

What is Epidemiology? Understanding the Science of Disease Control and Prevention

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One of the hardest problems that an epidemiologist has to face in their day-to-day life is probably to come up with a satisfactory answer to the question, “What do you exactly do?”

Epidemiology has its origin in healthcare, and till date, it has largely remained a sub-specialty of medicine. However, unlike other branches of medicine, it is notoriously hard to describe the exact nature of the work that an epidemiologist does. If you ask a cardiologist or a nephrologist to sum up their work in a single phrase, they can do so quite effortlessly. But ask an epidemiologist the same question, and you’ll find yourself in a cone of silence more awkward than when your crush heard your confession and replied with, “Oh, okay.”

One of the primary reasons why this is the case is probably due to the sheer vagueness and scope of the subject, which makes it very confusing to condense all of it within a neat little box. This is why many scientists, physicians, and thinkers have over the years proposed many different definitions of the term ‘epidemiology’. However, each time a new definition came out, it was met with a barrage of (mostly valid) critiques and criticism regarding the shortcomings and gaps left unaddressed. This has led to an almost never-ending debate which is yet to be solved beyond doubt.

Currently, the most widely recognized among the numerous definitions of epidemiology is the one recommended by the World Health Organization (WHO), which itself is a modified version of the definition proposed by John M Last. This is the definition that we will be focusing on in this article. However, if you are interested in reading about the chronology and evolution of the term epidemiology over the years, **Frérot M.** et al. have published a wonderful paper about it in the journal *PloS One*, which is accessible for free on the internet. [1]

The definition of epidemiology

The definition of epidemiology, as stated by the WHO reads as follows:

Epidemiology is the study of the distribution and determinants of health-related states or events (including disease)

in specified populations, and the application of this study to the control of diseases and other health problems. [2]

Sounds confusing? Because it kind of is. Most students, including myself, get completely stumped by this definition, which seems to raise more questions than it answers. However, as with all definitions, it is much easier to digest if we break it down to bite-sized bits. So let us do that.

Breaking it all down

There are a couple of key words and phrases in this definition. Our first task is to identify them and list them up, which will look like this:

1. Study
2. Distribution
3. Determinants
4. Health-related states or events (including disease)
5. Populations
6. Application
7. Control of disease and other health problems

Now, let us work our way through each of these terms one by one. But before that, we will rearrange the order of the list a little, so that it looks kind of like this:

1. Health-related states or events (including disease)
2. Populations
3. Distribution
4. Determinants
5. Study
6. Application
7. Control of disease and other health problems

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This will make it a bit easier to understand. So, let us begin.

Health-related state or event

To understand epidemiology, we have to first understand that it is a subject that deals with health. As we have discussed before, epidemiology is primarily a sub-specialty of medicine, and therefore, like all other branches, also deals with health and deviations from it. However, unlike other medical branches, which largely (sometimes almost solely) focus on diseases, epidemiology is a bit unique, as it includes within its purview not only disease, but also other factors that may be directly or indirectly related to health. For example, an epidemiologist might focus their attention on studying not only lung cancer, but also behaviors which are directly or indirectly related to the development of the lung cancer, such as tobacco smoking. Or they might even focus on neither the disease nor the causal behavior, but an event associated with the disease, such as the death of the affected person. This is why in the definition of epidemiology we have the term health-related state or event, which broadens the scope of the subject from only disease to include the cause, the process, and the outcome of the condition too.

Populations

No human disease, or state of health for that matter, can exist without people. So, identifying a population is very important in the understanding of that health-related state or event. In this context, a population can be understood as a group of people living in a particularly defined geographical area (can be a village, a country, a district, a country, a continent, or even the whole world) and sharing one or more similar characteristic of interest.

While the entire global human population belongs to a single species, our physical, environmental, socio-cultural, and economic characteristics lead to a great diversity among people, giving rise to populations with distinct attributes. These attributes vary widely between different geographic regions, and even between populations belonging to different socio-economic strata in the same area. Due to these variations, each population is uniquely vulnerable or resistant to different forms of health problems. For example, people living in sub-Saharan Africa might be vulnerable to sickle-cell anemia, but their sickle-celled adaptations make them resistant to malaria, a disease that has historically devastated populations without this particular trait. Therefore, interventions developed to control malaria in a sub-Saharan African population might yield little to no results in other malaria-endemic regions such as those populations of South and South-east Asia.

So, when an epidemiologist decides to pursue a particular health problem, they must first identify a population they want to study, because the knowledge they generate is spe-

cific to that population only, and might not be generalizable to populations which have different characteristics.

Distribution and determinants

Next come the two terms ‘distribution’ and ‘determinants.’ Some epidemiologists (including myself) prefer to add another term in front of these two, that is ‘frequency’. These terms act as descriptors of the phrase ‘health-related state or event’. How? Well, it is best explained by an example.

Suppose you are an epidemiologist with a keen interest in understanding malaria. Here, malaria is our health-related state or event. But malaria as a disease does not occur in a vacuum. Rather, to study malaria we must know important characteristics and information related to the disease. This information can be broadly divided into three questions:

1. How many people in a particular population (globally, or in a specific region of interest) are affected by malaria?
2. Where and how do these people who are affected, or are at a risk of being affected by the disease live in the world?
3. Why does malaria occur among these people, and how?

Not only malaria, answering these three questions is key to understanding almost any disease or health problem that one can think of. And the answers to these three questions make up the three terms that we have stated earlier. Let us see how. The answer to the first question or how many people are affected by malaria can be simply counted by identifying people with a confirmed diagnosis of the disease, and expressed as a simple whole number. And this property of an event (in this case a confirmed diagnosis of malaria) to occur for a countable number of times in a set of data (here, the population of interest) is mathematically called its frequency of occurrence.

Next comes the term ‘distribution’. As most of us know, malaria generally occurs in tropical and sub-tropical regions, and is quite rare in arctic climate. You cannot expect to find a malaria-stricken person in the deserts of Antarctica. This geographical dissemination of the cases of the disease across specific regions of the world is called its geographic or ‘place’ distribution. There are two other types of distribution, which are the ‘time’ and ‘person’ distributions. Not all diseases occur at the same time. Some diseases occur more in some months, others occur throughout the year. Some diseases occur in bursts of cases, events known as outbreaks or epidemics; others, like diabetes or hypertension might cement themselves in human populations slowly through many decades. This is known as the time distribution of the disease. Finally, there is the ‘person distribution’. Each one of us are vulnerable to different types and forms of health problems, which depend on the age, sex, and genetic makeup of the individual. You might be hard-pressed to diagnose adenoid hypertrophy or testicular cancer in an adult woman, who, by virtue of being an adult, and a woman, is protected against both of these diseases. Similarly, Down’s syndrome occurs

only in people with three copies of the chromosome 21. Person distribution of a health state or event differs widely across populations, and based on underlying characteristics, person-distribution of a disease might itself give rise to specific populations of interest.

Just as chocolate chips are unevenly distributed in a muffin, and knowing the precise location of the chocolate chip is key to getting a mouthful of goodness, so are diseases spread unequally in populations, and it is critical for an epidemiologist to know the place, time, and person distribution of a disease to generate accurate knowledge on it.

Finally comes the term ‘determinant’. In the context of our example, a determinant is any factor that either promotes or prevents malaria to occur and spread in a specific population. Interestingly, almost anything can be a determinant, and the scope of the term is quite a bit broader than one might think. Malaria cannot occur without a person being infected with the Plasmodium parasite by the bite of the female Anopheles mosquito, so both the mosquito as well as the parasite are determinants of the disease. However, even if you live in a place where is a rampant presence of Anopheles mosquitoes as well as Plasmodium parasite, you might not contract malaria, because you use bed nets while sleeping. So here, the use of bed nets at night can also be considered a determinant of the disease. Similarly, a very large and diverse number of factors can be identified which, through their direct or indirect effects, might either enable a disease to occur, or prevent its development and spread in a person or population.

It is one of the most important jobs of an epidemiologist to focus on studying these characteristics, as the interactions between the frequency, the distribution, and the determinants of a health-related state or event is key to unlocking not only its secrets but also devise plans to prevent or mitigate problems associated with it.

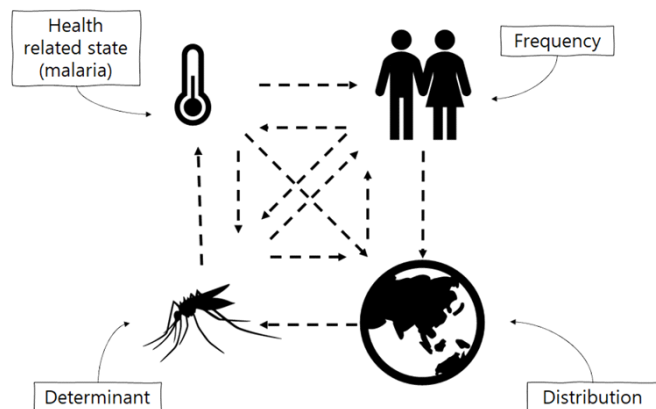


Fig A. Note how the frequency, distribution, and determinants of a health event (malaria) interact with each other

Study (of)

To gather all the necessary information regarding a health problem and its frequency, distribution, and determinants among human populations, epidemiologists have to devote a significant part of their time and effort in study and research. In fact, it is just not enough to gather information about a problem. The epidemiologist, by virtue of their work goes into excruciating detail synthesize the raw information (which are generally a bunch of numbers) and generate ‘scientific knowledge’. This is what makes up most of our day-to-day work.

Control of disease and other health problems

Once the study of the health-related state or event is finally concluded, it is the responsibility of an epidemiologist to go out into the world and share not only their observations and the knowledge they generated from this study, but also important ways that this knowledge can be applied for the betterment of the lives of the general population. This is why the definition of epidemiology stresses so much on ‘application’. Just gathering the data and publishing our findings is not enough. We have to apply the knowledge that we have generated to tackle problems that plague humankind, by introducing preventive, promotive, and curative interventions to mitigate these issues.

Building it back up

By now we have understood what each of the key terms that we have identified within the definition of epidemiology mean. So, let us put it all back together.

In order to understand epidemiology, we have to:

1. Identify a health-related state or event
2. Identify a particular population of interest
3. Identify the frequency, distribution, and determinants of that particular health related state or event
4. Study these characteristics and their interactions between each other
5. To apply the knowledge that we have generated to solve the problems associated with that health-related state or event

Collecting the four statements together, we can now easily understand the definition of epidemiology:

Epidemiology is the study of the distribution and determinants of health-related states or events (including disease) in specified populations, and the application of this study to the control of diseases and other health problems.

To sum it all up, from now on, if you find yourself on the receiving end of the question of “What do you exactly do?”, you can break the chain of awkward silence with “I study how to control health problems in a population.” And if you are feeling particularly mischievous that day, you can just tell

them the definition of epidemiology, smile at their confusion, and refer them to this blog to sort it out.

Till next time!

References

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