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Pesticides and cancer: New analyses of a multi- centre case control study

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Pesticides and cancer: Workplace uses, established and suspected links, and knowledge gaps

Pesticides: Exposure Situations



- Workers engaged in manufacture
- Workers engaged in application
 - Farmers
 - Commercial agricultural applicators
 - Urban commercial applicators
 - Greenhouse workers
- Homeowner applications
- Indirect exposures
 - Drift from others use
 - Contaminations of food and water

Pesticides and cancer: Types of Evidence



- Bioassays
- Mechanistic evidence
- Epidemiology
 - Farmers
 - Commercial applicators
 - Manufacturers
 - Case-control studies

Pesticides and cancer: Suspected relationships

- Farmers: brain, stomach, prostate, soft tissue sarcoma, leukemia, myeloma, non-Hodgkin lymphoma
- Commercial applicators: lung
- Case-control studies: prostate, brain, leukemia and non-Hodgkin lymphoma

Pesticide class	Suspected cancer site
Phenoxyacetic acid herbicides	Non-Hodgkin lymphoma, soft tissue sarcoma, prostate
Organochlorine insecticides	Leukemia, non-Hodgkin lymphoma, soft-tissue sarcoma, pancreas, lung, breast
Organophosphate insecticides	Non-Hodgkin lymphoma, leukemia
Arsenical insecticides	Lung, skin
Triazine herbicides	Ovary

Pesticides and cancer: Knowledge gaps



- Limited information on effects of specific pesticides
- Little information on interactions from exposure to multiple pesticides
- Little information on risks to susceptible subgroups
 - Examples:
 - Children or the elderly
 - Genetic polymorphisms
 - Other diseases (immunologic conditions)

Effects of multiple pesticide exposure and immunologic conditions on risk of non-Hodgkin lymphoma:

Findings from US case-control studies

US case-control study: Pesticides and NHL

- Purpose: to examine pesticide exposures in farming as risk factors for non-Hodgkin's lymphoma (NHL) in men
- Pooled analysis of 3 case-control studies: Iowa and Minnesota, Kansas, Nebraska
- Total of 2583 men age 18+ met the inclusion criteria for this analysis
- Cases (n=650) identified through hospitals and state cancer registries; controls (n=1933) identified using random digit dialing and Medicare records
- Data collected through telephone/in-person interview; analyzed using logistic regression

Results: Descriptive



Characteristic	Cases (n=650)	Controls (n=1933)
Study site		
Iowa/Minnesota	436 (67.1%)	895 (46.3%)
Kansas	101 (15.5%)	596 (30.8%)
Nebraska	113 (17.4%)	442 (22.9%)
Ever lived or worked on a farm		
No	243 (37.5%)	775 (40.1%)
Yes	405 (62.5%)	1157 (59.9%)
First degree relative with haematopoietic cancer		
No	594 (92.8%)	1863 (96.7%)
Yes	46 (7.2%)	63 (3.3%)
Histological type		
Follicular	196 (30.1%)	N/A
Diffuse	233 (35.9%)	
Small lymphocytic	77 (11.9%)	
Other	144 (22.2%)	

Results: Exposure to individual pesticides



Pesticide	Cases (n=650)	Controls (n=1933)	Odds ratio† (95% CI)
Herbicides			
Alachlor	152 (7.9%)	152 (7.9%)	1.1 (0.7 - 1.8)*
Atrazine	90 (13.8%)	185 (9.6%)	1.6 (1.0 - 2.2)
Glyphosate	36 (5.5%)	61 (3.2%)	2.1 (1.1 - 4.0)*
Sodium chlorate	8 (1.2%)	7 (0.4%)	4.1 (1.3 - 13.6)*
Insecticides			
Aldrin	47 (7.2%)	115 (5.9%)	0.5 (0.3 - 0.9)*
Copper acetoarsenite	41 (6.3%)	68 (3.5%)	1.4 (0.9 - 2.3)
Coumaphos	15 (2.3%)	22 (1.1%)	2.4 (1.0 - 5.8)
Diazinon	40 (60.1%)	62 (3.2%)	1.9 (1.1 - 3.6)*
Dieldrin	21 (3.2%)	39 (2.0%)	1.8 (0.8 - 3.9)
Fonofos	28 (4.3%)	44 (2.3%)	1.8 (0.9 - 3.5)

†Adjusted for use of all other collected pesticides

*Statistically significant

Results: Exposure to multiple pesticides



Number of pesticides used	Cases exposed (n=650)	Controls exposed (n=1933)	Odds ratio* (95% CI)
Any pesticide			
0	370 (56.9%)	1252 (64.8%)	1.0
1	89 (13.7%)	230 (11.9%)	1.2 (0.8 to 1.8)
2-4	87 (13.4%)	221 (11.4%)	1.0 (0.6 to 1.6)
≥ 5	104 (16.0%)	230 (11.9%)	0.8 (0.4 to 1.9)
Potentially carcinogenic pesticides			
0	496 (76.3%)	1632 (84.4%)	1.0
1	74 (11.4%)	168 (8.7%)	1.6 (0.8 to 3.1)
2-4	68 (10.5%)	123 (6.4%)	2.7 (0.7 to 10.8)
≥ 5	12 (1.8%)	10 (0.5%)	25.9 (1.5 to 450.2)*

Pesticide exposure	Cases exposed (n=650)	Controls exposed (n=1933)	Odds ratio* (95% CI)
Atrazine	59 (9.1%)	125 (6.5%)	1.5 (1.0 to 2.3)
Atrazine and diazinon	31 (4.8%)	44 (2.3%)	3.9 (1.7 to 8.8)*
Atrazine and alachlor	53 (8.2%)	99 (5.1%)	2.1 (1.1 to 3.9)*
Atrazine and dicamba	31 (4.8%)	60 (3.1%)	2.1 (1.0 to 4.7)

*Statistically significant

Results: Immunologic complications



	Non-asthmatics			Asthmatics		
	Cases	Controls	Odds ratio* (95% CI)	Cases	Controls	Odds ratio* (95% CI)
Non-farmers	259	684	1.0	9	37	0.6 (0.3-1.4)
Farmers	560	1510	1.0 (0.8-1.2)	36	95	1.1 (0.7-1.6)
No pesticide use	137	419	1.0 (0.8-1.3)	3	14	0.7 (0.2-2.6)
Pesticide use	423	1091	1.0 (0.8-1.2)	33	81	1.1 (0.7-1.7)

	Non-asthmatics			Asthmatics		
	Cases	Controls	Odds ratio* (95% CI)	Cases	Controls	Odds ratio* (95% CI)
Chlordane	67	108	1.5 (1.1-2.2)	9	8	2.7 (1.0-7.2)
Fonofos	41	69	1.6 (1.0-2.4)	8	6	3.7 (1.3- 10)
Lindane	84	146	1.3 (1.0-1.8)	11	11	2.4 (1.0-5.7)
Cyanazine	53	131	0.9 (0.6-1.3)	8	7	2.8 (1.0-8.1)

Results: Summary



- Exposure to a few individual pesticides were found to increase the risk of NHL
- Exposure to several of these pesticides in combination tends to increase risk
- Exposure to atrazine may increase risk of NHL from other pesticides
- Individuals with immunologic alterations such as asthma may be at greater risk of non-Hodgkin lymphoma when exposed to pesticides than those without
- Important to confirm results in other populations

Effects of multiple pesticide exposure on risk of non-Hodgkin lymphoma:

Work of the Occupational Cancer Research Centre

Cross-Canada case-control: Pesticides and multiple cancers



- Purpose: explore the link between pesticide exposure in various occupations and several cancers of interest
- Four cancers of interest: non-Hodgkin lymphoma, Hodgkin lymphoma, multiple myeloma, and soft-tissue sarcoma
- Six participant provinces: Alberta, British Columbia, Manitoba, Ontario, Quebec, Saskatchewan
- A total of 2019 men 19 years of age or older were included in this analysis; 513 cases and 1506 controls
- Cases were recruited through provincial cancer registries and hospital records; controls were recruited through provincial health insurance records and voters lists

Results: Descriptive



Characteristic	Cases (n=513) n(%)	Controls (n=1506) n(%)
Province		
Alberta	65 (12.67)	196 (13.01)
British Columbia	126 (24.56)	230 (15.27)
Manitoba	34 (6.63)	113 (7.50)
Ontario	142 (27.68)	585 (38.84)
Quebec	117 (22.81)	291 (19.32)
Saskatchewan	29 (5.65)	91 (6.04)
Ever lived or worked on a farm		
No	275 (53.61)	828 (54.98)
Yes	235 (45.81)	673 (44.69)

Preliminary results: Pesticide use



Commonly used pesticide	Frequency	Percent
2,4-D	386	19.12
Methoxychlor	265	13.13
Malathion	191	9.46
Glyphosate	160	7.92
Chlordane	137	6.79
Mecoprop	112	5.55
DDT	92	4.56
Dicamba	76	3.76
Dimethoate	72	3.57
Bromoxynil	69	3.42
Copper salt	53	2.62

Preliminary results: Health conditions



Health condition	Cases (n=513)		Controls (n=1506)	
	N	%	N	%
Acne	9	1.75	48	3.19
Allergies	125	24.37	378	25.10
Food	80	15.59	222	14.74
Drugs	97	18.91	264	17.53
Inhaled substances	88	17.15	270	17.93
Asthma	32	6.24	107	7.10
Chicken pox	185	36.06	638	42.36
Diabetes	36	7.02	99	6.57
Hay fever	43	8.38	155	10.29
Mononucleosis	13	2.53	48	3.19
Measles	253	49.32	888	58.96
Mumps	199	38.79	661	43.89
Tuberculosis	10	1.95	15	1.00

Future directions



- Effects of exposure to multiple pesticides:
 - In-depth look at groups and combinations (based on common uses, IARC classifications)
- Immunologic conditions
 - Conditions beyond asthma as potential effect modifiers in the relationship between pesticides and cancer

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