

## Epidemiology: Basics of Study Design, Measures, and Limitations

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## Defining Epidemiology

“...the study of the distribution and determinants of health-related states or events in specified populations and the application of this study to control of health problems.”

--Last, 1988, *The Dictionary of Epidemiology*

## Another Definition of Epidemiology

➤ “The science of making the obvious obscure.”

--Anonymous Epidemiologist

## Epidemiology Defining Itself

*Etymological derivation:* From the Greek

- “Epi” on/upon +
- “demos” the people +
- “logos” theory or study of

## Characteristics of Epidemiology

- Concerned with the *frequencies* and types of illnesses and injuries in *groups* of people and the *factors* that influence their distribution.



## Characteristics (Continued)

- This implies that disease is **NOT** randomly distributed throughout a population, but rather that subgroups differ in the frequency of different diseases.
- Knowledge of this uneven distribution can be used to investigate causal factors and thus to lay the groundwork for programs of prevention and control.
- Can similarly be used to study consequences of different treatments

## Prevalence vs. Incidence rates

- Prevalence
  - Proportion of persons in a population who have a particular status (presence of disease or some other health-related condition) at either
    - 1) A specified point in time
    - 2) A specified period in time
  - Point vs. period prevalence

## Incidence

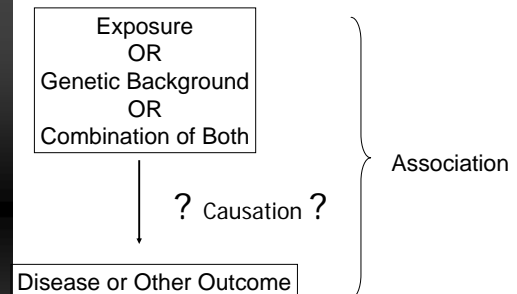
- Incidence
  - The rate of new occurrences of a condition in a population
  - = (New occurrences of a condition [=event] during a specified time period / the population during that same specified time period)

## Prevalence vs. Incidence rates

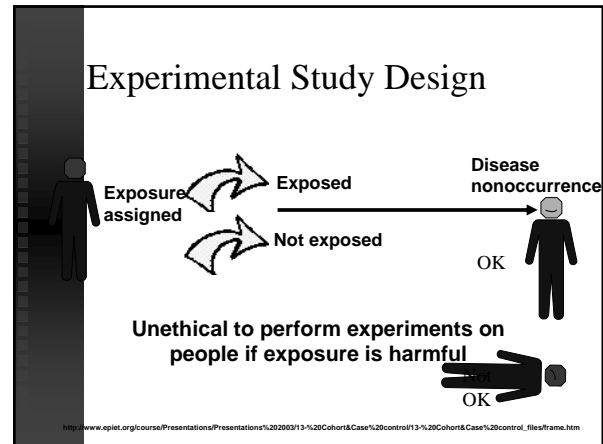
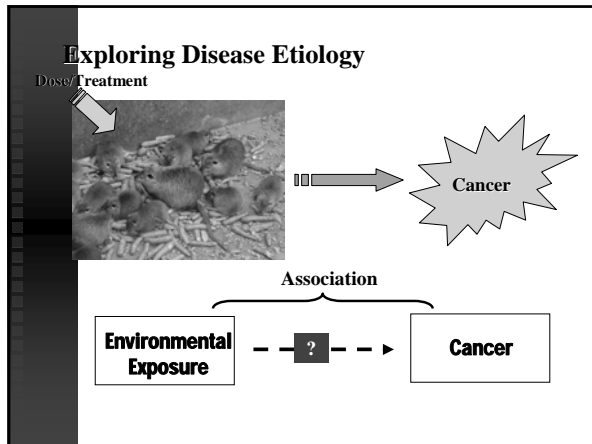
- Prevalence (continued)
  - Amount of disease prevailing in a population at a given time or within a given period
  - What if we are interested in how quickly new cases are developing in a population?
  - What if the condition of interest lasts a long time (years)?  
E.g., osteoarthritis

## Study Designs In Epidemiology...

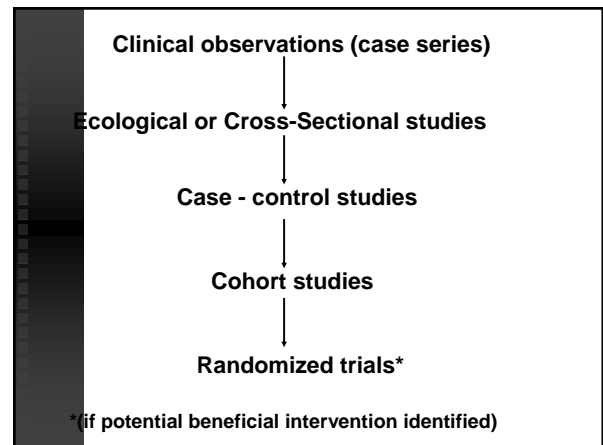
Basic Considerations;  
Fundamental Designs



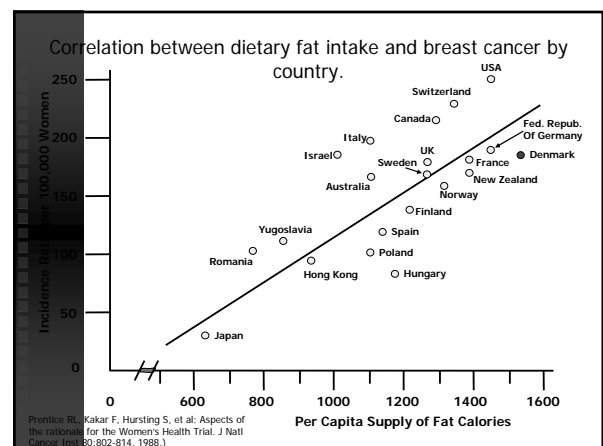
How do we know if an observed association reflects a causal relationship?



- The next step in determining causation:  
Conducting Studies in Human Populations
- Observational Epidemiology often key here....
  - Allows capitalization on “natural” or “unplanned” experiments.
  - Take advantage of groups who have been exposed for non-study purposes.



- ### Ecologic Study
- Units of analysis are populations or groups of people, rather than individuals.
  - Often exploit pre-existing data collected for other purposes
  - Efficient and economical design



### Key potential limitation: The ecologic fallacy

- Attributing to members of a group characteristics that they do not possess as individuals
- E.g., only know average values of fat consumption by country
  - Don't know if individuals with breast cancer had higher fat intake

### Cross-sectional Study

- Draw sample from population of interest at particular time
- Identify cases and non-cases of disease
- Measure characteristics (exposures)
- Examine associations between characteristics and disease

### Example: Is stress associated with symptoms of TMD?

- Random sample of population (N=680)
- Interviewed re: symptoms of TMD (pain, joint sounds, limited opening)
- Measure of life stress

### Stress and TMD

#### Percent reporting frequent stress:

Those with TMD symptoms = 56%

Those without symptoms = 21%

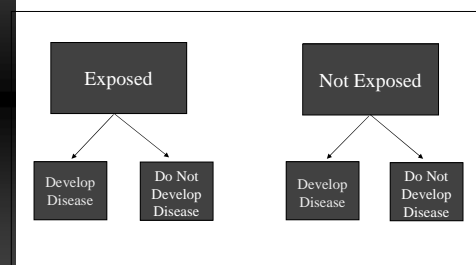
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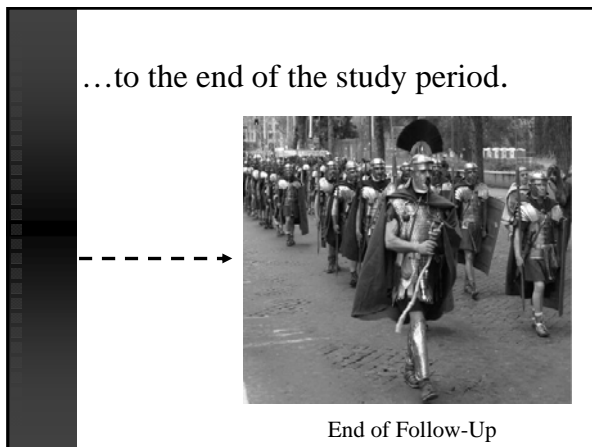
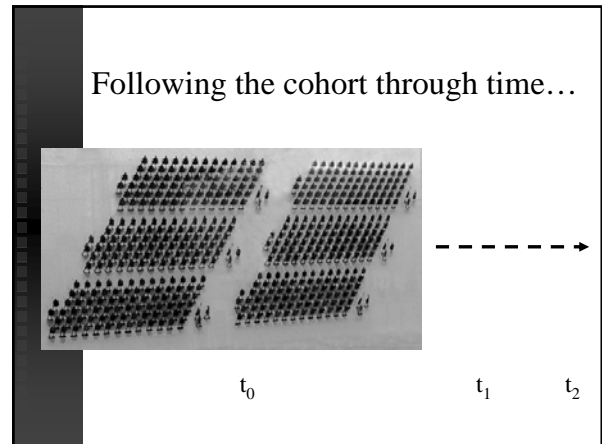
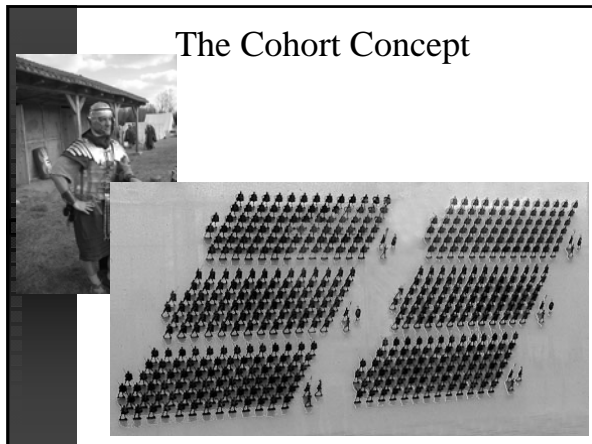
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### Cross-sectional studies:

- Can assess associations
- Cannot establish correct temporal relationship for inferring causation
  - ⚡ Why?
  - Factor and disease measured at same point in time

### Cohort Study





### Analytical Design of a Cohort Study

		Then follow to see whether...		Totals	Incidence Rates of Disease
		Disease develops	Disease does not develop		$\frac{a}{a+b}$
Select	Exposed	a	b	a + b	$\frac{a}{a+b}$
	Not exposed	c	d	c + d	$\frac{c}{c+d}$

### Relative Risk

$$\frac{\text{Risk in exposed}}{\text{Risk in non-exposed}}$$

### Relative Risk Calculation for Cohort Study

	Exposed group Develop CHD New incidents	Do Not Develop CHD	Total population Totals	Incidence per 1,000 per Year
Smoke Cigarettes	84	2,916	3,000	28.0 (= 84/3000) ( x 1,000 )
Do not smoke Cigarettes	87	4,913	5,000	17.4 (= 87/5000) ( x 1,000 )

$RR = 28.0 / 17.4 = 1.61$

## Interpreting RR of a Disease

- If RR = 1** Risk in exposed equal to risk in unexposed (no association)
- If RR > 1** Risk in exposed greater than risk in unexposed (positive association; possibly causal)
- If RR < 1** Risk in exposed less than risk in unexposed (negative association; possibly protective)

## Advantages of cohort studies

- Temporal relationship more certain
- Less opportunity for distortion of exposure data
- Can examine multiple disease outcomes

## Disadvantages of cohort studies

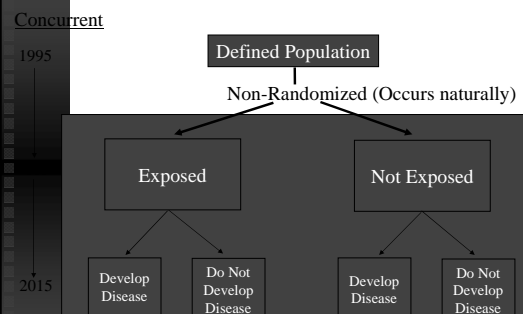
- Can be time consuming and expensive – follow large group over long periods of time
- Potential bias due to drop outs from study

## Drop out in cohort study of oral health of older adults

Baseline	N=907
3 years	N=611
7 years	N=425

## The Two Major Flavors of Cohort Studies: It's All in the Timing

### Concurrent Cohort Study Begun in 1995



# Retrospective Cohort Study Begun in 1995

