

Pesticide Poisoning and Depressive Symptoms as Associated with Safety Behaviors and Injury in Colorado Farm Residents

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Overview of Presentation

- Impact of depression in farmers
- The biological connection: pesticides and depression
- Cross-sectional, longitudinal and case-control studies show high pesticide exposure associated with depression
- Effects on safety and injuries
- Future directions

The State of Farming: But it has always been this way!

“Education is not helping the American farmer, and will not help him. The economic conditions are all against him. The country districts will not keep the population. The map of France is covered with deserted farms. The country population are leaving the farms and flocking to the cities, to the mining, industrial, and commercial centres, as in this land. The children will persist in leaving the old homesteads until some way can be found to make farm life attractive. There must be a great change in the economic conditions, which do not favor the farming class as they do the business class.”

The New York Times
Published: December 10, 1895

Prevalence of depression in farmers

- General population: Lifetime 21.3% women; 12.7% men; Current 6.7% women; 4.0 men
- Colorado (1993): CES-D 7.9% men and 11.1% women
- Iowa (2000): CES-D 12.2% men
- Tennessee (1977-1979): CES-D 19% in farmers 17% in non-farmers; only 5.3% (5.7% of those depressed (CES-D scale) sought treatment (Linn & Husaini, 1987)

Mental Health in UK Farmers

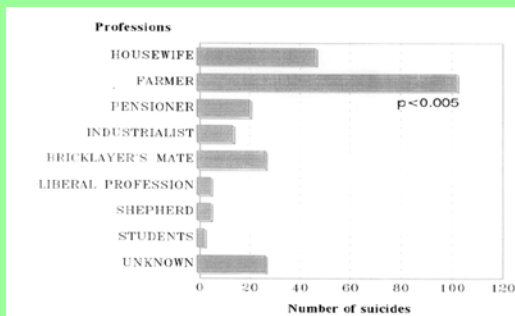
- UK (1995): Hospital Anxiety and Depression Scale (Booth & Lloyd, 1999)
 - Depression 3% men; 12% women
 - Anxiety: 13% men; 38% women
- 6% of British farmers reported significant psychiatric morbidity, lower than general population, but:
 - Significantly more likely to think that life was not worth living (OR 3.26; 95% CI 1.51-7.02) (Thomas et al., 2003)

Mental Health of Farmers in Norway

- Hordaland Health Survey collected depression and anxiety data on 17,295 farmers and non-farmers using HADS-A and HADS-D
- Using a cut-off for “caseness” of 8, male farmers were 2.3 times and females were 2.1 times more likely to be depressed than non-farmers; this was higher for male animal producers (OR=3.1); no difference between full-time farmers and part-time farmers

Sanne et al., 2004

Suicide in agriculturally-intensive region of Spain, 1976-1987



Parron et al., 1996

Conclusions from these studies

- Higher rates of depression and anxiety are found in farmers compared to their non-farming counterparts in many countries
- Farmers are at an increased risk of suicide
- Relationship between depression and suicide ideation may be different in farmers than in the general population

The role of organophosphates and carbamates in the mental health of farmers

Background of Organophosphates

- Organophosphate (OPs) compounds were first synthesized in 1854.
- All OPs are structurally and functionally related.
- Over 20,000 OP agents have been developed, especially during and after World War II.
- Since 1937 when the insecticidal properties of OPs were described, the most common use of OPs has been as pesticides.

Physiological effects of OP exposure

- Acute OP poisoning is produced by the phosphorylation and inhibition of cholinesterases leading to accumulation of acetylcholine at synapses in central, peripheral, and autonomic systems.
- Routes of exposure include: dermal absorption, inhalation

CNS manifestations of acute OP poisoning

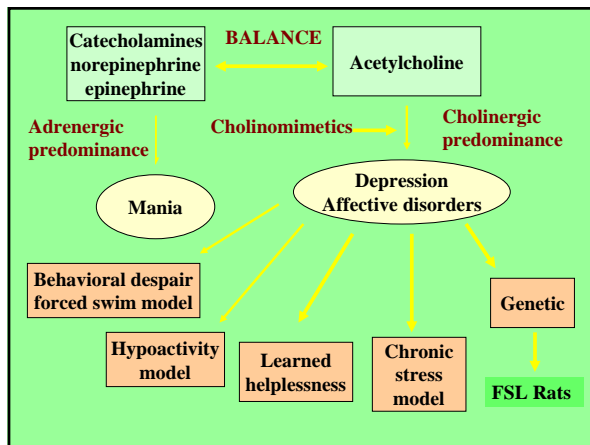
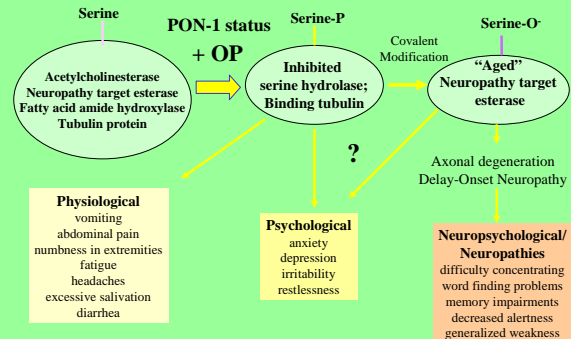
- Giddiness; emotional lability
- Excessive dreaming
- Insomnia
- Nightmares
- Drowsiness
- Anxiety; restlessness
- Apathy; withdrawal
- Confusion; difficulty concentrating
- Headache
- Tremors
- Slurred speech
- Ataxia; generalized weakness
- Coma with absence of reflexes
- Convulsion
- Depression of respiratory and circulatory centers

Long term effects of OP exposure

Long term sequelae of acute OP poisoning include:

- anxiety, depression, sleep disruption, mood disturbances, inability to concentrate, and spatial disorientation.
- can be detected 10 years after acute poisoning

Serine hydrolase inhibition and neurological effects associated with organophosphate pesticides



Epidemiological evidence for an association between OPs and depression

- Depression and pesticide exposure have rarely been addressed in hypothesis-driven research
- Previous epidemiological studies have shown that an acute poisoning is associated with depression (Savage et al., 1988)
- Some studies have shown mood effects (irritability) from chronic pesticide exposures (Amr et al., 1997; Salvi et al., 2003)

Objectives of the Colorado Eight County Study

- Evaluate the association between pesticides and depression among a population exposed to pesticides as a result of agricultural use
- Characterize the type of pesticides used and symptoms of poisoning most frequently associated with depression

Study design: Study Population

- The Colorado Farm Family Health and Hazard Surveillance (CFFHHS) was a cross sectional survey conducted between 1993-1997.
- CFFHHS was a multi-stage area sample that included eight counties in Northeastern Colorado.
- 479 farm representing 761 farm resident operators and their spouses were enrolled

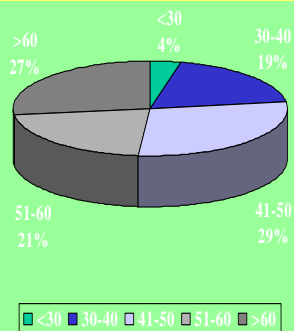
Study design: Interview

- In-person interviews on the farms were conducted and took 45 minutes-2 hours
- Extensive information obtained on farming operation (crops, safety practices, pesticides used), injuries, medical care, health status and health-related behaviors, negative life events

Study design: Variables measured

- Primary risk factor: Past pesticide poisoning
- Outcome: Depressive symptoms assessed using the 20 question Center for Epidemiological Studies-Depression (CES-D) scale
- Symptoms experienced in the past week prior to the interview were based on a scale of less than 1 day, 1-2 days, 3-4 days, or 5-7 days

Age Distribution of Colorado Farmers



Results

- 69 pesticide poisonings reported (9.1%)
- 24 sought medical attention
- 6% depressed by CES-D scale; 9.5% in women and 4.0% in men

Conditional logistic regression of depression and risk factors for depression

Risk Factor for Depression	Odds Ratio	95% Confidence Interval
Pesticide Poisoning	5.95	2.56, 13.84
Female gender	4.64	2.14, 10.06
Poor health	10.82	4.07, 28.76
Income Loss	2.16	1.08, 4.32

Stallones and Beseler, 2002

Longitudinal analyses of pesticide poisoning and depression

Objectives of Study

- Describe the pattern of association between pesticide poisoning and depressive symptoms (CES-D scale) over a three-year period in a cohort of farm residents.
- Identify specific depressive symptoms in the CES-D scale which are significantly associated with having reported a pesticide poisoning

Methods: Study Population

- A stratified sample of farms was randomly selected to represent approximately 2.55% of all rural farm residents with an operator living on the farm
- The sample was proportional to the number of farms with resident operators in each of six crop reporting districts and identified using farm truck registration
- Eligibility requirements included an income of at least \$1,000 in a normal year from sales of agricultural product; operator had to make at least 51% of his or her income from farming owned or leased land
- 485 farms representing 872 individuals enrolled in longitudinal study; 745 in yr 2; 653 in yr 3

Methods: Interview

- The survey was conducted by telephone and designed to take approximately 20 minutes
- Data were collected on types of crops, the number of acres farmed, number of workers and pesticides used
- Depressive symptoms measured using CES-D scale
- Respondents were asked about their health status, including the use of tobacco and alcohol, and whether they had ever become ill from any exposure to pesticides

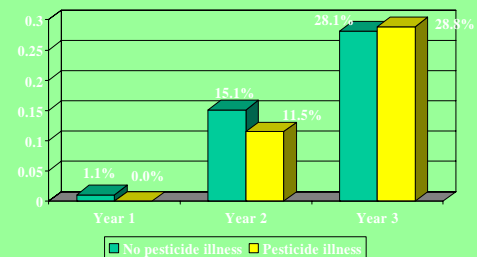
Methods: Analysis

- Weighted Least Squares (WLS) for repeated measures to examine the time-dependence of depression with and without having reported a pesticide-related illness in a univariate analysis
- Generalized Estimating Equations (GEE) for multivariate modeling of depression and pesticide-related illness with other explanatory variables in the model

Demographics of farm cohort

Characteristic	Males % (n) (n=467)	Females % (n) (n=400)
Age < 30	5.4 (25)	8.3 (33)
30-60	71.0 (331)	76.7 (307)
> 60	23.6 (110)	15.0 (60)
Involved in farm work	99.4 (464)	77.8 (311)
Good to excellent health	91.9 (429)	94.5 (378)
Pesticide Poisoning	6.8 (32)	5.0 (20)
Depressed in Year 1	8.0 (37)	10.6 (42)
Depressed in Year 2	2.9 (11)	7.3 (26)
Depressed in Year 3	4.2 (13)	6.7 (21)

Missing depression data over three year period by reported pesticide illness



Time-dependent WLS regression modeling the probability of depression and poisoning

Weighted Least Squares Model	Regression Coefficient	Standard Deviation	Chi-square	P-value
Time only				
Year 2	-0.33	0.11	8.12	0.004
Year 3	0.19	0.12	2.78	0.95
Time & poisoning				
Year 2	-0.32	0.11	7.84	0.005
Year 3	0.21	0.12	3.31	0.069
Poisoning	0.46	0.20	5.01	0.025

Generalized Estimating Equations modeling the probability of depression and pesticide poisoning

Depression or Symptom	Regression coefficient	Standard error	OR	95% CI
Depression by CES-D	1.03	0.37	2.81	1.37, 5.78
Bothered by things	1.34	0.36	3.81	1.87, 7.77
Felt depressed	0.91	0.46	2.50	1.01, 6.16
Talked less than usual	1.00	0.40	2.71	1.25, 5.89

adjusted for gender, age, health status, financial problems

Results

- WLS results indicated that reporting a pesticide poisoning at the first year was significantly associated with depression over the three year period
- Adjusted GEE models showed pesticide poisoning was significantly associated with depression by the CES-D scale and with several symptoms including being bothered by things that do not usually bother them, feeling depressed and talking less than usual

Comparisons to Depression and Poisoning in the Agricultural Health Study

Study Population	OR	95% CI
CFFHHS – 8 county survey	5.95	2.56, 13.84
Statewide 3 yr survey	2.81	1.37, 5.78
AHS spouses	3.28	1.73, 6.22
AHS farmer applicators	3.83	2.63, 5.60

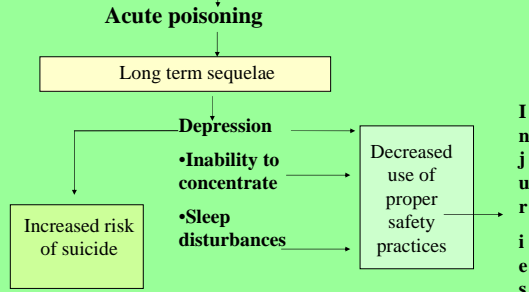
Consequences of Depression – The Relationship of Injury to Pesticide Poisoning

Injuries as an occupational hazard

- Approximately 1.8 million agricultural workers in the U.S.
- On average, 516 workers die on a farm every year (CDC: 1990-1996)
- Every day 243 agricultural workers suffer lost-work time due to injuries and 5% are permanently impaired

Safety practices, depression and pesticides

Organophosphates



Safety behaviors, depression and pesticides-study design

- Ten safety behaviors were assessed related to personal protective equipment, animal handling, farm equipment safety, and miscellaneous safety practices including chemical storage.
- Ten safety knowledge questions related to above activities

Exact logistic regression of safety behavior and depression by pesticide poisoning, Colorado 1993-1997

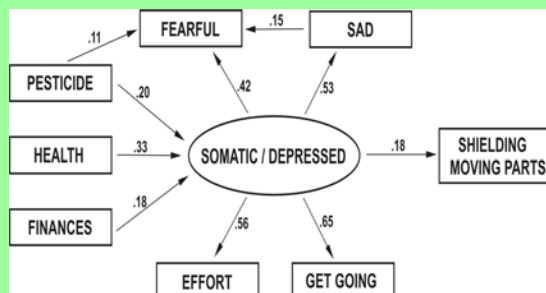
Characteristic	Depression OR (95% CI)	Depression among poisoned OR (95% CI)
Farm machinery		
Moving parts shielded	1.50 (0.33, 6.83)	4.19 (1.06, 16.5)
Replace shields	2.92 (0.88, 9.64)	2.04 (0.42, 9.96)
Read manuals	2.24 (0.69, 7.28)	3.42 (0.97, 12.1)
Animal-related		
Restraining facilities	2.68 (1.00, 7.20)	2.99 (0.56, 15.8)
Calm	3.13 (1.23, 7.99)	4.25 (1.05, 17.2)

Modeling the probability of never, rarely or sometimes vs. most of the time or always exercising the safety behavior

Next steps in modeling safety, pesticide poisoning and depression

- Using Structural Equation Modeling, identify the model that best explains the covariance structure between the risk factors for depression (financial problems, poor health, pesticide poisoning) and exercising a safety behavior

SEM for keeping moving equipment parts shielded - 8 County Sample



Beseler and Stallones, J of Agromedicine 2006

Association of safety knowledge, safety behaviors and depression in three years of Colorado farm resident data

- N=652 individuals representing 124 of the most severe injuries over three years
- 57 injuries in year 1; 42 injuries in year 2 and 54 injuries in year 3
- Of the 124 with at least one injury in three years, 77 missed at least one day of work and 73 sought medical attention
- Safety knowledge score was based on individual factor scores dichotomized at the median; sum scores and factor-weighted score also used

Logistic regression modeling the probability of injury over a 3- year period and low safety knowledge score and depression at baseline*

Risk Factor	OR	95% CI
Hours/week	1.04	1.01, 1.06
Financial problems	1.44	0.94, 2.22
Depression	0.85	0.30, 2.40
Safety Score	0.93	0.60, 1.43
Depression*Safety Score	3.87	1.00, 15.0

*Adjusted for age and gender

Further observations from this study

Variable Used	Odds Ratio	95% CI
Summed safety knowledge score*depression	1.63	1.11, 2.39
Factor-weighted safety factor score * depression	2.28	1.16, 4.31
Not Depressed	1.0	reference
Depressed + High knowledge	0.86	0.31 2.37
Depressed + Low knowledge	3.09	1.31, 7.29

Additional analyses using Poisson in GEE models

- Only depression was associated with total injury count (153 injuries) over the 3-year period
 - Unadjusted model: OR 1.96; 95% CI 1.12, 3.43
 - Adjusted by age, gender, financial problems OR 2.53; 95% CI 1.09, 5.87
- Conclude that the most serious injuries may be related to both depression and safety knowledge/perception and total injuries show only the effects of depression

Relationship of Safety Knowledge to Safety Behaviors

- Not wearing a dust mask during dusty operations (OR 1.65; CI 1.14, 2.38) or wearing hearing protection when tending to noisy operations (OR 1.51; CI 1.01, 2.26) were the only safety behaviors significantly associated with safety knowledge in age- and gender-adjusted model logistic regression models

Relationship of safety behaviors to injury

- Not keeping passageways clear of slippery substances was the only safety behavior that was significantly associated with the risk of injuries (OR 2.08; CI 1.08, 3.99)
- Not keeping chemicals out of the reach of children showed an elevated risk for injury (OR 3.03; CI 0.84, 10.9)

Combining the two Colorado studies to look at all risk factors

- 1,600 farm residents included in the analysis
- Depressive symptoms were ordinal scale
- Safety behaviors were ordinal scale
- Structural Equation Modeling used to simultaneously assess stressors, pesticide poisoning, depressive symptoms, safety knowledge and safety behaviors

Factor loadings for Depressive Symptoms (Somatic/Negative Affect)

Symptom	Factor loading	Symptom	Factor loading
Felt bothered	0.62	Felt fearful	0.68
Not eating	0.55	Slept restlessly	0.53
Felt blue	0.85	Talked less	0.58
Trouble concentrating	0.60	Couldn't get going	0.70
Felt depressed	0.89	Crying	0.76
Everything an effort	0.58	Felt sad	0.81
Life had been a failure	0.70	Felt lonely	0.65

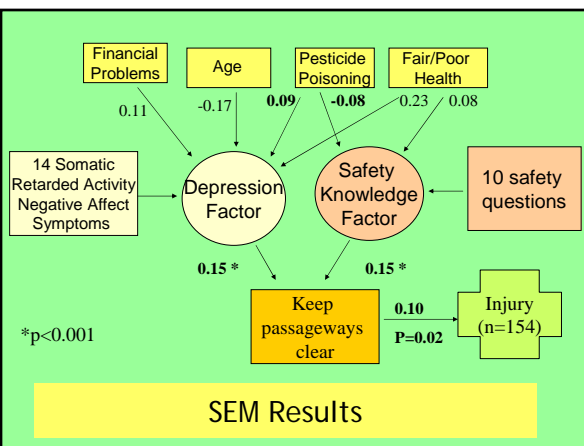
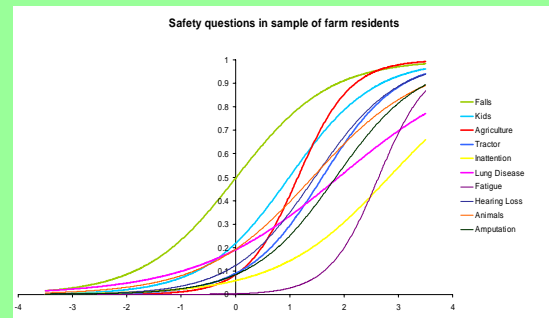
Safety Behavior Questions

Safety Behavior Question: Exercise this behavior always, most of the time, occasionally, rarely, never, n/a	n
Wearing respirator when handling dusty or moldy grain	939
Being calm around animals in close quarters	1342
Replacing protective shields after working on equipment	1107
Wearing a dust mask during dusty operations	1183
Using restraining or handling facilities for treating animals	1110
Wearing hearing protection when tending to noisy operations	1197
Keeping chemicals out of the reach of children	1415
Keeping passageways clear of slippery substances	1342
Reading instruction manuals for farm machinery	1219
Keeping moving equipment parts shielded	1199

Safety Knowledge Questions

Question	% correct	Factor loading
More falls are connected with the use of farm machinery than any other farm work operation	50.5	0.57
Children are rarely injured in falls from farm equipment	72.3	0.60
Agriculture has one of the lowest injury rates of the major U.S. industries	81.8	0.77
Tractors are involved in many fatal farm injuries	85.3	0.65
Inattention is a leading cause of injuries	92.1	0.50
Farmer's lung disease results from overexertion	78.3	0.41
Fatigue can lead to injuries	98.0	0.79
Hearing loss is common among farm workers	81.9	0.62
Animals are rarely responsible for injuries	76.7	0.51
Amputation injuries are more common when working with farm equipment than when involved in other agricultural work	87.0	0.60

Item Response Theory analysis of safety knowledge questions



Final Remarks and Future Directions

- Pesticide poisoning is associated with depression
- Pesticide poisoning may decrease concentration as does depression and the combination may reduce safety behaviors
- **Depression and low safety knowledge appear to reduce safety behaviors and increase the risk for injury**
- **Need interventions to detect depression in the context of farm safety programs**

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