Master List of Formulas

Chapter 1 Introduction and Descriptive Statistics

NONE.

Chapter 2 Frequency Distributions in Tables and Graphs

Σx (Frequency)

$\frac{\Sigma x}{n}$ (Relative frequency)

$\frac{\Sigma x}{n} \times 100$ (Relative percent)

Chapter 3 Summarizing Data: Center Tendency

$\mu = \frac{\Sigma x}{N}$ (Population mean)

$M = \frac{\Sigma x}{n}$ (Sample mean)

$M_w = \frac{\Sigma(M \times n)}{\Sigma n}$ (Weighted sample mean)

Chapter 4 Summarizing Data: Variability

$R = L - S$ (Range)

$\text{IQR} = Q_3 - Q_1$ (Interquartile range)

$\text{SIQR} = \frac{\text{IQR}}{2}$ (Semi-interquartile range)

$SS = \Sigma(x - \mu)^2$ (Definitional formula for the sum of squares in a population)

$SS = \Sigma x^2 - \Sigma \frac{(\Sigma x)^2}{N}$ (Computational formula for the sum of squares in a population)

$\sigma^2 = \frac{SS}{N}$ (Population variance)

$\sigma = \sqrt{\sigma^2} = \sqrt{\frac{SS}{N}}$ (Population standard deviation)

$SS = \Sigma(x - M)^2$ (Definitional formula for sum of squares in a sample)

$SS = \Sigma x^2 - \frac{(\Sigma x)^2}{n}$ (Computational formula for sum of squares in a sample)

$df = n - 1$ (Degrees of freedom for sample variance)

$s^2 = \frac{SS}{n-1} = \frac{SS}{df}$ (Sample variance)

$SD = \sqrt{s^2} = \sqrt{\frac{SS}{n-1}} = \sqrt{\frac{SS}{df}}$ (Sample standard deviation)

Chapter 5 Probability

$p(x) = \frac{f(x)}{sample\ space}$ (Simple probability)

$p(U / P) = \frac{p(P / U)p(U)}{p(P)}$ (Bayes's theorem)

$\mu = \Sigma(xp)$ (Mean of a probability distribution)

$\sigma^2 = \Sigma\left((x - \mu)^2 p\right)$ (Variance of a probability distribution)

$\sigma = \sqrt{\sigma^2} = \sqrt{\Sigma\left((x - \mu)^2 p\right)}$ (Standard deviation of a probability distribution)

$\sigma = \sqrt{\sigma^2} = \sqrt{\left(\Sigma\left(x^2 p\right) - \mu^2\right)}$ (Computing formula for variance of a probability distribution)

$\sigma = \sqrt{\left(\Sigma(x^2 p) - \mu^2\right)}$ (Computing formula for standard deviation of a probability distribution)

$\mu = np$ (Mean of a binomial probability distribution)

$\sigma^2 = np(1 - p) = npq$ (Variance of a binomial probability distribution)

$\sigma = \sqrt{np(1-p)} = \sqrt{npq}$ (Standard deviation of a binomial probability distribution)

Chapter 6 Probability, Normal Distributions, and z Scores

$z = \frac{x - \mu}{\sigma}$ (z transformation for a population of scores)

$z = \frac{x - M}{SD}$ (z transformation for a sample of scores)

Chapter 7 Probability and Sampling Distributions

$z = \frac{x - \mu}{\sigma}$ (z transformation for a population of scores)

$z = \frac{x - M}{SD}$ (z transformation for a sample of scores)

$z = \frac{M - \mu}{\sigma_M}$ (z transformation for a distribution of sample means)

$\sigma_M = \sqrt{\frac{\sigma^2}{n}} = \frac{\sigma}{\sqrt{n}}$ (Standard error of the mean)

Chapter 8 Hypothesis Testing: Significance, Effect Size, and Power

$z_{obt} = \frac{M - \mu}{\sigma_M}$ (Test statistic for the one-sample z test)

$d = \frac{M - \mu}{\sigma}$ (Cohen's d effect size measure for the one-sample z test)

Chapter 9 Testing Means: One-Sample and Two-Independent-Sample *t* Tests

One-Sample *t*

$t_{obt} = \frac{M - \mu}{s_M}$ (Test statistic for the one-sample t test)

$s_M = \sqrt{\frac{s^2}{n}}$ (Estimated standard error)

$df = n - 1$ (Degrees of freedom for the one-sample t test)

Two-Independent-Sample *t*

$t_{obt} = \frac{(M_1 - M_2) - (\mu_1 - \mu_2)}{s_{M_1 - M_2}}$ (Test statistic for the two-independent-sample t test)

$s_{M_1 - M_2} = \sqrt{\frac{s_p^2}{n_1} + \frac{s_p^2}{n_2}}$ (Estimated standard error for the difference)

$s_p^2 = \frac{s_1^2(df_1) + s_2^2(df_2)}{df_1 + df_2}$ (Pooled sample variance for unequal sample sizes)

$df = (n_1 - 1) + (n_2 - 1)$ (Degrees of freedom for the two-independent-sample t test)

Effect Size

$d = \frac{M - \mu}{SD}$ (Estimated Cohen's d for the one-sample t test)

$\frac{M_1 - M_2}{\sqrt{s_p^2}}$ (Estimated Cohen's *d* for the two-independent-sample *t* test)

$\eta^2 = \frac{t^2}{t^2 + df}$ (Eta-squared estimate of proportion of variance; used for all *t* tests)

$\omega^2 = \frac{t^2 - 1}{t^2 + df}$ (Omega-squared estimate of proportion of variance; used for all *t* tests)

CHAPTER 10 TESTING MEANS: THE RELATED-SAMPLES *t* TEST

Related-Samples *t*

$t_{obt} = \frac{M_D - \mu_D}{s_{MD}}$ (Test statistic for the related-samples *t* test)

$s_{MD} = \sqrt{\frac{s_D^2}{n_D}} = \frac{s_D}{\sqrt{n_D}}$ (Estimated standard error for difference scores)

$df = n_D - 1$ (Degrees of freedom for related-samples *t* test)

Effect Size

$d = \frac{M_D}{s_D}$ (Estimated Cohen's *d* for related-samples *t* test)

$\eta^2 = \frac{t^2}{t^2 + df}$ (Eta-squared estimate of proportion of variance; used for all *t* tests)

$\omega^2 = \frac{t^2 - 1}{t^2 + df}$ (Omega-squared estimate of proportion of variance; used for all *t* tests)

CHAPTER 11 ESTIMATION AND CONFIDENCE INTERVALS

$M \pm z(\sigma_M)$ (The estimation formula for a one-sample *z* test)

$M \pm t(s_M)$ (The estimation formula for a one-sample *t* test)

$M_1 - M_2 \pm t(s_{M_1 - M_2})$ (The estimation formula for a two-independent-sample *t* test)

$M_D \pm t(s_{MD})$ (The estimation formula for a related-samples *t* test)

Chapter 12 Analysis of Variance: One-Way Between-Subjects Design

Table for One-Way Between-Subjects ANOVA

Source of Variation	SS	df	MS	F_{obt}
Between groups		$k-1$	$\frac{SS_{BG}}{df_{BG}}$	$\frac{MS_{BG}}{MS_E}$
Within groups (error)		$N-k$	$\frac{SS_E}{df_E}$	
Total		$N-1$		

Between-Subjects Design

$F_{obt} = \frac{MS_{BG}}{MS_E}$ (Test statistic for the one-way between-subjects ANOVA)

$MS = \frac{SS}{df}$ (Mean square for each source of variation; used for all ANOVA tests)

$df_{BG} = k - 1$ (Degrees of freedom between groups)

$df_E = N - k$ (Degrees of freedom error)

$df_T = N - 1$ (Degrees of freedom total)

Effect Size (Between-Subjects Design)

$R^2 = \eta^2 = \frac{SS_{BG}}{SS_T}$ (Eta-squared estimate for proportion of variance)

$\omega^2 = \frac{SS_{BG} - df_{BG}(MS_E)}{SS_T + MS_E}$ (Omega-squared estimate for proportion of variance)

Post Hoc Tests

$t_\alpha \sqrt{MS_E\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}$ (Fisher's LSD formula)

$q_\alpha \sqrt{\frac{MS_E}{n}}$ (Tukey's HSD formula)

Chapter 13 Analysis of Variance: One-Way Within-Subjects (Repeated-Measures) Design

Table for One-Way Within-Subjects (Repeated-Measures) ANOVA

Source of Variation	*SS*	*df*	*MS*	F_{obt}
Between groups		$k - 1$	$\frac{SS_{BG}}{df_{BG}}$	$\frac{MS_{BG}}{MS_E}$
Between persons		$n - 1$	$\frac{SS_{BP}}{df_{BP}}$	
Within groups (error)		$(k - 1)(n - 1)$	$\frac{SS_E}{df_E}$	
Total		$(kn - 1)$		

Within-Subjects Design

$F_{obt} = \frac{MS_{BG}}{MS_E}$ (Test statistic for the one-way within-subjects ANOVA)

$df_{BG} = k - 1$ (Degrees of freedom between groups)

$df_{BP} = n - 1$ (Degrees of freedom between persons)

$df_E = (k - 1)(n - 1)$ (Degrees of freedom error)

$df_T = (kn) - 1$ (Degrees of freedom total)

Effect Size (Within-Subjects Design)

$\eta_P^2 = \frac{SS_{BG}}{SS_T - SS_{BP}}$ (Partial eta-squared)

$\omega_P^2 = \frac{SS_{BG} - df_{BG}(MS_E)}{(SS_T - SS_{BP}) + MS_E}$ (Partial omega-squared)

Chapter 14 Analysis of Variance: Two-Way Between-Subjects Factorial Design

ANOVA Table for Two-Way Between-Subjects Factorial Design

Source of Variation	SS	df	MS	F
Factor A		$p-1$	$\frac{SS_A}{df_A}$	$F_A = \frac{MS_A}{MS_E}$
Factor B		$q-1$	$\frac{SS_B}{df_B}$	$F_B = \frac{MS_B}{MS_E}$
A × B		$(p-1)(q-1)$	$\frac{SS_{A\times B}}{df_{A\times B}}$	$F_{A\times B} = \frac{MS_{A\times B}}{MS_E}$
Error (within groups)		$pq(n-1)$	$\frac{SS_E}{df_E}$	
Total		$npq-1$		

Between-Subjects Design

$F_A = \frac{MS_A}{MS_E}$ (Test statistic for the main effect of Factor A)

$F_B = \frac{MS_B}{MS_E}$ (Test statistic for the main effect of Factor B)

$F_{A\times B} = \frac{MS_{A\times B}}{MS_E}$ (Test statistic for the A × B interaction)

$df_A = p-1$ (Degrees of freedom for Factor A)

$df_B = q-1$ (Degrees of freedom for Factor B)

$df_{A\times B} = (p-1)(q-1)$ (Degrees of freedom for the A × B interaction)

$df_E = pq(n-1)$ (Degrees of freedom error)

$df_T = npq-1$ (Degrees of freedom total)

Effect Size (Two-Way Between-Subjects ANOVA)

$\eta_A^2 = \frac{SS_A}{SS_T}$, $\eta_B^2 = \frac{SS_B}{SS_T}$ (Eta-squared for main effects)

$\eta_{A \times B}^2 = \frac{SS_{A \times B}}{SS_T}$ (Eta-squared for the interaction)

$\omega_A^2 = \frac{SS_A - df_A(MS_E)}{SS_T + MS_E}$, $\omega_B^2 = \frac{SS_B - df_B(MS_E)}{SS_T + MS_E}$ (Omega-squared for main effects)

$\omega_{A \times B}^2 = \frac{SS_{A \times B} - df_{A \times B}(MS_E)}{SS_T + MS_E}$ (Omega-squared for the interaction)

Chapter 15 Correlation

Correlation Coefficients

$r = \frac{SS_{XY}}{\sqrt{SS_X SS_Y}}$(Pearson correlation coefficient)

$r_s = 1 - \frac{6\Sigma D^2}{n(n^2 - 1)}$ (Spearman rank-order correlation coefficient)

$r_{pb} = (\frac{M_{Y_1} - M_{Y_2}}{s_Y})(\sqrt{pq})$ (Point-biserial correlation coefficient)

$r_\phi = \frac{ad - bc}{\sqrt{ABCD}}$ (Phi correlation coefficient)

Converting the Correlation Coefficient (*r*) to *t* and χ^2

$t^2 = \frac{r^2}{(1 - r^2)/df}$ (Formula for converting *r* to *t*)

$\chi^2 = r_\phi^2 n$ (Formula for converting *r* to χ^2)

Effect Size

$r^2 = \eta^2$ (The coefficient of determination)

Chapter 16 Linear Regression and Multiple Regression

Method of Least Squares

$Y = bX + a$ (Linear equation for a straight line)

$b = \frac{SS_{XY}}{SS_X}$ (Slope of a straight line)

$a = M_Y - bM_X$ (*y*-intercept for a straight line)

Analysis of Regression

$F_{obt} = \frac{MS_{\text{regression}}}{MS_{\text{residual}}}$ (Test statistic for analysis of regression and multiple regression)

$df_{\text{regression}} = 1$ (Degrees of freedom regression with one predictor variable)

$df_{\text{residual}} = n - 2$ (Degrees of freedom residual)

$s_e = \sqrt{MS_{\text{residual}}}$ (Standard error of estimate)

Chapter 17 Nonparametric Tests: Chi-Square Tests

Chi-Square Tests

$\chi^2_{obt} = \Sigma \frac{(f_o - f_e)^2}{f_e}$ (Test statistic for the chi-square goodness-of-fit test and the chi-square test for independence)

$df = k - 1$ (Degrees of freedom for the chi-square goodness-of-fit test)

$df = (k_1 - 1)(k_2 - 1)$ (Degrees of freedom for the chi-square test for independence)

Effect Size (Chi-Square Test for Independence)

$\phi^2 = \frac{\chi^2}{n}$ (Effect size using the proportion of variance)

$\phi = \sqrt{\frac{\chi^2}{n}}$ (Effect size using the phi coefficient)

$V = \sqrt{\frac{\chi^2}{n \times df_{\text{smaller}}}}$ (Effect size using Cramer's V)

Chapter 18 Nonparametric Tests: Tests for Ordinal Data

The Sign Test

$z = \frac{x - np}{\sqrt{np(1-p)}}$ (Test statistic for the normal approximation of the sign test)

Wilcoxon Signed-Ranks *T* Test

$z = \frac{T - \mu_T}{\sigma_T}$ (Test statistic for the normal approximation of the Wilcoxon T)

$\mu_T = \frac{n(n+1)}{4}$ (The mean for the test statistic T)

$\sigma_T = \sqrt{\frac{n(n+1)(2n+1)}{24}}$ (The standard deviation for the test statistic T)

Mann–Whitney *U* Test

$z = \frac{U - \mu_U}{\sigma_U}$ (Test statistic for the normal approximation of the Mann–Whitney *U*)

$\mu_U = \frac{n_A n_B}{2}$ (The mean for the test statistic *U*)

$\sigma_U = \sqrt{\frac{n_A n_B (n_A + n_B + 1)}{12}}$ (The standard deviation for the test statistic *U*)

The Kruskal–Wallis *H* Test

$H = \frac{12}{N(N+1)}\left(\Sigma \frac{R^2}{n}\right) - 3(N+1)$ (Test statistic for the Kruskal–Wallis *H* test)

The Friedman Test

$\chi^2_R = \frac{12}{nk(k+1)}\Sigma R^2 - 3n(k+1)$ (Test statistic for the Friedman test)