EMBLEM
High Quality, High Impact Research

Cancer Research Methods Workshop

Mayur M. Desai, PhD, MPH

Mwanza, Tanzania

September 18-19, 2012

Yale SCHOOL OF PUBLIC HEALTH

Measurement Issues

Measurement issues

Validity (accuracy)

- The degree to which a measurement measures what it purports to measure

Reliability (precision, consistency, reproducibility)

- The degree of stability exhibited when a measurement is repeated
- Lack of reliability may arise from divergences between observers or instruments of measurement, or instability of the attribute being measured

Common indices of validity

- Sensitivity
- Specificity
- Positive predictive value
- Negative predictive value

Indices of validity

		Disease or "Gold Standard"	
		Positive	Negative
Test Result	Positive	True + (a)	False + (b)
	Negative	False – (c)	True – (d)

Sensitivity = a / (a+c)

PPV = a / (a+b)

Specificity = d / (b+d)

NPV = d / (c+d)

Example

Using data abstracted from medical records as the "gold standard," researchers sought to determine the validity of self-reported use of antihypertensive medications in a sample of 217 patients. According to their medical records, 50 individuals were taking antihypertensives. During the interview, 44 of the 217 reported use of antihypertensives. There was no indication of any use of these medications from either source of information for 154 patients.

- Calculate and interpret the following parameters: sensitivity, specificity, PPV, and NPV

Example

Sensitivity = 31 / 50 = 62.0%

Specificity = 154 / 167 = 92.2%

		Medical Record "Gold Standard"		
		Pos	Neg	
Self-report	Pos	31	13	44
	Neg	19	154	173
		50	167	217

Example

PPV = 31 / 44 = 70.5%

NPV = 154 / 173 = 89.0%

		Medical Record "Gold Standard"		
		Pos	Neg	
Self-report	Pos	31	13	44
	Neg	19	154	173
		50	167	217

Reliability

some measures of agreement

- % agreement
- Cohen's kappa statistic

% agreement

		Observation 1	
		Positive	Negative
Observation 2	Positive	a	b
	Negative	c	d

- The situation where two raters or methods rate each subject, or each rater rates subjects at two different time points
- Cells indicate pairs of ratings

% agreement = ([a+d] / [a+b+c+d]) * 100

% agreement (cont.)

		Observation 1			
		1	2	3	
Observation 2	1	17	14	6	37
	2	5	104	46	155
	3	5	64	725	794
		27	182	777	986

- Can be extended to tables greater than 2 x 2

% agreement = (17 + 104 + 725) / 986 * 100 = 85.8%

% agreement (cont.)

		Observation 1	
		Positive	Negative
Observation 2	Positive	a	b
	Negative	c	d

Limitations:

- Tends to be high whenever…
  - negative-negative (cell d) is high – low prevalence; high specificity
  - positive-positive (cell a) is high – high prevalence; high sensitivity
- Does not take into account the agreement that may occur by chance alone

Kappa statistic

Measure of agreement that corrects for chance agreement, but still dependent on prevalence

		Observation 1		
		Pos	Neg	
Obs 2	Pos	a	b	r_1
	Neg	c	d	r_2
		c_1	c_2	N

$$K = \frac{P_o - P_e}{1.0 - P_e}$$

+1 = perfect agreement
0 = no better than chance
-1 = perfect disagreement

where: P_o is the observed agreement = (a+d) / N
and P_e is the expected chance agreement = $([r_1 * c_1] + [r_2 * c_2]) / N^2$

Example

Two radiologists, Dr. A and Dr. B, independently reviewed the results of 146 chest X-rays. Drs. A and B identified 37 and 30 tuberculosis cases, respectively; 16 were identified by both.

- Calculate the % agreement
- Calculate the kappa

% agreement calculation

- % agreement = (16 + 95) / 146 = 76.0%

		Dr. A		
		Pos	Neg	
Dr. B	Pos	16	14	30
	Neg	21	95	116
		37	109	146

Kappa calculation

$K = (P_o - P_e) / (1 - P_e)$

P_o = (16 + 95) / 146 = 0.760

P_e = ([30*37] + [116*109]) / 146^2 = 0.645

K = (0.760 – 0.645) / (1 – 0.645) = **0.32**

One "rule of thumb" for interpreting kappa values

K	**Interpretation**
< 0	No agreement
0.00 – 0.20	Slight agreement
0.21 – 0.40	Fair agreement
0.41 – 0.60	Moderate agreement
0.61 – 0.80	Substantial agreement
0.81 – 1.00	Almost perfect agreement

Note: Others have suggested different categorizations – e.g., >0.5 good, <0.3 poor

Example of Kappa calculation

		Observation 1			
		1	2	3	
Observation 2	1	17	14	6	37
	2	5	104	46	155
	3	5	64	725	794
		27	182	777	986

$K = (P_o - P_e) / (1 - P_e)$

P_o = (17 + 104 + 725) / 986 = 0.858

P_e = ([37*27] + [155*182] + [794*777]) / 986^2 = 0.665

K = (0.858 – 0.665) / (1 – 0.665) = **0.576**