Rates and person time

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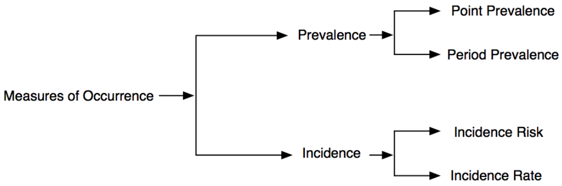
Overview of Measures of Occurence

There are two main measures of occurence used in epidemiology:



- Prevalence - concerned with quantifying the number of existing cases in a population at a designated time.
- Incidence - concerned with quantifying the frequency of occurrence of new cases in a defined population, arising during a given time period

Incidence

Incidence Rate

relates the number of new cases to the total *person-time* at risk

$$Incidence\ Rate, \lambda = \frac{Number\ of\ new\ cases}{Total\ persontime\ at\ risk} = \frac{d}{T} \tag{3}$$

where *person-time* is calculated as

$$Persontime\ in\ years = \frac{exit\ date - entry\ date}{365.25} \tag{4}$$

Incidence

Incidence Rate

Example 3:

By the end of a 13-year follow-up diabetes study, 250 out of 4000 developed diabetes. The total time of observation was 40000 person-years. What is the incidence of diabetes in this poulation?

Incidence

Incidence Rate

Confidence interval for a rate

$$s.e\,(log\ rate) = \frac{1}{\sqrt{d}} \tag{5}$$

$$95\%\ CI\ for\ log\ rate = log\ rate \pm 1.96 \times \frac{1}{\sqrt{d}} \tag{6}$$

$$95\%\ CI\ for\ rate = \frac{rate}{exp(1.96/\sqrt{d})} \quad to \quad rate \times \exp(1.96/\sqrt{d}) \tag{7}$$

Comparing Rates

- The rates of disease in two exposure groups may be compared using two different measures: **rate difference** and **rate ratio**

- Example to work with is the child deaths data which contains the variables: date of birth, date of death, sex, location of death, status and mothers' education level

Rate Difference

Gender	Number of Deaths	Person Years	Rate/1000child yrs
female	21	1148.698	18.28157
Male	20	1162.845	17.1992
Total	**41**	**2311.543**	**35.48077**

- The **rate difference** comparing the female with male deaths is $18.28157 - 17.1992 = 1.082363$ deaths per 1000 child-years

Rate Difference: Confidence Interval

- The 95% confidence interval is:

$$1.082363 \pm 1.96X5.5$$

$$(-9.7, 11.9)$$

- **Conclusion**: With 95% confidence, the interval -9.7 to 11.9 contains the actual (population) difference in mortality rates between females and males.

Rate Ratios

- The analysis of rates is usually done using rate ratios rather than rate differences.
- The rate ratio is defined as:

$$Rate\ \ Ratio = \frac{rate\ \ in\ \ group\ \ A}{rate\ \ in\ \ group\ \ B} = \frac{\lambda_1}{\lambda_0} = \frac{\frac{d_1}{T_1}}{\frac{d_0}{T_0}} = \frac{d_1 X T_0}{d_0 X T_1}$$

- We use the standard error of the log rate ratio to derive confidence intervals and test the null hypothesis of no difference between rates in any two groups.

Rate Ratio Standard Error and CI

- The standard error is given by:

$$s.e \;\; of \;\; log(rate \;\; ratio) = \sqrt{\frac{1}{d_1} + \frac{1}{d_0}}$$

- The 95% confidence interval for the rate ratio is:

$$95\% \;\; CI = \frac{rate \;\; ratio}{EF} \;\; to \;\; rateratio \;\; X \;\; EF$$

$$EF = exp[1.96 \;\; X \;\; s.e. \;\; of \;\; log(rateratio)]$$

Example 1 (contd. . .)

$$rate \;\; ratio = \frac{\frac{21}{1148.698}}{\frac{20}{1162.845}} = 1.06$$

$$s.e \;\; log(rate \;\; ratio) = \sqrt{\frac{1}{20} + \frac{1}{21}} = 0.31$$

And the 95% error factor is given by:

$$95\% EF = exp(1.96 X 0.31) = 1.84$$

Example: Conclusion

This gives a confidence interval of:

$$(\frac{1.06}{1.84},\ \ 1.06X1.84)\ \ =\ \ (0.58,\ \ 1.95)$$

Conclusion: There is a 95% probability that the interval 0.58 to 1.95 contains the actual (population) mortality rate ratio.