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LESSON:

Pyrethroid Panic?

Summary: Students read a brief article summarizing the findings of a new research study on pesticide exposure in the home. Students then interpret box plots from the original research study to answer questions about the study and its findings.

Lesson Type: Warm-up—This lesson can take 20 minutes or less to implement.

***EHP* Article:** "Pyrethroids in the Home"
EHP Student Edition, December 2006, p. A544
http://www.ehponline.org/docs/2006/114-9/ss.html

Objectives: By the end of this lesson, students should be able to

1. name two classes of pesticides that have human health impacts;
2. identify how children are most likely exposed to pyrethroid pesticides;
3. read and interpret data from a box plot; and
4. discuss how parents could reduce their children's exposure to pesticides.

Class Time: 20 minutes

Grade Level: 9–12

Subjects Addressed: Biology, Environmental Health, Chemistry, Mathematics

Prepping the Lesson (5 minutes)

INSTRUCTIONS:

1. Download the entire *EHP Student Edition* at http://www.ehponline.org/science-ed/, or download just the article "Pyrethroids in the Home" at http://www.ehponline.org/docs/2006/114-9/ss.html.
2. Review the Instructions, Student Instructions, and Background Information.
3. Make copies of the Student Instructions.

MATERIALS (per student):

- 1 copy of the article "Pyrethroids in the Home"
- 1 copy of the Student Instructions

VOCABULARY:

- box-and-whiskers plot
- box plot
- chlorpyrifos
- consecutive
- cyfluthrin
- cypermethrin
- deltamethrin
- diazinon
- extreme values
- hormones
- median
- metabolite
- organic
- organophosphorus

- outliers
- percentiles
- permethrin
- pesticide
- pyrethroid

BACKGROUND INFORMATION:

Pyrethrum is a pesticide that is derived from a natural toxin created by the chrysanthemum. Permethrin is the synthetic, or man-made, version of pyrethrum. Both pyrethum and permethrin are in a class of pesticides called pyrethroids that work by paralyzing the nervous system of insects. Interestingly, permethrin lasts longer in the environment compared to pyrethum. Toxicological research is investigating whether there are differences in the extent and type of adverse health effects between the "natural" and "synthetic" pyrethoid chemicals. Research has shown the toxicity of organophosphate pesticides (a different class of pesticides) and as a result, they have been phased out of residential use. The permethrins, used in their stead, appear to be getting into children's bodies and their health effects are unknown. Additional resources for information about pyrethroid pesticides and alternatives are listed below.

One factor to keep in mind when discussing this research with students is that it studied only one type or class of pesticides (pyrethroids). Different pesticides can be used for different applications (e.g., food versus residential use). Therefore, the finding of no significant difference between the amounts of metabolic by-products in children who ate organic versus nonorganic diets could be a function of looking at only one class of pesticides. Numerous studies have been published on children's exposure to pesticides via food and have compared organic and nonorganic diets. Some of these studies have been described in earlier *EHP* news articles (see a link to the Environews by Topic index in the Resources section below). One study in particular, summarized in a news article at http://www.ehponline.org/docs/2006/114-2/ss.html, looked at metabolic products of organophosphate pesticides in children eating organic versus nonorganic diets. More in-depth *EHP Student Edition* Science Education lessons on pesticide exposure can be found in the May 2006 issue.

References:

Beyond Pesticides. 1990. chemicalWATCH fact sheet: synthetic pyrethroids, http://www.beyondpesticides.org/pesticides/factsheets/Synthetic%20Pyrethroids.pdf.

Lu C, Barr DB, Pearson M, Bartell S, Bravo R. 2006. A longitudinal approach to assessing urban and suburban children's exposure to pyrethroid pesticides. Environ Health Perspect 114:(9): (pages*) http://www.ehponline.org/members/2006/9043/9043.html

RESOURCES:

Environmental Health Perspectives, Environews by Topic page, http://ehp.niehs.nih.gov. Choose Organophosphates, Pesticides/Pest Management

Beyond Pesticides, "Least Toxic Control of Pests In the Home and Garden" (includes fact sheets on nontoxic pesticide alternatives), http://www.beyondpesticides.org/alternatives/factsheets/index.htm

Extension Toxicology Network (a service summarizing research findings on permethrins), http://extoxnet.orst.edu/pips/permethr.htm

Pesticide Action Network (a database of toxicity and regulatory information), http://www.pesticideinfo.org/Detail_Chemical.jsp?Rec_Id=PC35397
Scorecard (a summary of research on permethrins and links to other resources), http://www.scorecard.org/, select "Chemical Profiles," then search by chemical name.

Implementing the Lesson

INSTRUCTIONS:

1. Have students read the article "Pyrethroids in the Home."
2. Students answer the questions about the box plots provided in the Student Instructions.

NOTES & HELPFUL HINTS:

- Many of the specific chemical compounds mentioned in the article are almost certainly unfamiliar to the students. It is not necessary to know the compounds to understand the article and do the lesson. Encourage students to make guesses about unfamiliar words based on their context. Most chemicals mentioned in the story are metabolites of pyrethroid-based pesticides.
- Depending on the background of your students, it may be necessary to introduce and explain box plots (also called box-and-whisker plots), median, percentiles, outliers, and extreme values.
- An extension of this lesson could be for students to go to a grocery store and compare the prices of organic versus nonorganic produce as well as pyrethroid-based versus pyrethroid-free home pesticide products. Is it always more expensive to protect your health?

Aligning with Standards

SKILLS USED OR DEVELOPED:

- Communication (oral, written—including summarization)
- Comprehension (listening, reading)
- Critical thinking and response
- Graph reading

SPECIFIC CONTENT ADDRESSED:

- Pesticide exposure
- Children's health
- Research methods
- Reading box plots

NATIONAL SCIENCE EDUCATION STANDARDS MET:

Science Content Standards

Science as Inquiry Standard

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Science in Personal and Social Perspectives Standard

- Personal and community health
- Environmental quality
- Natural and human-induced hazards
- Science and technology in local, national, and global challenges

History and Nature of Science Standard

- Science as a human endeavor
- Nature of scientific knowledge

Assessing the Lesson

Step 2:

1. In Figure A, how many children in the data set reported no use of residential pyrethroid pesticides? (Note: *n* = the sample number.)

   The answer is 249.

2. Looking at Figures A, B, and C, approximate the highest concentration of *trans*-DCCA found in any child's urine sample. Be sure to give the answer with the correct units.

   Approximately 8.5 micrograms per liter was reported for the highest outlier value. The "outlier" values are the high scores that were above the percentiles represented by the horizontal bars, another way of showing the mean and the distribution around that mean. Although researchers sometimes discard outlier values and use only the means, you can see in this study that some children's urine had concentrations of the chemicals of interest about 300% higher than the mean. The researchers believe this was accounted for by differences in children's behavior, possibly related to recreational sport exposure. Because of the importance of dose for toxic effects, these outlier values are important to understanding potential population effects.

3. According to Figure B, does an organic diet appear to reduce exposure to pyrethroid pesticides?

   Yes, the group eating the organic diet does show overall lower levels of pyrethroids in their urine than the group eating the conventional diet.

4. According to the article, what do the researchers hypothesize about exposure to these particular pesticides via diet versus residential use?

   The means of the organic and nonorganic groups (the 50th percentile line, the top of the box) are close. The researchers hypothesize that the bulk of the exposure in both groups in Figure B came from residential application of the pesticide. Thus, the change in diet did not appear to reduce the exposure to these specific pesticides enough to make an impact statistically.

5. As a parent of a child, might you change your behavior based on the information presented in the figures? What factors might keep you from acting on this information?

   This answer will vary by the student. Some might feel that parents should eliminate all use of pyrethroid pesticides in the home and also fully convert to an organic diet. Others may consider the risk too small to make lifestyle changes that involve time and effort. Factors that could influence this decision include perceived risk of illness associated with pesticide use, perceived severity of the possible health outcome and cost (both financial and the time involved in researching and applying other pesticides), and perceived efficacy of other options.

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Give us your feedback! Send comments about this lesson to ehpscienceed@niehs.nih.gov.

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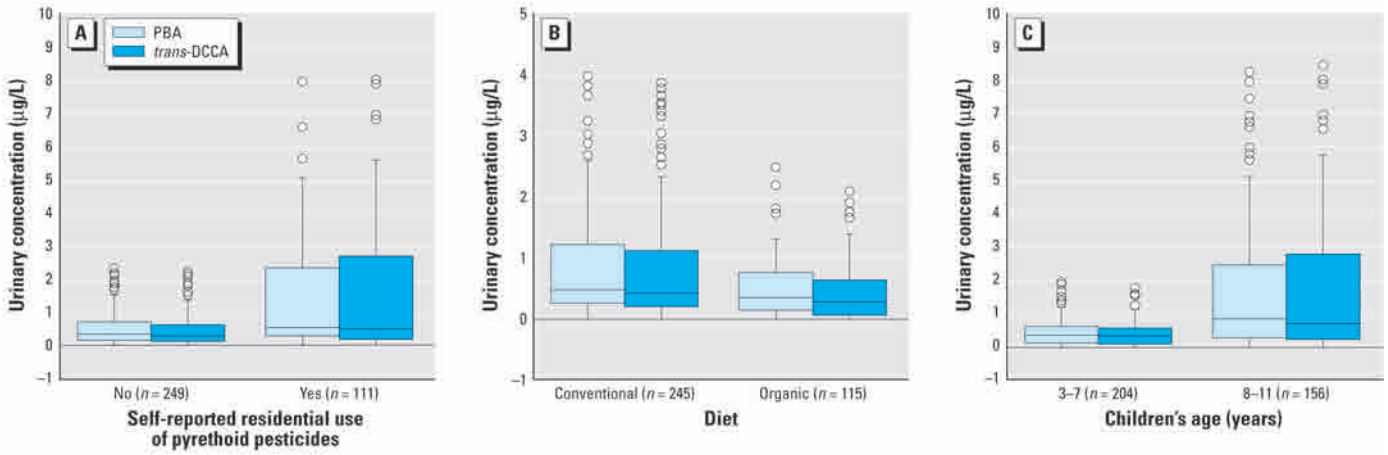
Student Instructions: Pyrethroid Panic?

Step 1: Read the article "Pyrethroids in the Home."

Step 2: The following box plots were taken from the actual scientific research article. Box plots are used to show the shape of the distribution of many results around the median. The horizontal lines in each plot represent the 10th, 25th, 50th, 75th, and 90th percentiles of the urine samples collected over 15 days. The 50th percentile (median) means 50% of the samples were above that value and the other 50% were below that value. The circles represent outlier values, or values above the 90th percentile. PBA and *trans*-DCCA are abbreviations for two urinary metabolites associated with pyrethroid exposure. Base your answers to the questions below on these box plots.



Source: Lu C, Barr DB, Pearson M, Bartell S, Bravo R. 2006. A longitudinal approach to assessing urban and suburban children's exposure to pyrethroid pesticides. *Environ Health Perspect* 114:1419–1423.

1. In Figure A, how many children in the data set reported no use of residential pyrethroid pesticides? (Note: *n* = the sample number.)

2. Looking at Figures A, B, and C, approximate the highest concentration of *trans*-DCCA found in any child's urine sample. Be sure to give the answer with the correct units.

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3. According to Figure B, does an organic diet appear to reduce exposure to pyrethroid pesticides?

4. Why doesn't the study recommend an organic diet to reduce exposure?

5. As a parent of a child, might you change your behavior based on the information presented in the figures? What factors might keep you from acting on this information?