

9.2.1.3	Checking Gaussianity: Simple but Approximate Methods	172
9.2.2	Reference or Normal Values.....	174
9.2.2.1	Implications of Normal Values.....	174
9.2.3	Normal Range	175
9.2.3.1	Disease Threshold.....	175
9.2.3.2	Clinical Threshold.....	175
9.2.3.3	Statistical Threshold	176
9.3	Measurement of Uncertainty: Probability.....	177
9.3.1	Elementary Laws of Probability	177
9.3.1.1	Law of Multiplication	178
9.3.1.2	Law of Addition.....	178
9.3.2	Probability in Clinical Assessments	179
9.3.2.1	Probabilities in Diagnosis	179
9.3.2.2	Forwarding Diagnosis.....	180
9.3.2.3	Assessment of Prognosis.....	180
9.3.2.4	Choice of Treatment.....	181
9.3.3	Further on Diagnosis: Bayes' Rule	181
9.3.3.1	Bayes' Rule	181
9.3.3.2	Extension of Bayes' Rule.....	182
9.4	Validity of Medical Tests.....	183
9.4.1	Sensitivity and Specificity	184
9.4.1.1	Features of Sensitivity and Specificity	185
9.4.1.2	Likelihood Ratio.....	186
9.4.2	Predictivities	186
9.4.2.1	Positive and Negative Predictivity	186
9.4.2.2	Predictivity and Prevalence.....	187
9.4.2.3	Meaning of Prevalence for Predictivity	188
9.4.2.4	Features of Positive and Negative Predictivities	189
9.4.3	Combination of Tests.....	190
9.4.3.1	Tests in Series.....	190
9.4.3.2	Tests in Parallel.....	190
9.4.4	Gains from a Test.....	191
9.4.4.1	When Can a Test Be Avoided?.....	192
9.5	Search for the Best Threshold of a Continuous Test: ROC Curve.....	192
9.5.1	Sensitivity-Specificity-Based ROC Curve.....	192
9.5.1.1	Methods to Find the Optimal Threshold Point	194
9.5.1.2	Area under the ROC Curve	195
9.5.2	Predictivity-Based ROC Curve	197
	References	198
	Exercises	199
10.	Clinimetrics and Evidence-Based Medicine.....	203
10.1	Indicators, Indices, and Scores	203
10.1.1	Indicators.....	203
10.1.1.1	Merits and Demerits of Indicators	203
10.1.1.2	Choice of Indicators	204
10.1.2	Indices.....	204
10.1.3	Scores	204
10.1.3.1	Scoring System for Diagnosis.....	205
10.1.3.2	Scoring for Gradation of Severity	206
10.1.3.3	APACHE Scores.....	207
10.2	Clinimetrics	208
10.2.1	Method of Scoring	208
10.2.1.1	Method of Scoring for Graded Characteristics.....	208
10.2.1.2	Method of Scoring for Diagnosis	209

10.2.1.3	Regression Method for Scoring.....	209
10.2.2	Validity and Reliability of a Scoring System	210
10.2.2.1	Validity of a Scoring System.....	210
10.2.2.2	Reliability of a Scoring System.....	211
10.3	Evidence-Based Medicine.....	212
10.3.1	Decision Analysis	212
10.3.1.1	Decision Tree.....	212
10.3.2	Other Statistical Tools for Evidence-Based Medicine.....	213
10.3.2.1	Etiology Diagram	213
10.3.2.2	Expert System	214
References	215
Exercises	216
11.	Measurement of Community Health	219
11.1	Measures of Fertility and Medical Demography	219
11.1.1	Indicators of Fertility.....	219
11.1.2	Medical Demography.....	221
11.1.2.1	Population Pyramid.....	221
11.1.2.2	Demographic Cycle.....	222
11.1.2.3	Other Demographic Indicators	223
11.1.2.4	Stable and Stationary Population.....	223
11.1.2.5	Sex Ratio	223
11.2	Indicators of Mortality	224
11.2.1	Crude and Standardized Death Rates	224
11.2.1.1	Crude Death Rate	224
11.2.1.2	Age-Specific Death Rate.....	224
11.2.1.3	Standardized Death Rate	224
11.2.1.4	Comparative Mortality Ratio.....	227
11.2.2	Specific Mortality Rates	228
11.2.2.1	Fetal Deaths and Mortality in Children	228
11.2.2.2	Maternal Mortality.....	230
11.2.2.3	Adult Mortality.....	230
11.2.2.4	Other Measures of Mortality.....	231
11.2.3	Death Spectrum	231
11.3	Measures of Morbidity	232
11.3.1	Prevalence and Incidence	232
11.3.1.1	Point Prevalence	232
11.3.1.2	Period Prevalence.....	233
11.3.1.3	Prevalence Rate Ratio	233
11.3.1.4	Incidence.....	233
11.3.1.5	Concept of Person-Time.....	234
11.3.1.6	Capture-Recapture Methodology	234
11.3.2	Duration of Morbidity	235
11.3.2.1	Prevalence in Relation to Duration of Morbidity	236
11.3.2.2	Incidence from Prevalence.....	236
11.3.2.3	Epidemiologically Consistent Estimates.....	237
11.3.3	Morbidity Measures for Acute Conditions	237
11.3.3.1	Attack Rates	238
11.3.3.2	Disease Spectrum.....	238
11.4	Indicators of Social and Mental Health	240
11.4.1	Indicators of Social Health	240
11.4.1.1	Education.....	240
11.4.1.2	Income.....	241
11.4.1.3	Occupation	241
11.4.1.4	Socioeconomic Status	241

11.4.1.5	Dependency Ratio	242
11.4.1.6	Dietary Assessment	242
11.4.1.7	Health Inequality	242
11.4.2	Indicators of Health Resources	243
11.4.2.1	Health Infrastructure	243
11.4.2.2	Health Expenditure	244
11.4.3	Indicators of Lack of Mental Health	245
11.4.3.1	Smoking and Other Addictions	245
11.4.3.2	Divorces	245
11.4.3.3	Vehicular Accidents and Crimes	245
11.4.3.4	Other Measures of Lack of Mental Health	245
11.5	Composite Indices of Health	246
11.5.1	Indices of Status of Comprehensive Health	246
11.5.1.1	Human Development Index	246
11.5.1.2	Physical Quality of Life Index	247
11.5.1.3	Index of Happiness	247
11.5.2	Indices of (Physical) Health Gap	248
11.5.2.1	DALYs Lost	248
11.5.2.2	Human Poverty Index	249
11.5.2.3	Index of Need for Health Resources	249
	References	249
	Exercises	250
12.	Confidence Intervals, Principles of Tests of Significance, and Sample Size	255
12.1	Sampling Distributions	255
12.1.1	Basic Concepts	255
12.1.1.1	Sampling Error	256
12.1.1.2	Point Estimate	256
12.1.1.3	Standard Error of p and \bar{x}	256
12.1.2	Sampling Distribution of p and \bar{x}	258
12.1.2.1	Gaussian Conditions	258
12.1.3	Obtaining Probabilities from a Gaussian Distribution	259
12.1.3.1	Gaussian Probability	259
12.1.3.2	Continuity Correction	261
12.1.3.3	Probabilities Relating to the Mean and the Proportion	261
12.1.4	Case of σ Not Known (t -Distribution)	262
12.2	Confidence Intervals	262
12.2.1	Confidence Interval for π , μ , and Median: Gaussian Conditions	263
12.2.1.1	Confidence Interval for Proportion π (Large n)	263
12.2.1.2	Lower and Upper Bounds for π (Large n)	265
12.2.1.3	Confidence Interval for Mean μ (Large n)	265
12.2.1.4	Confidence Bounds for Mean μ (Large n)	267
12.2.1.5	CI for Median (Gaussian Distribution)	268
12.2.2	Confidence Interval for Differences (Large n)	269
12.2.2.1	CI for the Difference in Two Independent Samples	269
12.2.2.2	Paired Samples	270
12.2.3	Confidence Interval for π , μ , and Median: Non-Gaussian Conditions	271
12.2.3.1	Confidence Interval for π (Small n)	272
12.2.3.2	Confidence Bound for π When the Success or Failure Rate in the Sample Is 0%	273
12.2.3.3	Confidence Interval for Median: Non-Gaussian Conditions	274
12.3	P -Values and Statistical Significance	276
12.3.1	What Is Statistical Significance?	276
12.3.1.1	Court Judgment	277
12.3.1.2	Errors in Diagnosis	277
12.3.1.3	Null Hypothesis	277

12.3.1.4	Philosophical Basis of Statistical Tests	278
12.3.1.5	Alternative Hypothesis	278
12.3.1.6	One-Sided Alternatives: Which Tail Is Wagging?	278
12.3.2	Errors, <i>P</i> -Values, and Power	279
12.3.2.1	Type I Error	279
12.3.2.2	Type II Error	280
12.3.2.3	Power.....	280
12.3.3	General Procedure to Obtain the <i>P</i> -Value	281
12.3.3.1	Steps to Obtain a <i>P</i> -Value	281
12.3.3.2	Subtleties of Statistical Significance	283
12.4	Assessing Gaussian Pattern.....	284
12.4.1	Approximate Methods for Assessing Gaussianity	284
12.4.2	Significance Tests for Assessing Gaussianity	285
12.4.2.1	Statistical Tests.....	285
12.4.2.2	Transformations to Achieve Gaussianity	285
12.5	Initial Debate on Statistical Significance	286
12.5.1	Confidence Interval versus Test of H_0	286
12.5.1.1	Equivalence of CI with Test of H_0	286
12.5.1.2	Valid Application of Test of Hypothesis	287
12.5.2	Medical Significance versus Statistical Significance.....	287
12.6	Sample Size Determination in Some Cases.....	289
12.6.1	Sample Size Required in Estimation Setup	289
12.6.1.1	General Considerations for Sample Size in Estimation Setup.....	289
12.6.1.2	General Procedure for Determining the Sample Size for Estimation	291
12.6.1.3	Formulas for Sample Size Calculation for Estimation in Simple Situations.....	292
12.6.2	Sample Size for Testing a Hypothesis with Specified Power	294
12.6.2.1	General Considerations for Sample Size in a Testing of Hypothesis Setup	294
12.6.2.2	Power Calculations	295
12.6.2.3	Sample Size Formulas for Test of Hypothesis in Simple Situations	295
12.6.2.4	Sample Size in Some Other Popular Setups.....	298
12.6.2.5	Nomograms and Tables of Sample Size.....	299
12.6.2.6	Thumb Rules.....	299
12.6.2.7	Power Analysis	300
12.6.3	Sample Size in Adaptive Clinical Trials	300
12.6.3.1	Stopping Rules in Case of Early Evidence of Success or Failure: Lan–deMets Procedure.....	301
12.6.3.2	Sample Size Reestimation in Adaptive Designs.....	302
	References	303
	Exercises	304
13.	Inference from Proportions.....	307
13.1	One Qualitative Variable.....	307
13.1.1	Dichotomous Categories: Binomial Distribution	307
13.1.1.1	Binomial Distribution.....	308
13.1.1.2	Large <i>n</i> : Gaussian Approximation to Binomial	309
13.1.1.3	Z-Test for Proportion in One Group	310
13.1.2	Poisson Distribution.....	310
13.1.3	Polytomous Categories (Large <i>n</i>): Goodness-of-Fit Test.....	311
13.1.3.1	Chi-Square and Its Explanation	312
13.1.3.2	Degrees of Freedom	313
13.1.3.3	Cautions in Using Chi-Square.....	313
13.1.3.4	Further Analysis: Partitioning of Tables	314
13.1.4	Goodness of Fit to Assess Gaussianity	315
13.1.5	Polytomous Categories (Small <i>n</i>): Exact Multinomial Test	316
13.1.5.1	Goodness of Fit in Small Samples.....	316
13.1.5.2	Data with Rare Outcomes: Negative Binomial Distribution	317