

## Asthma "Outbreak" Exercise

### Purpose

This exercise demonstrates how epidemiological investigations of disease outbreaks are performed.

### Overview

In groups or as individuals, students evaluate numerical data on a possible asthma epidemic in a hypothetical school. They develop a case definition of disease and formulate possible hypotheses as to its source. They evaluate these risk hypotheses by using math and basic statistics (including graphs and odds ratios) and mapping. They recommend prevention interventions. These results can be presented orally by individuals or groups. An optional Historic Smog Outbreak Appendix is offered which includes a similar evaluation of a real historic outbreak of mortality from a severe smog episode in London in the 1950's.

### Time

1 two-hour block class period or can be broken up with homework calculations. The results can be written up and/or presented verbally in class.

### Key Concepts

The collection and analysis of data is a key step in identifying a disease "outbreak". The development of a case definition allows for comparison of cases and non-cases. Mapping in time and space allows for identification of a possible source of an outbreak. The use of simple statistical analysis aids in identifying a epidemic's source.

### Skills

Data analysis  
Graphing and mapping data  
Hypothesis formation  
Generating odds ratios

### Materials

Handheld calculators

Computer access to spreadsheet and graphing software such as Excel would be useful, but not essential since tables can be created and used.

### Facilitator Preparation

You will need to divide the students into groups or teams. Prior knowledge of the Teacher's Guide to Air Quality will prepare you for the range of issues addressed in this section.

Teachers should meet with each group to evaluate their progress in collecting information and deciding on formulating a spreadsheet and graphing, and analyzing the data, as well as formulating and substantiating hypotheses.

### Background

Epidemiology is the study the patterns and risk of diseases and exposures in populations. Outbreak investigations or "epidemic" investigations, an important and challenging component of epidemiology and public health, can help identify the source of ongoing outbreaks and prevent additional cases. Even when an outbreak or epidemic is over, a thorough epidemiologic and environmental investigation often can increase our knowledge of a given disease and

prevent future outbreaks. Finally, outbreak investigations provide epidemiologic training and foster cooperation between the clinical and public health communities.

### Procedure

Students should be given the following worksheets as individuals or groups to work either independently or as a class directed exercise. Written answers can be handed in or presented orally.

### Follow-up Activities

- Class field trip to the local Public Health Department and talk with an epidemiologist (a physician or public health scientist who studies diseases and exposures at the population level)
- Students can create educational materials (brochures, videos, fact sheets, posters) on asthma, exposures and risk Issues)

### Student Assessment

Give the following components to each student team as a guide:

- ❖ In pairs or groups, read the enclosed case (Asthma Epidemic at AMBIENT High School?) answering the questions using full written sentences
- ❖ Formulate written hypotheses as to the populations and exposures in this epidemic
- ❖ Design a spreadsheet to collect and calculate the data
- ❖ Graph the data and evaluate
- ❖ Evaluate the geographic data presented in the Map
- ❖ Decide if the results are consistent or not with the hypotheses, and why
- ❖ Present the data and results as written and/or oral presentation
- ❖ Each group member should take part in the Presentation, even if it is just to read or explain one piece of the presentation
- ❖ Each group member should answer at least one question from the audience at the end of their Group presentation.

Assign points for the following components of the Team Project:

- ❖ Were the original hypotheses clearly formulated?
- ❖ Was the spreadsheet appropriately constructed?
- ❖ Were data entered appropriately into the spreadsheet?
- ❖ Were the graphs appropriate constructed?
- ❖ Was the map data appropriately interpreted?
- ❖ Were data interpreted by all members of the Team?
- ❖ Were proper science terms used in the written interpretation of the hypotheses?
- ❖ If a presentation was made, was each group member actively involved in the presentation?

## Asthma Epidemic at AMBIENT High School?

AMBIENT High School is located in Miami, a city of 2 million people in Miami Dade County, FL. During the last week of January, several physicians contacted public health authorities to report an increase in the number of teenagers who had come to the emergency rooms of the 4 large urban hospitals seeking medical care for acute severe asthma. Specifically, on Tuesday January 21, a total of 108 teenagers and other people sought care at these hospitals for difficulty in breathing. Most of these people were thought to be suffering asthma. The attacks struck very suddenly and caused such severe problems that about 10% of the people were in intensive care units requiring the use of a ventilator.

1. What is asthma?
2. Is this an epidemic of asthma? What additional information do you need?
3. Review of the hospital records reveals that the 4 hospitals treated **236** teenagers and other people with asthma during the month of January. Now can you determine if this is an epidemic?
4. Develop a brief description of an asthma case (known as a “case definition”) to be used to study this particular possible outbreak involving person, time and place characteristics.

Table 1. Number of persons who presented with acute asthma to the 4 city emergency rooms during the prior year.

Month	Number of Cases
January	199
February	136
March	160
April	125
May	135
June	108
July	118
August	104
September	161
October	146
November	162
December	127

5. Draw a graph or bar chart of these data (Table 1). What additional information does the graph or bar chart provide?

6. Do you now have sufficient information to determine if there is an epidemic of asthma?

Table 2. Number of persons who presented with acute asthma at the 4 city emergency rooms during January

Day	Number of Cases	Day	Number of Cases
1	5	17	7
2	8	18	4
3	8	19	9
4	5	20	11
5	5	21	64
6	4	22	9
7	4	23	4
8	9	24	0
9	7	25	8
10	9	26	8
11	9	27	8
12	5	28	7
13	8	29	3
14	6	30	8
15	7	31	2
16	6		

7. Draw a graph or bar chart of these data (Table 2). What additional information does the graph or bar chart provide?

8. What else would you like to know about this epidemic?

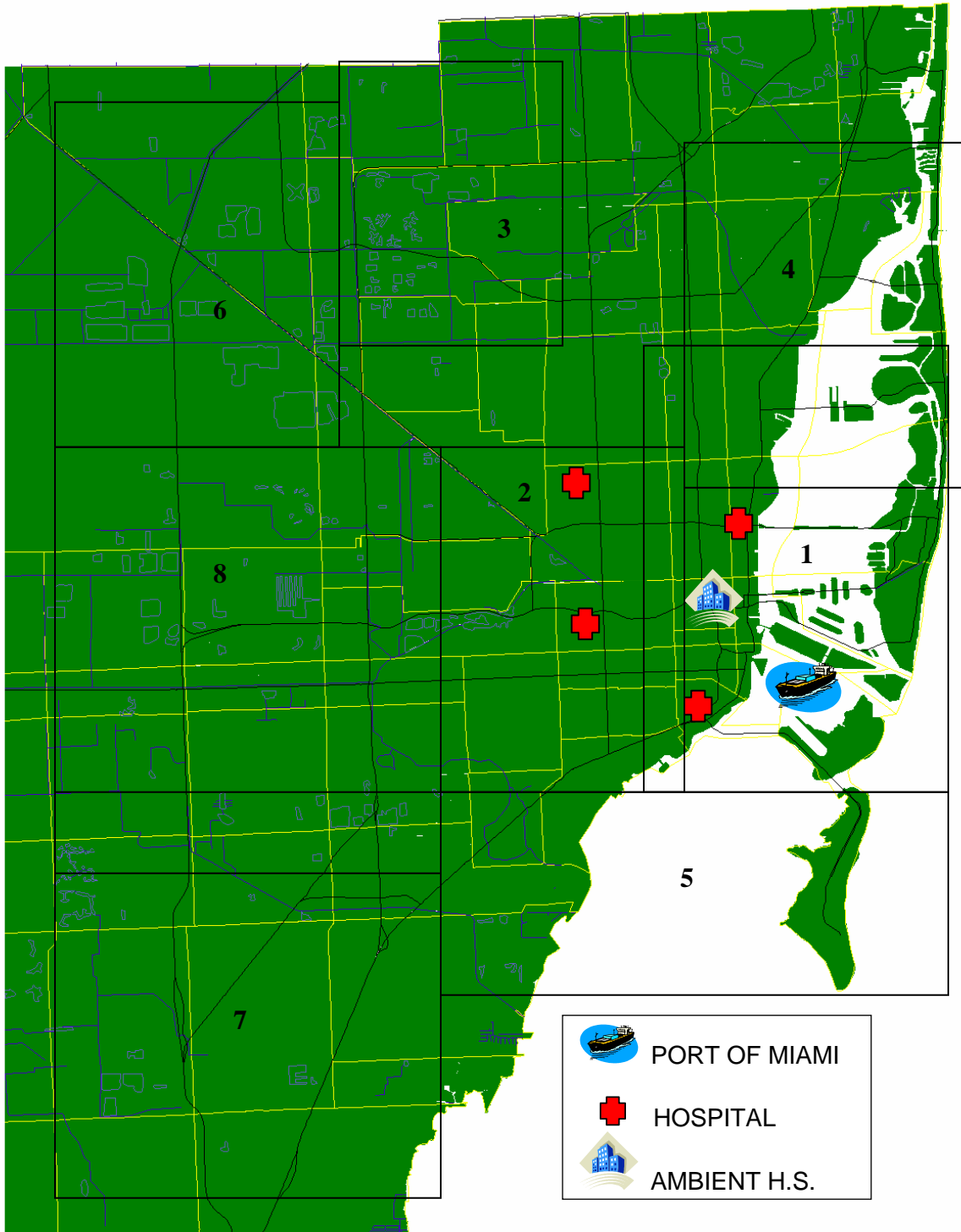
Table 3. The distribution of age, gender, time of Asthma Onset and Geographic place at time of onset of Asthma attacks of all cases

Age	Gender	Time of Asthma Onset	Place (region)	Age	Gender	Time of Asthma Onset	Place (region)
14	F	10:55	4	29	F	12:05	2
18	M	13:40	2	14	M	9:25	8
16	F	12:00	3	16	F	12:15	2
65	F	8:20	3	35	M	16:50	1
13	M	17:15	1	15	M	13:20	1
18	M	17:10	1	17	F	12:35	1
15	F	11:10	2	40	F	11:30	2
16	M	11:35	1	16	M	12:08	2
17	F	15:10	6	18	M	10:17	1
4	M	9:05	5	19	F	10:45	1
15	M	11:08	2	16	M	10:25	1
15	F	23:25	4	18	M	15:15	2
13	M	11:15	2	14	M	10:08	1
16	F	11:25	1	15	F	14:10	2
19	F	14:00	3	17	F	10:50	1
35	M	15:05	1	44	M	13:20	1
14	M	11:50	1	17	F	12:35	1
15	F	11:10	2	14	F	11:30	2
16	M	11:35	1	16	M	12:08	2
17	F	22:10	6	14	F	11:17	1
14	M	12:05	1	17	F	12:45	1
15	M	11:08	2	60	M	10:25	1
14	F	10:55	4	19	F	12:05	2
14	F	12:25	1	13	F	14:10	2
67	F	15:00	3	14	F	12:50	1
13	M	15:05	1	16	M	11:30	1
15	M	11:50	1	18	F	12:35	1
25	F	12:30	2	43	F	12:30	2
18	M	11:35	1	14	M	13:08	2
15	F	22:10	6	16	F	10:17	1
13	M	11:05	1	19	F	11:45	1
50	M	11:08	2	17	M	13:25	1

9. Draw a graph or bar chart of these data looking at age and gender (Table 3). What additional information does the graph or bar chart provide?

10. On the attached city map and using the information in Table 3, show the geographic distribution of the place of onset of illness for the 64 persons who came into the emergency rooms with acute asthma on January 21. What hypotheses does this geographic distribution suggest?

### Map of Miami Asthma Cases in January



11. Draw a graph or bar chart of the cases of asthma by hour of asthma attack onset (Table 3). What hypotheses does this time distribution suggest?

In your discussions with emergency room personnel, you learn that this is not the first time that these 4 emergency rooms have been overwhelmed with teenagers suffering from acute asthma attacks. You are told that “asthma epidemic days” have occurred on 12 other occasions during the last 2 years.

Noting the clustering of emergency room asthma cases in time and space, you request data on air pollution levels in the city during the last 2 years. For Tuesday January 21, the air pollution levels were below normal for the city, as were the pollen and spore counts. Meteorological data showed high atmospheric pressure and stagnancy of air with very low wind speed.

12. What conclusions can you draw from this information?

Table. 4. Asthma Epidemic Days by Handling or Not of Products at the Port

Product	Days Product Handled (Exposure +)		Days Product NOT handled (Exposure -)	
	Asthma Epidemic Days		Asthma Epidemic Days	
	Yes	No	Yes	No
Coal	196	4	521	9
Fuel Oil	150	3	561	10
Gasoline	180	2	537	11
Cotton	399	7	318	6
Coffee	300	5	417	8
Corn	135	1	582	12
Soy Beans	249	13	468	1

Since many of the asthma cases came from Region 1 where AMBIENT school is near the Port of Miami, you decide to find out more about the activities there. You learn that the following 7 products were handled (either loaded or unloaded) from barges and boats in the harbor during the last 2 years: coal, fuel oil, gasoline, cotton, coffee, corn and soybeans.

13. How can you use this information to further explore this problem?

**14. [FOR MORE ADVANCED STUDENTS]**

An Odds Ratio is a way of comparing the risk of 2 different groups (diseased vs. undiseased or cases and controls) to have had a particular exposure. Using the same “2x2 table” (Table 5) and an Odds Ratio as a measure of risk, describe the risk of there being an asthma epidemic day with the loading of a particular product at the Port in Table 4.

**Table 5. "2x2Table" Calculation of an Odds Ratio**

	<b>Disease +</b>	<b>Disease -</b>	
<b>Product Exposure +</b>	A	B	A+B
<b>Product Exposure -</b>	C	D	C+D
	A+C	B+D	A+C+B+D

**Odds Ratio = AD/BC**

An Odds Ratio = 1 means that the risk is those days with and without disease for that exposure

An Odds Ratio > 1 means that the risk is higher those days with asthma

An Odds Ratio <1 means that the risk is lower for those days with asthma

<b>Coal</b>	<b>Disease +</b>	<b>Disease -</b>	
<b>Exposure +</b>			
<b>Exposure -</b>			

Odds Ratio = AD/BC=

<b>Fuel Oil</b>	<b>Disease +</b>	<b>Disease -</b>	
<b>Exposure +</b>			
<b>Exposure -</b>			

Odds Ratio = AD/BC=

<b>Gasoline</b>	<b>Disease +</b>	<b>Disease -</b>	
<b>Exposure +</b>			
<b>Exposure -</b>			

Odds Ratio = AD/BC=

<b>Cotton</b>	<b>Disease +</b>	<b>Disease -</b>	
<b>Exposure +</b>			
<b>Exposure -</b>			

Odds Ratio = AD/BC=

<b>Coffee</b>	<b>Disease +</b>	<b>Disease -</b>	
<b>Exposure +</b>			
<b>Exposure -</b>			

Odds Ratio = AD/BC=

<b>Corn</b>	<b>Disease +</b>	<b>Disease -</b>	
<b>Exposure +</b>			
<b>Exposure -</b>			

Odds Ratio = AD/BC=

<b>Soybeans</b>	<b>Disease +</b>	<b>Disease -</b>	
<b>Exposure +</b>			
<b>Exposure -</b>			

Odds Ratio = AD/BC=

15. The handling of which product at the port was associated with the highest risk of having asthma epidemic days?

16. What can you recommend that the City of Miami and AMBIENT High School do to prevent future episodes of asthma epidemic days among the teenagers?

This Epidemic of Asthma was actually based on a report of a real asthma epidemic in the 1980’s in Barcelona (Spain). The case is described in: Entzel RA. Case VI. Epidemic Asthma. In: Problem Based Training Exercises for Environmental Epidemiology. Markowitz S, ed. Geneva, Switzerland: Office of Global and Integrated Environmental Health, World Health Organization, 1998:43-53.

To read more about this actual epidemic, see the following references:

Anto JM et al. Community outbreaks of asthma associated with inhalation of soybean dust. New England Journal of Medicine 1989; 320(17): 1097-1102.

Anto JM, Sunyer J. Epidemiologic studies of asthma epidemics in Barcelona. Chest 1990; November Supplement: 185s-189s.

## Appendix

For more advanced students, in groups or as individuals, use the Atmospheric Fog in Greater London Case Study enclosed in the Appendix to explore issues of significant air pollution and its effect on respiratory and general health in London during a major smog event in the 1950s. Students analyze real mortality and morbidity data, as well as air contaminant data, to evaluate whether there is an epidemic and its possible causes, as well as recommend prevention interventions.

Kjellstrom T, Hicks NV. Case X. Atmospheric Fog in Greater London. In: Problem Based Training Exercises for Environmental Epidemiology. Markowitz S, ed. Geneva, Switzerland: Office of Global and Integrated Environmental Health, World Health Organization, 1998:89-104.