Final Remarks

Statistics is no bloodless algebra. It is a discipline at the interface of biology and mathematics. Mathematics is used to answer biological questions. Biological processes are full of variations, and statistics gives no certainties, only chances. What kind of chances: chances that your prior hypotheses are true or untrue. The human brain hypothesizes all the time. And we currently believe that hypotheses must be assessed with hard data.

When it comes to statistical data analyses, clinicians and clinical investigators soon get very nervous, and tend to leave their data to a statistician who runs the data through SAS of SPSS or any other software program to see if there are significant p-values. This practice is called data dredging and is the source of multiple type I errors of finding a difference where there is none.

The best defense against this practice is the use of simple tests. These tests, generally, provide the best power for confirmative research, because this research is based on sound arguments. Multiple variable tests are not always in place here, as they tend to enhance the risk of power loss, data dredging, and type I errors producing a host of irrelevant p-values. Also multiple variable tests, although interesting, are considered exploratory rather than confirmatory, in other words they, generally, prove nothing, and have to be confirmed.

The current book was written for various reasons:

1. To review the basic principles of statistical testing which tends to be increasingly forgotten in the current computer era.
2. To serve as a primer for nervous investigators who would like to perform their own data analyses but feel inexpert to do so.
3. To make investigators better understand what they are doing, when analyzing clinical data.
4. To facilitate data analysis by use of a number of *rapid* pocket calculator methods.
5. As a primer for those who wish to master more advanced statistical methods. More advanced methods are reviewed by the same authors in the books "SPSS

T.J. Cleophas and A.H. Zwinderman, *Statistical Analysis of Clinical Data on a Pocket Calculator: Statistics on a Pocket Calculator*, DOI 10.1007/978-94-007-1211-9,

© Springer Science+Business Media B.V. 2011

for Starters" 2010, "Statistics Applied to Clinical Trials" fourth edition, 2009, "Statistics Applied to Clinical Trials: Self-Assessment Book, 2002, all of them edited by Springer, Dordrecht. These books closely fit and complement the format and contents of the current book.

The current book is very condensed, but this should be threshold lowering to readers. As a consequence, however, the theoretical background of the methods described are not sufficiently explained in the text. Extensive theoretical information is also given in the above mentioned books from the same authors.

Index

A
Alpha, 20
Analysis of variance, 41, 50
Areas under the curve, 21

B
Beta, 20
Bloodless algebra, 55
Bonferroni inequality, 41
Bonferroni t-test, 41–42
Boundaries of equivalence, 17

C
Chi-square table, 31–33
Chi-square test, 31–35, 37, 38, 43
Chi-square test for cross-tabs, 31–34
Cohen's kappa, 53
Confidence intervals, 1, 15
Confounding, 1, 47–49
Cross-tabs, 29–35, 37, 39, 40

D
Data dredging, 41
Degrees of freedom, 6–8, 20, 29, 31, 43–45, 48
Dependent variables, v
Diagnostic tests, 51
Duplicate standard deviation, 51–52

E
Equivalence tests, 17

F
Frequency distribution, 8
F-table (Fisher), 44, 45
F-test (Fisher), 44

G
Gaussian distribution, 36

I
Independent variables, v
Interaction, 49–50
Irrelevant p-values, 42

K
Kappa, 53–54
Kappa-values, 54

L
LnOR, 35, 36, 40
Ln values, 40
Log likelihood ratio, 37–38
Log likelihood ratio tests, 37–38

M
Mann Whitney tables, 11
Mann Whitney test, 11–13
Margin of inferiority, 27
Matched groups, 7
McNemar odds ratios, 40
McNemar's test, 39–40

Means, 10, 41, 48
Multiple regression analysis, 48
Multiple testing, 1, 41
Multiple variable tests, 55

N
Noninferiority testing, 27–28
Non-parametric tests, 1, 9–13
Normal distribution, 29

O
Odds ratios, 15, 35–36
Odds ratio test for cross-tabs, 35–36
One-sample t-test, 5–6

P
Paired t-test, 6
Parallel groups, 27, 49
Parallel-group study, 17, 50
P-calculator for z-values, 36, 37
Pocket calculator method, 31
Pocket calculators, 1–3, 31, 34, 40, 48
Pooled SE. *See* Pooled standard error
Pooled standard deviation, 26
Pooled standard error, 17, 29, 48
Power, 19–21, 23–27
Power equations, 19–21
Power index, 23–27
Prior hypothesis, 55
Propensity scores, 48
Proportions, 31–33
Proportional duplicate standard deviation, 51, 52
P-values, 5–13, 21, 23, 24, 27–33, 36–44, 48

R
Rank numbers, 9–11
Regression modeling, 50
Reliability assessment, 51–54
Reproducibility, 51–54

S
Sample size, 1, 6, 8, 15, 20, 23–27, 43
Sample size and binary data, 25–26
Sample size and continuous data, 23–25
SAS statistical software, 55
SD. *See* Standard deviation (SD)
SE. *See* Standard error (SE)
SEM. *See* Standard error of the mean (SEM)
SEM-unit, 23, 28
Sensitivity of tests for cross-tabs, 37
SE-unit, 8, 20, 28
SPSS for Starters, 2
SPSS statistical software, v
Standard deviation (SD), 3–7, 15, 19, 23–27, 44, 51
Standard error (SE), 5–7, 15, 19, 20, 28–30, 35, 36, 40, 47, 48
Standard error of the mean (SEM), 17, 23, 24, 28, 29, 40
Subclassification, 47

T
T-distribution, 20, 21, 29
T-table, 6–8, 19–21, 29, 30, 36, 40, 48
T-tests, 5–8, 41–42
Two-sided p-values, 21
Type I error, 20, 41
Type II error, 20

U
Unpaired t-test, 7–8

V
Variability analysis, 1, 43–45
Variability test one sample, 43
Variability test two samples, 44–45

W
Weighted mean, 48
Weighted standard error, 48
Wilcoxon table, 10
Wilcoxon test, 9–10

Z
Z-distribution,
Z-test for cross-tabs, 29–30
Z-values, 29, 36, 37