Interpreting test statistics, *p*-values, and significance

Analysis	Test statistic	Null hypothesis	Alternative hypothesis	Results	p-value	significance	decision
Difference-of- means test	*t* (two-tailed) (see note 1)	$\mu_1 = \mu_2$	$\mu_1 \neq \mu_2$	big *t* (> +2.0 or < -2.0)	small *p* (< 0.05)	yes (significant difference of means)	reject H_o, accept H_a
				small *t* (< +2.0 and > -2.0)	big *p* (> 0.05)	no	don't reject H_o
	t (one-tailed) (see note 2)	$\mu_1 > \mu_2$	$\mu_1 \leq \mu_2$	big *t* (> +2.0 or < -2.0)	small *p* (< 0.05)	yes (significant difference of means)	reject H_o, accept H_a
				small *t* (< +2.0 and > -2.0)	big *p* (> 0.05)	no	don't reject H_o
Analysis of variance (ANOVA)	*F* (see note 3)	$\mu_1 = \mu_2 = \mu_3 = \ldots = \mu_k$	$\mu_1 \neq \mu_2 \neq \mu_3 \ldots \neq \mu_k$	big *F*	small *p* (< 0.05)	yes (significant difference among means)	reject H_o, accept H_a
				small *F*	big *p* (> 0.05)	no	don't reject H_o
Homogeneity of variance (Bartlett)	X^2 (see note 4)	$\sigma^2_1 = \sigma^2_2 = \sigma^2_3 = \ldots = \sigma^2_k$	$\sigma^2_1 \neq \sigma^2_2 \neq \sigma^2_3 \neq \ldots \neq \sigma^2_k$	big X^2	small *p* (< 0.05)	yes (sig. difference among variances)	reject H_o, accept H_a
				small X^2	big *p* (> 0.05)	no	don't reject H_o
Regression analysis	*F* (see note 5)	no relationship between response and predictor vars.	relationship between response and predictor vars.	big *F*	small *p* (<0.05)	yes (there is a relationship)	reject H_o, accept H_a
				small *F*	big *p* (>0.05)	no (there is not a relationship)	don't reject H_o
	t (see note 6)	$b_p = 0$	$b_p \neq 0$	big *t* (> +2.0 or < -2.0)	small *p* (< 0.05)	yes (x_p is an important predictor)	reject H_o, accept H_a
				small *t* (< +2.0 and > -2.0)	big *p* (> 0.05)	no (x_p is not an important predictor)	don't reject H_o

Notes:

1) The null hypothesis here is that the means are equal, and the alternative hypothesis is that they are not. A *big t, with a small p*-value, means that the null hypothesis is discredited, and we would assert that the *means are significantly different* (while a small *t*, with a big *p*-value indicates that they are *not*

significantly different).

2) The null hypothesis here is that one mean is greater than the other, and the alternative hypothesis is that it isn't. A big *t,* with a small *p*-value, means that the null hypothesis is discredited, and we would assert that the *means are significantly different* in the way specified by the null hypothesis (and a small *t*, with a big *p*-value means they are *not significantly different* in the way specified by the null hypothesis).

3) The null hypothesis here is that the group means are all equal, and the alternative hypothesis is that they are not. A big *F,* with a small *p*-value, means that the null hypothesis is discredited, and we would assert that the *means are significantly different* (while a small *F*, with a big *p*-value indicates that they are *not significantly different*).

4) The null hypothesis here is that the group variances are all equal, and the alternative hypothesis is that they are not. A *big* X^2, (Chi-squared) value, with a small *p*-value, means that the null hypothesis is discredited, and we would assert that the group variances *are significantly different* (while a small X^2, with a big *p*-value indicates that they are *not significantly different*).

5) The null hypothesis here is that there is not a general relationship between the response (dependent) variable and one or more of the predictor (independent) variables, and the alternative hypothesis is that there is one. A big *F,* with a small *p*-value, means that the null hypothesis is discredited, and we would assert that there is a *general relationship between the response and predictors* (while a small *F*, with a big *p*-value indicates that *there is no relationship*).

6) The null hypothesis is that the value of the *p*-th regression coefficient is 0, and the alternative hypothesis is that it isn't. A big *t,* with a small *p*-value, means that the null hypothesis is discredited, and we would assert that the *regression coefficient is not 0* (and a small *t*, with a big *p*-value indicates that it is *not significantly different from* 0).