

Table of contents

Preface to Third Edition ix

Preface to First Edition xi

Preface to Second Edition xiii

1 The Whys and Wherefores of Statistics 1

1.1 Learning objectives 1

1.2 Aims of the book 1

1.3 What is statistics? 2

1.4 Statistics in veterinary and animal science 3

1.5 Evidence-based veterinary medicine 4

1.6 Types of variable 4

1.7 Variations in measurements 5

1.8 Terms relating to measurement quality 7

1.9 Populations and samples 9

1.10 Types of statistical procedures 10

1.11 Conclusion 10

Exercises 10

2 Descriptive Statistics 12

2.1 Learning objectives 12

2.2 Summarizing data 12

2.3 Empirical frequency distributions 12

2.4 Tables 14

2.5 Diagrams 15

2.6 Numerical measures 19

2.7 Reference interval 24

Exercises 25

3 Probability and Probability Distributions 28

3.1 Learning objectives 28

3.2 Probability 28

3.3 Probability distributions 30

3.4 Discrete probability distributions 31

3.5 Continuous probability distributions 33

3.6 Relationships between distributions 42

Exercises 43

4 Sampling and Sampling Distributions 46

4.1 Learning objectives 46

4.2 Distinction between the sample and the population 46

4.3 Statistical inference 46

4.4 Sampling distribution of the mean 48

4.5 Confidence interval for a mean 50

4.6 Sampling distribution of the proportion 52

4.7 Confidence interval for a proportion 53

4.8 Bootstrapping and jackknifing 53

Exercises 54

5 Experimental Design and Clinical Trials 55

5.1 Learning objectives 55

5.2 Types of study 55

5.3 Introducing clinical trials 59

5.4 Importance of design in the clinical trial 60

5.5 Control group 61

5.6 Assignment of animals to the treatment groups 62

5.7 Avoidance of bias in the assessment procedure 65

5.8 Increasing the precision of the estimates 66

5.9 Further considerations 68

Exercises 73

6 An Introduction to Hypothesis Testing 75

6.1 Learning objectives 75

6.2 Introduction 75

6.3 Basic concepts of hypothesis testing 75

6.4 Type I and Type II errors 79

6.5 Distinction between statistical and biological significance 80

6.6 Confidence interval approach to hypothesis testing 81

6.7 Collecting our thoughts on confidence intervals 82

6.8 Equivalence and non-inferiority studies 82

Exercises 83

7 Hypothesis Tests 1. The t -test: Comparing One or Two Means 85

7.1 Learning objectives 85

7.2 Requirements for hypothesis tests for comparing means 85

7.3 One-sample t -test 87

7.4 Two-sample t -test 89

7.5 Paired t -test 92

Exercises 96

8 Hypothesis Tests 2. The F -test: Comparing Two Variances or More Than Two Means 100

8.1 Learning objectives 100

8.2 Introduction 100

8.3 The F -test for the equality of two variances 100

8.4 Levene's test for the equality of two or more variances 102

8.5 Analysis of variance (ANOVA) for the equality of means 102

8.6 One-way analysis of variance 105

Exercises 109

9 Hypothesis Tests 3. The Chi-squared Test: Comparing Proportions 112

9.1 Learning objectives 112

9.2 Introduction 112

9.3 Testing a hypothesis about a single proportion 112

9.4 Comparing two proportions: independent groups 113

9.5 Testing associations in an $r \times c$ contingency table 117

9.6 Comparing two proportions – paired observations 120

9.7 Chi-squared goodness-of-fit test 122

Exercises 123

10 Linear Correlation and Regression 126

10.1 Learning objectives 126

10.2 Introducing linear correlation and regression 126

10.3 Linear correlation 127

10.4 Simple (univariable) linear regression 132

10.5 Regression to the mean 142

Exercises 142

11 Further Regression Analyses 146

11.1 Learning objectives 146

11.2 Introduction 146

11.3 Multiple linear regression 147

11.4 Multiple logistic regression: a binary response variable 154

11.5 Poisson regression 159

11.6 Regression methods for clustered data 161

Exercises 163

12 Non-parametric Statistical Methods 165

12.1 Learning objectives 165

12.2 Parametric and non-parametric tests 165

12.3 Sign test 167

12.4 Wilcoxon signed rank test 169

12.5 Wilcoxon rank sum test 171

12.6 Non-parametric analyses of variance 173

12.7 Spearman's rank correlation coefficient 175

Exercises 178

13 Further Aspects of Design and Analysis 181

13.1 Learning objectives 181

13.2 Transformations 181

13.3 Sample size 184

13.4 Sequential and interim analysis 189

13.5 Meta-analysis 190

13.6 Methods of sampling 194

Exercises 198

14 Additional Techniques 200

14.1 Learning objectives 200

14.2 Diagnostic tests 200

14.3 Bayesian analysis 208

14.4 Measuring agreement 211

14.5 Measurements at successive points in time 218

14.6 Survival analysis 221

14.7 Multivariate analysis 226

Exercises 227

15 Some Specialized Issues and Procedures 230

15.1 Learning objectives 230

15.2 Introduction 230

15.3 Ethical and legal issues 230

15.4 Spatial statistics and geospatial information systems 233

15.5 Veterinary surveillance 237

15.6 Molecular and quantitative genetics 240

Exercises 242

16 Evidence-based Veterinary Medicine 243

16.1 Learning objectives 243

16.2 Introduction 243

16.3 What is evidence-based veterinary medicine? 244

16.4 Why has evidence-based veterinary medicine developed? 244

16.5 What is involved in practising evidence-based veterinary medicine? 245

16.6 Integrating evidence-based veterinary medicine into clinical practice 249

16.7 Example 249

Exercises 250

17 Reporting Guidelines 252

17.1 Learning objectives 252

17.2 Introduction to reporting guidelines (EQUATOR network) 252

17.3 REFLECT statement 254

17.4 ARRIVE guidelines (research using laboratory animals) 255

17.5 STROBE guidelines

(observational studies) 255

17.6 STARD statement (diagnostic accuracy) 262

17.7 PRISMA statement (systematic reviews and meta-analysis) 265

18 Critical Appraisal of Reported Studies 269

18.1 Learning objectives 269

18.2 Introduction 269

18.3 A template for critical appraisal of published research involving animals
270

18.4 Paper 1 273

18.5 Critical appraisal of paper 1 284

18.6 Paper 2 288

18.7 Critical appraisal of paper 2 297

18.8 General conclusion 302

Solutions to Exercises 303

Appendices 331

A Statistical Tables 331

B Tables of Confidence Intervals 347

C Glossary of Notation 349

D Glossary of Terms 353

E Flowcharts for Selection of Appropriate Tests 376

References 377

Index 379