

## Asthma Epidemic at AMBIENT High School?: ANSWER KEY

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?

*Asthma is a non-contagious disease of the lungs in which reversible obstruction of the airways occurs. It is characterized by coughing, wheezing, and difficulty in breathing, often preceded by inhalation of dusts or other allergens, or an upper respiratory infection (a “cold”). The lungs are typically normal between attacks.*

2. Is this an epidemic of asthma? What additional information do you need?

*The presence of an epidemic cannot be determined without knowing the background rate of the disease (in this case, asthma), in the general or similar population, and whether alterations in the surveillance system have occurred recently.*

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?

*Not yet. You will need to get more information about the usual number of emergency room visits for asthmatic symptom during the past several months at these same emergency rooms.*

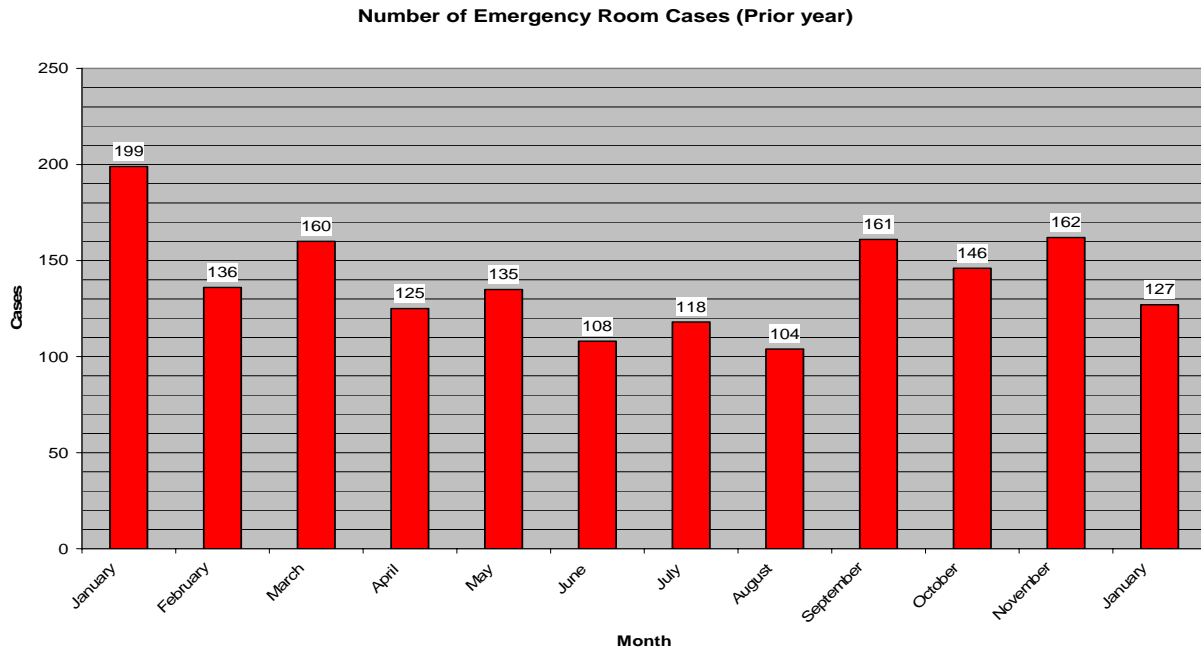
4. Develop a brief description of an asthma case (known as a “case definition”) to be used to study this particular possible outbreak involving person, time and place characteristics.

*As an example: a case of asthma is a person 14 years or older who came to one of the four hospitals emergency rooms with wheezing, coughing, and/or difficulty breathing who was diagnosed as having asthma.*

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
January	127

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



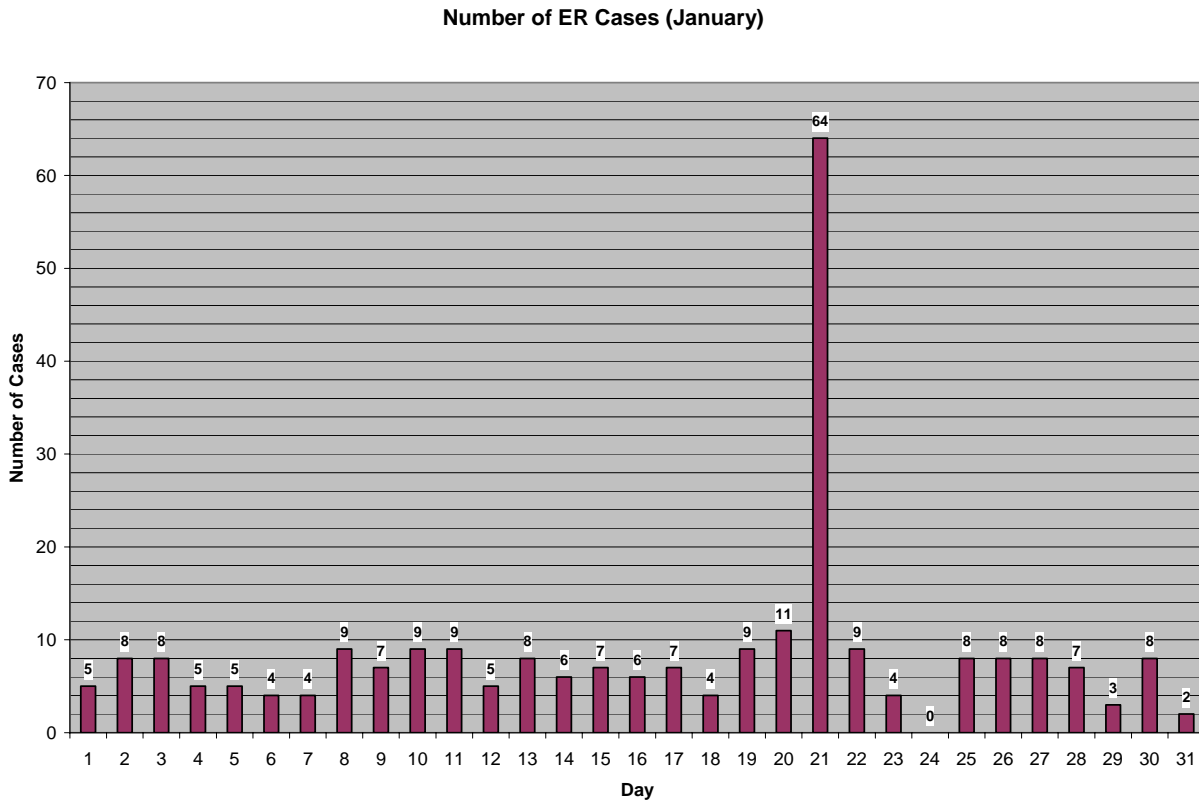
*It appears that there was indeed an epidemic because the number of cases in January was dramatically in excess of the "expected rate."*

6. Do you now have sufficient information to determine if there is an epidemic of asthma?  
*Yes, because the graph shows an unusual increase (visually) over the usual background rate of asthma cases in these 4 emergency rooms.*

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?



*It does appear that the cases had a common exposure, meaning the epidemic has a "common source", with the number of asthma cases peaking on January 21.*

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

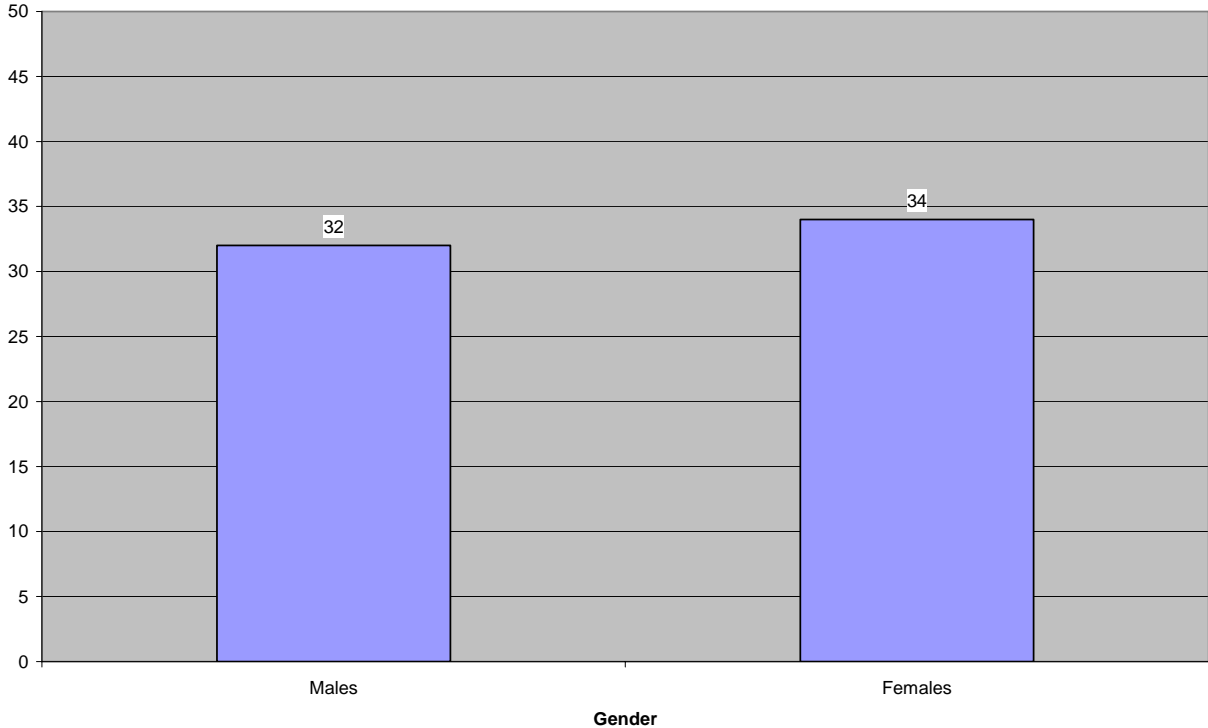
- a) Person - age, sex*
- b) Time – date and time of day*
- c) Place - where the asthma attack occurred, which hospital emergency room; maybe a geographic distribution such as a mapping of the cases*

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

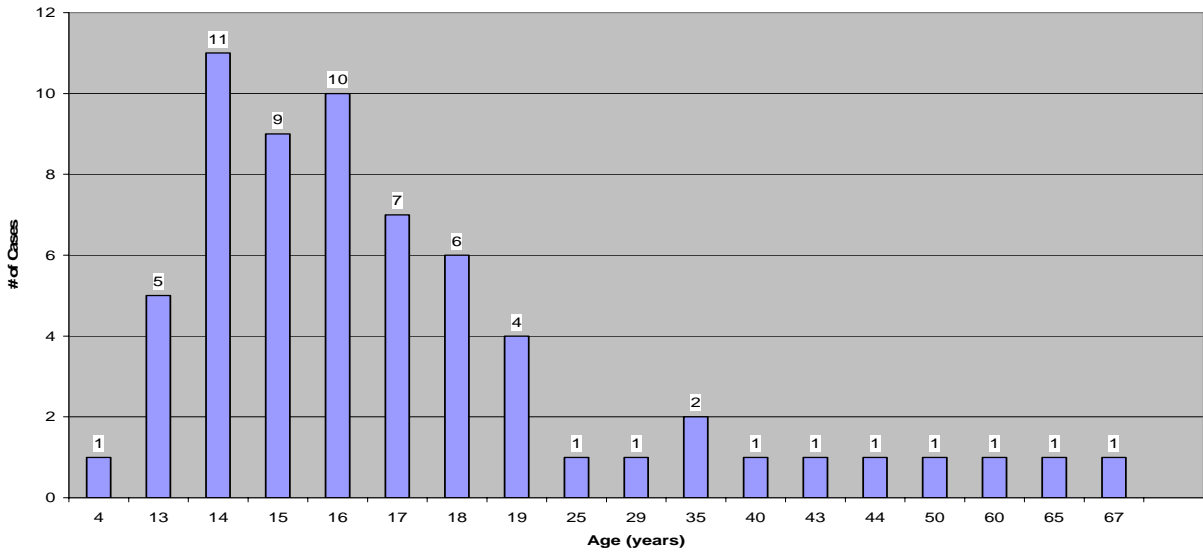
Age	Gender	Time of Asthma Onset	Place (region)	Age	Gender	Time of Asthma Onset	Place (region)
14	F	10:55	4	29	F	12:05	2
18	M	13:40	2	14	M	9:25	3
16	F	12:00	3	16	F	12:15	2
65	F	8:20	3	35	M	16:50	1
13	M	17:15	1	15	M	13:20	1
18	M	17:10	1	17	F	12:35	1
15	F	11:10	2	40	F	11:30	2
16	M	11:35	1	16	M	12:08	2
17	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?

Gender Distribution



Age Distribution of Cases



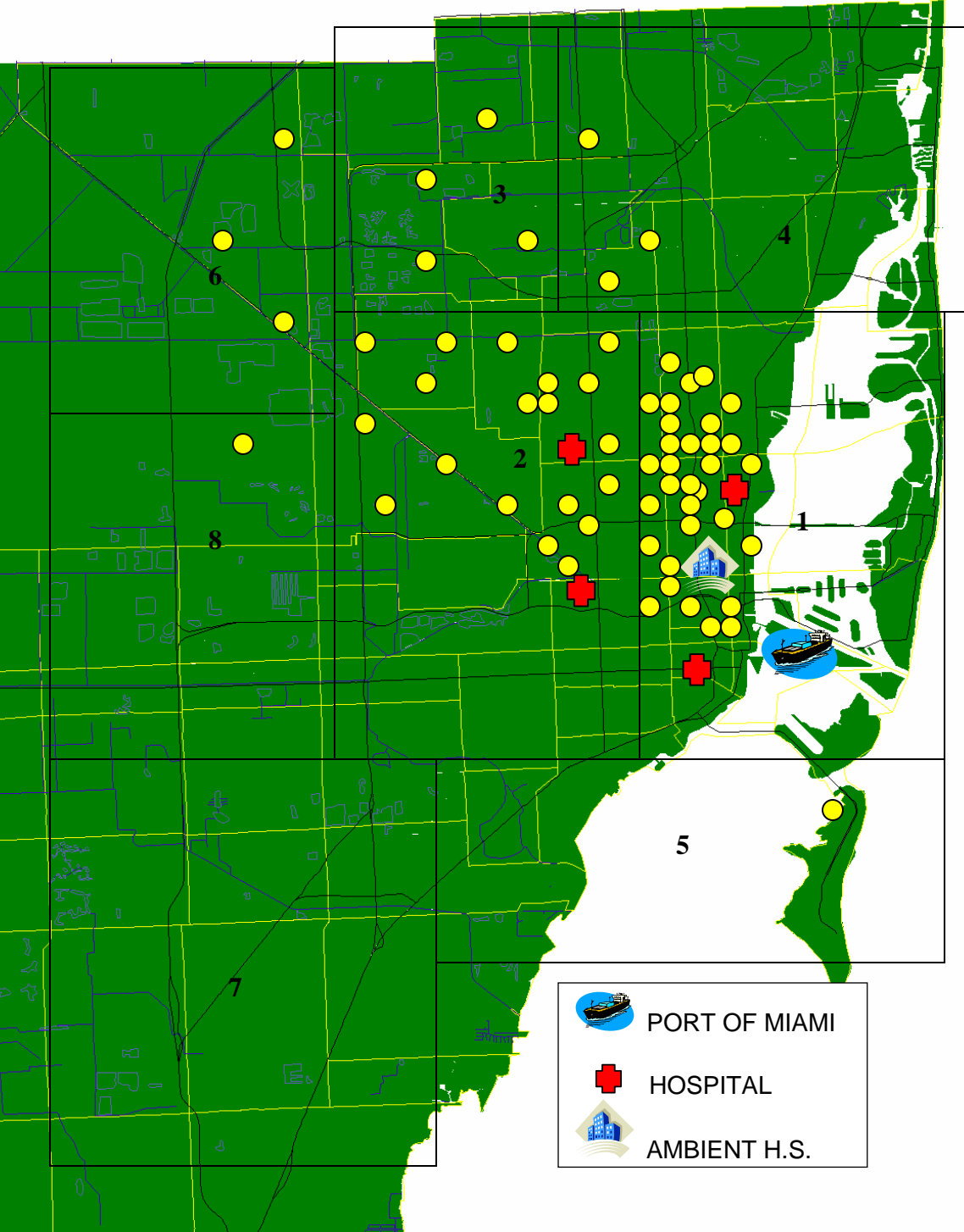
*The majority of the cases occurred in persons aged 13-19. The number (or ratio) of males and females is approximately equal (i.e. 1:1 as a ratio), and the age distributions are similar among the males and females. These data point towards a possible epidemic in a location with teenage men and women, i.e. a High School!*

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?

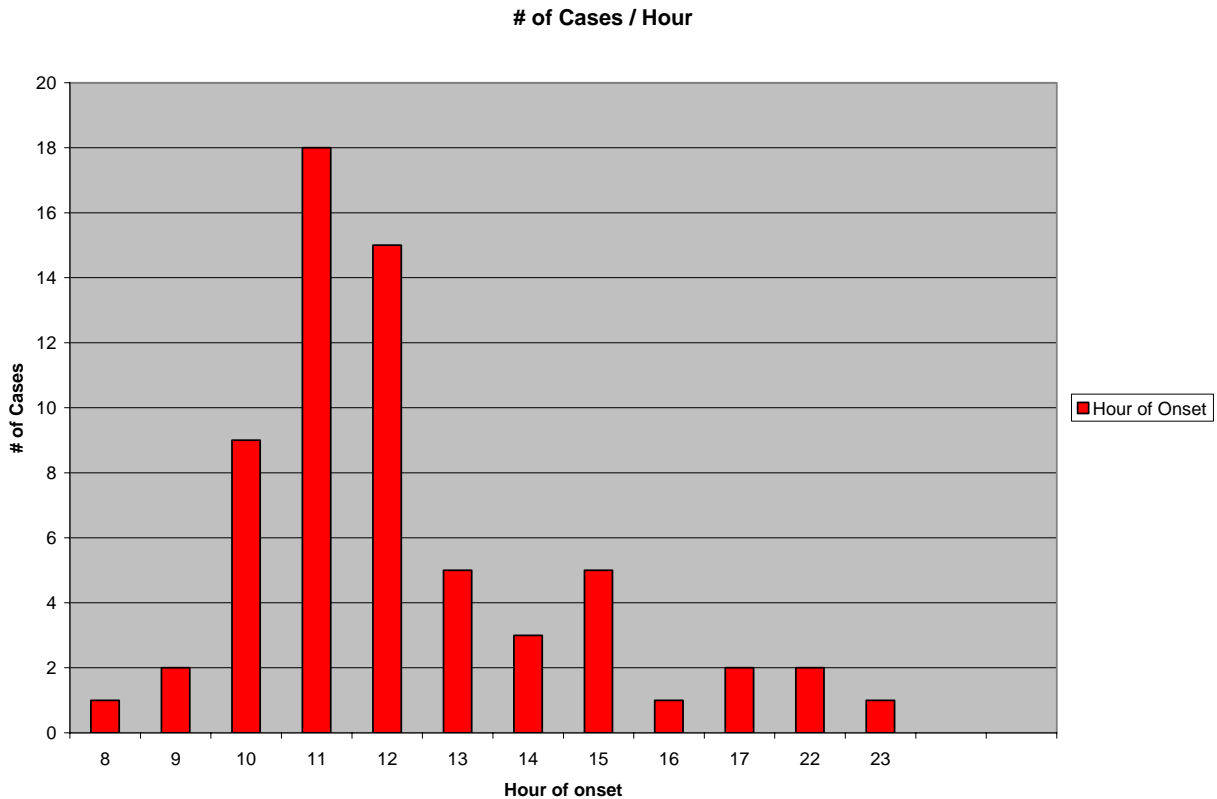
The "distribution" of cases suggests that persons became ill with asthma predominantly in Region 1 and 2 of the city, assuming that the populations of the regions (i.e. the denominator population) are roughly equal. These areas incorporate AMBIENT High School and the Port as

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# 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?



*The chart indicates that the asthma attack onset of the reported asthma cases peaked between 11AM and noon. The majority of persons reported onset between 10 am and 4 PM. The fact that these asthma attacks tended to occur around mid-day suggests that the "exposure factor" could be something deriving from daytime activities (i.e. industries) which exposed a large group of teenagers (i.e. A high school).*

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?

*Since the number of cases of asthma among teenagers on January 21 were so extraordinary, and the air pollution levels were certainly no higher than normal (indeed, below normal), it is reasonable to assume that these particular air pollutants were not the cause of the epidemic.*

Since many of the asthma cases came from Region 1 where AMBIENT school is near the waterfront Port, 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.

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
Soybeans	249	13	468	1

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

*You might consider looking at whether any of these products were being loaded or unloaded on January 21.*

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

	Disease +	Disease -	
Product Exposure +	A	B	A+B
Product Exposure -	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

	Disease +	Disease -	
Coal			

<b>Exposure +</b>	4	196	200
<b>Exposure -</b>	9	521	530
	13	717	730

Odds Ratio = AD/BC= 1.8

Therefore the risk of there being an asthma epidemic day was 1.8 times greater on days when coal was unloaded than on days when coal was not unloaded

<b>Fuel Oil</b>	<b>Disease +</b>	<b>Disease -</b>	
<b>Exposure +</b>	3	150	153
<b>Exposure -</b>	10	567	577
	13	717	730

Odds Ratio = AD/BC= 1.13

Therefore the risk of there being an asthma epidemic day was 1.13 times greater on days when fuel oil was unloaded than on days when fuel oil was not unloaded

<b>Gasoline</b>	<b>Disease +</b>	<b>Disease -</b>	
<b>Exposure +</b>	2	180	182
<b>Exposure -</b>	11	537	548
	13	717	730

Odds Ratio = AD/BC=0.54

Therefore the risk of there being an asthma epidemic day was 0.54 times greater on days when gasoline was unloaded than on days when gasoline was not unloaded; this means that the risk of an asthma epidemic day was actually less on days when gasoline was unloaded than on the days when gasoline was not unloaded!

<b>Cotton</b>	<b>Disease +</b>	<b>Disease -</b>	
<b>Exposure +</b>	7	399	406
<b>Exposure -</b>	6	318	324
	13	717	730

Odds Ratio = AD/BC=0.93

Therefore the risk of there being an asthma epidemic day was 0.93 times greater on days when cotton was unloaded than on days when cotton was not unloaded; this means that the risk of an asthma epidemic day was actually less on days when cotton was unloaded than on the days when cotton was not unloaded!

<b>Coffee</b>	<b>Disease +</b>	<b>Disease -</b>	
<b>Exposure +</b>	5	300	305
<b>Exposure -</b>	8	417	425
	13	717	730

Odds Ratio = AD/BC=0.87

Therefore the risk of there being an asthma epidemic day was 0.87 times greater on days when coffee was unloaded than on days when coffee was not unloaded; this means that the risk of an asthma epidemic day was actually less on days when coffee was unloaded than on the days when coffee was not unloaded!

<b>Corn</b>	<b>Disease +</b>	<b>Disease -</b>	
<b>Exposure +</b>	1	135	136
<b>Exposure -</b>	12	582	594
	13	717	730

Odds Ratio = AD/BC=0.36

*Therefore the risk of there being an asthma epidemic day was 0.36 times greater on days when corn was unloaded than on days when corn was not unloaded; this means that the risk of an asthma epidemic day was actually less on days when corn was unloaded than on the days when corn was not unloaded!*

<b>Soybeans</b>	<b>Disease +</b>	<b>Disease -</b>	
<b>Exposure +</b>	13	249	262
<b>Exposure -</b>	1	468	469
	14	717	731

Odds Ratio = AD/BC=24.43

*Therefore the risk of there being an asthma epidemic day was 24.43 times greater on days when soybeans were unloaded than on days when soybeans were not unloaded. This is a greatly increased risk. Therefore, unloading of soybeans at the Port should be strongly considered as a possible exposure, which lead to the asthma epidemic days currently and in the past.*

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

*The loading or unloading of soybeans at the port apparently increased the risk (or odds) of having a surge in asthma emergency room visits 24.43 times the expected risk on days when there is no unloading of soybeans at the Port.*

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?

*The school should urge the City to have the Port develop an engineering solution to the soybean dust emanating from the shipping area during loading/offloading. A "bag filter" is a common way of controlling such dust in many ports.*

This Epidemic of Asthma was actually based on a report of a real asthma epidemic in the 1980s 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 and interested students, in groups or as individuals, use the Atmospheric Fog in Greater London Case Study enclosed 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.