Occupational Pesticide Exposure in Adolescents:

Biomarkers, Neurodevelopmental & Health Outcomes

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Pesticides are Critical Public Health Tools



Pesticides in the Developing World

Although developing countries use only 25% of the pesticides produced worldwide, they experience 99% of the deaths

Pesticide ingestion is the leading global means of suicide



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Organophosphorus (OP) Insecticides

Most commonly utilized pesticides worldwide \rightarrow considered our most toxic agricultural pesticides

Acetylcholinesterase inhibitors and cause adverse health effects at high doses

Chlorpyrifos, an OP insecticide, is widely used around the world





Chlorpyrifos (CPF)

2000 US EPA bans indoor use

2015 US EPA proposes to ban CPF

2017 US EPA decides more research is needed, have until 2022

Aug 2018 US Federal court overturns ruling



* 2016 UK banned most uses of CPF



High-Risk Populations: Children











High-Risk Populations: Children



OP Exposure in Children

(9 studies)

24-36 month (5 studies) Preschool

(8 studies)

School-age

(8 studies)

weight head circum. weight/length gestation

Abnormal reflexes

▶ Bayley MDI
▶ Bayley PDI
↑ reports of delay

♥ gross/fine motor
 ♥ speed/coordination
 ♥ coord/memory/draw
 ♥ speed/coord/attent
 ↑ ADHD symptoms

✓ visuospatial
✓ response speed
✓ attent/learning
✓ memory
▲ ADHD

Youth and Agricultural Work



Perform the same work as adults

Bodies/brains still developing

Little work experience / limited knowledge about work safety

Risk-takers / do not think about long-term implications of exposure

Youth and Agricultural Work

Few studies examine occupational exposure among adolescents

Most studies examine only a single time point – not repeated exposure



What is <u>not</u> established is if these effects <u>are cumulative across time</u> or <u>if they reverse after exposure ends</u>

Follow adolescent applicators and non-applicators **before – during – after** the application season





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Egyptian Pesticide Workers





Pesticide Application and Test Schedule



CPF = Chlorpyrifos (OP) PYR = Alpha-cypermethrin PFF = Profenofos (OP)



Methods



Outcome Measures

Biomarkers in urine and blood Neurobehavioral outcomes Symptoms







Adolescent Participants

	Non-Applicators (n=38)	Applicators (n=57)
Age	16.6 years	16.2 years
Education	9.8 years	9.9 years
Home pesticide use *	1.6 years	2.5 years
Occupational application of pesticides		3.1 years
Application Status	% (n)	% (n)
Applicator for Ministry of Agriculture		100 (57)
Mix pesticides in home in last 5 years **	47.4 (18)	78.9 (45)

* P <0.05 for group difference; ** p < 0.05 (44 applicators; 19 non-applicators)

TCPy (Chlorpyrifos) in 2010 (April – December)



BCP (Profenofos) in 2010 (April – December)



3-PBA (Pyrethroids) in 2010 (April – December)



Changes in Cholinesterase Activity in 2010

Cholinesterase Activity: Nerve impulse transmission and brain growth and development

Red Blood Cell AChE Activity





* Used in cholinesterase monitoring programs

Neurobehavioral Tests*

- Memory/Learning: Serial Digit Learning, Benton Visual Retention, Reversal Learning
- Attention/Short-term Memory: Digit Span
- Sustained Attention: Selective Attention
- Motor Speed/Coordination: Finger Tapping, Santa Ana Pegboard
- Information Processing Speed: Reaction Time
- Executive Functioning: Symbol-Digit, Trail Making
- Verbal Abstraction: Similarities
- Perception: Block Design





Analyses controlled for field station and years of education

Cumulative impact of exposure on neurobehavioral outcomes



High exposed participants consisted primarily of applicators and low exposed consisted of non-applicators. Rohlman et al., 2016



ADHD Symptoms



Next Steps...

Continue to follow cohort

Relationship between biomarkers of exposure, effect and susceptibility and neurobehavioral function

Develop and evaluate intervention materials to reduce pesticide exposure



Intervention to Reduce Exposure

Found that higher TCPy levels were associated more hours applying and hygiene

Focus groups to return results and discuss **feasible** solutions



Intervention

- Using stick instead of hand to mix
- Don't walk in the spray
- Bathe and wear clean clothes



Conclusions (repeated exposure and recovery)

- Differences between applicators and non-applicators
- Biomarkers of Exposure (TCPy, BCP, 3-PBA) and Effect (ChE) increased for both groups during the application season and decreased following the end of application.
- Neurobehavioral deficits increased during the season and remained even months after application ended.

This study is the first to examine the impact of changes in pesticide exposure and neurobehavioral performance among adolescents across the application season.















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