# Simple Statistics with Excel

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**Made possible by the**

**Clinical and Translational Science Institute (CTSI),
and the**

**Division of Biostatistics**

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# CME Evaluations!

Please help us by filling out an evaluation even if you are not eligible for CME credit.

# Outline

- Data entry
- Descriptive statistics
  - means
  - cross-tabulation
- Statistical inference
  - t-test
  - regression

Note: all specifics are for Excel 2007

# Data Analysis Tools

- Many statistical analyses are available through the Data Analysis Add-in
- To install:
  - Office Button
  - Excel Options (button at bottom right)
  -  Add-Ins tab
  - at bottom: Manage Add-Ins > Go…
- Will appear on the Data tab

# Getting data into Excel

- Data can be
  - entered directly into Excel
  - imported from an existing file (text, Access)
  - imported from a Web-page
  - copy-pasted from Word, Acrobat, etc
    - if Excel puts it into one column, use the Text-to-Columns Wizard

- Many of these features are accessed through the Data tab

# Data structure

- All data should be structured as a **list**:
  - each cell contains one value
  - each column contains one variable
  - the physical arrangement, spacing, color, etc should not carry additional information
  - each row contains information on one subject
  - each row is self-contained
- Do not mix data with analyses
- Missing values should be empty cells

# Not a list

| | Group 1 | Group 2 | Group 3 | Group 4 | Group 1 | Group 2 | Group 3 | Group 4 |
|---|---|---|---|---|---|---|---|---|
| | Cholesterol (mg/dL) | Cholesterol (mg/dL) | Cholesterol (mg/dL) | Cholesterol (mg/dL) | HDL (mg/dL) | HDL (mg/dL) | HDL (mg/dL) | HDL (mg/dL) |
| | 291 | 386 | 311 | 249 | 30 | 19 | 22 | 21 |
| | 209 | 208 | 248 | 252 | 27 | 24 | 37 | 26 |
| | 272 | 250 | 279 | 237 | 27 | 21 | n/a | 27 |
| | 293 | 246 | 256 | 231 | 27 | 24 | 22 | 23 |
| | 302 | 214 | 215 | 311 | 24 | 29 | 26 | 24 |
| | 304 | 292 | 334 | 197 | 23 | 20 | 26 | unk |
| | | 326 | 240 | 269 | | 9 | 30 | 33 |
| | | 399 | | 252 | | 18 | | 33 |
| | | | | 294 | | | | 33 |
| | | | | | | | | |
| | | | | | | | | |
| AVG | 278.50 | 290.13 | 269.00 | 254.67 | 26.33 | 20.50 | 27.17 | 27.50 |
| SD(n-1) | 35.9 | 74.1 | 41.7 | 33.9 | 2.5 | 5.8 | 5.7 | 4.9 |
| SEM | 14.7 | 26.2 | 15.8 | 11.3 | 1.0 | 2.1 | 2.3 | 1.7 |
| N | 6 | 8 | 7 | 9 | 6 | 8 | 7 | 9 |

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# Converted to a list

- Each row is one experimental unit
- Group is repeated for every subject
- Variable names have no special characters
- Averages/standard deviations are not part of the data
- Missing values coded consistently
- Extra notations removed

| Group | Cholesterol | HDL |
|---|---|---|
| 1 | 291 | 30 |
| 1 | 209 | 27 |
| 1 | 272 | 27 |
| 1 | 293 | 27 |
| 1 | 302 | 24 |
| 1 | 304 | 23 |
| 2 | 386 | 19 |
| 2 | 208 | 24 |
| 2 | 250 | 21 |
| 2 | 246 | 24 |
| 2 | 214 | 29 |
| 2 | 292 | 20 |
| 2 | 326 | 9 |
| 2 | 399 | 18 |
| 3 | 311 | 22 |
| 3 | 248 | 37 |
| 3 | 279 | n/a |
| 3 | 256 | 22 |
| 3 | 215 | 26 |
| 3 | 334 | 26 |
| 3 | 240 | 30 |
| 4 | 249 | 21 |
| 4 | 252 | 26 |
| 4 | 237 | 27 |
| 4 | 231 | 23 |
| 4 | 311 | 24 |
| 4 | 197 | n/a |
| 4 | 269 | 33 |
| 4 | 252 | 33 |
| 4 | 294 | 33 |

5/25/2022

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# Transforming data

- Use Excel formulas for calculations
  - any cell that starts with an "=" sign is interpreted as a formula
- Create a new column for the transformed value
- Refer to values by column/row: A3, B12
- Refer to ranges as *topleft:bottomright*  A2:C4

| | A | B | C | Contents of column C |
|---|---|---|---|---|
| 1 | Cholesterol | HDL | Ratio | |
| 2 | 291 | 30 | 9.7 | =A2/B2 |
| 3 | 209 | 27 | 7.7 | =A3/B3 |
| 4 | 272 | 27 | 10.1 | =A4/B4 |

formula auto-updates if copied

# Descriptive statistics

- Built-in functions can be used:
    - AVERAGE
    - MEDIAN
    - STDEV
    - "Insert function" on Formulas tab

|    | A | B |
|----|---|---|
| 1 |  | Group 1 |
| 2 |  | Cholesterol (mg/dL) |
| 3 |  | 291 |
| 4 |  | 209 |
| 5 |  | 272 |
| 6 |  | 293 |
| 7 |  | 302 |
| 8 |  | 304 |
| 9 |  |  |
| 10 |  |  |
| 11 | AVG | 278.50 |
| 12 | SD(n-1) | 35.9 |
| 13 | SEM | 14.7 |
| 14 | N | 6 |

=AVERAGE(B3:B8)
=STDEV(B3:B8)
=B12/SQRT(B14)
=COUNT(B3:B8)

# Descriptive statistics

- In Data Analysis Tools: Descriptive statistics
  - don't put the result on the same page
  - results don't update if data is changed
  - "Confidence Level(95.0%)" is the margin of error: adding and subtracting it from the mean gives a 95% confidence interval
    - do NOT use the CONFIDENCE function for getting confidence limits – it assumes a known variance

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# Cross-tabulations

- Pivot tables give very good one- or multi-way tables
  - Can show frequencies, but also means, sums of one variable grouped by other variables
  - Found on "Insert" tab
  - Will update when "Refresh" is pressed

| Row Labels | Values | | | | | |
|---|---|---|---|---|---|---|
| | Count of Group | Percent in group | Average of Cholesterol | StdDev of Cholesterol | Average of HDL | Average HDL as percent of group 1 |
| 1 | 6 | 20.0% | 278.5 | 35.9 | 26.3 | 100.0% |
| 2 | 8 | 26.7% | 290.1 | 74.1 | 20.5 | 77.8% |
| 3 | 7 | 23.3% | 269.0 | 41.7 | 27.2 | 101.4% |
| 4 | 9 | 30.0% | 254.7 | 33.9 | 27.5 | 101.7% |
| Grand Total | 30 | 100.0% | 272.2 | 49.2 | 25.2 | |

# Correlations

- Data Analysis Tool > Correlations
  - gives matrix of Pearson's correlation coefficient for a contiguous set of columns
  - no sample sizes, p-values
- CORREL function

  `=CORREL(B2:B31, C2:C31)`
  - will calculate correlation coefficient for any two columns
- Cannot compute Spearman correlation
  - The ranking tool and the RANK function give incorrect results for tied values

# Statistical inference

- Essentially no support for categorical data analysis (confidence interval for proportion, chi-square test, etc)

- t-test, ANOVA, regression are available through Data Analysis Tools and/or functions
  - function can behave differently from add-in
  - have numerical instabilities, and should not be used for large problems

# Two-sample t-test

- Requires values for each group to be contiguous
  - Data might have to be sorted
  - Excel tries to ensure that entire data row is sorted
- Data Analysis Tools > t-test: two-sample assuming equal/unequal variances
- TTEST function
  - gives only p-value (one- or two-tailed)
  - TYPE=2: equal variances
  - TYPE=3: unequal variances

2-tailed    equal variances

=TTEST(B2:B7, B8:B15, 2, 2)

- No confidence interval

# Paired t-test

- Data Analysis Tools > t-test: paired samples
- TTEST function
    - gives only p-value (one- or two-tailed)
    - TYPE=1: paired
- Missing values are handled incorrectly by the Data Analysis Tool (but not the TTEST function)

# Linear regression

- Data Analysis Tools > Regression
  - predictors (x variables) have to be in contiguous columns
  - no missing values allowed
  - do NOT run a regression through the origin
- In a scatter plot a trend line can be added with equation shown

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# ANOVA

- Balanced one- or two-way ANOVA available in Data Analysis Tools, but requires different data arrangement

- Unbalanced (or balanced) ANOVA can be run using the regression module: instead of Group, use G2, G3, and G4 as predictors

| | A | B | C (formula) | C | D (formula) | D | E (formula) | E |
|---|---|---|---|---|---|---|---|---|
| 1 | Group | Y | | G2 | | G3 | | G4 |
| 2 | 1 | 291 | =IF(A2=2,1,0) | 0 | =IF(A2=3,1,0) | 0 | =IF(A2=4,1,0) | 0 |
| 3 | 2 | 386 | =IF(A3=2,1,0) | 1 | =IF(A3=3,1,0) | 0 | =IF(A3=4,1,0) | 0 |
| 4 | 3 | 311 | … | 0 | | 1 | | 0 |
| 5 | 4 | 249 | | 0 | | 0 | | 1 |
| 6 | … | … | | | | | | |

# Limitations of Excel

- Potential problems with analyses involving missing data

- Varying expectations regarding the arrangement of data

- Output scattered in many different worksheets, or all over one worksheet

- Output may be incomplete or may not be properly labeled

- No record of what you did to generate your results

# Right tool for the right job



Excel is not the right tool for all but the simplest analyses

# Resources

- The Clinical and Translation Science Institute (CTSI) supports education, collaboration, and research in clinical and translational science: www.ctsi.mcw.edu

- The Biostatistics Consulting Service provides comprehensive statistical support www.mcw.edu/biostatistics.htm

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# Free Drop-In Consulting

- MCW/Froedtert/CHW: 1 – 3 PM
  - Monday, Wednesday, Friday @ CTSI Administrative offices (LL772A)
  - Tuesday, Thursday 1 – 3 PM @ Health Research Center, H2400
- VA: 1st and 3rd Monday, 8:30-11:30 am
  - VA Medical Center, Room 111-B-5423
- Marquette: Tuesday, 8:30-10:30 am
  - School of Nursing, Clark Hall, Office of Research & Scholarship