# Measures of Occurrence

The focus of epidemiology is on occurrence of diseases and health-related states in defined populations rather than individual cases of a disease. Once a clear case definition is established and the population is defined as discussed in the previous lecture, occurrence of disease can be quantified in that population. Quantification of the occurrence of disease in the population is one of the principal functions of epidemiology. Measures of occurrence tell us how common a disease is in a defined population. The two main measures of occurrence are prevalence and incidence. Prevalence is a measure to quantify the number of existing cases in a population and incidence is a measure to quantify the new cases of a disease in the population. Measures of prevalence and incidence are meaningless unless we define:

1. What we mean by a case (case definition)as we explained in an earlier lecture.
2. What is the population at risk of becoming cases as explained earlier
3. The time frame for the measurement.

**Risk**

Risk is a proportion; it is the proportion of people who get the disease. Risk is therefore number of people with the disease divided by total. Incidence is a risk. If 10 children get measles in a nursery during an outbreak of measles, this means that risk of measles in this nursery is 10/100= 10% i.e.one in 10 gets measles.

**Odds**

Unlike risk, odds is not a division by total; it is a division by non-cases i.e. we divided number of people who develop the disease by number of people who do not develop the disease.

Odds= number of people who have the disease/number of people who do not have the disease.

For example if 10 children out of 30 who attended a birthday party got diarrhea, the odds of diarrhea in this situation will be:

Number of children with diarrhea/ number of children with no diarrhea
Odds of diarrhea=10/(30-10)=10/20= 0.5

We say the odds of having diarrhea was 0.5. Odds is a comparison between cases and non-cases. The odds of becoming a case is not used as a measure of occurrence on its own. However, it is an important measure in analysis of case-control studies which will be discussed later on.

**Incidence**

Incidence or more accurately incidence risk is the proportion of new cases that occur in a population during a specified period of time. In other words, incidence is the number of new cases of a disease during a certain period of time divided by the total number of population at risk during that period.

Incidence = number of new cases in time period / population at risk at that period

Incidence only measures number of NEW cases of the disease that occur during the period of the study. The number of new cases is called the *numerator* and the total population at risk is the *denominator* in this equation. Both the numerator and denominator must be clearly defined. The numerator is the number of new cases which should be decided according to a clear case definition. The denominator is the population at risk i.e. total number of people who are at risk of becoming a case in the population which has produced the cases. For example an imaginary study registered 250 new cases of cancer in one year in a city with a population of 500,000; what is the incidence of cancer in this city?

Incidence = number of new cases in time period / population at risk at that period
Incidence of cancer in this city= number of new cases of cancer/ total population of the city =250/500,000 =5/10,000

Therefore incidence of cancer was 5 per 10,000 (or 50 per 100,000) that year in the city meaning that out of each 10,000 people 5 persons developed cancer during the year. Because incidence is usually a small fraction, we don't report it as a percent, but per 1000, 10,000 or 100,000 depending on how big is the incidence.

The incidence of burn injuries was 389 per 100,000 in 2008 in Sulaymaniyah city. This means that out of each 100,000 people of the city 389 persons suffered new burn injuries. In the same year, burn incidence was 10 per 1000 amongst pre-school children; what does this mean?

**Prevalence**
Prevalence is the proportion of persons in a defined population that has the outcome under study at a specific point in time. In other words prevalence is the number of existing cases of a disease divided by population at risk.

Prevalence = number of existing cases/ population at risk

The number of existing cases is called the *numerator* and the total population at risk is the *denominator*. Both the numerator and denominator must be clearly defined. All cases should be from this population. Prevalence is expressed as a percentage.

Example: imagine you did a study on prevalence of smoking amongst the 600 medical college students (population at risk) of whom 90 were currently smoking (i.e. they were existing cases). Now calculate prevalence of smoking amongst medical students.

Prevalence = number of existing cases/ population at risk
Prevalence of smoking =number of students who currently smoke/ total number of students =90/600=0.15=15%

Prevalence is 15% meaning that at the time of the study 15% of students were smokers.

This type of prevalence is called point prevalence because it calculates prevalence in a single point in time which is the time when the survey is done. Example: 3% of children were PPD (tuberculin test) positive in London when they were tested at school entry in September 1996.

The prevalence of childhood diabetes in Sudan in July 1990 was 9.5%. In 2011, prevalence of female genital mutilation was 23% in Kurdish females aged 0-20 years. What do these figures mean?

There is another form of prevalence called period prevalence which counts the number of cases in a population over a defined period of time for example 6 months. Period prevalence therefore includes existing and new cases during the period. This is not very useful and rarely used.

***Factors that influence prevalence***

Prevalence counts the existing cases. Existing cases depend on number of new cases (incidence) and the duration of the disease. Therefore we can say that prevalence (P) equals the number of new cases (I) multiplied by duration (D) of the disease.

**P= I x D**.

***Factors that increase incidence*** of the disease increase prevalence. For example prevalence of diarrhea could be more in summer because incidence of diarrhea is more in summer. ***Factors that reduce incidence*** of the disease will also reduce prevalence. For example measles vaccination campaign in a city may protect children from measles therefore there will be less new cases (lower incidence) and subsequently prevalence of measles will also fall.

***Factors that increase the duration*** of the disease increase prevalence. For example prevalence of type I diabetes has increased dramatically since insulin has become available, why? Before introduction of Insulin, children who had diabetes lived less, but insulin therapy has prolonged their lives i.e. increased duration of the disease, therefore it has led to an increase in the prevalence of diabetes. As you see, when prevalence of a disease increases in the population, it does not always mean worsening of the health situation. In this way better care to patients can lead to an increase of the prevalence of the disease. Chronic diseases like diabetes, asthma, hypertension, normally have a long duration, therefore their prevalence are higher than prevalence of diseases with a shorter duration if their incidence are similar.

***Factors that reduce the duration*** of the disease lead to a reduction in prevalence of the disease. If the disease is rapidly fatal, the prevalence will be lower. For example, the prevalence of coronary heart disease in population A may be lower than population B because in population A, many patients die rapidly from the disease because of lack of care. In the same way, treatment if leads to cure and hence to reduction of the duration of the disease, it will lead to reduction of the prevalence. For example TB is a chronic infectious disease; treatment can lead to cure and shortening of the duration of the disease therefore to a reduction in prevalence of TB. But treatment of diabetes leads to increased prevalence, why?

Better care, therefore, can lead to a reduction or an increase in prevalence depending whether it leads to cure (e.g. in tuberculosis) or to prolonging life but not cure (e.g. diabetes and cancer).

**Further reading**

1. Gordis, L., *Epidemiology*. 2nd ed. 2000, London: Saunders
2. Coggon, D., G. Rose, and D. Barker, *Epidemiology for the uninitiated*. 4th ed. 1997, London: BMJ Publishing.