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

The research question concerned depression differences between women and men.

# **Initial ANOVA**

# Analyze $\rightarrow$ GLM $\rightarrow$ Univariate

age 🔨		Dependent Variable:	<u>M</u> odel
ethnic years separate from fa		Eixed Factor(s):	Co <u>n</u> trasts
financial dependence loneliness [ruls]		(*) gender	Plo <u>t</u> s
total social support [ts significant other socia			Post <u>H</u> oc
family social support [ 📑 friend social support [1		R <u>a</u> ndom Factor(s):	<u>S</u> ave
mcs stait anxiety [stanx]	$\rightarrow$		<u>O</u> ptions
trait anxiety [tranx] stress		<u>C</u> ovariate(s):	
self seteem scale [se: group	$\rightarrow$		
predruls preddep			
predtrnx tradruls		WLS Weight	
tradruls 💌			-1

Univariate: Options	
Estimated Marginal Means Eactor(s) and Factor Interactions:	Display <u>M</u> eans for:
(OVERALL) gender	
	<u>Compare main effects</u>
	Confidence interval adjustment
	LSD (none)
Display	
Descriptive statistics	Homogeneity tests
Estimates of effect size	Spread vs. level plot
Observed power	Residual plot
✓ Parameter estimates	Lack of fit
Contrast coefficient matrix	☐ <u>G</u> eneral estimable function
Significance le <u>v</u> el: .05	Confidence intervals are 95%
	Continue Cancel Help

Select "Descriptive Statistics" & "Parameter estimates"

click "options"

# **GLM** output

### **Descriptive Statistics**

Dependent Variable: depression (BDI)						
	Std.					
gender	Mean	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

#### Dependent Variable: depression (BDI)

	Type III Sum					
Source	of Squares	df	Mean Square	F	Sig.	
Corrected Model	298.522 <sup>a</sup>	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				

Tests of Between-Subjects Effects

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

#### **Parameter Estimates**

Dependent Variable: depression (BDI)						
	95% Confidence Inter					ence Interval
Parameter	В	Std. Error	t	Sig.	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 <sup>a</sup>					

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 $\rightarrow$ GLM $\rightarrow$ Univariate



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

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

Estimated Marginal Means	Display Means for
(OVERALL) gender	gender
	Compare main effects Confidence interval adjustment LSD (none)
Display	
Estimates of effect size	Spread vs. level plot
Observed power	Besidual plot
Parameter estimates	Lack of fit
Contrast coefficient matrix	☐ General estimable function
Significance le <u>v</u> el: .05 C	Confidence intervals are 95%
	Continue Cancel Help

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	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

#### gender

Dependent Variable: depression (BDI)							
	95% Confidence Interval						
gender	Mean	Std. Error	Lower Bound	Upper Bound			
male	6.642 <sup>a</sup>	.400	5.855	7.429			
female	9.104 <sup>a</sup>	.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.

#### Tests of Between-Subjects Effects

Dependent Variable: depression (BDI)							
	Type III Sum						
Source	of Squares	df	Mean Square	F	Sig.		
Corrected Model	6281.245 <sup>a</sup>	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)

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#### Parameter Estimates

					95% Confide	ence Interval
Parameter	В	Std. Error	t	Sig.	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 <sup>a</sup>					

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

Univariate			X
<ul> <li>Image: white the second second</li></ul>		Dependent Variable:	<u>M</u> odel
<ul> <li>financial dependence from</li> <li>significant other social sur</li> </ul>		Fixed Factor(s):	Co <u>n</u> trasts
<ul> <li>family social support [fass</li> <li>friend social support [frss]</li> </ul>		gender     morital	Plo <u>t</u> s
<ul> <li>♠ mcs</li> <li>♠ stait anxiety [stanx]</li> </ul>	P		Post <u>H</u> oc
<ul> <li>trait anxiety [tranx]</li> <li>stress</li> </ul>		R <u>a</u> ndom Factor(s):	<u>S</u> ave
<ul> <li>♦ self seteem scale [ses]</li> <li>♦ group</li> </ul>			Options
<ul> <li></li></ul>		<u>C</u> ovariate(s):	
predtmx     tradruls     nontruls		age     loneliness [ruls]     total social support [ts	
Wigenee j		WLS Weight	
OK <u>F</u>	aste	Reset Cancel Help	

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.

Univariate: Model	Univariate: Options
Specify Model         C Full factorial       © Custom         Eactors & Covariates:       Model:         gender(F)       gender         marital(F)       age(C)         ruls(C)       Build Term(s)       ruls         tss(C)       Utility fortune       Itss	Estimated Marginal Means Eactor(s) and Factor Interactions: (OVERALL) gender marital Compare main effects Corridence interval adjustment: LSD (none)
	Display         Image: Descriptive statistics       Homogeneity tests         Image: Estimates of effect size       Spread vs. level plot         Image: Observed power       Residual plot         Image: Parameter estimates       Lack of fit         Image: Contrast coefficient matrix       General estimable function
Sum of sguares: Type III 💌 🔽 Include intercept in model Continue Cancel Help	Significance level: 05 Confidence intervals are 95% Continue Cancel Help

# **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.

### **Tests of Between-Subjects Effects**

Dependent Variable: depression (BDI)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	6328.474 <sup>a</sup>	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)

#### **Parameter Estimates**

Dependent Variable: depression (BDI)						
				95% Confidence Interv		ence Interval
Parameter	В	Std. Error	t	Sig.	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 <sup>a</sup>					
[marital=1]	.298	1.213	.246	.806	-2.087	2.683
[marital=2]	764	.969	789	.431	-2.669	1.141
[marital=3]	0 <sup>a</sup>					
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.

#### 1. gender

Dependent Variable: depression (BDI)					
			95% Confidence Interval		
gender	Mean	Std. Error	Lower Bound	Upper Bound	
male	6 5/17a	51/	5 535	7 558	

8.097

9.885

.455 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)

8.991<sup>a</sup>

female

			95% Confidence Interval		
marital	Mean	Std. Error	Lower Bound	Upper Bound	
single	8.222 <sup>a</sup>	.452	7.333	9.111	
married	7.160 <sup>a</sup>	.636	5.910	8.411	
divorced	7.924 <sup>a</sup>	.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.

# 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.

Note: It is possible to have a significant F, without either of the dummy-code t-tests to be significant  $\rightarrow$  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.