Evaluating Health Effects Among Adolescent Pesticide Applicators

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ABSTRACT

Adolescents work seasonally in pesticides application to the cotton crop in Egypt, which is a highly regulated process across the country. Our research group started a series of studies to examine pesticide health effects among adolescents applying pesticides; who are consider to be at greater risk than adults due to still their developing body systems. The aim of this study was to evaluate the methods used to assess health effects among adolescent pesticide applicators in Egypt and examine the replication of the results of studies conducted in 2005 and 2009. Male children currently applying pesticides were recruited for both studies. Findings are presented from 41 pesticide applicators between the ages of 12 and 18 from 2005 and 21 applicators from 2009. They completed a neurobehavioral test battery, health, and exposure questionnaires, and medical and neurological screening exams. Blood samples were collected to measure cholinesterase activity, and a chlorpyrifos-specific metabolite (TCPy) in urine was measured in 2009. Children not working in agriculture, matched for age and education, also participated in the study. Adolescent pesticide applicators in both 2005 and 2009 studies had similar neurological symptoms and signs and neurobehavioral performance. Applicators in both studies performed significantly worse than controls on the majority of neurobehavioral tests. Applicators in 2009 had significantly higher levels of TCPy than controls, and these higher levels were associated with increased reporting of neurological symptoms. Both studies demonstrate health effects from pesticides exposure in adolescent pesticide applicators.

INTRODUCTION

Pesticide application to the cotton crop in Egypt is regulated by the Ministry of Agriculture. Pesticides are applied during the summer at 4 times points: first a biological growth stimulator (*Bacillus thuringiensis)* is applied, followed by an application of Pestban (chlorpyrifos), an application of Pyrethrins, and finally an application of Dursban (another formulation of chlorpyrifos). The pesticides are often applied by adolescents using backpack sprayers.

Previous research examining adults occupationally exposed to pesticides have demonstrated increased symptom reporting and neurobehavioral deficits. Furthermore they have shown elevated urine metabolite levels and reduced cholinesterase activity. Little research has examined occupational exposure to pesticides in adolescents. Adolescents are exposed to the same pesticides as adults but there is concern about greater risk because they are still developing.

In 2005 a study examining adolescent applicators reported neurobehavioral deficits, and increased symptoms and neuromuscular disorders associated with number of days worked in the current season and number of years worked as an applicator. Additionally the applicators demonstrated deficits on neurobehavioral measures compared to controls and these deficits were associated with decreased cholinesterase activity. In 2009 a second study was conducted to replicate the 2005 study.

STUDY AIM

Evaluate health effects in adolescent pesticide applicators in Egypt compared to controls in studies conducted in 2005 and 2009.

METHODS

Participants

- Applicators: Adolescents between the ages of 12-18 working as pesticide applicators in 2005 (n=41) and 2009 (n=21)
- Controls: Adolescents between the ages of 12-18 not working in agricultural in 2005 (n = 38) and 2009 (n= 20)

Both studies were conducted at the end of the application season in August.

Procedure

Test	2005	2009
Symptom Questionnaire	√	√
Occupational History	√	√
Neurobehavioral Test Battery		
WAIS Information	√	
WAIS Arithmetic	√	
WAIS Similarities	√	√
WAIS Digit Symbol	√	
WAIS Block Design	√	√
WAIS Digit Span	√	
Trail Making A & B	√	√
BVRT	√	√
BARS (Match to sample, Serial digit learning, Digit Span, Continuous Performance, Selective Attention, Finger Tapping, Santa Ana Pegboard, Reaction time, Symbol Digit tests)		√
Medical Exam	√	√
Cholinesterase Activity		
RBC AChE		√
Plasma BuChE	√	√
Urinary chlorpyrifos Metabolite		TCPy

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CONFLICT OF INTEREST OHSU and Dr. Rohlman have a significant financial interest in Northwest Education Training and Assessment, LLC, a company that may have a commercial interest in the results of this research and technology. This potential conflict of interest was reviewed and a management plan approved by the OHSU Conflict of Interest in Research Committee was implemented.

RESULTS

Characteristics of participants

Although participants in 2005 and 2009 were of similar ages and worked similar days per week applying pesticides, the applicators in 2005 have worked more years as applicators (5.5 year vs. 2.0 years). Both applicators and controls in 2009 also had more years of education than participants in 2005.

Characteristics of the participants of both studies; 2005 = 79, 2009 = 41

Studied variables		Study	N	Mean ± SD	t-test	p-value
Age	Applicators	2005	41	15.2 ± 1.7	0.6	0.5
		2009	21	15.5 ± 2.1		
	Controls	2005	38	15.4 ± 1.7	0.2	0.9
		2009	20	15.5 ± 1.5		
Years of education	Applicators	2005	41	6.7 ± 4.2	3.4	0.001
		2009	21	9.3 ± 1.5		
	Controls	2005	38	7.8 ± 3.8	2.4	0.02
		2009	20	9.5 ± 1.5		
No. of days worked this season	Applicators	2005	41	22.4 ± 6.9	1.9	0.07
		2009	21	18.9 ± 7.4		
No. of years worked	Applicators	2005	41	5.5 ± 2.3	8.2	< 0.001
		2009	21	2.0 ± 1.0		

Neurological manifestations

Distribution of applicators in 2005 (n=41) and 2009 (n=21) studies according to frequency of Neurological symptoms.

Symptoms	Groups 2005 (%)	Groups 2009 (%)	χ^2	P-value
Fatigue	36.6	19.0	2.0	0.2
Headache	36.6	19.0	2.0	0.2
Blurred vision	34.1	14.3	2.8	0.1
Feeling depressed	31.7	19.0	1.1	0.3
Dizziness	29.3	9.5	3.1	0.1
Difficulty in concentration	29.3	9.5	3.1	0.08
Troubles in remembering[a]	29.3	19.0	0.8	0.4
Difficulty in understanding[b]	26.8	14.3	1.3	0.3
Feeling irritable	26.8	19.0	0.5	0.5
Numbness	22.0	19.0	0.1	0.8
Low pack pain	19.5	9.5	1.0	0.3

a) Troubles in remembering things observed by relatives, b) Difficulty in understanding meanings of new spapers and books

Distribution of applicators in 2005 (n=41) and 2009 (n=21) studies according to frequency of Neuromuscular signs

Neuromuscular Signs Abnormalities in:	Studies 2005 (%)	Studies 2009 (%)	χ^2	P-value
Superficial sensation	29.3	19.0	0.8	0.4
Knee reflex	24.4	9.5	2.0	0.2
Coordination	24.4	19.0	0.2	0.6
Movements (tremors)	19.5	9.5	1.0	0.3
Ankle reflex	14.6	4.8	1.4	0.2
Muscle power	12.2	4.8	0.9	0.3
Deep sensation	2.4	0.0	0.5	0.5

- Both 2005 and 2009 applicators had a non significant difference in the frequencies of all reported neurological symptoms and signs (P > 0.05).
- The same thing was found in comparing controls of both studies.

Neurobehavioral Performance

Neurobehavioral performance of applicators in the two studies in comparison to their controls

Function	Test	2005	2009
Memory	Match to Sample	-	S
	Serial Digit Learning	-	NS
	Benton Visual Retention	S	NS
	Reversal learning	-	NS
Attention/short memory	Digit Span	S	NS
	Arithmetic	S	-
Sustained Attention	Continuous Performance	-	S
	Selective Attention	-	NS
Motor speed/ coordination	Finger Tapping	-	S
	Santa Ana Pegboard	-	NS
Information processing speed	Reaction Time	-	S
Visual Memory	Symbol Digit	-	S
	Digit Symbol	S	-
	Trail Making	S	S
Verbal Abstraction	Similarities	S	S
Perception	Block Design	S	S

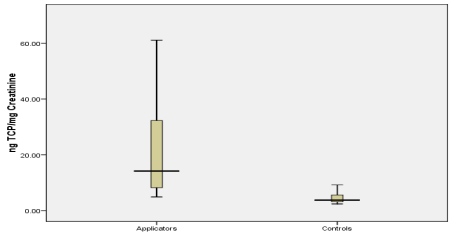
Both studies demonstrate that applicators performed significantly worse than controls on the majority of neurobehavioral tests.

Similar performance was found for Applicators 15 years or older on 3 of the 4 tests that were identical across studies. Applicators in 2009 performed worse on Similarities

Mean (SD) of Neurobehavioral performance among applicators of both studies (2005= 20, 2009 = 15).

Test	Study	Mean ± SD	t-test	p-value
Similarities	2005	16.2 ± 1.8	7.5	< 0.001
	2009	8.9 ± 3.4		
Block design	2005	19.5 ± 5.9	1.4	> 0.05
	2009	22.5 ± 6.4		
Trail making A	2005	59.6 ± 5.2	1.2	> 0.05
	2009	66.5 ± 21.1		
Trail making B	2005	117.8 ± 6.5	0.2	> 0.05
	2009	115.8 ± 45.2		

Chlorpyrifos metabolite (TCPy) in 2009 study



- Significantly higher levels of TCPy were found in applicators compared to controls in 2009.
- Elevated levels of TCPy in the urine are associated with more reports of neurological symptoms (14 out of 17 symptoms; p < 0.05).

Neurobehavioral performance and Acetyl cholinesterase

No relationship was found between neurobehavioral performance and inhibition of cholinesterase enzymes in 2009. Performance on one test, Trail Making, was significantly associated with ChE levels in 2005.

CONCLUSIONS

Seasonal adolescent pesticide applicators in both 2005 and 2009 studies had similar **neurological symptoms and signs** and **neurobehavioral performance**.

Applicators in both studies performed significantly worse than controls on the majority of **neurobehavioral tests**.

2009 applicators had significantly higher levels of **TCPy (chlorpyrifos metabolite)** than controls, and applicators with neurological symptoms had significantly higher levels of TCPy than applicators without these symptoms.