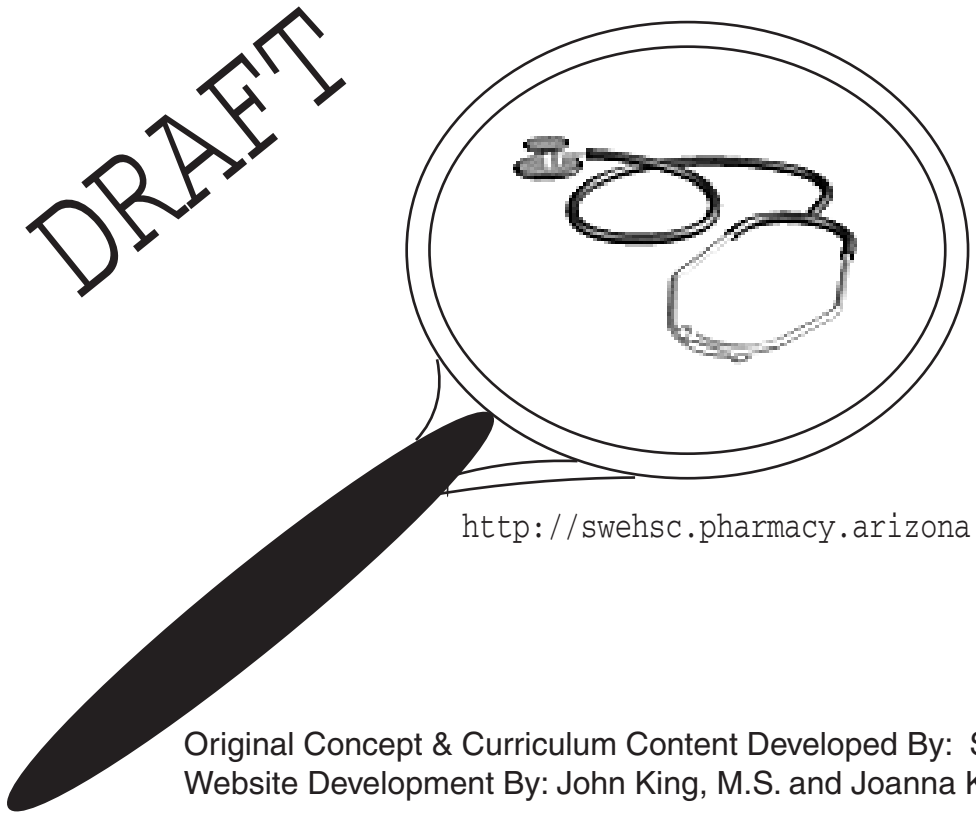
Scenario: Ms. Ima Well (Colon Cancer)

Cluster Busters:

A Game of Disease Mystery Solving



http://swehsc.pharmacy.arizona.edu/coep/clusterbusters/

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Introduction

"Cluster Busters: A Game of Disease Mystery Solving" is designed to introduce students to epidemiology, risk assessment and toxicology as they apply to disease clusters potentially induced by environmental toxins. "Cluster Busters" encourages logical thinking and problem solving and also enhances student knowledge of research techniques, statistics, and toxicology. The game has 6 different disease cluster scenarios, all of which are based on actual cancer or disease cluster investigations. Details and locations of the investigations have been modified to better suit the game. References are included with each scenario.

The Scenarios include:

1. Ms. Ima Well	Colon Cancer
2. Dr. Wanda B. Better	Toxic Mold
3. Mr. Bill M. Later	Skin Cancer
4. Mr. Peter Out	Non-Hodgkin's Lymphoma/mix
5. Mr. Phillip Metub	Adenomatous Polyps
6. Ms. Geri Atricks	Lung Cancer

The "Cluster Buster" format follows a common disease cluster response protocol used by many state health departments in the United States. The protocol guides students in the preliminary investigation process used to determine the validity of a disease cluster and consists of eight steps: 1. Describe the cluster; 2. Verify the cases; 3. Assess the risk; 4. Statistically analyze disease rates; 5. Examine potential exposures; 6. Determine if the disease is biologically plausible; 7. Determine the cluster significance; and 8. Report the results.

The game typically requires 3-5 hours, though it can easily be shortened or extended (refer to the "Teacher Reference Sheet" for suggestions on how to lengthen or shorten the game). In its full-length version, the game is appropriate for high school students, however, activities can be modified to work at the middle school level. You may prefer to have the entire class play a single scenario, or, the class could be divided into several groups, each with a different scenario. At the end of the game, each group could report their findings to the rest of the class.

About Disease Clusters

Many Americans have raised concerns about exposures to unknown environmental contaminants and their potential health impacts. Reporting potential disease clusters is one avenue for citizens to voice their concerns. In fact, many of the cluster reports come from persons who are either sick themselves or have ill friends or family members (Devier et al. 1990)[1]. Thus, many of the reports are initiated during times when personal stress and fear are prevalent.

State health agencies receive approximately 1500 cancer cluster investigation requests per year* (Greenberg and Wartenberg 1991)[2]. These numbers far exceed the agency's time available to conduct detailed investigations for each case and, most of the time, the reported disease cluster is not real (i.e. the disease rate for the reported "cluster" is the same as the national average).

However, state health agencies do not want to over look or neglect a real disease cluster. They want to be able to take appropriate action to protect the people who are directly affected and a true disease cluster can provide useful information to protect people elsewhere. To better manage the large number of cases, most agencies use a prioritization system that identifies the most serious and probable disease clusters (Greenberg and Wartenberg 1991)[2]. The system typically consists of several phases including a "preliminary review," "disposition of cancer inquiries," and then a full "investigation." The "preliminary review" consists of gathering and verifying information, obtaining cancer incidence and/or death rates, determining environmental risk factors, and determining biological plausibility between the risk factors and the disease. The "disposition of cancer inquiries" involves a review of all the data by a committee comprised of epidemiologists, physicians, environmental health specialists, local health officials, and a statistician. The committee ultimately decides whether the "cluster" merits an expensive, time consuming investigation (Devier et al. 1990)[1].

Disease clusters are defined spatially and temporally. This means that clusters occur within a defined region and time frame. The "strength" of the cluster depends on several factors including: 1) The disease rate; 2) The type of disease; and 3) The demographics of the affected population. A true cluster must have a disease rate that is statistically significantly greater than the disease rate of the general population. Of course, the larger the difference between cluster disease rate and the average disease rate the greater the certainty of a cluster. The type of disease is also an important consideration when deciding whether to investigate a cluster. For example, a general cancer cluster report (one with multiple types of cancer) typically does not merit further investigation because "cancer" is not a single illness from a single cause. Each type of cancer is unique and distinct, like tuberculosis (*Mycobacterium tuberculosis*) is very different from

[1] Devier, J., Brownson, R., Bagby, J., Carlson, G., and Crellin, J. A public health response to cancer clusters in Missouri. *American Journal of Epidemiology* 132 Supplement (1): S23-S31, 1990.
[2] Greenberg, M. and Wartenberg, D. Communicating to an alarmed community about cancer clusters: A fifty state survey. *Journal of Community Health* 16 (2): 71-82, 1991.

Legionnaire's Disease (*Legionella pneumophila*) even though both are bacterial infections. Also, "cancer" is very common. In fact, 1 in 4 deaths is caused by cancer (American Cancer society: http://www.cancer.org/). If a specific cancer type, like cancer of the pancreas, was reported as a potential cluster then the investigation would be given higher priority.

The demographics of the affected population is also used to prioritize investigations. The victims' ages, gender, and health, employment, and residential histories are all taken into account. Using cancer as an example, a cluster that occurs in a young population will be given higher priority. This is because cancer is rare in young people, especially children. Health and employment histories of the cancer victims are also important. For example, if a lung cancer cluster were reported for a specific workplace, but most of the affected employees smoked, you cannot, with any confidence, determine if an agent in the workplace caused the cancer or the cigarettes caused the cancer.

Determining the legitimacy of a disease cluster can be a very challenging task. Rarely is anything in these types of investigations clear-cut, especially with cancer. Because cancers generally take so long to develop, epidemiologists have to identify an exposure that occurred 10-20 years ago. Even if a potential exposure is identified, health scientists may not know if the person's affliction is a direct result of a specific chemical. This is because there are only a limited number of toxicological studies compared to the number of chemicals in this world.

For more information on disease clusters you can refer to these websites:

http://www.facsnet.org/report_tools/guides_primers/risk/main.html

http://www.iet.msu.edu/local/citizen.htm

DIRECTIONS

1. To begin the game, read the "Setting Description" out loud to the class.

2. Read to the class the "Biography" description for the scenario named after a specific person (in this case Ms. Ima Well).

3. Review the "State Health Department Protocol for Reports on Disease Clusters" with the students (page 41).

4. Refer to the "Cluster Details: Teacher Reference Sheet" for the directions related to the scenario Ms. Ima Well.

5. Hand out the "Student Note Sheet"

Alternative Approach: You can have the class break-up into groups and run several different scenarios at once. At the end of the game, each group can share their results and you can discuss some of the similarities and differences between the scenarios. If you play multiple scenarios at once you may want someone in each group to read the "Background" description.

SETTING DESCRIPTION

You all are epidemiologists, or scientists that study the incidence, distribution, and control of disease in a population, and you work for the state department of health. You just received a phone call from *Ms. Ima Well* who was reporting a potential disease cluster. A disease cluster is when a specific type of illness occurs in an identified population within a given period of time and the number of people with the illness exceeds the normal disease rate.

Your supervisor has assigned all of you to this case to work as a team. You need to determine if this cluster is real or if it falls within the same incidence rate as the rest of the nation's population (i.e. there is no difference between the people you study and everyone else). At the end of the game you decide if this disease cluster report merits further investigation.

SCENARIO BIOGRAPHY DESCRIPTION: MS. IMA WELL

Ms. Well isn't so well, she is 66 years old has just been diagnosed with colorectal cancer. She currently lives in a retirement complex in Somewhere Town, Florida. She has lived in Somewhere Town for 5 years. Prior to that Ms. Well lived with her husband in Australia. But their divorce prompted her to move to Florida. After she was diagnosed with cancer, she noticed that several of her neighbors also had cancer. She thought it was peculiar that so many people she new were ill and it made her wonder if there was something wrong with where they live. She saw a report on the news about cancer clusters and contaminated water. The reporters recommended calling the state health department if anyone suspected a disease cluster in their area – so she did.

Teacher Reference Sheet

Scenario: Ms. Ima Well

Cluster Busters: Teacher Reference Sheet

Case: Ms. Ima Well

I. DESCRIBE THE CLUSTER:

1. Hand out the "Student Note Sheet, Section I: Describe the Cluster"

Conduct Phone Interviews:

1. Explain that the students need to listen to an interview in order to fill out the information in Section I of the Student Note Sheet. Give the students a few minutes to review the information they need to listen for.

2. Assign students to be an interviewer or interviewee (2 interviewees, 1-2 interviewers)

   (You may want to have select students conduct the interview in front of the class or divide the students into groups of 3-4 and have them conduct the interviews within the group.)

3. Hand out the "Phone Interviews: Question Guide" and the "Phone Interviews: Answer Guide" to the students who will role play. Remember there are two people to interview Ms. Ima Well and Mr. Frank Leigh. Ms. Well should be interviewed first followed by Mr. Frank Leigh (friend of Ms. Well with colon cancer who lives in the mobile home park).

   - Students can refer to the "Phone Interview Question/Answer Guide" or you can have them brainstorm to determine what information they need.

   - Students need to take detailed notes of the phone interview. They can use their Cluster Buster "Student Note Sheet" to help them.

Note: This information is incomplete because it is *verbal* and based on recollection. It provides a beginning point from which to start the investigation. A more complete picture occurs when the students *Verify the Cases*. Verification is important because medical records are often more accurate than people's memory.

Note: In a real epidemiological study the race and gender of the people would also be considered. This is because some illnesses are more prevalent in certain races and genders. However, for this activity, neither race nor gender will be considered as factors.

Summary of Interview

- Type of Disease: Colon cancer
- Total # of disease cases reported by interviewees (including interviewees): **4**
- Age range of people with colon cancer: **66 – 75 years**
- How long interviewees have lived in area: **5 & 10 years**
- Cluster locations: **Happy Haven Retirement condominiums, 4500 Howdy Rd.; Blue Sky Mobile Home Park, 6000 block of Tellville Lane**
- Other Information: **The two interviewees have or had high fat diets with frequent ingestion of red meat. Ms. Well has poor exercise habits.** Location of Ms. Well's Previous Residence: **Near the intersection of First Ave. & Tellville Lane**

Define the Time Period

1. Inform the students that the defined time period for this cluster is 3 years

Note: The time period is based on the actual time period used for the investigation this scenario was based on [Aldrich, T. E.: Statistical analysis of potential cancer clusters. Oncology 38: 144-146 (1981)].

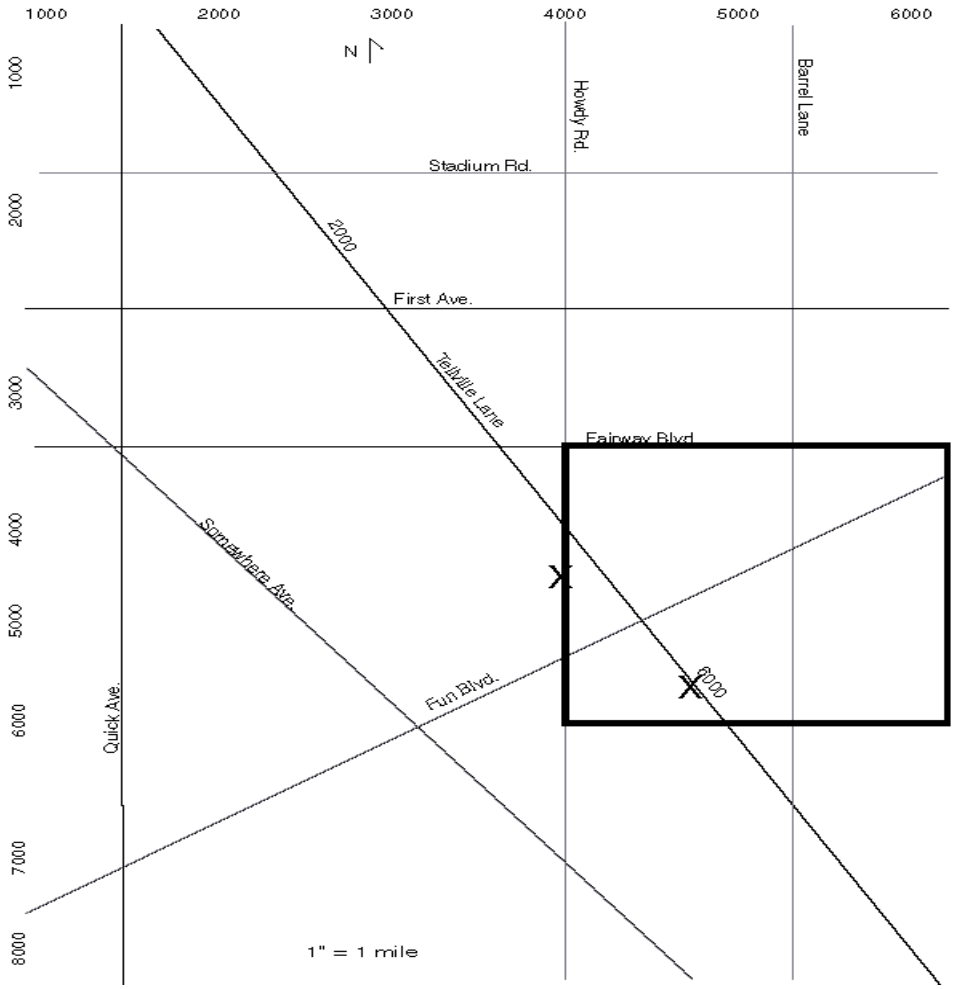
Map the Cluster Locations:

2. Have the students map the addresses reported in the interviews. This is a first step to defining the region for the investigation.

3. Inform the students that the defined region for investigation is 9 square miles, within the zip code 12345.

Note: Zip codes are commonly used as an investigation boundary or "cell." "Cells" can also be partitioned using census tracts, water delivery boundaries, groundwater or contamination boundaries, or even specific buildings.

4. Map the defined region: They should draw a 3" X 3" square with the upper left corner of the square placed at the intersection of Tellville Ln. and Howdy Rd.



5. Determine the population density for the region – **refer to website: http://swehsc.pharmacy.arizona.edu/coep/clusterbusters/** . Look in the Somewhere Town library for the information.

Summary

- Based on Ms. Wells description, she knows people within her retirement condominium complex and a nearby retirement mobile home park who have colon cancer. The region will be defined based on a square area encompassing the reported cancer incidence (**9 square miles, zip code 12345**).

- # people in defined region: **9112 (population density of 1012.4 per square mile X 9 square miles)**

II. VERIFY THE CASES:

1. Hand out the "Student Note Sheet: Sections II & III."

2. Check medical records: visit **website: http://swehsc.pharmacy.arizona.edu/coep/clusterbusters/** to access medical records in the hospital. This will verify the verbal reports from the interviews and provide a total number of colon cancer cases within the defined region.

   Summary

   - Total # of new colon cancer cases in defined region (zip code 12345):
     Last Year: **7**
     2 Years Ago: **9**
     3 Years Ago: **8**
     Total: **24 (This does not include Ms. Wind because she has diverticulitis not colon cancer.)**

III. RISK ASSESSMENT

1. Go to the **website: http://swehsc.pharmacy.arizona.edu/coep/clusterbusters/** to obtain the following information about the disease group: average age, age range, average time lived in the zip code, range of time lived in the zip code (found in the hospital).

Note: "Risk assessment is a scientific process of evaluating the adverse effects caused by a substance, activity, lifestyle, or natural phenomenon" (from "Reporting on Risk: A Journalist's Handbook on Environmental Risk Assessment" which can be found at http://www.facsnet.org/report_tools/guides_primers/risk/main.html). Many possible variables are often considered, such as age, place of residence, employment, and exposure types and lengths.

Summary

- Average Age: **Last Year = 72**
  2 Years Ago = 68
  3 Years Ago = 71

- Age Range: **Last Year = 62-83**
  2 Years Ago = 45-95
  3 Years Ago = 61-80
- Average Time Lived (years) in 12345 Zip Code:
  Last Year = 8 years

2 Years Ago = 10
3 Years Ago = 8

- Range of Time Lived in Zip Code:
  Last Year = 3-15 yrs
  2 Years Ago = 0.5-34
  3 Years Ago = 0.1 – 20

Note: You are interested in how long the people have lived in the area because cancers can take at least 10-20 years to develop. Thus, if the cancer was caused due to exposure to a chemical carcinogen, the exposure would have occurred 10-20 years ago. If most everyone moved into the area fairly recently, that decreases the likelihood that the cancer is due to a chemical exposure in that particular region.

IV. STATISTICALLY ANALYZE DISEASE RATES

1. Hand out "Student Note Sheet: Section IV."

2. Define the populations you want to compare to the "cluster" population (Somewhere Town & Nation)

   - You may want to ask the students why they need comparison populations, which populations they would select and why.

Note: Comparison populations are needed in order to determine if a deviation from the "normal" disease rate exists. A number by itself does not tell you anything; but a number placed in the context of other numbers provides information.

3. Go to the **website: http://swehsc.pharmacy.arizona.edu/coep/clusterbusters/** to obtain the disease incidence rate information (found in the hospital or the library). Find the average disease incidence rate per year for zip code 12345 (the defined cluster region), Somewhere Town, and the nation.

   a. National population
      - Disease incidence rate: **47.2/100,000 people**

   (The students should select the most recent cancer statistics)

   b. Defined Cluster Region: (Zip code 12345)
      - Population: **9112 (population density X # square miles)**
      - Incidence of disease over 3 years: **24 (year 1=7 cases, year 2=9 cases, year 3=8 cases)**
      - Average disease incidence rate per year: **8/9112**

c. Somewhere Town
- Population: **63,011**
- Incidence of Disease over 3 years: **110 people (year 1=35 cases, year 2=39 cases, year 3=36 cases)**

- Average disease incidence rate per year: **36.7/63,011 people**

3. Next the students need to figure out how they can compare the various disease incidence rates. Ask the students if they can tell just by looking at the numbers if 8 out of 9112 people is more, less, or the same as the National colon cancer incidence rate of 47.2 out of 100,000 people.

a. First, they must convert the numbers to the same ratio. You may want to use a denominator of 100,000, as opposed to dividing 8 by 9112, so they can easily compare the Somewhere Town cancer incidence rates to the national cancer incidence rates without dealing with decimals or very small numbers. You may want to encourage the students to figure out how to do this on their own.

Zip Code 12345 Incidence Rate: 8/9112

$9112x = 100{,}000 \quad \Rightarrow \quad x = 10.97$

10.97 is the number they need to multiply the numerator and the denominator by to convert their disease incidence rate to a population of 100,000 ($10.97 \times 8 = 87.8$ & $10.97 \times 9112 \approx 100{,}000$)

Zip Code 12345 Comparison Incidence Rate: **87.8 /100,000**

Note: If you want to extend this lesson further, you can discuss rounding errors and significant figures.

Somewhere Town Incidence Rate: 36.7/63,011

$63{,}011x = 100{,}000 \quad \Rightarrow \quad x = 1.59$

Somewhere Town Comparison Incidence Rate: **58.4/100,000**
National Population Disease Incidence Rate: **47.2/100,000**

4. Ask the students if it looks like there is a difference between the colon cancer incidence rates for the zip code, town, and nation. Compare the national rate to the town and zip code rates, then compare the town and zip code rates to each other. They all *appear* to be different from one another.

Summary

- Both Somewhere Town, Florida and zip code 12345 are significantly different from the national population ($p<0.05$) and zip code 12345 is significantly different from the rest of Somewhere Town ($p<0.05$).

OPTIONAL STATISTICS ACTIVITIES (Recommended for high school students)

5. Explain to the students that scientists cannot just look at numbers and say that one number looks *significantly* different from another number (the word *significant* is used to imply a meaningful difference). For example, the chances of 47 out of 100,000 people getting cancer may be the same as 50 people getting cancer out of 100,000. Thus, 47 would NOT be significantly different than 50 and the difference between these two numbers is due to *random* events. In order to determine if 47 is significantly different from 50, scientists would need to study very large populations, and determine the *average* number of people that get colon cancer within that population. Lets say that after conducting many studies, the scientists found that the average colon cancer incidence rate is 47.2 people per 100,000 ± 1 (which is the national colon cancer rate). This means that a normal colon cancer incidence range would be between 46.2 and 48.2 people per 100,000 people. Since 50 is outside of that range, the two numbers would be significantly different from each other.

6. Have the students determine the *average* and the *deviation* and *standard deviation* from that average for the Somewhere Town cancer incidence rates and the 12345 zip code cancer incidence rates. There are tables on the "Student Note Sheet" to guide the students.

The *standard deviation* measures how closely data are clustered about the mean and is represented by the equation:

$$S=\sqrt{\sum(x_i-x)^2/n-1}$$

where x_i is an individual result, x is the mean, and n is sample number.

Note: They only have 3 samples per population (one for each year). In a real study they would need to take many more samples. A "Chance & Probability" exercise would illustrate why they would need to take more samples.

To find the *average, deviation*, and the *standard deviation* have the students fill in the following tables (blank tables with instructions are included on the "Student Note Sheet"):

A. Find the *average, deviation*, and the *standard deviation* for the cancer incidence rate for the Defined Region (Zip code 12345)

a. Find the *average* and the *deviation*

Year (=Sample #)	Number of Cases	Deviation (cases-average)	Deviation Squared
1	7	7 – 8 = -1	-1 x -1 = 1
2	9	9 – 8 = 1	1 x 1 = 1
3	8	8 – 8 = 0	0 x 0 = 0
	Sum = 24 Average = 24/3 = 8		Sum = 2

b. Find the *standard deviation***:**

= sum of the deviation squared/(# years - 1) = 2/(3-1) = 1

c. Write the complete answer as the *average ± the standard deviation*

8 ± 1 per 9112 people.

d. Convert the answer to a *comparison ratio:* Convert the number to the comparison ratio (per 100,000) using the same factor derived previously (10.97)

8 x 10.97 = 87.8 1 x 10.97 = 10.97 **87.8 ± 10.97/100,000**

e. Write the range: 87.8 – 10.97 to 87.7 + 10.97 = **76.8 to 98.7**

B. Find the *average, deviation*, and the *standard deviation* of the cancer incidence rate for Somewhere Town

a. Find the *average* and the *deviation*

Year (=Sample #)	Number of Cases	Deviation (cases – average)	Deviation Squared
1	35	35 – 36.7 = -1.7	(-1.7) x (-1.7) = 2.9
2	39	39 – 36.7 = 2.3	2.3x 2.3 = 5.3
3	36	36 – 36.6 = - 0.6	(-0.6) x (-0.6) = 0.4
	Sum = 110 Average = 110/3 =		Sum = 8.6

	36.7		

b. Find the *standard deviation*:

= sum of the deviation squared/(# years – 1)= 8.6/(3-1) = 4.3

c. Write the complete answer as the *average ± the standard deviation*:

36.7 ± 4.3 per 63,011 people.

d. Convert the answer to a *comparison ratio:* Convert the number to the comparison ratio (per 100,000) using the same factor derived previously (1.59)

36.7 x 1.59 = 58.3 4.3 x 1.59 = 6.8 **58.3 ± 6.8/100,000**

e. Write the range: **51.5 to 65.1**

7. Provide the students with the standard deviation for the national colon cancer incidence rates: **47.2 ± 1 per 100,000 people**

Note: The standard deviation used in this example is an estimated standard deviation for the national statistics based on the Annual Percentage change

Note: In real epidemiological studies the statistics are much more complex. You may consider incorporating additional lessons on statistics at this point. For the purposes of this activity, you can tell the students that both Somewhere Town, Florida and zip code 12345 are significantly different from the national population ($p<0.05$) and zip code 12345 is significantly different from the rest of Somewhere Town ($p<0.05$).

Note: p represents how *confident* you are in your research results. A p of less than 0.05 means that you expect at least 95% of future results to fall within the range you determined in your study (e.g. 95% of the time the numbers will fall between 46.2 and 48.2). The *confidence* will generally increase as the number of samples increases. Scientists can plug numbers obtained from a preliminary study into a special equation to determine how many samples they will need to take to get within a certain confidence level.

Summary

	Adjusted Incidence Rate (per 100,000 people)	Standard Deviation (±)	Range
Defined Region (zip code 12345)	87.8	10.97	76.8 to 98.7
Somewhere Town	58.3	6.8	51.5 to 65.1
Nation	47.2	1	46.2 to 48.2

- Both Somewhere Town, Florida and zip code 12345 are significantly different from the national population ($p<0.05$) and zip code 12345 is significantly different from the rest of Somewhere Town ($p<0.05$).

- Based on these results, there is a disease cluster in the defined region (as well as in Somewhere Town as a whole). This is because the disease incidence rates significantly exceed the disease rates of the comparison populations (the nation and Somewhere Town).

(Suggestion: Conduct CEPUP Risk Comparison Activity 1 "Chance & Probability" in the "Risk Comparison" curriculum to illustrate the concepts of chance and probability - this activity also demonstrates why they want to take many samples)

8. Once the students understand how to calculate the standard deviation, you can further explore why taking more samples is better. To illustrate this, have the students divide a deviation of 2 by 1, 3, 8, and 50. The answers are 2, 0.7, 0.25, and 0.04 respectively. Thus the standard deviation decreases as the number of samples increase. Scientists want a small standard deviation because it increases their certainty in the conclusions they draw from the data. For example, if the comparison population is 8 ± 2 (range of 6 to 10) and the result is 10.1, that is a very "borderline" result and the researcher cannot make any strong conclusions. However, if the comparison population is 8 ± 0.7, the researcher can more confidently conclude that 10.1 is significantly different than 8. This is because the smaller the standard deviation, or the larger number of samples, the more representative the sample is of the whole population.

Note: You can also have the students explore how the standard deviation changes with the range and clustering of numbers. The standard deviation will decrease as the range, or number of outliers, decreases. For example, the standard deviation will be smaller if the range is 43-47 as opposed to 40-55. Generally, the standard deviation will also

decrease if the numbers are clustered. For example, lets say we have two sets of numbers with the same range of 40-55, but the distribution of numbers is:

Set 1: 40, 41, 42, 42, 42, 42, 55
Set 2: 40, 43, 47, 47, 53, 54, 55

The average & standard deviation for Set 1 is: 43 ± 23
The average & standard deviation for Set 2 is: 48 ± 29

V. EXAMINE POTENTIAL EXPOSURE

1. Hand out the "Student Note Sheet: Section V & VI."

2. Go to the **website: http://swehsc.pharmacy.arizona.edu/coep/clusterbusters/** and click on the Environmental Quality Office to find the town's environmental assessment reports

3. Map potential problem locations

   Summary:
   Locations:
   - Landfill: 6700 Barrel Lane
   - Agricultural Drainage Ditches: run parallel to Quick Ave
   - 2 Gasoline Storage Tanks: only one spill reached the groundwater, 1326 Howdy Road
   - The groundwater contamination does extend into the zip code 12345

   Types of contaminants:
   - cadmium, lead, nitrate, ametryn, animal fecal matter, gasoline/benzene, total dissolved solids

4. Go to the **website: http://swehsc.pharmacy.arizona.edu/coep/clusterbusters/** to research the water quality supplied to Somewhere Town (Environmental Quality Office)

   Summary:

   - There are no identified chemical exposures for the Somewhere Town water supply, including the zip code 12345

VI. DETERMINE IF THE DISEASE IS BIOLOGICALLY PLAUSIBLE

1. Go to the **website: http://swehsc.pharmacy.arizona.edu/coep/clusterbusters/** and click on the hospital to find common risk factors for colon cancer. A specific link for colon and rectum cancer is found further down the page.

   Summary:

   - Colon cancer risk factors: diet high in fat and red meat, low physical activity, overweight, alcohol

2. Go to the **website: http://swehsc.pharmacy.arizona.edu/coep/clusterbusters/** and click on the library to research the listed contaminants to see if they are linked to colon cancer. You may want to explain to the students that this is done "just in case" the people were exposed, considering the fact that the plume is nearing the southeastern pumping station (which supplies water to zip code 12345).

Note: If one of the nearby contaminants was linked to the cancer, yet there was no identified exposure, then the investigation would take a different turn and likely require further research.

Summary:

- List of contaminants and their toxicological effects:
  - Cadmium: Acute exposure high dose – vomiting, diarrhea, Death; Chronic, low-level exposure – emphysema, lung cancer
  - Lead: Acute exposure high dose – brain & kidney damage, death; Chronic, low-level exposure – brain & growth problems
  - Nitrate: Harmful to infants, inhibits oxygen transport in the Blood, not likely to cause cancer
  - Total Dissolved Solids (TDS): None known
  - Ametryn (pesticide)- Acute exposure to high doses include nausea,vomiting, diarrhea, muscle weakness, and salivation; Chronic, low-level exposure – uncertain, no known links to cancer
  - Animal fecal matter – Contains harmful bacteria and viruses
  - Gasoline/Benzene - Acute exposure high dose – drowsiness, dizziness, headaches, death; Chronic, low-level exposure – leukemia

- None of the known contaminants in other regions of Somewhere Town are linked to colorectal cancer

VII. DETERMINE CLUSTER SIGNIFICANCE

1. Hand out the "Student Note Sheet: Section VII" and the "Cluster Significance Chart."

2. Answer the following questions:
    a. Does the cluster disease incidence rate significantly exceed the comparison population incidence rate? **Yes**
    b. Was the disease population exposed to any known environmental or occupational contaminants? **No**
    c. If an exposure did occur, is there a biological link between the disease and the contaminant? **No**

3. Refer to the "Cluster Significance Chart" to determine if further action is needed.

Summary:

- High Disease Rate: Yes
- Documented Exposure: No
- Biologic Plausibility: No
- Further Action: No

VIII. REPORT RESULTS

1. Students can write a report summarizing their findings and conclusions. Be sure to include the following information:
    a. Total # of new cancer cases in Ms. Well's subdivision : **24**
    b. Time Period Investigated: **3 years**
    c. Type of cancer in Ms. Well's subdivision: **Colon**
    d. Age range: **45-95 years**
    e. How Long People with Cancer Have Lived in Area: **0.1- 34 years**
    f. Statistical Comparison of disease rates of the cluster vs. comparison population: **Somewhere Town, Florida was significantly different from the national population ($p>0.05$), and zip code 12345 was significantly different from the rest of the community and the Nation ($p<0.05$).**
        - **Zip code cancer incidence rate (adjusted per 100,000): 87.8 ± 10.97**

- **Somewhere Town cancer incidence rate (adjusted per 100,000): 58.3 ± 6.8**
- **National cancer incidence rate (adjusted per 100,000): 47.2 ± 1**

g. Potential exposures: **None in their zip code; Cadmium, lead, nitrate, Ametryn, benzene (gasoline), and animal feces were found in other parts of the city.**

h. Biological plausibility (if applicable): **None of the contaminants are linked to colon cancer.**

i. Conclusion:

- Even though there is a colon cancer cluster in both Somewhere Town and the zip code 12345, it does not merit further investigation because there is no environmental or chemical link to the cancer
- There is a dietary link to the colon cancer. The interviews revealed poor diet and exercise habits.
- The colon cancer patients in the zip code are older. Colon cancer is very common in older populations and, with the exception of the 45 year old, the majority of the patients fit this description.
- Florida contains a large number of older people, this explains why Somewhere Town, Florida has a significantly higher colon cancer incidence rate compared to the rest of the nation. Zip code 12345 has a higher colon cancer incidence rate than the rest of Somewhere Town because it is a densely populated retirement area (population density of Somewhere Town is 884.6 persons/mi^2 and the population density of the zip code 12345 is 1012.4 persons/mi^2)
- The average time spent in region of concern (zip code 12345) is less than 10 years (average is 8.7). Since it typically takes 10-20 years for cancer to develop, the *majority* of residents with colon cancer would need to have been living in the zip code for at least ten years to trigger another "red flag."

Section III: Student Materials

Scenario: Ms. Ima Well

Phone Interviews:
Question & Answer Guides

Case: Ms. Ima Well

Phone Interviews: Question Guide

Ms. Well

Try to obtain at least the following information in addition to what you think is important to know. Be sure to take good notes! You'll need them later.

Hello Ms. Well, this is _____ from the Florida State Health Department. I am following up on the phone message you left last week.

1. What is the reason for your call to the State Health Department?

2. So, you are currently ill?

3. What type of illness do you have and when were you diagnosed?

4. Where do you currently live?

5. What is your address?

6. How long have you lived there?

7. So you are 66 years old?

8. Where did you live previously?

9. You said you lived in a nearby apartment complex. How long were you there?

10. What zip code was that apartment complex in?

11. What is your current marriage status?

12. Do you know the health condition of your ex-husband?

13. When did you see him last?

14. Speaking of Luby's, could you please describe your diet?

15. How many times a week do you eat: red meat, fish, chicken, fresh fruit and vegetables?

16. Describe the food you snack on.

17. How many times a week or month do you exercise?

18. Could you provide a list of people you know who live in the area and have been diagnosed with colon cancer within the last 3 years?

19. Where do Ms. Nest and Mr. Leigh live?

20. So all of you live in retirement complexes. Are there a lot of retirement complexes in this area?

Thank you for your time. We'll be sure and let you know the results of the investigation.

Phone Interviews: Question Guide

Mr. Leigh

Try to obtain at least the following information in addition to what you think is important to know. Be sure to take good notes! You'll need them later.

Hello Mr. Leigh. My name is _____ and I am calling from the Florida State Health Department. Your friend Ms. Ima Well contacted us and requested that we conduct an investigation into a possible cancer cluster. She listed you as a person to contact.

1. Are you currently ill?

2. What type of cancer do you have and when were you diagnosed?

3. How old are you Mr. Leigh?

4. Where do you currently live?

5. What is your address?

6. How long have you lived at this location?

7. Where did you live previously?

8. What is your marriage status?

9. What is your wife's health condition?

10. Could you please describe your diet?

11. How many times a week do you eat: red meat, fish, chicken, fresh fruit and vegetables?

12. What was your diet like before Fancy got diabetes?

13. How many times a week or month do you exercise?

14. Could you provide a list of people you know who live in the area and have been diagnosed with colon cancer within the last 3 years?

15. Where does Ms. Wind live?

Thank you for your time. We'll be sure and let you know the results of the investigation.

Phone Interviews: Answer Guide

Ms. Well

You are going to be the interviewee, so be sure to provide the information below. The numbers correspond with Interview Questions. Have fun with it!

(You are a chipper older lady with an Australian accent – you answer these questions with a sense of humor).

1. I called because me and a bunch of my old mates have our guts clogged with cancer. The TV guy said to call the health department if ya' thought there was a problem.

2. Yes, I'd say I'm pretty sick.

3. I have colon cancer. Lets see, I think I found out about this time last year.

4. I live in the Happy Haven Retirement condominiums – pretty nice places if I say so myself.

5. 4500 Howdy Rd.

6. I've been in this place for about 1 year – since I was 65.

7. Yes, 66. Though if ya' saw me you'd never guess – but I'm starting to look my age since I've been trying to fight this cancer.

8. Well, let me see, before this condo I lived in an apartment complex about 3 miles from here, near the intersection of 1st and Tellville. Before that I lived in Sydney, Australia – can ya' tell mate?

9. I've been in the states for 5 years now, and that was the first place I lived.

10. Same zip code, 12345.

11. Oh my, I'm divorced. That man did not know how to have fun. I guess he thought it was quite a novelty to marry an Aussie.

12. Does grumpy count as an illness? Nah, his health is fine last I knew.

13. I saw him about a month or two ago. He lives up the street and we occasionally run into him at the Luby's cafeteria.

14. Oh mate, me and food get along great. So what do you mean? I eat almost anything.

15. Red meat…hmmm…I eat it 3 or 4 times a week. As for fish, I live near an ocean but about all the fish I eat is an occasional trip to Long John Silver's. Chicken, about once a week. And I have a veggie with each dinner – like mashed potatoes and gravy, fried okra, and the occasional egg salad.

16. Cookies, potato chips, and the like. When I can get ahold of vegemite, I eat that with butter and bread. Good stuff.

17. Well, I don't do much exercising now that I'm sick. But I used to go out for a round of golf once a week.

18. Oh yes. Ms. Robin Nest, Mr. Frank Leigh and one of his friends

19. Robin lives just upstairs. Frank lives in the Blue Sky Retirement Mobile Home Park.

20. Oh yes. The locals joke that our zip code, 12345, is the average age of this part of Somewhere Town.

Phone Interviews: Answer Guide

Mr. Frank Leigh

You are going to be the interviewee, so be sure to provide the information below. The numbers correspond with Interview Questions. Have fun with it!

(Mr. Leigh is a World War II veteran and tends to be very matter-of-fact in his demeanor.)

1. I don't know what you mean by ill. If you mean "do I have cancer" then the answer is yes.

2. I have colon cancer that was diagnosed about 6 months ago.

3. I am 75 years old.

4. I live in a mobile home retirement complex about 2 blocks away from Ima's place.

5. 6010 Tellville Lane.

6. 10 years.

7. In Ohio. Ackron, if you must know.

8. I am married. In fact, tomorrow is our 50th wedding anniversary.

9. She doesn't have any cancer, just diabetes.

10. Well, since Fancy, my wife, got diabetes 4 years ago, we eat pretty darn good.

11. We eat red meat 5 times a week, chicken once a week, and fish every Sunday. Fancy makes some good vegetables with every meal.

12. We used to eat a lot more butter and sweets, like cake and pies.

13. Exercise….I try to get out once a week. I had better exercise habits when I was in the military.

14. Other than Ima, there's Ms. Robin Nest and Ms. Gail Wind.

15. She lives at 6015 Tellville Lane.

Student Note Sheets

Scenario: Ms. Ima Well

Name: _____ Date: _____ Class: _____

CLUSTER BUSTERS

Student Note Sheet: Ms. Ima Well

I. Describe the Cluster:

(You can obtain this information from the introduction, the interviews, your teacher, and the website)

Interviews:

Type of Disease (be specific):

Total Number of Disease Cases Reported:

Ages of People with Disease:

How Long Interviewees Have Lived in the Area:

Cluster Locations (Addresses):

Other Information from the Interviews:

Mapping & Characterizing the Region

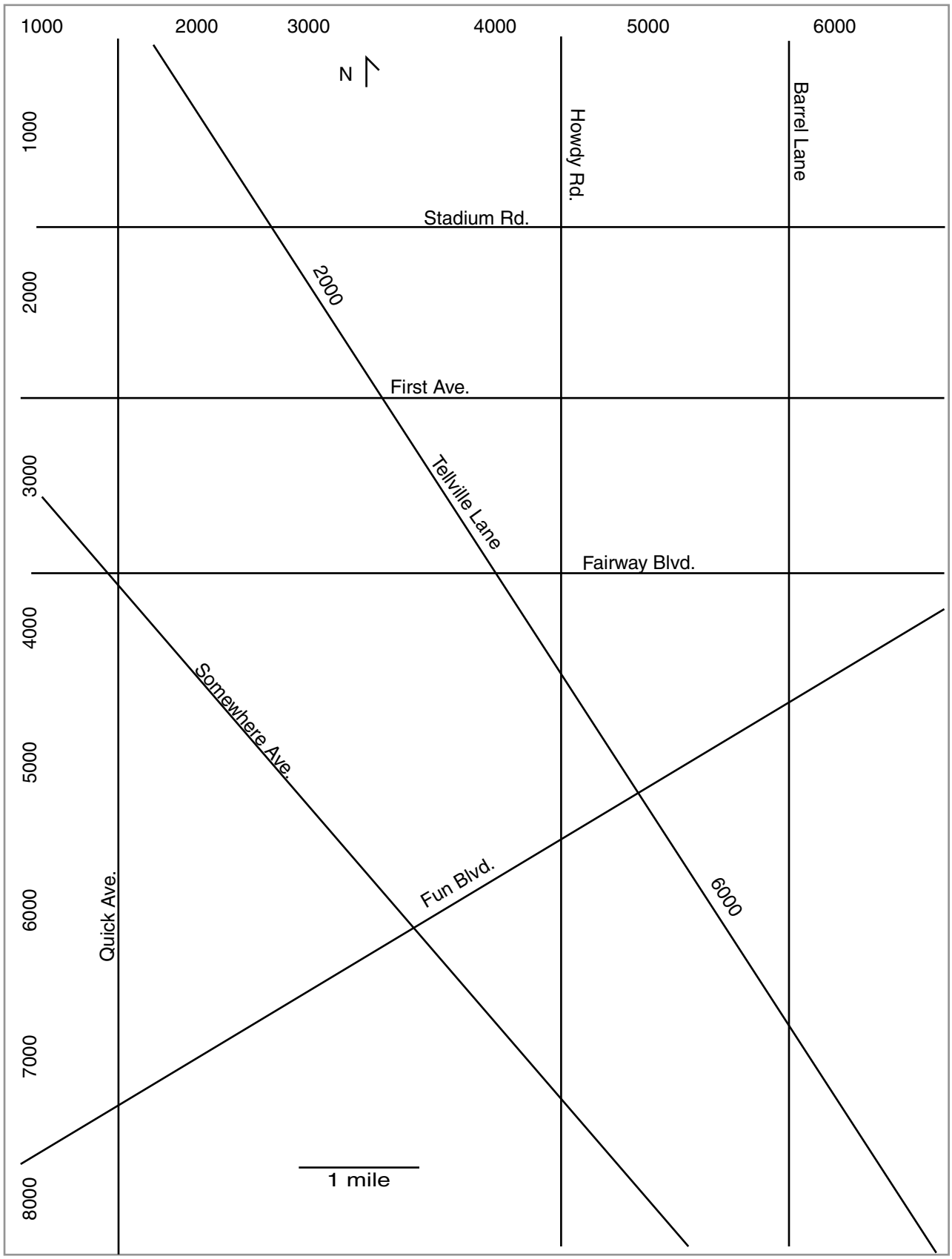
Defined Time Period for Disease Incidence:

[Map the Addresses Reported in the Interview (refer to Somewhere Town Map)]

Defined Cluster Region: [Map the defined region Zip Code 12345. 9 square miles, northwest corner is the intersection of Howdy Road & Fairway Blvd.]

Population Density for the Cluster Region [obtain from website]:

Number of People (population) in the Defined Cluster Region (population density X # square miles):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Howdy Rd.
Barrel Lane
Stadium Rd.
First Ave.
Fairway Blvd.
Quick Ave.
2000
Tellville Lane
6000
Somewhere Ave.
Fun Blvd.
1 mile

Student Note Sheet: Sections II & III

II. Verify the Cases

(This information you obtain from the website)

Number of Cancer Cases in Defined Region for Time Period Investigated (List for each year and then add the number of cases)

Total Over All Years:

III. Risk Assessment

(This information you obtain from the website)
(You may need to calculate some of the averages yourself)

Average Ages (list for each year):

Age Ranges (list for each year):

Average Times Lived in Defined Region (list for each year):

Range of Times Lived in Defined Region (for each year):

Student Note Sheet: Section IV

IV. Statistically Analyze Disease Rates

(This information you obtain from the website)

1. Find the disease incidence rates for the nation, the defined region, and Somewhere Town

   a. Disease Incidence Rate for the Nation:

   b. Disease Incidence Rate for Defined Region (average # people with disease in defined region per population in the region per year):

   c. Somewhere Town (average # people with disease in Somewhere Town per town population):

2. Convert the disease incidence rates from 1b & 1c (above) to ratios you can compare (e.g. per 100,000 people).

   a. Adjusted disease incidence rate for the Defined Region:

   b. Adjusted disease incidence rate Somewhere Town:

Student Note Sheet: **OPTIONAL SECTION**

3. **Statistical Analysis**: Find the *average, deviation*, and the *standard deviation*

   A. Find the *average, deviation,* and the *standard deviation* of the cancer incidence rate for the DEFINED REGION using the table below to help you.

   a. Find the *average* and the *deviation*

Year (=sample #)	Number of Cases	Deviation (cases – average)	Deviation Squared $(\text{deviation})^2$
1			
2			
3			
	Sum = Average =		Sum of deviations^2 =

   b. Find the *standard deviation* : [= (sum of the deviations squared) ÷ (total numbers of samples – 1)] **Note:** The total number of samples = the total number of years in the defined time period.

   c. Write the complete answer as **the Average cancer rate ± the Standard Deviation**:

   d. Convert the answer to a *comparison ratio:* Convert the average cancer rate and the standard deviation to the comparison ratio (per 100,000) using the same factor derived in problem 2a (Student Note Sheet page 4). (adjusted rate = rate X factor & adjusted standard deviation = standard deviation X factor). Write answer as **adjusted rate ± the adjusted Standard Deviation:**

   e. Calculate & write the range of cancer incidence rates (rate minus standard deviation to rate plus standard deviation)

OPTIONAL SECTION, Pg. 2

B. Find the *average, deviation,* and the *standard deviation* of the cancer incidence rate for SOMEWHERE TOWN using the table below to help you.

a. Find the *average* and the *deviation*

Year (=sample #)	Number of Cases	Deviation (cases – average)	Deviation Squared $(\text{deviation})^2$
1			
2			
3			
	Sum = Average =		Sum of Deviations^2=

b. Find the *standard deviation* : [= (sum of the deviations squared) ÷ (total numbers of samples – 1)] **Note:** The total number of samples = the total number of years in the defined time period.

c. Write the complete answer as **the Average cancer rate ± the Standard deviation**:

d. Convert the answer to a *comparison ratio:* Convert the average cancer rate and the standard deviation to the comparison ratio (per 100,000) using the same factor derived in problem 2b (Student Note Sheet page 4). (adjusted rate = rate X factor & adjusted standard deviation = standard deviation X factor). Write answer as **adjusted rate ± the adjusted Standard deviation:**

e. Calculate & write the range of cancer incidence rates (rate minus standard deviation to rate plus standard deviation)

OPTIONAL SECTION, Pg. 3

4. Based on the Averages & Standard deviations you calculated summarize your results:

Summary:

	Adjusted Incidence Rate (per 100,000 people)	Standard deviation (±)	Range
Defined Region			
Somewhere Town (Comparison Population)			
Nation (Comparison Population)			
(Other Comparison Populations)			

a. Is the disease incidence rate for your defined region significantly different from the comparison population(s)? (i.e. does the disease incidence rate for your defined region fall outside of the average and range of your comparison populations?):

b. Based on these results, would you say there is a disease cluster in your defined region? Why or why not?

Student Note Sheet: Section V & VI

V. Examine Potential Exposure

(This information you obtain from the website)

Contamination Location: (Write down addresses and then map them)

Types of Contaminants Present:

Drinking Water Quality for Defined Region:

VI. Determine if the Disease is Biologically Plausible

(This information you obtain from the website)

Known Disease Risk Factors:

Toxicological Effects of Chemicals People were Exposed to (or potentially exposed to):

Are any of the contaminants linked to the disease?

Student Note Sheet: Section VII & VIII

VII. Determine Cluster Significance

1. Answer the following questions:

    a. Does the cluster disease incidence rate significantly exceed the comparison population incidence rate?

    b. Was the disease population exposed to any known environmental or occupational contaminants?

    c. If an exposure did occur, is there a biological link between the disease and the contaminant?

2. Refer to your answers to the above questions and to the "Cluster Significance Chart" to determine if further action is recommended.

    a. High Disease Rate (Yes or No):

    b. Documented Exposure (Yes or No):

    c. Biologic Plausibility (Yes or No):

    d. Further Action Recommended (Yes or No):

VIII. Report Results (summary)

1. Write your conclusions about the presence of a disease cluster and your recommendations for further action. Justify your conclusions with the information and data you collected.

State Health Department Response Protocol for Reports on Disease Clusters

Adapted from: Fiore, B.J., Hanrahan, L.P., and Anderson, H.A. (1990) State health department response to disease cluster reports: A protocol for investigation. American Journal of Epidemiology, 132, supplement (1), S14-S21.

Use this protocol as a guide for your investigation

Describe the Cluster
Determine geographic locations, type, number of cases, age, time period

Verify the Cases
Obtain medical records of disease cases, death certificates

Risk Assessment
Characterize disease group cases by age and time lived in defined region. Determine comparison population's disease rate (via state, county, zip code, or US census)

Statistically Analyze Disease Rates
Compare the disease rates of the "cluster" vs. the comparison population

Examine Potential Exposure
Investigate environmental or occupational exposures

Determine if the Disease is Biologically Plausible
Does the type of disease match the exposure?

Determine Cluster Significance
Determine if this investigation merits further action
Refer to the "Cluster Significance Chart"

Report Results
Write a report on the investigation. This is kept on file and used for future reference, especially if a full investigation is done.

Cluster Significance Chart

Use this chart to help you determine if further action is needed for your investigation. If you answer "yes" to more than one of the three criteria (high disease rate, documented exposure, or biologic plausibility), further action is probably needed. You may personally draw a different conclusion, which is fine, just be sure to justify your decision.

High Disease Rate +	Documented Exposure	+ Biologic Plausibility	= Further Action
Yes	Yes	Yes	Yes
Yes	No	Yes	Yes
No	Yes	Yes	Yes
Yes	Yes	No	Yes
No	No	No	No
Yes	No	No	No
No	Yes	No	No

Adapted from: Fiore, B.J., Hanrahan, L.P., and Anderson, H.A. (1990) State health department response to disease cluster reports: A protocol for investigation. American Journal of Epidemiology, 132, supplement (1), S14-S21.

Vocabulary

Scenario: Ms. Ima Well

References: http://rex.nci.nih.gov; The American Illustrated Medical Dictionary; Webster's II New Riverside University Dictionary

Adenoma: A noncancerous tumor.

Angiosarcoma: A type of cancer that begins in the lining of blood vessels.

Aplastic anemia: A deficiency of certain parts of the blood caused by a failure of the bone marrow's ability to generate cells.

Basal Cell Carcinoma: One of the most common types of skin cancer. It arises from the basal cells located deeper in the epidermis than squamous cells.

Benign: Not malignant; not cancerous

Biological Therapy: also called immunotherapy, uses the body's immune system, either directly or indirectly, to fight cancer. The immune system recognizes cancer cells in the body and works to eliminate them. Biological therapies are designed to repair, stimulate, or enhance the immune system's natural anticancer function. Biological therapy may be given after surgery, either alone or in combination with chemotherapy or radiation treatment. Most biological treatments are given by injection into a vein (IV).

Cancer: A term for diseases in which abnormal cells divide without control. Cancer cells can invade nearby tissues and can spread through the bloodstream and lymphatic system to other parts of the body.

Carcinogen: Any substance that is known to cause cancer.

Carcinogenesis: The process by which normal cells are transformed into cancer cells.

Carcinoma: Cancer that starts in the lining or covering of an organ, e.g. skin cancer

Colorectal: Related to the colon and/or rectum.

Diverticulitis: A medical condition where small pouches are formed in the colon and then become filled with feces. This results in irritation, inflammation, and problematic abscesses.

Endometriosis: A disease where tissue from the uterus covers surrounding organs like the ovaries, bladder, intestine, or various other places. It is generally corrected by hormone therapy or surgery.

Epidimiologist: A scientist who studies disease incidence

Glioblastoma multiforme: A type of brain tumor that forms in the nervous (glial) tissue of the brain.

Leukemia: Cancer of the blood cells.

Lymphatic system: The tissues and organs that produce, store, and carry white blood cells that fight infection and disease. This system includes the bone marrow, spleen, thymus, and lymph nodes and a network of thin tubes that carry lymph and white blood cells. These tubes branch, like blood vessels, into all the tissues of the body.

Lymphoma: Cancer that arises in cells of the lymphatic system.

Malignant: Designating an abnormal growth that tends to metastasize; life-threatening

Mastectomy: surgical removal of the breast

Melanoma: Cancer of the cells that produce pigment in the skin. Melanoma usually begins in a mole.

Metastasize: Transmission of disease from an original site to one or more sites elsewhere in the body, as in cancer.

Neoplasm: A new growth of tissue. Can be referred to as benign or malignant.

Polyp: A mass of tissue that projects into the colon.

Polypectomy: If colon cancer is found in a polyp, the polyp is often removed in an operation using a colonoscope

Radiation Therapy: also called radiotherapy, involves the use of high-energy x-rays to kill cancer cells. Radiation therapy is a local treatment and affects the cancer cells only in the treated area.

Rheumatism: Disease marked by inflammation of the connective tissue structures of the body, especially muscles and joints. **Chronic,** a form of chronic joint inflammation, moderate pain, produces progressive deformity; **cerebral,** acute rheumatic fever marked by delirium, convulsions, and coma; **Herberden's,** rheumatism of the finger joint, marked by the formation of nodules

Squamous Cell Carcinoma: A common type of skin cancer that starts in the squamous cells located in epidermis. Squamous cell carcinoma is less common than basal cell carcinoma and spreads more quickly than basal cell carcinoma.