Introduction to Epidemiology

ENVE 569
Environmental Risk Assessment

What is Epidemiology?

• Study of disease in populations
• Study of patterns, causes and control of disease in populations
• The branch of medicine that deals with the study of the causes, distribution, and control of disease in populations.
• The study of the spread of diseases within and between populations.
Definitions (from JAWWA Sept. 1996, Craun et al.)

- **Association**
  - The dependence between two or more events, characteristics or variables (e.g., exposure and disease)
  - Association DOES NOT necessarily imply cause-effect between the events and variables.

- **Carrier**
  - One who harbors a specific infectious agent and is a potential source of infection

- **Case**
  - Person who has a particular disease or health condition

Definitions (from JAWWA Sept. 1996, Craun et al.)

- **Causality**
  - Relating causes to their effects

- **Cohort**
  - People assembled on the basis of a common characteristics and followed over time (may be retrospectively or prospectively followed) to determine a health-related outcome

- **Control**
  - A person who does not have the condition being studied.
Definitions (from JAWWA Sept. 1996, Craun et al.)

• **Endemic**
  – The constant low-level presence of a disease or infection.

• **Environmental epidemiology**
  – Use of epidemiologic methods to assess human health effects associated with environmental contaminants

• **Epidemic**
  – Occurrence of disease clearly in excess of the number of cases normally found or expected; if confined to a limited population, it is an ‘outbreak.’

Definitions (from JAWWA Sept. 1996, Craun et al.)

• **Etiologic agent**
  – Agent responsible for the postulated cause of a disease.

• **Etiology**
  – Postulated cause(s) of disease, specifically those that initiate the pathogenic medium.

• **Incubation period**
  – Time between first contact with an infectious agent and the appearance of the first disease symptom.
Definitions (from JAWWA Sept. 1996, Craun et al.)

- **Latency or Latent Period**
  - Delay between exposure and disease
  - The period between initiation of infection or disease to its detection.

- **Risk Factor**
  - An exposure, characteristic, or aspect of personal behavior (e.g., age, occupation) associated with an increased probability of a health-related condition
  - Not necessarily a causal explanation

- **Secondary transmission**
  - Transmission among familial, institutional, or other contacts.
  - Person who is sick did not have primary contact with the source

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**Basic Measures of Disease Frequency**

- **Incidence**
  - Rate at which new cases of disease occur.

- **Prevalence**
  - Measures both new and existing cases in a population with and without disease.
  - Proportion of people who have a specific condition at any specified time.

- **Attack rate**
  - Measures the cumulative incidence of disease during an epidemic or outbreak.
Geographic-Specific Attack Rates from a Waterborne Outbreak of Giardiasis in Massachusetts

<table>
<thead>
<tr>
<th>Water Source</th>
<th>Cases</th>
<th>Population</th>
<th>Attack Rate per 1,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir A</td>
<td>68</td>
<td>9,405</td>
<td>7.2</td>
</tr>
<tr>
<td>Reservoir B</td>
<td>14</td>
<td>2,309</td>
<td>6.1</td>
</tr>
<tr>
<td>Reservoir C</td>
<td>126</td>
<td>4,200</td>
<td>30.0</td>
</tr>
<tr>
<td>Mixed</td>
<td>427</td>
<td>34,351</td>
<td>12.4</td>
</tr>
<tr>
<td>Total</td>
<td>635</td>
<td>50,265</td>
<td>12.6</td>
</tr>
</tbody>
</table>

Summary of John Snow’s Data

<table>
<thead>
<tr>
<th>Water Supply Company</th>
<th>Cholera Deaths</th>
<th>Population</th>
<th>Mortality Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southwark and Vauxhall</td>
<td>4,267</td>
<td>266,516</td>
<td>160/10,000</td>
</tr>
<tr>
<td>Lambeth</td>
<td>473</td>
<td>173,748</td>
<td>27/10,000</td>
</tr>
</tbody>
</table>
Dose-response attack rates from a waterborne outbreak of chronic diarrhea

<table>
<thead>
<tr>
<th>Water consumption during outbreak (glasses)</th>
<th>Attack Rate per 100</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – 10</td>
<td>12.5</td>
</tr>
<tr>
<td>11 – 30</td>
<td>37.5</td>
</tr>
<tr>
<td>&gt;30</td>
<td>57.1</td>
</tr>
</tbody>
</table>

Morbidity and Mortality

- **Morbidity**
  - The relative incidence of a particular disease

- **Mortality**
  - A fatal outcome
Study Types

• Descriptive Epidemiological Studies
  – Information is only available about the occurrence of disease or associations among exposures, demographic characteristics, and disease rates in population groups

• Analytical Studies
  – Test hypotheses to evaluate exposure-disease information

• Ecological Studies
  – Explore associations between routinely gathered health and demographic statistics and other information (such as environmental parameters).

Reporting of Study Results

• The likelihood of a positive association is caused by random error can be estimated by calculating the level of statistical significance (p value) or the confidence interval (CI).

• Epidemiologists typically use the confidence interval.
  – CI provides a range of possible values of the risk estimate.
Guide to the Strength of an Epidemiologic Association

<table>
<thead>
<tr>
<th>Rate Ratio</th>
<th>Strength of Association</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>None</td>
</tr>
<tr>
<td>&gt;1.0 - &lt;1.5</td>
<td>Weak</td>
</tr>
<tr>
<td>1.5 – 3.0</td>
<td>Moderate</td>
</tr>
<tr>
<td>3.1 – 10.0</td>
<td>Strong</td>
</tr>
<tr>
<td>&gt; 10.0</td>
<td>Very strong/infinite</td>
</tr>
</tbody>
</table>

Incidence* of Cancer Mortality in Females in a Cohort Study in Maryland

<table>
<thead>
<tr>
<th>Cause of Death</th>
<th>Chlorinated Surface Water</th>
<th>Unchlorinated Surface Water</th>
<th>Risk**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Deaths Incidence Rate</td>
<td>Deaths Incidence Rate</td>
<td>RR</td>
</tr>
<tr>
<td>Liver cancer</td>
<td>31 19.9</td>
<td>2 11</td>
<td>1.81</td>
</tr>
<tr>
<td>Kidney cancer</td>
<td>11 7.2</td>
<td>2 7.1</td>
<td>1.01</td>
</tr>
<tr>
<td>Bladder cancer</td>
<td>27 16.6</td>
<td>2 10.4</td>
<td>1.60</td>
</tr>
</tbody>
</table>

*Adjusted incidence rate per 100,000 person-years
**RR – relative risk CI – confidence interval
Confounding Bias

• Confounders
  – Characteristics inherent in the population studied that may affect the data leading to an erroneous interpretation of an association or cause
  – Characteristic must be associated with the exposure being evaluated, a risk factor for the disease, and not part of the exposure-disease pathway.

Evaluating Causality

• Temporal association
• Study precision and validity
• Strength of association
• Consistency
• Specificity
• Biological plausibility
• Dose-response relationship
• Reversibility