Attention-Deficit/Hyperactivity Disorder and Urinary Metabolites of Organophosphate Pesticides

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"Exposure to organophosphates has been associated with adverse effects on neurodevelopment, such as behavioral problems and lower cognitive function."

This study of 1139 children 8 to 15 years of age, showed that children with higher urinary levels of organophosphate metabolites were more likely to meet the diagnostic criteria for ADHD.

FROM ABSTRACT
OBJECTIVE: The goal was to examine the association between urinary concentrations of dialkyl phosphate (DAP) metabolites of organophosphates and attention-deficit/hyperactivity disorder (ADHD) in children 8 to 15 years of age.

METHODS: Cross-sectional data from the National Health and Nutrition Examination Survey (2000 –2004) were available for 1139 children, who were representative of the general US population. A structured interview with a parent was used to ascertain ADHD diagnostic status, on the basis of slightly modified criteria from the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition.

RESULTS: One hundred nineteen children met the diagnostic criteria for ADHD. Children with higher urinary dialkyl phosphate concentrations, especially dimethyl alkylphosphate (DMAP) concentrations, were more likely to be diagnosed as having ADHD.

For the most-commonly detected DMAP metabolite, dimethyl thiophosphate, children with levels higher than the median of detectable concentrations had twice the odds of ADHD compared with children with undetectable levels.

CONCLUSIONS:
These findings support the hypothesis that organophosphate exposure, at levels common among US children, may contribute to ADHD prevalence.

THESE AUTHORS ALSO NOTE:

There are 40 organophosphate pesticides in use in the United States.

In 2001, 73 million pounds of organophosphate pesticides were used in agricultural and residential settings.

Pesticide exposure is through food, drinking water, and residential use.

The major source of exposure to pesticides for infants and children is through the diet.

The organophosphate malathion is found in 28% of frozen blueberries, 25% of strawberries, and 19% of celery.

"Children are generally considered to be at greatest risk from organophosphate toxicity, because the developing brain is more susceptible to neurotoxicants and the dose of pesticides per body weight is likely to be larger for children."

Children have both the greatest exposure to pesticides and the lowest concentration of detoxifying enzymes, which makes them particularly vulnerable to pesticides.

Prenatal organophosphate pesticide exposure is linked to:
1) Pervasive [spreading widely] developmental disorders
2) Delays in mental development at 2 to 3 years of age

Postnatal organophosphate pesticide exposure is linked to:
1) Behavioral problems
2) Poorer short-term memory and motor skills
3) Longer reaction times

Urinary DAP (dialkyl phosphate) is a metabolite of organophosphate pesticide exposure. These authors measured DAP concentrations and attention-deficit/hyperactivity disorder (ADHD) prevalence in children 8 to 15 years of age.

This study was conducted by the National Center for Health Statistics of the Centers for Disease Control and Prevention. They assessed 1139 children 8 to 15 years of age. 12.1% children met the diagnostic criteria for any ADHD, which corresponds to a population prevalence.

"The odds of meeting the DISC-IV (Diagnostic Interview Schedule for Children IV) criteria for ADHD increased with the urinary concentrations of total DAP metabolites."

Children with "dimethyl thiophosphate [broad-spectrum insecticide used on cockroaches, beetles, bugs, spiders and other arthropods, and on nuisance flies] concentrations above the median of detectable values had twice the odds of ADHD, compared with children with concentrations below the detection limit."

DISCUSSION

Organophosphates are among the most widely used pesticides.

Higher blood chlorpyrifos [organophosphate insecticide that inhibits acetylcholinesterase] concentrations during pregnancy are associated with poorer

mental and motor development at 3 years.

"Greater postnatal exposure to organophosphate pesticides is associated with difficulties with memory, attention, motor tasks, behavior, and reaction time."

Prenatal exposure to organophosphate pesticides is also associated with poorer mental development at 2 years of age.

In this study, the organophosphate pesticide DMAP (dimethyl alkylphosphate) metabolites was found to be the most toxic.

These biological mechanisms might underlie an association between organophosphate pesticides exposure and ADHD:

1) Organophosphates, inhibit acetylcholinesterase, disrupting cholinergic signaling
2) They disrupt neurochemical targets
3) They disrupt growth factors
4) They disrupt neurotransmitter systems
5) They disrupt second messenger systems

"Developmental exposure to organophosphates might have persistent effects on multiple neural systems that may underlie ADHD behaviors, such as inattention and cognitive deficits, similar to the effects of developmental nicotine exposure."

CONCLUSIONS

"The present study adds to the accumulating evidence linking higher levels of pesticide exposure to adverse developmental outcomes."

"Our findings support the hypothesis that current levels of organophosphate pesticide exposure might contribute to the childhood burden of ADHD."

KEY POINTS FROM DAN MURPHY

1) Organophosphates are among the most widely used pesticides. There are 40 organophosphate pesticides in use in the United States.

2) In 2001, 73 million pounds of organophosphate pesticides were used in agricultural and residential settings.

3) Pesticide exposure is through food, drinking water, and residential use.

4) The major source of exposure to pesticides for infants and children is through the diet.

5) "Exposure to organophosphates has been associated with adverse effects on neurodevelopment, such as behavioral problems and lower cognitive function."

6) This study of 1139 children 8 to 15 years of age showed that children with higher urinary levels of organophosphate metabolites were more likely to meet the diagnostic criteria for ADHD (attention-deficit/hyperactivity disorder).

7) For the most-commonly detected organophosphate pesticide metabolite, dimethyl thiophosphate, children with levels higher than the median of detectable concentrations had twice the odds of ADHD compared with children with undetectable levels.

8) These findings support the hypothesis that organophosphate exposure, at levels common among US children, may contribute to ADHD prevalence.

9) The organophosphate malathion is found in 28% of frozen blueberries, 25% of strawberries, and 19% of celery.

10) "Children are generally considered to be at greatest risk from organophosphate toxicity, because the developing brain is more susceptible to neurotoxicants and the dose of pesticides per body weight is likely to be larger for children."

11) Children have both the greatest exposure to pesticides and the lowest concentration of detoxifying enzymes, which makes them particularly vulnerable to pesticides.

12) Prenatal organophosphate pesticide exposure is linked to:
A)) Pervasive developmental disorders
B)) Delays in mental development at 2 to 3 years of age

13) Postnatal organophosphate pesticide exposure is linked to:
A)) Behavioral problems
B)) Poorer short-term memory and motor skills
C)) Longer reaction times

14) Higher blood chlorpyrifos concentrations during pregnancy are associated with poorer mental and motor development at 3 years.

15) "Greater postnatal exposure to organophosphate pesticides is associated with difficulties with memory, attention, motor tasks, behavior, and reaction time."

16) "Developmental exposure to organophosphates might have persistent effects on multiple neural systems that may underlie ADHD behaviors, such as inattention and cognitive deficits, similar to the effects of developmental nicotine exposure."

17) Higher levels of pesticide exposure is linked to adverse developmental outcomes.

18) "Current levels of organophosphate pesticide exposure might contribute to the childhood burden of ADHD."