

Keokuk County Iowa Rural Health Study: Self-reported Use of Pesticides and Protective Equipment

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Abstract

The Keokuk County Rural Health Study is a unique, population-based, prospective study of an agricultural community in Iowa. The research includes in-depth evaluations of respiratory disease, injury, and other health outcomes in relation to environmental and occupational exposures. This article reports descriptive findings on pesticide use from among the first 653 participants completing occupational surveys. Thirty-one percent of respondents (farmers and non-farmers) had applied insecticides, and lawn and garden chemicals at home during the past year. Forty-one percent of respondents had personally mixed or applied farm chemicals during their life. Eleven percent had a current pesticide applicator's license, but only 1% worked as a custom pesticide applicator. Information on the specific types of pesticides and protective measures used were obtained for the 95 individuals who had mixed or applied pesticides on farms within the previous year. Of these individuals, 69% worked with fertilizers, 52% with herbicides, 48% with crop insecticides, 44% with crop storage insecticides, 26% with livestock insecticides, and 11% with fungicides. The use of personal protective equipment such as gloves, aprons, and respirators varied depending on the chemical. A significant proportion did not use gloves even for mixing. Thirty-four percent reported at least one symptom after working with pesticides during the previous year. In addition to providing a detailed description of pesticide use by farmers in this midwestern population, these data will be used to evaluate exposure-response relationships in conjunction with health outcome data from the Keokuk County Rural Health Study.

Keywords. Pesticide, Agriculture, Exposure assessment.

Agricultural chemicals used on modern farms include a diversity of fertilizers, herbicides, crop insecticides, livestock insecticides, fumigants, fungicides, and other compounds (Wintersteen, 1987; Merchant, 1995; Reynolds, 1996). Although the development of less toxic materials, and better packaging to reduce handling, has helped reduce exposure, the risk of acute poisoning and chronic health

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Table 2. Pesticides applied in past 12 months

	N*	Number of Days	
		Mean	SD
Termite control	10	1.8	0.7
Rodent control	102	5.7	9.1
Lawn & garden	175	4.9	9.4
Greenhouse	6	7.8	5.9
Highway right of way	20	8.3	22.7
Forestry	7	3.2	2.2
Pet insecticide	87	4.6	5.5
Home insecticide	206	5.4	6.2
Commercial building insecticide	20	11.6	21.8
Fumigants	36	2.5	2.4
Flea bomb	52	22.1	30.3
Other/crops/livestock	44	-	-

* N = 368.

and garden (175), and rodent control (102). The mean number of days used ranged from 2 for termite control to 22 for flea bombs, although this category had a few individual users who reported many applications over the past 12 months. Of all individuals using pesticides within the past year, 72 had a current pesticide applicator's license. However, only 18 had reported ever worked as a professional applicator, and 7 currently did.

Of the 172 current farmers, 95 individuals reported personally working with farm chemicals in the past year. Eighty-nine percent were male. Sixty-nine percent worked with fertilizers, 52% used herbicides, 48% used crop insecticides, 44% crop storage insecticides, 26% livestock insecticides, and 11% worked with fungicides.

Information on fertilizer use in the last 12 months is presented in table 3. The rank order of fertilizer types used was anhydrous ammonia, manure, liquid nitrogen, and urea. More than one-half of respondents reported using an enclosed tractor cab during application. The mean number of days of use ranged from 10 for urea to 25 for manure. More individuals used gloves during mixing than during application. Use of other personal protective equipment was very low during both mixing and application.

The most frequently used herbicides were 2,4-D (20%), Atrazine (10%), Glyphosate (10%), and Metolachlor (10%) in liquid formulations (table 4). More than half of respondents used gloves all the time during mixing, with only 25% reporting glove use during application. Rubber gloves were most often used. Use of other personal protective equipment was very low. The most frequently applied crop insecticide was Chlorpyrifos (Lorsban) (36%), in a solid form (table 5). Fifty percent of respondents used an enclosed tractor cab when applying crop insecticides. Again, rubber was the most common glove material used, and 54% always used gloves during mixing/loading with 31% always using gloves during application. Twenty percent reported using leather or cloth gloves.

Phosmet (22%), Permethrin (22%), and Malathion (12%) were used most frequently for livestock insecticides (table 6). Malathion (78%) was also used most often for crop storage treatments (table 7). Fungicides were limited to Captan, Systhane, and Zineb (table 8).

The pattern of low utilization of personal protective equipment held true for livestock insecticides (table 6), crop storage insecticides (table 7), and fungicides (table 8). A larger proportion of respondents used rubber boots and respirators when using these categories of pesticides compared to fertilizers and herbicides. More than

Table 3. F

N =	
Enclosed cab	
Days used	Mean sd
Percent using gloves during mixing/loading	Never < 50% > 50% Always
Percent using gloves during application	Never < 50% > 50% Always
Glove type (%)	Cloth Leather PVC Rubber Other

	Other PP	
	Never	During Load < 50%
Rubber boots	60	17
Protective apron	90	0
Goggles	34	14
Faceshield	94	4
Respirator	88	8
Disposable clothing	88	6

one quarter used leather or cloth insecticides.

Table 9 presents the proportion with pesticides during the last year at least one symptom. Twenty-four of 18 reported five or more symptoms were headache, eye irritation, difficulty breathing, and

Discussion

Differences exist between this Minnesota. Farm operators in California, clothing, cartridge respirators, and KCRHS farmers. The consistent use of time among California farmers in 1997). This difference may partially be due to the Worker Protection Standard and protection programs in the state or types of pesticides used may also be similar to that of farmers was more similar to that

ast 12 months

Number of Days	
Mean	SD
1.8	0.7
5.7	9.1
4.9	9.4
7.8	5.9
8.3	22.7
3.2	2.2
4.6	5.5
5.4	6.2
11.6	21.8
2.5	2.4
22.1	30.3
-	-

mean number of days used ranged although this category had a few s over the past 12 months. Of all year, 72 had a current pesticide ted ever worked as a professional

orted personally working with farm it were male. Sixty-nine percent % used crop insecticides, 44% crop d 11% worked with fungicides. this is presented in table 3. The rank onia, manure, liquid nitrogen, and using an enclosed tractor cab during aged from 10 for urea to 25 for ing than during application. Use of luring both mixing and application. : 2,4-D (20%), Atrazine (10%), uid formulations (table 4). More ne during mixing, with only 25% loves were most often used. Use of z. The most frequently applied crop a solid form (table 5). Fifty percent 1 applying crop insecticides. Again, sed, and 54% always used gloves gloves during application. Twenty

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protective equipment held true for pesticides (table 7), and fungicides i rubber boots and respirators when fertilizers and herbicides. More than

Table 3. Fertilizer use in last 12 months

		Anhydrous Ammonia	Urea	Liquid Nitrogen	Manure
N =		66	18	23	51
Enclosed cab		37	9	16	32
Days used	Mean	10.8	10.2	20.1	24.7
	sd	29.1	37.5	42.4	43.2
Percent using gloves during mixing/loading	Never	5	35	9	30
	< 50%	21	18	18	16
	> 50%	7	24	18	32
	Always	67	24	55	22
Percent using gloves during application	Never	45	53	50	37
	< 50%	20	13	15	17
	> 50%	10	13	10	24
	Always	25	20	25	22
Glove type (%)	Cloth	0	23	5	51
	Leather	5	23	5	31
	PVC	18	0	5	0
	Rubber	78	6	73	6
	Other	0	0	11	0

Other PPE Worn During Fertilizer Use

	During Loading/Mixing (%)				During Application (%)			
	Never	< 50%	> 50%	Always	Never	< 50%	> 50%	Always
Rubber boots	60	17	19	4	71	15	10	4
Protective apron	90	0	4	6	98	0	2	0
Goggles	34	14	18	34	75	10	6	10
Faceshield	94	4	2	0	100	0	0	0
Respirator	88	8	4	0	96	2	0	2
Disposable clothing	88	6	4	2	92	4	2	2

one quarter used leather or cloth gloves for livestock insecticides and crop storage insecticides.

Table 9 presents the proportion of individuals reporting symptoms after working with pesticides during the last year. Thirty-four percent (32 individuals) reported at least one symptom. Twenty-four individuals reported three or more symptoms, and 18 reported five or more symptoms. In rank order, the most frequently reported symptoms were headache, eye irritation, unusual tiredness, chest tightness, skin irritation, difficulty breathing, and dizziness.

Discussion

Differences exist between this Iowa population and farmers in California, and Minnesota. Farm operators in California reported greater use of gloves, protective clothing, cartridge respirators, and face shield/goggles during pesticide use than did KCRHS farmers. The consistent use of protective equipment more than 50% of the time among California farmers was strikingly different (Nieuwenhuisen, 1996, 1997). This difference may partially be explained by stricter application of EPA's Worker Protection Standard and the long-term implementation of pesticide protection programs in the state of California. Geographic differences in crops and types of pesticides used may also play a role. The pattern of pesticide use by KCRHS farmers was more similar to that of neighboring Minnesota farmers, although a

Table 4. Herbicide use in last 12 months

N = 49	Total Number of Application Days		Formulation (%)	
	Mean	sd	Liquid	Solid
	8.4	17.7	94	6

Personal Protective Equipment Worn During Herbicide Use

	During Loading/Mixing (%)				During Application (%)			
	Never	< 50%	> 50%	Always	Never	< 50%	> 50%	Always
Gloves	19	10	13	58	56	10	8	25
Rubber boots	86	0	7	7	85	3	5	8
Protective apron	86	2	5	7	93	2	3	2
Goggles	74	0	9	16	85	2	7	5
Face shield	98	0	0	2	100	0	0	0
Respirator	98	0	2	0	100	0	0	0
Disposable clothing	98	2	0	0	100	0	0	0

Type of Glove Used During Herbicide Application/Loading/Mixing (%)

Cloth	3
Leather	3
PVC	16
Rubber	76
Other	2

Herbicides in Rank Order of Frequency Used (Brand Names)

2,4-D (Crossbow)	Lactofen (Cobra)
Atrazine (Bicep, Extrazine, Marksman)	Acetochlor (Harness)
Glyphosate (Roundup)	Bromacil (Hyvar)
Metolachlor (Dual)	Sethoxydim (Poastplus)
Imazethapyr (Pursuit)	Picloram (Tordon 22KT)
Trifluralin (Treflan)	Acifluorfen (Blazer)
Cyanazine (Extrazine, Bladex)	Quizalofop-ethyl (Assure)
Triclopyr (Crossbow)	Thifensulfuron + Chlorimuron (Concert)
Pendimethalin (Prowl)	Select
Nicosulfuron (Accent)	Metribuzin (Sencor)
Dicamba (Banvel, Marksman)	

smaller percentage of KCRHS farmers reported applying herbicides and fungicides (Mandel, 1996). The proportions of KCRHS farmers and Minnesota farmers using gloves most of the time for herbicides, crop insecticides, and livestock insecticides were similar.

The results of this study of farmers in Keokuk County Iowa can also be compared to the Agricultural Health Study's population of registered pesticide applicators. The number of years and the number of days personally mixing or applying pesticides are roughly comparable. In the first year of the Agricultural Health Study applicators reported a history of about 16 years of pesticides use, with a median of 20 days per year for farmers (Alavanja, 1996). A smaller proportion of farmers in Keokuk County mixed and applied crop herbicides (52%) and crop insecticides (48%) compared to applicators in the Agricultural Health Study (Alavanja, 1996; Tarone, 1997). The proportions of Keokuk County farmers using livestock pesticides (44%), stored grain treatments (26%) and fumigants (11%) was higher compared to Agricultural Health Study applicators (Alavanja, 1996; Tarone, 1997). In general,

Table 5. Insecticide use

Participants Using Enclosed Tractor Cab During Application	Total Number of Application Days
N = 23	Mean 6.5

Personal Protective Equipment Worn During Insecticide Use

	During Loading/Mixing (%)	
	Never	< 50%
Gloves	26	9
Rubber boots	85	5
Protective apron	95	0
Goggles	69	7
Face shield	95	0
Respirator	98	0
Disposable clothing	98	2

Type of Glove Used During Insecticide Application

PVC	15
Leather	21
Rubber	54
Cloth	6
Other	4

Crop Insecticides in Rank Order of Frequency Used (Brand Names)

Chlorpyrifos (Lorsban)
Terbufos (Counter)
Tefluthrin (Force)
Permethrin (Pounce, Pounce 32)
Agritox
Phorate (Thimet, Thimet 20 G)
Fonofos (Dyfonate)
Captan
Paraquat (Gramoxone)
Agritox
Esfenvalerate (Asana XL)
Endosulfan (Thiodan)

applicators in the Agricultural Health Study, including chemical gloves (83% in Iowa) more often than farmers in Keokuk County. Symptoms observed in Keokuk County farmer applicators include pesticide use in the Agricultural Health Study eye irritation, tiredness, nervous (Tarone, 1997). Reporting symptoms also appear to be similar. Overall, Keokuk County Farmer applicators used PPE during mixing and application. PPE was used, it usually consisted of gloves, which was partially attributed to the fact that 24% of the chemicals were not currently registered. Lack of training associated with registration

months

Formulation (%)	
Liquid	Solid
94	6

g Herbicide Use

During Application (%)			
Never	< 50%	> 50%	Always
56	10	8	25
85	3	5	8
85	2	3	2
100	2	7	5
100	0	0	0
100	0	0	0
100	0	0	0

n/Loading/Mixing (%)

ed (Brand Names)

fen (Cobra)
 ochlor (Harness)
 acil (Hyvar)
 oxydim (Poastplus)
 ram (Tordon 22KT)
 orfen (Blazer)
 alofop-ethyl (Assure)
 ensulfuron + Chlorimuron (Concert)
 t
 ibuzin (Sencor)

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nty Iowa can also be compared
 stered pesticide applicators. The
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 using livestock pesticides (44%),
 1%) was higher compared to
 996; Tarone, 1997). In general,

Table 5. Insecticide use on crops in last 12 months (N = 46)

Participants Using Enclosed Tractor Cab During Application	Total Number of Application Days		Formulation (%)	
	Mean	SD	Liquid	Solid
N = 23	6.5	5.1	7	93

Personal Protective Equipment Worn During Insecticide Use

	During Loading/Mixing (%)				During Application (%)			
	Never	< 50%	> 50%	Always	Never	< 50%	> 50%	Always
Gloves	26	9	11	54	57	10	2	31
Rubber boots	85	5	10	0	89	3	8	0
Protective apron	95	0	0	5	100	0	0	0
Goggles	69	7	12	12	92	0	8	0
Face shield	95	0	0	5	100	0	0	0
Respirator	98	0	0	2	97	0	3	0
Disposable clothing	98	2	0	0	97	3	0	0

Type of Glove Used During Insecticide Application/loading/mixing (%)

PVC	15
Leather	21
Rubber	54
Cloth	6
Other	4

Crop Insecticides in Rank Order of Frequency Used (Brand Names)

Chlorpyrifos (Lorsban)
 Terbufos (Counter)
 Tefluthrin (Force)
 Permethrin (Pounce, Pounce 32)
 Agritox
 Phorate (Thimet, Thimet 20 G)
 Fonofos (Dyfonate)
 Captan
 Paraquat (Gramoxone)
 Agritox
 Esfenvalerate (Asana XL)
 Endosulfan (Thiodan)

applicators in the Agricultural Health Study used personal protective equipment, including chemical gloves (83% in Iowa) and eye protection (51% in Iowa) more often than farmers in Keokuk County (Tarone, 1997). Similar to the pattern observed in Keokuk County farmers, symptoms reported most frequently after pesticide use in the Agricultural Health Study included: headaches, skin irritation, eye irritation, tiredness, nervous (Tarone, 1997). The proportions of individuals reporting symptoms also appear to be comparable.

Overall, Keokuk County Farmers reported little use of personal protective equipment (PPE) during mixing and application of agricultural chemicals. When PPE was used, it usually consisted of only gloves. The low use of PPE might be partially attributed to the fact that 24% of the KCRHS farmers using agricultural chemicals were not currently registered pesticide applicators, and had not had the training associated with registration. It is also important to note that EPA

Table 8. Fungicide use in last 12 months

	Total Number of Application Days		Formulation (%)		
	Mean	SD	Liquid	Solid	Dust
N = 10	15.4	24.1	67	11	22

Personal Protective Equipment Worn During Fungicide Use

	During Loading/Mixing (%)				During Application (%)			
	Never	< 50%	> 50%	Always	Never	< 50%	> 50%	Always
Gloves	60	0	20	20	70	10	10	10
Rubber boots	70	0	20	10	70	0	20	10
Protective apron	100	0	0	0	100	0	0	0
Goggles	80	0	10	10	80	0	10	10
Face shield	100	0	0	0	100	0	0	0
Respirator	90	10	0	0	90	10	0	0
Disposable clothing	90	0	0	10	90	0	0	10

Type of Glove Used During Fungicide Application/loading/mixing (%)

Rubber	100
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Fungicides In Rank Order of Frequency Used (Brand Names)

Captan (Istox)
Systhane (Nova)
Zineb

Table 9. Percent of farmers reporting symptoms after working with pesticides in last 12 months (N = 95)

	Never	< 50% of the Time	> 50% of the Time	100% of the Time
Unusual tiredness	82	13	5	0
Headaches	71	24	5	0
Dizziness	89	10	1	0
Eye irritation	78	21	1	0
Blurred vision	93	7	0	0
Nose bleeds	100	0	0	0
Nausea	93	6	1	0
Vomiting	98	2	0	0
Stomach cramps	95	4	1	0
Diarrhea	92	7	1	0
Weakness	92	7	1	0
Chest tightness	85	13	1	0
Difficulty breathing	87	12	1	0
Muscle twitches	90	9	1	0
Skin irritation	87	11	2	0
Fast heart rate	92	7	1	0
Excess sweating	92	7	1	0
Fever	94	6	0	0

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12 months

	Formulation (%)		
	Liquid	Solid	Dust
	67	11	22

During Fungicide Use

	During Application (%)			
	Never	< 50%	> 50%	Always
	70	10	10	10
	70	0	20	10
	100	0	0	0
	80	0	10	10
	100	0	0	0
	90	10	0	0
	90	0	0	10

Application/loading/mixing (%)

Used (Brand Names)

Symptoms after working
days (N = 95)

Number of days	100% of the Time
5	0
5	0
1	0
1	0
0	0
0	0
1	0
0	0
1	0
1	0
1	0
1	0
1	0
1	0
2	0
1	0
1	0
0	0

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