AN OVERVIEW OF MEASUREMENTS IN EPIDEMIOLOGY

EXPOSURES → ? → OUTCOME

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.

Measures of Disease Frequency

Incidence

- Cumulative Incidence (or) Incidence Risk (or) Incidence Proportion
- Incidence Density (or) Incidence Rate (or) Hazard Rate (or) Person-time Incidence
- Incidence Odds

Prevalence

- Point Prevalence
- Period Prevalence
- Prevalence Odds

Measures of Association (Measures of Effect)

Absolute Difference Measures

- [1]Risk Difference (or) Excess Risk (or) Absolute Risk Reduction (or) Attributable Risk
- [2]Number Needed to Treat (NNT)

Relative Difference or Ratio Measures (Generally called Relative Risks)

- [3]Risk Ratio (or) Cumulative Incidence Ratio
- [4]Rate Ratio (or) Incidence Density Ratio
- [5]Odds Ratio (or) Relative Odds
- [6]Prevalence Ratio & Prevalence Odds Ratio

Measures of Potential Impact

Impact of exposure removal on exposed

- [7]Attributable Risk (AR) (or) Excess Risk
- [8]Attributable Risk Percent (AR%) (or) Etiologic Fraction among the exposed (or) Relative Risk Reduction (or) Attributable Fraction (Exposed)

Impact of exposure removal on population

- [9]Population Attributable Risk (PAR)
- [10]Population Attributable Risk Percent (PAR%) (or) Attributable Fraction (Population)

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
PAR = Population Attributable Risk
ARR = Absolute Risk Reduction
RRR = Relative Risk Reduction
NNT = Number Needed to Treat
CIR = Cumulative Incidence Ratio
IDR = Incidence Density Ratio
PF = Prevented Fraction

[1]**Risk Difference** (ARR, AR) = $a/(a + b) - c/(c + d) = I_e - I_o$

[2]**Number Needed to Treat** (NNT) = 1 / ARR

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

[4]**Rate Ratio** (RR, IDR) = see end of this handout

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

[6] **Prevalence Ratio** (PR) = P_e / P_o

[7] **Attributable Risk** (AR) = Same formula as Risk Difference

[8] **Attributable 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% = $\frac{(RR - 1)}{RR} * 100$

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

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

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

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

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

[4] **Rate 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

♣ Note: In some situations (like in a clinical trial or a vaccine field study), the exposure is protective. In such situations, some of the above formulae will have to be computed and interpreted differently. Also, the names will change. For example, when the exposure is protective, the AR% is meaningless because the I_e is less than I_o, because exposure leads to a lower incidence. In this situation, the formula changes to:

RRR (PF) = $\frac{I_o - I_e}{I_o} * 100$

The name changes from AR% (also called *etiologic fraction)*, to Relative Risk Reduction [RRR] (also called *prevented fraction*). Similarly, when the exposure is protective, AR (also called Excess Risk) becomes Absolute Risk Reduction (ARR) and the formula becomes: ARR = $I_o - I_e$