

# Disease Detectives Notes 2018 SSSS

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### Diseases related to environmental quality:

All citations included on last page.

These are intended to give you a quick overview and understanding of some health problems linked to environmental quality. As the main topic for 2018-19 isn't released yet, the topic may not be related to the ones provided.

Heavy Metals in Food and Water (All sections include overview, sources, symptoms, and example(s) of environmentally linked outbreak(s) if existing) (15)

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## Quick Definitions & Other Basics

**Epidemiology**- *“Epidemiology is the study of the distribution and determinants of health-related states or events in specified populations, and the application of this study to the control of health problems.”* - CDC Principles of Public Health Online

This is split into classical epidemiology and clinical epidemiology. Classical is concerned with the population while clinical uses epidemiological principles and applies them to clinical cases. The second one isn't too important in Disease Detectives.

**Cluster**- A group of similar cases in a certain area at a certain time, may or may not be more than expected. For example, if 13 people in my neighborhood suddenly all get the flu in the same week, it is a cluster, regardless of how many cases there usually are.

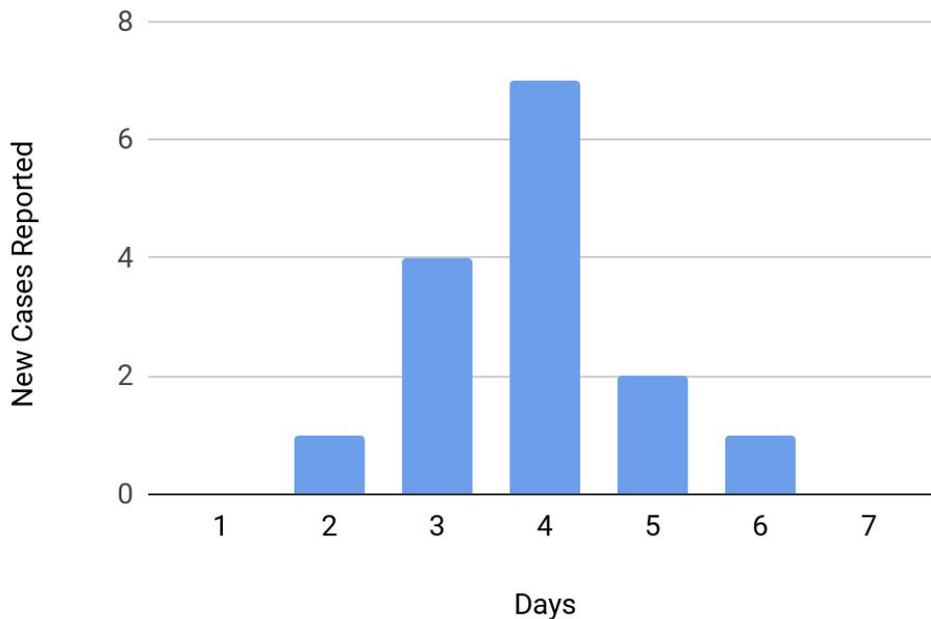
**Outbreak**-A group of similar cases in a certain area at a certain time, except it is more than expected at this time and place. It is usually assumed that the cases had a common source. For example, if I check the records and at the same time last year, only 2 people had the flu in my neighborhood, it could be an outbreak.

**Epidemic**-The difference between epidemic and outbreak is debated. In most cases, they can be used interchangeably, however, an epidemic is usually associated with a larger area or greater number of people affected. Also, the word epidemic creates more panic in the media. The previous example could also apply to an epidemic.

**Pandemic**- An outbreak that spans over continents or countries. For example, if more people than expected in a certain time period in the United States, Mexico, and Canada started getting the same type of flu, it could be a pandemic.

**Epi curves, Epidemic Curves (tests will usually allow both answers)** - A histogram that shows how many new cases appeared in each time interval shown. For example, if 0 cases are reported on day one, 1 new case appears on day 2, 4 new cases on day 3, 7 on day 4, 2 on day five, 1 on day 6 and none on day seven, the graph would look like this.  
Remember: only new cases are put on the graph.

## Epi Curve Example



### Types of Epi Curves/Epidemics

**Common Point Source**-This is caused by a single exposure, such as a party where a plate of food had norovirus. The epi curve sometimes has a single index case (perhaps a chef who had norovirus and prepared the food) followed by an incubation period, then a sudden spike in cases that decreases quickly.

**Common Continuous Source**-An exposure that lasts for a while and continues causing cases for a while. For example, if a water fountain has pathogens on it and goes unnoticed for a while, it would be a common continuous source. The curve will rise quickly and stay stable for a while at the top. It can either slowly decrease, suddenly decrease, or continue indefinitely. The main difference between point and continuous source is that is that the peak will last for longer than an incubation period.

**Common Intermittent**-These are exposures that appear every once in a while and infect a few people. They have small peaks once in a while followed by gaps longer than the maximum incubation period.

Propagated-This is an outbreak that is spread from people to more people. There are many peaks separated by the time of an incubation period. For example, if a group of people have the cold and go to school, by the next incubation period, another group of people will get the cold, and so on.

**Incidence**-The number of new cases of a disease that appear in a certain time period in a population at risk (known as **incidence proportion**). This is used when it is assumed the incidence will remain constant.

If there was a group of 100 people and 2 of them develop a disease in 8 years, the incidence would be 0.25 new cases per 100 person-years (or per person per year), or 0.25% (sometimes the percentage is then multiplied by a certain number, like 100,000 to get a ratio like 25000 new cases per 100,000 person-years, but most likely you won't be graded on this).

**(incidence rate)**

There's a more complicated calculation involving a cohort study, but that will most likely not be on your test. Unless your test gives you the number of people that drop out, get sick, or die each year in a study, do not use this. However, it involves removing 0.5\*length of time between each check in (usually less than 10) person-years for every person that drops out of the study or gets the disease during the study.

If I do a study with 100 people, and check in every year, it could look something like this:

First check in: 1 person dropped out, 2 got sick.

Second year check it: 1 person dropped out, 1 died, and 3 new people got sick.

Out of 100 people, 97 never got sick, dropped out, or died in the first year. They add 97 person-years to the denominator.

Out of 100 people, 3 either got sick, died, or was lost to follow up (dropped out) in the first year. They add 0.5 person year each,  $0.5*3$ , so 1.5 in total. Since 2 people got sick, they are added to the numerator. The ratio is currently 2 new illnesses/98.5 person-years.

For year 2, out of the 100, 92 remained healthy and in the study. They add 92 person-years to the denominator. 5 people were lost to follow up, died, or got sick. They add  $0.5*5=2.5$  person-years to the denominator. Since 3 got sick, they add 3 to the numerator.

The final incidence rate is 5 new illnesses per 193 healthy person-years or about 2.59%.

**Prevalence**-How many cases of the disease are present at a certain point in time in proportion to the sample population (**Point prevalence**), a certain period in time (**Period prevalence**), or has it at some point in their life (**Lifetime prevalence**).

Point prevalence example: If 6 people out of a sample of 1,000 have the cold at a random point in time, the prevalence is 0.006%.

**Absolute Risk/Risk/Attack Rate**-How many people get a condition compared to the total amount of people in that sample. Using the chart below, attack rate is  $a/(a+b)$  or  $c/(c+d)$ . Basically either the rate of exposed people who got sick or unexposed people who got sick.

**Risk Ratio/Relative Risk**- The ratio of risk between exposed and unexposed, used in cohort studies. If it is above one, there is a positive correlation between exposure and condition. If 1, there is no relationship. If less than 1, there is a negative correlation between exposure and condition, maybe suggesting the exposure is preventative. **REMEMBER: CORRELATION DOESN'T EQUAL CAUSATION.** Given a 2x2 table like the one below:

	Case	Control
Exposed	a	b
Unexposed	c	d

The formula is  $(a/(a+b))/(c/(c+d))$ .

	Case	Control
Exposed	12	43
Unexposed	1	54

The RR would be  $(12/55)/(1/55)$ , or 12. This means people who were exposed were 12 times more likely to develop the condition. RR is more accurate than odds ratio (see below), but they are similar when in rare diseases. Odds ratio will overestimate the risk ratio.

**Attributable Risk**-Usually in cohort studies, difference in risk between exposed and unexposed.

If 8 people out of 20 exposed get a disease, compared to 5 out of 20 unexposed, the AR is  $8/20-5/20$ ;  $0.4-0.25$ ; 0.15.

**Odds Ratio**-This compares the odds (ratio between someone who is sick was exposed vs someone who was sick wasn't exposed). This is used in case-control studies instead of risk ratio since RR requires every exposed and non-exposed member of a sample pop to be known, which a case-control can't do. If the OR is above one, the exposure is positively linked to the condition, if 1, no link, if less than 1, negatively linked, maybe preventative.

The formula is  $(a/c)/(b/d)$  or  $(ad/bc)$ , since they are the same.

	Case	Control
Exposed	5	24
Unexposed	10	42

In this case, the OR would be 0.5. People who were exposed were half as likely to be a case than unexposed.

**Bias**-These are systematic errors can be results of research that come from problems in method of research. They can also be a result of a consistently inaccurate measuring device. No matter what, they are not results of chance alone. There are many types.

For example, if I decided to measure the height of everyone in my class, but my ruler was broken and off by 2 centimeters, it would be a systematic error/bias.

**Random Error**-These are errors that come from chance, as implied in the name. Their effects can be mitigated by taking more measurements.

If I decided to use an online test to survey my classmates on hours of computer usage, but the survey would mess up and change the value submitted randomly sometimes, that would be random error.

**Vector**-An animal that carries a disease, such as a mosquito in the case of malaria.

**Fomite**-An inanimate object that carries a disease, such as a doorknob.

**(Healthy/Asymptomatic) Carrier**- Someone who has a pathogen and can transmit it, but doesn't show any symptoms. Typhoid Mary is the most famous one, she transmitted typhoid fever by cooking for a lot of people and making them sick.

**Mortality rate**-The ratio between death and total population in a certain time. Crude mortality is usually out of 1,000 people per year, so if 5 people out of 2000 die one year, the crude mortality would be 2.5 deaths/1000 people per year.

**Morbidity**-The state of not being healthy, including disease, injury, and psychological issues. Measures of morbidity include incidence, prevalence, and some other things.

**Surveillance**-The collection of health data, done in a systematic manner. It can be active or passive. In passive surveillance, the healthcare providers give data to the investigators/gov/ppl when they want to. In active surveillance, the people that want the data try to get it from healthcare providers, like by calling hospitals or visiting them. Passive surveillance is best if data

is just being collected to find trends or spot and emerging outbreak. Once an outbreak starts, investigators might switch to active surveillance to gather more information.

#### How to avoid bias in a study:

The first step to reduce or avoid bias is identifying all the possible types.

There are many types, but some of them can be solved with the following strategies.

Pick a large sample population to study, this reduces chance of confounding bias and random error.

Make sure control/exposed and exposed/case have similar characteristics. (If 2 of the exposed are smokers, try to have a similar amount of smokers in the non-exposed) This also helps reduce confounding.

Make sure subjects (blinding), interviewers (double blind), and people interpreting data (triple blind) don't know the hypothesis. This reduces confirmation bias.

Prevent certain people from joining a study. For example, you might exclude old people from a study because they have a higher chance of getting sick and dying. This helps with confounding bias.

#### Microorganisms

**Bacteria**-Bacteria are very common microorganisms and are part of a normal microbiome.

However, some produce toxins, which can damage cells. They usually thrive in normal pH. They cause diseases like typhoid fever.

**Virus**-It's debated whether viruses are alive or dead because they don't have cells. They consist of an outer shell, or envelope, and some RNA to insert into the host. There is a lytic cycle, where the virus reproduces by injecting their genetic material into the host. There is also a lysogenic cycle, where a virus puts its genes into the host's and remains dormant for a while. This is done by viruses such as HIV.

**Fungi/Fungus**-Fungi include mushrooms, but they can also cause disease. They cause things like Athlete's foot. They release spores to reproduce and prefer moist environments.

**Protozoans**-Protozoans are a group of unicellular microscopic animals that can get into the human body, usually by vector transmission. Some examples are malaria, caused by the plasmodium protozoa.

**Other Parasites**-These are things like worms or lice that are multicellular.

#### Useful Tools and Basic Stats

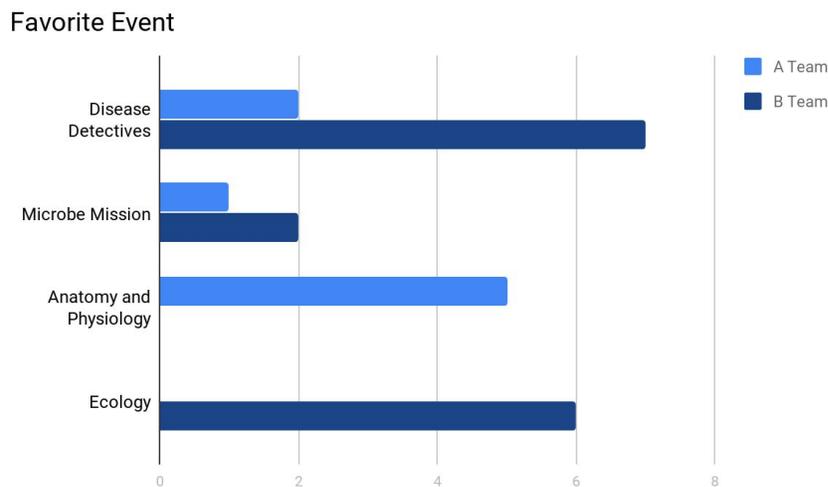
A spot map containing places where the ill people live can be very helpful in determining exposure. A famous example of this is John Snow, who used a spot map to find the cause of

cholera in London. He noticed a lot of cases were clustered around Broad Street Pump, which turned out to be the cause.

A map with shading on it to indicate something like prevalence in certain areas is known as a choropleth. It is a lot like a spot map, but not as specific.

Scatter plots can help show the correlation between 2 variables, like study time and test grade.

Bar charts can compare different groups of data using bars. A bar chart can also be grouped, meaning it compares two groups in different categories, like below.



Pie charts and 100% component bar charts are basically the same, they show how much of the total (Deaths each year, outcome of disease) each factor (homicide, starvation, accident; death, recovery, vegetative state) takes up.

In epidemiology, sometimes a seemingly convincing result will occur by chance. This is the null hypotheses, which means whatever results happened was accidental and not a real sign of correlation. The p-value is the chance that the null hypotheses will be true. If the p-value is under 0.05, there is a very small chance that what happened was by chance, so the null hypotheses can be rejected. The opposite of the null hypotheses is the alternative hypotheses, which basically says that what happened wasn't by chance.

#### Basic History of Epidemiology/microbiology

Hippocrates (father of medicine) is the first person to use the term epidemic in a medical way. This was sometime around 400 BC.

John Graunt publishes the first mortality report with demographics in 1662.

In 1673, von Leeuwenhoek uses a microscope to see microorganisms. He is the father of microbiology.

In the 1800s, Williams Farr continues reporting mortality and other epidemiological data, and he is the father of modern vital statistics and surveillance.

John Snow famously solves the cholera outbreak in 1854. He is known as the father of modern epidemiology.

Koch manages to prove a link between bacteria and disease with anthrax in 1876, he comes up with his postulates sometime later.

In 1954, Doll and Hill publish a study linking smoking to lung cancer.

Smallpox is wiped out in 1980 by Edward Jenner's vaccine (invented in 1796). It remains the only human disease caused by an infectious agent to be eradicated completely.

### Reasons to investigate

Control and prevention-The most obvious reason, protecting the health of the public.

Research opportunity- If a new disease springs up, it can be a good idea to find out what caused it, treatments, and prevention.

Public, political, or legal concerns- The public is easily scared about clusters of diseases, so an investigation can help quell their fears. Health departments are also legally required to investigate some diseases/clusters.

Public Health Program Concerns- An investigation can help determine the effectiveness of the current public health program and improve it.

Training- Help teach some newer epidemiologists and introduce them to how to investigate.

### Additional Notes

The test will probably ask you about diseases or past pandemics/epidemics not related to the year's rotation topic. A few ones you might want to have in the back of your head as knowledge are:

SARS-pandemic in 2003, caused by a virus that attacked the respiratory system which started in China.

Smallpox-a dangerous disease that was eradicated by vaccines in 1980

AIDS-ongoing pandemic caused by Human Immunodeficiency Virus, an STD that destroys T cells in the immune system

Ebola- dangerous viral disease that pops up every once in a while in Africa, you might want to know a few facts especially during years there are outbreaks

Malaria- serious problem in multiple parts of the world, caused by protozoa spread by mosquitoes

Keep up on the latest epidemiology news, those come up on tests every once in a while.

How to write a case definition:

- 1) Include the suspected time the symptoms will start, such as March 5, 2016 onwards.
- 2) Include a place, such as went to the community pool or live in/visited Chicago.
- 3) Include person details, like possible other exposures/risk factors, for example, people over 65 or under 5, people who ate ice cream, people who touched the parrot, etc.

Finally, include symptoms.

There can be different levels of a case definition: suspected, probable, confirmed.

For suspected and probable, the difference will most likely be the number of symptoms present.

For confirmed, there should be lab confirmation.

NOTE: for exposures, make sure your case definition also captures exposures other than the one you suspect. If ice cream is suspected to be the cause, you could put “all foods” to make sure it’s not something else.

Scioly wiki has some useful things to copy/paste because for some reason every ES uses info from that website.

Ten steps to investigating an outbreak, taken from Scioly.org. Reminder: these don’t have to be done in this order.

1. *Prepare for Field Work*- Do research on stuff, get materials like protection ready, and make sure the people who will help you, like labs, are also ready.
2. *Establish the Existence of an Outbreak - Consider Severity, Potential for Spread, Public Concern, and Availability of Resources*-Make sure it’s actually an outbreak or it could become a serious one before spending resources to investigate it.
3. *Verify the Diagnosis*-Make sure you have the right disease, or if it’s a new disease, make sure it isn’t actually a known one.
4. *Define and Identify Cases - Case Definition and Line Listing*-Put out a case definition (see above) and find people who match it.
5. *Describe and Orient the Data in Terms of **Person, Place, and Time** - Descriptive Epidemiology*
6. *Develop Hypotheses (Agent/Host/Environment Triad) = Chain of Transmission*
7. *Evaluate Hypotheses - Analytical Studies (MUST Have a Control Group)*-Use a study with a control group to determine the accuracy of your hypothesis.
8. *Refine Hypotheses and Carry Out Additional Studies*-This step is to either fix an incorrect hypothesis or double check a correct one.
9. *Implement Control and Prevention Measures (ASAP!)*
10. *Communicate Findings*-Publish your work to a medical community and make sure the public knows.

## Types of Studies

### Intro to Studies

Epidemiologists will have to come up with hypotheses when faced with public health issues. They can test these hypotheses by doing studies. Studies can also be used just to gather information. There are two main types of studies. When the case and control group are being controlled by the researchers (i.e. given either a real pill or a placebo pill), it is an experiment. When the researcher isn’t in control of the exposure, but are just comparing 2 groups (ie a group of people who don’t smoke vs one that already smokes), it is an observational study.

There are also analytical studies which basically are anything with a case/control scenario. These are used to test hypothesis, while descriptive studies generate them. (ecological and cross-sectional are usually descriptive)

## Case-control study

This study uses disease status as a way to determine causation. It is retrospective observational, which means it looks back in time. It is useful with rare diseases. In this study, 2 groups of people, one diseased and a control group, have their past exposures compared to determine what caused the disease. In a case-control study, odds ratio (OR) is used because risk ratio (RR) can only be used when the entire target population is known.

In a case control, the biases that are most likely to occur are interviewer bias, recall bias, and possibly confounding bias. These are best avoided by making the study double or triple blind, or at least blind. A larger sample size, matching case/control, and restricting people with certain attributes can help with confounding bias.

## Cohort study

A cohort study selects case and control group based on exposure status. This study can be retrospective or prospective. This type of study is good for rare exposures, but is expensive and time consuming. A cohort is a group of people with something in common that are followed to see the outcome (prospective); if it is retrospective, things like medical records are used to determine exposure. This type of study can use either risk ratio (RR) or odds ratio (OR), but usually RR.

Confounding bias is a possible bias, but can be reduced using matching, randomizing, and restricting.

A famous example is British Doctors' Study (done by Doll and Hill, and later Peto) where a prospective cohort was done on male doctors that smoked or didn't smoke. By sending them questionnaires about their health and smoking habits multiple times, as well as using their cause of death, determined a higher rate of lung cancer and heart attack in smokers.

## Cross-Sectional Study

While the previous 2 studies were longitudinal (they looked at several points in time to come to a conclusion), this study uses data from one point in time only. It is also known as a prevalence study for that reason. This can be done by a survey. It is cheaper than both case-control and cohort, and easier to do. However, the data collected in a single cross-sectional may be inadequate to answer many questions. Recall bias can also be an issue if the survey asks about possible exposures. The evidence collected in a cross-sectional is not usually strong enough to confirm a hypothesis, but can be used to make one.

## Ecological Study

This type of study takes geographically based or temporally based data from a population and uses statistics to figure out possible exposures. It is easy to misinterpret, but a cheap study method. A famous example is Snow's cholera study, where he mapped cases of cholera to determine the cause. Maps, graphs, and charts are tools this type of study utilizes. It is better to formulate hypothesis rather than testing them.

## Randomized Control Trial

This is an analytical study that randomly selects a control and trial group from a sample population (which is preselected). The trial group receives experimental treatment usually while the control gets a placebo. This type of trial is usually used for experimental drugs and not with harmful exposures because of ethical reasons.

Examples include pretty much every drug trial ever.

## Sample Investigation

For as long as I've done this event, the rules have required students to look at an outbreak and make a hypothesis, do some numerical crunching, solve, and find solutions to the outbreak. Sometimes the entire test is 2 outbreak scenarios with like 50 questions each (multiple past nationals).

Here's a guideline to solving these things in a timely and efficient manner.

It might begin with a summary of the disease being studied, especially in pop growth/environmental factor years (you're kind of expected to know the disease during foodborne years). Read it and make sure you understand the transmission, symptoms, and past cases if in the text. Also, be sure to kind of know what flu like symptoms mean because that's mentioned a ton.

*"Influenza, commonly known as "the flu", is an **infectious disease** caused by an influenza virus. Symptoms can be mild to severe. The most common symptoms include: **a high fever, runny nose, sore throat, muscle pains, headache, coughing, and feeling tired**. These symptoms typically **begin two days after exposure to the virus and most last less than a week**. The cough, however, may last for more than two weeks. In children, there may be nausea and vomiting, but these are not common in adults."*-Wikipedia on the Flu

Take this sample paragraph about the flu. I've highlighted all the important information in it. In this case, the paragraph failed to mention the method of transmission. However, this can usually be guessed by symptoms. Remember that infectious diseases want to spread more.

Coughing and/or sneezing usually mean airborne. Hemorrhaging, bloody diarrhea, and the like usually mean spread by blood or certain insect-carried diseases. Diarrhea and vomiting or any other kind of weird excrement usually mean foodborne.

Since there is coughing and the article makes it a point to mention that vomiting/nausea isn't common in adults, it is reasonable to assume the flu is mostly airborne.

After you answer some simple questions about the disease which are answered by the paragraph, you will most likely be given a story of past case of the disease in an outbreak. It may or may not be complete.

For example (based on the SARS pandemic):

In late 2002, doctors in Guangdong saw a patient with an unknown respiratory illness. In March of 2003, a doctor from Guangdong visiting Hong Kong brought the illness with him. He died of the respiratory illness in March, after spreading it to some of his family and 13 people who were on the same hotel floor as him. He is considered a super-spreader. In March, Dr. Urbani, a WHO infectious disease specialist, realized he was dealing with a new infectious disease after treating someone who had lived on the same hotel floor as the doctor. You're part of a WHO team asked to investigate this new disease. You've already gotten everything ready, protective clothing, things to take samples with, and the latest news on the disease. You know it is a serious public health threat since it appears to spread easily in the air, and since it has never appeared before anywhere, it is technically an outbreak.

This is a possible chunk they will give you before asking a few questions. What is a super-spreader and what are some possible routes of transmission for this disease are possible questions. Remember: Dates and locations are important! Do take notes/mark important stuff on the test if allowed. This will help you greatly later.

They might also ask you what you should do next (Ten Steps to Investigating an Outbreak) or how you would design a study. Using the example above, since its clear from the story that you've already prepared for fieldwork and established the outbreak, now you would verify the diagnosis. A good idea is to send samples to labs for testing to make sure this isn't just an extremely rare disease that's already known and to learn more about if it is new.

After a long story (that you should read carefully!), you will most likely be presented with a ton of numbers.

For example, if some people at a party got sick, this might be the data you get.

	Cases		Controls	
	Exposed	Not exposed	Exposed	Not exposed
Cake	1	6	4	6
Ice cream	4	2	1	9
Juice	3	3	7	3
Cheese	2	4	5	5
Cookie	0	6	8	2

You will most likely have to do a ton of calculations in this part. Bring your calculator, double check your work, and write in complete sentences when in doubt. Be sure to use the right equation. Also, this section will most likely end with asking you what probably caused the outbreak. According to this data, the ice cream probably caused it. You might also get a question like “why did some of the cases report that they didn’t eat ice cream? Or why did one control eat ice cream and not get sick?” Think about recall bias, the fact that someone might have not noticed symptoms, and that they could’ve been exposed without their realization. (For example, if the ice cream spoon fell into the juice or some other food, it could’ve contaminated that.) Some cases will have multiple exposures.

The next questions will almost certainly be: “What should you do next now that you’ve identified the cause?” If the story has made it clear it probably can’t be anything else, the next thing to do is implement control and prevention measures, as well inform the public and anyone else by communicating your findings. Prevention measures include isolating cases in case of contagious disease, dealing with the source by eliminating it, giving out treatment, telling people with symptoms to see a doctor, and asking hospitals to report all cases and isolate them.

Usually, the story will have a conclusion. After which, there will most likely be the question: “What are x (usually 2-5) way(s) we could prevent this/learn from this?” Usually, for vector borne diseases, a good answer is to remove/control the vector, or, if it’s the vector’s excrements that spread the disease, a good answer could be to clean up the waste with protection. For a foodborne/waterborne infectious illness, it is always good advice to properly cook and prepare all foods, and avoid cross-contamination. Water should be boiled and filtered. For airborne diseases, prevention could include developing a surveillance system to quickly identify any cases since these are the most easily spread. Wearing masks may help.

# Heavy Metals: Food and Water

## Mercury Poisoning

### Quick Overview

Mercury poisoning is caused by ingesting or inhaling the heavy metal mercury, often in fish or industrial processes. Organic mercury can accumulate in fish and other organisms.

It leads to neurodegeneration, as well as affecting other organ systems if inhaled. It affects neurological development in children.

There was an epidemic near the Minamata Bay in Japan during the 1950's-1960's (and possibly later), caused by Chisso Corporation dumping mercury-laced wastewater into the bay.

### Sources

Mercury is often found in fish from burning coal for fuel and smelting. Biomagnification (poisons are more common in predators because they accumulate more of the poison from all the smaller fish they eat, which contain smaller amounts of the poison from what they eat) makes this worse in fish likes shark and swordfish [1].

Mercury poisoning is most common in people that often eat fish with high mercury levels but can also be in air containing mercury. Mercury can be transformed into methylmercury by bacteria, which bioaccumulates. [2]

### Symptoms

Mercury poisoning is most dangerous to fetuses or people with chronic poisoning. Organic mercury ingested affects the nervous system by causing:

- Tremors
- Numbness in extremities
- Lack of coordination, leading to inability to walk
- Loss of vision and hearing, as well as speech
- Negative effects on development of children (reduced attention, speech, etc) [3]

Inhaled mercury may affect other organ systems.

### Case (Minamata Disease)

#### Timeline [4]:

**1932**-the Chisso Corporation started producing acetaldehyde, which resulted in methylmercury as a waste product, which was being dumped into the Minamata Bay, poisoning the fish.

**1950 and later**-Cats are reported to be “dancing” and going mad from the disease. Other wildlife (fish, bird, plants) are also noticed to be affected.

**April 1956**-a young girl went into the hospital with unexplained neurological issues, such as impairments in speech and walking, the first recorded case.

**May 1956**-the disease is announced as an epidemic by the local health public health office, Strange Disease Countermeasure Committee (SDCC) is formed as a result.

**1956**-Kumamoto University Research Group investigates the disease, they find out about the natural history (progression of symptoms) of the disease. They notice a lot of the people live in fishing communities. In November, they announce that the disease is probably caused by heavy metals from fish consumption.

**1957-1958**- different possible causes for Minamata are suggested because multiple heavy metals are found in Chisso Corporation's wastewater. Douglass McAlpine suggests organic mercury based on the symptoms, leading to investigations on that.

**1959**-the disease is officially declared as caused by methylmercury poisoning from fish and shellfish. The Chisso Corporation hospital director feeds fish from Minamata Bay to cats, which then start showing signs of Minamata disease. He is ordered to end the experiment.

Wastewater treatment facilities are installed, but later prove useless.

**1961**- Masazumi Harada and other doctors starts researching children with cerebral palsy and other disorders after high numbers of these disorders are reported in the area. He and others discovers that Minamata is congenital (got from mother in womb).

**1965**-an outbreak of Minamata disease breaks out near the Agano River, where the Showa Denko company had been dumping their waste. "Dancing" cats are also seen before human cases here. (Niigata Minamata)

**1968**-The Chisso company finally stops making acetaldehyde with mercury components and the Japanese government releases an official statement about the cause of the disease.

## Cadmium Poisoning

### Quick Overview

Cadmium can be more common in certain crops and in water supplies.

It can cause kidney damage, weaken the bones, and cause vomiting and diarrhea if ingested. If inhaled, it can damage the lungs.

There was an epidemic in Japan around the 1910s and onwards caused by rice that had been irrigated with water containing cadmium as a waste product of mining.

### Sources

Cereal grains, such as rice, potatoes, tobacco, and some other plants absorb cadmium from the soil. Cadmium can end up there as a result of mining and smelting or water supplies contaminated with cadmium. It can also be more common (in certain areas) in mushrooms, shellfish, and kidneys/livers. It can end up in water supplies from pipes or wastewater containing cadmium. Cadmium accumulates in the body. [5]

### Symptoms

Ingesting too much cadmium at once causes vomiting, diarrhea, and possibly death. Chronic exposure to cadmium via ingestion causes kidney damage and weakened bones. In animals, it has been noticed to cause liver damage, neurological damage, and anemia (lack of healthy red blood cells).

Breathing cadmium fumes can cause death if a lot is breathed in, but chronic exposure to smaller amounts can damage kidneys, bones, and lungs. [6]

### Case (Itai-Itai Disease) [7]

#### Timeline:

**1910**-Cadmium starts being released into water around Toyama Prefecture, by a mine of Mitsui Mining and Smelting Co., into the Jinzu River, which people used to water rice, drink, and fish.

**1912**-The first cases of the disease appears.

**1940s-1950s**-Researchers start looking for the cause of Itai-Itai disease. Lead is considered at first, but in 1955, Dr. Hagino and other researchers considered cadmium. There are no more new cases after 1946.

**1961**-Toyama Prefecture does its own investigation and determines cadmium from the mine is causing the disease.

**1968**-Ministry of Health and Welfare officially states symptoms and cause of Itai-Itai disease.

#### Additional Notes

Later studies showed that cadmium was not the only cause of all the symptoms of Itai-Itai disease. Malnourishment is suspected to play a part since older women are more affected by it. Also, the cadmium probably attacked mitochondria in the kidney cells.

Itai-Itai disease was named because of pain in the spine and connective bone tissue felt by people with the disease.

## Lead Poisoning

### Quick Overview

Lead is a common heavy metal that can get ingested. Pipes sometimes are made from it. It causes neurological damage and damage to other organ systems, like the gastrointestinal system.

Water from Flint, Michigan was contaminated with lead after a change in the water source caused lead from pipes to leak into drinking water.

### Sources

Lead is often in older water pipes, soil, and paints (which young children may eat). However, it can also be in jewelry (which young children might put in their mouths) and certain traditional medicines. [8]

### Symptoms

Lead poisoning can cause neurological damage, including

- Problems with speech, hearing, and memory

- Fatigue
- Headache
- Problems with fine muscle control
- Concentration problems
- At high doses, paralysis, encephalopathy (which can lead to coma and death)

It can also cause vomiting, weight loss, abdominal pain/discomfort, joint pain, severe abdominal cramps, and constipation. [9]

## Case

### Timeline [10]

**April 2014**-The city of Flint, Michigan switches their water supply to the Flint River while they worked on changing their water supply to another provider. The water is considered safe at this time.

**August 2014**-Some bacteria in the water cause the city to add more chlorine and tell citizens to boil water. There are still concerns about the water since the Flint River wasn't exactly the cleanest.

**January 2015**-There are problems with the water related to chlorine, which are fixed. Before this point, General Motors notices that the Flint River water corrodes metals easier and decides to stop using Flint water.

**February 2015**-High levels of lead are detected in the water, by both city tests and Virginia Tech tests, and reported.

**April 2015**-The EPA receives a report that Flint did not implement corrosion prevention measures at the plant.

**July 2015**-In response to a leaked memo from the EPA, containing worries about lead levels in the water, Michigan's Department of Environmental Quality says the water is safe to drink. (Which later proved untrue.)

**August 2015**-In a report about lead levels in water, Michigan removes two values that would have made it above the federally allowed level. They claim it was because the two samples didn't satisfy federal criteria.

**September 2015**-Virginia Tech notes that there is a dangerous amount of lead in water they tested from hundreds of homes. The city claims that their results are inaccurate. High lead levels are detected in children, prompting the city to issue a statement that lead isn't safe for children.

**October 2015**-The city gives free water filters and testing to citizens and switches the water back to the original supply.

**December 2015**-The city declares a state of emergency.

**January 2016**-The state, President Obama, and EPA declare it an emergency. The EPA orders Flint to take action.

**2017 onwards**- at this time, the city is still working on the water problem, but there are still lead pipes that need to be replaced. However, the lead levels, even in places with lead pipes, are low. After the state funds for free bottled water ran out, Nestle is currently donating bottled water to people who still are unsure about drinking the water. [11]

### Additional Notes:

Flint did add things to the water to try to fix to problem, but far too late. Multiple officials and two corporations were charged.

### Case #2 [12]

**January-April 2010-** Wildlife, such as ducks, start becoming uncommon in Northern Nigeria  
**May 2010 and later-**It is reported that a lot of children have died of a mysterious illness. They suffered from headaches, seizures, abdominal pain, and vomiting before their death. An investigation in Zamfara State finds out that it is linked to lead, probably from mining activities done by families. Work was done to reduce the level of lead and treat children.

Arsenic poisoning (Note: this type of poisoning is often not environmental, but can be)

### Quick Overview

Arsenic can be in water and soil. It is also found in some products. It causes damage to the nervous, digestive, hepatic, and muscular systems. It can also harm other systems.

### Sources

Arsenic is often in groundwater and can contaminate soil with industrial processes. They might also be in cosmetics, which can be accidentally ingested or absorbed into skin. It can also be found in air. [13]

### Symptoms [14]

Symptoms include loss of appetite, muscular weakness, pins and needles, pains in extremities, liver damage, and edema (excess fluid buildup in body cavities).

It can cause

- bloody diarrhea from hemorrhage in the gastrointestinal system
- stomach inflammation
- Hepatitis
- Portal hypertension (high blood pressure in portal vein) from cirrhosis of liver)
- Liver cancer
- Kidney failure and necrosis of kidney cells
- Muscle cramps
- Numbness
- Epilepsy, hearing loss, and other cognitive issues in kids that ingested arsenic chronically
- Increased melanin in skin, sometimes patchy
- Skin cancer
- Keratoses (darker growths on skin)

There are a lot of other things, but these are the main ones.

## Case

There hasn't been an epidemic of arsenic poisoning that is linked to environmental quality.

## Air Pollution

### Yokkaichi Asthma [15]

#### Quick Overview

Sulfur oxide was released from the burning of oils for fuel. It caused a lot of lung problems including chronic cough, COPD, and asthma in the people around the factory. (Note: technically Yokkaichi asthma has been reported outside)

#### Source

Yokkaichi asthma was caused by sulfur oxide in smog released as a result of burning oils. Japan had been changing their fuel source from coal at the time. The oil they used had sulfur in it. After complaints about the smog, the factory heightened its smokestacks, which did nothing useful and just spread the pollutants further. Finally, flue-gas desulfurization prevented the sulfur from being dispersed.

#### Results

People exposed to the smog developed chronic obstructive pulmonary disease (COPD, lung disease caused by breakdown of alveoli), chronic bronchitis (long term productive cough, also sometimes a synonym for COPD), and bronchial asthma. People suffering from Yokkaichi asthma were found to have a higher mortality than people in other areas of the prefecture.

### Collapse of Twin Towers [16]

#### Quick Overview

The rubble and fires of 9/11 resulted in the release of lots of toxins into the air around Twin Towers. Rescue workers and other people were affected by this, leading to chronic lung diseases and cancer.

#### Source

On September 11, 2001, terrorists flew planes into the Twin Towers, causing them to collapse, killing thousands. The collapse also released a lot of dust from the buildings and things inside of them into the air. Among other things, the dust contained lead, mercury, asbestos, concrete dust, dioxins, and cadmium. The smoke from the fire spread to other places in Manhattan, hurting people there as well.

#### Results

In rescue workers lung function was decreased chronically. Rhinosinusitis (inflammation of nasal passage), acid reflux, asthma, sleep apnea (breathing issues during sleep), cancer,

PTSD, COPD (see Yokkaichi asthma), depression, and anxiety are currently, according to the World Trade Center Health Program (created to deal with health problems as a result of 9/11), the symptoms. Some believe that 75 of rescue workers at Twin Towers developed cancer that is linked to the toxins at 9/11.

## Air Pollution in China

### Quick Overview

As a result of fuel burning in China, a lot of particulates are being released into the air. They cause pulmonary issues.

### Source [17]

A lot of particulate matter smaller than 2.5 micrometers (PM 2.5) come from burning coal, traffic, and burning biomass. They can contain sulfur dioxide, potassium, calcium, formaldehyde (from house construction or furniture), nitrate, and sulfate.

### Results

In 2003, according to Chinese Academy for Environmental Planning, air pollution has been responsible for 411,000 early deaths. It also causes cough, throat irritation, asthma, bronchitis, heart attacks, cancer, birth defects, and lung disease. [18]

[1] <https://www.scientificamerican.com/article/how-does-mercury-get-into/>

[2] <http://www.who.int/news-room/fact-sheets/detail/mercury-and-health>

[3] <https://www.epa.gov/mercury/health-effects-exposures-mercury>

[4] <http://www.bu.edu/sustainability/minamata-disease/> (This page apparently is a shortened copy of this Wikipedia page: [https://en.wikipedia.org/wiki/Minamata\\_disease](https://en.wikipedia.org/wiki/Minamata_disease))

[5] <https://www.atsdr.cdc.gov/csem/csem.asp?csem=6&po=5>

[6] <https://www.atsdr.cdc.gov/phs/phs.asp?id=46&tid=15>

[7] [https://en.wikipedia.org/wiki/Itai-itai\\_disease#cite\\_note-icett-1](https://en.wikipedia.org/wiki/Itai-itai_disease#cite_note-icett-1)

- [8] <https://www.cdc.gov/nceh/lead/tips/sources.htm>
- [9] <https://www.atsdr.cdc.gov/csem/csem.asp?csem=34&po=12>
- [10] <https://www.npr.org/sections/thetwo-way/2016/04/20/465545378/lead-laced-water-in-flint-a-step-by-step-look-at-the-makings-of-a-crisis>
- [11] [https://en.wikipedia.org/wiki/Flint\\_water\\_crisis](https://en.wikipedia.org/wiki/Flint_water_crisis)
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- [13] <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4186553/>
- [14] <https://www.atsdr.cdc.gov/csem/csem.asp?csem=1&po=11>
- [15] [https://en.wikipedia.org/wiki/Yokkaichi\\_asthma](https://en.wikipedia.org/wiki/Yokkaichi_asthma)
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- [17] [https://en.wikipedia.org/wiki/Pollution\\_in\\_China#Air\\_pollution](https://en.wikipedia.org/wiki/Pollution_in_China#Air_pollution)
- [18] <https://www.usnews.com/news/best-countries/articles/2017-01-13/the-health-effects-of-beijings-smog>