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Estimating Risk

Absolute Risk:

- Defined as the incidence of a disease in a population
- Can show magnitude of risk in a specific group of people with a specific exposure, but does not include consideration of the risk of disease to people who were not exposed

Relative Risk:

- The ratio of the risk of disease in exposed persons to the risk of disease in nonexposed persons

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Relative Risk

$$\text{Relative Risk} = \frac{\text{Risk in exposed}}{\text{Risk in nonexposed}}$$

If RR = 1 Risk in exposed equal to risk in non-exposed (no association)

If RR > 1 Risk in exposed greater than risk in non-exposed (positive association; possibly causal)

If RR < 1 Risk in exposed less than risk in non-exposed (negative association; possibly protective)

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Relative Risk in Cohort Studies

	Disease Develops	Disease Does Not Develop	Totals	Incidence Rates of Disease
Exposed	a	b	$a+b$	$\frac{a}{a+b}$
Nonexposed	c	d	$c+d$	$\frac{c}{c+d}$

Incidence in exposed

Incidence in nonexposed

$$\text{Relative Risk} = \frac{\textit{Incidence in exposed}}{\textit{Incidence in nonexposed}} = \frac{\left(\frac{a}{a+b}\right)}{\left(\frac{c}{c+d}\right)}$$

Cohort Study of Smoking & Coronary Heart Disease (CHD)

	Disease Develops	Disease Does Not Develop	Totals	Incidence per 1,000 per year
Exposed	a 84	b 2916	$a+b$ 3,000	$\left(\frac{a}{a+b}\right)$ *1000 =**28**
Nonexposed	c 87	d 4913	$c+d$ 5,000	$\left(\frac{c}{c+d}\right)$ *1000=**17.4**

$$\text{Relative Risk} = \frac{\textit{Incidence in exposed}}{\textit{Incidence in nonexposed}} = \frac{\left(\frac{a}{a+b}\right)}{\left(\frac{c}{c+d}\right)} = \frac{28}{17.4} = 1.61$$

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The Odds Ratio (Relative Odds)

In order to calculate a relative risk we need to know the incidence of disease in exposed and nonexposed individuals. This can be determined in a cohort study. In a case-control study however, we do not have this information because we start with diseased and non-diseased persons. Therefore, we cannot calculate relative risk directly in a case-control study. ***The odds ratio is the measure of association used in case-control studies***. Under many conditions, the odds ratio can provide a very good estimate of the relative risk.

$$\text{Odds of an Event} = \frac{\text{Probability of an event occurring}}{\text{Probability of an event not occurring}} = \frac{P}{1-P}$$

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Odds Ratio

Odds Ratio in a COHORT STUDY

	Develop Disease	Do Not Develop Disease
Exposed	a	b
Not Exposed	c	d

ODDS RATIO

= Odds that an exposed person develops disease
Odds that a non-exposed person develops disease

$$= \frac{a/b}{c/d} = \frac{ad}{bc}$$

Odds Ratio in a CASE-CONTROL STUDY

	Cases (With Disease)	Controls (Without Disease)
History of Exposure	a	b
No History of Exposure	c	d

ODDS RATIO

= Odds that a case was exposed
Odds that a control was exposed

$$= \frac{a/c}{b/d} = \frac{ad}{bc}$$

Interpreting the Odds Ratio

Same interpretation as Relative Risk.

If OR = 1 Exposure is not related to disease

If OR > 1 Exposure is positively related to disease

If OR < 1 Exposure is negatively related to the disease

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The Odds Ratio can be a good estimate of Relative Risk when…

1. **Cases** are representative (in respect to history of exposure) of all people with the disease in the population that the cases are drawn from.

2. **Controls** are representative (in respect to history of exposure) of all people without the disease in the population that the cases are drawn.

3. When the disease is **rare**.

Ex: Infrequent Disease RR ~ OR

	Develop Disease	Do Not Develop Disease	
Exposed	200	9800	10,000
Not Exposed	100	9900	10,000

Relative Risk = $\frac{200/10{,}000}{100/10{,}000} = 2$

Odds Ratio = $\frac{200\ X\ 9900}{100\ X\ 9800} = 2.02$

Ex: Frequent Disease RR ≠ OR

	Develop Disease	Do Not Develop Disease	
Exposed	50	50	100
Not Exposed	25	75	100

Relative Risk = $\frac{50/100}{25/100} = 2$ $\neq$ **Odds Ratio =** $\frac{50\ X\ 75}{25\ X\ 50} = 3$

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Attributable Risk

- How much of the disease is due to a specific exposure?
- Tells us the potential for prevention of a disease if the exposure under study is eliminated

Incidence in the EXPOSED group = Incidence NOT due to exposure (background incidence)

+ incidence due to the exposure

Incidence in the NONEXPOSED group = Incidence NOT due to exposure (background incidence)

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Attributable Risk Calculations

Incidence Attributable to Exposure

In Exposed Group

(Incidence in exposed group) - (Incidence in nonexposed group)

In Total Population

(Incidence in total population) - (Incidence in nonexposed group)

Proportion of Incidence Attributable to Exposure

In Exposed Group

$$\frac{(\text{Incidence in exposed group}) - (\text{Incidence in nonexposed group})}{\text{Incidence in exposed group}}$$

In Total Population

$$\frac{(\text{Incidence in total population}) - (\text{Incidence in nonexposed group})}{\text{Incidence in total population}}$$

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Study Designs & Measures of Association

MEASURES OF ASSOCIATION	STUDY DESIGN		
	Case-Control	Cohort	Randomized Controlled Trial
Absolute Risk		YES	YES
Relative Risk		YES	YES
Odds Ratio	YES	YES	YES

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REVIEW QUESTIONS

(From: Gordis, L. (2000). Epidemiology: Second Edition. Philadelphia, Pennsylvania: W.B. Saunders Company)

1. Several studies have found that approximately 85% of cases of lung cancer are due to cigarette smoking. This measure is an example of:

a) An Incidence Rate
b) An Attributable Risk
c) A Relative Risk
d) A Prevalence Risk
e) A Proportionate Mortality Ratio

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REVIEW QUESTIONS

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2. In a study of a disease in which all cases that developed were ascertained, if the relative risk for the association between a factor and the disease is equal to or less than 1.0, then:

a) There is no association between the factor and the disease
b) The factor protects against development of the disease
c) Either matching or randomization has been unsuccessful
d) The comparison group used was unsuitable, and a valid comparison is not possible
e) There is either no association or a negative association between the factor and the disease

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3. In a study begun in 1965, a group of 3,000 adults in Baltimore were asked about alcohol consumption. The occurrence of cases of cancer was studied in the group between 1981 and 1995. This is an example of a:

   a) Cross-sectional study
   b) Concurrent cohort study
   c) Retrospective cohort study
   d) Clinical Trial
   e) Case-Control Study

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REVIEW QUESTIONS

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4. In a case-control study, which of the following is (are) true?

a) The proportion of cases with the exposure is compared with the proportion of controls with the exposure

b) Disease rates are compared for people with the factor of interest and for people without the factor of interest

c) The investigator may choose to have multiple comparison groups

d) Recall bias is a potential problem

e) a, c, and d

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REVIEW QUESTIONS

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5. A randomized trial comparing the efficacy of two drugs showed a difference between the two (with a P value < 0.5). Assume that in reality, however, the two drugs do not differ. This therefore an example of:

a) Type I error (α error)
b) Type II error (β error)
c) 1 – α
d) 1 – β
e) None of the above

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REVIEW QUESTIONS

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6. In many studies examining the association between estrogens and endometrial cancer of the uterus, a one-sided significance test was used. The underlying assumption justifying a one-sided rather than a two-sided test is:

a) The distribution of the proportion exposed followed a “normal” pattern
b) The expectation before doing the study was that estrogens cause endometrial cancer of the uterus
c) The pattern of association could be expressed by a straight line function
d) A type II error was the most important potential error to avoid
e) Only one control group was being used

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