

## Title

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Association of Pyrethroid Pesticide Exposure with Attention-Deficit/Hyperactivity Disorder in a Nationally Representative Sample of U.S. Children

## Author(s)

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## Abstract

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### Background

Attention-Deficit Hyperactivity Disorder (ADHD) is one of the most common neurobehavioral disorders in children. It is characterized by difficulty paying attention and controlling behaviors, and by hyperactivity. According to the Centers for Disease Control and Prevention, 5.9 million children in the United States (U.S.) have been diagnosed with ADHD, while the annual societal “cost of illness” for ADHD is estimated to be between \$36 and \$52 billion. Although the exact cause of ADHD is unclear, recent evidence suggests a link between ADHD and exposure to certain environmental chemicals, such as pesticides.

Two of the most common types of pesticides in the U.S. are organophosphate (OP) pesticides and pyrethroid pesticides. The U.S. Environmental Protection Agency (EPA) placed a ban on residential use of two commonly used OP pesticides in 2001 due to their acute toxicity in birds and mammals. Pyrethroids were considered a safer alternative. As a result, pyrethroid usage increased greatly throughout the U.S., and pyrethroids are now used in many household products, including flea and tick pet shampoos, lice shampoos, and cockroach sprays, and are commonly used to treat crops.

Despite their perceived safety, however, pyrethroids are lethal to certain animals, and are potentially harmful to humans. High amounts of pyrethroid exposure in humans can cause headaches, difficulty breathing, nausea, and vomiting. Moreover, EPA has indicated that one type of pyrethroid, permethrin, is “likely to be carcinogenic to humans”.

Recent research also indicates that pyrethroid exposure in laboratory animals may produce behavioral and neural changes similar to those of ADHD. More specifically, pyrethroid exposure in mice increases hyperactivity and impulsivity and disrupts the normal function of the brain chemical dopamine. Interestingly, male mice also appear to be more susceptible to the effects of pyrethroids than female mice, which is consistent with higher rates of ADHD in human males compared to females. Although there are a small number of studies that have examined the effects of pyrethroids on human behavior, the results of these studies are conflicting. Moreover, no previous studies have examined the behavioral effects of pyrethroid exposure using ADHD-specific diagnostic measures.

### Objective

To determine if pyrethroid exposure is associated with ADHD diagnostic status and to examine whether the effects of pyrethroid exposure are sex-specific.

### Methods

Pyrethroid exposure and ADHD diagnostic status and symptoms were assessed in a sample of 687 children, ages 8-15. Pyrethroid exposure was assessed by measuring levels of a pyrethroid metabolite in the children’s urine. ADHD diagnostic status was assessed using the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* criteria. ADHD symptoms were determined using the Diagnostic Interview Schedule for Children.

### Results

Children with higher levels of the pyrethroid metabolite were more likely to be diagnosed with ADHD and exhibited a greater number of ADHD symptoms. This affect was observed in boys, but not girls.

### Conclusion

This study is the first to examine the effects of pyrethroid exposure using ADHD-specific diagnostic criteria, and the first to find a sex-specific association between pyrethroid exposure and ADHD diagnostic status and symptoms.

### Policy Implications

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In 2011, EPA published a Pyrethrins/Pyrethroid Cumulative Risk Assessment. This assessment indicated that current exposures to pyrethroids do not pose a risk to children or adults. Moreover, the assessment recommended expanding the use of pyrethroids. However, findings from this study indicate that further research is needed to better understand the effects of pyrethroids, particularly in regard to neurodevelopment and behavior among children. It is likely that the effects of pyrethroid exposure are subtle and complex, and may manifest themselves across a longer timeline. Policy makers should proceed with caution and potentially reconsider expanding the use of pyrethroids.

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### Reference

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Article available in [Environmental Health](#).

### Keyword(s)

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[Attention Deficit Hyperactivity Disorder \(ADHD\)](#), [Pyrethroids](#)