Measures of Association

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Measures of Association

Measures of association = comparisons of measures of disease frequency

2 Approaches:

Calculate the difference between two measures of disease frequency

Absolute measure

Calculate the ratio of two measures of disease frequency

Relative measure

Absolute vs. Relative Measures

You are running late for class, and you get stopped by a police officer because you are driving 60 MPH in a 30 MPH zone.

How would the police officer describe your offense using absolute terms?

"You were traveling 30 MPH over the speed limit."

How would the police officer describe your offense using relative terms?

"You were traveling twice the speed limit."

Absolute Measures of Association

Prevalence

Prevalence Difference = Difference in prevalence between index and comparison groups

$PD = P_E - P_U$

Cumulative Incidence

Risk Difference = Difference in cumulative incidence between index and comparison groups

$RD = CI_E - CI_U$

Incidence Rate

Rate Difference = Difference in incidence rate between index and comparison groups

$RD = IR_E - IR_U$

General Formula: $RD = R_E - R_U$

Absolute Measures of Association

If there is **NO ASSOCIATION** between the exposure and disease,

then the RD **= 0**

If the exposure is associated with **INCREASED RISK** of disease

then the RD **> 0**

If the exposure is associated with **DECREASED RISK** of disease

then the RD **< 0**

Absolute Measures of Association: Practice

The Nurses' Health Study is a longitudinal cohort study of factors that influence women's health. NHS researchers investigated the hypothesis that hypertension increases the risk of myocardial infarction (MI). Among 13,422 women with hypertension, 117 had an MI over 10 years of follow-up. Among 106,541 women without hypertension, 125 had an MI during the same follow-up period.

Based only on this information, which type of absolute difference measure can we calculate?

A. Prevalence difference
B. Risk difference
C. Rate difference

Absolute Measures of Association: Practice

What is the risk difference?

- Among 13,422 women with hypertension, 117 had an MI over 10 years of follow-up.
- Among 106,541 women without hypertension, 125 had an MI during the same follow-up period.

Risk Difference = Difference in cumulative incidence between index and comparison groups

$RD = CI_E - CI_U$ (no units)

Risk Difference

= CI in exposed women – CI in unexposed women

= (117/13,422) – (125/106,541)

= 0.0087 – 0.0012

= 0.0075

= 75/10,000 over 10 years of follow-up

2 x 2 Table: Practice

- Among 13,422 women with hypertension, 117 had an MI over 10 yrs.
- Among 106,541 women without hypertension, 125 had an MI over 10 yrs.

1. **Identify exposure and disease**
2. **Fill in the table cells and margins**
3. **Use the table for your calculations**

		(Hypertension) Exposed	*(No Hypertension)* Unexposed	Total
(MI)	Disease	117	125	242
(No MI)	No Disease	13,305	106,416	119,721
	Total	13,422	106,541	119,963

CI **117/13,422** **125/106,541**

RD **(117/13,422)** **–** **(125/106,541)** **= 75/10,000 over 10 yrs**

RD **.0087** **-** **.0012** **= 75/10,000 over 10 yrs**

Interpreting Absolute Measures of Association

RD = Difference comparison of prevalence/risk/rate of disease in the exposed group to the prevalence/risk/rate of disease in the unexposed group

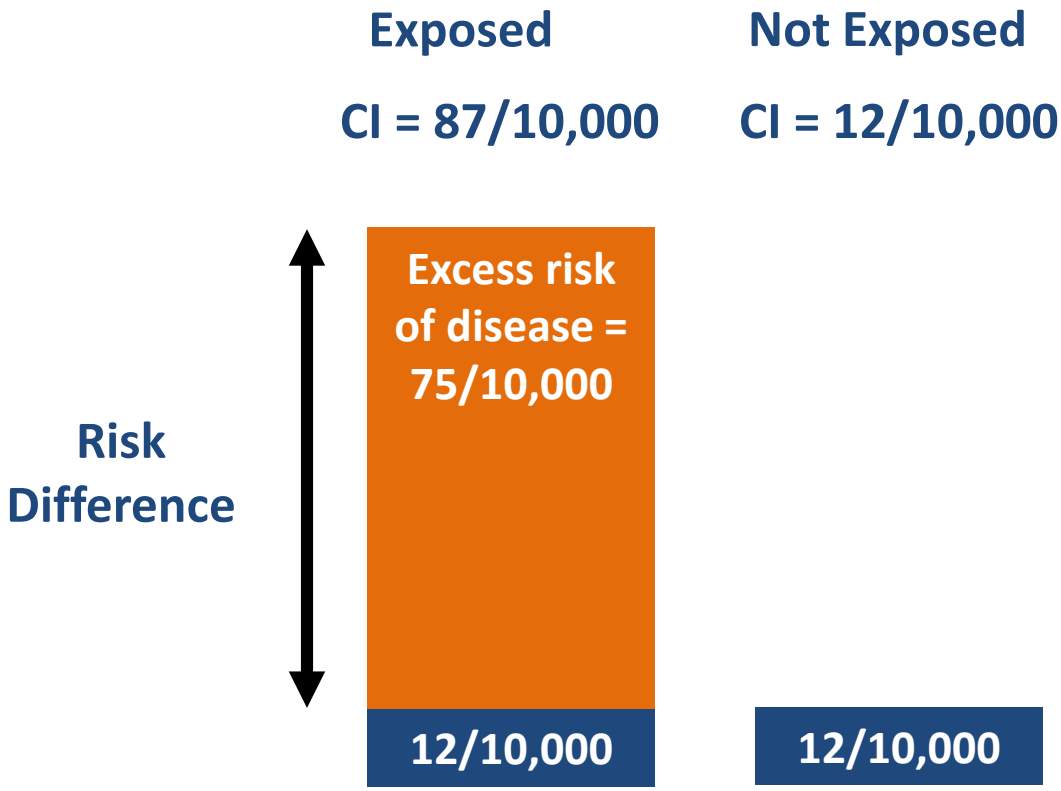
Here RD = 75/10,000

Women with hypertension had 75 more MIs per 10,000 women over a 10-year period compared to women without hypertension.

Important:

- *Focus on the excess disease in the exposed group*
- *Specify the comparison group*
- *Specify the time period*

Interpreting Absolute Measures of Association



Relative Measures of Association

Prevalence

Prevalence Ratio	=	Ratio of prevalence between index and comparison groups **$PR = P_E / P_U$ (no units)**

Cumulative Incidence

Risk Ratio	=	Ratio of cumulative incidence between index and comparison groups **$RR = CI_E / CI_U$ (no units)**

Incidence Rate

Rate Ratio	=	Ratio of incidence rate between index and comparison groups **$IRR = IR_E / IR_U$ (no units)**

General Formula: $RR = R_E / R_U$

“Relative Risk”

- Relative risk is a generic term used to represent all of the classes of relative measures of association.
- “Relative risk” is often used interchangeably with “risk ratio” (cumulative incidence ratio), because that is the most commonly used relative measure of association
  - But pay attention to context
- It is often up to you to interpret which measure is being used (i.e. prevalence ratio, risk ratio, rate ratio)

Relative Measures of Association

If there is **NO ASSOCIATION** between the exposure and disease,

then the RR **= 1**

If the exposure is associated with **INCREASED RISK** of disease

then the RR **> 1**

If the exposure is associated with **DECREASED RISK** of disease

then the RR **< 1**

Relative Measures of Association: Practice

The Nurses' Health Study is a longitudinal cohort study of factors that influence women's health. NHS researchers investigated the hypothesis that hypertension increases the risk of myocardial infarction (MI). Among 13,422 women with hypertension, 117 had an MI over 10 years of follow-up. Among 106,541 women without hypertension, 125 had an MI during the same follow-up period.

Based on this information, which type of relative risk measure can we calculate?

A. Prevalence ratio
B. Risk ratio ✓
C. Rate ratio

Relative Measures of Association: Practice

What is the risk ratio?

- Among 13,422 women with hypertension, 117 had an MI over 10 years of follow-up.
- Among 106,541 women without hypertension, 125 had an MI during the same follow-up period.

Risk Ratio	=	Ratio of cumulative incidence between index and comparison groups **RR = CI_E / CI_U (no units)**

Risk Ratio

= CI in exposed women / CI in unexposed women

= (117/13,422) / (125/106,541)

= 0.00872 / 0.00117

= 7.45

2 x 2 Table: Practice

- Among 13,422 women with hypertension, 117 had an MI over 10 yrs.
- Among 106,541 women without hypertension, 125 had an MI over 10 yrs.

		Exposed	Unexposed	
		Hypertension	No Hypertension	Total
Diseased	MI	117	125	242
Not Diseased	No MI	13,305	106,416	119, 721
	Total	13,422	106,541	119, 963

CI	**117/13,422**		**125/106,541**	
RD	**(117/13,422)**	**–**	**(125/106,541)**	**= 75/10,000**
RR	**(117/13,422)**	**/**	**(125/106,541)**	**= 7.45**

Interpreting Relative Measures of Association

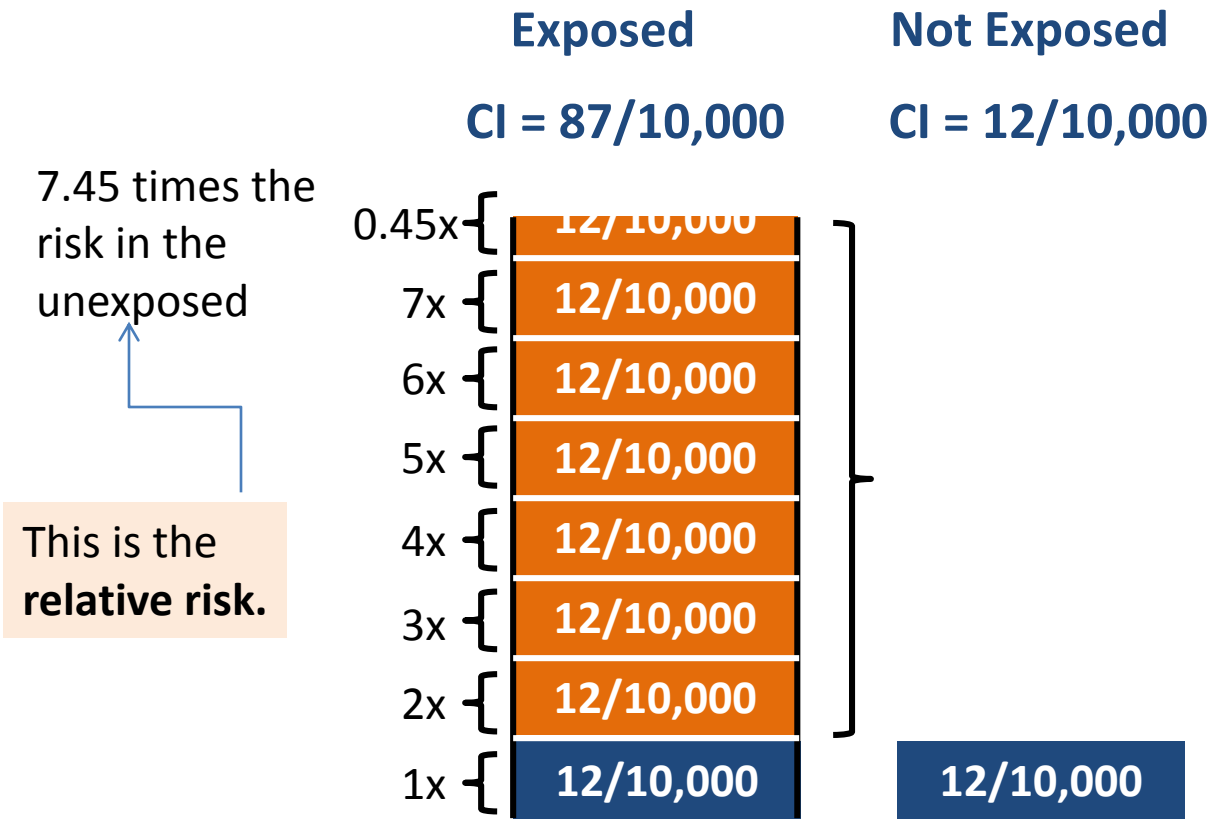
Relative Risk = Ratio comparison of prevalence/risk/rate of disease in the exposed group to the prevalence/risk/rate of disease in the unexposed group

If **RR = 7.45**…

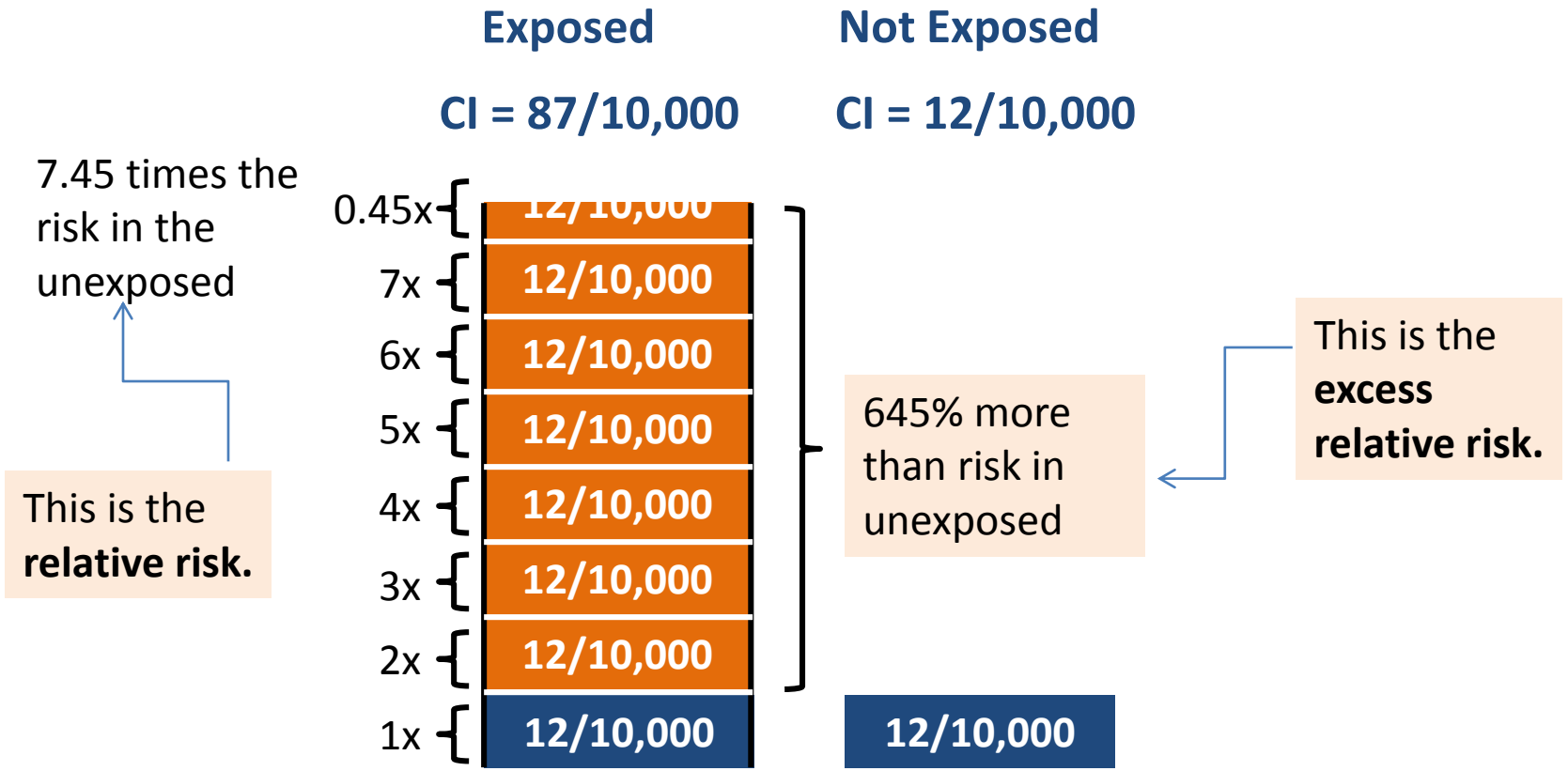
Women with hypertension were 7.45 times as likely to have an MI over a 10 year period, compared with women without hypertension.

Or, women with hypertension had 7.45 times the risk of an MI over a 10 year period, compared with women without hypertension.

Interpreting Relative Measures of Association



Interpreting Relative Measures of Association



Interpreting Relative Measures of Association

Excess Relative Risk = (RR-1) x 100%

If RR = 7.45…

Women with hypertension had 645% increased risk of having an MI compared with women without hypertension

What is the excess RR if….

RR = 1.0 **Excess RR = 0%**

RR = 2.0 **Excess RR = 100%**

RR = 1.6 **Excess RR = 60%**

RR = 0.5 **Excess RR = -50% (or 50% reduced risk)**

Interpreting Relative Measures of Association

What are two ways to interpret an incidence rate ratio of 1.2?

1. The exposed group has 1.2 times the incidence rate of the unexposed group.
2. The exposed group has a 20% excess incidence rate as compared to the unexposed group.

What are two ways to interpret an incidence rate ratio of 3.0?

1. The exposed group has 3.0 times the incidence rate of the unexposed group.
2. The exposed group has a 200% excess incidence rate as compared to the unexposed group.

What are two ways to interpret an incidence rate ratio of 0.57?

1. The exposed group has 0.57 times the incidence rate of the unexposed group.
2. The exposed group has a 43% decreased incidence rate as compared to the unexposed group.

2 x 2 Table: Odds Ratio

- Assume that, we collected 1,000 people and assess their health status. We found that 300 people have hypertension and 150 patients occurred MI. 100 patients have both hypertension and MI.

		Diseased	Not diseased	
		MI	No MI	Total
Exposed	HT	100	200	300
Not exposed	No HT	50	650	700
	Total	150	850	1000

Odds ratio = (100/50) / (200/650)

= (100*650) / (200*50)

= 6.5

RD vs. RR

The RD and RR provide different information, and different perspectives

RD = Absolute measure

- Represents measure of public health impact of exposure on disease occurrence
  - How much impact would prevention have?
  - How many people have detrimental effect of harmful exposure?

RR = Relative measure

- Represents measure of strength or magnitude of the association between an exposure and a disease. More commonly used for etiologic research.
  - How much more likely are exposed persons to develop disease?

Another Measure of Association: Population Attributable Proportion (PAR%)

Assuming a causal association **between exposure and disease, the proportion of disease in the total population that can be attributed to exposure**

OR……..

Assuming a causal association **between exposure and disease, the proportion of disease in the total population that would have been prevented if the exposure had not occurred**

Difference Measures	$\frac{R_T - R_U}{R_T} \times 100$ ***Where R = P, CI, or IR***
Ratio Measures	$\frac{[P_e (RR - 1)]}{[P_e (RR-1) + 1]} \times 100$ ***Where RR = PR, RR, or IR and*** ***P_e = proportion exposed***

Population Attributable Proportion

Using the RR, calculate the proportion of MI cases in the total study population that would have been avoided if the women did not have hypertension.

P_e = **Proportion Exposed**

= **# Exposed/Total Pop'n**

= **13,422/119,963**

= **0.112**

	Hypertension	No Hypertension	Total
MI	117	125	242
No MI	13,305	106,416	119, 721
Total	13,422	106,541	119, 963

Population Attributable Proportion:

$$\frac{[P_e\,(RR-1)]}{[P_e\,(RR\text{-}1)+1]} \times 100 = \frac{[0.112\,(7.45-1)]}{[0.112\,(7.45\text{-}1)+1]} \times 100 = 41.9\%$$

INTERPRETATION: If the association between hypertension and MI is causal, 41.9% of MIs among women in the Nurses' Health Study would have been avoided if they had normal blood pressure (instead of hypertension) during the 10 year study period

Summary

- The amount of disease (P, CI, IR) that occurs in a group of exposed people can be compared to the amount of disease that occurs in a group of unexposed people to determine whether the exposure is associated with an increased or decreased risk of disease

- These measures of association can be absolute (difference measures) or relative (ratio measures); both types are important and can be used for different things

- If an exposure causes disease, we can also assess how much disease can be attributed to the exposure (population attributable proportion).