Epidemiological Methods

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**What is Epidemiology?**

Epidemiology is the study of the **distribution** and **determinants** of health-related states or **events** in specified **populations**.

Epidemiologists develop and evaluate hypotheses about the effects of genetic, environmental, behavioral, and health care factors on human health/disease.

Epidemiologists also apply epidemiological study results to the prevention and control of health problems.

The field is interdisciplinary and has a methodology distinctive from, but also dependent on, biostatistics.
Clinical Epidemiology and Clinical Research

Primary Prevention

Risk Factors (Etiology)

Disease (Outcome)

Diagnostic Tests Se, Sp, FP, and FN

Progression / Regression

Medical intervention
## Classical Epidemiological Studies

### Categories by Objectives

<table>
<thead>
<tr>
<th>Descriptive Studies</th>
<th>Analytic Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Correlational (Ecological) Studies</td>
<td>1. Cohort Study</td>
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<tr>
<td>2. Case Reports</td>
<td>2. Case-Control Study</td>
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<tr>
<td>Case Series</td>
<td></td>
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<tr>
<td>3. Cross-sectional Studies</td>
<td>3. Intervention Study</td>
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Conclusion: Fat intake may be associated with breast cancer risk.
Ecological fallacy!!
It assumes that individual members of a group have the average characteristics of the group at large. However, statistics that accurately describe group characteristics do not necessarily apply to individuals within that group.
CROSS-SECTIONAL STUDY
(Prevalence study)

An epidemiological study in which exposure and/or outcome are assessed simultaneously among individuals in a well-defined population.

CDC: 1 in 13 pregnant women say they drink alcohol (AP, July 19, 2012):

ATLANTA (AP) — A government survey shows 1 in 13 pregnant women drink alcohol and some even go on binges.

The Centers for Disease Control and Prevention says drinking — especially binge drinking — can damage fetal brain development.
CROSS-SECTIONAL STUDY
(Prevalence study)

Prevalence: The total number of cases of a disease/condition in a given population at a specific time.

CDC: 1 in 13 pregnant women say they drink alcohol (AP, July 19, 2012):

The CDC numbers are from national telephone surveys that included 14,000 pregnant women. They were asked whether they drank alcohol the previous month and how much. Of those who said they drank, nearly 1 in 5 said they went on at least one binge — downing four or more drinks. Pregnant women ages 35 to 44 were the biggest drinkers.

The good news: Binge drinking among pregnant women is down slightly since a similar study was done in the early 2000s.

The survey results from 2006 through 2010 were released Thursday.

**Prevalence_drinking**: N of Yes / total number of women surveyed = n / 14000 = 1 / 13
n of drinker = 1077, or the prevalence of 7.7%.

**Prevalence_binge** = n of women drink 4 or more drinks / total number of drinkers
= n / 1077 = 1 / 5, thus, n= 215, or prevalence of 20%
CROSS-SECTIONAL STUDY
(Prevalence study)

Use cross-sectional study to generate hypothesis of the etiological relationship between a risk factor and a disease.

Defined Pop → Collect data on exposure, outcome and covariates

<table>
<thead>
<tr>
<th></th>
<th>E+ &amp; D+</th>
<th>E+ but D-</th>
<th>E- but D+</th>
<th>E- &amp; D-</th>
</tr>
</thead>
<tbody>
<tr>
<td>D+</td>
<td>a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D-</td>
<td>b</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E+</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E-</td>
<td>c</td>
<td></td>
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</tbody>
</table>

Data Structure 2 x 2 Table

\[
\begin{align*}
P_1 (D|E+) &= \frac{a}{(a+b)} \ vs. \ P_0 (D|E-) = \frac{c}{(c+d)} \\
P_1 (E+|D+) &= \frac{a}{(a+c)} \ vs. \ P_0 (E+|D-) = \frac{b}{(b+d)}
\end{align*}
\]
Example: Smoking and prevalent CHD in the baseline examination of a subsample of the ARIC Study.

Defined Pop  N=2601

Smoking status
Hx. Of CHD
Covariates (age, race, sex, educ)

Pop. Characteristics

E+ & D+

E+ but D-

E- but D+

E- & D-

D +    D -

E +    89  1453
E -    28  986

D +    D -

E +    a     b
E -    c     d

D +    D -

E +    a     b
E -    c     d

Prevalence of CHD in this population-based sample=

Data structure

\[
P_1 (D|E+) = \frac{89}{89+1453} = 5.8\%
\]

\[
P_0 (D|E-) = \frac{28}{28+986} = 2.8\%
\]

\[
P_1 (E+|D+) = \frac{89}{89+28} = 76\%
\]

\[
P_0 (E+|D-) = \frac{1453}{1453+986} = 24\%
\]
CHD prevalence:
Among Smokers: 89 / (89 + 1453) = 5.7%
Among non-Smokers: 28 / (28 + 986) = 2.8%

Smoking prevalence:
Among CHD +: 89 / (89 + 28) = 76%
Among CHD -: 1453 / (1453 + 986) = 24%

Table 2. The Exposure x Disease (2 x 2)

<table>
<thead>
<tr>
<th></th>
<th>CHD +</th>
<th>Non-CHD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smoker</td>
<td>89 - a</td>
<td>1453 - b</td>
</tr>
<tr>
<td></td>
<td>28 - c</td>
<td>986 - d</td>
</tr>
</tbody>
</table>

From X² test:
X² = 12.69, p = 0.001
Prevalent Odds Ratio:
OR = (a x d) / (b x c)
= 2.16
Cross-Sectional Association between Sleep and Hypertension (Sleep 2009, 32: 491-497)

Population of 1741: Sleep Variables and Hypertension Diagnosis

Pop. Characteristics

Hyp +  Hyp -

Insomnia +  Insomnia -

<table>
<thead>
<tr>
<th></th>
<th>121</th>
<th>78</th>
</tr>
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<tbody>
<tr>
<td>837</td>
<td>705</td>
<td></td>
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</tbody>
</table>

Prevalence of Hypertension: 958 / 1741=55%, weighted 35%
Prevalence of Insomnia: 199/1741=11%, weighted 8%

\[
P_1 (D|E+) = \frac{121}{121 + 78} = 61% \\
P_0 (D|E-) = \frac{837}{837 + 705} = 54%
\]

Prevalence ratio = 61 / 54 = 1.13
Odds Ratio = \(\frac{(121 * 705)}{(78 * 837)} = 1.31\)

After accounting for sampling weight:

Prevalence of Hypertension: 35%
Prevalence of Insomnia: 8%

\[
P_1 (\text{Prevalence of Hyp among insomnia}) = 55% \\
P_0 (\text{Prevalence of Hyp among non-insomnia}) = 34%
\]

Prevalence ratio = 55 / 34 = 1.62
Odds Ratio = 2.45, 95% CI 1.71, 3.51, p < 0.01
The odds of hypertension is significantly higher among chronic insomnia patients than among non-insomnia patients.

\[
X^2 = 25, \ p < 0.01
\]

The prevalence of hypertension is significantly higher among persons with chronic insomnia than among persons without.