

Contents

<i>Preface</i>	<i>xiii</i>
<i>Acronyms</i>	<i>xvii</i>
1 <i>The Basics</i>	1
1.1 Distinguish Randomized and Observational Studies	2
1.2 Beware of Linear Models	3
1.3 Understand Omnibus Quantities	6
1.4 Independence, Equal Variance, and Normality	7
1.5 Models As Simple As Possible, But Not More Simple	11
1.6 Do Not Multiply Probabilities More Than Necessary	12
1.7 Know the Sample Space for Statements of Risk	13
1.8 Use Two-sided p -Values	14
1.9 p -Values for Sample Size, Confidence Intervals for Results	16
1.10 Use at Least Twelve Observations in Constructing a Confidence Interval	18
1.11 Know the Unit of the Variable	19
1.12 Know Properties Preserved When Transforming Units	20
	<i>vii</i>

1.13	Be Flexible About Scale of Measurement Determining Analysis	23
1.14	Be Eclectic and Ecumenical in Inference	24
1.15	Consider Bootstrapping for Complex Relationships	25
1.16	Standard Error from Sample Range/Sample Size	26
2	<i>Sample Size</i>	29
2.1	Begin with a Basic Formula for Sample Size	31
2.2	No Finite Population Correction for Survey Sample Size	33
2.3	Calculating Sample Size Using the Coefficient of Variation	35
2.4	Do Not Formulate a Study Solely in Terms of Effect Size	38
2.5	Overlapping Confidence Intervals Do Not Imply Nonsignificance	39
2.6	Sample Size Calculation for the Poisson Distribution	40
2.7	Sample Size for Poisson With Background Rate	41
2.8	Sample Size Calculation for the Binomial Distribution	43
2.9	When Unequal Sample Sizes Matter; When They Don't	45
2.10	Sample Size With Different Costs for the Two Samples	47
2.11	The Rule of Threes for 95% Upper Bounds When There Are No Events	49
2.12	Sample Size Calculations Are Determined by the Analysis	50
3	<i>Covariation</i>	53
3.1	Assessing and Describing Covariation	55
3.2	Don't Summarize Regression Sampling Schemes with Correlation	56
3.3	Do Not Correlate Rates or Ratios Indiscriminately	58
3.4	Determining Sample Size to Estimate a Correlation	59
3.5	Pairing Data is not Always Good	61
3.6	Go Beyond Correlation in Drawing Conclusions	63

3.7	Agreement As Accuracy, Scale Differential, and Precision	65
3.8	Assess Test Reliability by Means of Agreement	68
3.9	Range of the Predictor Variable and Regression	70
3.10	Measuring Change: Width More Important than Numbers	72
4	<i>Epidemiology</i>	75
4.1	Start with the Poisson to Model Incidence or Prevalence	76
4.2	The Odds Ratio Approximates the Relative Risk Assuming the Disease is Rare	77
4.3	The Number of Events is Crucial in Estimating Sample Sizes	82
4.4	Using a Logarithmic Formulation to Calculate Sample Size	84
4.5	Take No More than Four or Five Controls per Case	86
4.6	Obtain at Least Ten Subjects for Every Variable Investigated	87
4.7	Begin with the Exponential Distribution to Model Time to Event	89
4.8	Begin with Two Exponentials for Comparing Survival Times	91
4.9	Be Wary of Surrogates	92
4.10	Prevalence Dominates in Screening Rare Diseases	95
4.11	Do Not Dichotomize Unless Absolutely Necessary	99
4.12	Select an Additive or Multiplicative Model on the Basis of Mechanism of Action	100
5	<i>Environmental Studies</i>	103
5.1	Think Lognormal	103
5.2	Begin with the Lognormal Distribution in Environmental Studies	104
5.3	Differences Are More Symmetrical	106
5.4	Beware of Pseudoreplication	108

5.5	Think Beyond Simple Random Sampling	109
5.6	Consider the Size of the Population Affected by Small Effects	111
5.7	Statistical Models of Small Effects Are Very Sensitive to Assumptions	112
5.8	Distinguish Between Variability and Uncertainty	113
5.9	Description of the Database is As Important as Its Data	115
5.10	Always Assess the Statistical Basis for an Environmental Standard	116
5.11	Measurement of a Standard and Policy	117
5.12	Parametric Analyses Make Maximum Use of the Data	119
5.13	Distinguish Between Confidence, Prediction, and Tolerance Intervals	120
5.14	Statistics Plays a Key Role in Risk Assessment, Less in Risk Management	122
5.15	Exposure Assessment is the Weak Link in Assessing Health Effects of Pollutants	124
5.16	Assess the Errors in Calibration Due to Inverse Regression	125
6	<i>Design, Conduct, and Analysis</i>	129
6.1	Randomization Puts Systematic Effects into the Error Term	129
6.2	Blocking is the Key to Reducing Variability	131
6.3	Factorial Designs Should be Used to Assess Joint Effects of Variables	132
6.4	High-Order Interactions Occur Rarely	134
6.5	Balanced Designs Allow Easy Assessment of Joint Effects	136
6.6	Analysis Follows Design	137
6.7	Plan to Graph the Results of an Analysis	139
6.8	Distinguish Between Design Structure and Treatment Structure	142
6.9	Make Hierarchical Analyses the Default Analysis	143

6.10	Distinguish Between Nested and Crossed Designs— Not Always Easy	145
6.11	Plan for Missing Data	146
6.12	Address Multiple Comparisons Before Starting the Study	149
7	<i>Words, Tables, and Graphs</i>	153
7.1	Use Text for a Few Numbers, Tables for Many Numbers, Graphs for Complex Relationships	153
7.2	Arrange Information in a Table to Drive Home the Message	155
7.3	Always Graph the Data	158
7.4	Never Use a Pie Chart	160
7.5	Bargraphs Waste Ink; They Don't Illuminate Complex Relationships	162
7.6	Stacked Bargraphs Are Worse Than Bargraphs	163
7.7	Three-Dimensional Bargraphs Constitute Misdirected Artistry	166
7.8	Identify Cross-sectional and Longitudinal Patterns in Longitudinal Data	167
7.9	Use Rendering, Manipulation, and Linking in High Dimensional Data	170
8	<i>Consulting</i>	175
8.1	Structure a Consultation Session to Have a Beginning, a Middle, and an End	176
8.2	Ask Questions	177
8.3	Make Distinctions	178
8.4	Know Yourself, Know the Investigator	180
8.5	Tailor Advice to the Level of the Investigator	181
8.6	Use Units the Investigator is Comfortable With	182
8.7	Agree on Assignment of Responsibilities	184
8.8	Any Basic Statistical Computing Package Will Do	185
8.9	Ethics Precedes, Guides, and Follows Consultation	186
8.10	Be Proactive in Statistical Consulting	187

- 8.11 Use the Web for Reference, Resource, and Education 189
- 8.12 Listen to, and Heed the Advice of Experts in the Field 190

Epilogue 193

References 195

Author Index 207

Topic Index 211