Methods to the madness - Activities for the teaching of research methods in AP Research using environmental science

John P. Danihel

Northeast High School, Philadelphia PA

Abstract

This unit plan was developed for the Advanced Placement (AP) Research teacher to utilize during the teaching of a research methods unit. It contains background information about the current science and technology of environmental air quality followed by teaching activities that can be deployed in the classroom. The intent is to anchor the teaching of research methods within the single theme of the state of the environment and its effects on children's health. Air quality was chosen specifically due to the poor air quality typically found in urban areas. Four activities are included that allow students to practice various research methods. These activities make use of student generated data as well as publicly available data sets.

Keywords – research methods, air quality, atmospheric science, publicly available environmental data sets

Unit Content

Rationale

Environmental science is a subject that has the potential for students to apply what they learned to their everyday surroundings – their homes, schools and workplaces. If we as teachers instill a knowledge of the environment and how it can be impacted by humans, then students will be better able to protect themselves and their families from possible impacts to their health. For example, many schools in Philadelphia have peeling paint which leaves pile of paint chips that accumulate on the floor. When the paint peels off all the way back to the original wall, there is a high likelihood that inner layers contain lead-based paint. Where do these paint chips go? Is the lead in the chips transported back to students' homes? If we educate students about the dangers of lead in their environment, then they can take steps to protect their health.

Childhood asthma is a major contributor to school absences (Hsu, 2016). Asthma can be triggered by poor air quality. We can and should educate our students about how humans impact air quality so actions can be taken to improve it. What is the state of the air quality in their schools and homes? What is the air quality in the U.S.? How has it changed? How can it be improved? The activities in this unit plan begin with a local focus in the school and extend to a nationwide focus. It is the intention that educating students about their immediate environment and giving them the tools to investigate it via a research method can make them more informed members of society.

The AP Capstone program

The AP Capstone program was launched by the College Board in 2014 and consists of two yearlong classes - AP Seminar followed by AP Research. The College Board offers an AP Capstone Certificate to students who pass these two classes with college eligible scores. An AP Capstone Diploma is awarded to students who pass both capstone classes in addition to receiving a college eligible score on four other AP exams. The AP Capstone program was developed in response to the need for high school students to design and conduct authentic, big "R" research rather than the little "r" research of summarizing previous studies. Instead of being a subject-specific class, AP Research is an interdisciplinary class in which students develop research questions, read peer-reviewed academic papers, employ research methods, collect and analyze data. The class culminates with the students writing a 5000-word, peer-reviewed academic paper and defending their theses in a presentation, similar to a master's thesis or PhD dissertation. The research methods unit gives the students a number of tools with which to conduct their research. The idea is to teach the research methods unit early in the year so that students develop their research questions from a method rather than choosing a method based on a research question. Due to the integral nature of this unit, it has become the focus of this unit plan.

Value and timeliness

Although air quality in the U.S. has improved significantly since the passage of the Clean Air Act of 1970, there are continuing factors that impact air quality. High school students should be educated about threats to environmental quality so that they can protect themselves and their families. For example, Philadelphia was home to a Sunoco oil refinery that exploded in 2019 due to a pipe elbow that had corroded from the transmission of hydrofluoric acid. The explosion released 676,000 pounds of hydrocarbons into the environment with 608,000 pounds combusted into the atmosphere (U.S. Chemical Safety and Hazard Investigation Board, 2022). Nearby residents were alarmed at the clouds of "black smoke" that were released from the refinery. Surprisingly, the plume of airborne contaminants was not detected by the air monitoring system because there were no detection devices placed downwind of the oil refinery (Union of Concerned Scientists, 2023). This led city officials to claim that there was no cause for concern.

Another recent impact to air quality in the Philadelphia area came from wildfires originating in Canada. In June 2023, the air quality index (AQI) in Philadelphia reached "hazardous" levels which were the highest levels ever reported since the installation of the air monitoring network in 1999 (Philadelphia Inquirer). The wildfire smoke created a visible haze over the city making breathing difficult and prompting the city to suspend trash collection and move outdoor activities indoors.

According to researchers at the Philadelphia Regional Center for Children's Environmental Health, 21% of Philadelphia's children have asthma (Bryant-Stephens, 2012). This is more than triple the national average of 6.5% reported by the Centers for Disease Control in 2021 (CDC, 2023). Furthermore, rates of hospitalization are more than 4 times higher for Black and Hispanic children compared to their white and Asian counterparts (Health of the City, 2021). This often translates to missed days of school. The CDC reports that despite recent nationwide improvements in asthma outcomes, socioeconomic, demographic and geographic disparities persist (CDC, 2023).

These examples serve to place value on the teaching of environmental issues within the secondary curriculum due to their relevancy to the residents of Philadelphia. In addition, PA state education standard - 10.2.12.E – "Analyze the interrelationship between environmental factors and community health," moves beyond requiring students to merely describe a process but to use higher order thinking skills like analyzing data and evaluating evidence. Hence, these topics can be incorporated into an AP Research methods unit.

Scientific Background

Atmospheric composition

The Earth's current atmosphere is a mixture of gasses. If water vapor is excluded then air consists of roughly 78% nitrogen, 20% oxygen, 1% argon and 1% "other" gasses that include carbon dioxide, noble gasses, nitrogen oxides and ozone (see table 1). The amount of water vapor is variable in the atmosphere and is biome dependent with deserts nearing 0% water vapor and tropical regions approaching 4% water vapor (NOAA atmosphere, 2023). Environmental scientists are most interested in this 1% "other" because it includes the human-produced greenhouse gasses of CO_2, Methane and other pollutants such as ozone and nitrous oxides.

Table 1 - composition of the atmosphere (from NOAA/atmosphere)

Chemical makeup of the atmosphere INCLUDING water vapor

WATER VAPOR	NITROGEN	OXYGEN	ARGON
0%	78.084%	20.947%	0.934%
1%	77.30%	20.70%	0.92%
2%	76.52%	20.53%	0.91%
3%	75.74%	20.32%	0.90%
4%	74.96%	20.11%	0.89%

Major air pollutants that impact human health

The Environmental Protection Agency (EPA) has identified 6 common air pollutants that negatively impact human health. These are lead, ground-level ozone, particulate matter, nitrogen dioxide, sulfur dioxide and carbon monoxide. The sources of these pollutants come mainly from emissions from the industrial and transportation sectors. Children are especially susceptible to the health effects of these pollutants because their lungs are still developing and they may breathe in a higher volume of air while playing outside. (America's children and the environment, 2019). Table 2 summarizes these pollutants and their sources.

Table 2 - Common air pollutants (adapted from America's children and the environment, 2019)

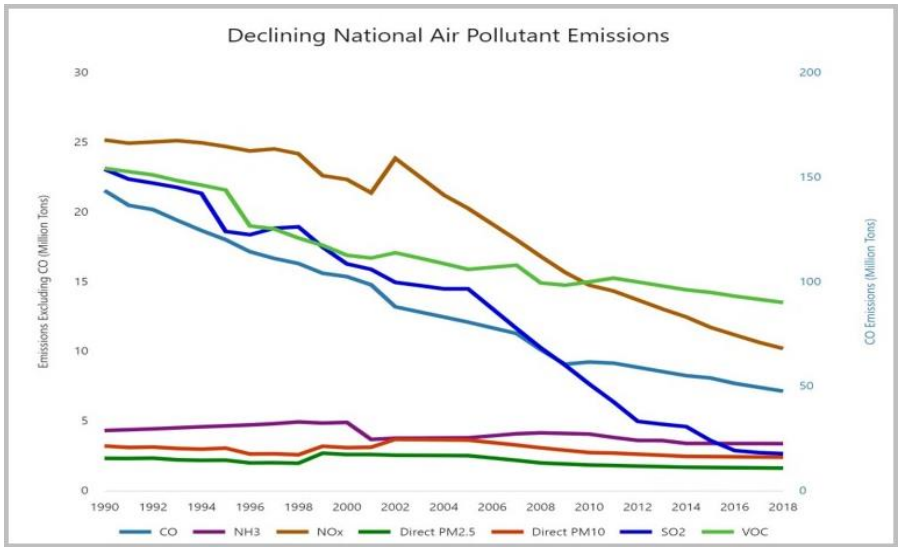
Pollutant	**Anthropogenic Source(s)**	**Health effect(s)**

lead	lead smelters, aviation, marine and farm equipment fuel	adversely affects the central nervous system development in young children leading to lower IQ and behavior problems
ground-level ozone	produced by a photochemical reaction involving sunlight and tailpipe emissions	irritates lung tissue, aggravates respiratory illnesses like asthma and bronchitis, has been linked to causing asthma (Kajekar, R. 2007)
particulate matter	occurs as tiny particles of dust from industrial processes and soot from fossil fuel combustion	decreased lung function, exasperation of allergic reactions, aggravates asthma
nitrogen dioxide	fossil fuel combustion	aggravates asthma
sulfur dioxide	fossil fuel combustion	aggravates asthma
carbon monoxide	incomplete fossil fuel combustion	inhibits red blood cell's ability to carry oxygen

The Clean Air Act of 1970

The EPA and the Clean Air Act were both created in 1970 in response to the presence of thick smog in U.S. cities that was injurious to public health. The EPA was given the power to monitor and enforce air quality standards. Since the inception of the Clean Air Act, air quality has improved in the U.S. See figure 1 from the EPA below.

Figure 1 – Declining national air pollutant emissions from "Our nation's air trends", 2021



Distribution of pollutants that impact human health

According to the 2023 "State of the Air" report from the American Lung Association, approximately one third of U.S. citizens live in counties that received failing grades for ozone and particulate matter pollution. On the positive side, fewer counties received a failing grade than in previous reports. On the negative side, people of color are almost four times more likely to live in a failing county than white people (State of the air, 2023).

Asthma

Asthma is a chronic respiratory disease in which breathing is difficult due to the inflammation of lung tissue (American Lung Association). There is no cure for asthma but it can be managed so that asthmatics can lead a normal life. Asthma can be triggered by the pollutants mentioned above (see table 2) in addition to cigarette smoke, pet dander, dust mites, mold, physical activity, even perfumes and cleaning solutions (Burbank, 2018). Individuals who grow up in urban areas have a higher chance of developing asthma because of proximity to sources of air pollution.

The CDC reports from an analysis of 2006-2018 health data that despite a decrease in asthma attacks and mortality among U.S. children, the disease disproportionally affects Black and Hispanic children of low income. The report suggests that asthma is exacerbated by lack of access to quality health care (Pate, et al. 2021). Figures 2 and 3 below compare the asthma hospitalization rate among children in Philadelphia and household income. A side-by-side comparison of these maps show that the highest hospitalization rates coincide with the lowest household income.

Figure 2 – Asthma hospitalization rate by zip code from the "Health of the City" report

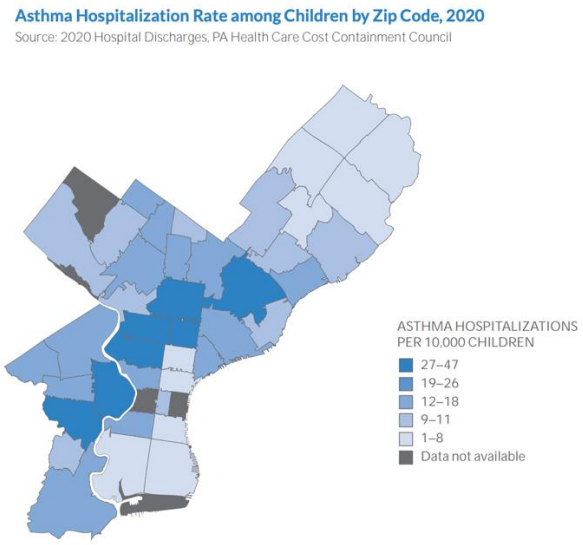
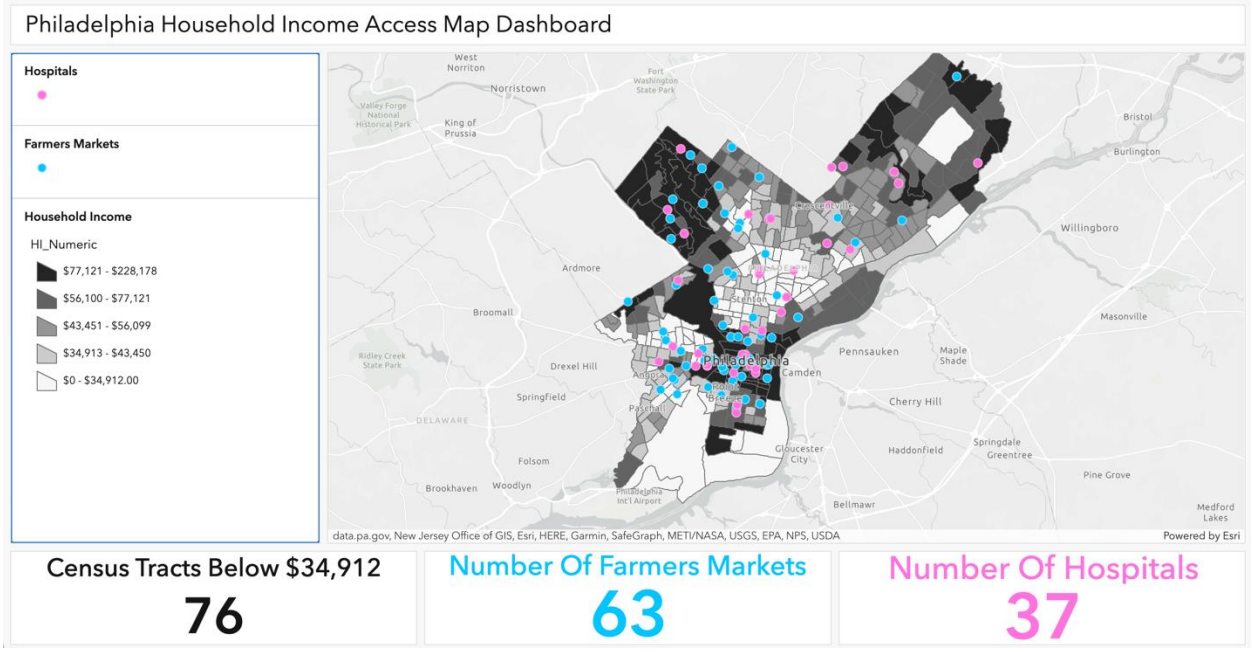


Figure 3 – Income distribution in Philadelphia



Research methods background

This unit plan was developed for the AP Research teacher to implement a research methods unit with an underpinning of environmental science focused on air quality and its impact on humans. In general, research methods are used in studies to collect data. Collecting original data is a core tenant of the AP Research class without which they cannot earn a college eligible score. While any valid research method can be used by the student, a few of the more student-friendly and accessible methods are used in this unit plan.

A research project begins with an approach. The two approaches exemplified here are experimental and non-experimental (or descriptive) approaches. Experimental approaches involve the manipulation of an independent variable to measure the change in a dependent variable. The researcher maintains control over the manipulation and attempts to keep other factors from affecting the independent variable so that valid conclusions can be drawn about the dependent variable. Experimental approaches aim to describe cause and effect. Non-experimental approaches often analyze the relationship between events that have already happened. Here, the researcher has no control over the independent variable. Because the researcher cannot control the independent variable, a correlation can be drawn between the variables but causation cannot.

Research methods fall into two broad categories – quantitative and qualitative. Quantitative research collects numerical data, or quantities. Qualitative research typically collects non-numerical data like words or images. A research question may also be answered by using a mixed methods approach that utilizes both quantitative and qualitative data. This unit plan focuses mainly on the research methods with minimal attention paid to the analysis of data since that is the topic of a whole separate unit. It is suggested that the AP Research teacher utilize some of the data collected in this unit for future lessons on data analysis and reporting.

Survey research

Survey research is used to measure people's attitudes, opinions and beliefs, An example is the Gallup poll that is used to ask the opinions of voters' political views. Both experimental and non-experimental (descriptive) research make use of surveys to collect data. Survey research includes questionnaires, interviews or a mix of the two. Surveys are the most popular type of research method used by the AP Research student due to their ease of creation, distribution and analysis. Google forms and Survey Monkey are two examples of questionnaire software that allow students to write different question types, send it out to survey participants, and see data visualizations. Questionnaires may contain both closed-ended (quantitative) and open-ended (qualitative) question types. A survey needs to be written so that it can be completed without the researcher being present (Christensen). Finally, surveys require informed consent of the participants and the AP Research teacher may use this opportunity to have the students practice writing informed consent forms.

Christensen, et al summarizes these principles of questionnaire construction in "Research methods, design and analysis:"

Principles of Questionnaire Construction

1. Write items to match the research objectives.
2. Write items that are appropriate for the respondents to be surveyed.
3. Write short, simple questions.
4. Avoid loaded or leading questions.
5. Avoid double-barreled questions.
6. Avoid double negatives.
7. Determine whether closed-ended and/or open-ended questions are needed.
8. Construct mutually exclusive and exhaustive response categories for closed-ended questions.
9. Consider the different types of closed-ended response categories.
10. Use multiple items to measure complex or abstract constructs.
11. Make sure the questionnaire is easy to use from the beginning to the end.
12. Pilot test the questionnaire until it is perfected.

Interviews are conducted in one-on-one and/or focus group format. The researcher writes a series of questions for an interview protocol and writes down or makes an audio recording of the responses. The interview may be structured or semi-structured, depending on the level of formality that the researcher wishes to create. During interviews, the researcher has more control of the data collection and can make use of follow up responses to elaborate on some topic (Christensen).

The qualitative data that comes from open-ended questions and interviews allow for a richer description from the research participants than answering an opinion question on a scale of 1-5 as in a questionnaire. Two more research methods – thematic analysis and content analysis – can then be employed to categorize and connect the data. During thematic analysis, the data is first coded for theme type and frequency. After the initial codes are generated, the researcher recodes the data to search for explanations of the themes (Braun and Clarke, 2006). Content analysis takes this process one step further and allows for hypothesis testing or theory generation.

The use of survey research allows students to be introduced to the concept of limitations in research a few of which are mentioned here. If students are distributing their surveys electronically, then they will notice the response rate will not be 100%. This will affect their sample size. If survey questions ask participants to remember an event then those responses will be subject to recall bias which may or may not reflect that event accurately. Social desirability bias seeps into to survey research when the participant responds with an answer that bolsters their status rather than admitting fault. Lastly, researchers need to be aware of researcher bias where the researcher is only asking questions to support some hypothesis rather than going about research in the most objective way possible.

Pretest posttest design

The pretest posttest design can be used to extend survey research from a non-experimental (descriptive) to an experimental design. The process involves measuring the extent of a variable with a pretest, interjecting a treatment of some kind, followed by measuring the effect of the treatment with a post-test (Bell, 2022). If a control group is used, then this is an experimental design. If no control group is used, then this becomes a quasi-experimental design. Limitations to this design include threats to internal validity which are weakness to how the research method is implemented. Threats to internal validity include testing saturation bias and attrition (Matthay and Glymour, 2020). When administering the post-test, participants may gloss over some of their responses the second time and not answer accurately. Attrition bias occurs when participants drop out of a study. These "practice runs" with using research methods prepare the AP Research student to look out for and overcome obstacles when they arise in their own research project.

Correlation research

Correlation research seeks to identify an association between two dependent variables. Association is not to be confused with causation. Cause and effect relationships can only be determined through experimental designs that utilize random selection and a control group (Sheskin, 2022). Correlation research lacks the use of a control group. With correlation research, two data sets are plotted against one another in regression analysis that yields an equation. This equation is descriptive and is only used to predict the value of one variable from the other rather than claiming causation. Regression analysis allows the researcher to identify a direct or indirect relationship between the two variables. In direct relationship, an increase in one variable leads to an increase in the other. In an indirect relationship, an increase in one variable leads to a decrease in the other. This relationship is represented by the correlation coefficient, r, which ranges from +1 to -1. The closer the r-value is to ±1 signifies the strength of the correlation. Weaker correlations have an r-value closer to zero.

Causal comparative research

Causal comparative research seeks to find a relationship between an independent and dependent variable after an event has already occurred (Brewer and Kuhn, 2022). It is also called "ex post facto" research meaning "after the fact" because the researcher cannot manipulate the independent variable. It is similar to correlational research in that it can be used to identify relationships where it may be unethical to conduct experiments such as the impacts of air quality on children's health. Both causal comparative and correlation research lack random assignment which limits their generalizability to a larger population. Causal comparative research, however, makes use of a control group which allows the researcher to test the possible effects of a treatment on an independent variable. While causal comparative designs are not true experimental research, they do allow the researcher to isolate the effects on an independent variable with more certainty

Teaching Strategies

Teaching strategies vary in this unit but utilize both teacher-centered and student-centered instruction. There are advantages and disadvantages to each. Many teachers use a mix of methods to reach the many different learning styles in the average classroom. Ultimately, it is the teacher's responsibility to create an environment that is conducive to learning and has latitude as to which strategy works best for them. This section contains the teaching strategies used in this unit with a short rationale for each.

Whole class instruction

Whole class instruction is the traditional mode of instruction where the teacher stands in the front of the room and delivers instruction using a lecture style with probing questions. It is the fastest way to teach the most content and can be described as teacher-centered instruction. It is used here to deliver environmental science content because AP Research is not a content driven class but a process driven one. Some students, however, have difficulty learning through this method because it is viewed as a passive way of learning rather than an active one. The activities presented here begin with a whole class instruction of 10-20 minutes, followed by classwork that the students can engage in "learn by doing."

Small group collaboration

Small group collaboration is a student-centered teaching method that allows students to work together on a task. Since the peer review process is an integral component of graduate and professional research, peer review groups are created in the AP Research classroom to emulate that process. AP Research teachers are not allowed to revise or edit student work so the onus is placed on the students to work with their peers. For example, students review each other's surveys and informed consent forms for clarity before they are put into operational data collection mode. Students may be put into peer review groups for many of the tasks required in AP Research from revising research questions to editing their final manuscripts before submission to the College Board.

Assigned readings

Homework can help introduce new concepts, allow students to practice something that they have learned, or it can be busy work. Since the latter wastes student's time and creates a disaffection towards homework, readings are assigned thoughtfully and with purpose. Instead of assigning students to read, for example, the entire chapter 4 in the research methods textbook, readings are shortened to smaller page counts. For example, students are given a 3-page reading assignment about pre and posttest designs and then asked to answer a question about exactly when this method can be used. This allows the teacher to assess whether or not the student did the reading assignment and focuses the students' attention on the important concepts, rather than just reading to read. Students have provided feedback that this "chunking" of reading sections is preferable to reading an entire chapter.

Independent work

The research methods unit is a trial run of how to conduct different types of research. While small group collaboration is necessary for the peer review process, students need to learn how to conduct these research methods on their own so that they can apply what they have learned to their own research question. The following activities require students to do some steps independently, like calculating the correlation coefficient, r. After the independent work is complete, the peer review process can be employed.

Use of the computer as a tool

Many of the secondary data sets that are used for these activities are found on government websites. Students get practice downloading data and putting it into software that allows for analysis. Google docs, sheets, slides and forms are used in these lessons due to their user-friendliness and availability.

Classroom Activities

Activity 1: Descriptive/evaluative research using surveys - an intro to survey writing (2-3 days)
Objectives: Students will be able to write an informed consent form for a survey. Students will be able to write a survey that describes/evaluates opinions about the perceived indoor air quality of their school.

Motivate: Provide an example of an indoor air quality survey (see Appendix 1). Include an example of informed consent (see Appendix 2).

Instruct:

Day 1 - Teach a lesson about the effects of poor indoor air quality on students with asthma. The lesson should include a definition of particulate matter, its sources and occurrences in an indoor environment. Additionally, the lesson should include the effects of indoor air pollution on asthmatics.

Day 2 - Teach a lesson about the principles of questionnaire construction using the sample provided. Students should see examples of scaled responses (Likert scales), closed ended, open ended, checkboxes and ranking scale type questions. Show students an example of informed consent and parent approval.

Produce: Students produce a survey in Google forms with an informed consent and parental permission. The survey is geared to gather perceptions of indoor air quality in the school and possibly gather quantitative data from asthmatics about frequency of air irritants. Students pilot/field test their surveys using small group collaboration.

Assess: Students peer review each other's work for strengths and weaknesses of question wording and quality of data obtained per a grading rubric (See appendix 3). Student assessment is combined with teacher assessment.

Extension: Activity could be adapted to perform action research where students would identify a problem through survey research, attempt to fix the problem and then re-evaluate to assess if the problem has been fixed.

Activity 2 Experimental research using a pretest posttest design (2-3 days)

Objective: Students will apply the pretest posttest design to assess which is the most effective method in educating their peers about air quality.

Motivate: Run the experiment on the students. Since this survey is for demonstration purposes, they do not need to acquire parental consent. Give students a pretest about environmental awareness (See appendix 4). Then, have them read a brochure about one of the environmental issues for example, EPAs particulate matter brochure (See appendix 5). Finally, issue the posttest. By this time, most students have figure out that they are part of an experiment that is the lesson.

Instruct:

Day 1 – Run the experiment on students.

Day 2 – Teach a lesson about particulate matter and outdoor air quality. The lesson should include sources and transport of particulates in the outdoor environment. Then, pose a hypothesis for students that ties back to AP Research. Ask - what is the most effective way of educating the public about an environmental issue like air quality? Students can brainstorm in small groups and can share out their ideas in a class discussion. Answers should include brochures, public service announcements, social media, YouTube videos, etc.

Day 3 - Teach a lesson about experimental research using the pretest posttest control group design. Assign students into groups to write a pretest about the average person's knowledge of the occurrences and effects of outdoor particulate matter. Each group will then test which form of media is the most effective in raising awareness about outdoor air quality. Students can find videos, social media postings or brochures and test the educational impact on their peers in other classes. There needs to be a control group that does not receive the treatment. The posttest is then administered.

Produce: Students are tasked with writing and administering a pretest and posttest (with informed consent) in Google forms. Students need to research educational media about particulate matter as part of the treatment.

Assess: Students will assess themselves according to a grading rubric (see appendix 3). Student assessment is combined with teacher assessment.

Extension: Students can brainstorm about other uses for this experimental design as it might apply to their AP Research project. This assignment may be altered so that only a post-test design is used.

Activity 3: Correlational research - Pearson's correlation coefficient with current asthma prevalence vs tons of air pollution per year in the U.S. (2-3 days)

Objective: Students will be able to determine the association between two dependent variables to determine the Pearson correlation coefficient from real world data.

Motivate: Ask students – is there an association between the amount of air pollution in the U.S. and prevalence of childhood asthma?

Instruct:

Day 1 – Teach a lesson about the prevalence of childhood asthma in the U.S. using whole class instruction. The lesson should include the demographics of the children with the highest asthma prevalence. Introduce students to National Health Interview Survey Data from the Centers for Disease control website (see sample in appendix 6). This data set shows population estimates and asthma prevalence back to 2001. Instruct students how to make a Google sheet that lists the population estimate (in thousands) by year.

Day 2 - Teach a lesson about correlational research. Emphasize that correlation does not equal causation. Direct students to the EPAs "Our Nation's Air" website that shows the millions of tons of air pollutants per year. Students can download a spreadsheet of the emissions totals per year (see appendix 7). Students input the data for PM 2.5 by year into their spreadsheet of asthma prevalence by year. Instruct students to make a scatterplot of the data and use the available functions in Google sheets to write the equation of the function and calculate the correlation coefficient, r.

Produce: Students will correlate millions of tons of PM 2.5 emissions per year with childhood asthma prevalence to assess strength or weakness of the association.

Assess: Graphs need to have titles, labeled axes, correct units, and should communicate the correlation between the variables

Extension: This activity could be subdivided into ethnicity to see if asthma prevalence is increasing or decreasing among whites, blacks, Hispanics, etc.

Activity 4: Causal Comparative Design of asthma hospitalizations among children and archive data of Philadelphia air quality from the EPAs air monitoring network.

Objective: Students will tabulate archive PM 2.5 data over a 5-10 year time span for selected air monitoring stations in Philadelphia and compare that data with zip codes that have a high number of hospitalizations versus a low number of hospitalizations.

Motivate: Introduce students to the city of Philadelphia's "Health of the City" report.

Instruct:

Day 1 – Teach a lesson about causal comparative design using whole class instruction. Differentiate causal comparative with correlational design by emphasizing that a control group is needed for causal. Reference the "Health of the City" report and show students the "Asthma hospitalization rate among children by zip code" graphic (Figure 2). Then, direct students to the "Air now – interactive map of air quality" so that they can see the location of air monitors in Philadelphia (see appendix 8). Pose a hypothesis – is there a causal comparative relationship among poor air quality and childhood asthma hospitalizations? Is there poor air quality in areas of the city with fewer asthma hospitalizations?

Day 2 – Direct students to the EPAs "outdoor air quality data" website. Students should use the "Asthma hospitalization rate" graphic to determine the zip codes with the highest rates. Then, students can locate the air monitor within that zip code and run a multi-year tile plot to create a 5-10 year average PM 2.5 pollutant level (appendix 9). The independent variable is the amount of PM 2.5 pollution and the dependent variable is the hospitalization by zip code. The control group can be a zip code with fewer hospitalizations. Students can choose an air monitor within one of these zip codes and compare the level of PM 2.5 pollution between monitoring stations.

Produce: Students will generate a table of data that averages PM 2.5 over a desired time span for selected monitoring stations. They will need to compare the level of pollution with hospitalizations to assess if a causal comparative relationship exists.

Assess: Students should provide written description of the procedure that they used in the causal comparative method with tables and figures. This is practice for them before they write the research methods of their paper.

Extension: Students can investigate other sources of publicly available data that they can use in their research projects.

Resources

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Appendix

Appendix 1 – from "Online Questionnaire as a Tool to Assess Symptoms and Perceived Indoor Air Quality in a School Environment."

S1. Online questionnaire of Indoor Air Police–project.

Indoor Air Quality Police – real-time questionnaire about perceived discomfort and symptoms

1. Hello! Welcome to the Indoor air police station! Next questions concern how you perceive indoor air quality and did you have any symptoms during last hour. First time we also ask some background questions about your health status and living. Question with * are mandatory. Please, select the option/options that describes best your situation. Remember to press the button "submit" at the end of the questionnaire. Thank you! *

- I have answer before
- Start here, if this is the first time

Next -->

2. Age *

2 characters remaining

3. Gender *

- Man
- Woman

4. How is your state of health? *

- Bad
- Rather bad
- Rather goor
- Good
- Excellent

5. Last two weeks, have you had any respiratory illnesess? *

- No respiratory illnessess
- flu / the common cold
- tonsillitis
- inflammation of the ear (otitis)
- sinusitis
- bronchitis
- pneumonia

6. Have you any doctor diagnosed allergic diseases? *

- [ ] No
- [ ] Asthma
- [ ] Hay fever / allergic rhinitis
- [ ] Atopic eczema
- [ ] Allergic ophthalmia

7. Is there moisture damge in your home? *

- ( ) No
- ( ) Yes, latest 12 months
- ( ) Yes, earlier
- ( ) En tiedä

8. Do you have pets? *

- [ ] No
- [ ] Dod/dogs
- [ ] Cat/cats
- [ ] other pets

9. What kind of house do you live? *

- ( ) Detached house
- ( ) Terrace house / semi-detached house
- ( ) Apartment house

10. How many occupants is living with you in the same house? *

( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6 ( ) More

11. Do you smoke regularly? *

- ( ) No
- ( ) Yes

<-- Previous | Next -->

12. Did the poor indoor air quality bother you during last hour? *

NO YES

13. What bothered?

	Little	Much
Dryness of the air		
Humidity of the air		
Too cold		
Too warm		
Draughtiness		
Stuffy air		
Too dusty / too dirty		
Odour of the mold		
Fragrance / perfume		

14. Something else?

<-- Previous Next -->

15. Did you get any respiratory or other symptoms during last hour? *

NO YES

16. What symptoms?

	Little	Much
Stuffy nose / cold		
Dry / sore throat		
Phlegm		
Dry cough		
Hoarseness		
Shortness of breath		
Wheezing cough		
Eye symptoms		
Tiredness		
Concentration difficulties		
Pain in joints		
Headache		
Skin symptoms (itch/erythema)		
Muscle pain		

17. Do the symptoms decrease when your are not at school?

Yes

No

<-- Previous Submit

Appendix 2 – Sample informed consent

Note to Investigators:

When creating informed consent letters, investigators are encouraged to keep language and vocabulary as basic and straightforward as possible. Investigators are also encouraged to use this template when creating informed consent letters. Use of alternative wording or format is permitted, but doing so may slow down the review process. All sections of the consent form, except the "Consent" section, should be written in second person ("You are invited...").

Headers should include "Informed Consent" followed by the title of the study (e.g., the header in this document). Footers should include page numbers. If your consent letter is more than one page, the footer should also include a space for the participant's initials (e.g., the footer in this document).

Be sure to include any basic components of informed consent that are appropriate to your study. If components apply to your study, they must be included. Please refer to the document entitled "components of informed consent" for more information. If you have any further questions, contact the Director of Institutional Research at (865) 354-3000, ext. 4822.

Information in italics is for your information and should be deleted from the actual consent form. Material in brackets should be completed with relevant information.

TITLE OF STUDY
[Insert title]

PRINCIPAL INVESTIGATOR
[Name]
[Department]
[Address]
[Phone]
[Email]

PURPOSE OF STUDY

You are being asked to take part in a research study. Before you decide to participate in this study, it is important that you understand why the research is being done and what it will involve. Please read the following information carefully. Please ask the researcher if there is anything that is not clear or if you need more information.

The purpose of this study is to [Briefly describe purpose of study.]

STUDY PROCEDURES

List all procedures, preferably in chronological order, which will be employed in the study.

Point out any procedures that are considered experimental. Clearly explain technical and medical terminology using non-technical language. Explain all procedures using language that is appropriate for the expected reading level of participants.

State the amount of time required of participants per session, if applicable, and for the total duration of the study.

If audio taping, videotaping, or film procedures are going to be used, provide information about the use of these products.

RISKS

List all reasonably foreseeable risks, if any, of each of the procedures to be used in the study, and any measures that will be used to minimize the risks.

You may decline to answer any or all questions and you may terminate your involvement at any time if you choose.

BENEFITS

List the benefits you anticipate will be achieved from this research. Include benefits to participants, others, or the body of knowledge. If there is no direct benefit to the participant, state so. For example, "There will be no direct benefit to you for your participation in this study. However, we hope that the information obtained from this study may…."

When applicable, disclose alternative procedures or courses of treatment, if any, which might be advantageous to participants.

CONFIDENTIALITY

Your responses to this [survey] will be anonymous. Please do not write any identifying information on your [survey]. OR For the purposes of this research study, your comments will not be anonymous. Every effort will be made by the researcher to preserve your confidentiality including the following:

[State measures taken to ensure confidentiality, such as those listed below:

- Assigning code names/numbers for participants that will be used on all research notes and documents
- Keeping notes, interview transcriptions, and any other identifying participant information in a locked file cabinet in the personal possession of the researcher.]

Participant data will be kept confidential except in cases where the researcher is legally obligated to report specific incidents. These incidents include, but may not be limited to, incidents of abuse and suicide risk.

COMPENSATION

If there is no compensation, delete this section.

Indicate what participants will receive for their participation in this study. Indicate other ways participants can earn the same amount of credit or compensation. State whether participants will be eligible for compensation if they withdraw from the study prior to its completion. If compensation is pro-rated over the period of the participant's involvement, indicate the points/stages at which compensation changes during the study.

CONTACT INFORMATION

If you have questions at any time about this study, or you experience adverse effects as the result of participating in this study, you may contact the researcher whose contact information is provided on the first page. If you have questions regarding your rights as a research participant, or if problems arise which you do not feel you can discuss with the Primary Investigator, please contact the Institutional Review Board at (865) 354-3000, ext. 4822.

VOLUNTARY PARTICIPATION

Your participation in this study is voluntary. It is up to you to decide whether or not to take part in this study. If you decide to take part in this study, you will be asked to sign a consent form. After you sign the consent form, you are still free to withdraw at any time and without giving a reason. Withdrawing from this study will not affect the relationship you have, if any, with the researcher. If you withdraw from the study before data collection is completed, your data will be returned to you or destroyed.

---

*Note**:** Please delineate the "Consent" section of the Informed Consent Form by drawing a line across the page (like the one above this paragraph). This delineation is important because the consent form grammar shifts from second person to first person, as shown in this example.*

CONSENT

I have read and I understand the provided information and have had the opportunity to ask questions. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason and without cost. I understand that I will be given a copy of this consent form. I voluntarily agree to take part in this study.

Participant's signature _____ Date _____

Investigator's signature _____ Date _____

Appendix 3 – Survey design rubric

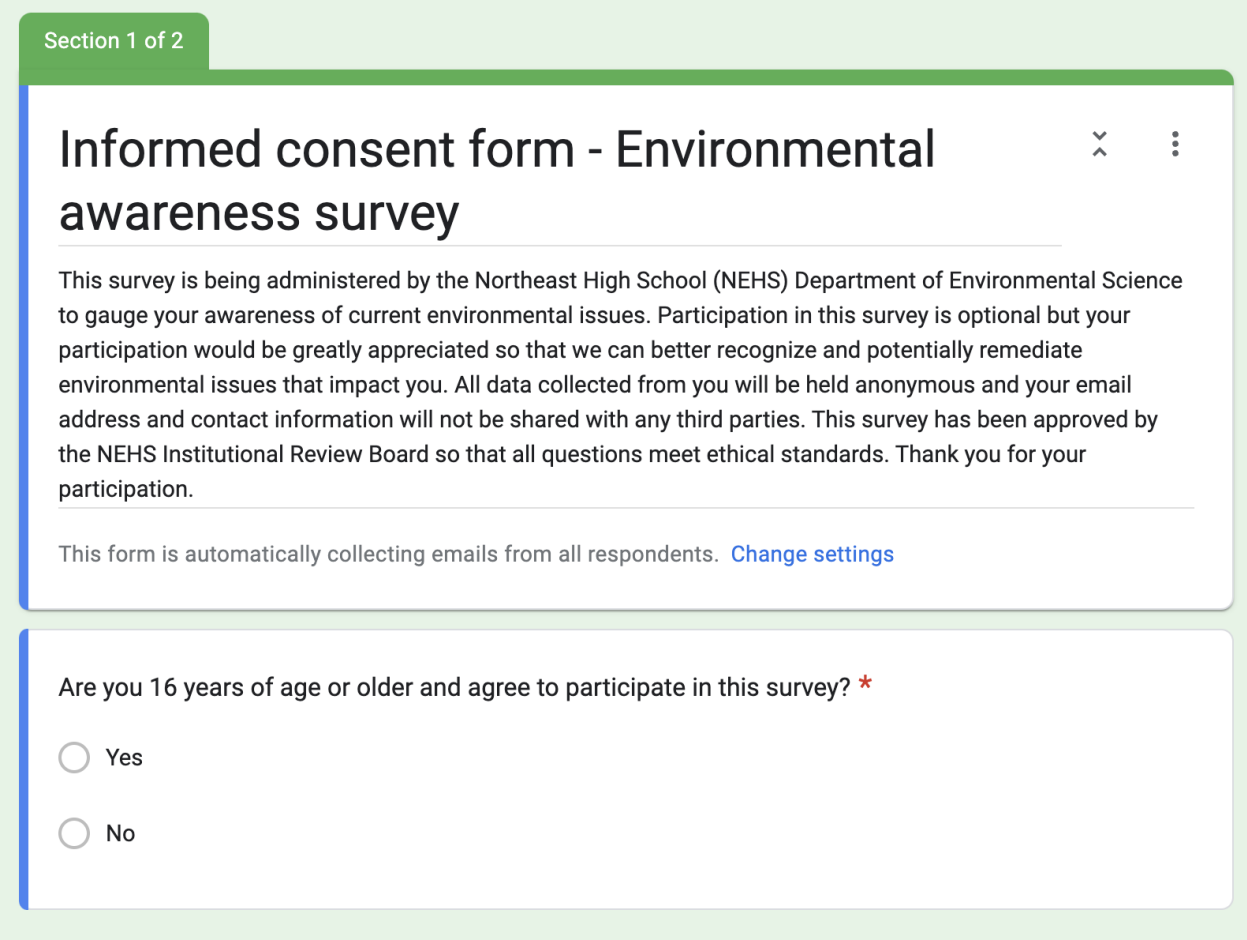
COLLEGE of CHARLESTON

OFFICE FOR INSTITUTIONAL EFFECTIVENESS AND STRATEGIC PLANNING

Survey Design Rubric

Category	*Rating*				*Score*
	4	**3**	**2**	**1**	
Purpose of survey	Purpose is stated clearly and addresses a particular outcome or goal of assessment plan and/or college mission.	Purpose is stated clearly but not relevant to assessment plan and/or college mission.	Purpose is stated vaguely.	Purpose is not stated.	
Implementation plan and timeline	The survey project sets forth an appropriate timeline, and, as relevant, utilizes a pilot test and sampling techniques.	Sets forth an appropriate timeline and pilot test but has not considered sampling.	The timeline is not realistic, sampling is being used but a pilot was not considered.	Planned timeline does not consider college priorities, pilot testing is not planned, and sampling is not considered.	
Clarity of questions and response choices	Questions are very clear and a respondent would not have to ask for clarification.	Questions are clear but a respondent might have to ask for clarification.	Questions are somewhat clear but a respondent would have to ask for clarification.	Questions are confusing and ambiguous.	
Construction	Survey questions are methodologically sound, aligned with survey goal, and are structured appropriately.	Survey questions are methodologically sound and are structured appropriately, but are not aligned with survey goal.	Survey questions are grammatically correct and aligned with survey goal, but are not methodologically sound.	Survey does not follow appropriate methodology, is not aligned with survey goal, and has issues with its structure.	
				Total Score	
Comments:					

Appendix 4 – pretest used for the experimental design



Section 1 of 2

Informed consent form - Environmental awareness survey

This survey is being administered by the Northeast High School (NEHS) Department of Environmental Science to gauge your awareness of current environmental issues. Participation in this survey is optional but your participation would be greatly appreciated so that we can better recognize and potentially remediate environmental issues that impact you. All data collected from you will be held anonymous and your email address and contact information will not be shared with any third parties. This survey has been approved by the NEHS Institutional Review Board so that all questions meet ethical standards. Thank you for your participation.

This form is automatically collecting emails from all respondents. Change settings

Are you 16 years of age or older and agree to participate in this survey? *

- Yes
- No

In your opinion, how important are these issues to you? *

	Not at all important	Somewhat import...	Important	Very important
Recycling	○	○	○	○
Global warming	○	○	○	○
Air pollution	○	○	○	○
Water pollution	○	○	○	○
Acid rain	○	○	○	○
Energy conservation	○	○	○	○

How frequently do you recycle products in your home? *

	1	2	3	4	5	
Never	○	○	○	○	○	Always

How frequently do you recycle products at school? *

	1	2	3	4	5	
Never	○	○	○	○	○	Always

What types of items you regularly recycle? Check all that apply.

- [ ] Plastic containers
- [ ] Glass
- [ ] Metal cans
- [ ] Paper/cardboard

How convenient are the locations of the recycling receptacles in your home neighborhood? *

	1	2	3	4	5	
Not at all convenient	○	○	○	○	○	Very convenient

In your opinion, what are some of the best ways to "reduce, reuse, recycle?" Check all that apply. *

- [ ] Use double-sided copies
- [ ] Use reusable water bottles
- [ ] Use reusable cups, plates, and flatware
- [ ] Avoiding the use of single use plastics (e.g. water bottles)
- [ ] Other...

How frequently do you:

	0 times per week	1-5 times per week	6-10 times per week	More than 10 time...
use public transpo...	○	○	○	○
turn off the lights ...	○	○	○	○
turn off the water ...	○	○	○	○
run the dishwasher...	○	○	○	○
use a refillable wat...	○	○	○	○

How frequently do you: *

	0 times per week	1-5 times per week	6-10 times per week	More than 10 time…
take a trip in an SU…	○	○	○	○
leave a window air …	○	○	○	○
leave the water run…	○	○	○	○
water your lawn or …	○	○	○	○
throw recyclables i…	○	○	○	○

Have you ever had your home tested for lead? *

- ○ Yes
- ○ No
- ○ Not sure

In your opinion, how important is home lead testing? *

	1	2	3	4	5	
Not at all important	○	○	○	○	○	Very important

Have you ever had your home tested for radon? *

- ○ Yes
- ○ No
- ○ Not sure

In your opinion, how important is home radon testing? *

	1	2	3	4	5	
Not at all important	○	○	○	○	○	Very important

Have you ever been exposed to particulate matter pollution? *

- ◯ Yes
- ◯ No
- ◯ Not sure

In your opinion, how important is it for the government to monitor particulate matter pollution? *

	1	2	3	4	5	
Not at all important	◯	◯	◯	◯	◯	Very important

Have you experienced any health effects that are due to the quality of the environment that you live in? Please explain.

Short answer text

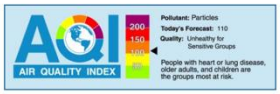
Appendix 5 – EPA particulate pollution brochure

Particle levels can be elevated indoors, especially when outdoor particle levels are high. Certain filters and room air cleaners can help reduce indoor particle levels. You also can reduce particle levels indoors by not smoking inside, and by reducing your use of other particle sources such as candles, wood-burning stoves, and fireplaces.

How can the Air Quality Index help?

In many areas, local media provide **air quality forecasts** telling you when particle levels are expected to be unhealthy. Forecasts use the same format as EPA's Air Quality Index, or AQI, a tool that state and local agencies use to issue public reports of actual levels of particles, ground-level ozone, and other common air pollutants.

Using the AQI's color-coded scale, these forecasts help you quickly learn when air pollution is expected to reach unhealthy levels in your area. In the newspaper forecast below, for example, the black arrow points to the "orange" range, indicating that particle levels are expected to be unhealthy for sensitive groups. On television, you might hear a meteorologist say something like this: *"Tomorrow will be a code orange air quality day, with particle pollution at levels that are unhealthy for sensitive groups. If you have heart or lung disease, or if you're an older adult or a child, you should plan strenuous activities for a time when air quality is better."*



AIR QUALITY INDEX FOR PARTICLE POLLUTION

Air Quality Index	Air Quality	Health Advisory
0 to 50	Good	None.
51 to 100	Moderate	Unusually sensitive people should consider reducing prolonged or heavy exertion.
101 to 150	Unhealthy for Sensitive Groups	People with heart or lung disease, older adults, and children should reduce prolonged or heavy exertion.
151 to 200	Unhealthy	People with heart or lung disease, older adults, and children should avoid prolonged or heavy exertion. Everyone else should reduce prolonged or heavy exertion.
201 to 300	Very Unhealthy	People with heart or lung disease, older adults, and children should avoid all physical activity outdoors. Everyone else should avoid prolonged or heavy exertion.

Daily air quality and health information are available on the AIRNOW Web site.

AIRNOW

AIRNOW (*www.epa.gov/airnow*) is a Web site that gives daily information about air quality, including ground-level ozone and particles, and how they may affect you. AIRNOW contains:

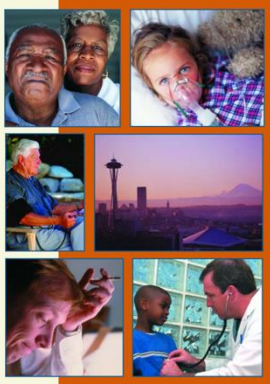
- Real-time particle levels for many locations.
- Air quality forecasts for many cities across the country.
- Kids' Web page and associated teacher curriculum.
- Smoke Web page.
- Links to state and local air quality programs.
- Ideas about what you can do to reduce particles. For example, you can keep your car, boat, and other engines well-tuned, and avoid using engines that smoke. You can also participate in local energy conservation programs.

*Photo courtesy of The Weather Channel.

Office of Air and Radiation
www.epa.gov/air
September 2003
EPA-452/F-03-001

EPA United States Environmental Protection Agency

Particle Pollution and Your Health



What Is Particle Pollution?

Are You at Risk?

How Can You Protect Yourself?

Airborne particles, the main ingredient of haze, smoke, and airborne dust, present serious air quality problems in many areas of the United States. This particle pollution can occur year-round—and it can cause a number of serious health problems, even at concentrations found in many major cities.

Particles contribute to haze, such as this brown haze over Boston.

What is particle pollution?

Particle pollution is a mixture of microscopic solids and liquid droplets suspended in air. This pollution, also known as particulate matter, is made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, soil or dust particles, and allergens (such as fragments of pollen or mold spores).

The size of particles is directly linked to their potential for causing health problems. Small particles less than 10 micrometers in diameter pose the greatest problems, because they can get deep into your lungs, and some may even get into your bloodstream. Exposure to such particles can affect both your lungs and your heart. Larger particles are of less concern, although they can irritate your eyes, nose, and throat.

Small particles of concern include "fine particles" (such as those found in smoke and haze), which are 2.5 micrometers in diameter or less; and "coarse particles" (such as those found in wind-blown dust), which have diameters between 2.5 and 10 micrometers.

Are you at risk from particles?

People with heart or lung disease, older adults, and children are considered at greater risk from particles than other people, especially when they are physically active. Exercise and physical activity cause people to breathe faster and more deeply—and to take more particles into their lungs.

People with heart or lung diseases—such as coronary artery disease, congestive heart failure, and asthma or chronic obstructive pulmonary disease (COPD)—are at increased risk, because particles can aggravate these diseases. People with diabetes also may be at increased risk, possibly because they are more likely to have underlying cardiovascular disease.

Older adults are at increased risk, possibly because they may have undiagnosed heart or lung disease or diabetes. Many studies show that when particle levels are high, older adults are more likely to be hospitalized, and some may die of aggravated heart or lung disease.

Children are likely at increased risk for several reasons. Their lungs are still developing; they spend more time at high activity levels; and they are more likely to have asthma or acute respiratory diseases, which can be aggravated when particle levels are high.

It appears that risk varies throughout a lifetime, generally being higher in early childhood, lower in healthy adolescents and younger adults, and increasing in middle age through old age as the incidence of heart and lung disease and diabetes increases. Factors that increase your risk of heart attack, such as high blood pressure or elevated cholesterol levels, also may increase your risk from particles. In addition, scientists are evaluating new studies that suggest that exposure to high particle levels may also be associated with low birth weight in infants, pre-term deliveries, and possibly fetal and infant deaths.

How can particles affect your health?

Particle exposure can lead to a variety of health effects. For example, numerous studies link particle levels to increased hospital admissions and emergency room visits—and even to death from heart or lung diseases. Both long- and short-term particle exposures have been linked to health problems.

Long-term exposures, such as those experienced by people living for many years in areas with high particle levels, have been associated with problems such as reduced lung function and the development of chronic bronchitis—and even premature death.

Short-term exposures to particles (hours or days) can aggravate lung disease, causing asthma attacks and acute bronchitis, and may also increase susceptibility to respiratory infections. In people with heart disease, short-term exposures have been linked to heart attacks and arrhythmias. Healthy children and adults have not been reported to suffer serious effects from short-term exposures, although they may experience temporary minor irritation when particle levels are elevated.

What are the symptoms of particle exposure?

Even if you are healthy, you may experience temporary symptoms, such as irritation of the eyes, nose, and throat; coughing; phlegm; chest tightness; and shortness of breath.

If you have lung disease, you may not be able to breathe as deeply or as vigorously as normal, and you may experience coughing, chest discomfort, wheezing, shortness of breath, and unusual fatigue. If you have any of these symptoms, reduce your exposure to particles and follow your doctor's advice. Contact your doctor if symptoms persist or worsen. **If you have asthma,** carefully follow your asthma management plan when particle levels are high. Your doctor can help you develop a plan if you don't have one.

If you have heart disease, particle exposure can cause serious problems in a short period of time—even heart attacks—with no warning signs. So don't assume that you are safe just because you don't have symptoms. Symptoms such as chest pain or tightness, palpitations, shortness of breath, or unusual fatigue may indicate a serious problem. If you have any of these symptoms, *follow your doctor's advice.*

How can you avoid unhealthy exposure?

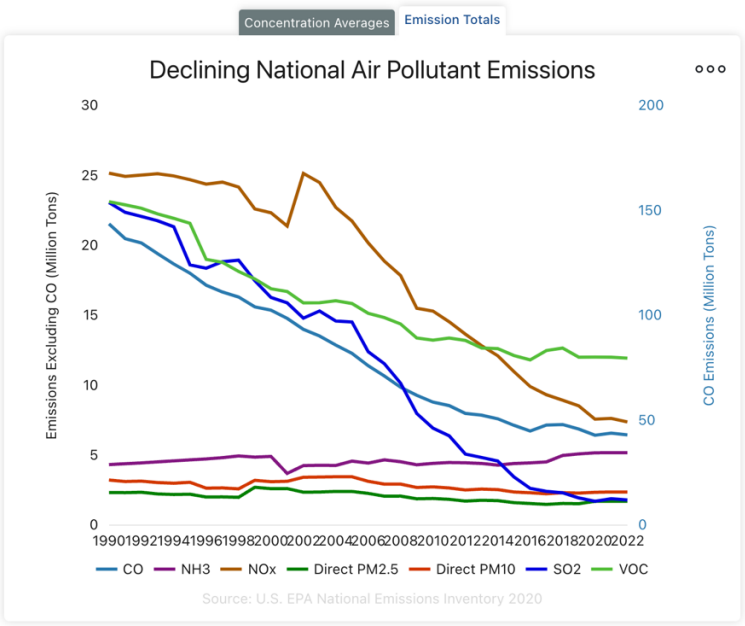
Your chances of being affected by particles increase the more strenuous your activity and the longer you are active outdoors. If your activity involves prolonged or heavy exertion, reduce your activity time—or substitute another that involves less exertion. Go for a walk instead of a jog, for example. Plan outdoor activities for days when particle levels are lower. And don't exercise near busy roads; particle levels generally are higher in these areas.

Appendix 6 – National Health Interview Survey data from the CDC

Table 1-1
Table Lifetime Asthma Population Estimates — in thousands by Age,
United States: National Health Interview Survey, 2015

				Age (years)							
						15-34					
Characteristic†	All ages Total	Children Age <18	Adults Age 18+	0 – 4	5 – 14	15 – 34	15 – 19	20 – 24	25 – 34	35 – 64	65+
Total:	40,153	9,546	30,606	1,127	6,299	11,734	3,654	3,150	5,581	15,561	4,780
Male	18,351	5,708	12,643	681	3,753	5,873	2,125	1,576	2,527	5,932	1,758
Female	21,802	3,839	17,963	447	2,547	5,861	1,530	1,574	3,054	9,629	3,022
White Non-Hispanic:	25,133	4,485	20,647	433	2,915	6,872	1,986	1,869	3,347	10,817	3,765
Male	11,310	2,691	8,619	308	1,705	3,342	1,194	822	1,512	4,340	1,429
Female	13,823	1,794	12,029	125	1,210	3,530	792	1,047	1,835	6,477	2,336
Black Non-Hispanic:	5,836	1,866	3,970	273	1,192	1,702	598	490	747	2,131	404
Male	2,581	1,105	1,475	147	714	873	339	301	306	676	97
Female	3,255	761	2,494	126	478	829	259	189	442	1,455	308

Appendix 7 – EPA air emissions inventory (graph and available data set to download)

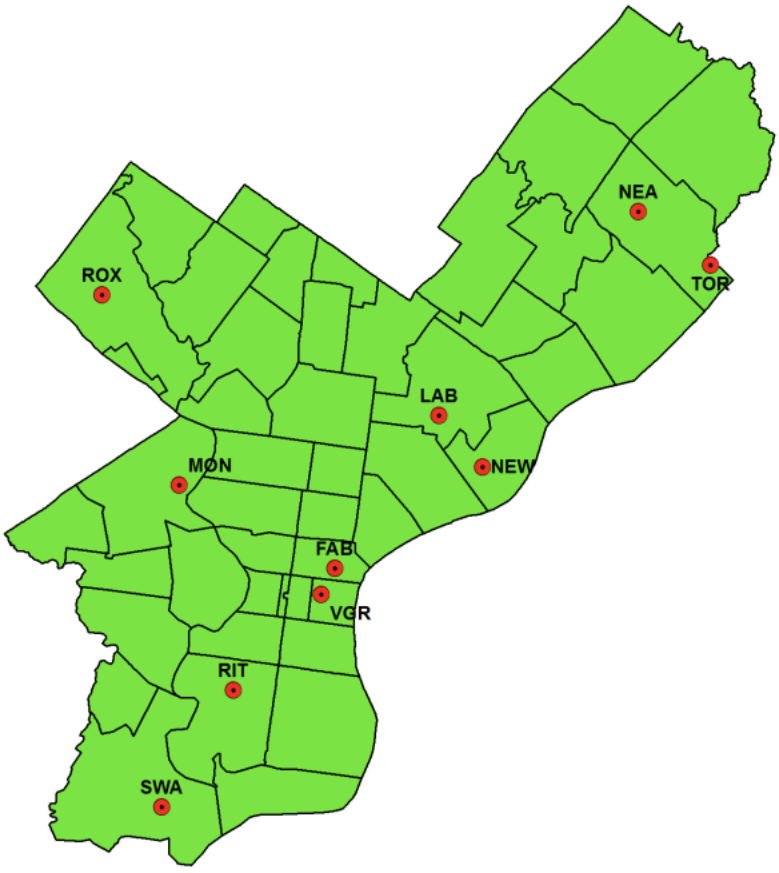


	A	B	C	D	E	F	G	H
1	year	CO	NH3	NOx	Direct PM2.5	Direct PM10	SO2	VOC
2	1990	143.605	4.32	25.165	2.327	3.217	23.065	23.125
3	1991	136.545	4.384	24.933	2.317	3.112	22.363	22.899
4	1992	134.506	4.443	25.027	2.344	3.14	22.073	22.659
5	1993	129.365	4.518	25.122	2.223	3.036	21.764	22.252
6	1994	124.469	4.589	24.968	2.183	2.989	21.332	21.932
7	1995	120.073	4.659	24.697	2.203	3.055	18.609	21.578
8	1996	114.356	4.727	24.382	2.003	2.638	18.37	19.001
9	1997	111.117	4.817	24.526	2.012	2.656	18.834	18.786
10	1998	108.726	4.94	24.176	1.981	2.585	18.939	18.136
11	1999	104.033	4.857	22.609	2.7	3.198	17.478	17.603
12	2000	102.418	4.907	22.335	2.6	3.098	16.278	16.898
13	2001	98.518	3.689	21.378	2.606	3.127	15.888	16.699
14	2002	93.298	4.25	25.147	2.349	3.417	14.799	15.89
15	2003	90.114	4.273	24.497	2.361	3.433	15.308	15.894
16	2004	85.815	4.26	22.721	2.403	3.454	14.593	16.037
17	2005	81.844	4.57	21.745	2.402	3.452	14.522	15.842
18	2006	75.97	4.43	20.182	2.262	3.127	12.395	15.142
19	2007	71.064	4.66	18.875	2.063	2.926	11.538	14.837
20	2008	65.709	4.527	17.846	2.069	2.927	10.145	14.38
21	2009	61.879	4.308	15.502	1.875	2.686	7.976	13.377
22	2010	58.599	4.411	15.303	1.897	2.73	6.925	13.218
23	2011	56.937	4.47	14.54	1.838	2.651	6.383	13.369
24	2012	53.207	4.451	13.654	1.713	2.507	5.073	13.201
25	2013	52.399	4.403	12.83	1.77	2.572	4.83	12.664
26	2014	50.639	4.285	12.107	1.745	2.532	4.575	12.62
27	2015	47.545	4.4	10.97	1.599	2.363	3.437	12.125
28	2016	44.844	4.445	9.907	1.539	2.308	2.624	11.81
29	2017	47.673	4.514	9.32	1.476	2.235	2.407	12.481
30	2018	47.923	4.975	8.931	1.542	2.314	2.307	12.657
31	2019	45.75	5.088	8.527	1.525	2.281	1.939	12.007
32	2020	42.818	5.164	7.569	1.694	2.342	1.704	12.008
33	2021	43.792	5.175	7.63	1.7	2.365	1.877	12.004
34	2022	42.964	5.174	7.372	1.695	2.363	1.793	11.934
35								
36								
37								
38								
39								

naaqs-emissions-totals-data

Appendix 8 – Philadelphia AMN

Figure 1 - 2021 Philadelphia Air Monitoring Network as of July 1, 2021



			Parameter																	
AQS Site Code	AMS Site	Address	CO	SO_2	Ozone	NO_2	NOy/NO	PM_{10}	$PM_{2.5}$	Speciated $PM_{2.5}$	PM Coarse	Black Carbon / Ultrafine PM	Carbonyls	PAMS VOC	BaP	TSP Metals (Be, Cr, Mn, Ni, As, Cd, Pb)	Toxics TO15	MET	AMS Site
421010004	LAB	1501 E. Lycoming St			X				X										LAB
421010014	ROX	Eva & Dearnley Sts											X				X		ROX
421010024	NEA	Grant Ave & Ashton Rd			X														NEA
421010048	NEW	2861 Lew is St	X	X	X	X	X	X	X	X	X		X	X			X	X	NEW
421010055	RIT	24th & Ritner Sts		X					X	X			X			X	X		RIT
421010057	FAB	3rd & Spring Garden Sts							X										FAB
421010063	SWA	8200 Enterprise Ave											X				X		SWA
421010075	TOR	4901 Grant Ave & James St	X			X			X									X	TOR
421010076	MON	I-76 & Montgomery Drive	X			X			X			X			X	X		X	MON
	VGR	6th & Arch Sts			X				X									X	VGR

Appendix 9 – PM 2.5 data for all air monitoring stations in Philadelphia. Downloadable csv at the bottom.

Air Data – Multiyear Tile Plot

Plot daily AQI values for a specific location and time period. Each "tile" represents one day of the year and is color-coded based on the highe

1. Pollutant PM2.5
2. Period from 2001 to 2022 (Maximum 25 years / Query time: 15 years ~ 30 sec, 25 years ~ 1 min)
3. Geographic Area Select a City (defined as CBSA) ...

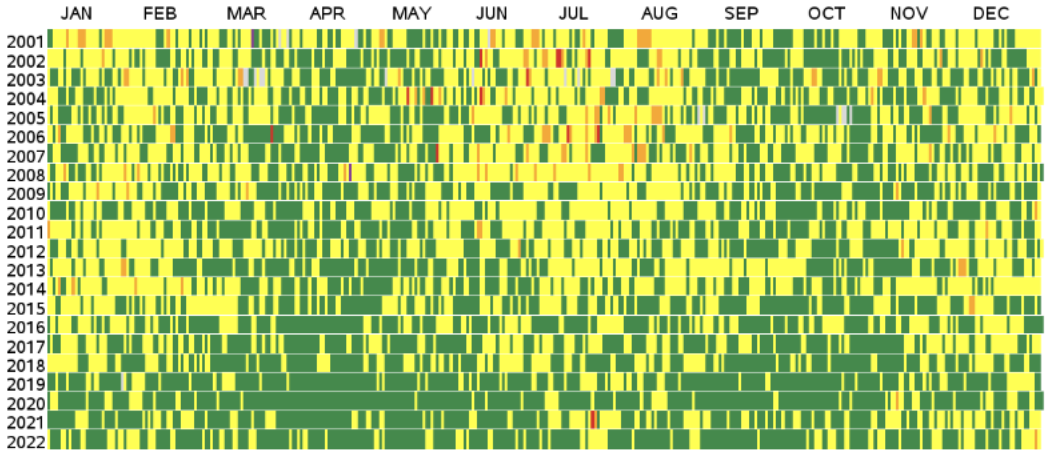
-- or --

PA - Philadelphia

4. Monitor Site
   - All Sites (Highest Daily AQI)
   - 421010003
   - 421010004
   - 421010014
   - 421010020
   - 421010024

PM2.5 Daily AQI Values, 2001 to 2022

Philadelphia County, PA



AQI Category

- Good (<=12.0 ug/m3)
- Moderate (12.1-35.4 ug/m3)
- Unhealthy for Sensitive Groups (35.5-55.4 ug/m3)
- Unhealthy (55.5-150.4 ug/m3)
- Very Unhealthy (150.5-250.4 ug/m3)
- Hazardous (>=250.5 ug/m3)

Source: U.S. EPA AirData <https://www.epa.gov/air-data>
Generated: December 13, 2023

The following data link is active for the next 10 minutes, after which you must resubmit your query.

Download CSV (spreadsheet)

Appendix X – College Board Standards

College Board Standards - Enduring Understanding

EU 1.3: The investigative process is aided by the effective organization, management, and selection of resources and information. Appropriate technologies and tools enable the scholar to become more efficient, productive, and credible.

College Board Standards - Essential Knowledge

EK 1.3A1: Information used to address a problem may come from various secondary sources (e.g., articles, other studies, analyses, reports) and/or primary sources (e.g., original texts and works, material culture, or personally collected data such as from experiments, surveys, questionnaires, interviews, observations, personal narratives).

College Board Standards - Enduring Understanding

EU 1.5: There are multiple ways to investigate questions, problems, and issues. Methods should be aligned with the purpose of the inquiry.

College Board Standards - Essential Knowledge

EK 1.5B5: Based on the research question or project goal, methods of data or information collection may be qualitative (e.g., open-ended survey questions, interviews, observational notes, interpretation of texts); may be quantitative (e.g., precise measurements, modeling, using structured and validated data collection instruments and procedures); or could include a combination of both qualitative and quantitative (mixed).

College Board Standards - Enduring Understanding

EU 1.4: The relevance and credibility of the source of information is determined by the context of its use.

College Board Standards - Essential Knowledge

EK 1.4A4: When gathering data on individuals' behaviors, attitudes, and preferences, the accuracy and validity of such data depends on the honesty, memory, and reliability of the respondents and/or observers as well as the design of the data collection instrument.