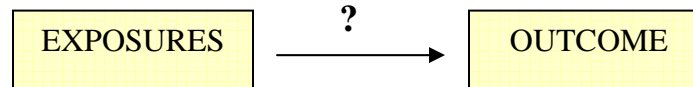
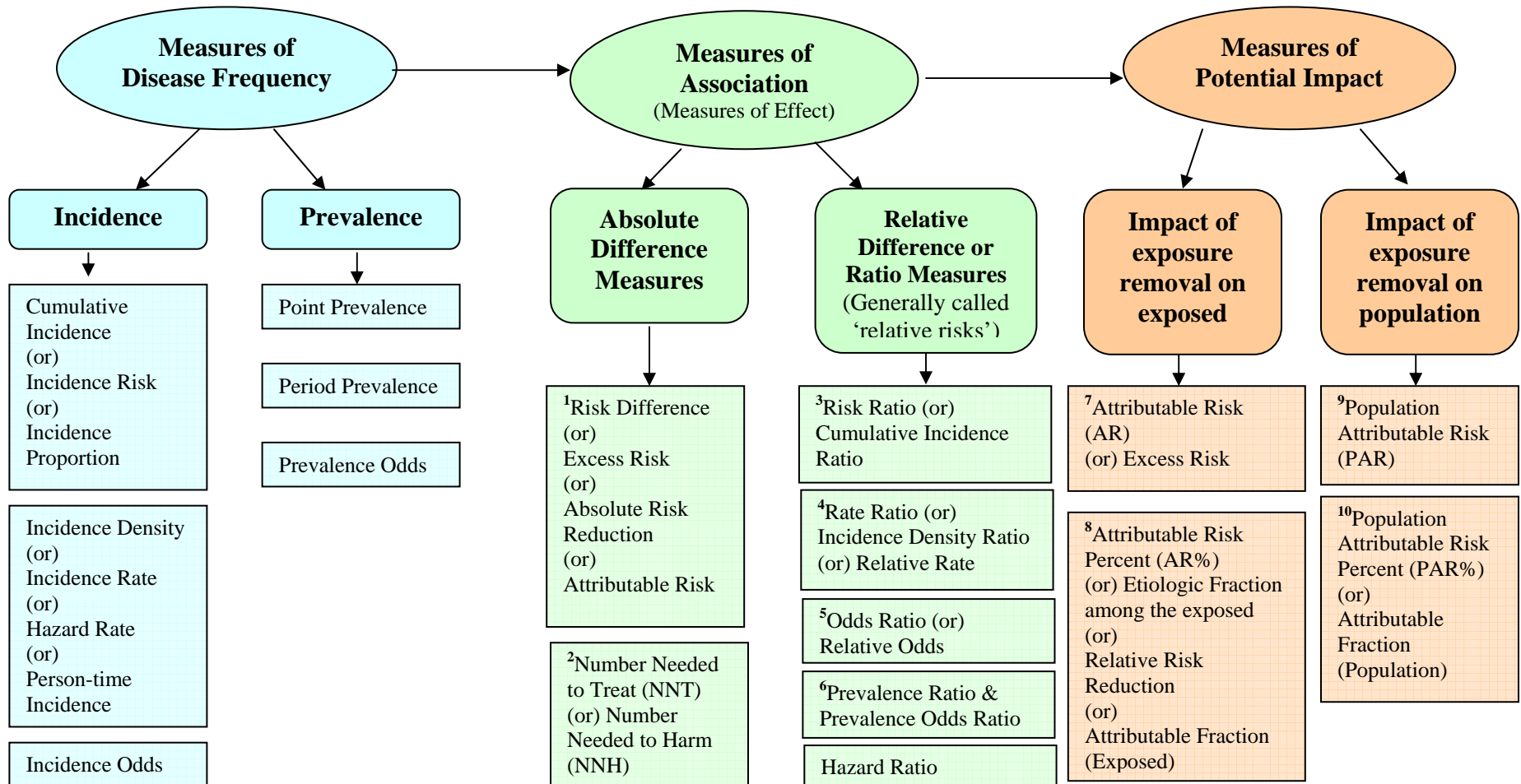


AN OVERVIEW OF MEASUREMENTS IN EPIDEMIOLOGY [VER 3, 2007]



Epidemiology is about identifying associations between exposures and outcomes. To identify any association, exposures and outcomes must first be measured in a quantitative manner. Then rates of occurrence of events are computed. These measures are called “*measures of disease frequency*.” Once measured, the association between exposures and outcomes are then evaluated by calculating “*measures of association or effect*.” Finally, the impact of removal of an exposure on the outcome is evaluated by computing “*measures of potential impact*.” In general, measures of disease frequency are needed to generate measures of association, and both these are needed to get measures of impact. There is some overlap between these measures, and terminology is poorly standardized.



The superscript numbers refer to the formulae used to compute those measures (formulae shown separately in the following pages)
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FORMULAE USED TO COMPUTE THE MEASUREMENTS

The following formulae are based on this typical epi 2 x 2 table with standard notation:

		Outcome (Disease)		
		Yes	No	
Exposure	Yes	a	b	a + b
	No	c	d	c + d
		a + c	b + d	

Other notation used:

- I_o = Incidence of outcome among the unexposed (baseline risk)
- I_e = Incidence of outcome among the exposed
- I_t = Incidence of outcome in the total population (exposed and unexposed)
- P_{exp} = Prevalence of exposure in the population
- P_o = Prevalence of outcome among the unexposed
- P_e = Prevalence of outcome among the exposed
- RR = Relative Risk (could refer to a Risk Ratio or a Rate Ratio)
- PR = Prevalence Ratio
- OR = Odds Ratio
- AR = Attributable Risk
- RD = Risk Difference
- PAR = Population Attributable Risk
- ARR = Absolute Risk Reduction
- RRR = Relative Risk Reduction
- NNH = Number Needed to Harm
- NNT = Number Needed to Treat
- CIR = Cumulative Incidence Ratio
- IDR = Incidence Density Ratio
- PF = Prevented Fraction

WHEN EXPOSURES ARE HARMFUL:

$$^1\text{Risk Difference (ARR, AR)} = \frac{a}{a + b} - \frac{c}{c + d} = I_e - I_o$$

$$^2\text{Number Needed to Harm (NNH)} = 1 / RD$$

$$^3\text{Risk Ratio (RR, CIR)} = \frac{a/(a + b)}{c/(c + d)} = I_e / I_o$$

$$^4\text{Rate Ratio (RR, IDR)} = \text{see end of this handout}$$

⁵Odds Ratio (OR) = $\frac{a/c}{b/d} = \frac{ad}{bc}$

⁶Prevalence Ratio (PR) = P_e / P_o

⁷Attributable Risk (AR) = Same formula as Risk Difference

⁸Attributable Risk Percent (AR%) = $\frac{I_e - I_o}{I_e} * 100 = \frac{AR}{I_e} * 100$

= $\frac{a/(a+b) - c/(c+d)}{a/(a+b)}$

Alternative formula for AR% = $\frac{(RR - 1) * 100}{RR}$

AR% in a case-control study = $\frac{(OR - 1) * 100}{OR}$

⁹Population Attributable Risk (PAR) = $I_t - I_o$

Alternative formula for PAR = $AR * P_{exp}$

¹⁰Population Attributable Risk Percent (PAR%) = $\frac{I_t - I_o}{I_t} * 100$

Alternative formula for PAR% = $\frac{P_{exp}(RR-1)}{P_{exp}(RR-1) + 1} * 100$

⁴Rate Ratio (RR, IDR) = $\frac{a/N1}{b/N2}$

This formula for Rate Ratio is based on the following 2 x 2 table format:

	Cases (Outcome)	Person-time
Exposed	a	N1
Unexposed	b	N2

WHEN EXPOSURES ARE PROTECTIVE:

In some situations (such as a clinical drug trial or a vaccine efficacy study), the exposure is protective. Therefore, incidence of disease in the exposed/intervention group (I_e) will usually be lower than incidence in the unexposed/control group (I_o). Hence, measures such as RR and OR will be < 1.0 [i.e. protective effect].

In such situations, some of the above formulae will have to be computed and interpreted differently. Also, the names will change.

$$\text{Absolute Risk Reduction (ARR)} = c/(c + d) - a/(a + b) = I_o - I_e$$

[ARR is the same as Risk Difference]

$$\text{Number Needed to Treat (NNT)} = 1 / \text{ARR}$$

$$\begin{aligned} \text{Relative Risk Reduction (RRR)} &= \frac{I_o - I_e}{I_o} * 100 = \frac{\text{ARR}}{I_o} * 100 \\ \text{(also called "prevented fraction")} & \\ &= \frac{c/(c + d) - a/(a + b)}{c/(c + d)} \end{aligned}$$

$$\text{Alternative formula for RRR} = 1 - \text{RR} * 100$$

$$\text{RRR in a case-control study} = 1 - \text{OR} * 100$$

$$\text{Vaccine Efficacy (VE)} = \text{Same formulae as RRR}$$