Logical Principles of Reserch in Medicine with Most Common Errors

From Idea to Publication

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1. Typing error

Logical Principles of Research in Medicine with Most Common Errors

a ☺

2. Logic, reasoning

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Logic of scientific work

1. rules of logic and logic itself as a way of valid thinking is more expressed in science and philosophy compared to other human activities…
2. science is recognized by utilizing empirical methods and therefore logic is prerequisite in scientific methodology...

Mirko Jakić. Logika. Školska knjiga, Zagreb 2003.

Logic of scientific work

3. use of is logic evident in using logical reasoning, by using terms such as rules, conclusions, definitions, distributions, proves, etc.
4. logic – how our thinking is valid in our mission to find the truth…

3. Nonscientific procedures

- diligence
  (habit, attitude, manner, believe, momentum)
- authority
- intuition

4. Argument, proof

5. Logic in science

- system
- models of the system
  - deterministic
  - probabilistic
- event probability → $P(E)$

$$0 \le P(E) \le 1$$

6. Probability

- mathematical calculation that something, event, will occur
- mathematic ⇨ probability theory
  - statistics
  - mathematics
  - scientific methodology
  - logic, philosophy
- reasoning about event feasibleness

Probability, calculation

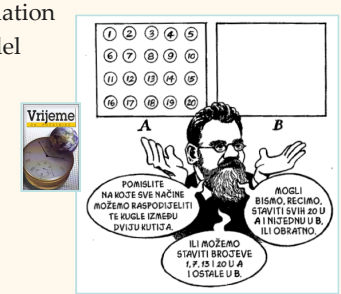
- symbol – P
- $$P = \frac{\text{No. of expected events}}{\text{No. of all events}}$$
- values range 0 – 1:
  - 0 – impossible event
  - 1 – certain event

Probability, the term

- probability
  - *vjerojatnost*, *mogućnost*
- possibility
  - *mogućnost*, *vjerojatnost*, *izvedivost*
- likelihood
  - vjerojatnost, mogućnost
- chance
  - *mogućnost, prigoda, slučaj, slučajnost, vjerojatnost, sreća, povoljna prilika*
- odds
  - *izgled, prednost, vjerojatnost, slučajnost*

7. Statistics

- probability calculation
- probabilistic model of the system

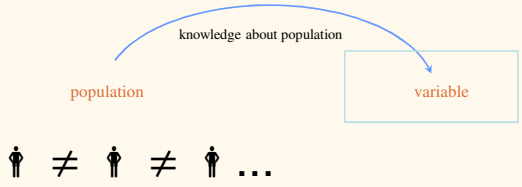


Statistical mechanics

- Lord Kelvin (1824.-1907.)
- James C. Maxwell (1831.-79.)
- Ludwig Boltzmann (1844.-1906.)
- Willard Gibbs (1839.-1903.)

p = ?

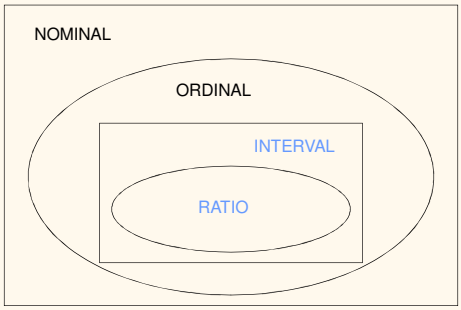
8. Measuring & 9. Research



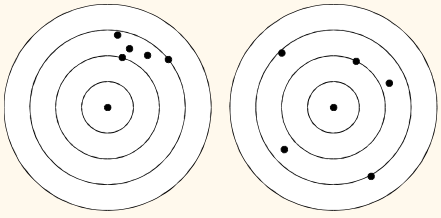
10. Variable

- all variables in research
- as many of them
- the end of research
- simple → complex (data)
- accuracy (numbers)
- measuring scales

11. Measuring scales

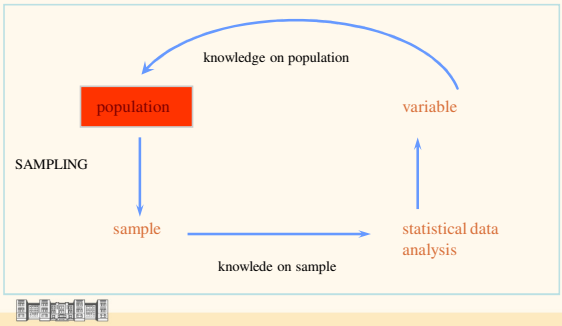


12. Error



systematic incidental

13. Population



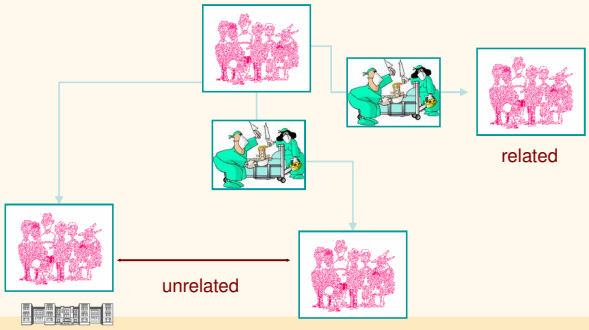
14. Sample

- part of population
  - what? who?
  - when?
  - where?
  - size

Sample

- representative
- measurable
- probabilistic
  - simple
  - system
  - stratified
  - cluster

Sample

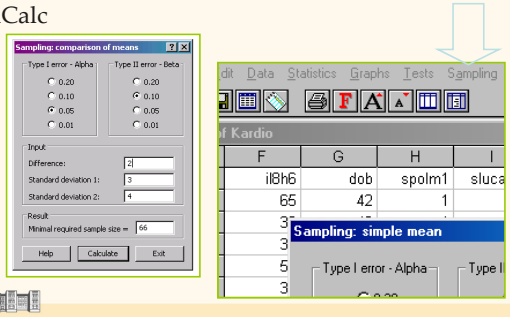


15. Sampling

www.statehousereport.com

Sampling

MedCalc

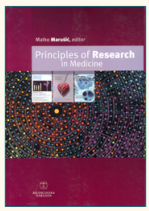


16. Bias (sampling)

Bias (sampling)

- Bias – systemic sampling error

- prevalence bias (Neyman)
- admittance rate bias (Berkson)
- answering rate bias
- etc.



17. Blinding

- single-blind
- double-blind
- triple-blind
- quadruple-blind

18. Control group

- must have
- to be compared with experimental group
- Hawthorn effect
  - research with no control group
  - subject changes behavior with a knowledge that is a part of experiment
  - subject feels better with knowledge to be a part of experiment

19. Hypothesis

http://biology.ucf.edu/~pascencio/images/Hypothesis.jpg

20. Statistical hypothesis

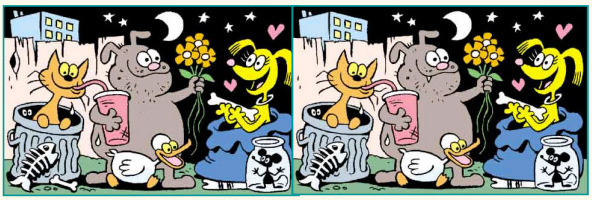
- elemental statement
- truth or not (false, lie)
- hypothesis testing → finding the truth

Statistical hypothesis

- truth ⇨ real object state
  probabilistic system:
  truth → probability

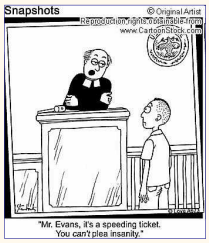
- significant ⇨ any occasion other that accidentally:
  probability → level of significance

21. Null-hypothesis



No difference

Null-hypothesis



No difference ≈ Not guilty

22. Testing the hypothesis

A. null-hypothesis
B. statistical test
C. level of significance
D. statistics calculation
E. conclusion

A. Hypothesis

- null – H_0 – no difference
- alternate – H_1 – difference exists
- only one can be truthful
- only one can be accepted, other will be rejected

B. Choosing the test

- measuring scales
- sample
  - size
  - related on unrelated samples
- data distribution
  - parametric
  - nonparametric
- no. of variables
- etc.

23. Statistical tests

Scale	One sample	Two		Three or more	
		related	unrelated	related	unrelated
Nominal	binomial chi-square	McNemar	Fisher chi-square/	Cohran	chi-sqr.
Ordinal	Kol.-Smirn.	Wilcoxon	MW Moses	Friedman	p/median KW
Interval	...				
Ratio	...				

C. Level of significance

- P
  - ➢ α if defined before statistics
  - ➢ α – probability of rejecting H_0 when H_0 = truth
- error α (type I error or false positive error)
- as less as possible
- default values, e.g. P<0,05

24. Statistical errors

Table 3-1. Making the conclusions – correct and incorrect concluding

	Conclusion from statistical hypothesis test	
True situation	No difference (accept H_0)	Difference exist (reject H_0)
No difference (H_0)	Correct conclusion (no error)	Incorrect conclusion (α error or type I error)
Difference exist (H_1)	Incorrect conclusion (β error or type II error)	Correct conclusion (no error)

Deducting presupposes the comparison of two systems. Systems may be, in theory, equal (the same) or they may differ in any aspect. We do not know the actual state and therefore we investigate. Assumption is presented in a statistical hypothesis, in two ways: null (H_0: no difference) and alternative (H_1: difference exists). From the testing we draw a conclusion with which we prove that the difference exists or that it does not exist. Correct conclusions are when there is no actual difference of systems and we do not find it, or when there is actual difference and we find it. Incorrect conclusions are when the difference actually does not exist but we find it, as well as when the difference actually does exist but we do not find it. Types of errors are indicated next to incorrect conclusions.

D. Statistics

- computation...
- P = exact value
- three decimals

P > 0,05

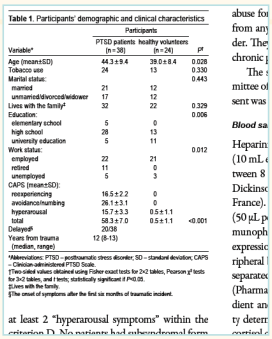
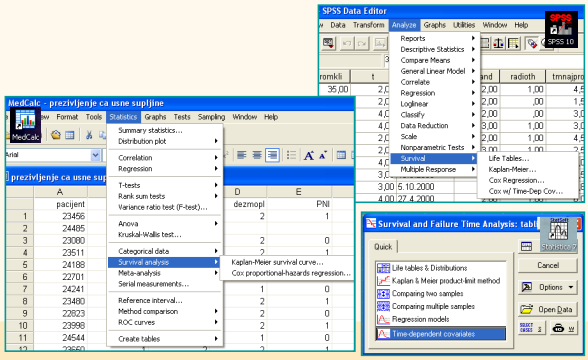


Table 1. Participants' demographic and clinical characteristics

at least 2 "hyperarousal symptoms" within the

25. Software



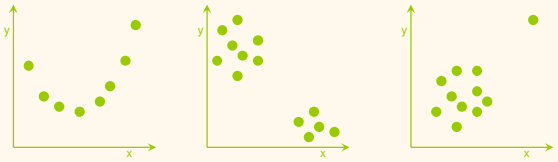
26. Conclusion (E)

- low P ⇨ low possibility to reject the truth
- conclusion:
  - P < α
  - low probability that H_0 is true
  - reject (not accept) null hypothesis
  - accept alternate hypothesis
  - statement "..." is truth with P = ...

27. Yes & No in statistics

- hypothesis = ?
- calculation = ?
- correct data = ?
- all conditions for statistic valid = ?
- no limitations = ?

Example 1: "Not" in correlation



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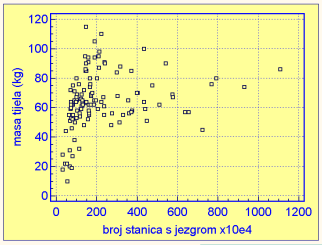


	N	r	p
linear	118	0,25	0,006
logarithm	118	0,43	<0,001

Example 2: "Not" with χ^2-test

lectures quality	students Zagreb	students other
well	10	31
bad	0	19
total	10	50

Example 3: Another "not"

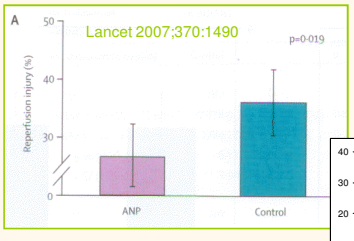
a predictor. All statistical tests were performed using the SAS software system and significance was determined when *P*-values were less than 0.05.

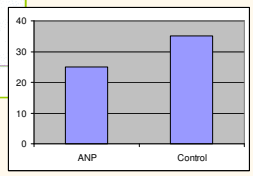
in Group I–II versus Group III was marginally significant ($P = 0.07$). However, when tests were

Lupus 2004;14:426

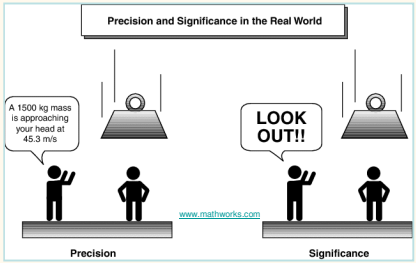
($P = 0.0007$) and a marginally significant increase in creatinine clearance ($P = 0.096$). There was no statistically significant longitudinal effect in serum creatinine levels.

Example 4: "Not" in graphs





28. Significance *vs.* 29. Accuracy



30. The truth

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