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

www.glasbergen.com/

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)

$$0 \leq p(E) \leq 1$$

6. Probability

Machiavelli za početnike. Jesenki & Turk, Zagreb

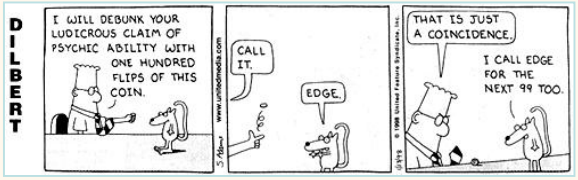
Probability, a term

- 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 vs. coincidence



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*

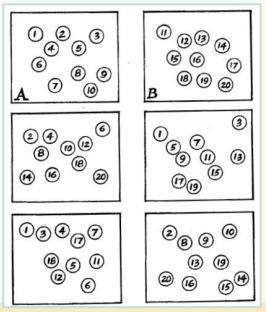
7. Statistical mechanics

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

p = ?

Statistical asimmetry

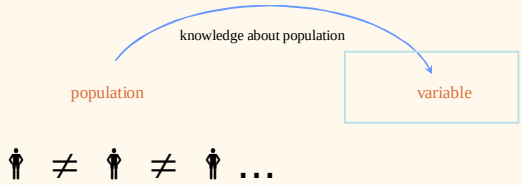
- 10A : 10B
  ⇨ 180.000 combinations
  $p = 5{,}56 \times 10^{-6}$



Statistical mechanics

- 1 : 180.000

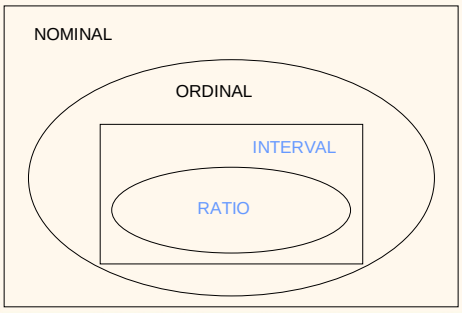
8. Measuring, 9. Research



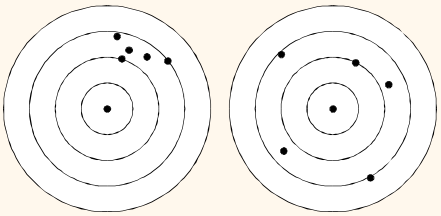
10. Variable

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

11. Measuring scales

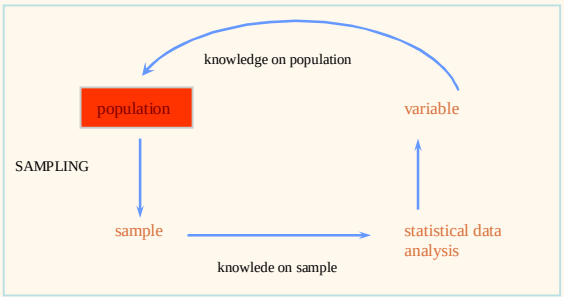


12. Error



systematic incidental

13. Population



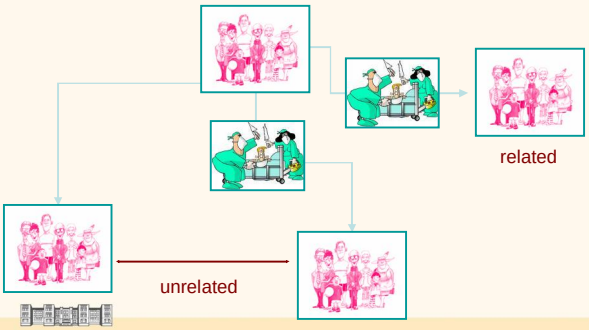
14. Sample

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

Sample

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

Sample

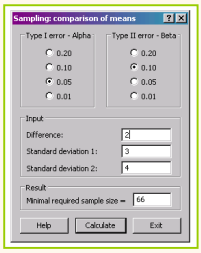


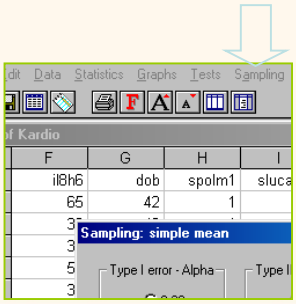
15. Sampling

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

Ivana Brlić Mažuranić
Kako je Potjeh tražio istinu
Mladost, Zagreb; Albert Kinert, 1967.

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	...				

Paired & unpaired tests

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

True situation	Conclusion from statistical hypothesis test	
	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~~

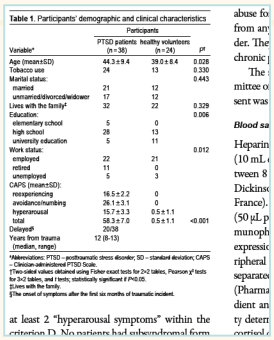


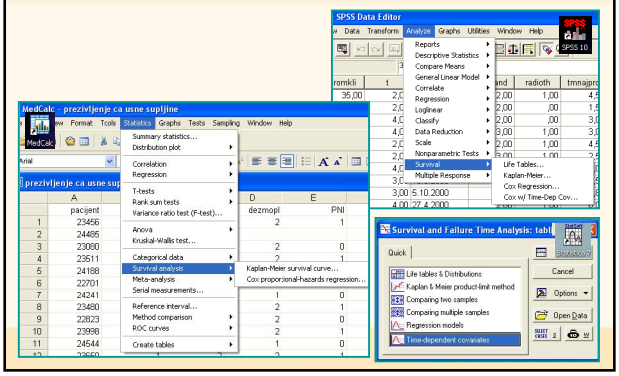
Table 1. Participants' demographic and clinical characteristics

Variable*	Participants: PTSD patients (n = 38)	Participants: healthy volunteers (n = 24)	p†
Age (mean±SD)	44.3 ± 9.4	39.0 ± 8.4	0.028
Tobacco use	24	13	0.330
Marital status:			0.443
married	21	12	
unmarried/divorced/widower	17	12	
Lives with the family‡	32	22	0.329
Education:			0.006
elementary school	5	0	
high school	28	13	
university education	5	11	
Work status:			0.012
employed	22	21	
retired	11	0	
unemployed	5	3	
CAPS (mean±SD):			
reexperiencing	16.5 ± 2.2	0	
avoidance/numbing	26.1 ± 3.1	0	
hyperarousal	15.7 ± 3.3	0.5 ± 1.1	
total	58.3 ± 7.0	0.5 ± 1.1	<0.001
Delayed§	20/38		
Years from trauma (median, range)	12 (6-13)		

*Abbreviations: PTSD – posttraumatic stress disorder; SD – standard deviation; CAPS – Clinician-administered PTSD Scale.
†Two-sided values obtained using Fisher exact tests for 2×2 tables, Pearson χ^2 tests for 3×2 tables, and *t* tests; statistically significant if P<0.05.
‡Lives with the family.
§The onset of symptoms after the first six months of traumatic incident.

at least 2 "hyperarousal symptoms" within the

25. Software



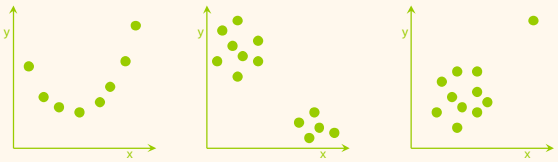
26. Concluding (E)

- 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 = ...

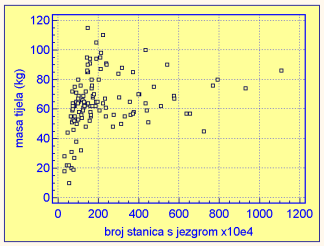
27. Yes & No in statistics

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

Example 1: "not" in correlation



Example 1, cont.



	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"

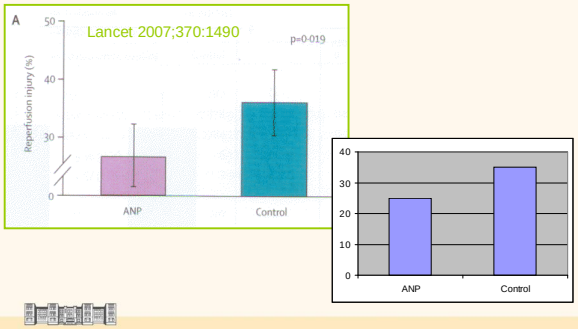
a predictor. All statistical tests were performed using the SAS software system and significance was determined when *P*-values were less than 0.05.

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

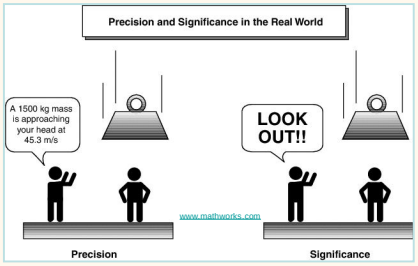
Lupus 2004;14:426

($P = 0.0007$) 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

Literature

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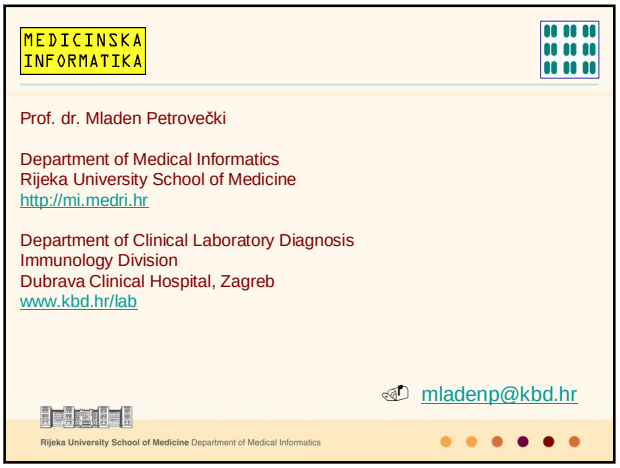
Medicinska naklada, 2008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