Cross-sectional studies

Allan Smith
Epidemiologic Study Designs

Validity

*anecdotes
*case series
*ecological study
*cross-sectional study
*case control study
*nested case-control study
*retrospective cohort study
*prospective cohort study
*intervention trial

Cost
Cross-Sectional Studies

• The cross-sectional study is one in which exposure and disease status are assessed simultaneously among individuals in a well-defined population.
Cross-Sectional Studies

• obtain current health data and
• current exposure data

from the same people at the same time

However, past exposure and health data are often collected as well. Even if so, such studies are still cross-sectional
Beware!

The fact that past exposure and health data are collected does not make it a retrospective cohort study.

The distinction is that in the cross-sectional study you start with people where they are now.

In the retrospective cohort study you start identifying people in the past before the outcomes occurred.

If you start with people where they are now, some are missing from the cohort that might have been defined years ago.
New Zealand’s think big policy

Build a second aluminium smelter

Design it the same as the first because the workers there do not get asthma

(Pot room asthma)
Cross-Sectional Study

Aluminum smelter

Pot room workers

Other workers

No difference in average pulmonary function between pot room workers and other workers, nor with the

General population

Build on!
In all cross-sectional studies you must think about how people got there

Selection in

Selection out
Were those there chosen, or chose to be there, for a health-related reason?

Pot room asthma was already known

Asthmatics would (or should) have been advised not to work there
Selection out

Were some already selected out from those still there for a health-related reason?

Those who developed asthmatic symptoms might choose, or be advised, not to work there
Cross-Sectional Study

Aluminum smelter

No difference in pulmonary function with general population

- Workers with respiratory problems might choose not to work in the pot room

- Workers experiencing symptoms in the pot room may choose to change jobs or leave altogether

Need longitudinal data
Bias  You got the wrong answer

Selection bias: always consider it in cross-sectional studies
Mercurialism in the Felt Hat Industry

Workmen dipped felt hats into an acid solution of mercuric nitrate

from I. Higgison, in Chiazze et al, Occupational and Environmental Epidemiology
The most characteristic symptom, though it is seldom the first to appear, is mercurial tremor. It is neither so fine nor so regular as that of hypothyroidism. It may be interrupted every few minutes by coarse jerky movements. It usually begins in the fingers, but the eyelids, lips and tongue are affected early. … As it progresses it passes to the arms and then to the legs so that it becomes very difficult for a man to walk about the workshop, and often he has to be guided to his bench. At this stage the condition is so obvious that it is known as the "hatters’ shakes,"…"
# Mercurialism in the Felt Hat Industry: findings from a cross-sectional study in the workplace

<table>
<thead>
<tr>
<th>Duration of work</th>
<th>Mercury Concentration (µg/m³)</th>
<th>No.</th>
<th>%</th>
<th>No.</th>
<th>%</th>
<th>No.</th>
<th>%</th>
<th>No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0-79</td>
<td>36</td>
<td>0</td>
<td>76</td>
<td>1.3</td>
<td>80</td>
<td>3.8</td>
<td>30</td>
<td>6.7</td>
</tr>
<tr>
<td></td>
<td>80-159</td>
<td>10</td>
<td>0</td>
<td>31</td>
<td>6.5</td>
<td>80</td>
<td>17.5</td>
<td>27</td>
<td>14.8</td>
</tr>
<tr>
<td></td>
<td>160-239</td>
<td>20</td>
<td>0</td>
<td>30</td>
<td>10.0</td>
<td>77</td>
<td>23.4</td>
<td>24</td>
<td>54.2</td>
</tr>
<tr>
<td></td>
<td>240+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Mercurialism in the Felt Hat Industry

Percent of workers affected

- 50%
- 10%

Mercury μg/cubic meter

- 80
- 160
- 240

* *
Selection bias?

Theoretically conceivable?

But very unlikely because of the dramatic findings with characteristic symptoms of a rare condition
To evaluate the effects of chronic lead exposure on the nervous system in adults, a set of tests was administered to 99 lead exposed foundry employees and 61 unexposed workers.
Mean percent scores on the profile of mood states by level of lead exposure

Blood lead concentration $\mu$g/dl

<table>
<thead>
<tr>
<th>Mood</th>
<th>0-20</th>
<th>21-40</th>
<th>41-60</th>
<th>61-80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tension</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anger</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depress</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vigor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fatigue</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confuse</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Those workers with the highest blood lead concentrations were

more tense
more angry
more depressed
more fatigued
more confused

and had less vigor

than those with low blood lead

Selection bias?

Who choose (or are chosen for) dirty jobs?
Who stay there?
Who get dirtiest on the job?
# Cross-Sectional Study

## Effect Measures

<table>
<thead>
<tr>
<th></th>
<th>Disease</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>Exposed</td>
<td>a</td>
<td>b</td>
<td>$N_e$</td>
<td></td>
</tr>
<tr>
<td>Not exposed</td>
<td>c</td>
<td>d</td>
<td>$N_{ne}$</td>
<td></td>
</tr>
</tbody>
</table>

Prevalence in the exposed: $\frac{a}{N_e}$

Prevalence in the unexposed: $\frac{c}{N_{ne}}$
Cross-Sectional Study
Effect Measures

Prevalence odds in the exposed: \( \frac{a}{b} \)
Prevalence odds in the unexposed: \( \frac{c}{d} \)

Prevalence odds ratio \( = \frac{(a/c)}{(b/d)} \)
\( = \frac{ad}{bc} \)

In steady state, the prevalence odds ratio is an unbiased estimate of the rate ratio! No rare disease assumption!!

A miracle of modern science.
## The prevalence ratio

<table>
<thead>
<tr>
<th>Disease</th>
<th>Yes</th>
<th>No</th>
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<tr>
<td>Not exposed</td>
<td>c</td>
<td>d</td>
<td>$N_{ne}$</td>
</tr>
</tbody>
</table>

Prevalence in the exposed: $\frac{a}{N_e}$

Prevalence in the unexposed: $\frac{c}{N_{ne}}$

Prevalence ratio $\frac{a/N_e}{c/N_{ne}}$

is biased from the rate ratio.
The Prevalence Ratio

<table>
<thead>
<tr>
<th></th>
<th>CHD</th>
<th>No CHD</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposed</td>
<td>14</td>
<td>75</td>
<td>89</td>
</tr>
<tr>
<td>Not exposed</td>
<td>3</td>
<td>87</td>
<td>90</td>
</tr>
</tbody>
</table>

Prevalence rate in the exposed:
\[ \frac{14}{89} = 157.2 / 1000 \]

Prevalence rate in the non-exposed:
\[ \frac{3}{90} = 33.3 / 1000 \]

Prevalence ratio \[ = \frac{(14/89)}{(3/90)} \]
\[ = 4.7 \]
The Prevalence Odds Ratio

Prevalence odds in the exposed: \( \frac{14}{75} \)

Prevalence odds in the non-exposed: \( \frac{3}{87} \)

Prevalence odds ratio \( = \frac{\frac{14}{75}}{\frac{3}{87}} \)

\( = \frac{5.4}{} \)
Study design, x-ray (HRCT) study in West Bengal, India

7600 surveyed

108 selected with skin lesions
- 27 had chronic cough more than 2 years

150 selected Without skin lesions
- 11 had chronic cough More than 2 years

Mazumder DN et al. Epidemiology 16:760-5, 2005
High resolution computed tomography (HRCT) with readings in India and the United States without knowing who had skin lesions.
Study design, x-ray (HRCT) study in West Bengal, India

10-fold increased prevalence of bronchiectasis OR=10.1, p<0.01
Cross-Sectional Studies

Require
- Contrasts in exposure within the study population
- Short latency period

Problems
- Selection bias: the selection of study participants should follow a carefully defined protocol
  Selection in and out

Advantages
- Quick, Cheap
- Accurate disease assessment
- Accurate current exposure assessment
Epidemiologic Study Designs

Validity

Cost

*anecdotes
*case series
*ecological study
*cross-sectional study
*case control study
*nested case-control study
*retrospective cohort study
*prospective cohort study
*intervention trial
Understanding What Scientists Mean:

• *It has long been known …* I didn’t look up the original reference.

• *A definite trend is evident …* these data are practically meaningless.

• *While it has not been possible to provide definite answers to the questions …* an unsuccessful study, but I still hope to get it published.

• *Three of the participants were chosen for detailed study …* the other findings didn’t make any sense.

• *Typical results are shown …* this is the prettiest graph.
Cross-Sectional Studies

• Maybubul Eunus et al. Assessment of lung function in rural adults and their relation with arsenic exposure

• The study involved 190 participants who had continuously used the same tubewell for the last ten years
Authors Conclusions:
The Respiratory function are greatly influenced by arsenic exposure but Investigations are poorly established this. So Need to further study in large sample

Questions and suggestions:
What were the water concentrations in the exposed?
What are the results when you treat lung function as a continuous variable (not dividing into restrictive, obstructive and “normal”).
It would seem further analysis is needed before expanding to a larger sample.
Be careful with exposure: Nobody in Bangladesh only drinks from one tubewell
Lung function findings of reduced FEV1 adjusted for age and height

- For all men combined $P=0.007$

- Among men in this population, arsenic-caused skin lesions were associated with a greater FEV1 reduction (-256ml) than from smoking (-156ml)

Cross-Sectional Studies

• Prasenjit Roy et al. Chewing tobacco increases incidence of nuclear abnormalities in exfoliated buccal epithelial cells in arsenic exposed population from Southern Assam

• The study involved 138 participants, including the arsenic exposed and the control group
Authors Conclusions:
Our results indicate statistically significant increase in all parameters of cytome assay when compared to the control group.... Maximum in those having tobacco chewing habit and arsenic exposure (p<0.001).

Future direction: determine the mode(s)-of-action for inorganic arsenic-induced toxicity and carcinogenicity.

Questions and suggestions
What were the water arsenic concentrations in the four groups? Were they comparable in those who did and did not chew tobacco?

What are the actual results? (i.e. the size of the effects). Statistically significant is not important ... better to give the actual p values.

Mechanisms of action: It will take decades to work them out.