

# Environmental Health Resources Self Learning Module

## Epidemiology



**Agency for Toxic Substances  
and Disease Registry**  
Division of Community  
Health Investigations



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# Overview and Objectives

This module has been created to provide local health agencies a summary overview of epidemiology as well as more detailed resources. The module consists of a printable overview of epidemiology basics and a more in-depth, optional self-study module. While geared to local health departments (LHDs), the materials may be useful for other environmental health professionals.

## Objectives:

- Gain familiarity with epidemiology **terminology**
- **Raise or enhance understanding** of epidemiology applications in communities
- Use the modules to **prepare for community engagement**, community requests, or more detailed epidemiology applications in land reuse communities



# Module Organization

This Epidemiology resource is organized by:

1. A [printable summary](#) of epidemiology basics.
2. A [self-study module](#) that contains more detailed training and resources

# Epidemiology

## Part One: **Summary Overview**





## John Snow Video



*John Snow: Pioneer of Epidemiology video*  
(Clicking on image or link below opens video in Web browser)

Watch this video, [John Snow: Pioneer of Epidemiology](#), funded by the National Institute of Environmental Health Science (NIEHS), to see how **John Snow, one of the first epidemiologists, who in the 1850s traced a major outbreak of Cholera in London.**



# Epidemiology Definition

Epidemiology Defined: “the study of the distribution and determinants of disease or health status in a population; the study of the occurrence and causes of health effects in humans”.

Stated simply, epidemiology involves trying to find out the causes of illness in a population and what keeps people healthy.

# Environmental Epidemiology



*Drums containing potentially hazardous waste.*

Environmental epidemiology is concerned with environmental conditions or hazards that may pose a health risk to populations.<sup>1</sup> For example, epidemiologists may investigate a cancer cluster in a particular community, or question whether people with a particular disease have higher levels of exposure than people without the disease.

<sup>1</sup>(Friis, Essentials of Environmental Health, 2011)



# The Role of Health Agencies

LHDs may receive calls from concerned residents when brownfields or land reuse sites lay idle or when redevelopment begins. People are often concerned about exposures to suspected contamination at these sites. In particular, people worry about increased cancers and lead poisoning.



A basic understanding of epidemiology and available resources may be useful to address community concerns and alleviate fears.

Local and state health departments often receive inquiries from the public regarding illness associated with exposures to toxicants from hazardous waste sites in their communities. State health departments maintain detailed cancer and disease registries that may address these issues.



# Types of Epidemiologic Study

A cross-sectional study is basically a survey. This type of study provides a “snapshot” of the health status of a population at a specific point in time and does not determine cause-and-effect (Gordis, 2009).

In a cohort study, the epidemiologist selects the study population based on an exposure of interest. The relationship between exposure and the health outcome in a cohort study is quantified by calculating the relative risk for the exposure (Gordis, 2009).

In a case-control study, the epidemiologist selects the study population according to whether or not they have disease. Participants are selected on the basis of the presence or absence of the disease or outcome in question, so that one group of people (case-subjects) have the health problem and one group does not (controls). These groups are then compared to determine the presence of specific exposures or risk factors. The relationship between exposure and outcome in a case-control study is quantified by calculating the odds ratio. The advantages and disadvantages to case-control studies are described below (Gordis, 2009).



### Advantages of Case-control Studies

Examine multiple exposures for 1 outcome

Suited for studying rare diseases

Require fewer cases compared to cohorts, making them less expensive

### Disadvantages of Case-control Studies

Not suitable for studying rare exposures

Cannot establish cause and effect, since disease has already occurred



# Epidemiologic Tools (CDC, 2011)

Standard 2x2 Table:

	Disease	No Disease	Total
Exposed	a	b	a + b
Unexposed	c	d	c + d
Total	a + c	b + d	N

The 2x2 table is used to illustrate and present measures of association, as well as measures of impact of disease screening.

N = Total size of the sample (a+b+c+d)

a = Individuals who are exposed and who have the disease

b = Individuals who are exposed but do not have the disease

c = Individuals who are not exposed but have the disease

d = Individuals who are not exposed and do not have the disease



## Risk Calculations

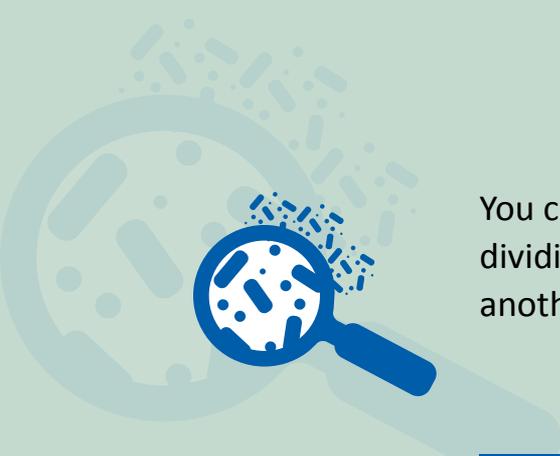
In **cohort studies**, you can calculate two risks:

1. Risk among people who are exposed

$$\text{Risk among people exposed} = \frac{a}{a+b}$$

2. Risk among people not exposed

$$\text{Risk among people not exposed} = \frac{c}{c+d}$$



You can compare the risks of disease among the exposed and unexposed by dividing one risk by the other risk. Because one risk is being compared to another, this calculation is called a relative risk (Gordis, 2009).

$$\text{Relative Risk} = \frac{\text{Risk among people exposed}}{\text{Risk among people not exposed}}$$

or

$$\text{Relative Risk} = \frac{\frac{a}{a+b}}{\frac{c}{c+d}}$$

### Relative Risk

>1 Exposure and disease are positively associated (more exposed people have the disease)

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= 1 Exposure and disease are not associated

---

<1 Exposure and disease are negatively associated (more unexposed people have the disease). Those exposed are protected from disease.

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In **case-control and cross-sectional studies**, you can calculate two odds:

1. The odds of disease among people who are exposed
2. The odds of disease among people who are not exposed

The “odds” are often tricky to understand and should not be confused with “probability” (CDC).

$$\text{Odds} = \frac{\text{\# of times something happens}}{\text{\# of times it does NOT happen}}$$

$$\text{Probability} = \frac{\text{\# of times something happens}}{\text{\# of times it COULD happen}}$$



To calculate the “Odds Ratio” based on a 2x2 table:

$$\text{Odds ratio} = \frac{\text{odds of disease among people exposed}}{\text{odds of disease among people not exposed}}$$

$$\text{Odds ratio} = \frac{ad}{bc}$$

### Odds Ratio

>1 Exposure and disease are positively associated (more diseased people exposed)

---

= 1 Exposure and disease are not associated

---

<1 Exposure and disease are negatively associated (more non-diseased people are exposed)

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**Incidence** and **prevalence** are also important in understanding disease.

The [incidence rate](#) quantifies how many people have been newly diagnosed during a specific time period.

Incidence reflects the number of new cases in a certain period of time. For example, number of new HIV cases in 2015.

The [prevalence rate](#) quantifies the number of people who have a particular disease at a defined point in time (Gordis, 2009).

Prevalence rate is the number of people who have the disease during a specified time. For example, the number of people currently living with HIV/AIDS out of the total population.

$$\text{Incidence} = \frac{\text{\# of new cases}}{\text{Population at Risk}}$$

$$\text{Prevalence} = \frac{\text{\# of existing cases}}{\text{Population at Risk}}$$



## Case Study

During the summer of 1999 in New York City, 59 patients were admitted to the hospital with encephalitis or meningitis (swelling of the brain and surrounding tissue) along with muscle weakness. The rapid increase in the **incidence** of cases triggered further study. A thorough **outbreak investigation** revealed the median age of the patients was 71 years old and a common exposure between these New York patients only revealed that they often spent time outdoors, especially in the evening. Early tests revealed that the patients had St. Louis Encephalitis transmitted by mosquitos.

Meanwhile, a rapid die-off of birds, especially crows, around the city was identified to also be caused by severe encephalitis. Birds cannot get St. Louis Encephalitis. Later that summer West Nile Virus (WNV) was isolated for the first time in the United States and found to be the cause of both the human and avian disease.

Currently there is no vaccine for WNV. But an understanding of disease transmission can lead to effective control strategies.

New York City responded to the WNV outbreak by distributing 300,000 cans of DEET-based mosquito repellent and 750,000 information leaflets about how to



reduce exposure to mosquito bites and eliminate niches where mosquitos may breed. Spraying schedules were also published and mosquito surveillance now occurs during the summer until several weeks after mosquito activity subsides.

**Case study information from:**

<https://www.cdc.gov/mmwr/preview/mmwrhtml/mm4838a1.htm>



## References

CDC. (2011). *Global Health — Health Protection*. Retrieved from Field Epidemiology Training Program (FETP) Development Handbook: [www.cdc.gov/globalhealth/FETP/FETPDevHandbook/Curriculum\\_and\\_Training/Lesson\\_Plan&Content.doc](http://www.cdc.gov/globalhealth/FETP/FETPDevHandbook/Curriculum_and_Training/Lesson_Plan&Content.doc)

CDC. (n.d.). *Key Concepts About Logistic Regression*. Retrieved from <http://www.cdc.gov/nchs/tutorials/NHANES/NHANESAnalyses/LogisticRegression/Info1.htm>

Friis. (2011). *Essentials of Environmental Health*, Chapter 2. Retrieved from <http://faculty.fgcu.edu/twimberley/EnviroHealthA/EnviroHlthFriis/Ch2.pdf>

Gordis, L. (2009). *Epidemiology*. Philadelphia, PA: Elsevier.



End of summary overview.

**If you need assistance in understanding concepts** in this resource, please contact your State Health Department, your [ATSDR Regional Office](#), or send an email to [atsdr.landreuse@cdc.gov](mailto:atsdr.landreuse@cdc.gov).

**For a hard copy** of the Epidemiology **summary overview**, **print pages 5–20**.

**For further epidemiologic learning and training materials** please explore the resources in the SELF STUDY Module, Part Two: Self Study Epidemiologic Materials.

Proceed to the [self-study](#) module on Epidemiology.

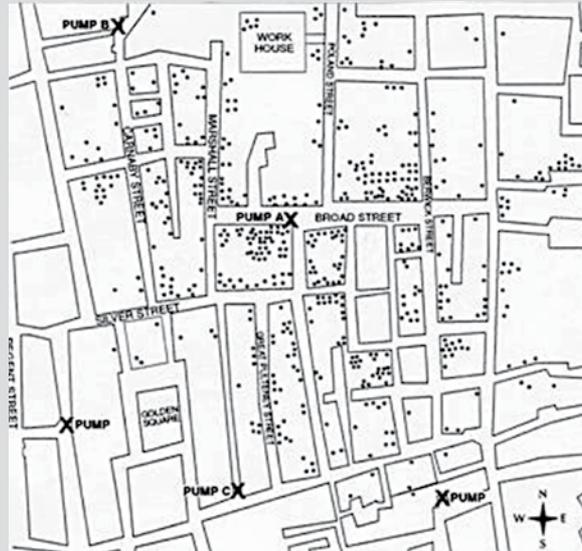
# Epidemiology

## Part Two: **Self-study Materials**





To learn more about the basics of epidemiology and biostatistics **check out the “self-study course” designed by Centers for Disease Control and Prevention (CDC) on [Applied Epidemiology and Biostatistics](#)**. This course is designed to describe key features of epidemiology, and provide explanations for calculating and interpreting several key epidemiological elements. This course also describes the steps to successfully conducting an outbreak investigation.



*Map of Cholera outbreak used by John Snow*



# Outbreak Investigation: Mobile App



For practice in **conducting an outbreak investigation** in a fun and interactive setting go play CDC's [Solve the Outbreak](#). In this game, not only can you learn about interesting case studies and outbreaks, but you will also learn the foundational skills to

conduct an outbreak investigation of your own. The game can be played on the CDC's website, or on your mobile phone or tablet.



# Outbreak Case Studies



*Artist's 3-D rendering of Salmonella bacteria*

For further information and practice with real-life outbreaks visit the CDC's [Epidemiologic Case Studies](#) website. Here you will be able to interact with [computer-based case studies](#), [classroom case studies](#), and an [outbreak simulation](#). These simulations require download and may be used offline.



# Quick Learn Lessons

Once you've mastered the basics of outbreak investigation. You can visit the [Quick-Learn Lessons](#), where you can participate in short (less than 20 minutes) lessons to **help you build an Epi Curve, use an Epi Curve to determine the mode of spread, and the most likely period of exposure.** Additionally, other lessons include how to recognize biosafety levels.

The screenshot shows the CDC TRAIN website interface. The main content area displays a search results table for 'Quick Learn Lessons'. The table has columns for 'Title', 'Type', and 'Rating'. The results include various courses such as 'Create an Epi Curve (Unavailable on Mobile Devices)', 'Using an Epi Curve to Determine Mode of Spread (Unavailable on Mobile Devices)', and 'Epi 2: Epidemiological Methods'. Each course entry includes a star rating and a link to the course.

Title	Type	Rating
<a href="#">Create an Epi Curve (Unavailable on Mobile Devices)</a>	Course	4.4 out of 5 stars
<a href="#">Using an Epi Curve to Determine Mode of Spread (Unavailable on Mobile Devices)</a>	Course	4.5 out of 5 stars
<a href="#">Using an Epi Curve to Determine Most Likely Period of Exposure (Unavailable on Mobile Devices)</a>	Course	4.7 out of 5 stars
<a href="#">Public Health Decision-Making: Strategy Overview of the Curric</a>	Course	(no reviews)
<a href="#">The Practice of Epidemiology: An Overview (E is for Epi, Session 1.1)</a>	Course	4.5 out of 5 stars
<a href="#">EPI 2: Epidemiological Methods</a>	Course	5.0 out of 5 stars
<a href="#">EPI 1: Basic Epidemiological Concepts</a>	Course	4.7 out of 5 stars
<a href="#">Pathways to Public Health</a>	Course	4.5 out of 5 stars
<a href="#">Use of Social Media for Health Promotion: An Overview of the Evidence</a>	Course	4.5 out of 5 stars
<a href="#">MMARS Recommendations and Features: Medical Countermeasures, Use and Clinical Treatment Framework for Use during an Anthrax Mass Casualty Incident (Video Series) - 05/2014</a>	Course	4.0 out of 5 stars
<a href="#">EPI 2: Measurement of Health Status</a>	Course	(no reviews)
<a href="#">Epidemiology Tools and Methods (E is for Epi, Session 2.1)</a>	Course	4.0 out of 5 stars

Screen capture of CDC Train Web site



## Training Modules: Noncommunicable Diseases

**Noncommunicable diseases, such as injuries, cancer, diabetes etc. are responsible for the majority of deaths each year.** For training specific to these types of non-communicable diseases please visit the CDC's [Noncommunicable Diseases—Training Modules](#). These trainings include several modules which range from describing the basics of epidemiology all the way to how to select interventions. These tools are useful for training on an individual level or may be used to facilitate group trainings as well.



# Environmental Public Health and Epidemiology



*Left to right: Water sampling, surveillance*

**To learn more about the role the environment plays on public health** go to the lesson funded by NIEHS [Teaching Environmental Public Health: The Role of Epidemiology](#) . In this lesson you will be able to explore a few short videos on the history of epidemiology and about potential disease clusters due to environmental exposures.



# Tools for Epidemiologic Investigation: EPI INFO™

Introducing...

EPI INFO™ 7

[Click here to download and get more information](#)

When conducting an epidemiologic investigation, the tools needed to properly and easily create data collection instruments, conduct data analysis, visualization, and reporting, can be achieved by downloading and using Epi Info.™ [Epi Info™](#) is **free and easy to use**, and is perfect for anyone not familiar with epidemiology or biostatistics.



## Additional Resources

### Coursera: **Free** Epidemiology Courses

Further resources for learning about epidemiology can be found at Coursera. There are available free courses on epidemiology including [Epidemiology: The Basic Science of Public Health](#) and [Epidemiology in Public Health Practice](#). These courses include several hours of videos and quizzes designed to allow the user to proceed through the course at their own pace. Some courses are always available, while others are only available at certain times of the year. Certificates for course completion are also available.



# Environmental Epidemiology Videos

To learn about some interesting areas specific to environmental epidemiology please explore the following videos funded by NIEHS:



The video entitled [The Effects of Pesticides on Children](#), covers some of the long-term effects of exposures to pesticides.



The video entitled [Environmental Justice in Dallas](#) , discusses the health effects of lead exposures and about how community involvement can make a difference.



*Deteriorated former chemical storage tanks (ATSDR, 2010)*



The video entitled [West Nile Virus Outbreak in NYC](#) , explains the relationship between large numbers of deaths in crows and an outbreak of human illness in NYC.





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