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

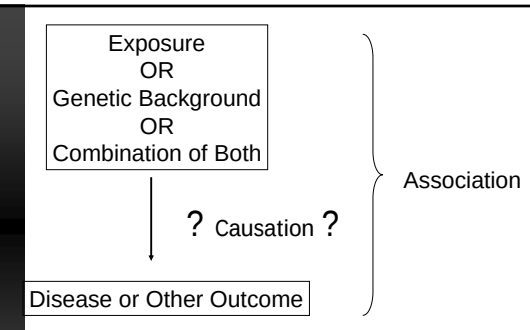
- Prevalence (continued)
  - Amount of disease prevailing in a population at a given time or within a given period
    - What if we are interested in how quickly new cases are developing in a population?
    - What if the condition of interest lasts a long time (years)?

      E.g., osteoarthritis

Study Designs In Epidemiology…

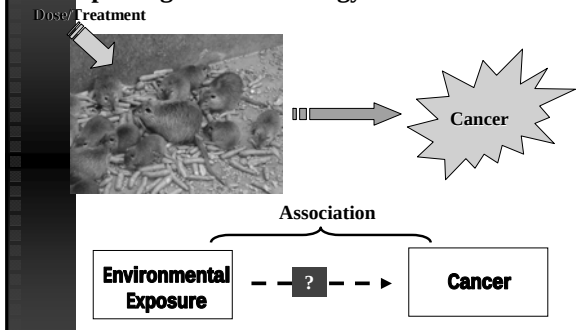
Basic Considerations;

Fundamental Designs

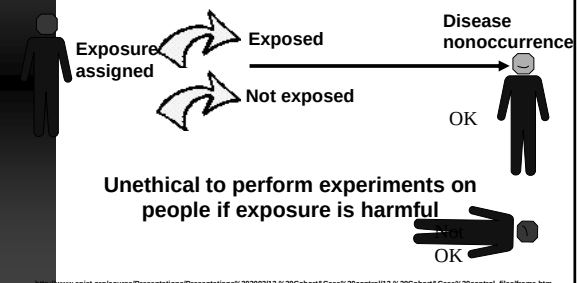


How do we know if an observed association reflects a causal relationship?

Exploring Disease Etiology



Experimental Study Design



http://www.epiet.org/course/Presentations/Presentations%202003/13-%20Cohort&Case%20control/13-%20Cohort&Case%20control_files/frame.htm

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.

Clinical observations (case series)

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Ecological or Cross-Sectional studies

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Case - control studies

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Cohort studies

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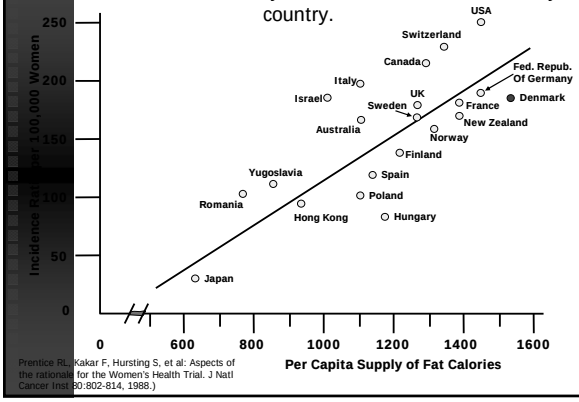
Randomized trials*

*(if potential beneficial intervention identified)

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

Correlation between dietary fat intake and breast cancer by country.



Prentice RL, Kakar F, Hursting S, et al: Aspects of the rationale for the Women's Health Trial. J Natl Cancer Inst 80:802-814, 1988.)

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%

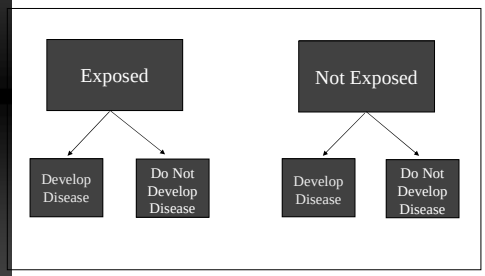
Those without symptoms = 21%

P<0.05

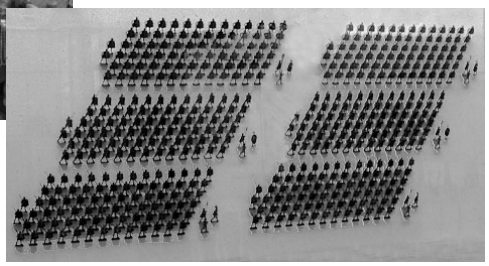
Cross-sectional studies:

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

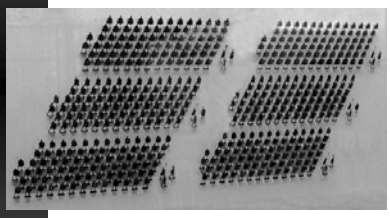
Cohort Study



The Cohort Concept



Following the cohort through time…



t_0 t_1 t_2

…to the end of the study period.

End of Follow-Up

Analytical Design of a Cohort Study

		Then follow to see whether… *Disease develops*	*Disease does not develop*	Totals	Incidence Rates of Disease
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	Totals (Total population)	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

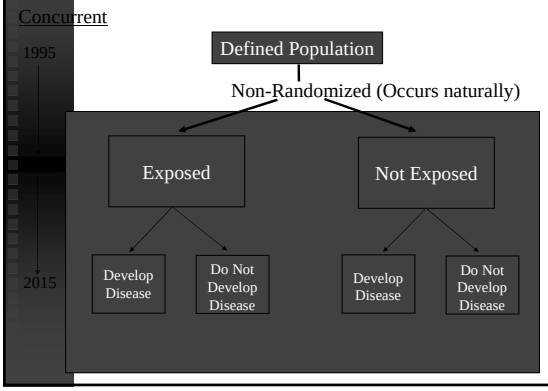
- Can be time consuming and expensive – follow large group over long periods of time
- Potential bias due to drop outs from study

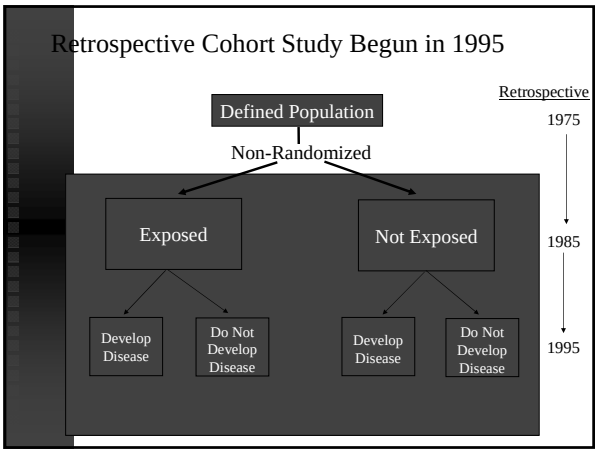
Drop out in cohort study of oral health of older adults

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
Retrospective
1975
Defined Population
Non-Randomized
Exposed
Not Exposed
1985
Develop Disease
Do Not Develop Disease
Develop Disease
Do Not Develop Disease
1995