

An Investigative Question

Is there a relationship between the time of year (or season) and the amount of air pollution in Washington?

Turn and talk:

- What is your hypothesis? *Why* do you think that?
- What kinds of data do you think we would need to answer the question?

Introduction to Air Pollution

What is air pollution?

What is air pollution?

- What do you know about air pollution?
- What causes it?
- Why is it a problem?
- Where have you seen it or heard about it?
- Does Seattle (or your own community) have a problem with air pollution? How do you know?

Air pollution is...

- Air pollution is particles that get into the air and harm the health of humans, animals and plants. Air pollution can even damage buildings!
- Air pollution can be solid particles (like dust or smoke), gases (like nitrogen oxides in car exhaust), or liquid droplets.
- (Definition modified from National Geographic Encyclopedia).



Sources of outdoor air pollution

- **Natural sources:** Wildfires, volcanic eruptions, methane gas, dust



- **Human sources:** Power plants, automobiles, fumes, burning wood fires/trash, fireplaces, furnaces



Some common outdoor air pollutants

- **Carbon monoxide (CO):** Produced by combustion of fuel such as natural gas, wood, and coal
- **Sulfur dioxide (SO₂):** Produced by volcanoes, and fuel combustion with coal and petroleum
- **Nitrogen dioxide (NO₂):** Expelled from high temperature combustion
- **Particulates:** Fine particulates from gases and natural/human made pollutants including dust, fires, and burning of fossil fuels
- **Volatile organic compounds (VOCs):** Natural or human-made compounds that turn into greenhouse gases when they interact with other particles.

Air Pollution and Human Health

How does air pollution affect human health?

Air pollution and human health

- Causes both short-term and long-term health effects.
- Associated with pulmonary, cardiac, vascular, and neurological impairments.
- High-risk groups are elderly, infants, pregnant women, and sufferers from chronic heart and lung diseases.
- Children are at greater risk.



Air pollution and its effects on human health

- Long-term exposure to outdoor air pollution contributed to nearly 5 million deaths from stroke, heart attack, diabetes, lung cancer, and chronic lung disease worldwide in 2017.
- 1 in 9 deaths worldwide are attributed to air pollution
- Exposure to air pollution could shorten the average life span of a child born today by 20 months.
- Air pollution is responsible for more deaths than many better-known risk factors such as malnutrition, alcohol use, and physical inactivity.



Data Science and Air Pollution in Washington State

What is data science and why is it important?

What is Data Science?

- Scientific investigations produce data, or information. For example, scientists in Washington have measured the amount of air pollution in different cities. The air pollution measured is the data.
- Once collected, data must be presented in a way that shows any patterns and relationships. A major practice of scientists is to present and interpret data by graphing and statistical analysis. Graphs and statistical analysis can bring out the *meaning* of data so that it can be used as evidence for making claims and, ultimately, for designing solutions.
- Data science involves asking questions, collecting data, presenting data through graphing and statistical analysis, analyzing and interpreting data, making claims supported by the data, and, finally, using data as evidence to inform decision-making.



Applying data science to understanding air pollution: Lesson Steps

1. Investigative Question #1: *Is there a relationship between the time of year (or season) and the amount of air pollution in Washington?*
2. Graph the data on air pollution in one city in order to see any patterns.
3. Compile our data as a class to see if we can identify any trends or patterns in air pollution and time of year across Washington.
4. Write a claim that answers the investigative question and support it with data.
5. Investigative Question #2: How does location affect the amount of air pollution?
6. Calculate statistics (mean, median, minimum, and maximum) for air pollution in your city.
7. Compare these statistics with one other city in Washington to find out how location affects the amount of air pollution.



How Air Pollution is Measured

How is air pollution measured?

Air pollution measurement

Ground monitors



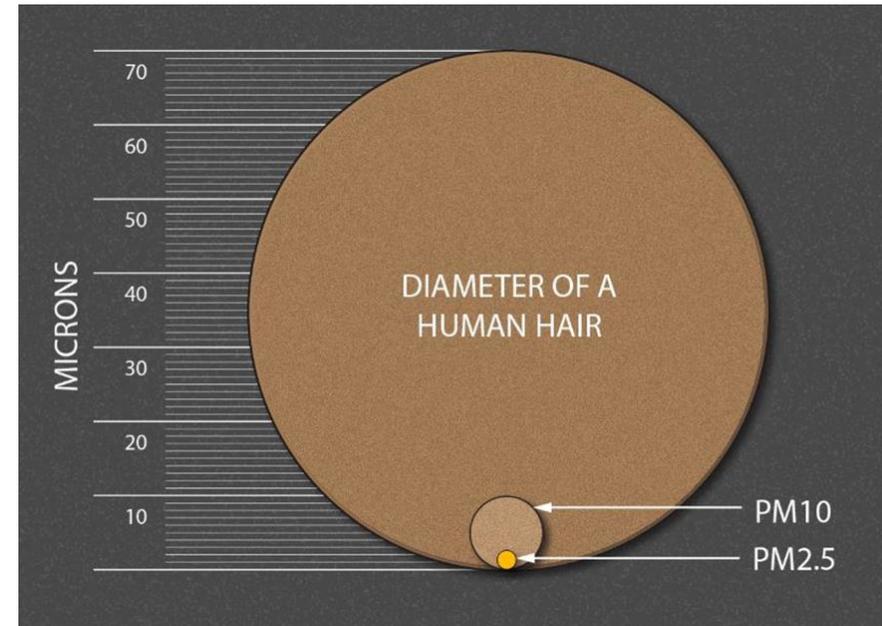
Satellite imagery



Air Pollution: Particulate Matter

Air pollution is measured in PM 2.5, which means particulate matter that is 2.5 micrometers or less in diameter. That's tiny! Tiny air pollution particles can actually be the most dangerous since they can get deep into the lungs and bloodstream.

Ground monitors in cities across Washington were used to measure the concentration of particulate matter with a diameter of less than 2.5 micrometers (PM2.5) in one cubic meter of air.



Investigative Question #1:

Is there a relationship between the time of year (or season) and the amount of air pollution in Washington?

Compiling Data Across Cities in Washington

Why do we need to analyze data from across cities in order to make a claim about whether the time of year affects the amount of air pollution in Washington?

Months with the Highest and Lowest Amounts of Pollution in Washington

Share out with the class the month (or months if tied) that had the highest pollution and lowest pollution in your city. Your teacher will make a tally in the table to the right.

- *Does there appear to be a trend in the highest amount of air pollution and the month(s) across cities?*
- *Does there appear to be a trend in the lowest amount of air pollution and the month(s) across cities?*

Month	Highest Air Pollution	Lowest Air Pollution
Jan.		
Feb.		
Mar.		
April		
May		
June		
July		
August		
Sept.		
Oct.		
Nov.		
Dec.		

Explaining the trends in the time of year and the amount of air pollution

Turn and Talk:

What ideas do you have about what could explain the pattern in the time of year and amount of air pollution in Washington?

In other words: What ideas do you have about why August, and the fall months, tend to have the highest air pollution?

Wildfires in Washington

Wildfires contribute to air pollution by adding smoke to the air. Wildfires tend to happen in Washington during the end of the summer/early fall after the warm, dry summer and before the rain starts. At the end of summer, the land is dry and warm and fires can spread rapidly.

In Washington:

- In **2014** there were **1,480 fires** that burned **386,972 acres**.
- In **2015** there were **1,541 fires** that burned **1,005,423 acres**. This was the largest wildfire season in Washington state history.
- In **2016** there were **1,272 fires** that burned **293,717 acres**.

Wildfire Smoke

- This satellite image shows the Puget Sound region covered in smoke from fires in Eastern Washington.
- The photo was taken on August 22nd, 2015.
- Which areas of Washington become most affected by wildfire smoke depends on the direction the wind is blowing. **Can you tell which direction its blowing here?**



Wildfire Smoke

- This satellite image shows smoke plumes from multiple wildfires happening at the same time in Washington.
- The photo was taken on July 18th, 2014



Generating Basic Statistics

How do basic statistics help us interpret and gain additional meaning from the data?

Investigative Question #2

How does location affect the amount of air pollution in Washington?

Turn and Talk:

- What is your hypothesis? Do you think that the amount of air pollution is different depending on the location (city) in Washington? Explain your thinking!
- What ideas do you have about how we might use math, or statistics, to help us compare the amount of air pollution in different cities?

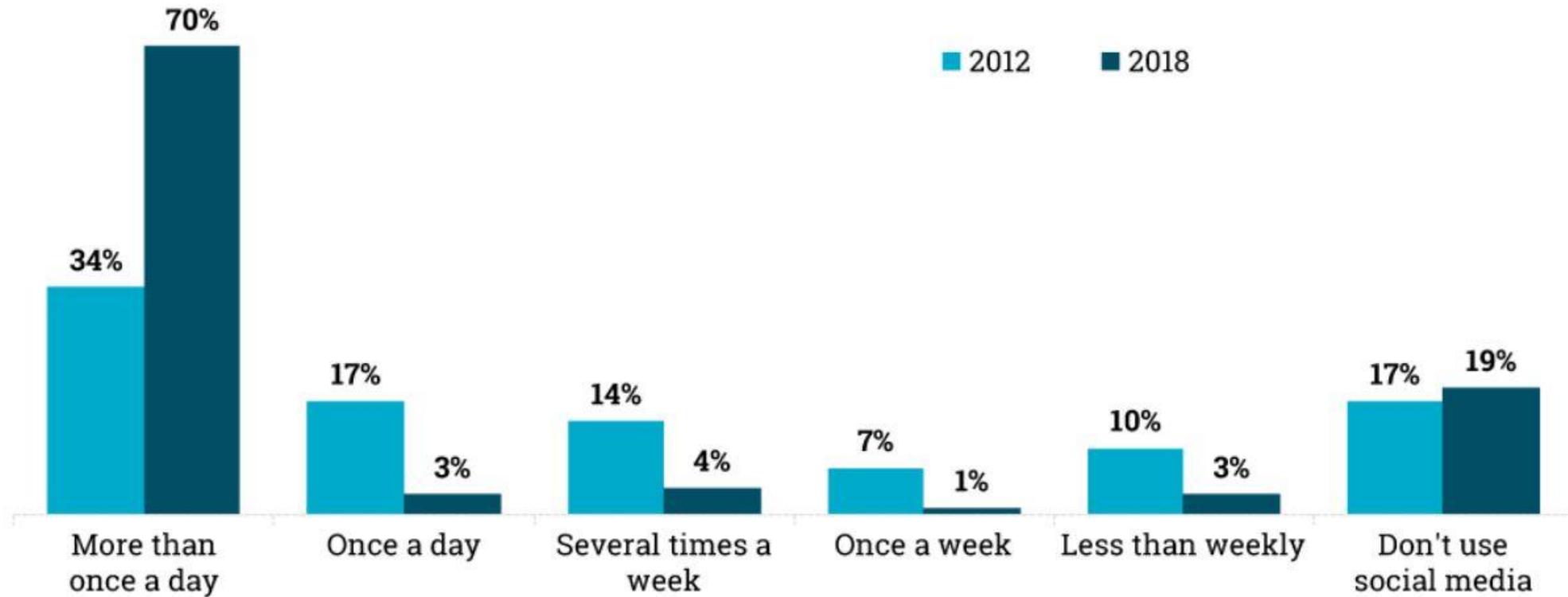
What is statistics?

- Statistics is the science concerned with developing and studying methods for collecting, analyzing, interpreting, and presenting data that has been collected.
- Statistics is concerned with manipulating, summarizing, and investigating data to provide information for decision-making.



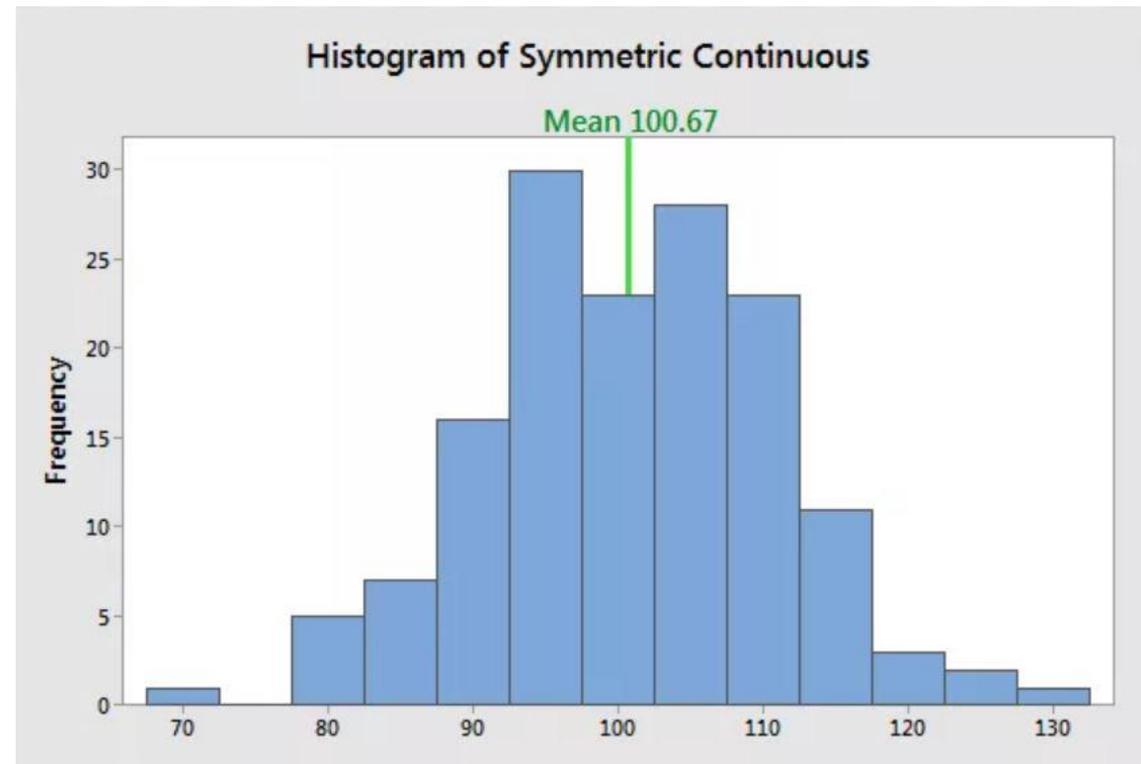
Statistics tell a story

Frequency of Teen Use of Social Media



Mean

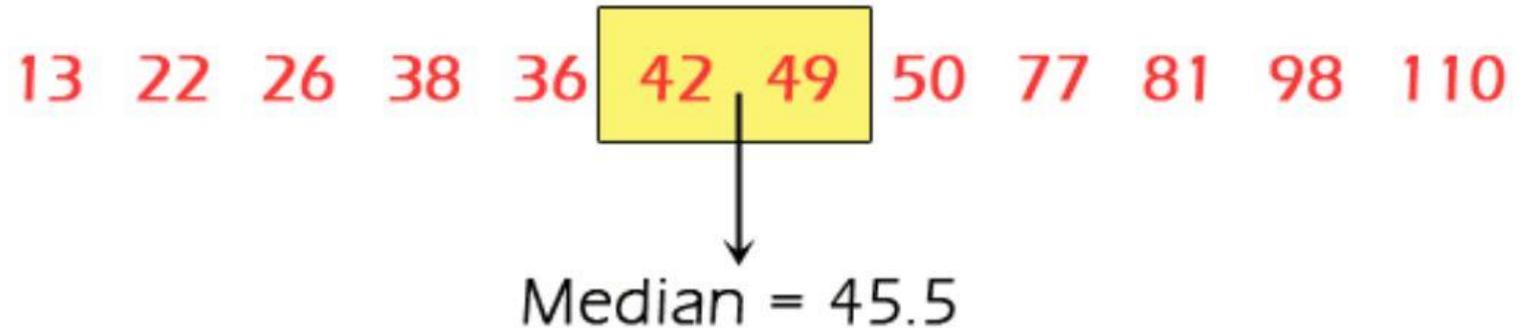
- Mean [or average] is equal to the sum of all the values in a set of data divided by the number of values in the data.



Median

- Median is the middle number of an ordered set of data

Median Even	
	40
	38
	35
	33
	32
	30
28	29
	27
	26
	24
	23
	22
	19
	17



Minimum and maximum

- **Minimum (Min):** The *lowest* value in the set of data
- **Maximum (Max):** The *highest* value in the set of data



City Comparison Groups for Basic Statistical Analysis

- Bremerton vs. Mountlake Terrace
- Anacortes vs. Tacoma
- Darrington vs. Methow
- Kent vs. Scotch Basin vs. Seattle **this group has three cities to compare. You will need to add a third column to the statistics table on your student handout.*

Optional: City/Region's Locations

- A: Anacortes
- B: Bremerton
- D: Darrington
- K: Kent
- ME: Methow
- MLT: Mountlake Terrace
- SB: Scotch (Creek) Basin
- SEA: Seattle
- T: Tacoma



Optional: Dictionary to Codes in the Dataset

- **Iso3:** 3 letter country code (iso-alpha3)
- **City:** City that data point is supposed to represent
- **Year:** Year that data point is supposed to represent
- **PM2.5_units:** Reporting units: should be micrograms per cubic meter, but could be useful for conversion if data is reported in non-standard units
- **Type_of_stations:** Station metadata describing the type of monitoring station/area
- **Reference:** Citation for source of these data
- **Latitude:** Physical latitude, can be input to Google Maps as (latitude, longitude)
- **Longitude:** Physical longitude, can be input to google maps as (latitude, longitude)
- **Month:** Month that data point is supposed to represent
- **PM2.5:** Outcome variable, level of pm25
- **NA:** Missing data