# Epidemiological methods – strengths and limitations as applied to health effects of electromagnetic fields

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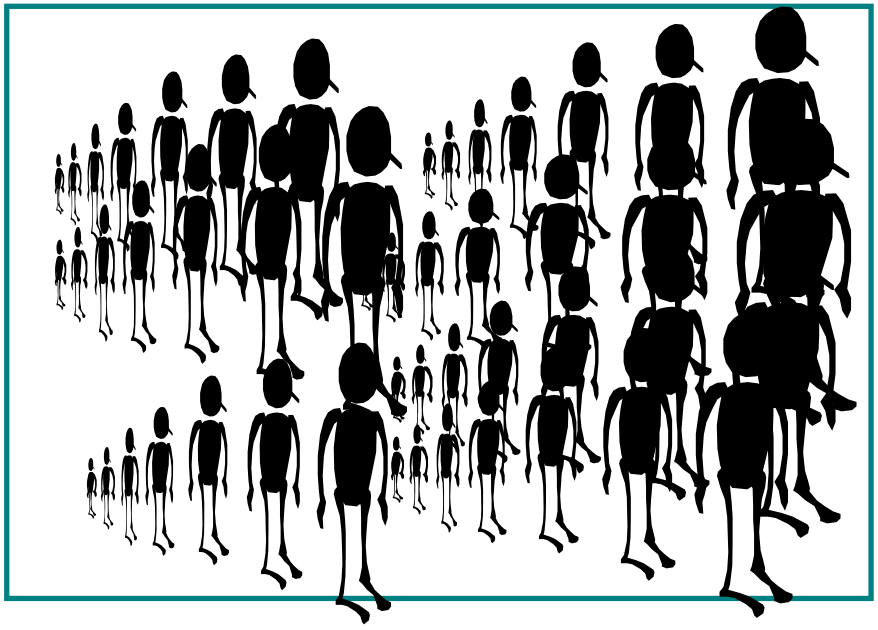


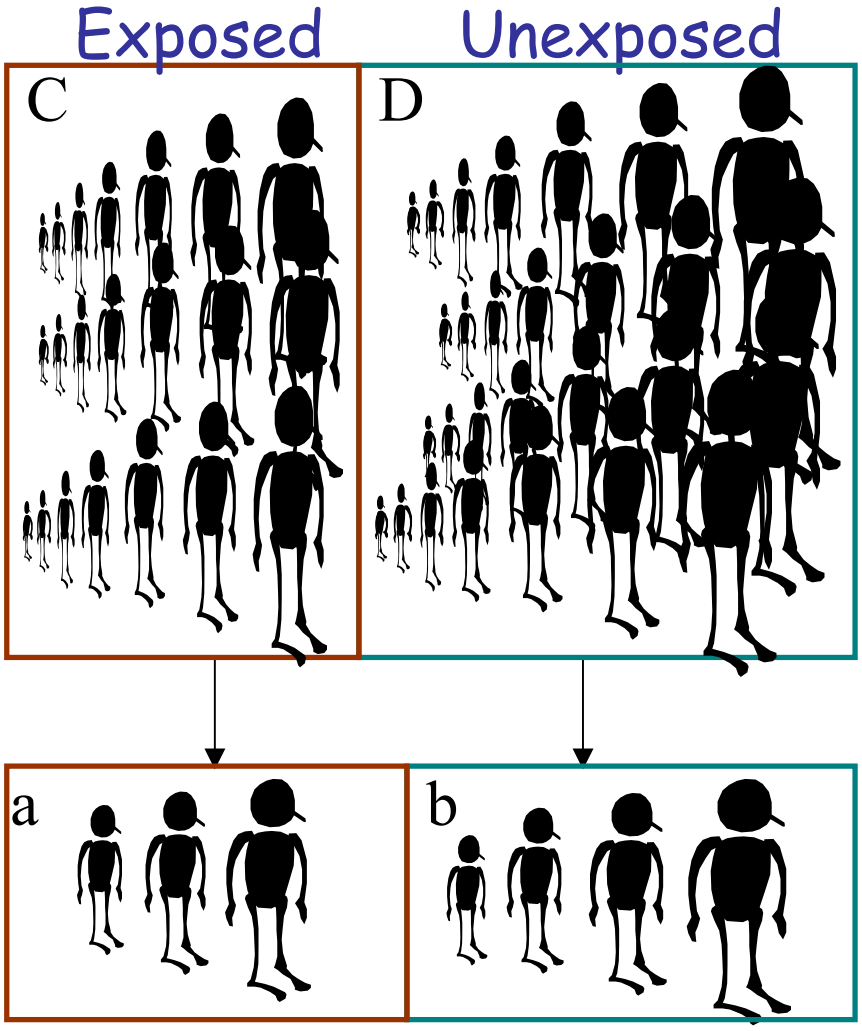
Follow over time

# Cohort studies

- A defined population is followed over time with regard to disease occurrence.

# Cohort studies

- Exposure must be determined for *all* persons included in the cohort

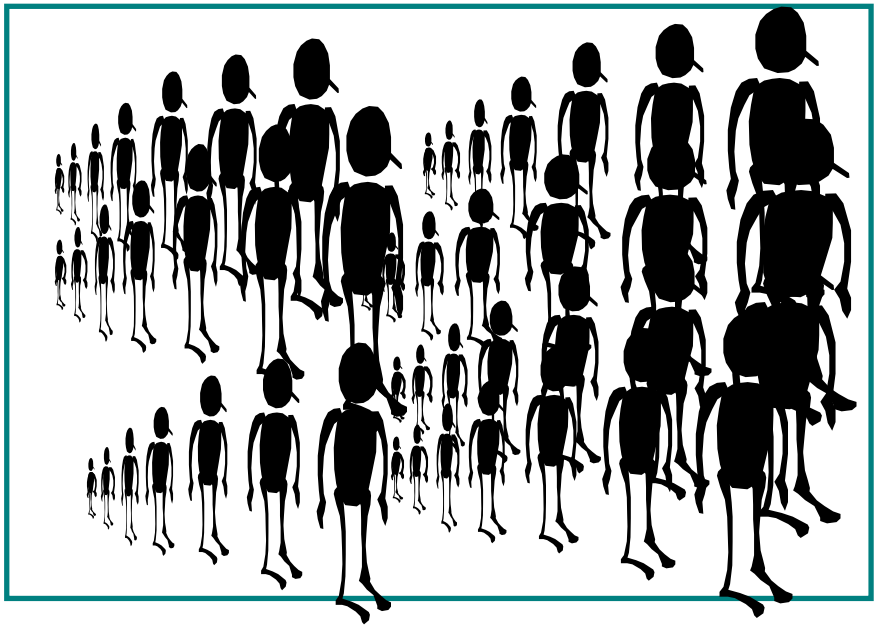



Follow over time

Cases must be identified independently of the exposure

- Disease occurrence among exposed are compared to that among unexposed

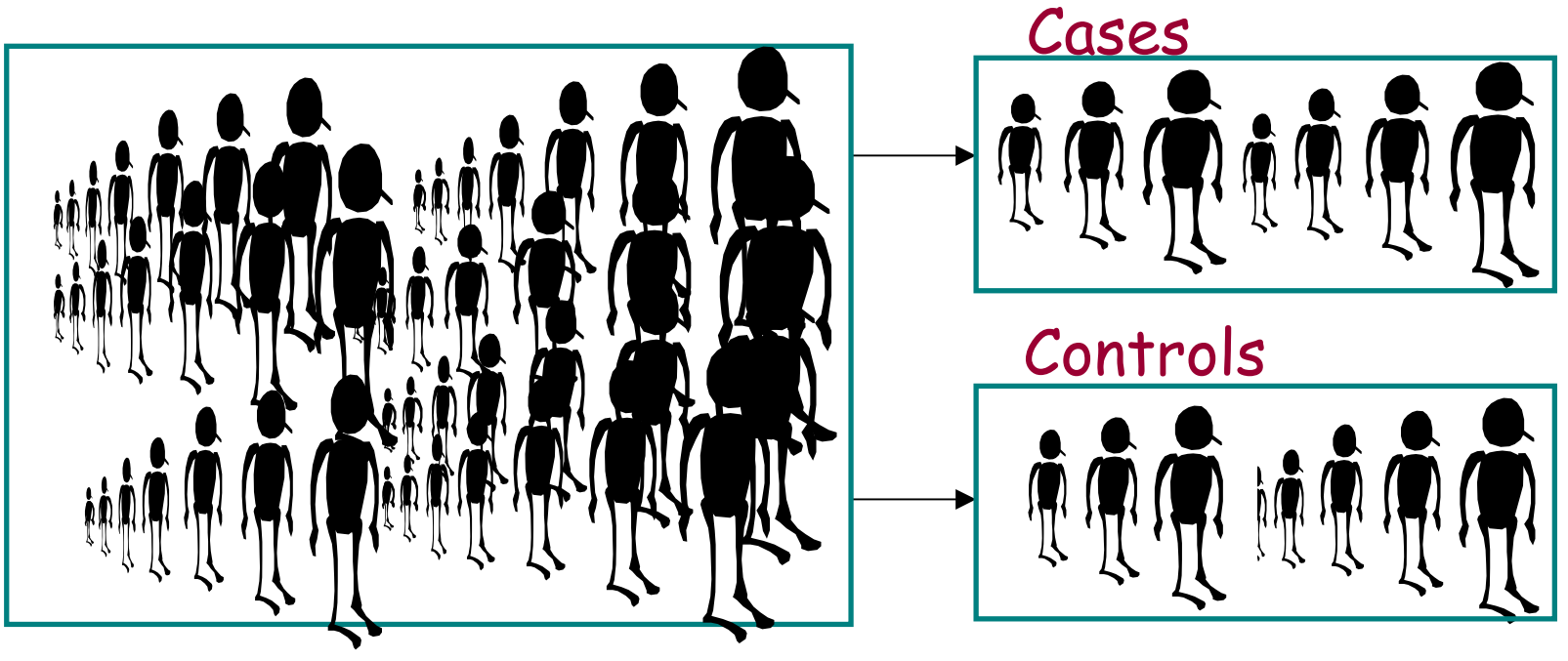
$$RR = \frac{a/C}{b/D}$$



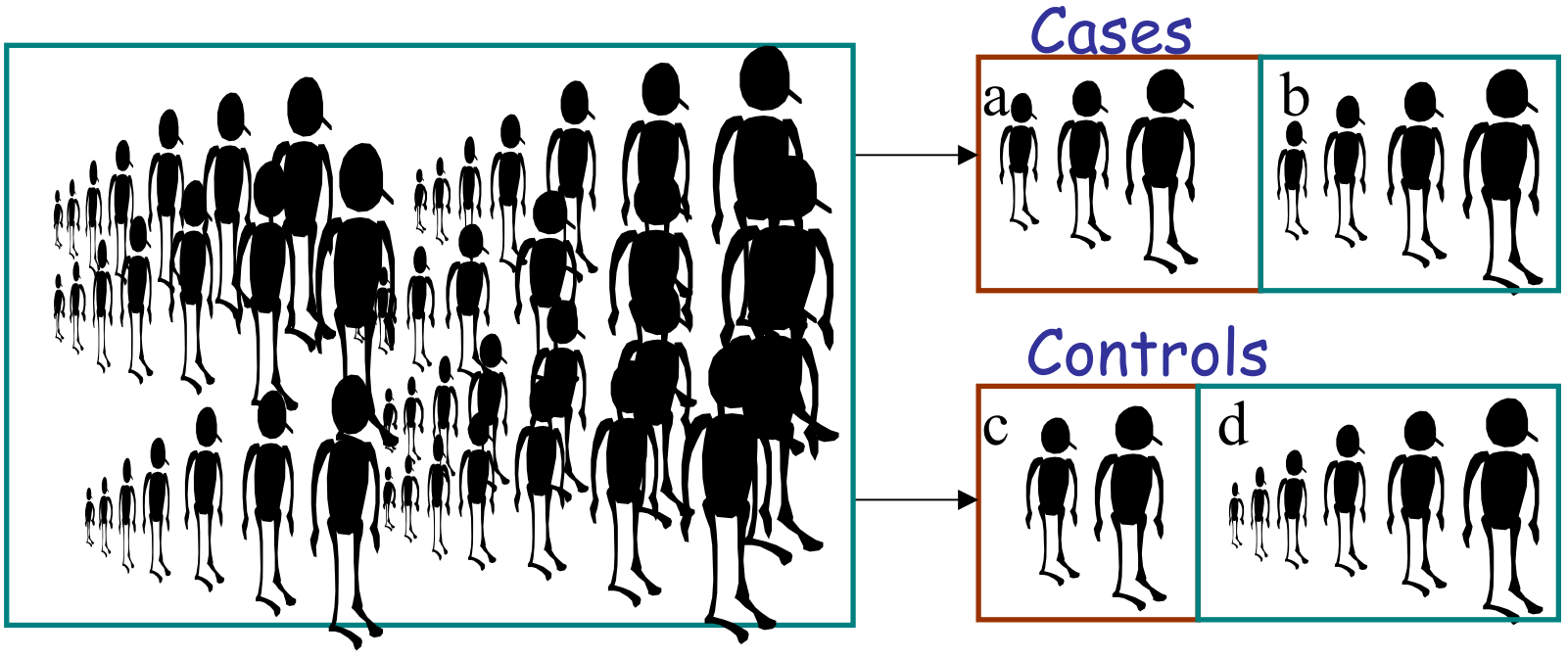
Follow over time

# Case-control studies

- A defined population is followed over time with regard to disease occurrence.




- ***All cases*** in the studied population must be identified
- Controls are selected randomly from the same population




- Exposure is determined for cases and controls

**Exposure must be determined independently of case/control status**

$$RR = \frac{a/c}{b/d} = \frac{a/d}{b/c}$$

# Sources of bias

- Selection bias
  - when the probability of being included in the study is related to both exposure and disease
- Misclassification
  - of exposure or disease
- Confounding

# Selection bias

- Usually not a problem i cohort studies
  - Can be a problem in retrospective cohort studies
- Control selection in case-control studies
  - controls must be a representative sample of the population that have generated the cases

# Control selection

- Hospital based
  - + Higher participation rates
  - - Patients in a hospital not a random sample of the population
- Population based
  - + Representative sample of the population
  - - Lower participation rates
    - non-participants are not a random sample of the population

# Misclassification of exposure

- Non-differential: independent of the disease
  - leads to diluted effect estimates: RR → 1
    - exception: intermediate categories when polychotomous exposure, distort dose-response pattern
  - magnitude of bias depends on:
    - prevalence of the exposure & sensitivity and specificity of exposure assessment method

# When exposure is rare

- High ***specificity*** of exposure estimate important

  Specificity = probability that unexposed individual is classified as unexposed

- Even a slight reduction in specificity may dilute risk estimate *considerably*

- Not important to find everyone that is exposed
  - misclassification of exposed subjects as unexposed does not affect results much

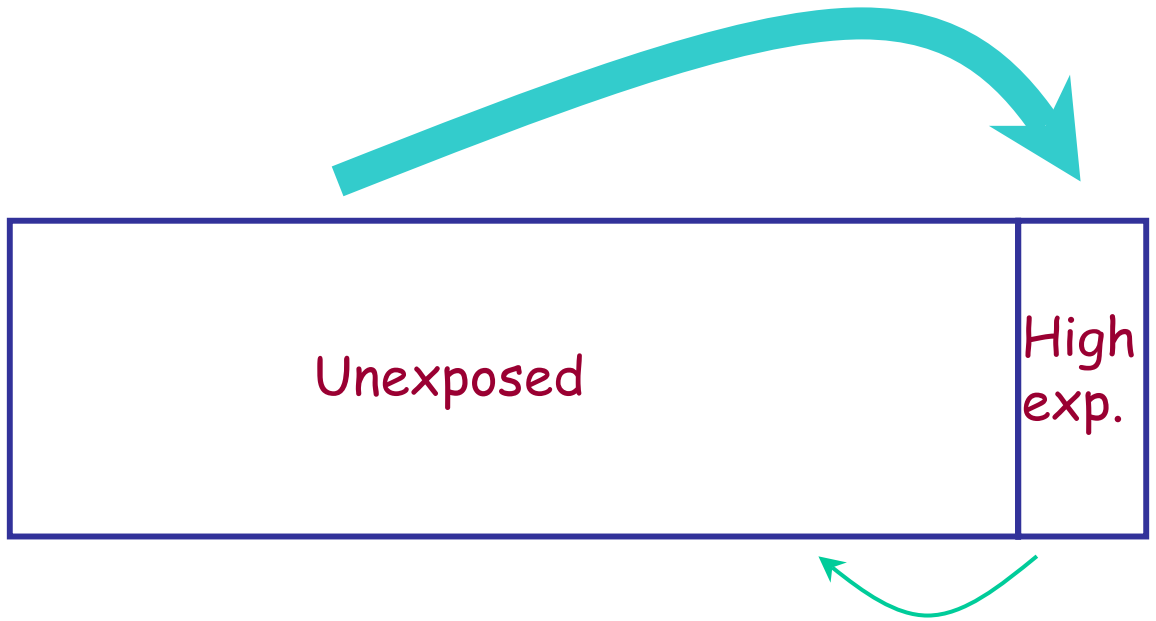
# Non-differential exposure misclassification

## Example: 2% exposure prevalence, true RR=2

| Specificity \ Sensitivity | 1.0 | 0.8 | 0.6 | 0.4 | 0.2 |
|---|---|---|---|---|---|
| 1.0 | **2.00** | **1.99** | **1.98** | **1.98** | **1.97** |
| 0.8 | **1.09** | 1.07 | 1.05 | 1.02 | 1.00 |
| 0.6 | **1.05** | 1.03 | 1.02 | 1.00 | |
| 0.4 | **1.03** | 1.02 | 1.00 | | |
| 0.2 | **1.02** | 1.00 | | | |

Norell SE, 1987

# Non-differential exposure misclassification



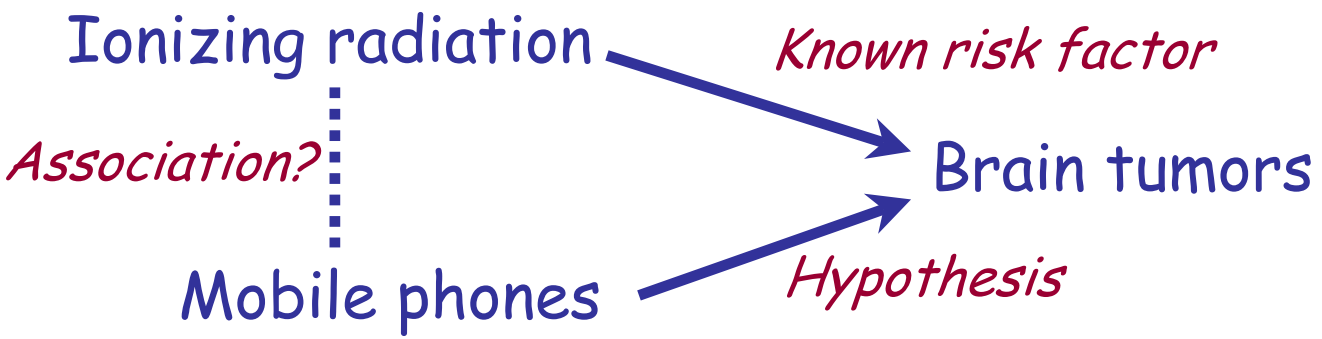
# Differential exposure misclassification

- Can affect risk estimate i any direction
- Exposure information must be collected in a similar way for both cases and controls
- "Recall bias" may lead to differential exposure misclassification
  - "objective" source of information better, i.e. registry

# Confounding

- A confounder must be related **both** to the exposure and to the disease
- A known risk factor for the disease is not necessarily a confounder

# Confounding?




To fully explain an observed association:

- Stronger association between disease and confounder
- Strong association between confounder and exposure

# Statistical power

- Number of *exposed cases* determines power:

*Childhood leukemia and ELF-EMF*

UK study: 1100 cases
≥0.4 μT: 5 cases

Swedish study: 38 cases
≥0.4 μT: 5 cases

*Mobile phones and brain tumors*

Danish cohort: >400,000
154 cases
Exposed ≥5 years 24 cases

Finnish case control: 398 cases
5 controls/case
≥2 years 18 cases