



**OCCUPATIONAL CAUSES FOR CANCER
ARE STILL COMMON:**

EXAMPLES FROM RECENTLY CONDUCTED STUDIES

2 examples



- Farming & NHL (non-Hodgkin's Lymphoma)
- Welding & lung cancer

Farming & NHL





Farming & NHL: NZ studies



Pearce et al. (1985) Am J Epi. 121(2): 225-237.

	OR	95%CI
Orchard farm	5.51	1.45-20.9
Livestock farm	0.73	0.21-2.50
Dairy farm	0.23	0.04-1.42
Poultry farm	1.77	0.69-4.56

Pearce et al. (1987) Int J Cancer. 39: 155-161

	OR	90%CI
Cropping farm	0.9	0.4-2.0
orchard	3.7	1.1-12.1
Sheep farm	1.1	0.7-1.6
Dairy farm	0.9	0.6-1.3
Mixed/sheep&beef farm	0.9	0.5-1.4
Poultry farm	0.4	0.1-2.5

't Mannetje et al. (2008) Occup Environ Med. 65: 354-63.

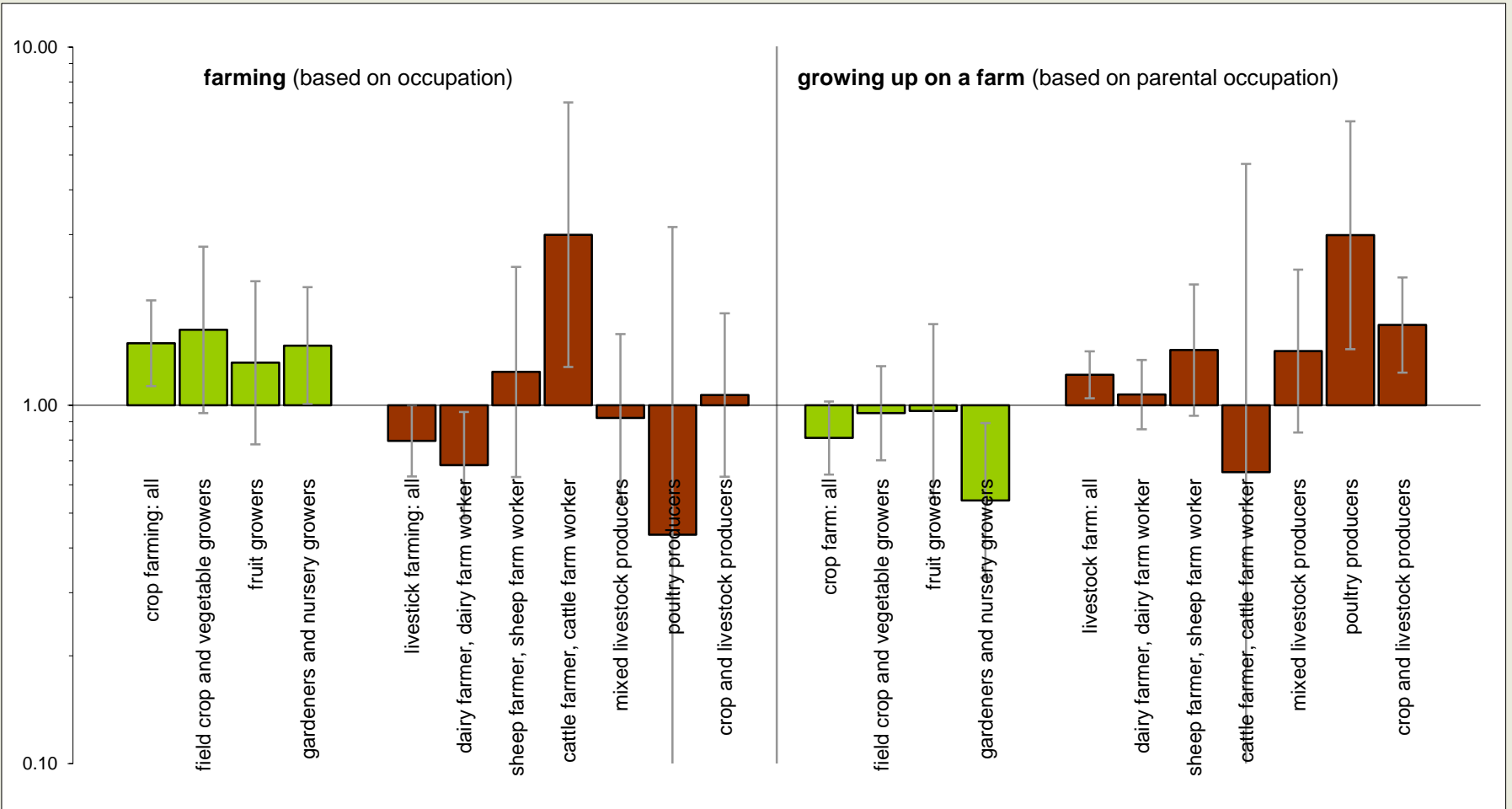
	OR	95%CI
Plant nurseries	4.3	1.1-17.2
Vegetable growing	2.3	0.9-6.0
Apple and pear growing	4.9	1.3-19.1
Kiwi fruit growing	1.8	0.6-5.6
Grain&sheep&beef	0.6	0.3-1.1
Dairy cattle	0.6	0.3-1.1

't Mannetje et al. (2011) Occup Environ Med. 10.1136/oem.2011.065110

	OR	95%CI
Crop farm	1.49	1.13-1.96
Livestock farm	0.80	0.63-1.00



't Mannetje *et al.* (2011) *Occup Environ Med.* 10.1136/oem.2011.065110



IARC classification of pesticides



Group 1 (carcinogenic to humans)

Arsenic and arsenic compounds (1)

Group 2A (probably carcinogenic to humans)

Captafol

Ethylene dibromide

Non-arsenical insecticides (occup exp in spraying and application)

Group 2B (possibly carcinogenic to humans)

1,2-Dibromo-3-chloropropane

Aramite

Chlordane

Clordecone (kepone)

Chlorophenoxy herbicides

Chlorothalonil

DDT

Dichlorvos

Heptachlor

Hexachlorobenzene

Lindane

Mirex

Nitrofen

Pentachlorophenol

Sodium ortho-phenylphenate

Toxaphene

Active ingredients most commonly used in New Zealand (2004) and their evaluation of human carcinogenicity

active ingredient (pesticide group) CAS	ton a./y	Evaluation of human carcinogenicity		
		HSNO (NZ)	EPA (US)	IARC (WHO)
Herbicides	2000			
MCPA (phenoxy hormones) 94-74-6	447		not likely (2003)	possibly (chlorophenoxy herbicides) (1987)
glyphosate (phosphonyls) 1071-83-6	344		evidence of non-carcinogenicity (1991)	
2,4-D (phenoxy hormones) 94-75-7	282		not classifiable (1997)	possibly (chlorophenoxy herbicides) (1987)
terbutylazine (triazines) 5915-41-3	224		not classifiable (1994)	
mecoprop (phenoxy hormones) 93-65-2	178			possibly (chlorophenoxy herbicides) (1987)
MCPB (phenoxy hormones) 94-81-5	174		not likely (2008)	possibly (chlorophenoxy herbicides) (1987)
isoproturon (urea derivatives) 34123-59-6	73			
acetochlor (amides) 34256-82-1	63		suggestive evidence (2007)	
hexazinone (triazines) 51235-04-2	53		not classifiable (1994)	
atrazine (triazines) 1912-24-9	49		not likely (2000)	possibly -> not classifiable (1999)
triclopyr (other hormones) 55335-06-3	44		not classifiable (1996)	
alachlor (amides) 15972-60-8	40	suspected	multiple indicators (1997)	
propachlor (amides) 1918-16-7	27	suspected	likely (1997)	
trifluralin (dinitroanilines) 1582-09-8	19		possible (1986)	not classifiable (1991)
linuron (urea derivatives) 330-55-2	14		possible (2001)	
glufosinate-ammonium (phosphonyls) 77182-82-2	12		not likely (1999)	
picloram (other hormones) 1918-02-1	11		evidence of non-carcinogenicity (1994)	not classifiable (1991)
fungicides	900			
mancozeb (dithiocarbamate) 8018-01-7	442		probable (1999)	(ethylenethiourea) possibly -> not classifiable (2001)
sulphur (inorganics) 7704-34-9	99			
captan (other fungicides) 133-06-2	47	suspected	multiple descriptors (2004)	not classifiable (1987)
chlorothalonil (other fung./organochlorine) 1897-45-6	25	suspected	likely (1994)	possibly (1999)
metalaxyl-m (other fungicides) no CAS	15			
metiram (dithiocarbamate) 9006-42-2	15		probable (1999)	
tolyfluanid (other fungicides) 731-27-1	14		likely (2002)	
thiram (dithiocarbamate) 137-26-8	11		not likely (2003)	not classifiable (1991)
phosphorous acid (inorganics) 13598-36-2	7			
ziram (dithiocarbamate) 137-30-4	6		suggestive evidence (2003)	not classifiable (1991)
insecticides	200			
diazinon (organophosphate) 333-41-5	93		not likely (1997)	
methamidophos (organophosphate) 10265-92-6	19		not likely (1997)	
chlorpyrifos (organophosphate) 2921-88-2	17		evidence of non-carcinogenicity (1993)	
carbaryl (carbamate) 63-25-2	16	suspected	likely (2002)	not classifiable (1987)
fenamiphos (organophosphate) 22224-92-6	11		evidence of non-carcinogenicity (1993)	
pirimiphos-methyl (organophosphate) 29232-93-7	8		cannot be determined (1998)	
phorate (organophosphate) 298-02-2	6		evidence of non-carcinogenicity (1993)	

Minor use active ingredients (<1% of total active ingredients) that are evaluated as at least possibly being a human carcinogen by at least 1 agency

	HSNO	EPA	IARC
Herbicides			
amitrole (other herbicides) 61-82-5		multiple descriptors (2006)	possibly
asulam (carbamate) 3337-71-1	suspected	possible (2001)	
Bromoxynil			
Clodinafop-propargyl			
dichlobenil (other herbicides) 1194-65-6	suspected	possible (1995)	
dimethenamid			
diuron (urea derivate) 330-54-1		known/likely (1997)	
haloxyfop [(r)-isomer] (FOPs&DIMs) 69806-34-4	suspected	??	
Linuron			
Mecoprop-P			
Metolachlor			
Norflurazon 27314-13-2		Possible (1990)	
Oxyfluorfen 42874-03-3		Possible (1989)	
pendimethalin			
Tralkoxydim			
Tribenuron-methyl			
Fungicides			
Benomyl			
Carbendazim			
difenoconazole			
Dithianon			
epoxiconazole (triazole/diazole) 106325-08-0,	suspected	likely (2001)	
Fluazinam			
folpet (other fungicides) 133-07-3	suspected	probable (2003)	
imazalil (triazole/diazole) 35554-44-0		likely (1999)	
iprodione (dicarboximide) 36734-19-7		likely (1998)	
kresoxim-methyl (strobilurin) 143390-89-0		likely (1999)	
Prochloraz			
Procymidone (dicarboximide) 32809-16-8		probable (1991)	
propiconazole 60207-90-1		possible (1992)	
Pyrimethanil			
tebuconazole			
thiabendazole			
thiophanate-methyl (benzimidazole) 23564-05-8		likely (1999)	
triadimefon 43121-43-3		Possible (1996)	
Triadimenol 55219-65-3		Possible (1988)	
Triforine			
Insecticides			
acephate (organophosphate) 30560-19-1	suspected	possible (1985)	
Bifenthrin			
Buprofezin			
Clofentezine			
Cypermethrin			
dichlorvos (organophosphate) 62-73-7	suspected	suggestive evidence (2000)	possibly
Dicofol			
Dimethoate			
Fipronil			
Metaldehyde			
permethrin (pyrethroid) 52645-53-1		likely (2002)	
primidicarb (carbamate) 23103-98-2		likely (2005)	
propargite (acaricide) 2312-35-8	suspected	probable (1992)	
Pymetrozine (other insecticides) 123312-89-0		likely (1999)	
thiacloprid (other insecticides) 111988-49-9		likely (2003)	

Pesticides that have been associated with NHL



- Phenoxy herbicides (e.g. 2,4-D, 2,4,5-T)
- Organochlorines (e.g. chlordane, DDT, lindane, toxaphene)
- Organophosphates (e.g. diazinon, dichlorvos, malathion)

- Risk estimates vary widely among studies
- Some studies showed no risk

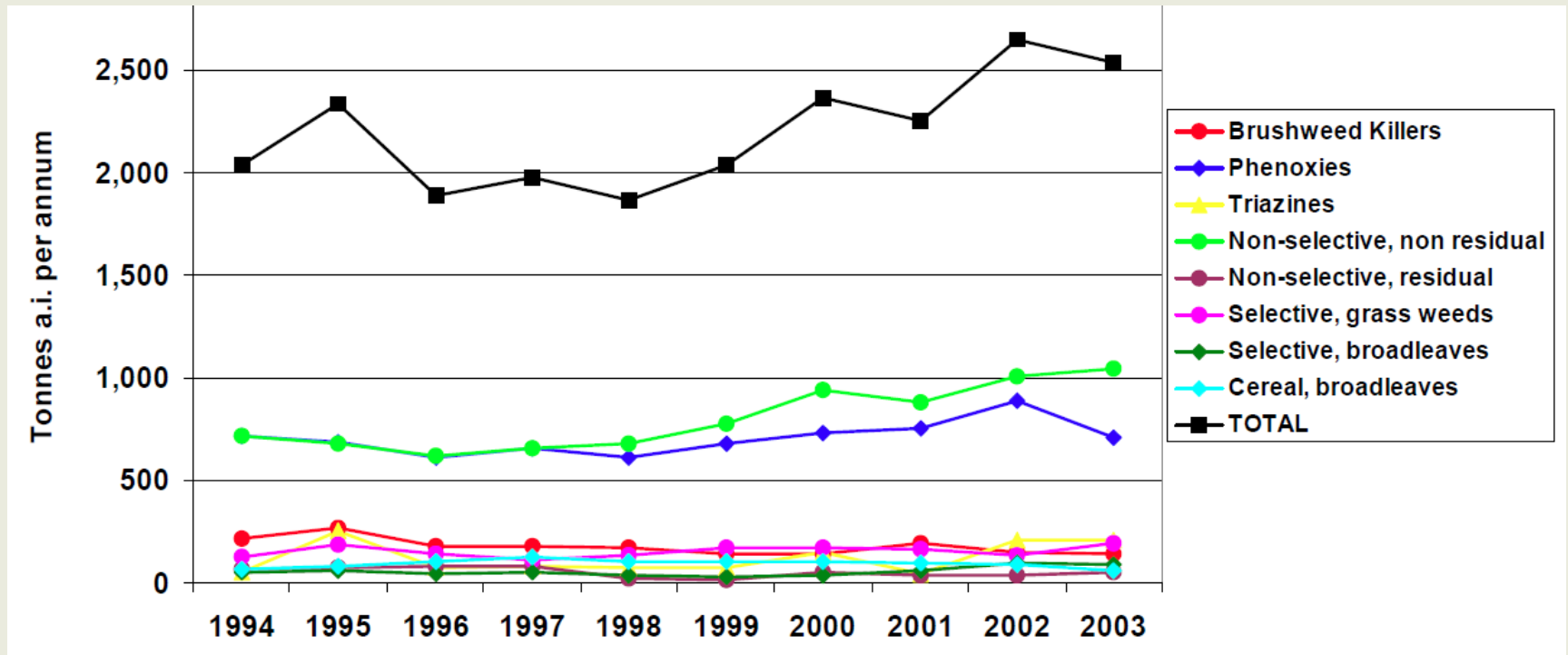
Pesticides that have been associated with NHL



Hohenadel *et al.* (2011) Int J Res Public health. Doi: 10.3390/ijerph8062320

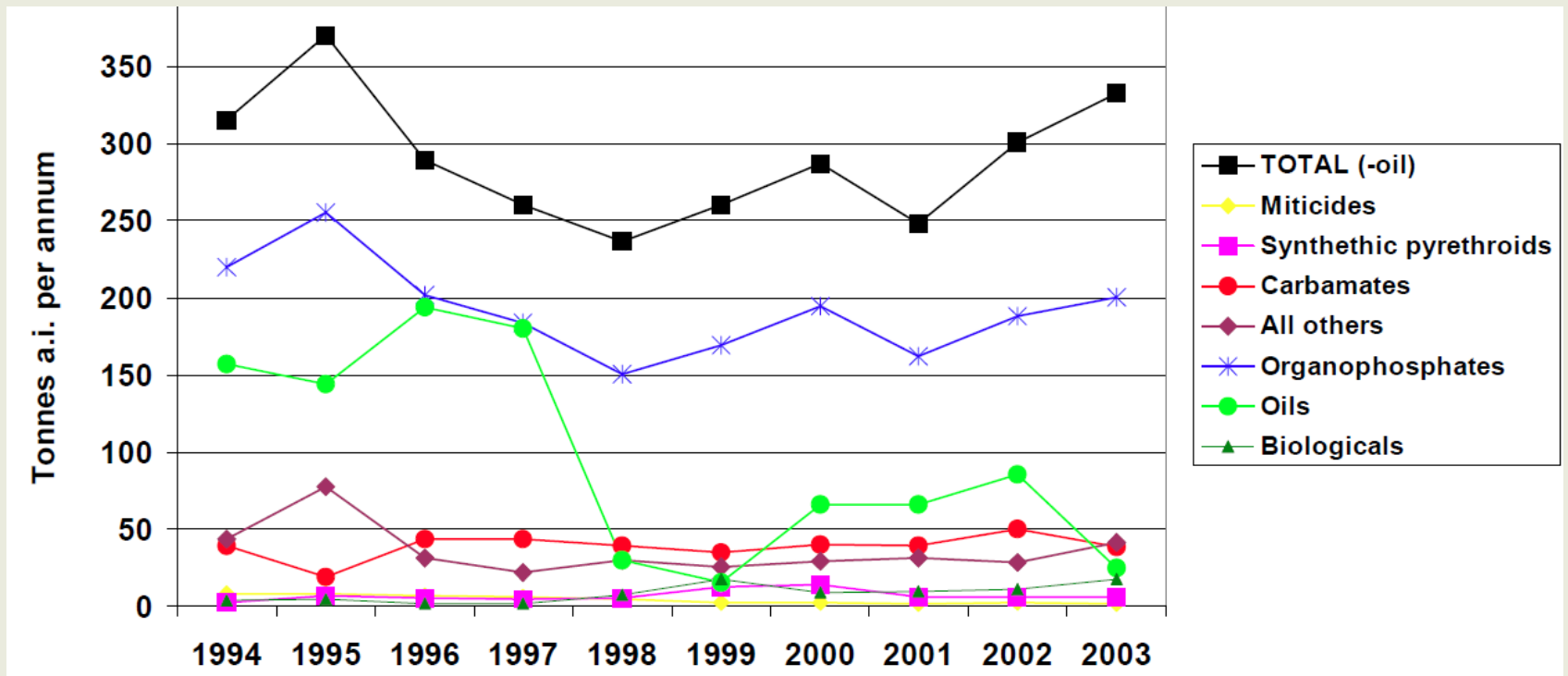
Phenoxy herbicides		
0	1	Ref
1	1.33	0.97-1.82
2+	1.78	1.27-2.50
Organochlorines		
0	1	Ref
1	1.33	0.97-1.81
2+	1.36	0.92-2.02
Organophosphates		
0	1	Ref
1	2.10	1.50-2.94
2+	1.69	1.04-2.74

Herbicide sales



From: Trends in Pesticide Use in New Zealand: 2004. Report to the Ministry for the Environment, project SMF4193

Insecticide use



From: Trends in Pesticide Use in New Zealand: 2004. Report to the Ministry for the Environment, project SMF4193

Conclusions: Farming & NHL



- Farming (particularly crop) has consistently been associated with an increased NHL risk in NZ
- This points towards pesticides as the causal agent
- Pesticide groups suspected to be associated with the increase in NHL risk for farmers, are still widely used in New Zealand
- None of the currently used pesticides are recognized as human carcinogens



2 examples



- Farming & NHL (non-Hodgkin's Lymphoma)
- Welding & lung cancer

Welding and lung cancer



- IARC classified welding fumes as **POSSIBLY CARCINOGENIC TO HUMANS** (2B) in 1990



Meta-analysis



Ambroise D, Wild P, Moulin JJ. Scand J Work Environ Health. 2006 Feb;32(1):22-31.

- 60 studies (1954-2004)
- Welders: OR= 1.26 (95% CI 1.20-1.32)
- No heterogeneity was observed

uncertainties



Is the increased lung cancer risk observed for welders..

- Due to smoking?
- Due to exposure to asbestos?
- Due to exposure to carcinogenic metals (chromium, nickel)?

International lung cancer case-control study



Table 1. Description of the study population

	cases		controls	
	n	%	n	%
All (men only)	2197		2295	
By country				
Romania	141	6.4	169	7.4
Hungary	312	14.2	262	11.4
Poland	553	25.2	578	25.2
Russia	521	23.7	521	22.7
Slovakia	287	13.1	294	12.8
Czech Republic	235	10.7	321	14.0
United Kingdom	148	6.7	150	6.5
By age of interview				
<45	94	4.3	118	5.1
45-54	452	20.6	507	22.1
55-64	825	37.6	774	33.7
>=65	826	37.6	896	39.0
By smoking status				
Never	98	4.5	605	26.4
Ex	1038	47.3	927	40.5
current	1061	48.3	760	33.2
By education (age end full time education)				
16 or younger	752	34.2	615	26.8
17-18	648	29.5	613	26.7
19-23	399	18.2	491	21.4
24 or older	398	18.1	576	25.1

List of exposures



INORGANIC INSULATION DUST
ASBESTOS (general exposure)
CHRYSTOLE ASBESTOS
AMPHIBOLE ASBESTOS
GLASS FIBRES
MINERAL WOOL FIBRES
CERAMIC FIBRES
ABRASIVES DUST
RESPIRABLE FREE CRYST. SILICA
CONCRETE DUST
CEMENT DUST
BRICK DUST
COAL DUST
CARBON BLACK DUST
SOOT (from coal, coke, fuel oil, wood)
COKE DUST
GRAPHITE DUST
CHARCOAL DUST
WOOD DUST (general exposure)
HARD WOOD DUST
SOFT WOOD DUST
INORGANIC PIGMENTS DUST
CHROMATE DUST
CHROMATE FUMES OR MIST
CHROMIUM & COMPOUNDS DUST
CHROMIUM & Cpds FUMES
NICKEL & COMPOUNDS DUST
NICKEL & Cpds FUMES
CADMIUM & COMPOUNDS DUST
CADMIUM & Cpds FUMES
ASHES
ARSENIC & COMPOUNDS DUST
ARSENIC & Cpds FUMES OR MIST
MILD STEEL DUST
STAINLESS STEEL DUST

HARD ALLOYS DUST
IRON & COMPOUNDS FUMES
COAL COMBUSTION FUMES
COKE COMBUSTION FUMES
PETROLEUM OIL COMB. FUMES
WOOD COMBUSTION FUMES
PETROL / GASOLINE ENGINE EMISSIONS
DIESEL ENGINE EMISSIONS
PLASTICS or RUBBER (Nat. or Synth.) PYROLYSIS FUMES
ARC WELDING FUMES
GAS WELDING FUMES
LUBRICATING OIL MIST
CUTTING FLUIDS MIST
OTHER MINERAL OIL MIST
GASOLINE / PETROLEUM
DIESEL / KEROSENE
MINERAL SPIRITS (ex WHITE SPIRIT)
ASPHALT- BITUMEN FUMES
COAL TAR-PITCH FUMES
CREOSOTES FUMES
INORGANIC ACIDS MIST
FORMALDEHYDE
BCME
VINYL CHLORIDE
ACRYLONITRILE
STYRENE
PAH s
INORGANIC PESTICIDES
ORGANIC PESTICIDES (SYNTHETIC)
WOOD PRESERVATIVES
MEAT AEROSOLS
LIVE ANIMALS
ORGANIC SOLVENTS
CHLORINATED SOLVENTS
IONIZING RADIATION

Prevalence of welding

	cases		controls	
	n	%	n	%
All (men only)	2197		2295	
Ever worked in ISCO-68 group 872 'welders and flame-cutters'	118	5.4	84	3.7
Ever exposed to welding fumes	582	26.5	522	22.8
Exposure to welding fumes categorized by occupational group (ISCO 68)				
production supervisors	18	0.8	18	0.8
blacksmiths, toolmakers & machine tool operators	60	2.7	50	2.2
machinery fitters, machine assemblers	90	4.1	102	4.4
electrical fitters & related electrical & electronics workers	33	1.5	37	1.6
plumbers, welders, sheet-metal & structural metal preparers	155	7.1	120	5.2
bricklayers, carpenters & other construction workers	26	1.2	23	1.0
material handling & related equipment operators, dockers	19	0.9	14	0.6
transport equipment operators	22	1.0	23	1.0
Other occupational groups	52	2.4	37	1.6
A combination of different occupational groups	107	4.8	98	4.4
Exposure to welding fumes by type				
Welding fumes from only arc welding	200	9.1	200	8.7
Welding fumes from only gas welding	87	4.0	75	3.3
Welding fumes from both arc and gas welding	295	13.5	247	10.8
Exposure to welding fumes by concomitant exposures (chromium, asbestos)				
Welding fumes (no chromium, no asbestos)	304	13.8	264	11.5
Welding fumes plus chromium (no asbestos)	134	6.1	103	4.5
Welding fumes plus asbestos (no chromium)	89	4.1	99	4.3
Welding fumes plus both chromium and asbestos	56	2.6	56	2.4

Results (1/3)



Odds Ratio for lung cancer in relation to occupational exposure to welding fumes, adjusting for different confounders

(model) adjusted for	Ever exposed to welding fumes		Ever worked as a welder/flame-cutter	
	OR	95% CI	OR	95% CI
(1) Age, center and education	1.19	(1.03-1.37)	1.46	(1.09-1.96)
Lifestyle factors				
(2) As 1 + tobacco consumption	1.19	(1.02-1.39)	1.37	(1.01-1.87)
Work environment exposures				
(3) As 2 + asbestos	1.18	(1.01-1.38)	1.36	(1.00-1.86)
(4) As 3 + silica	1.17	(1.00-1.36)	1.34	(0.98-1.83)
(5) As 4 + metals *	1.18	(1.01-1.38)	1.34	(0.98-1.83)
Welding-related exposures				
(6) As 5 + chromium	1.11	(0.93-1.32)	1.20	(0.86-1.68)
(7) As 6 + nickel	1.11	(0.93-1.32)	1.19	(0.85-1.66)
(8) As 7 + cadmium	1.10	(0.92-1.32)	1.18	(0.84-1.66)

* chromium, nickel, cadmium and arsenic, in jobs not exposed to welding fumes.

OR: Odds Ratio

95%CI: 95% Confidence Interval

Results (2/3)



Exposure to welding fumes	N	N	OR ¹⁾	95%CI	OR ²⁾	95%CI
	cases	controls				
Never	1615	1773	1.00	reference	1.00	reference
Duration						
1-8 years	177	176	1.06	0.83, 1.36	1.02	0.79, 1.31
9-25 years	181	172	1.06	0.83, 1.36	1.00	0.77, 1.30
>25 years	224	174	1.38	1.09, 1.75	1.29	1.00, 1.67
	linear trend			p=0.01		p=0.11

Results (3/3)



	N	N	OR	95%CI
	cases	controls		
No welding fumes, no chromium	1470	1655	1.00	reference
Welding fumes with chromium	190	159	1.34	1.04, 1.71
1-8 YEARS welding fumes	54	42	1.47	0.94, 2.30
9-25 YEARS welding fumes	64	52	1.28	0.85, 1.92
>25 YEARS welding fumes	71	65	1.27	0.87, 1.85
Welding fumes without chromium	393	363	1.14	0.95, 1.36
1-8 YEARS welding fumes	123	134	0.98	0.74, 1.30
9-25 YEARS welding fumes	117	120	1.00	0.75, 1.34
>25 YEARS welding fumes	153	109	1.48	1.11, 1.97
Chromium without welding fumes	144	118	1.32	1.00, 1.75

Conclusions: welding & lung cancer



- Long term exposure to welding fumes is associated with an increased lung cancer risk
- Increased risk is not due to confounding by smoking or asbestos
- Increased risk is not only due to exposure to chromium or nickel
- Welding fumes is a common exposure: two million workers worldwide perform welding as part of their work duties
- NZ: estimated 8000 fitters/welders/flame-cutters
estimated 40.000 may be exposed to welding fumes
- Welding fumes is not recognized as a human carcinogen at this point

2 examples



- Farming & NHL (non-Hodgkin's Lymphoma)
- Welding & lung cancer

- Evidence of increased risk has been consistent over time, but specific causal agent have been difficult to identify
- Exposures are common and are likely remain common
- Exposures are currently not classified as carcinogenic to humans

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Thank you!



**OCCUPATIONAL CAUSES FOR CANCER
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