1-hour introduction to epidemiology

- What is epidemiology?
- What are the purposes of epidemiological studies?
- Some important measures of disease frequency
- Some important study designs
- Confounding

What is epidemiology?

- “The study of the occurrence of illness”
- The study of the distribution and determinants of disease in the population

Purposes of epidemiological research

- Identify causes of disease
  - environmental
  - genetic
  - interplay between factors
  \{ Mechanisms (targets for prevention or treatment) \}
- Evaluate the effect of interventions
  (diet, exercise, vaccines, treatment, screening...)
- Study the natural course of disease
- General health statistics - planning of health services

Purposes of epidemiological research

Descriptive epidemiology: describe the occurrence of disease

How many Norwegians have diabetes?
How many people get lung cancer every year?

Analytic epidemiology: identify causes of disease

Does smoking increase the risk of lung cancer?
Do high cholesterol levels lead to heart disease?
Exposure → Disease

Exposure → Disease

Lung cancer
Heart disease
Diabetes etc...

Common principle:
These are observational studies, where we observe the natural course of disease, as opposed to experiments / clinical trials, where we decide who is being exposed.

How do we measure disease occurrence?

Prevalence: How many are ill?
Incidence: How many fall ill?

Prevalence – How many are ill?
Prevalence: the proportion of the population having the disease at a specific point in time.
Examples:
- In 2012, 20% of adult Norwegians had high blood pressure.
- Today, 10% of the population of Trondheim suffer from a cold.

Incidence – How many fall ill?
Incidence expresses the number of new cases of a disease during a specified time period.
Examples:
- We follow 100,000 people for 1 year. 40 of them get lung cancer. Incidence of lung cancer = 40 / (100,000 persons x 1 year)
- Every year, 5% of elderly women in Trondheim get a hip fracture.
Risk - the probability of getting a disease

Risk expresses the proportion who get a disease during a specified period of time.

Example:
Does smoking cause myocardial infarction?

Is the risk of myocardial infarction different in smokers and non-smokers?

Risk among smokers: 10-year risk of MI = 5%
Risk among non-smokers: 10-year risk of MI = 2%
Relative risk = 5% / 2% = 2.5
Smokers have 2.5 times higher risk of myocardial infarction, compared to non-smokers.

Epidemiological measures - summary

Prevalence: How many people have a disease at a specific point in time?
Incidence: How many people get a disease during a specific time period?
Risk: What is the probability of getting a disease during a specific time period?
Relative risk: Compares risk between two groups (ratio between the risk among the exposed and the risk among the unexposed)
Types of observational studies

**Cohort study:**
Comparison of disease frequency between groups with different exposure.

Is the disease more common among exposed than among unexposed?

**Case control study:**
Comparison of exposure between people who have fallen ill (cases) and a comparison group without the disease (controls).

Is the exposure more common among cases than among controls?

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**Cohort study**

- We identify a population (cohort) without the disease.
- We measure the exposure.
- We follow the population and observe who gets the disease.
- We compare the disease frequency between exposed and unexposed.

\[
\text{exposed incidence of disease} \quad \text{population} \quad \text{unexposed incidence of disease}
\]

Comparison

Smokers 5% 10 years myocardial infarction
Non-smokers 2%

Relative risk = 5% / 2% = 2.5

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**Case-control studies**

In a cohort study, we start with the exposed and the unexposed.

\[
\text{Exposure} \quad \text{Disease} \quad \text{Exposure} \quad \text{Disease}
\]

In a case-control study, we start with those who have got the disease (cases). We then choose a group of people without the disease (controls).

We measure exposure in the two groups.

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The controls tell us about the distribution of exposure in the population that the cases come from.
Is the association causal?

Marve Fleksnes once said: “I am probably allergic to leather because every time I have slept with my shoes on, I wake up the following morning having a headache.”

Systematic errors

Confounding and bias can lead to systematic errors in observational studies:

- Confounding
- Selection bias
- Information bias
- Both underestimation and overestimation can occur.
- The result is wrong regardless of the study size.

Beta-carotene and mortality from cardiovascular diseases

<table>
<thead>
<tr>
<th>Cohorts</th>
<th>Mortality from cardiovascular disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male health workers (US)</td>
<td>1.25</td>
</tr>
<tr>
<td>Male social insurance workers (Fin)</td>
<td>1.20</td>
</tr>
<tr>
<td>Female social insurance workers (Fin)</td>
<td>1.30</td>
</tr>
<tr>
<td>Male chemical workers (Switzerland)</td>
<td>1.10</td>
</tr>
<tr>
<td>Hypertensive men (US)</td>
<td>1.15</td>
</tr>
<tr>
<td>Nursing home residents (United States)</td>
<td>1.15</td>
</tr>
<tr>
<td>Cohorts combined</td>
<td>1.25</td>
</tr>
</tbody>
</table>

Should we recommend carrots for prevention of heart disease?

Exposure

• Beta-carotene

Disease

• Mortality from cardiovascular disease

Confounder

Cardiovascular disease
Control for confounding

- We can control for confounding in the statistical analyses if the confounders are known and measured with adequate precision.
- We can seldom exclude the possibility of confounding or bias in observational studies - this limits the possibility to draw causal conclusions from observational studies.
- Randomization prevents systematic differences between the exposure groups (treatment groups) - therefore, it is possible to draw conclusions about causality.
- Randomized studies give the most robust evidence for treatment effects.
- So, why aren’t all studies randomized?

Summary

- In epidemiology, we observe disease occurrence in the population.
- The purpose is often to identify causes of disease.
- Some important measures: prevalence, incidence, relative risk.
- Some important study designs: cohort study and case control study.
- Confounding and bias can distort the results of observational studies.