Principles of Biostatistics and Informatics

Lecture 14th:

Evidence based medicine. Clinical studies.

2018. December 12.

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Evidence Based Medicine (EBM)

A series of conscientious, unambiguous and logical decisions based on the evidence currently available that serves the patient's personalized treatment.

Known results of „statistical trials”

Personal knowledge, clinical practice

„Common sense”

Biostatistics – why to learn?

- „ To decide whether we should believe in something we are reading or to see where the mistake is, that is to say, do not fall so easily into statistical „juggling”, artifacts and mistakes. (see excel – panacea,…)
- „To judge better whether we were lucky or not – or none of them….”
- „ To judge better what is worth , whether it is worth for risking it…”

- „ So that we can do our best to design and evaluate our own statistics in our work (diploma…).”
- „I got an interested, unexpected result? I just discovered something or just the game of chance I see?”
- „ To make our results more understandable and effective, we can highlight the essence. "
- „ To have a clear understanding of the literature. "

(J. Reiczigel)

Known results of „statistical trials” – how they will be?

- We collecting data and analysing them.

Known results of „statistical trials” – how they will be?

- ~~We collecting data and analysing them.~~
- HOW TO GET DATA? – first PLAN it!

Considerational considerations :

- What is the aim, the question?
- What „mistakes” should be considered?
- How much should the samplesize be?
- What methods can be applied?
- Which sampling techniques are available?
- ... So THEN collect data…

Known results of „statistical trials” – how they will be?

- ~~We deal with existing, existing data that we have collected.~~
- HOW TO GET DATA?

Considerational considerations :

- What is the aim, the question?
- What „mistakes” should be considered?
- What methods can be applied?
- Which sampling techniques are available?
- How much should the sample size be?
- ... So THEN collect data…

- **The most sophisticated, most accurate data analysis does not compensate for a poorly planned, designed or executed data collection or survey !!!!!!!!**

What is the aim?

Is there any difference?
Is there any relation (correlation)?
Is there any effect?
…

Aim + Relevant?

Is there any difference?
Is there any relation (correlation)?
Is there any effect?
…

There may be a „difference” – but is it relevant (clinically important)?
Based on clinical practice – that is NOT A STATISTICAL QUESTION – but it is really IMPORTANT

– How much is the difference…? EFFECT SIZE
…

Effect size

There could be a difference, but is it relevant?
– How much is the „difference”? : How to express it?

Difference between means, medians; ratio of means, medians
How much (how many times) does it change in another group?

Correlation, determination coefficient
To what extent does the change in y affected by the change in x?
slope
If the x (independent) variable increased by 1 unit what will be the average change in the y (dependent) variable.

Odds ratio, Risk ratio
How many times does the odds or risk increased if the risk factor present?
…

Error 1 – why? Significance

Problem: we couldn't examine everybody (the population)!
Solution: sampling – but…
…sampling error (chance)… Hypothesis testing!
The observed effect could be by chance?
Is the „difference” significant?
(*see excel, radiation)

Effect size and „significance” together

Confidence interval!

(NOTE: learn this carefully – we like to ask it in the exam!)

If there is a difference can we recognize it?

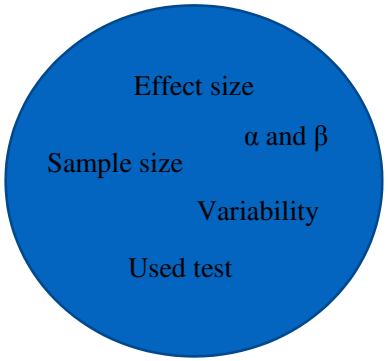
		In population (in reality) the null hypothesis is:	
		True	False
Decision on null hypothesis:	Accepting (Not rejecting)	Good decision	Error (**type II**) (β) (false negative result)
	Rejecting	Error (**type I**) (α) (false positive result)	Good decision **power(1-β)**

(NOTE: learn this strictly – we like to ask it in the exam!)

Power

Is there a difference can we recognize it?
- it can be recognized easier, if:
  - higher sample size
  - high effect size
  - (may be others: small SD…)
  - high power hypothesis test:
    - higher scale!!!
    - normal distribution
    - „effectively" paired

Power **(1-β)**



They depend on each other.

Relevant, but not significant…

Reasons:

small power:
- small sample size (limitation: money, ethical issues)*
- large variability
- less powerfull statistical test

we could not measure it accurately
violated assumptions for the test

Plan ahead!!

we were unlucky (sampling error)

other errors

-*Ask yor statisticians...

(☺ eg: https://www.youtube.com/watch?v=PbODigCZqL8)

Other errors

Effect size based on the sample (the estimate)

True effect size (the estimand)

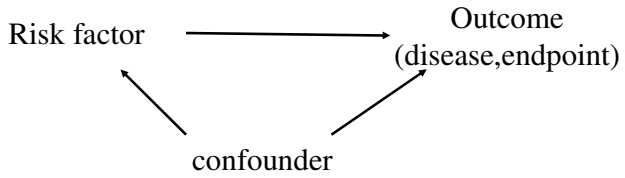
Errors

Bias:
Selection bias
Information bias
confounding bias

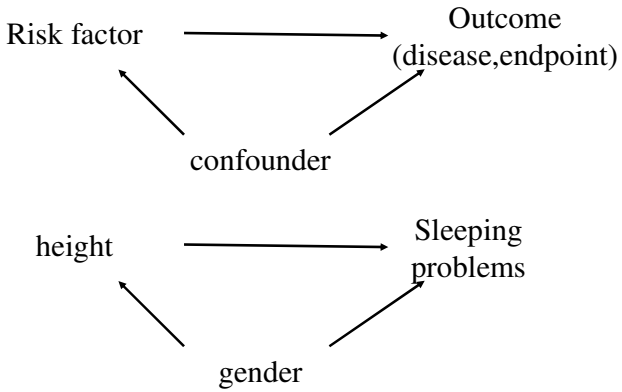
Sampling (random) error

(NOTE: learn this strictly – we like to ask it in the exam!)

Confounding bias



Confounding bias



Most common confounders: gender, age – always think about them!

(NOTE: learn this strictly – we like to ask it in the exam!)

Selection bias, Information bias

Selection bias:
There is a difference between the selected and not selected individuals, or difference between assignment to groups (erroneous selection with respect to an outcome influencing parameter)

tipical: age, gender different in the groups
different population
different follow-up time

Information bias:
erroneous data collection about or from subjects (which affects the outcome)

tipical: recall bias
more careful monitoring for diseased, young

(NOTE: learn this strictly – we like to ask it in the exam!)

Which methods?

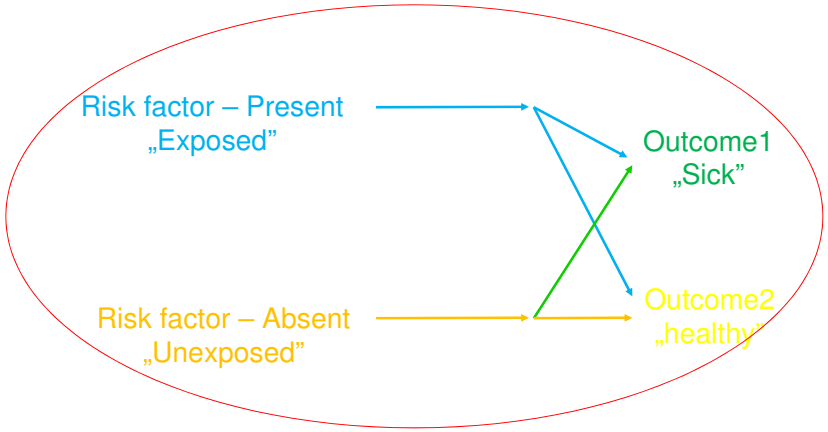
Main type of Clinical Studies (Study Designs):

Observation: no intervention, just observation
Cross-sectional studies – at a given time
Case-control studies – pro-/retrospective
Cohort – pro-/retrospective

Experimental: intervention („treating”)
main type: randomized controlled and clinical trials

(NOTE: learn this strictly – we like to ask it in the exam!)

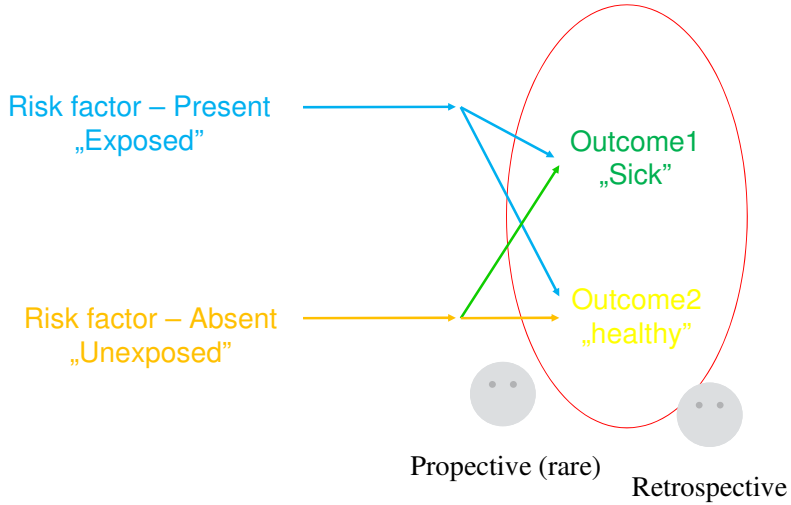
Cross-sectional



Risk factor and outcomes observed at the same time

Case-control

Selection based on the outcomes.

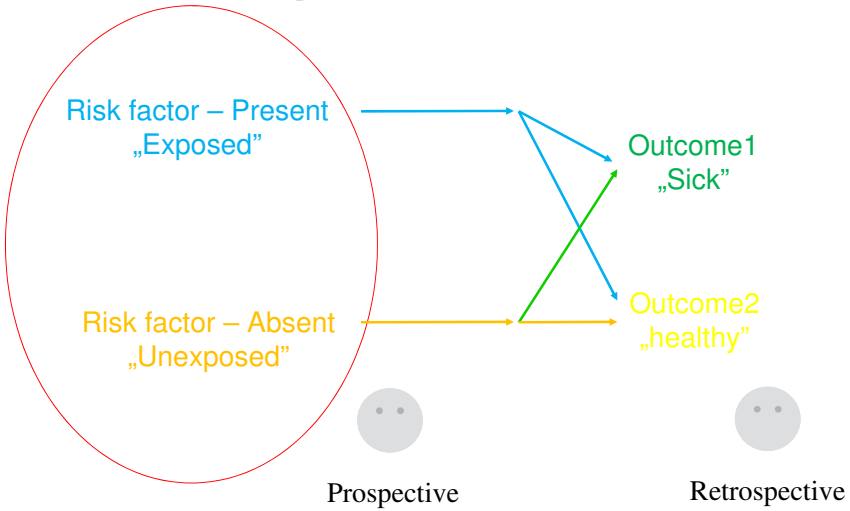


Propective (rare)

Retrospective

Cohort

Selection based on the exposure.



Prospective

Retrospective

Note

Prevalence - Measures the existence of a disease (or exposure, treatment) at a given point in time (point prevalence)

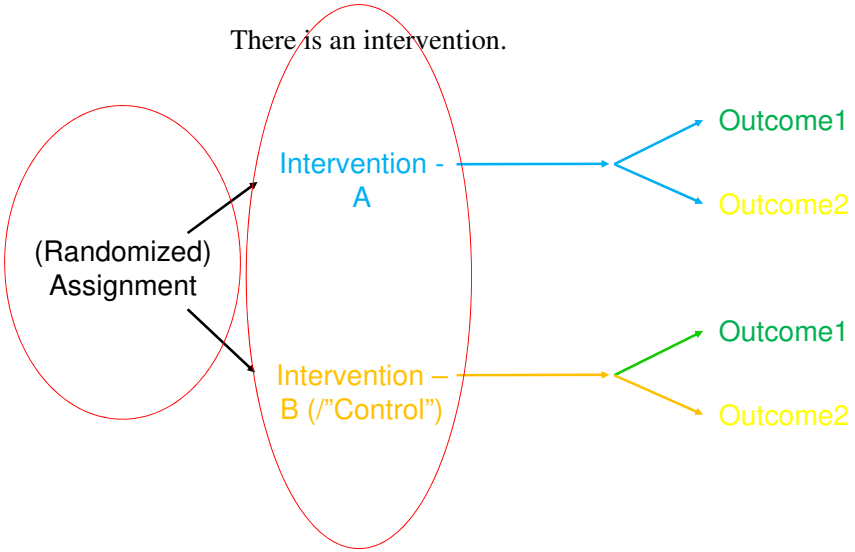
Incidence - Measures occurence of a disease in a population over a specified period in time (**new cases**!)

Acute disease: prevalence ~ incidence

chronic: prevalence ? incidence

(NOTE: learn this strictly – we like to ask it in the exam!)

Experimental (RCT)



Summary table of study design

	Cross-sedtional	Case-control	Cohort	RCT
Property	Selection at a given time point	Selection based on: outcome (case/control)	Selection based on: risk factor (exposure)	There is an intervention
Advantages	Logistically easier and faster Cheap	Good for rare disease, Logistically easier and faster Less expensive	Good for rare risk factor	Reduced bias
Dis-advantages	No causality	Hard to select controls – selection, information bias (eg. recall bias)	Long follow-up time Information bias (eg. recall bias)	Expensive, logistically hard and slow

(NOTE: learn this strictly – we like to ask it in the exam!)

▪▪▪

What's the difference between a physicist, a mathematician, and a statistician?

The physicist calculates until he gets a correct result and concludes that he has proven a fact.

The mathematician calculates until he gets a wrong result and concludes that he has proven the contrary of a fact.

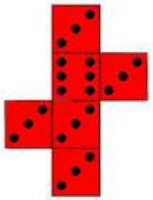
The statistician calculates until he gets a correct result about an obviously wrong proposition and concludes NOTHING, because the explanation is the task of the scientist who consulted the statistician.

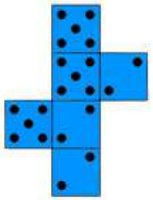
Source of stat jokes: http://www.ilstu.edu/~gcramsey/Gallery.html

+Notes

- Correlation:
  - *GRAPH!!!!;*
  - *Correlation NOT egual with causality*
    ☺eg: http://www.fastcodesign.com/3030529/infographic-of-the-day/hilarious-graphs-prove-that-correlation-isnt-causation
- Multiplicity
  - *☺eg: Chocolate Helps Weight Loss*
  - *https://io9.gizmodo.com/i-fooled-millions-into-thinking-chocolate-helps-weight-1707251800*

Non-transitivity





*see excel file
Links:
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