

Introduction to Epidemiology: Basic Terminology Part 1

Lecturer: Dr. Brandon Guthrie

In this lecture, I will provide you with an introduction to epidemiology and define some basic terms.

History of epidemiology

Let's start with a brief history of epidemiology.

Epidemiology and a systematic approach to studying disease began in the 1800s, at a time when there were major epidemics of cholera in Europe, America, and elsewhere. Cholera, at that time, was believed to spread either by bad air, often called “miasma”, or person-to-person contact. But John Snow, a British doctor who had examined cholera patients, had seen that his patients had gastrointestinal symptoms such as vomiting and diarrhea. Since cholera causes gastrointestinal symptoms and no pulmonary symptoms, he believed something other than air—perhaps water or food consumption—could cause the disease. We now know that cholera is transmitted through ingestion of contaminated water or food.

At this time, people use town pumps and wells to get water for drinking and other purposes. In 1854, there was a cholera outbreak in Soho, a suburb of London. Dr. Snow lived near Soho, and so he started collecting data on the disease to link cholera to specific water sources. He mapped each case to determine their proximity to pump water.

Most of the cholera victims were clustered around and retrieved water from one of the water pumps, located at Broad Street. In order to rule out other possibilities, he also examined a group of people who did not get cholera and tracked to see if they drank water from the pump. He found that a prison near Soho that had its own well had no cases of cholera. He convinced the officials to remove the pump handle, after which the number of new cases quickly decreased.

Today, John Snow is considered to be the pioneer of public health research in epidemiology. Looking back, he made several important contributions: hypothesis that cholera was transmitted by contaminated water instead of contaminated air. In order to test this hypothesis, you compare groups of people who got cholera and who did not get cholera and determine which pumps they used. He provided evidence that the cholera outbreak was associated with drinking water from the Broad Street pump, and finally he convinced officials to remove the pump handle after which the epidemic ended.

Epidemiology today

Epidemiology focused on studying diseases such as cholera in its early days. But today, epidemiology is applied to all kinds of health-related issues from influenza to high blood pressure, cancer, depression, and gun violence.

Let us look at the example of cervical cancer. Cervical cancer is the fourth most common cancer in women with approximately 300,000 deaths every year worldwide. It's the most common cancer in women living in less developed regions. Almost all cervical cancer cases (about 99%) are linked to infection with high-risk human papillomaviruses, or HPV. The evidence identifying HPV as a cause of cervical cancer came from all kinds of epidemiological studies—from surveys to clinical trials. Initially, patients with cervical cancer were compared to patients without cervical cancer using information collected from the questionnaires. The differences between these two groups of women was mostly related to the number of sexual partners, early age at first intercourse, or previous STDs.

Later, with a cervical examination, it was found that all the risk factors—number of sexual partners, early age at first intercourse, or previous STDs—were surrogate markers for HPV exposure. Epidemiological evidence of the association of HPV with cervical cancer has provided the background and the justification for many public health interventions, such as improving screening programs and developing HPV vaccines. Infection with HPV has declined by nearly two-thirds among teenage girls since HPV vaccination was recommended in the US. Today, screening and treatment of precancerous lesions in women of 30 years and more is a cost-effective way to prevent cervical cancer.

Formally defined, epidemiology is the study of the distribution and determinants or causes of health-related states or events in specific populations, and the application of this knowledge to address health problems. In other words, epidemiology is the study of disease patterns within a population to determine risk factors that can be prevented or controlled. Data generated by epidemiologists are a key part of planning, implementing, and monitoring health interventions.

Why do we study epidemiology and what are the objectives? Epidemiology provides insight regarding the causes (or etiology) extent (or burden), and nature or natural history of a disease. It also helps to make meaningful comparisons of disease frequency between diseases, between population subgroups, between places, and also between time periods. In doing this, we may be able to identify modifiable causes of disease and use this to design disease control efforts. Epidemiology helps us to evaluate disease control efforts and provides information needed to plan resources and make appropriate policies.

Terms and definitions

I will now talk about some basic terminology used in epidemiology. A few terms that may come to mind when we mention epidemiology are epidemic and pandemic. While these terms are

commonly used, they have a specific definition in epidemiology. An **epidemic** is when a disease occurs at a level that is greater than what is expected in a specific population in a defined geographical area within a defined time period. For example, when COVID-19 was first identified in Wuhan, China in late 2019, it was considered an epidemic. In that case, because this was a new disease, and the number of cases represented a higher level of disease than would be expected. In the case of diseases that occur normally in some level in the population, we would only consider using the term epidemic if the level of disease in the population rose above normal levels.

The term “**outbreak**” is often used in place of “epidemic” to describe an elevated number of cases of disease, particularly when talking about smaller geographic areas or limited time period. There is no formal difference between an epidemic and an outbreak.

When an epidemic spread worldwide, across multiple countries or continents, and affects a high proportion of the global population, it is called a pandemic. Continuing with the same example before, COVID-19 was soon declared pandemic in March 2020 after it spread to several countries.

A **pandemic** is when an epidemic spreads worldwide, across multiple countries or continents, and affects a high proportion of the global population. Continuing with the same example as before, COVID-19 was soon declared pandemic in March 2020 after it spread to several countries.

Disease and case definitions

I will now talk about disease and case definition. Some of these terms and concepts are probably very familiar to you, at least in their informal usage, but others may not be as familiar.

In epidemiology, we used the term “**disease**” broadly when referring to a negative health outcome of interest. It may be an infectious disease such as measles, a chronic disease such as heart disease or mental illness, or even a societal disease such as gun violence. Epidemiology is often used to investigate outcomes that are not necessarily negative, such as pregnancy or recovery from cancer. So, when we hear about epidemiologic concepts discussed in terms of “diseases”, remember that we can apply these concepts more broadly to any type of outcome we’re interested in. A disease or outcome of interest is often defined using a **case definition**.

Here’s the case-definition for a suspected case of COVID-19 infection for the World Health Organization in March 2020. A patient with acute respiratory illness (fever and at least one sign/symptom of respiratory disease, e.g., cough, shortness of breath), AND a history of travel to or residence in a location reporting community transmission of COVID-19 disease during the 14 days prior to symptom onset. **OR** A patient with any acute respiratory illness AND having been in contact with a confirmed or probable COVID-19 case in the last 14 days prior to symptom onset; **OR** A patient with severe acute respiratory illness (fever and at least one

sign/symptom of respiratory disease, e.g., cough, shortness of breath; AND requiring hospitalization) AND in the absence of an alternative diagnosis that fully explains the clinical presentation.

WHO also defined a probable case and a confirmed case of COVID-19 infection. A probable case is a suspected case for whom testing is inconclusive, or, for any reason, the testing could not be performed. A confirmed case is a person with laboratory evidence of COVID-19 infection. Why do you think there are three definitions of COVID-19? Pause the video while you consider your answer, then press play to continue with the lecture.

The case definition allows public health professionals to consistently determine who is and is not a case in order to count the number of cases, which can in turn lead to identifying the possible causes of an outbreak, or of disease occurrence in general. This allows public health to efficiently prioritize their investigation and response. Case definitions often change over time, and it's important to be clear about which case definition is being used and to apply it consistently.

Early in the outbreak, case definitions are often broad to include all cases. This may also result in some people without the disease being incorrectly classified as a case. To address this, case definitions often include categories for suspected and probable cases. It is very important to have a standard case definition so that there isn't a lot of variation in terms of how a particular disease is being reported in different settings.

A **case definition** is a specific set of criteria, as we just saw for COVID-19, for classifying individuals as having a disease or condition. Understanding the case definition is critical. Unless we appreciate whether something is defined as a case or not a case at a given time point, we'll be making very different decisions in terms of including them, not including them or not including them in our assessments. It may be different from a clinical diagnosis, and it may or may not require laboratory testing. It can change over time as an outbreak or disease investigation unfolds. The case definition of COVID-19 was changed seven times between January and March in China to include milder cases. The data usually are obtainable at the population level. And different definitions are used for different purposes. So, we may have a case definition of malaria for the purpose of early case detection that could be very different from a case definition of malaria used for determining an individual patient's treatment needs. Appreciating how and when a case definition is used should be based on what we are trying to use the case definition for.

There are often standardized case definitions. And these may be provided by national or international public health agencies or associations. These are developed with the clinical experience and expertise of many individuals. Other sources of case definitions may be from previously published studies.

In this lecture, I introduced you to epidemiology and some common epidemiological terms, such as epidemic, pandemic, and case definition. The next lecture will build on these concepts and introduce additional terms and concepts commonly used in epidemiology.