Control Bias

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Sources of bias and error

- Random error
- Systemic error
- Reducing random error = increasing precision
- Reducing systemic error = increasing validity

Precision

Random error = sources of variation due to chance

Example: sampling error

We can reduce random error by

- Increasing the sample size
- Modifying the study design to increase efficiency (e.g. by targeting a group of people likely to be exposed to the risk factor or likely to develop the disease)

Example:

- If a sample of size 10,000 is chosen but only 5 people are exposed to the risk factor the study is not efficient
- If a study of arthritis is planned and a sample of high school students is chosen the study is not efficient.

Validity

- External validity: validity with respect to the target population
- Internal validity: Validity within the study group

Note: Internal validity is a prerequisite for external validity

- External validity:

1. Are the study findings abstract able to the target population?

Threats: Representative of the sample Non-participation

2. Is the target population chosen wisely?

(i.e. choose the Eskimo to represent the whole US. Population)

- External validity:

1. Does the effect found in the study group accurately reflect the true effect in the study group?

Threats: bias

Bias = systematic error which results in an incorrect estimate of the association between cause and effect (Rothman)

There are 3 major biases

- Selection bias
- Information bias
- Confounding

Sources of bias in experimental study

1. selection bias
2. Performance bias
3. Information or observation bias
4. confounding bias

Selection Bias

Systemic error resulting in an inflated or deflated effect estimate; caused by the way study participants were selected.

1. Self-selection bias
2. Healthy worker effect
3. Diagnostic bias
4. Berkson's bias

Selection Bias

1. Self Selection Bias:

The reasons for self-referral may be related to the outcome under study.

e.g. Gulf War syndrome

If Gulf War veterans with symptoms volunteer to participate whereas veterans without symptoms tend not to participate the study results will be biased “away from the null”

Selection Bias

2. Healthy worker effect: People able to come to work are healthier, on average, than the general population.
3. Diagnostic bias: Detection or diagnosis of the disease may be influenced by knowledge about the presence of the risk factor.

Example: More in depth tests for congenital syphilis may be performed if the mother is a drug addict

4. Berkson's bias: Occurs since hospitalized patients are not representative of patients in the general population

Example: Cases have lung cancer (high hospitalization rate)

Controls have asthma (lower hospitalization rate)

Observer/recorder/interviewer bias

- Observer/recorder bias
- Interviewer bias
- Instrument bias

Observer/recorder bias

Ex: if the physician is more likely to interpret the lab results as positive for congenital syphilis if the mothers are drug users differential misclassification occurs.

(bias away from the null)

If the physician is equally likely to incorrectly interpret lab results for all mothers non-differential misclassification occurs.

(bias toward the null)

Interviewer bias

Ex: If the physician asks mothers of babies with congenital syphilis more in depth questions about drug use than mothers of healthy babies differential misclassification occurs.

(bias away from null)

If the physician asks mothers of babies with congenital syphilis and mothers of healthy babies the same questions about drug use non-differential misclassification occurs.

(bias toward the null)

Instrument bias

Lack of calibration

Ex: If the lab testing mothers from high risk groups is under-funded and has faulty equipment whereas the lab testing low-risk mothers has correctly working equipment differential misclassification occurs.

(bias may be toward or away from the null).

Otherwise non-differential misclassification may occur.

(bias toward the null).

Information Bias

Systemic error resulting in an inflated or deflated effect estimate; occurring when the measurement of the risk factor or the disease is systematically different between the groups being compared.

Information bias leads to misclassification with respect to the disease or the risk factor.

Diseased people may be classified as non-diseased and vice versa.

Exposed people may be classified as non-exposed and vice versa.

1. Differential misclassification
2. Non - differential misclassification
3. Subject despondence bias

Information Bias

1. Differential misclassification

- Misclassification of study subjects with respect to the disease depends on the subjects' exposure status.
- Misclassification of study subjects with respect to the exposure depends on the subjects' disease status.

Differential misclassification can lead to a bias toward or away from the null.

Information Bias

2. Non - differential misclassification

- Misclassification of study subjects with respect to the disease does not depend on the subjects' exposure status.
- Misclassification of study subjects with respect to the exposure does not depend on the subjects' disease status.

Non-differential misclassification always leads to a bias toward the null.

Information Bias

3. Subject despondence bias

- Recall bias
- Reporting bias
- Placebo effect
- Hawthorne effect

Recall bias

Ex: If mothers or babies with birth defects remember every drop of alcohol they drank during pregnancy, and mothers of healthy babies forget small amounts of alcohol they consumed differential misclassification occurs (the bias is away from the null).

If mothers of babies with birth defects and mothers of healthy babies forget about alcohol they consumed in the same manner non-differential misclassification occurs and the bias is toward the null.

Reporting bias

Ex: If mothers of babies with birth defects feel guilty about the amount of alcohol they drank during pregnancy and lie about it, whereas mothers of healthy babies correctly report the amount of alcohol they consumed differential misclassification occurs (the bias is toward the null).

If mothers of babies with birth defects correctly report the amount of alcohol they consumed during pregnancy whereas mothers of healthy babies don't want to admit the amount of alcohol they consumed and lie about it differential misclassification occur (the bias is away from the null).

If mothers of babies with birth defects and mothers of healthy babies lie in the same manner about the amount of alcohol they drank during pregnancy non-differential misclassification occurs and the bias is toward the null.

Placebo bias

A patient symptoms may improve because he/she thinks he/she is taking medication even if the "medication" is a placebo.

This may result in a bias toward the null

Hawthorne effect

A person's behavior may change because he/she knows he/she is being studied.

If the behavior of non-exposed study subjects changes in the same manner as the behaviors of exposed study subjects the misclassification is non-differential and the bias is toward the null.

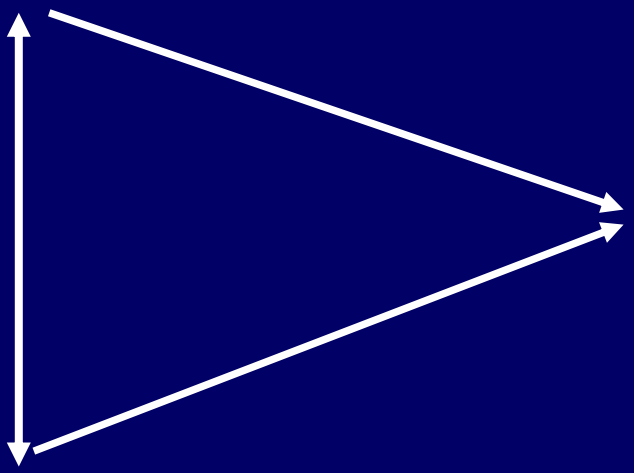
Otherwise the misclassification is differential and the bias is away from the null.

3. Confounding bias

(Exposure)

(Type of Behavior)

(Secondary association)



(Statistical association)

(outcome)

(Causal association)

(confounding factors)

1. (Hypertension)
2. (Smoking)
3. (Hypercholesteroemia)

Selection Bias	Performance Bias	Information Bias
1. Different Prognostic factors ■ Extent of disease ■ Major co-mobidity ■ Age 2. Self-selection	1. Performer's skill 2. Supportive treatment 3. Dosage 4. Compliance 5. Contamination 6. Co-intervention	1. Unequal diagnostic surveillance 2. Measurement error 3. Misclassification 4. Incorrect diagnostic criteria and interpretation

1. Before-experimental control
   - (Randomization)
   - (Blind assignment)
2. During-experimental control
   - (Machine variation)
   - (Biological variation)
   - (Environmental variation)
   - (Balancing of bias)
3. After-experimental control
   - (Selection of outcome)
   - (Blind assessment)
   - (Control in analysis)

Reference

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