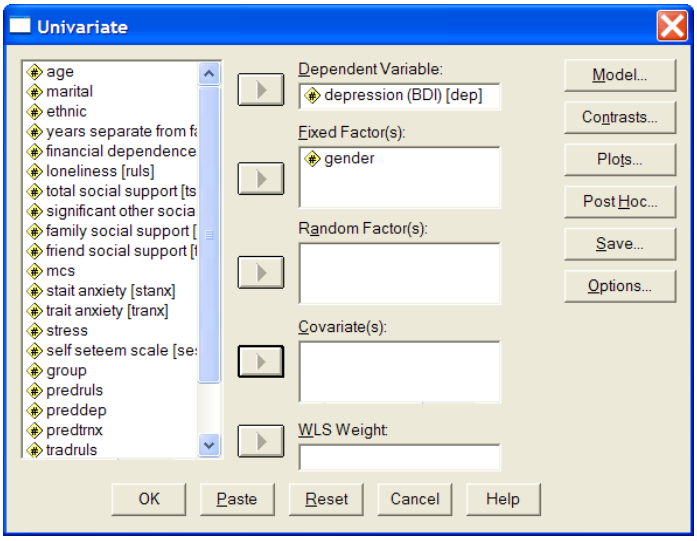
ANCOVA Example #2 – Multiple Covariates & Including a Categorical Covariate

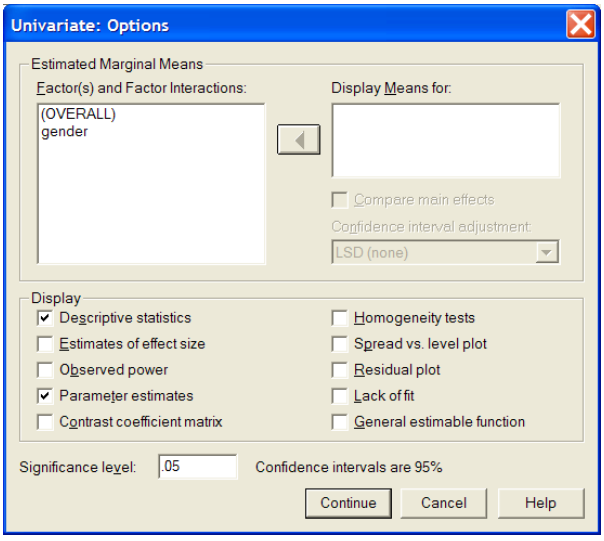
The research question concerned depression differences between women and men.

Initial ANOVA

Analyze → GLM → Univariate



click "options"



Select "Descriptive Statistics" & "Parameter estimates"

GLM output

Descriptive Statistics

Dependent Variable: depression (BDI)

gender	Mean	Std. Deviation	N
male	7.05	5.992	180
female	8.78	6.950	225
Total	8.01	6.590	405

The mean difference is…

8.78 – 7.05 = 1.73

Things to notice:

$F = t^2$ they both test group difference

GML uses a dummy code with the highest coded group as the control group, so …
a = mean of control group (females)
b = group dif male – female = -1.728

Tests of Between-Subjects Effects

Dependent Variable: depression (BDI)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	298.522[a]	1	298.522	6.975	.009
Intercept	25051.855	1	25051.855	585.356	.000
gender	298.522	1	298.522	6.975	.009
Error	17247.439	403	42.798		
Total	43530.000	405			
Corrected Total	17545.960	404			

a. R Squared = .017 (Adjusted R Squared = .015)

Parameter Estimates

Dependent Variable: depression (BDI)

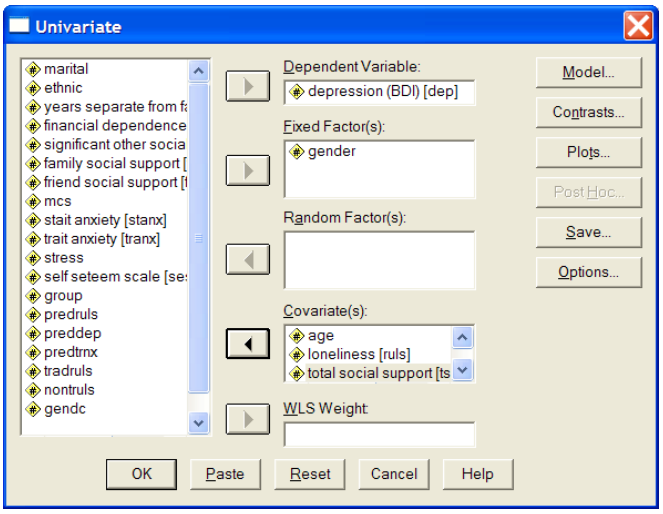
Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	8.778	.436	20.126	.000	7.920	9.635
[gender=1]	-1.728	.654	-2.641	.009	-3.014	-.442
[gender=2]	0[a]	.	.	.	.	.

a. This parameter is set to zero because it is redundant.

mean of males = a + b = 8.778 + (-1.728) = 7.050

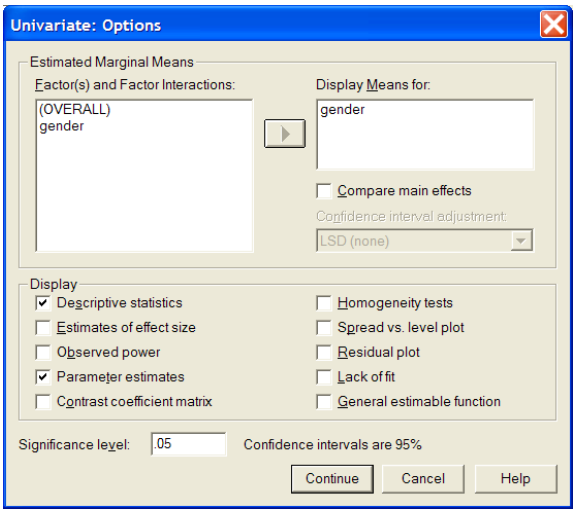
ANCOVA with Multiple Covariates

Analyze → GLM → Univariate



"Covariates" can be any quantitative, binary or coded variable.

Adding variables to the "Covariates" window will create a ANCOVA.



Moving the "IV" into the "Display Means for" window will give use the "corrected mean" for each condition of the variable.

GLM outtput

Descriptive Statistics

Dependent Variable: depression (BDI)

gender	Mean	Std. Deviation	N
male	7.05	5.992	180
female	8.78	6.950	225
Total	8.01	6.590	405

Descriptive Statistics

	Mean	Std. Deviation
age	28.48	10.885
loneliness	37.21	11.377
total social support	5.6233	1.18204

Tests of Between-Subjects Effects

Dependent Variable: depression (BDI)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	6281.245[a]	4	1570.311	55.760	.000
Intercept	40.821	1	40.821	1.450	.229
age	930.640	1	930.640	33.046	.000
ruls	2982.872	1	2982.872	105.919	.000
tss	74.807	1	74.807	2.656	.104
gender	580.881	1	580.881	20.627	.000
Error	11264.715	400	28.162		
Total	43530.000	405			
Corrected Total	17545.960	404			

a. R Squared = .358 (Adjusted R Squared = .352)

gender

Dependent Variable: depression (BDI)

gender	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
male	6.642[a]	.400	5.855	7.429
female	9.104[a]	.357	8.402	9.806

a. Covariates appearing in the model are evaluated at the following values: age = 28.48, loneliness = 37.21, total social support = 5.6233.

Parameter Estimates

Dependent Variable: depression (BDI)

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	4.340	2.633	1.649	.100	-.835	9.515
age	-.145	.025	-5.749	.000	-.195	-.096
ruls	.311	.030	10.292	.000	.251	.370
tss	-.473	.290	-1.630	.104	-1.043	.097
[gender=1]	-2.462	.542	-4.542	.000	-3.528	-1.396
[gender=2]	0[a]	.	.	.	.	.

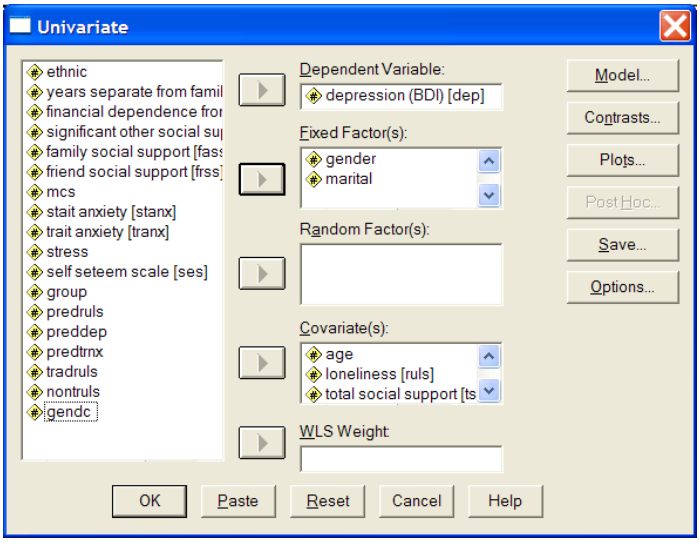
a. This parameter is set to zero because it is redundant.

Again, the regression weight for gender is the same as the corrected mean difference.

- b = the mean difference "holding the value of the covariates constant ***at their means***"

Because there are no interactions (i.e.,making the regression homogeneity assumption) the regression weights tell and test the slope of each quantitative covariate for both group, correcting for the other variables in the model.

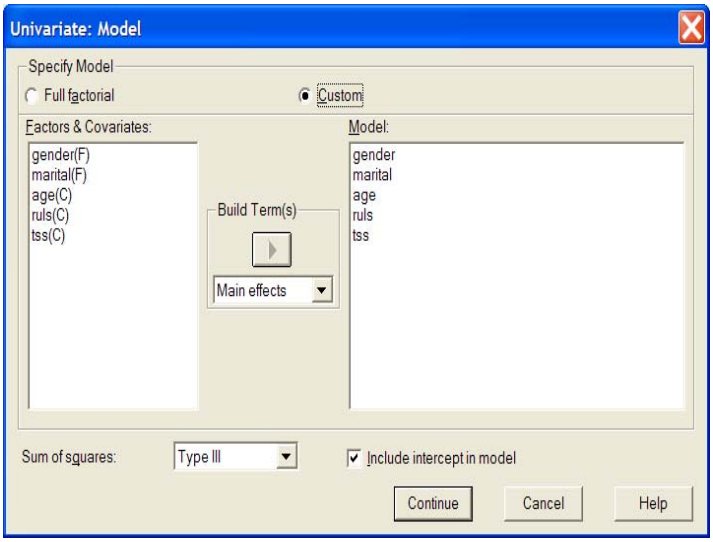
ANCOVA with Multiple Covariates Including a Categorical Covariate

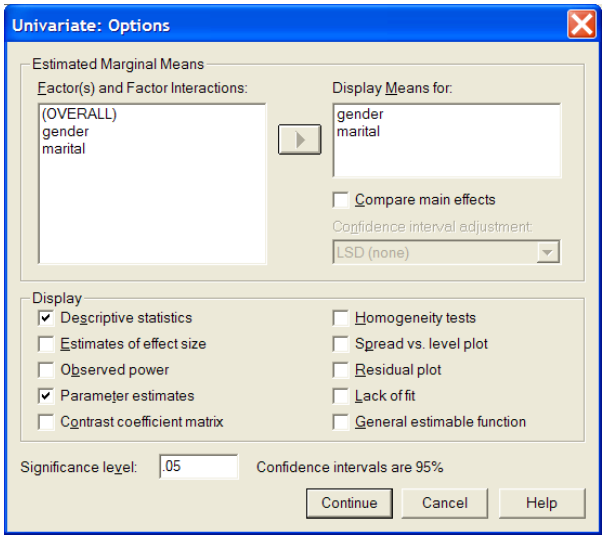


If we put more than one variable into the “Fixed Factors” window, we will obtain a factorial analysis.

If we want an ANCOVA instead of a factorial, we can specify that we want a “main effects model” -- as shown below on the left.

We would also want to get the corrected group means for each of the categorical variables (gender and marital status) that go with the ANCOVA F-tests for these variables and regression parameters that tell about the corrected effects of the quantitative variables (age, ruls,TSS) that go with the ANCOVA F-tests for these variables – as shown below on the right.





GLM output

Descriptive Statistics

Dependent Variable: depression (BDI)

gender	marital	Mean	Std. Deviation	N
male	single	7.25	5.673	122
	married	6.11	6.699	47
	divorced	8.91	6.188	11
	Total	7.05	5.992	180
female	single	10.04	8.110	120
	married	6.89	4.571	74
	divorced	8.39	5.800	31
	Total	8.78	6.950	225
Total	single	8.63	7.113	242
	married	6.59	5.483	121
	divorced	8.52	5.832	42
	Total	8.01	6.590	405

The “raw” means are above and the “corrected” means are on the right.

1. gender

Dependent Variable: depression (BDI)

gender	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
male	6.547[a]	.514	5.535	7.558
female	8.991[a]	.455	8.097	9.885

a. Covariates appearing in the model are evaluated at the following values: age = 28.48, loneliness = 37.21, total social support = 5.6233.

2. marital

Dependent Variable: depression (BDI)

marital	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
single	8.222[a]	.452	7.333	9.111
married	7.160[a]	.636	5.910	8.411
divorced	7.924[a]	.981	5.995	9.854

a. Covariates appearing in the model are evaluated at the following values: age = 28.48, loneliness = 37.21, total social support = 5.6233.

Tests of Between-Subjects Effects

Dependent Variable: depression (BDI)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	6328.474[a]	6	1054.746	37.423	.000
Intercept	11.239	1	11.239	.399	.528
gender	568.049	1	568.049	20.155	.000
marital	47.229	2	23.614	.838	.433
age	208.332	1	208.332	7.392	.007
ruls	2981.050	1	2981.050	105.769	.000
tss	57.999	1	57.999	2.058	.152
Error	11217.487	398	28.185		
Total	43530.000	405			
Corrected Total	17545.960	404			

a. R Squared = .361 (Adjusted R Squared = .351)

Notice again that the F-tests and t-tests tell the same story, except for Marital status

The F-test is a test of the “marital effect”, while the t-tests of the individual dummy codes test specific pairwise comparisons.

If either of the dummy codes (pairwise comparisons) are significant, then the F-test of that k-group effect will be significant.

Parameter Estimates

Dependent Variable: depression (BDI)

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	3.207	3.150	1.018	.309	-2.985	9.399
[gender=1]	-2.445	.545	-4.489	.000	-3.515	-1.374
[gender=2]	0[a]	.	.	.	.	.
[marital=1]	.298	1.213	.246	.806	-2.087	2.683
[marital=2]	-.764	.969	-.789	.431	-2.669	1.141
[marital=3]	0[a]	.	.	.	.	.
age	-.114	.042	-2.719	.007	-.197	-.032
ruls	.311	.030	10.284	.000	.251	.370
tss	-.421	.293	-1.435	.152	-.997	.156

a. This parameter is set to zero because it is redundant.

Note: It is possible to have a significant F, without either of the dummy-code t-tests to be significant → if the comparison group happens to be the middle-value mean, then it might be different from neither the group with the higher nor the lower mean, while those groups are different from each other

Because there are no interactions (i.e.,making the regression homogeneity assumption) the regression weights tell and test the slope of each quantitative covariate for both groups, correcting for the other variables in the model.