How to integrate biostatistics into the curriculum?

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Biostatistics courses held by the staff of the Department

- Biostatistics for pharmacy students, compulsory course, I. year, 1+1 hours/week lecture and practical, 1992-
- Biostatistics for medical students, elective course, IV-V. years, 2 hours/week 1994- (Hungarian) 1998- (English).
- Biostatistics for Ph.D. students, compulsory course, 2+1 hours/week, 1993-
- Biostatistics for applied mathematical students, compulsory course, 2+1 hours/week, 2005-
- Biomathematics and biostatistics for biology and ecology students, 2+2 hours/week, 2008-
- Medical Physics and Statistics. Compulsory course, for I. year medical students, biostatistics lecture 1 hour/week + elective practical 2 hours/week, 2010-
Former curriculum

- Earlier biostatistics was taught as a part of the subject „Biophysics”. That time, students studied biostatistics during two months, in 3+2 hours/week, and the biostatistical module finished by a written test.
- The result of this test was added to the exam of biophysics.
From the year 2010/2011 biostatistics is taught by the staff of our Department as a part of the subject „Medical Physics and Statistics”.
Main changes and challenges in the curriculum

• **Medical physics** and **Biostatistics** is taught *parallel* during the semester as a compulsory course.

• **Exam (common):** 2/3 physics, 1/3 statistics – both parts should be at least passed!!!

• **Lessons:**
  - **Medical physics**
    - Lecture: 2 hours/week
    - Practicals/seminars: 2 hours/week
  - **Biostatistics**
    - Lecture: 1 hour/week
    - Practical: -

• The total number of lessons per week did not change
  - Lecture: 3 hours/week
  - Practicals: 2 hours/week

• But how to practice biostatistics?? Solution: „Biostatistical calculations” compulsory elective course, 2 hours/week
Main changes and challenges (cont.)

- **Biostatistics**
  - Lecture: 1 hour/week
  - Practical:
    - A) nothing
    - B) Biostatistical calculations” compulsory elective course, 2 hours/week

- How to present lectures so that students not choosing practicals could take the exam?

- How to present practicals so that students choosing practicals could take the exam more easily and better?
Principles of teaching biostatistics

- Theoretical background possibly precise but not too detailed
- We assume elementary mathematical knowledge at secondary school level (calculus?)
- Many practical examples understandable for everybody but possibly related to medicine
- Using manual calculations for simple elementary formulas on small number of cases and using statistical software, to find the appropriate ratio
- Interpretation of results of calculations
- By the end of the semester students recognise the importance of biostatistical knowledge
Lecture, requirements

- Give an overview about the basic biostatistical methods
- Precise enough but understandable
- Practical examples from the usual life, medical literature
- Students not choosing any practical, be able to take the final exam
- But students choosing the practical „Biostatistical calculation”, let it be worth to listen the lecture, and let the exam more easy
- Give an outline to advanced biostatistical methods as well
Biostatistical calculations (elective practical), requirements

- The subject is designed to give basic biostatistical knowledge commonly employed in medical research and to learn modelling and interpreting results of computer programs (SPSS). The main purpose is to learn how to find the most appropriate method to describe and present their data and to find significant differences or associations in the data set.

- Attendance of the course facilitates the accomplishment of the obligatory course “Medical physics and statistics”.

- **Methods:**
  - Simple calculations manually and by computer
  - Advanced or complicated calculations performed by software
  - Interpretation of results
  - Application the appropriate test to a given experimental design
Former experiences in teaching biostatistics

• The staff of our department is experienced in teaching biostatistics based on more than 20 years activity.
Biostatistics lecture syllabus

1. Introduction. Course requirements, training objectives, subject, structure. Introductory examples. Types of data.


4. The basics of probability theory. Experiments, events, operations with events, the concept of probability, rules of probability calculus in special cases. Distribution of variables, some important distributions (uniform, binomial, normal).

5. Statistical estimation, confidence interval. The standard error of mean. The aim and steps of hypothesis testing, one-sample t-test.


7. Statistical errors, the increase of Type I error, ANOVA models

8. Models of linear and nonlinear regression. The significance of the correlation coefficient, hypothesis tests for the coefficients of regression line.


10. Contingency table, observed and expected frequencies, degrees of freedom, the chi-square test, assumptions. Special case: a 2x2 table. Odds ratio, relative risk.

11. Diagnostic tests.


13. Summary, case-studies.
Course material

- Rice Virtual Lab in Statistics http://onlinestatbook.com/rvls.html
- Lecture notes
Handouts

2010/2011 (1st semester)

Faculty of Medicine - Medical physics and statistics I.

Requirements:
Medical Physics curriculum

QUESTIONS TO PRACTICE (Prof. Ferenc Baró)

Lectures:
- Medical physics lecture 1 - Introduction (Prof. Ferenc Baró)
- Medical physics lecture 2 - Basic Mathematical Tools to describe Physiological Phenomena (Dr. James Kasten)
- Medical physics lecture 3 - Mechanics of the human body (Prof. Ferenc Baró)
- Medical physics lecture 4 - Mechanical oscillations, resonance (Prof. Péter Maróti)
- Medical physics lecture 4 (handout) - Mechanical oscillations, resonance (Prof. Péter Maróti)
- Medical physics lecture 5 - Mechanical waves (Prof. Péter Maróti)
- Medical physics lecture 5 (handout) - Mechanical waves (Prof. Péter Maróti)
- Medical physics lecture 6 - Optics (Dr. Katalin Varga)
- Medical physics lecture 6 - Optics (black and white) (Dr. Katalin Varga)
- Medical physics lecture 7 - Temperature, its measurement, heat, heat transport (Prof. Ferenc Baró)
- Medical physics lecture 8 - Principles of fluid mechanics (Prof. Zoltán Hambors)
- Medical physics lecture 9 - Physics of biophysical membranes diffusion, osmosis (Dr. László Nagy)
- Medical physics lecture 10 - Thermodynamics of transport processes (Dr. László Nagy)
- Medical physics lecture 11 - Biomedical phenomena (Prof. Ferenc Baró)
- Medical physics lecture 12 - Signals (Prof. Zoltán Hambors)

Practice:
- Laboratory practice 1 - Anthropometric measurements
- Laboratory practice 2 - Force, work and power
- Laboratory practice 3 - Electrocardiography
- Laboratory practice 4 - Acoustics
- Laboratory practice 5 - Noninvasive measurement of arterial pressure

Biostatistics:
- Biostatistics lecture 1, 2 - Basic statistical concepts (Dr. Kristina Gola)
- Biostatistics lecture 3 - Correlation, regression (Dr. Kristina Gola)
- Biostatistics lecture 4 - The basics of probability theory (Dr. Kristina Gola)
- Biostatistics lecture 5 - Confidence intervals (Dr. Kristina Gola)
- Biostatistics lecture 6 - Hypothesis tests, one sample test, paired test (Dr. Kristina Gola)
- Biostatistics lecture 7 - Hypothesis tests, two-sample test (Dr. Kristina Gola)
- Biostatistics lecture 8 - Hypothesis tests, analysis of variance (Dr. Kristina Gola)
Biostatistical calculations syllabus

1. Introduction. Data sets, types of data, distribution of data, graphical presentations (frequencies, percentages, bar chart, histogram)
2. Summary measures (mean, standard deviation, median, mode, range, quartiles). Figures based on summary measures.
4. Calculation of simple probabilities and distributions. The use of standard normal table. Sketch of the normal curve and finding some probabilities given the mean and standard deviation
5. Confidence intervals, interpretation.
6. Test 1: descriptive statistics, probability theory.
7. Paired t-test by calculator and by software.
9. One-way ANOVA.
10. Correlation and linear regression
11. Chi-square tests
12. Tests based on ranks. Summary
13. Test 2. T-tests, correlation-regression, -chi-square test
14. Summary, preparation to the exam
Biostatistical calculations
Compulsory elective practical course

- **Practice:** 2 lessons per week
  **Form of examination:** practical mark
  **Year/semester:** 1st year, 1. semester
  **Credits:** 2

- The subject is designed to give basic biostatistical knowledge commonly employed in medical research and to learn modelling and interpreting results of computer programs (SPSS). The main purpose is to learn how to find the most appropriate method to describe and present their data and to find significant differences or associations in the data set. Attendance of the course facilitates the accomplishment of the obligatory course “Medical physics and statistics”.

- **Data sets**
  - Data about yourself
  - Real data of medical experiments

- **Forms of testing:** The students have to perform two tests containing practical problems to be solved by hand calculations and by a computer program (EXCEL, Statistica or SPSS). During the tests, use of calculators, computers (without Internet) and lecture notes are permitted. Final practical mark is calculated from the results of the two tests.
Forms of testing

• The students have to perform two tests containing practical problems to be solved by hand calculations and by a computer program (EXCEL, Statistica or SPSS). During the tests, use of calculators, computers (without Internet) and lecture notes are permitted. Final practical mark is calculated from the results of the two tests.

• Test 1. (40 points)
  – Descriptive statistics, one problem to be solved manually and another to be solved by SPSS

• Test 2. (60 points)
  – 1 manual calculation (paired t-test, significance of correlation, evaluation of a 2x2 contingency table )
  – 1 test by SPSS given a data base (paired t-test, two-sample t-test, regression, chi-square test)
  – Interpretation of the result of a given test (software output)
Data base

• Data about the students themselves. On the first lecture they fill in a questionnaire. The resulting data file contain all important types of variables.
• Data measured on physics practicals (anthropometric data, blood pressure, pulse, etc…)
• Data of earlier medical research
• Data file of scientific papers (downloaded)
Data base about the students

This questionnaire is an experiment. The resulting data will be written in a data base and will be evaluated on the practical lessons. Please fill in the empty spaces with the appropriate numbers. Please find some "nickname" (not longer than 15 letters) if you would like to find your data in the data base.

Thank you for your contribution:

Krisztina Boda

Nickname: ________________________________

Sex (Male - 1 , Female - 2)________________________

Age in years: ________________________________

Body height in centimetres: ______________________

Body mass in kilograms: _________________________

Body mass in kilograms three years ago: ______________

Ideal body height in centimetres: ___________________

Ideal body mass in kilograms: _______________________

How do you like to eat? ____________________________

1: I dont like to eat at all
2: I dont like to eat
3: indifferent
4: I like to eat
5: I like to eat very much

Eye colour ________________________________

1: blue
2: green
3: grey
4: brown
5: black

What is your opinion about biostatistics ? ( 1 :yes, 2 : no )

difficult
necessary
interesting

Are you pleased with using a statistical software? ( 1 :yes, 2 : no) __________

Have you heard about any statistical sofware? ( 1 :yes, 2 : no) __________
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## Anthropometric data

| Massmean | MassSD | Mass1 | Mass2 | Mass3 | sex | Heightmean | HeightSD | Height1 | Height2 | Height3 | Height4 | Height5 | Height6 | Height7 | Height8 | Height9 | Height10 | Height11 | Height12 | Height13 | Height14 | Height15 | Height16 | Height17 | Height18 | Height19 | Height20 | Height21 | Height22 | Height23 | Height24 | Height25 | Height26 | Height27 | Height28 | Height29 | Height30 | Height31 | Height32 | Height33 | Height34 | Height35 |
|----------|--------|-------|-------|-------|-----|------------|----------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
Lecture-slides. Introduction

Why study statistics?

- Understand the statistical portions of most articles in medical journals
- Avoid being bamboozled by statistical nonsense.
- Do simple statistical calculations yourself, especially those that help you interpret published literature.
- Use a simple statistics computer program to analyze data.
- Be able to refer to a more advanced statistics text or communicate with a statistical consultant (without an interpreter).

Testing hypotheses, motivating example I.

This table is from a report on the relationship between aspirin use and heart attacks by the Physicians’ Health Study Research Group at Harvard Medical School.

The Physicians’ Health Study was a 5-year randomized study of whether regular aspirin intake reduces mortality from cardiovascular disease.

Every other day, physicians participating in the study took either one aspirin tablet or a placebo. The study was blind; those in the study did not know whether they were taking aspirin or a placebo.

Testing hypotheses, motivating example III.

Primary Outcome Measure

The primary outcome measure used was the Norwegian version of the RMDQ, which is a widely used, back-specific, self-administered measure of pain-related disability. Greater levels of disability give higher numbers on a 24-point scale.

Results

Table 2. Primary and Secondary Outcomes

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<th>Assessment (Range)</th>
<th>Glucosamine (n = 156)</th>
<th>Placebo (n = 155)</th>
<th>Treatment Effect</th>
<th>P Value</th>
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<td>9.7 (8.9 to 10.9)</td>
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<td>Na</td>
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<td>5.8 (5.0 to 6.8)</td>
<td>6.5 (5.7 to 7.3)</td>
<td>-0.7 (-1.8 to 0.5)</td>
<td>0.34</td>
</tr>
<tr>
<td>6 mo</td>
<td>5.0 (4.2 to 5.8)</td>
<td>5.8 (4.8 to 5.8)</td>
<td>-0.8 (-1.7 to 0.2)</td>
<td>0.22</td>
</tr>
<tr>
<td>1 y</td>
<td>4.8 (3.9 to 5.6)</td>
<td>5.5 (4.7 to 6.4)</td>
<td>-0.7 (-2.0 to 0.4)</td>
<td>0.50</td>
</tr>
</tbody>
</table>

CONCLUSION

No significant differences were found between glucosamine and placebo during the intervention period or at 1-year follow-up. Both interventions improved functional status by the end of treatment by a similar amount. No serious adverse events were associated with either of the study agents. Based on our results, it seems unsafe to recommend glucosamine to all patients with chronic LBP and degenerative lumbar OA. Further research is needed to clarify whether glucosamine is advantageous in an alternative LBP population.
### Measures of the center

- **Mean:**
  \[ \bar{x} = \frac{x_1 + x_2 + \ldots + x_n}{n} \]
- **Mode:** is the most frequent number.
- **Median:** is the value that half the members of the sample fall below and half above.
  - In other words, it is the middle number when the sample elements are written in numerical order.
  - **Example:** Data: 1 2 4 1, in ascending order: 1 1 2 4
    - Range: max-min=4-1=3
    - Quartiles:
    - The variance:
    - Standard deviation:

### Measures of variability (dispersion)

- **The range** is the difference between the largest and smallest number.
- **Percentiles** (5%-95%): 5% percentile is the value below which 5% of the cases fall.
- **Quartiles:** 25%, 50%, 75% percentiles.

#### Example

<table>
<thead>
<tr>
<th>Data</th>
<th>Percentiles</th>
<th>25</th>
<th>50</th>
<th>75</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weighted Average (Definition 1)</td>
<td>1.0000</td>
<td>1.5000</td>
<td>3.5000</td>
<td></td>
</tr>
<tr>
<td>Tukey's Hinges</td>
<td>1.0000</td>
<td>1.5000</td>
<td>3.0000</td>
<td></td>
</tr>
</tbody>
</table>

### Table

<table>
<thead>
<tr>
<th>(x_i)</th>
<th>(x_i - \bar{x})</th>
<th>((x_i - \bar{x})^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1-2=-1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>1-2=-1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2-2=0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>4-2=2</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>0</td>
<td>6</td>
</tr>
</tbody>
</table>

\[ SD = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n-1}} = \sqrt{\frac{6}{3}} = \sqrt{2} = 1.414 \]
Example from the medical literature

Differential Effect of Use Normal Subjects and Patie
Mehdi Linn, Rittman, Sven Johannes, Priy Ramnath
Andrew Laing, BSc, PhD

Lion et al U-II in Heart Failure 1213

Demographic Indexes

How to

- If H0 is true, the computed statistic has a t-distribution
- Then with 95% probability the t-value lies in the “acceptance region”
- Check it: now t=-1.059
- The p-value is the shaded area, p=0.28. The probability of the observed test statistic is or more extreme in either direction when the null hypothesis is true.

How to get the t-value using statistical software – given sample size, sample mean and sample SD?

- Using SPSS, t-test is performed on sample data. Given only sample characteristics, it is difficult to get t-value.
- Excel:

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>SE</th>
<th>DF</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>14</td>
<td>50</td>
<td>4</td>
<td>4</td>
<td>25</td>
<td>-3.89444</td>
<td>0.000649</td>
</tr>
<tr>
<td>II</td>
<td>13</td>
<td>56</td>
<td>4</td>
<td>4</td>
<td>25</td>
<td>1.05915</td>
<td>0.299659</td>
</tr>
</tbody>
</table>

Using SPSS, t-test is performed on sample data.
Lecture slides. Use of the data of the students in the lecture

Answer to the motivated example (mean age of boys and girls)

<table>
<thead>
<tr>
<th>Sex</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>84</td>
<td>21.18</td>
<td>3.025</td>
<td>.330</td>
</tr>
<tr>
<td>Female</td>
<td>53</td>
<td>20.38</td>
<td>3.108</td>
<td>.427</td>
</tr>
</tbody>
</table>

- The mean age of boys is a little bit higher than the mean age of girls. The standard deviations are similar.

Comparison of variances (F test for the equality of variances):
p=0.741>0.05, not significant, we accept the equality of variances.

Comparison of means: according to the formula for equal variances, t=1.505, df=135, p=0.135. So p>0.05, the difference is not significant. Although the experienced difference between the mean age of boys and girls is 0.816 years, this is statistically not significant at 5% level. We show that the mean age of boys and girls is different.

Significance of the correlation

Other examples

- Biostat 9.

r=0.018, p=0.833

r=0.873, p<0.0001
### A questionnaire

1. Identification number.
2. Gender
   - 1: male
   - 2: female
3. Age (year)
4. Education
   - 1: No
   - 2: elementary
   - 3: secondary
   - 4: university
5. Body mass (kg)
6. Height (cm)
7. Eye colour
   - 1: blue
   - 2: green
   - 3: grey
   - 4: brown
   - 5: black
8. Hobby
   - sport
   - music listening
   - collecting stamps
   - dancing
   - fine arts
   - other

Create variables using the questionnaire! Let’s define the following variables (no more than 8 characters are valid for name of a variable):

- **ID**
- **GENDER** (Nominal)
- **AGE** (Quantitative)
- **EDUCATION** (Ordinal)
- **WEIGHT** (Quantitative)
- **HEIGHT** (Quantitative)
- **E_COLOUR** (Nominal)
- **SPORT** (Binary)
- **MUSIC** (Binary)
- **STAMP** (Binary)
- **DANCE** (Binary)
- **FINEART** (Binary)
- **OTHER** (Binary)

Create this dataset using **EXCEL**.

<table>
<thead>
<tr>
<th>ID</th>
<th>GENDER</th>
<th>AGE</th>
<th>EDUCATION</th>
<th>WEIGHT</th>
<th>HEIGHT</th>
<th>E_COLOUR</th>
<th>SPORT</th>
<th>MUSIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>1.00</td>
<td>2.00</td>
<td>3.00</td>
<td>4.00</td>
<td>5.00</td>
<td>6.00</td>
<td>7.00</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>7</td>
<td>2</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
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<td>2</td>
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<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>10</td>
<td>2</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>11</td>
<td>2</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>12</td>
<td>2</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>13</td>
<td>2</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>14</td>
<td>2</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>15</td>
<td>2</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>16</td>
<td>2</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>17</td>
<td>2</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

### Practice

**Discrete variables: Distributions, Absolute and relative frequencies, column charts**

1.1. Characterize the **GENDER** variable: **GENDER** (1=boy, 2=girl).

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Relative frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boy</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Girl</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Total</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Create a barchart! Make scale on y-axis!

<table>
<thead>
<tr>
<th>Gender</th>
<th>Frequency</th>
<th>Relative frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boy</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Girl</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

1.2. Characterize the **EDUCATION** variable!

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Relative frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Primary</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Secondary</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>University</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Total</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Create a barchart! Make scale on y-axis!

<table>
<thead>
<tr>
<th>Gender</th>
<th>Frequency</th>
<th>Relative frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Primary</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Secondary</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>University</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

1.3. Create an piechart using **EDUCATION** variable!

**SPSS:**

1.4. Open the SMALLQUEST.SAV data file! Repeat the characterization of both **GENDER** and **EDUCATION** variables using SPSS commands!

1.5. Open the **Breast cancer survival.sav** data file! Characterize the discrete variables!
Exam

- **Physics**: test-exam, multiple choice
- **Biostatistics**: manual evaluation of an exam-sheet with the following parts:
  - 5 theoretical questions
  - 1 descriptive statistics problem
  - 1 hypothesis test
- **ONLY a given formula-sheet and calculator can be used**
Biostatistics exam sample sheet

Give short answer to the following questions! 40 p.

1. The two main types of variables

2. What is the relationship between the standard deviation (SD) and the variance?

3. The meaning and properties of the coefficient of correlation (r)

4. The meaning of a confidence interval

5. The principle of finding the equation of the regression line

Solve the following problems! Total: 60 p.

1. 2.17. Given the following of the following small sample: X: 4; 1; 5; 5; 0, calculate mean and standard deviation, and sketch a mean-SD chart:

   Mean (5 p) ……………
   Standard deviation (10 p) ……………

   Chart (5 p) ……………

2. The following table shows the results of placebo and aspirin in an experiment, with the number of people in each treatment group who did and did not develop thromboses. Decide whether the aspirin had or had not effect on thrombus formation.

<table>
<thead>
<tr>
<th></th>
<th>Developed thrombi</th>
<th>Free of thrombi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Placebo</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Aspirin</td>
<td>10</td>
<td>20</td>
</tr>
</tbody>
</table>

   Find the value of the test statistic, and give your conclusion. (alfa=0.05, *2table=3.84)
   Name of the test (2 p) ……………
   Null hypothesis (3 p) ……………
   Assumption (5 p) ……………
   Test statistic: (10 p) ……………

   Degrees of freedom: (5 p) ……………
   Decision about the significance: (10 p) ……………
   Interpretation: (5 p) ……………
1. When is a distribution skewed to the right?

2. Calculation of the sample median

3. Properties of the normal distribution

4. Decision rules of the one-sample t-test

5. When to use nonparametric tests?

Solve the following problems!  
Total: 60 p.

1. In a study, systolic blood pressure of 10 healthy women was measured. The mean was 119, the standard error 0.664. Calculate the 95% confidence interval for the population mean! (α=0.05, $t_{\text{table}}=2.26$).

Data (5 p):
Mean………….
SE…………….
$t_{\text{table}}=…………….$
Lower limit (5 p) …………..
Upper limit (5 p) …………..
Meaning of this interval (5 p) …………..

2. On the physics practicals the waist circumference was measured. The measurement was repeated three times. The relationship of the first two measurements was examined by linear regression. Interpret the results below (coefficient of correlation, the significance of correlation, null hypothesis, t-value, p-value, the equation of the regression line).

Coefficient of correlation (5 p).………………… Meaning:……………………..
Null hypothesis for the significance of correlation: (5 p) …………..
Test statistic ( 5 p)…………………
p-value (5 p)…………………
Significance: (10 p)…………………
Equation of the regression line: (5 p) …………..
Interpretation (5 p): …………..
<table>
<thead>
<tr>
<th>Pácienst neme:</th>
<th>TESTTÖMEG</th>
<th>TESTMAGA</th>
<th>CSÍPŐ</th>
<th>DERÉK</th>
<th>Csípőkörfogat /derékkörfogat</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Átlag 181</td>
<td>Átlag 181</td>
<td>Átlag 181</td>
<td>Átlag 181</td>
<td>Átlag 181</td>
</tr>
<tr>
<td>fiú N Mean</td>
<td>75.6972</td>
<td>178.8398</td>
<td>91.4751</td>
<td>86.0000</td>
<td>1.0717</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>13.81377</td>
<td>7.26879</td>
<td>10.6862</td>
<td>10.50926</td>
<td>.12710</td>
</tr>
<tr>
<td>Minimum</td>
<td>50.00</td>
<td>158.00</td>
<td>61.00</td>
<td>65.00</td>
<td>.74</td>
</tr>
<tr>
<td>Maximum</td>
<td>129.00</td>
<td>201.00</td>
<td>126.00</td>
<td>121.00</td>
<td>1.42</td>
</tr>
<tr>
<td>lány N Mean</td>
<td>59.7845</td>
<td>167.6133</td>
<td>88.6519</td>
<td>74.0000</td>
<td>1.2152</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>8.09204</td>
<td>5.58914</td>
<td>9.75109</td>
<td>8.74960</td>
<td>.18609</td>
</tr>
<tr>
<td>Minimum</td>
<td>46.00</td>
<td>152.00</td>
<td>62.00</td>
<td>60.00</td>
<td>.68</td>
</tr>
<tr>
<td>Maximum</td>
<td>92.00</td>
<td>181.00</td>
<td>119.00</td>
<td>105.00</td>
<td>1.51</td>
</tr>
<tr>
<td>Total N Mean</td>
<td>67.7409</td>
<td>173.2265</td>
<td>90.0635</td>
<td>80.0000</td>
<td>1.1434</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>13.83021</td>
<td>8.57417</td>
<td>10.31250</td>
<td>11.37281</td>
<td>.17460</td>
</tr>
<tr>
<td>Minimum</td>
<td>46.00</td>
<td>152.00</td>
<td>61.00</td>
<td>60.00</td>
<td>.68</td>
</tr>
<tr>
<td>Maximum</td>
<td>129.00</td>
<td>201.00</td>
<td>126.00</td>
<td>121.00</td>
<td>1.51</td>
</tr>
</tbody>
</table>
Exam results

• The experiences of the first year are positive: the knowledge of the students was found to be satisfactory, and students had a favourable opinion about biostatistics.

• The exam mark from biostatistics was higher for those students who attended “biostatistical calculations” (3.25±1.41) related to those who did not attend it (2.66±1.44).

• We hope that using this method of teaching, biostatistical knowledge of the students will be deeper and they will use it successfully during their study or later in their usual life.
### Exam results

#### Biostatistics exam mark, 1st trial * Attended biostatistical calculations?

<table>
<thead>
<tr>
<th>Biostatistics exam mark, 1st trial</th>
<th>Attended biostatistical calculations?</th>
<th>NO</th>
<th>Yes</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>111</td>
<td>100.0%</td>
<td></td>
</tr>
<tr>
<td>Count 1</td>
<td>% within Biostatistics exam mark, 1st trial</td>
<td>43.2%</td>
<td>56.8%</td>
<td>100.0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>48</td>
<td>63</td>
<td>111</td>
</tr>
<tr>
<td>Count 2</td>
<td>% within Biostatistics exam mark, 1st trial</td>
<td>36.0%</td>
<td>64.0%</td>
<td>100.0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>32</td>
<td>57</td>
<td>89</td>
</tr>
<tr>
<td>Count 3</td>
<td>% within Biostatistics exam mark, 1st trial</td>
<td>19.2%</td>
<td>80.8%</td>
<td>100.0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>19</td>
<td>80</td>
<td>99</td>
</tr>
<tr>
<td>Count 4</td>
<td>% within Biostatistics exam mark, 1st trial</td>
<td>28.5%</td>
<td>71.5%</td>
<td>100.0%</td>
</tr>
<tr>
<td></td>
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<tr>
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<tr>
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<td>% within Biostatistics exam mark, 1st trial</td>
<td>28.6%</td>
<td>71.4%</td>
<td>100.0%</td>
</tr>
<tr>
<td></td>
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<td>154</td>
<td>384</td>
<td>538</td>
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#### Chi-Square Tests

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<thead>
<tr>
<th></th>
<th>Value</th>
<th>df</th>
<th>Asymp. Sig. (2-sided)</th>
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a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 25.48.
## Exam results

### Group Statistics

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<tr>
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<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
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<td>Biostatistics exam mark, 1st trial</td>
<td></td>
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<tr>
<td>NO</td>
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<td>.072</td>
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p<0.001, the difference is significant
Exam results

Descriptive Statistics

Dependent Variable: Biostatistics exam mark, 1st trial

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<th>Attended biostatistical</th>
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<th>Std. Deviation</th>
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<td>Yes</td>
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p<0.001, the difference is significant
Exam results

Descriptive Statistics

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<th>Std. Deviation</th>
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</thead>
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p<0.001, the difference is significant
### Exam results

**Exam trial how many times?** * Attended biostatistical calculations?**

**Crosstabulation**

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<tbody>
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<td>100.0%</td>
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<tr>
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<td>100.0%</td>
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<td>72.0%</td>
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Our plans

- Topics remain almost the same
- The exam will be also a test-exam from biostatistics
- Drawback
  - impersonal
  - Students must see erroneous statements
  - Simple mistake in calculation causes fail of the question
  - More difficult to check relationships
- Advantage
  - objective
  - Equal measure for everybody
  - Allows big group of students
  - Relatively small time
  - Less examiner
Is biostatistics difficult?

<table>
<thead>
<tr>
<th>év</th>
<th>Count</th>
<th>% within év</th>
<th>A biostatisztika nehéz-e</th>
<th>% within év</th>
<th>Total</th>
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<tbody>
<tr>
<td>2000</td>
<td>13</td>
<td>6</td>
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<td>19</td>
</tr>
<tr>
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<td>2001</td>
<td>13</td>
<td>6</td>
<td>nem</td>
<td>31.6%</td>
</tr>
<tr>
<td></td>
<td>2002</td>
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<td>43</td>
<td>igen</td>
<td>68.4%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>nem</td>
<td>31.6%</td>
<td>100.0%</td>
</tr>
<tr>
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<td></td>
<td></td>
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<td>nem</td>
<td>50.0%</td>
<td>100.0%</td>
</tr>
<tr>
<td></td>
<td>2004</td>
<td>40</td>
<td>42</td>
<td>igen</td>
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</tr>
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<td></td>
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<td>nem</td>
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<td>100.0%</td>
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<td>nem</td>
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<td>100.0%</td>
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<tr>
<td></td>
<td>2009</td>
<td>18</td>
<td>44</td>
<td>igen</td>
<td>29.0%</td>
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<td>nem</td>
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<tr>
<td></td>
<td>2010</td>
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<td>43</td>
<td>igen</td>
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<tr>
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<td></td>
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<td>nem</td>
<td>70.5%</td>
<td>100.0%</td>
</tr>
<tr>
<td></td>
<td>2011</td>
<td>28</td>
<td>37</td>
<td>igen</td>
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<td></td>
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Chi-Square Tests

<table>
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<tr>
<th>Test</th>
<th>Value</th>
<th>df</th>
<th>Asymp. Sig. (2-sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Chi-Square</td>
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<td>11</td>
<td>.000</td>
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<td>11</td>
<td>.000</td>
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<td>Linear-by-Linear Association</td>
<td>23.207</td>
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</table>

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 7.32.

Bar Chart

A biostatisztika nehéz-e
gén
nem
Is biostatistics necessary?

<table>
<thead>
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<th>Count</th>
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<th>Total</th>
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</thead>
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<td></td>
</tr>
<tr>
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<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>2001</td>
<td>46</td>
<td>100.0%</td>
<td></td>
</tr>
<tr>
<td>% within év</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>2002</td>
<td>83</td>
<td>100.0%</td>
<td></td>
</tr>
<tr>
<td>% within év</td>
<td>2</td>
<td>4</td>
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<tr>
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<td>84</td>
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<tr>
<td>% within év</td>
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<td>4</td>
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<tr>
<td>2004</td>
<td>84</td>
<td>100.0%</td>
<td></td>
</tr>
<tr>
<td>% within év</td>
<td>2</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td>82</td>
<td>100.0%</td>
<td></td>
</tr>
<tr>
<td>% within év</td>
<td>2</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>72</td>
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<td></td>
</tr>
<tr>
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<td>4</td>
<td></td>
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<td>2007</td>
<td>77</td>
<td>100.0%</td>
<td></td>
</tr>
<tr>
<td>% within év</td>
<td>2</td>
<td>4</td>
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<tr>
<td>2008</td>
<td>100</td>
<td>100.0%</td>
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<tr>
<td>% within év</td>
<td>2</td>
<td>4</td>
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<td>2</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>61</td>
<td>100.0%</td>
<td></td>
</tr>
<tr>
<td>% within év</td>
<td>2</td>
<td>4</td>
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<td></td>
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Chi-Square Tests

<table>
<thead>
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<th>df</th>
<th>Asymp. Sig. (2-sided)</th>
</tr>
</thead>
<tbody>
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<td>.000</td>
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<td>.000</td>
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<td>.014</td>
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N of Valid Cases = 867

* 0 cells (.0%) have expected count less than 5. The minimum expected count is 7.37.

Bar Chart

A biostatisztika szükséges-e

Count

év

Is biostatistics interesting?

<table>
<thead>
<tr>
<th>év</th>
<th>Count</th>
<th>% within év</th>
<th>A biostatistika érdekes-e</th>
<th>Total</th>
</tr>
</thead>
<tbody>
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<td>62.2%</td>
<td>igen</td>
<td>37</td>
</tr>
<tr>
<td>2001</td>
<td>23</td>
<td>62.2%</td>
<td>nem</td>
<td>37</td>
</tr>
<tr>
<td>2002</td>
<td>42</td>
<td>52.5%</td>
<td>igen</td>
<td>80</td>
</tr>
<tr>
<td>2003</td>
<td>60</td>
<td>75.0%</td>
<td>nem</td>
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<td>2004</td>
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<td>igen</td>
<td>830</td>
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</table>

**Chi-Square Tests**

<table>
<thead>
<tr>
<th>Test</th>
<th>Value</th>
<th>df</th>
<th>Asymp. Sig. (2-sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Chi-Square</td>
<td>46.555^a</td>
<td>11</td>
<td>.000</td>
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<tr>
<td>Likelihood Ratio</td>
<td>45.678</td>
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<td>Linear-by-Linear Association</td>
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N of Valid Cases: 830

---

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 11.06.

**Bar Chart**

- **A biostatistika érdekes-e**
  - **igen**
  - **nem**
Are you pleased to use SPSS on the practicals?

év * Örül-e a szoftver megismerésének Crosstabulation

<table>
<thead>
<tr>
<th>év</th>
<th>Count</th>
<th>% within év</th>
<th>Total</th>
</tr>
</thead>
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<td>26</td>
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<td>65.8%</td>
<td>34.2%</td>
<td>100.0%</td>
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<tr>
<td>Count</td>
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<td>76</td>
</tr>
<tr>
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<td>65.8%</td>
<td>34.2%</td>
<td>100.0%</td>
</tr>
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<td></td>
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<tr>
<td>Count</td>
<td>55</td>
<td>33</td>
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<tr>
<td></td>
<td>62.5%</td>
<td>37.5%</td>
<td>100.0%</td>
</tr>
<tr>
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<td></td>
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<td></td>
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<tr>
<td>Count</td>
<td>61</td>
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<td>72.6%</td>
<td>27.4%</td>
<td>100.0%</td>
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<td>31.1%</td>
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<tr>
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<tr>
<td></td>
<td>70.8%</td>
<td>29.2%</td>
<td>100.0%</td>
</tr>
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<td>Total</td>
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<td>294</td>
<td>947</td>
</tr>
<tr>
<td>% within év</td>
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<td>31.0%</td>
<td>100.0%</td>
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</table>

Chi-Square Tests

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<th>Asymp. Sig. (2-sided)</th>
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<tr>
<td>N of Valid Cases</td>
<td>947</td>
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</table>

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 18.94.

Bar Chart

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<tr>
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<td>2010</td>
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<tr>
<td>2011</td>
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</table>

Summer School - 2011  July 19
What statistical software do you know?

<table>
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<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
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</tr>
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<td>DOS, Norton</td>
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</table>
Summary

• Teaching biostatistics during 4 months (instead two months) made possible to slightly expand the topics.
• On the practicals besides of some manual calculations, mainly the use and interpretation of a software was studied.
• The data files were highly related to the physics practicals: measurements made on physics practicals were used on biostatistics lessons.
• The exam consists also from two parts: failing biostatistics means failing the whole subject as well -> biostatistics has a greater respect.
„If had only one day left to live, I would live it in my statistics class: it would seem so much longer.”

(http://davidmlane.com/hyperstat/humor.html)