Analytic Epidemiology

Part 2

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Analytic Studies: Observational Study Designs

Cohort Studies
- Prospective Cohort Studies
- Retrospective (historical) Cohort Studies

Case-Control Studies
- Nested case-control
- Case-cohort studies
- Case-crossover studies

Determinants of disease:
Analytic Epidemiology

- Identifying the *causes* of disease
- Testing hypotheses using epidemiologic studies
- Goal is to prevent disease (deterrents)

Epidemiology: Risk factors

- A behavior, environmental exposure, or inherent human characteristic that is associated with an important health related condition*
- Risk factors are associated with an increased probability of disease but may not always cause the diseases

*Last, J. Dictionary of Epidemiology

Analytic Studies: Cohort Studies

- Healthy subjects are defined by their exposure status and followed over time to determine the incidence of disease, symptoms or death
- Subjects grouped by exposure level - exposed and unexposed (reference group, comparison group)

Panel Studies

- Combination of cross-sectional and cohort
- Same individuals surveyed at several points in time
- Can measure changes in individuals
Analytic Studies:
Case-Control Studies
- A group of individuals with a disease (cases) are compared with a group of individuals without the disease (controls).
- Also called a retrospective study because it starts with people with disease and looks backward for previous exposures which might be relevant to the development of the disease.

Nested case-control studies
- Case-control study conducted within a cohort study
- Advantages of both study designs

Other case-control designs
- Case-cohort studies – controls sampled from entire source population - those at risk at the start of the study
- Case-crossover – cases serve as own controls- good for events that have acute onset times

Intervention Studies
- Also called Experimental studies
- Randomized Controlled Clinical Trials
- Community or field trials

Randomized Controlled Trials
- Preventive
- Intervention
- Therapeutic
Random allocation of volunteers to experimental or control procedure to determine impact of experimental exposure on outcome

Community Trials
- Random allocation is at community level or other group such as a school
Why do we do an analytic study?

- Most often to look for a relationship between an exposure and disease
- Does exposure to factor X increase/decrease your risk of disease Y?
- Need a measure of this association

Measures of Association

Goal:
- A single measure that estimates the association between an exposure and the risk of developing disease
- Calculate ratios of the measures of disease frequency (usually incidence) This ratio is called a relative risk or
- Calculate the difference between the two measures of disease frequency called risk difference or attributable risk

Measures of association

- Relative risk and risk difference/attribution risk are the two most frequently used measures used in epidemiology
- Together they provide a more complete picture than either measure alone

Relative Risk Estimates

- Cohort studies- calculate relative risk
- Case-control studies – calculate odds ratio to estimate relative risk
- Cross-sectional studies – calculate the prevalence rate ratio

Cohort Studies:
Calculating the Relative Risk

- It indicates the likelihood of developing the disease in the exposed group relative to those not exposed.
- It is the ratio of the incidence of disease among exposed group divided by the incidence of disease among non-exposed
- The RR estimates the strength of an association between exposure and disease.
- RR = Ie / Io

Two kinds of Incidence

- Cumulative Incidence
  \[
  \frac{\text{Number of new cases of disease}}{\text{Total population at risk}} \quad \text{over a specified time period}
  \]

- Incidence Density
  \[
  \frac{\text{Number of new cases of disease}}{\text{Total person-time of observation}} \quad \text{over a specified time period}
  \]
Relative Risk

- If the incidence measure being used is *cumulative incidence*, the relative risk is called the **risk ratio**.
- If the incidence measure being used is *incidence density*, the relative risk is called the **rate ratio**.

Risk Ratio

\[
\text{Risk ratio} = \frac{a}{a+b} \div \frac{c}{c+d} = \frac{\text{CI}_{\text{exposed}}}{\text{CI}_{\text{unexposed}}}
\]

Meaning of RR

- **1.0 = no association:** *There is no relation between the Exposure and Disease*.
- **> 1.0 = Exposure is a risk factor for the Disease:** *Persons with the exposure are more likely to get Disease*.
- **< 1.0 = E is inversely related to D:** *Persons with the exposure are less likely to get Disease*.

Relative Risk

- The relative risk estimate is relative to the baseline incidence.

The relative risk is RELATIVE to the baseline incidence.

- Risk ratio (RR) = 1.0
- Rate ratio (RR) = 1.0
Cohort Study: Risk Ratio

<table>
<thead>
<tr>
<th>OC Use</th>
<th>Infection</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>27</td>
<td>482</td>
</tr>
<tr>
<td>No</td>
<td>77</td>
<td>1908</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>104</strong></td>
<td><strong>2390</strong></td>
</tr>
</tbody>
</table>

Risk Ratio

Cumulative incidence = \( \frac{\text{CI in Exposed}}{\text{CI in Unexposed}} \)

<table>
<thead>
<tr>
<th>OC Use</th>
<th>Infection</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>27/482= .056 (CI in Exposed)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>77/1908=.040 (CI in Unexposed)</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>104/2286 = 1.4</strong></td>
<td></td>
</tr>
</tbody>
</table>

Rate Ratio

Question: HRT use and CHD

Study sample:

30 women taking HRT developed CHD after 54,308.7py of follow-up

60 women not taking HRT developed CHD after 51,477.5py of follow-up

Rate ratio = \( \frac{\text{Incidence density among E}}{\text{Incidence density among U}} \)

\( \text{Rate ratio} = \frac{30}{54308.7} = 0.0005524 \)

\( \text{ID}_{E} = \frac{30}{54308.7} = 0.0005524 \)

\( \text{ID}_{U} = \frac{60}{51477.5} = 0.0011655 \)

\( \text{RR} = \frac{0.0005 / 0.00116 = .47 or .5} \)

Interpretation: women using HRT had only half (.5) the risk of developing CHD as did non-users.

Cross-sectional studies: Calculating the prevalence rate ratio

- Prevalence rate among exposed
- Prevalence rate among unexposed

Prevalence Rate Ratio

<table>
<thead>
<tr>
<th>Exposure smoking</th>
<th>Outcome</th>
<th>No</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>27 (a)</td>
<td>34 (b)</td>
<td>61</td>
</tr>
<tr>
<td>No</td>
<td>26 (c)</td>
<td>62 (d)</td>
<td>88</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>149</strong></td>
</tr>
</tbody>
</table>

- \( \text{PR}_{E} = \frac{27}{61} = .443 \)
- \( \text{PR}_{U} = \frac{26}{88} = .295 \)
- \( \text{PRR} = \frac{.443}{.295} = 1.5 \)

The prevalence of the outcome (depression) is 1.5x more common among those exposed (smokers) than those unexposed (non-smokers)
Case-control Studies

- Cannot calculate incidence in case-control studies, so cannot calculate relative risk
- Estimate relative risk in case-control studies by calculating the odds ratio (OR)

Review Quiz 2: Rationale

**Question 1**

<table>
<thead>
<tr>
<th>Obese</th>
<th>Diabetic</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>450</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1150</td>
<td>380</td>
<td></td>
</tr>
</tbody>
</table>

Prevalence Rate Ratio = \( \frac{450/(450 + 20)}{1150/(1150 + 380)} = 1.27 \)

**Question 2**

<table>
<thead>
<tr>
<th>Smoking</th>
<th>Lung Cancer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>160</td>
</tr>
<tr>
<td>No</td>
<td>40</td>
</tr>
</tbody>
</table>

RR = \( \frac{160/(160 + 80)}{40/(40 + 320)} = \frac{0.667}{0.111} = 6.009 \)