Measures of Association in Epidemiology

LINK TO ORGINAL SLIDES WITH RECORD

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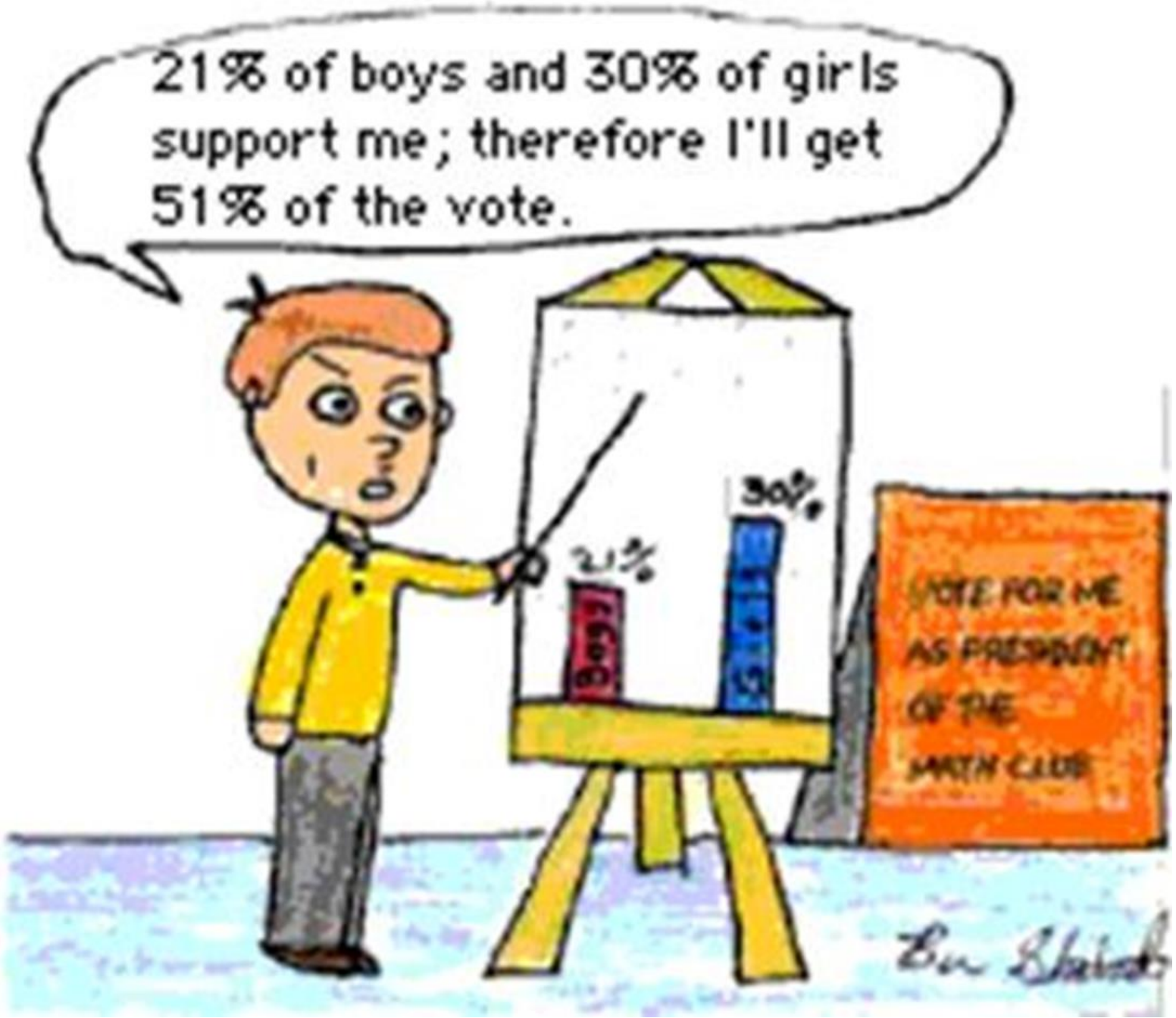
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Measures of Association in Epidemiology

- Chi square
- Odds Ratio (OR)
- Relative Risk or Risk Ratio (RR)
- Attributable Risk (AR)

2X2 Table (contingency table)

		Disease		
		Yes (+)	No (-)	Total
Exposure	Yes (+)	a	b	a+ b
	No (-)	c	d	c+ d
	Total	a+ c	b+ d	a+b+c+d

Cells

Event forecast	Event observed		
	Yes	No	Marginal total
Yes	a	b	a + b
No	c	d	c + d
Marginal total	a + c	b + d	a + b + c + d =n

A= Exposed, and diseased

B= Exposed, Not diseased

C= Not exposed, diseased

D= Not exposed, Not diseased

A+B+C+D=Total

Totals

Event forecast	Event observed		
	Yes	No	Marginal total
Yes	a	b	a + b
No	c	d	c + d
Marginal total	a + c	b + d	a + b + c + d =n

Marginal totals

a+b= Exposed

c+d= Non-exposed

a+c= Diseased

b+d= Non-diseased

Grand total

n = a+b+c+d

1. Chi-square in Cross-sectional studies

Chi-square tests whether there is an association between two categorical variables.

For a 2X2, table: $$X^2 = \frac{n(ad - bc) - n/2)^2}{(a+b)(a+c)(c+d)(b+d)}$$

If the calculated chi-square value is greater than the critical value or P<0.05, we say that there is a significant association between the risk factor and the disease (usually calculated using software like SPSS or excel).

Chi-square statistic tells only whether there is association. It doesn't tell us how strong an association is.

2. Relative risk (RR) or Risk Ratio (RR) In a cohort study

RR: The estimation of disease risk associated with exposure (strength of association)

RR Expresses risk of developing a disease in exposed group (a + b) as compared to non-exposed group (c + d)

$$RR = \frac{\text{Incidence (risk) among exposed}}{\text{Incidence (risk) among non-exposed}}$$

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

Event forecast	Event observed		
	Yes	No	Marginal total
Yes	a	b	a + b
No	c	d	c + d
Marginal total	a + c	b + d	a + b + c + d = n

Analysis in Cohort studies

In a Cohort Study, we can calculate Incidence.

So, Relative Risk can be obtained from a cohort study.

Cigarette smoking (Exposure)	*Disease (with Ca lung)*	*No Disease (without Ca lung)*	*Total*
Yes	*70 (a)*	*6930 (b)*	*7000 (a+b)*
No	*3(c)*	*2997(d)*	*3000 (c+d)*

RR in a Cohort Study

Incidence rates :

Risk among exposed (smokers) = 70/7000 = 10 / 1000.

Risk among non-exposed(non smokers) = 3/3000 = 1 / 1000.

$$RR = \frac{\text{Risk (Incidence) among exposed}}{\text{Risk (Incidence) among non exposed.}}$$

RR = 10/1=10

The exposed have 10 times the risk of developing the disease when compared to non-exposed

Interpretation of relative risk

What does a RR of 2 mean?

Risk in exposed=2X Risk in non-exposed

Thus a relative risk of 2 means the exposed group is two times at a higher risk of developing the disease when compared to non-exposed

Strength of association

In general strength of association can be considered as:

High association if RR≥3

Moderate if RR is between 1.5 & 2.9

Weak association if RR is between 1.2 & 1.4

No association exists if RR is 1

Negative association (protective effect) if RR <1

3. ODDS RATIO (OR)

Odds Ratio (OR) is a measure of the strength of the association between risk factor & outcome.

✓The odds ratio is the cross product of the entries in table.

✓ OR can be calculated in case-control studies instead of RR

2 by 2 table

	Diseased - Cases	Non-diseased – Controls	Total
Exposed	A	B	A+B
Non-exposed	C	D	C+D
Total	A+C	B+D	A+B+C+D

Odds ratio (OR)

Odds Ratio can be a good estimate of RR.

Odds ratio is the ratio of odds of exposure among diseased to odds of exposure among non-diseased

$$OR = \frac{\text{Odds of exposure among diseased}}{\text{Odds of exposure among non-diseased}}$$

$$= (a/c)/(b/d) = ad/bc$$

Interpretation of OR is the same as that of RR

Odds ratio…

RR can be best estimated by OR if the following conditions are fulfilled:

1. **Controls are representative of general population**
2. **Selected cases are representative of all cases**
3. **The disease is rare**

ANALYSIS in case-control studies

Estimation of the odds of exposure among the cases (odds ratio)

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OR in a case-control study

	Cases (with Ca lung)	Controls (without Ca lung)
Smokers	33 (a)	55 (b)
Non smokers	2 (c)	27 (d)
Total	35 (a+c)	82 (b+d)

OR in Case-control studies

Odds ratio is a key parameter in the analysis of Case-control studies

	Disease	
	Cases (Lung Ca)	Controls (No Lung Ca)
Smokers	*a (33)*	*b (55)*
Not smokers	*c (2)*	*d (27)*

$$\text{Odds Ratio} = ad/bc = \frac{33 \times 27}{55 \times 2} = 8.1$$

Exposed people have 8 times the odds of developing the disease compared to those not exposed.

Attributable Risk (AR)

AR indicates how much of the risk is due to (attributable to) the exposure.

Quantifies the excess risk in the exposed that can be attributable to the exposure, by removing the risk of the disease that occurred due to other causes.

AR= Risk (incidence) in exposed- Risk (incidence) in non-exposed

AR= [a/(a+b)] - [c/(c+d)]

Attributable risk is also called risk difference.

Attributable risk percent (AR%)

Estimates the proportion of disease among the exposed that is attributable to the exposure (example of smoking and lung C).

$$AR\% = \frac{\text{Risk in exposed} - \text{Risk in non-exposed}}{\text{Risk in exposed}} \times 100\%$$

$$AR\% = \frac{10 - 1}{10} \times 100\% = 90\%$$ (as in the previous Cohort study example)

- **90% of the lung cancer among smokers was due to their smoking.**
- **This suggests the amount of disease that might be eliminated if smoking could be controlled or eliminated.**

Possible outcomes in studying the relationship between exposure & disease

1. No association

   RR=1

   AR=0

2. Positive association

   RR>1

   AR>0

3. Negative association

   RR<1 (fraction)

   AR<0 (Negative)

Risk Vs Preventive factors

A ***risk factor*** is any factor positively associated with a disease (RR>1). It is associated with an increased occurrence of a disease

A ***preventive factor*** is any factor negatively associated with a disease (RR<1). It is associated with a decreased occurrence of a disease.

Risk and preventive factors ***may (not)*** be amenable to change (e.g. Smoking, age)