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LESSON:

Investigating PAHs: Your Own Mini-Epi Study

Summary: Students are introduced to the risk of chromosomal damage due to prenatal exposure to polycyclic aromatic hydrocarbons (PAHs) by reading the article "Prenatal PAH Exposure Causes Genetic Changes in Newborns." They generate a hypothesis about risk and assess the potential risk for PAH exposure within three local counties. They develop and apply research and analytical skills to 1) evaluate the frequency of "high" $PM_{2.5}$/PAH exposure, 2) evaluate the relationships between public health risk, population, and potential PAH pollution exposure, and 3) reflect on their findings.

EHP Article: "Prenatal PAH Exposure Causes Genetic Changes in Newborns"
EHP Student Edition, July 2005, p. A237
http://ehp.niehs.nih.gov/docs/2005/113-4/niehsnews.html#syne

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

1. Identify in writing and discuss, the potential sources for PAHs in their community.
2. Identify the at-risk population by using population data, air quality data, and geographical information.
3. Support their findings with accurate and valid data.
4. Present their findings in a public format.
5. Reflect on further research opportunities and strategies.

Class Time: 5–6 hours in class; some outside research is possible

Grade Level: 10–12

Subjects Addressed: Environmental Health, Anatomy and Physiology, Geography, Epidemiology, Statistics

Prepping the Lesson (40 minutes)

INSTRUCTIONS:

1. Obtain a class set of *EHP Student Edition*, July 2005, or download the article "Prenatal PAH Exposure Causes Genetic Changes in Newborns" at http://ehp.niehs.nih.gov/docs/2005/113-4/niehsnews.html#syne .
2. Make copies of the Student Instructions and information sheet on the Air Quality Index (AQI).
3. Read the Background Information section and visit the websites in the Resources section to gather the introductory information to discuss the following concepts with the students: air quality (especially PAHs and $PM_{2.5}$), Air Quality Index (AQI), census population information and population density/distribution, risk, generating a testable hypothesis.
4. Review the Assessing the Lesson section and the Student Instructions.

MATERIALS (per student):

- 1 copy of *EHP Student Edition*, July 2005, or 1 copy of the article "Prenatal PAH Exposure Causes Genetic Changes in Newborns."
- 1 copy of Student Instructions and the Air Quality Index (AQI) information sheet.
- Computers with Internet access.
- Maps of three local counties (mapping group), either printed or online.

VOCABULARY:

Chromosome
Cytogenic
Epidemiology

Frequency
Hybridization
Incidence
In situ
In utero
Leukemia
Particulate matter (PM)
Placenta
Polycyclic aromatic hydrocarbons (PAHs)
Prevalence
Risk
Risk Assessment
Toxicology

BACKGROUND INFORMATION:

What are PAHs?

The article "Prenatal PAH Exposure Causes Genetic Changes in Newborns" provides an overview and preliminary results of an NIEHS-funded research project that studied the impact of prenatal exposure to polycyclic aromatic hydrocarbons (PAHs). Researchers demonstrated that such exposure causes chromosomal changes that are linked to leukemia and other childhood cancers.

According to the Agency for Toxic Substances and Disease Registry (ATSDR), PAHs are a group of over 100 different chemicals that are formed during the incomplete burning of coal, oil, gas, garbage, and other organic substances like tobacco and charbroiled meat.

Risk

As stated by the NIEHS, human health and human disease result from three interactive elements: environmental factors/exposures, individual susceptibility and time (age and duration). Exposure can influence the type of disease depending on the agent to which a person is exposed. For example, not all chemicals cause cancer and those chemicals that can cause cancer generally cause a specific type of cancer (e.g. skin or lung). Also, some chemicals are more toxic or potent than other chemicals (it takes a smaller dose of a more toxic chemical to generate an effect). Dose, or the amount of chemical that gets inside of the body, is related to exposure and time. The concentration of the chemical in the air, water, or other source will affect the dose, as will the length of time—the longer the exposure time, the higher the dose.

An exposure must occur to trigger a disease response. However, once an exposure occurs, that does not guarantee that a person will become sick. Individual susceptibility can depend on a number of factors including genetic make-up, age, and current health status. People who are already ill, are children or elderly, have a poor diet, or have certain genes are more susceptible to diseases from environmental triggers.

The interaction between exposure, time, and individual susceptibility in causing disease is complex. Environmental health scientists use research to try to identify the dose at which a chemical becomes harmful to humans, as well as the dose where there is "no observable effect" (NOEL). Then they extrapolate to try to identify a "safe" exposure level that, under normal living conditions, would result in a dose no more than the NOEL level. From there, scientists try to frame environmental exposures in terms of "risk." Risk is the combination of exposure, time, and individual susceptibility for each person's unique circumstance. If risks are known, then changes can be made to protect health.

When doing this research project with your students, be sure to share these concepts with them to help them place the information they are obtaining within context. For example, an exposure to a PAH *in utero* does not guarantee that a child will get leukemia, but the research done by scientists on PAHs provides additional useful information to help people protect their health. Prevention is the best protector of health. The more we understand about the environment's influence on our health the more empowered we are to protect it.

Air Quality

Across many communities in the United States., local and state agencies and the U.S. EPA monitor air quality. Air quality standards fall under two categories, primary and secondary standards. Primary standards have been established to protect public health, especially specified populations such as the elderly, the very young, and asthmatics. Secondary standards have been established to protect the general public welfare and address safety issues including decreased visibility, danger to animals, crop damage, structural damage, and aesthetics.

The most commonly monitored air quality values are levels of ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), lead (Pb), and particulate matter (PM). The EPA has identified these pollutants as "criteria air pollutants" because of their potential impact on human health and safety. Air quality levels are based on two factors: 1) air concentrations of criteria pollutants derived from actual measurements of ambient air and 2) emissions, which are engineering estimates.

Particulate matter (PM), which includes PAHs, can be generated from diverse sources such as vehicles, industry, dust from construction or agriculture, burning organic fuels such as coal and wood, and chemical reactions in the atmosphere. The EPA classifies particulate matter as either PM_{10} or $PM_{2.5}$. These numbers reflect the relative size of the particulates. $PM_{2.5}$ refers to particles that are 2.5 microns in diameter or less, which are small enough to penetrate the lungs. PM_{10} refers to particles up to 10 microns in diameter.

PAHs are not included as a specific criteria pollutant but instead fall under the $PM_{2.5}$ category. Therefore, students should consider that there is a probability of higher concentrations of PAHs in places and times when $PM_{2.5}$ concentrations are high.

Epidemiology

Epidemiology can be defined as the study of the occurrence and distribution of a disease or condition in a population and of the factors that determine or influence the distribution. As both a scientific body of knowledge and a scientific method, epidemiology has the objectives of discovering factors that contribute to disease occurrence and the development of preventative measures. There are two major types of epidemiological studies: one is based on the study of the general population, and the other is based on individual case studies.

In this lesson, students will be conducting a study on the general population and $PM_{2.5}$ levels of three local counties. When applied to environmental health, epidemiological studies can ascertain the relationship of various elements —in this case, PAHs to disease. In this study, students will generate and analyze data in order to develop potential local risk associations with PAHs. It is these associations and inferences that will form the basis of their epidemiological findings and either support or negate their class hypothesis. Keep in mind the potential exists that students may not be able to obtain enough data to say whether the hypothesis is supported. This is OK and is an important part of the scientific process. Students need to recognize the limitations of their data or when there are not enough data. Students also need to be shown or be able to communicate what additional information is needed to answer their research question/hypothesis.

One obvious limitation of this student research is the inability to separate individual factors (like genetics) that can affect disease, as well as individual PAH exposures (such as a person's frequency of eating charbroiled food or occupational exposures like working at a truck stop). This should be discussed with students to help them understand the complexity of epidemiological research.

RESOURCES:

Environmental Health Perspectives, Environews by Topic page. Choose: Chemical Exposures, Children's Health, Genetic Research, Headliners, Polycyclic Aromatic Hydrocarbons (PAHs), Reproductive Toxicology and Health , http://ehp.niehs.nih.gov/topic

Agency for Toxic Substances and Disease Registry (ATSDR), ToxFAQs for Polycyclic Aromatic Hydrocarbons, http://www.atsdr.cdc.gov/tfacts69.html

Air Info Now, "What is Particulate Matter?", http://www.airinfonow.org/html/ed_particulate.html

Cancer Epidemiology Biomarkers and Prevention, "Chromosomal Aberrations in Cord Blood Are Associated with Prenatal Exposure to Carcinogenic Polycyclic Aromatic Hydrocarbons," http://cebp.aacrjournals.org/cgi/content/full/14/2/506

Center for Disease Control and Prevention, "Epidemiology in the Classroom: An Introduction to Epidemiology," http://www.cdc.gov/excite/classroom/intro_epi.htm

Columbia University Mailman School of Public Health, "Effects of Transplacental Exposure to Environmental Pollutants on Birth Outcomes in a Multiethnic Population," http://www.ccceh.org/publications/perera_birthoutcomes.html

National Weather Service, http://www.nws.noaa.gov/

U.S. Census Bureau, Census Bureau Map Products, http://www.census.gov/geo/www/maps/CP_MapProducts.htm

U.S. Census Bureau, State and County Quick Facts, http://quickfacts.census.gov/qfd/index.html

U.S. Environmental Protection Agency, Air Data, http://www.epa.gov/air/data/geosel.html

U.S. Environmental Protection Agency, AirNow website, http://cfpub.epa.gov/airnow/index.cfm

U.S. Environmental Protection Agency, Envirofacts Data Warehouse, http://www.epa.gov/enviro/

U.S. Environmental Protection Agency, Guideline for Reporting of Daily Air Quality: Air Quality Index, http://www.epa.gov/ttn/oarpg/t1/memoranda/rg701.pdf

U.S. Environmental Protection Agency, "What are the Six Common Air Pollutants?", http://www.epa.gov/air/urbanair/6poll.html

Implementing the Lesson

INSTRUCTIONS:

1. Hand out copies of *EHP Student Edition*, July 2005, and refer students to the article "Prenatal PAH Exposure Causes Genetic Changes in Newborns," or hand out copies of the article.
2. Hand out the information sheet on the Air Quality Index (AQI).
3. Have students read the article and the AQI information.
4. Review the project with the students.
5. Help the class generate a hypothesis by introducing or having them research the following topics:
   - Air quality, especially PAHs and $PM_{2.5}$
   - Air Quality Index (AQI)
   - Census population information and population density/distribution
   - Risk and risk assessment
   - What is a testable hypothesis?
   - You can guide the students by saying something like: "based on EPA $PM_{2.5}$ data, generate a hypothesis about PAH exposure risk by county." From the data students will be collecting, they cannot make a statement about cancer incidence, ONLY the potential for PAH exposure based on $PM_{2.5}$ levels.
   - Example hypothesis: Of the three counties, residents of _____ county will have the highest risk for PAH exposure because _____.
6. Hand out and review the Student Instructions.
7. Guide students to form three teams (mapping, population, and air quality) appropriate to specific tasks/requirements to complete the project.
8. Assist as required/requested in identifying professional/expert contacts, sources, and resources.
9. Arrange for equipment required for students' presentation of findings.
10. After students give their first presentation (Step 7), guide the data analysis process. Decide if you want students to analyze the data individually, in teams, or together as a class, and review the questions under bullet three on Step 7. It should help the process if students first identify several conclusions that will be shared in the final summary presentation.
11. Organize the class to create the final summary presentation. Arrange venues for presenting such as other classes, the whole school, community meetings, PTA meetings, etc.
12. Have students write personal reflections on their efforts, data, lessons learned, etc. that they found to be valuable to them as individuals. Remind students that their reflections should include possible sources of error and/or shortcomings in their efforts and findings, as well as identify possible areas for future research.

NOTES & HELPFUL HINTS:

- The teams listed in the Student Instructions are examples and suggestions. There is no definitive method of organization that limits this project.
- Maps are available and printable from numerous online sources (the Resources section includes some links). If access is limited or unavailable, maps may be copied or hand-drawn. Aerial and space-based imagery may also be used provided proper credit is noted.
- A geographic information system (GIS) may be used as a map source and to depict site location(s), population centers, and other appropriate data points.
- If you want to incorporate statistics into the activity, you could have the students calculate the average and standard deviation of the annual and 98^{th} percentile $PM_{2.5}$ values.
- This research effort may be used by individual students and/or a two-student team as a research ("science fair") project at the local, regional, and state level with potential for competing at the international level (i.e., The Intel International Science and Engineering Fair).
- If students want to collect some childhood leukemia or cancer data they need to make sure the rates are on a "per number of people" basis to account for population density differences between urban and suburban populations. Also, students need to be made aware that there are MANY factors that contribute to cancer. In fact, it is unlikely that even if they have these data they will be able to use them to support or refute their hypothesis because locations of cancer cases are generally treated as private information and not publicly accessible.
- You may consider having two sections in the mapping team. One group would map the county boundaries, population centers, major geographical features, and major interstates/highways for the three counties (this is

already built into the Student Instructions). The second (optional) group would investigate and map specific PAH point sources in the communities being investigated. This group could use the EPA website http://www.epa.gov/enviro/ to look up companies with air permits. The challenge with looking up individual companies is the website/database is marginally user-friendly and requires "digging" to determine what air pollutant(s) the companies are releasing. These students would also need to understand sources of PAHs well enough to infer that PAHs would likely be a pollutant released by this company. For example, a restaurant that has a wood-fired oven, barbecue, or grill would qualify.

Aligning with Standards

SKILLS USED OR DEVELOPED:

Communication (note taking, oral, written—including summarization)
Comprehension (listening and reading)
Computation
Critical thinking and response
Experimentation (data analysis)
Graphing
Graph reading
Reading maps and legends
Research
Tables and figures (creating and reading)
Unit conversions

SPECIFIC CONTENT ADDRESSED:

Environmental health, air quality, epidemiology, mapping, census data

NATIONAL SCIENCE EDUCATION STANDARDS MET:

Content Standards

Science as Inquiry
- Ability to do inquiry
- Understanding iInquiry

Life Science
- Molecular basis of heredity
- Matter and organisms in living systems

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

History and Nature of Science
- Science as human endeavor
- Nature of scientific knowledge

Teaching Standards

Plan an inquiry-based science program
- Develop student understanding and nurture community of science learners
- Work within and across disciplines and grade levels

Guide and facilitate learning
- Support inquiries when interacting with students
- Model inquiry, curiosity, openness to new ideas, data, and skepticism

Create learning environments that provide time, space, and resources for learning science
- Make tools, materials, media, and resources available to students
- Use resources outside of the school

Develop communities of science learners that reflect the intellectual rigor of scientific inquiry, attitudes, and social values conducive to scientific learning
- Facilitate ongoing formal and informal discussion based on a shared understanding of rules of scientific discourse
- Model and emphasize the skills, attitudes, and values of scientific inquiry

Actively participate in the ongoing planning and development of school science program
- Participate in decisions concerning the allocation of time and other resources to the science program

Assessing the Lesson

Research assessment considerations:
- Class hypothesis—is it clear and testable?
- Team organization—level of organization, fair distribution of work
- Task assignments and timeline—how thoroughly were tasks completed, were timelines met?
- Accuracy of maps
- Legend and use of color code
- Inclusion of all required map components
- Current census data per county and population center
- Epidemiological data from valid sources (if applicable)
- Graphs organized and color coded
- Graphs labeled correctly, independent and dependent variables identified
- Data compared accurately and properly
- Analysis is concise, correct, and appropriately applied to the hypothesis
- Summary statement of support or negation of hypothesis, or explanation of why data neither support or negate the hypothesis
- References noted in Modern Language Association format
- Future research opportunities identified

Presentation assessment considerations:
- Similar to research assessment but to include the development and use of overheads, PowerPoint slides, or other supporting materials

Reflection assessment considerations:
- Writing is clear, concise, accurate, and grammatically correct. Explanations are complete and logical. Students should describe their contribution to the group, personal impact of the project, how s/he would expand or change the research, and possible sources of errors and/or shortcomings.

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STUDENT INSTRUCTIONS:

Investigating PAHs: Your Own Mini-Epi Study

Step 1: Read "Prenatal PAH Exposure Causes Genetic Changes in Newborns," *EHP Student Edition*, July 2005, A237, http://ehp.niehs.nih.gov/docs/2005/113-4/niehstml#syne.

Step 2: Read the information sheet on the Air Quality Index (AQI).

Step 3: Conduct research to answer the following questions (or take notes if your teacher presents this information):

a) What are polycyclic aromatic hydrocarbons (PAHs)?
b) What are sources of PAHs?
c) What is particulate matter (PM), specifically $PM_{2.5}$?
d) What is risk and risk assessment?
e) What is epidemiology?

Step 4: As a class, identify three local counties that will be included in your epidemiology research. Your own county must be included. It is recommended, but not required, that the other two counties be adjacent (next to) your county.

Step 5: Based on the preliminary information and definitions provided by your teacher, the class will generate a hypothesis as to which county has the highest potential risk for fetal/newborn exposure to PAHs based on air quality data for $PM_{2.5}$. Once the hypothesis is completed, print it out and put it somewhere prominent in the room so each of the teams can refer to it as you conduct your research.

Step 6: After developing and posting your class hypothesis, divide into teams (mapping, population, and air quality) and give each team specific assignments (see below).

Mapping Team: This group will obtain, copy ,or hand-draw maps of the three selected counties. These maps must include:

- the county boundaries
- major population centers (cities, towns, etc.)
- major geographical features (rivers, mountains, water supplies, etc.)
- major interstates or highways
- (if assigned by the teacher) businesses emitting PAHs available at (http://www.epa.gov/enviro/)

It is recommended that a color code be used to identify the different sources of PM and PAHs as well as geographical features. Students must develop a legend to describe their use of colors and the different boundaries.

Population Team: "Population Team: This group will obtain data about the population demographics in the three selected counties and should include information on "larger" cities within the counties. These data should include location, numbers of people, age groups, and projected growth rates and locations. Data can be presented graphically and/or on maps.

Use the following website to help you: U.S. Census Bureau, State and County Quick Facts, http://quickfacts.census.gov/qfd/index.html

Air Quality Team: This group will develop bar graphs depicting the $PM_{2.5}$ air quality information for the three

counties for three years. Compare the three counties and rank them in order of 1) the 98th percentile values for $PM_{2.5}$ level and 2) the average annual $PM_{2.5}$ values. In your graphs, use the Air Quality Index (AQI) color code to indicate if these values correspond with Good, Moderate, Unhealthy for Sensitive Groups, Unhealthy, Very Unhealthy, or Hazardous (refer to Table 1 below).

The $PM_{2.5}$ values in the table are given in the unit micrograms per cubic meter ($\mu g/m^3$). These values correspond with the Air Quality Index values and the appropriate EPA color code (Table 1). This will help you color code your bar graph. For example, if the 98th percentile $PM_{2.5}$ value is 36 $\mu g/m^3$, it will fall under the Moderate category (range of 15.5–40.4 $\mu g/m^3$), and the color code for your bar on your graph would be yellow.

$PM_{2.5}$ ($\mu g/m^3$)	**Air Quality Index Value**	**Color Code**	**Warning**
0–15.4	Good	Green	None
15.5–40.4	Moderate	Yellow	None
40.5–65.4	Unhealthy for Sensitive Groups	Orange	People with respiratory or heart disease, the elderly, and children should limit prolonged exertion.
65.5–150.4	Unhealthy	Red	People with respiratory or heart disease, the elderly, and children should avoid prolonged exertion; everyone else should limit prolonged exertion.
150.5–250.4	Very Unhealthy	Purple	People with respiratory or heart disease, the elderly, and children should avoid any outdoor activity; everyone else should avoid prolonged exertion.
Above 250.5	Hazardous	Maroon	Everyone should avoid any outdoor exertion; people with respiratory or heart disease, the elderly, and children should remain indoors.

Table 1: $PM_{2.5}$ Air Quality Index Descriptions

Use the following website to help you obtain the data: U.S. Environmental Protection Agency, Air Data, http://www.epa.gov/air/data/geosel.html

- Scroll down past the interactive map to the title "Select From List," select your state, and press the "Go" button.
- Under the headings "Monitoring," "Criteria Air Pollutants," "Reports," select "County Air Quality."
- Then select the year you want and push the "Generate Report" button. (Remember to collect data for three

years, so you will repeat this three times.)
- You should see a table that shows the summary of air quality data for all counties in your state for the year you selected.
- Graph the 98th percentile data and the annual mean data of $PM_{2.5}$ for your three counties for all three years. These numbers are in the units $\mu g/m^3$.

Step 7: First Presentation and Data Analysis

- Each group will present its work to the rest of the class. This will help you understand what the other groups researched.
- Review the class hypothesis and generate a plan to incorporate all of the data and information generated by the three groups (mapping, population, and air quality).
- Using the data generated by the teams, evaluate the potential impact of the PAHs on local populations. Consider the following:
  - $PM_{2.5}$/PAH air quality trends (e.g., in a specific county, do they consistently fall in good, moderate, or unhealthy categories?)
  - Major $PM_{2.5}$ and PAH sources on the maps (e.g., interstates or incinerators). Does one county appear to have more $PM_{2.5}$/PAH sources? Does that correlate with the $PM_{2.5}$ data?
  - Is a certain county more at risk because of higher populations being exposed or because there are more infants/children in a certain area? Or consider the proximity of a population near $PM_{2.5}$ /PAH sources.
  - What are the limitations of the air quality information collected from the EPA Air Data website?
- This analysis should lead to a determination as to the validity or invalidity of the class hypothesis. To complete the analysis, the class must identify the reasons why the analysis either supports or negates the hypothesis, or that there are not enough data to support or negate the hypothesis and what additional data would be needed.

Step 8: Final Summary Presentation

In this step, the class will have the opportunity to deliver their findings to an audience that may include other classes, teachers, school administrators and members of the community. The presentation should include:

- An introduction describing the project, the goals, and the class hypothesis. This should include overheads or PowerPoint slides for the introduction, goals, and class hypothesis.
- Briefings on the efforts and findings of each of the teams. Each team should develop overheads or a series of PowerPoint slides to support its briefing. Each member of the team should participate in the presentation.
- An overview of your findings and how you analyzed your data. It is important that you show how you applied your analysis to your hypothesis. Your overheads or PowerPoint slides should be bulleted and summarized. If possible, include any graphs of the data.
- An evaluation of the analysis and how it either supports or negates your hypothesis or whether you even have enough data to determine this. Also, address the reasons for your answer and what additional data your group may need to collect.
- A summary slide of your findings and the value to your class and your community.

Step 9: Reflection

- This is your opportunity to describe, in your words, what part(s) of this project mean something to you as an individual and as a member of the community. For example, has your opinion about air pollution changed, or do you now have a personal opinion about air pollution in your community? Is public health important to you, your family and/or your community?
- How would you continue, expand, or change research if you were to be assigned to continue researching this topic? What other areas or subjects could be researched, using this topic as your starting point?
- What are the possible sources of errors and/or shortcomings in this research effort? Explain why it is important to recognize this.
- Evaluate your contribution to the group.

Information Sheet
Air Quality Index (AQI)
(from the U.S. EPA website, http://cfpub.epa.gov/airnow/index.cfm?action=static.aqi)

The AQI is an index for reporting daily air quality. It tells you how clean or polluted your air is, and what associated health effects might be a concern for you. The AQI focuses on health effects you may experience within a few hours or days after breathing polluted air. The EPA calculates the AQI for five major air pollutants regulated by the Clean Air Act: ground-level ozone, particle pollution (also known as particulate matter), carbon monoxide, sulfur dioxide, and nitrogen dioxide. For each of these pollutants, the EPA has established national air quality standards to protect public health.

How Does the AQI Work?
Think of the AQI as a yardstick that runs from 0 to 500. The higher the AQI value, the greater the level of air pollution and the greater the health concern. For example, an AQI value of 50 represents good air quality with little potential to affect public health, while an AQI value over 300 represents hazardous air quality.

An AQI value of 100 generally corresponds to the national air quality standard for the pollutant, which is the level the EPA has set to protect public health. AQI values below 100 are generally thought of as satisfactory. When AQI values are above 100, air quality is considered to be unhealthy—at first for certain sensitive groups of people, then for everyone as AQI values get higher.

Understanding the AQI
The purpose of the AQI is to help you understand what local air quality means to your health. To make it easier to understand, the AQI is divided into six categories:

Air Quality Index (AQI) Values	Levels of Health Concern	Colors
0–50	Good	Green
51–100	Moderate	Yellow
101–150	Unhealthy for Sensitive Groups	Orange
151–200	Unhealthy	Red
201–300	Very Unhealthy	Purple
301–500	Hazardous	Maroon

Each category corresponds to a different level of health concern. The six levels of health concern and what they mean are:

- **Good:** The AQI value for your community is between 0 and 50. Air quality is considered satisfactory, and air pollution poses little or no risk.
- **Moderate:** The AQI for your community is between 51 and 100. Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people. For example—people who are unusually sensitive to ozone may experience respiratory symptoms.
- **Unhealthy for Sensitive Groups:** When AQI values are between 101 and 150, members of sensitive groups may experience health effects. This means they are likely to be affected at lower levels than the general public. For example, people with lung disease are at greater risk from exposure to ozone, while people with either lung disease or heart disease are at greater risk from exposure to particle pollution. The general public is not likely to be affected when the AQI is in this range.
- **Unhealthy:** Everyone may begin to experience health effects when AQI values are between 151 and 200. Members of sensitive groups may experience more serious health effects.
- **Very Unhealthy:** AQI values between 201 and 300 trigger a health alert, meaning everyone may experience more serious health effects.
- **Hazardous:** AQI values over 300 trigger health warnings of emergency conditions. The entire population is more likely to be affected.