For a list of potentially hazardous ozone generators sold as air purifiers, go to:
www.arb.ca.gov/research/in indoor/o3g-list.htm

PAINLESS TEST: Otana measured the amount of oxygen in a person's blood by placing a pulse oximeter (below) on the subject's fingertip.
One teen’s science project helped pass a law to protect people from invisible danger

True or false: An air purifier can help you breathe easier. You might think the answer is a no-brainer, especially since advertisers claim that these machines improve air quality. But California teen Otana Jakpor suspected that instead of helping, some air purifiers might leave people gasping for breath.

Not all air purifiers raise a red flag. Some simply filter particles from the air. But others produce ozone, a highly reactive gas. Manufacturers of these devices say that the ozone cleans air by reacting with and removing harmful particles, although research doesn’t support all of their claims. An ozone layer in the upper atmosphere, where humans can’t breathe it in, protects us by blocking the sun’s harmful ultraviolet rays (invisible energy waves). But when ozone forms at ground level, trouble is in the air. This gas, which is the main ingredient of air pollution known as smog, damages cells in the lungs and airways and makes breathing difficult. The effects are even more severe for people with the breathing disorder asthma.

Last year, when Otana was 13, she started a science project to test the pulmonary (lung) effects of ozone-generating air purifiers. Her award-winning project exposed hidden dangers and helped pass a California law limiting the amount of ozone these devices can pump into the air.

STEPS TO SUCCESS

Otana’s project could have become complicated without the scientific method. This step-by-step process that scientists use to design and perform experiments kept things running smoothly. “I can’t imagine how I could have accomplished my project if I hadn’t followed the scientific method,” she says. This systematic process also confirmed that her results were accurate, even when they contradicted what many people thought about air purifiers.

FRESH IDEA

As with all science experiments, Otana’s idea came from an observation. When she read a Consumer Reports article warning that some air purifiers produce high ozone levels, she wondered how this would affect breathing. To state the purpose of her project, she wrote this research question: What effect do ozone-generating
air purifiers have on pulmonary function?

To find out what was already known about her topic, Otana did background research. She surfed the Internet to locate information written by scientists. “I did some Medline searches because I wanted to see if people had done my experiment before,” she says. She found studies that had measured the amount of ozone produced by air purifiers, but none that had measured the effects on breathing. The only information about ozone’s pulmonary effects dealt with outdoor smog. Otana would be conducting original research.

She also learned that California lawmakers were concerned about certain air purifiers. They had asked the California Air Resources Board to write a regulation limiting the amount of ozone that these devices could produce. The regulation was still up in the air as Otana’s project got under way.

AIRTIGHT PLANS

Based on what she’d learned in her background research about the effects of outdoor ozone and the amount of ozone produced by indoor air purifiers, Otana had a possible answer to her research question. Her hypothesis was that if people are exposed to ozone-generating air purifiers, then their pulmonary function will be reduced, especially if they have asthma.

To test her hypothesis, Otana conducted experiments. She followed a procedure, a step-by-step plan that contains clear instructions to test the effect of one variable, or characteristic, on another variable. Her independent variable, or the factor she would change on purpose during the experiment, would be the type of air purifier. She’d test room air purifiers, plus a personal air purifier that hangs around the neck. After people were exposed to these devices, Otana would measure their pulmonary function, which would be her dependent variable, or the factor that responds to a change in the independent variable.

TESTING FOR INVISIBLE DANGER

To start her experiments, Otana used an ozone sensor to measure the amount of ozone flowing from the air purifiers. “I was really surprised at how much ozone some of them made,” she says. One produced levels 15 times higher than a Stage 3 Smog Alert—the worst air pollution warning issued in California!

Next, Otana needed to measure the effects on people who spend time in a room with these devices. To ensure accurate results, she recruited 34 test subjects, some with asthma and some without the condition. She says, “I had science experimentation parties where I’d say, ‘Come to my house and we’ll watch a movie, and I’ll test you for my science project.’” First, she got informed consent, meaning the subjects knew they were being tested and had given their permission.

Otana borrowed a microspirometer (device that measures the amount of air a person can exhale) and a pulse oximeter (device that measures the amount of oxygen in a person’s blood) from her mother, who has asthma. Using these, Otana measured her subjects’ pulmonary function before and after they spent two hours exposed to a room air purifier, or three hours wearing a personal air purifier.

Her data, or collected information, revealed that the ozone-producing room air purifiers reduced the pulmonary function of the subjects with asthma. The personal air purifier made breathing harder for all the subjects. Based on these data, Otana reached a conclusion, or summary of her results. “My hypothesis was correct,” she says.

CLEARING THE AIR

Otana sent her data to the California Air Resources Board. They invited her to present the research at a hearing where they’d vote on the regulation to limit ozone produced by...
air purifiers. She says, "I felt like I was able to make a difference, because there weren't very many people at the hearing who were speaking in favor of the regulation. There were mostly people in favor of ozone-generating air purifier companies." The California Air Resources Board adopted the regulation, making California the first state to regulate air purifiers.

Otana later expanded her project by testing the effects of other ozone-generating household devices, such as certain blow dryers and food purifiers. Her project has won many awards, including the President's Environmental Youth Award. But she says that the biggest reward is knowing her research will help people breathe easier.

―Jacqueline Adams

**ON DISPLAY:**
Otana has exhibited her project at several science fairs.

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**nuts & bolts**

What are the steps to the Scientific Method?

**SCIENTIFIC-METHOD CHECKLIST**

1. Base your idea for an experiment on an observation.
2. State your purpose. Usually the purpose of an experiment is stated in the form of a research question: What is the effect of your independent variable on your dependent variable?
3. Perform background research to find out what is already known about your topic.
4. State your hypothesis, a possible answer to a research question.
5. Design a detailed procedure, or list of steps (see p.12).
6. Carry out your experiment and collect data.
7. Record your results. In many cases you can present your results in charts, pictures, or graphs (see p.15).
8. Draw a conclusion from your results. Did your hypothesis prove true?

**SCIENTIFIC METHOD WORDS TO KNOW**

- **VARIABLES:** Characteristics in an experiment that change or could be changed.
- **INDEPENDENT VARIABLE:** Factor that you change on purpose; also called manipulated variable.
- **DEPENDENT VARIABLE:** Factor that you observe or measure in response to a change in the independent variable; also called responding variable.
- **HYPOTHESIS:** Possible explanation for a set of observations or an answer to a scientific question; must be testable.
- **CONSTANTS:** Characteristics in an experiment that are kept unchanged in all trials.
- **CONTROL:** Standards to which you will compare your results.
- **TRIALS:** Number of times an experiment is repeated for each level, or value, of the independent variable. The more trials, the more reliable your results.