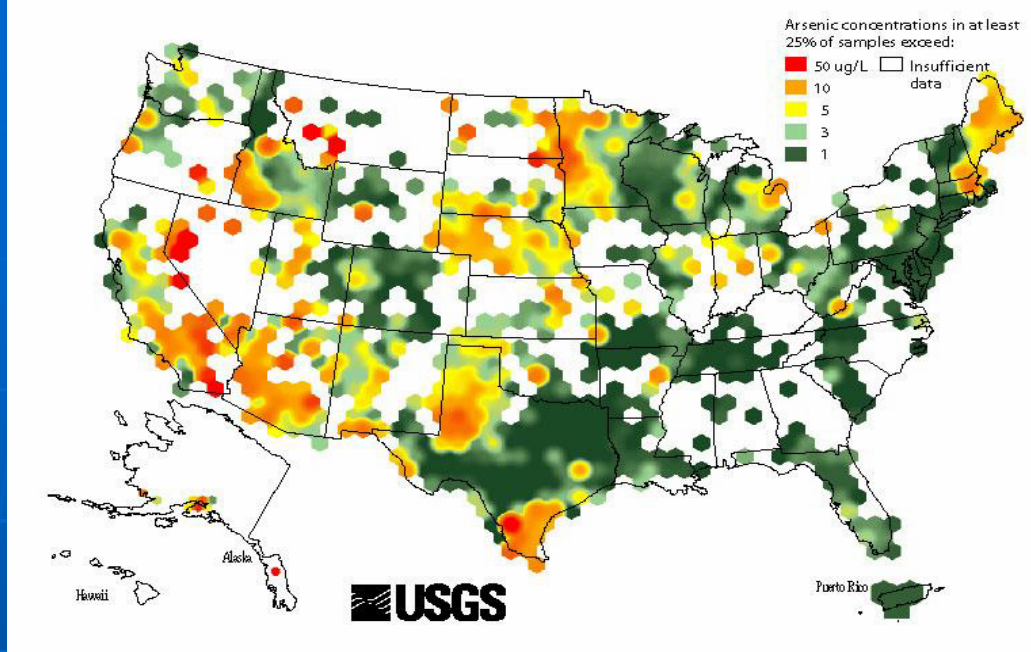


Levels of Inorganic Arsenic in U.S. Drinking Water

	Arsenic (ug/L)	Population Served
<div style="border: 1px solid black; padding: 5px; width: fit-content;"> 10 ug/L New US drinking water standard </div>	5 or less	197,530,000
	 over 5	21,690,000
	over 25	2,740,000
<div style="border: 1px solid black; padding: 5px; width: fit-content;"> 50 ug/L Current US drinking water standard </div>	 over 50	347,000
	over 100	20,000
	over 150	2,000

EPA. National Primary Drinking Water Regulations; Arsenic and Clarification to Compliance and New Source Contaminants Monitoring: EPA, 2001.

Science Application International Corporation. Estimated National Occurrence and Exposure to Arsenic in Public Drinking Water Supplies (Revised Draft). Washington, D.C.: Prepared for U.S. EPA, 1987

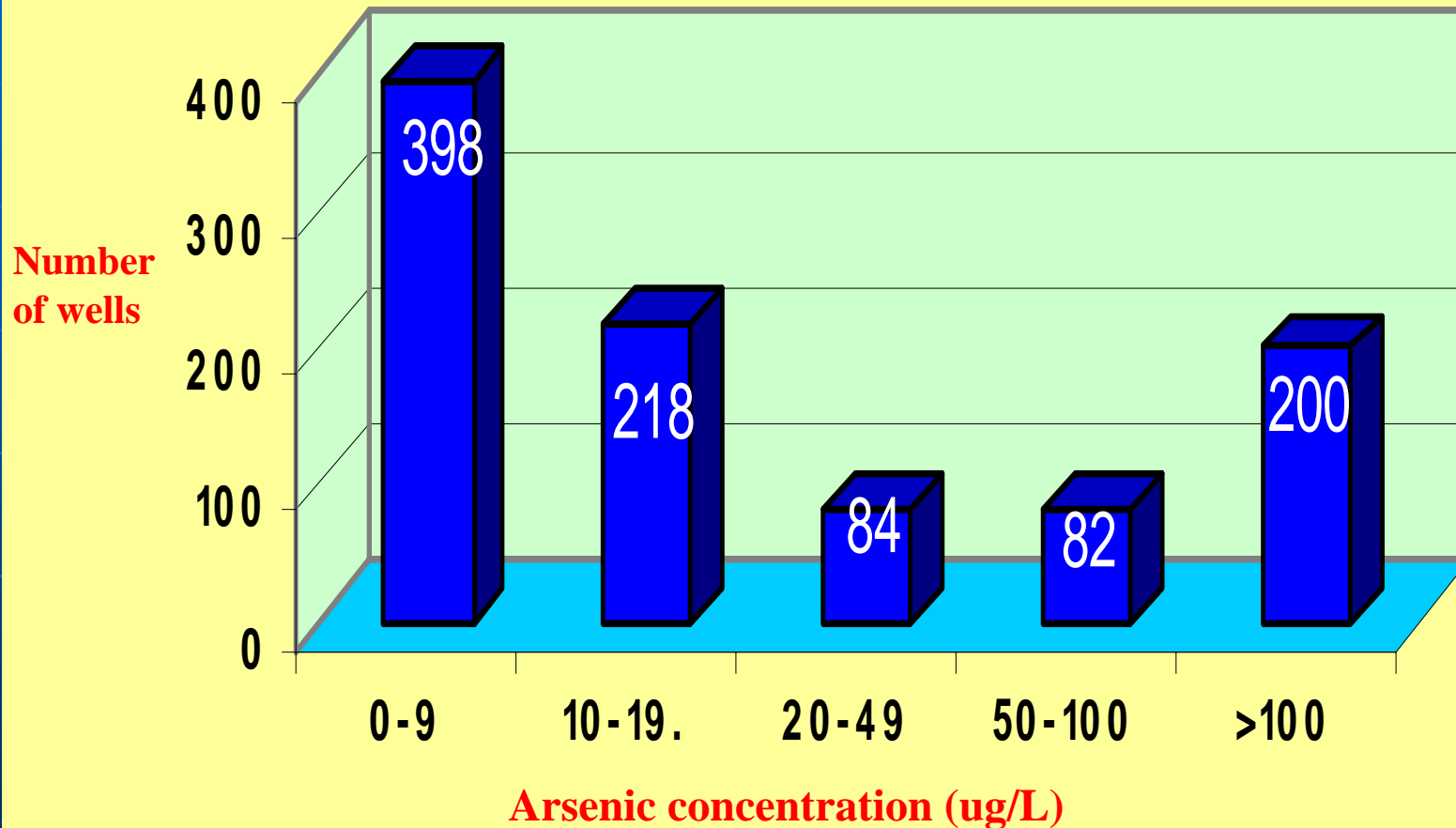


THE NEW ARSENIC STANDARD DOES NOT APPLY TO PRIVATE WELLS

15% of people in the US receive water from private wells (USGS, 2000)

- 12.3% of all community supplies have arsenic > 10 ug/L (US EPA)
- US Population: 296 million
- $15\% \times 12.3\% \times 295 \text{ million} = 5.4 \text{ million people}$

Arsenic levels in private drinking water wells in western Nevada (n = 982)



Steinmaus C, Yuan Y, Smith AH. The temporal stability of arsenic well water concentrations in western Nevada. *Environmental Research* (In press), 2004

Some Health Effects of Chronic Arsenic Ingestion:

Skin lesions

Diabetes?

CVD

Liver disease

Developmental effects

Reproductive effects

Cancer



**Health Effects of
Chronic Arsenic
Ingestion:**

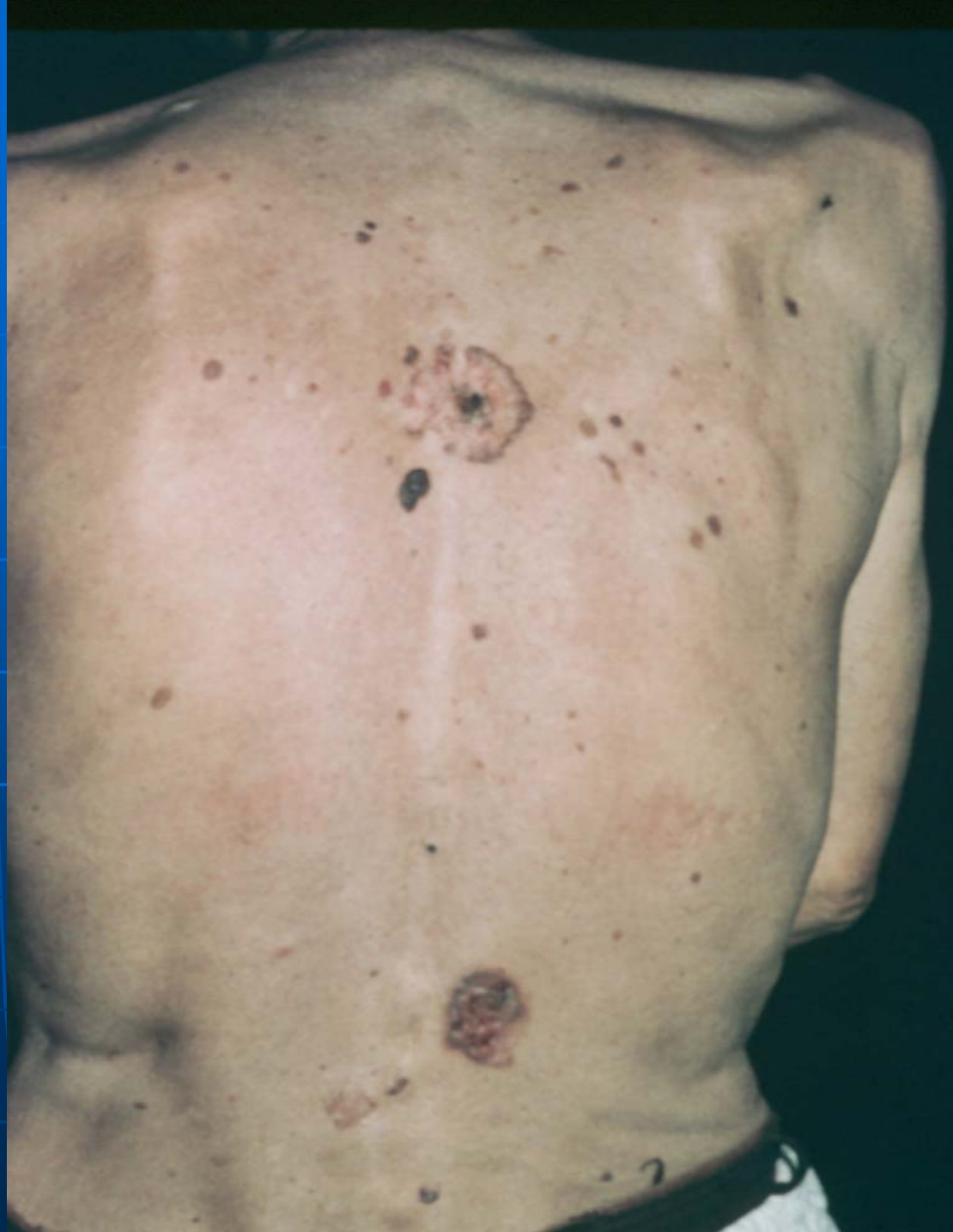
SKIN CANCER

**BLADDER
CANCER**

LUNG CANCER

OTHERS?

All major risk assessments
based on cancer outcomes

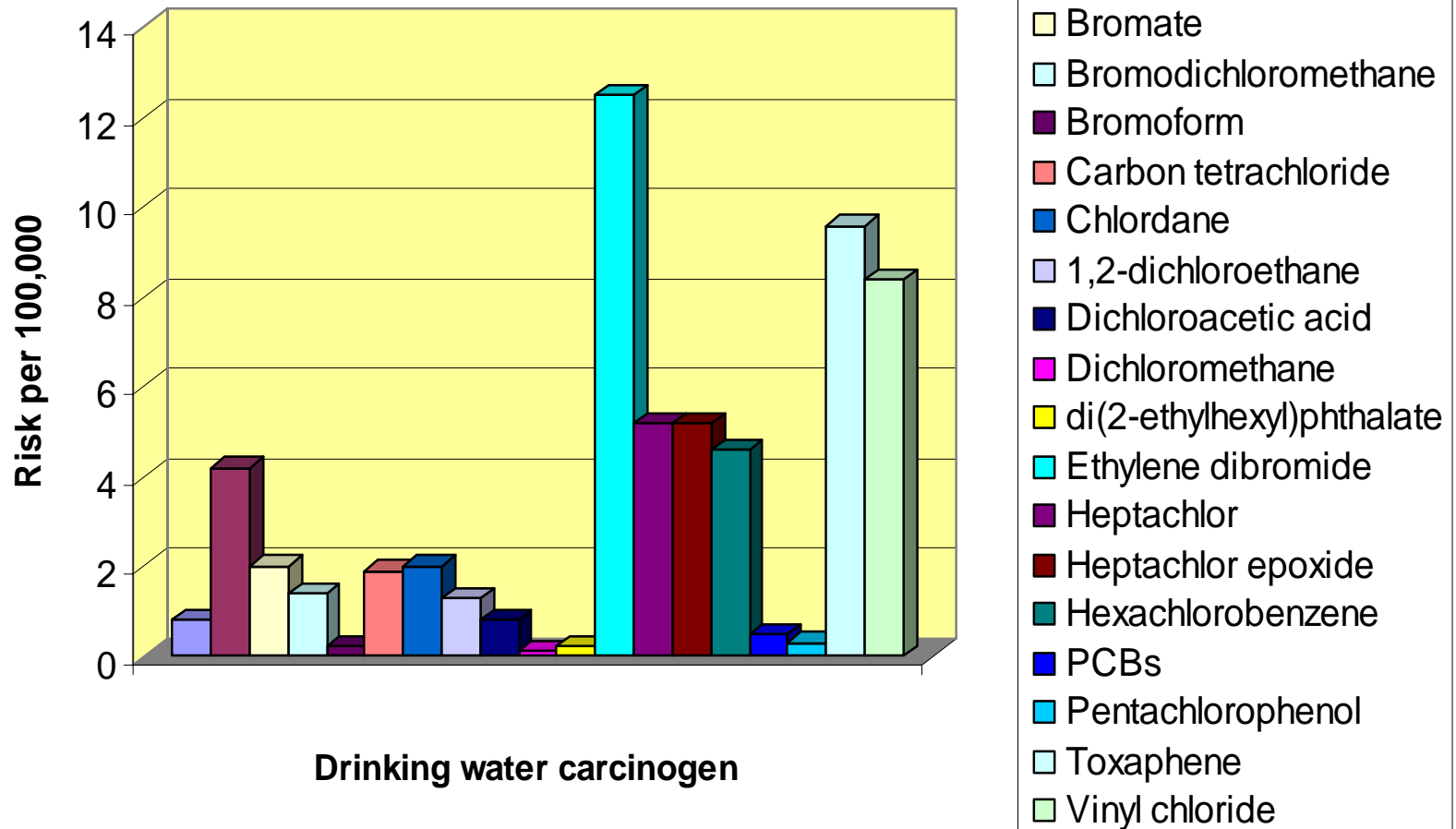


IARC GROUP 1 CARCINOGEN

“Arsenic in drinking-water (primarily inorganic, as arsenate and to a lesser extent arsenite) was evaluated as *carcinogenic to humans* (Group 1) on the basis of *sufficient evidence* for an increased risk for cancer of the urinary bladder, lung and skin.”

IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. Some Drinking-water Disinfectants and Contaminants, including Arsenic. (Volume 84, 15–22 October 2002)

Estimated excess cancer risks per 100,000 people exposed at the MCL

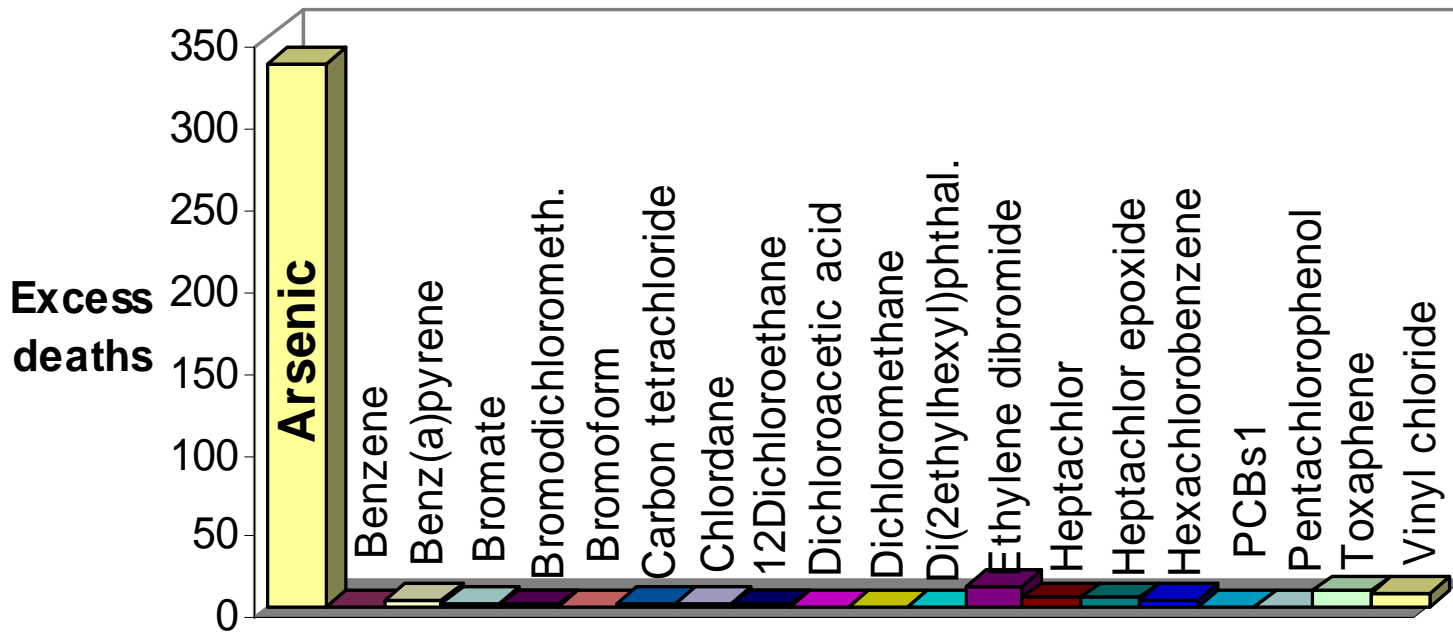


Risks estimated based on cancer potency estimates from IRIS

“EPA has historically considered 10^{-4} to 10^{-6} as a target risk range protective of public health in its drinking water program”

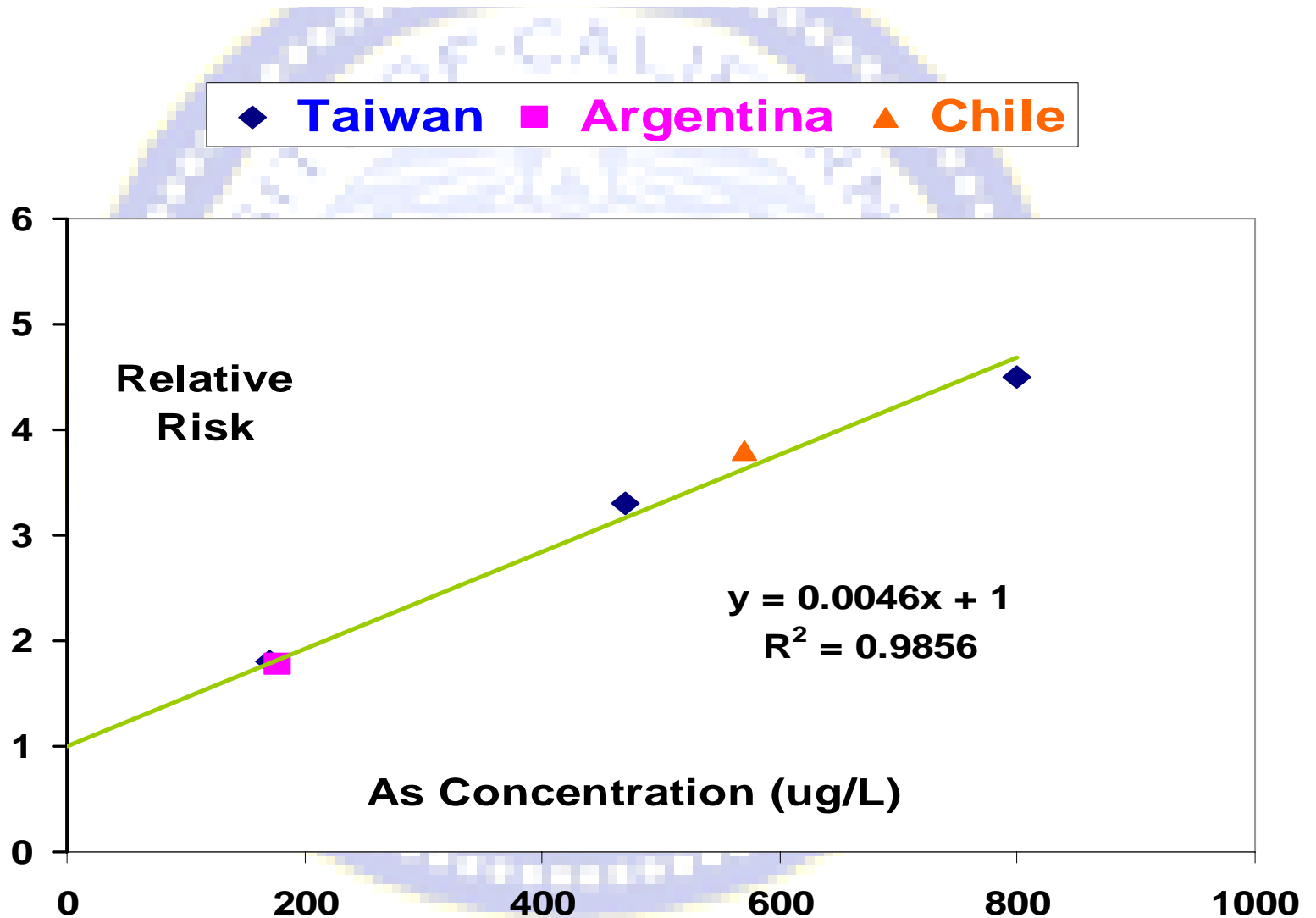
40 CFR Parts 9, 141, 142

Figure 1. Estimated cancer risk deaths per 100,000 people exposed at the MCL of each drinking water chemical carcinogen

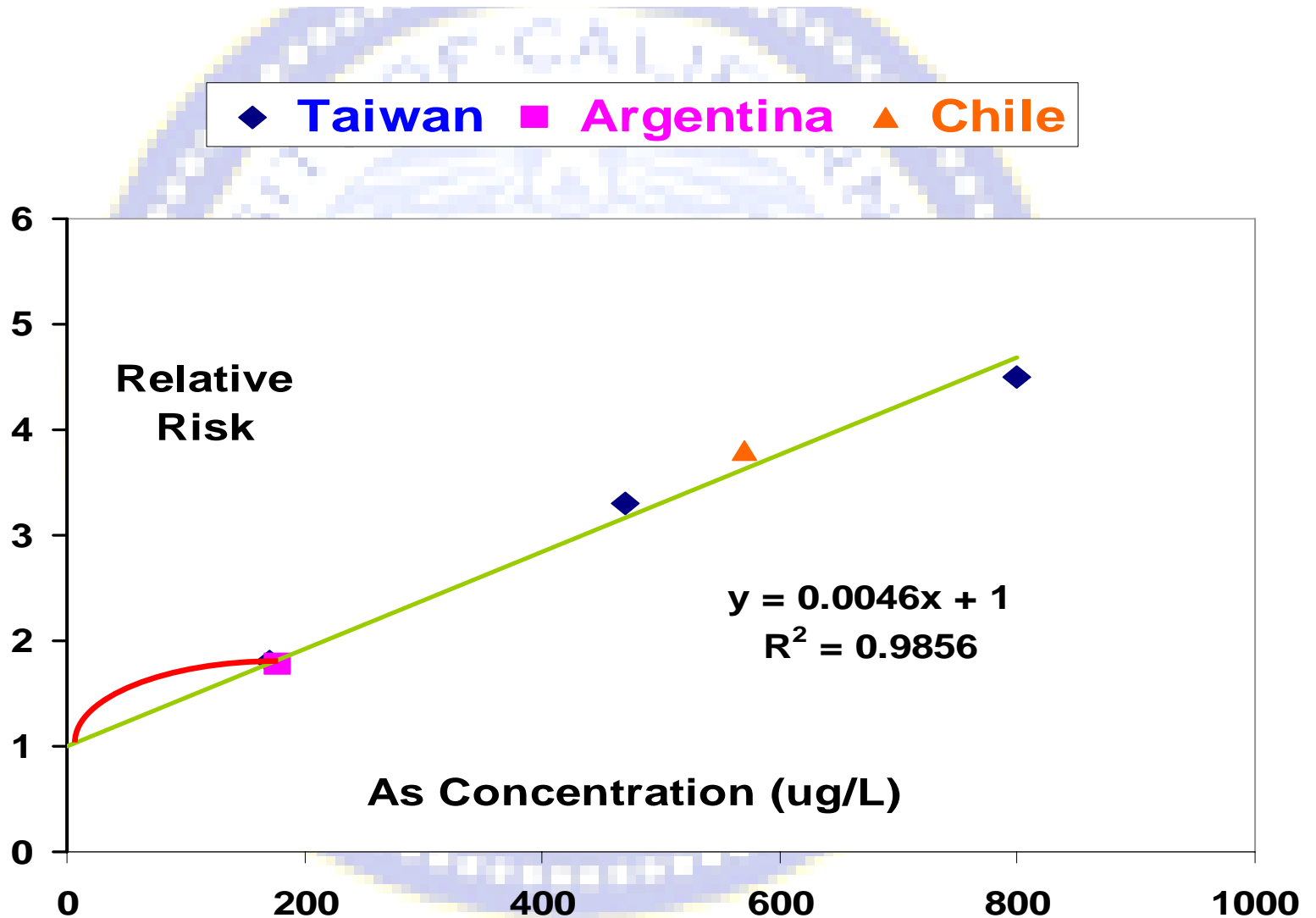


Risks for arsenic based on NRC 2001 cancer potency estimates

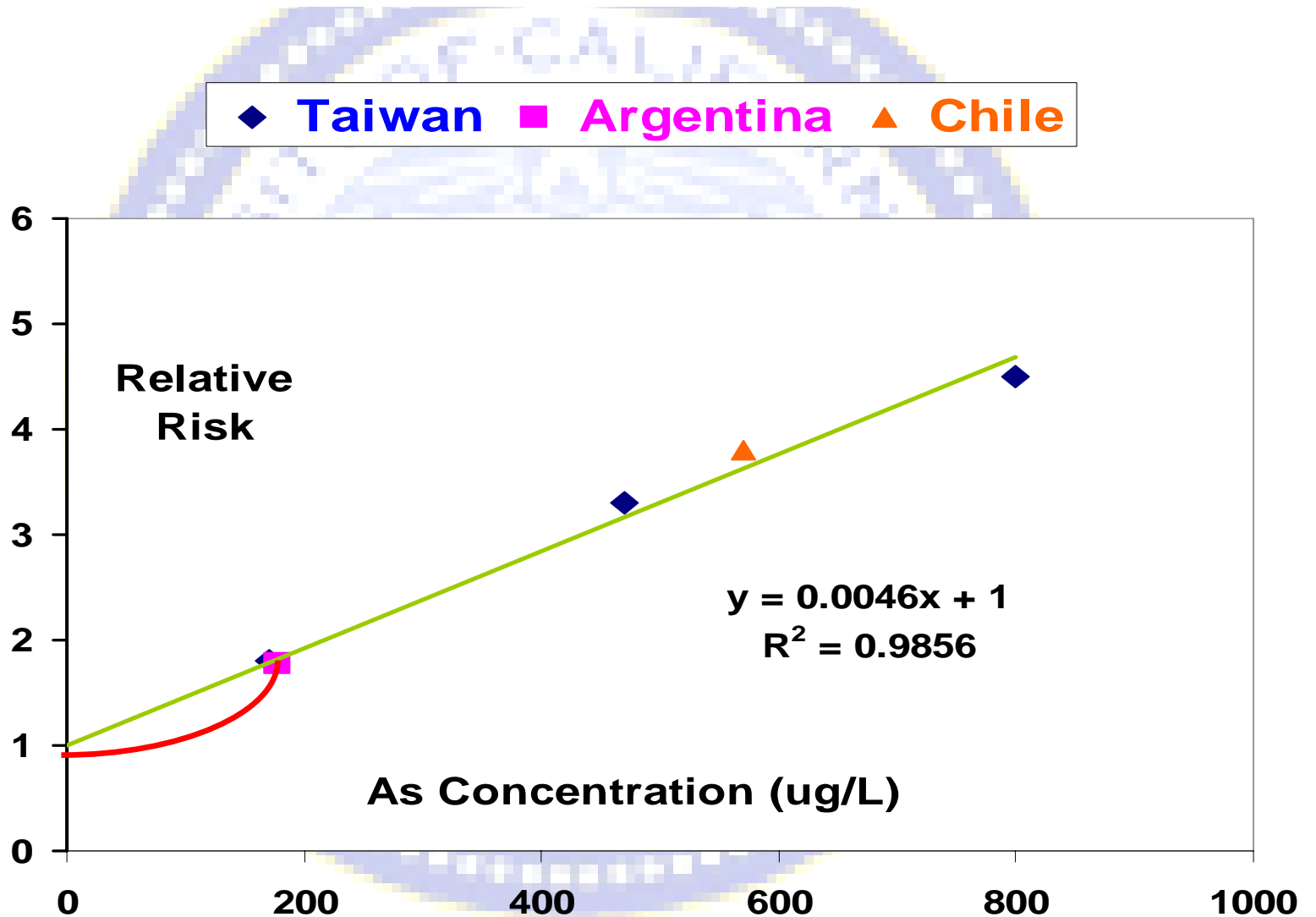
Lung Cancer Relative Risk by Arsenic Concentration- males



Lung Cancer Relative Risk by Arsenic Concentration- males



Lung Cancer Relative Risk by Arsenic Concentration- males



Studies of low exposure levels of arsenic

Author	Area	Cancer	Type	Dose	RR	95% CI	Cases	Notes
Ferracio	Chile	Lung	CC	10-29 ppb	0.3	0.1-1.2	3	Control selection issues
Ferracio	Chile	Lung	CC	30-59 ppb	1.8	0.5-6.9	4	Control selection issues
Chiou	Taiwan	Bladder	Cohort	10-50 ppb	1.9	0.1-32.5	1	
Chiou	Taiwan	Bladder	Cohort	50-100 ppb	8.2	0.7-99.1	2	
Steinmaus	Nevada/Calif	Bladder	CC	80 ppb	0.94	0.56-1.57	37	All subjects
Steinmaus	Nevada/Calif	Bladder	CC	80 ppb	1.78	0.89-3.56	19	40 year latency
Steinmaus	Nevada/Calif	Bladder	CC	80 ppb	3.67	1.43-9.42	17	Smokers with a 40 year latency
Bates	Argentina	Bladder	CC	51-100	1.1	0.3-2.3	8	All subjects
Bates	Argentina	Bladder	CC	Well water	2.65	1.2-5.8	48	Smokers with 51-60 years latency
Kurtio	Finland	Bladder	CC	>0.5 ppb	2.44	1.11-5.37	19	Short latency. Most exposures < 5 ppb
Kurtio	Finland	Bladder	CC	>0.5 ppb	1.51	0.67-3.38	17	Long latency. Most exposures < 5 ppb
Kurtio	Finland	Bladder	CC	>0.5 ppb	10.3	1.16-92.6	7	Smokers. Most exposures < 5 ppb
Lamm	USA	Bladder	Ecological	20-50 ppb	0.80	0.54-1.17	58	Mortality study
Lamm	USA	Bladder	Ecological	50-60 ppb	0.73	0.41-1.27	29	Mortality study
Lewis	Utah	Bladder	Ecological	<200 ppb	0.95 (M) 1.11 (F)	NA	5	For exposures > 5000 ppb-years
Lewis	Utah	Lung	Ecological	<200 ppb	0.44 (M) 0.22 (F)	NA	34	For exposures > 5000 ppb-years
Karagas	New Hampshire	Skin	CC	Unknown	2.07	0.92-4.66	13	For 97 th percentile of toenail As
Karagas	New Hampshire	Bladder	CC	Unknown	1.36	0.63-2.90	14	For 97 th percentile of toenail As
Karagas	New Hampshire	Bladder	CC	Unknown	2.17	0.92-5.11	14	Smokers. For 97 th percentile toenail AS