Measuring Health and Disease

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Objectives

• Define **prevalence** and **incidence**.
• Distinguish between disease incidence expressed as a **risk** versus a **rate**
• Define **odds**
• Describe measures of effect
What is epidemiology?

• Measurement of occurrence of disease or health status of a population and their determinants in relation to time.

• **Criteria for disease/case definition**
  • Set of diagnostic criteria to distinguish individuals with disease (cases) and those without.
  • May be based on specific symptoms, signs, medical history or test results

• **Population at risk**
  • individuals who are able to develop the disease or condition of interest

• **Time frame**
  • Specific point in time
  • Interval of time
Prevalence

• Two main measures of prevalence
  • Point prevalence
  • Period prevalence
Point prevalence

• This is the proportion of population at risk who have a disease of interest at a particular point in time.
  • *number of existing cases at a specific point in time*
    *Total population at risk*

• Persons in the numerator are also included in the denominator
• Gives a snap shot of the population
• It is a measure of disease burden.
• It is a proportion and therefore can be expressed as a percentage
Period Prevalence

• The proportion of the population at risk that had a particular disease with a certain period of time
  • number of existing cases in time period
    Total population at risk in that same period

• The numerator includes cases present at the start, as well as incident cases which arose during the period of interest.

• Period prevalence measures the frequency of all events (old and new) for a prescribed period of time.
Example: Scenario

- A population of 150 school children were screened for a condition.
- They were followed up for one year
- 25 children had condition of interest at beginning of study
- Another 15 cases developed during year of follow-up

**Point prevalence:** $\frac{25}{150} = 0.17 = 17\%$

**Period prevalence:** $\frac{25 + 15}{150} = 0.27 = 27\%$
Incidence

• The measure of occurrence of **new cases** of disease in a defined **population at risk**, in specified period of time.

• This is a proportion and can be expressed as a %
Incidence

• The measure of occurrence of new cases of disease in a defined population at risk, in specified period of time.

• This is a proportion and can be expressed as a %
Prevalence vs Incidence

- **Prevalence** can be seen as describing a pool of disease in a population.
- **Incidence** is the input flow of new cases into the pool.
- Deaths and cures reflect the output flow from the pool.
Factors influencing prevalence

• **Number of new cases**
  • Increased new cases (improved detection, immigration of patients), increases prevalence
  • Decreased new cases (improved cure rate or emigration of patients), decreases prevalence

• **Duration of illness**
  • Short duration, prevalence will be reduced
  • Long duration results in increased prevalence
Uses of prevalence data

• Assessing health care needs of a population
• Planning health services after understanding burden of disease
Measuring incidence

• 2 main measures of incidence
  • Risk
  • Rate
Incidence Risk

• Reflects the **absolute risk** of developing disease within a given population
  
  - *number of new cases from population at risk*
  
  *Disease free population at the start of the follow-up*

• Neither the denominator nor numerator includes people who already have the disease
  
  • No prevalent cases included

• Also known as **cumulative incidence, incidence proportion**
Incidence Rate

• Measures the pace at which new cases of disease occur in a population at risk.
  • number of new cases from population at risk
    sum of disease free time of each person in the population at risk

• The total time the population was at risk of developing disease is also known as person-time
• Person time can be measured with whatever scale that makes the most sense i.e., person-days, person-weeks, person-months, person-years (PY)
• Incidence rate is also known as incidence density, hazard rate, person-time rate
Incidence Rate

• Typically individuals are followed up until one of 3 endpoints occurs
  • Diagnosis of disease of interest
  • End of study
  • Loss to follow-up

• Loss to follow-up may occur due to
  • Migration out of the population
  • Death
  • Refusal to continue to participate in the study
  • These individuals may be described as “censored”
Example...total person-time
Example...total person-time

5 years
Example... total person-time

5 years  3 years
Example... **total person-time**

| 5 years | 3 years | 4.5 years |
Example... **total person-time**

- 5 years
- 3 years
- 4.5 years
- 1+3 years
Example... total person-time

5 years  3 years  4.5 years  1+3 years  1 years
Example... **total person-time**

Total person-time:  

\[
5 + 3 + 4.5 + 1 + 3 + 1 = 17.5 \text{ years}
\]
A graphic representation of incidence

Incidence Rate in A Prospective Cohort Study

Subject
A-
B-
C-
D-
E-
F-
G-
H-
I-
J-
K-
L-

Time at Risk
8.3
11.0
14.0
14.0
10.2
3.0
12.0
7.0
10.0
3.0
9.0
6.2

81 82 83 84 85 86 87 88 89 90 91 92 93 94 95

Incidence (IR) = 3/107.7 = .028/ person-yr
Total time at risk = 107.7 person-yrs
= 28/1000 p-yrs

X= when they got disease
Types of cohorts

Closed
• After start of follow-up, no new persons can be added in the study
• Can directly calculate
  • Incidence risk
  • Incidence rate
  • odds

Open
• May gain members over time (birth or immigration)
• May also lose members through emigration
• Can directly calculate incidence rate using person-time of follow-up
Uses of incidence data

• Useful in describing trends in disease
• Allows evaluation of impact of primary prevention programs
Odds

• The **odds** of becoming a case is a measure of the number of cases in a defined population and time period, divided by the number of people who *did not* become a case in the same time period.
  
  • \[
  \frac{\text{number of cases}}{\text{number of non-cases}}
  \]

• The odds of becoming a case is rarely used as a measure of occurrence.

• However, it is an important measure of *effect*, known as **odds ratio**,.
Example

• In a population of 100 school children, 20 children had at least one episode of diarrhoea during a one year study period. The odds of developing diarrhoea in the school during the study period was:
  • \( \text{odds} = \frac{\text{number of cases}}{\text{number of non-cases}} \)
  
\[
\begin{align*}
\frac{20}{(100-20)} &= 0.25 \\
&= 25%
\end{align*}
\]
Measures of effect

• Important for assessing for an association between a suspected factor and the outcome of interest e.g. disease.

• The factor suspected to be associated with an event is referred to as an exposure.

• An exposure could be anything from
  • a harmful substance to
  • a specific behaviour or
  • a personal characteristic.
Measures of effect

• **Compare** the occurrence of the outcome in a group of people that has been 'exposed' to the factor, with the occurrence in a group of people that has not been 'exposed'.

• The measures are expressed as a **ratio** to get the **relative** measure of effect of the exposure on disease.

• Alternatively, the **difference** of the two measures of occurrence gives the **absolute** measure of effect of the exposure.
Relative measures of effect

• estimate the magnitude of an association between exposure and disease
• Different types of relative measures can be calculated, known as measures of relative risk:
  • Risk ratio = \( \frac{\text{Risk in the exposed group}}{\text{Risk in the unexposed group}} \)
  • odds ratio = \( \frac{\text{odds of disease in the exposed group}}{\text{odds of disease in the unexposed group}} \)
  • Rate ratio = \( \frac{\text{Incidence rate in the exposed group}}{\text{Incidence rate in the unexposed group}} \)
Example....

<table>
<thead>
<tr>
<th></th>
<th>Exposed</th>
<th>Unexposed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number initially at risk</td>
<td>2000</td>
<td>8000</td>
</tr>
<tr>
<td>Deaths during the period</td>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td>Person-years at risk</td>
<td>3985</td>
<td>15970</td>
</tr>
</tbody>
</table>

\[
Risk \ ratio = \frac{15}{2000} = 2 \\
\frac{30}{8000}
\]

\[
odds \ ratio = \frac{15}{(2000-15)} = 2.0076 \\
\frac{30}{(8000-30)}
\]

\[
Rate \ ratio = \frac{15}{3985} = 2.0038 \\
\frac{30}{15970}
\]
Interpreting measures of effect

• A value of 1 indicates the risk in exposed and unexposed is **identical**, thus **no association** observed between exposure and disease

• A value >1 indicates a **positive association** or an **increased risk** among those exposed

• A value <1 indicates an **inverse association** or a **decreased risk** among those exposed i.e. exposures appears protective
Thank you