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

The research question concerned depression differences between people living in rural and urban areas.

Initial ANOVA

Analyze \rightarrow GLM \rightarrow Univariate

🔚 Univariate		X 👘 Univariate: Options	×
age marital marital wears separate from family [sepfam] financial dependence from family [fi loneliness [ruls] total social support [tss] significant other social support [soss] family social support [fass] fining social support [fass]	Dependent Variable: Mod Image: depression (BDI) [dep] Contration Fixed Factor(s): Plot Image: depression (BDI) [dep] Post [Image: depression (BDI) [dep] Plot Image: depression (BDI) [dep] Post [Image: depression (BDI) [dep] Image: depression (BDI) [dep] Image: depression (BDI) [dep] Plot Image: depression (BDI) [dep] Plot Image: depression (BDI) [dep] Image: depression (BDI) [dep] Image: depression (BD	Iel Display asts Descriptive statistics Is Descriptive statistics Inc Parameter estimates Is Lack of fit Contrast coefficient matrix General estimable function Heteroskedasticity Tests Modified Breusch-Pagan test Is Model	
 	<u>C</u> ovariate(s):	the Univariate: Estimated Marginal Means	×
	WLS Weight Paste Reset Cancel	Estimated Marginal Means	

click "options" & Select "Descriptive Statistics" & "Parameter estimates" click "EM Means" & push the IV into the "Display means for" window

GLM output

Descriptive Statistics

Dependent Variable: depression (BDI)

rural_urban	Mean	Std. Deviation	Ν
rural	7.0500	5.99187	180
urban	8.7778	6.95036	225
Total	8.0099	6.59019	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 (urban) b = group dif rural – urban = -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
rural_urban	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)

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

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

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

ANCOVA with Multiple Covariates

Analyze \rightarrow GLM \rightarrow Univariate

tin Univariate	×	🔚 Univariate: Options		×
 marital depression depression depression depression financial dependence from family [sepfam] financial dependence from family [fi significant other social support [soss] family social support [fass] friend social support [fass] friend social support [fras] frait anxiety [stanx] depression (BDI) [dep_orig] stress covariate(s): age 	ble: BDI) [dep] Contrasts Plots Post Hoc EM Means Save Options	Display Descriptive statistics Estimates of effect size Observed power Parameter estimates Contrast coefficient matrix Heteroskedasticity Tests Modefied Breusch-Pagan test Modefiel	 Homogeneity tests Spread vs. level plot Residual plot Lack of fit General estimable function 	
foreiness foreiness		Estimated Marginal Means Eactor(s) and Factor Interactions: (OVERALL) rural_urban	Display <u>M</u> eans for:	

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

Request the same ou	tput as the last analysis

GLM output

Descriptive Statistics

Dependent Variable: depression (BDI)						
rural_urban	Mean	Std. Deviation	N			
rural	7.0500	5.99187	180			
urban	8.7778	6.95036	225			
Total	8.0099	6.59019	405			

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			
rural_urban	580.881	1	580.881	20.627	.000			
tss	74.807	1	74.807	2.656	.104			
ruls	2982.872	1	2982.872	105.919	.000			
age	930.640	1	930.640	33.046	.000			
Error	11264.715	400	28.162					
Total	43530.000	405						
Corrected Total	17545.960	404						

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

Parameter Estimates

dep	pression (BD	I)		Dependent Variat	ole: depres	sion (BDI)				
		95% Confid	ence Interval						95% Confid	ence Interval
	Std Error	Lower Bound	ower Bound Upper Bound	Parameter	В	Std. Error	t	Sig.	Lower Bound	Upper Bound
a	400		7 400	Intercept	4.340	2.633	1.649	.100	835	9.515
	.400	5.855	7.429	[rural_urban=1]	-2.462	.542	-4.542	.000	-3.528	-1.396
a	.357	8.402	9.806	[rural_urban=2]	0ª					
ring in the model are evaluated at the		tss	473	.290	-1.630	.104	-1.043	.097		
age = 28.48, Ioneliness = 37.21, total social			ruls	.311	.030	10.292	.000	.251	.370	
				ade	145	.025	-5.749	.000	195	096

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

Again, the regression weight for rural_urban is the same as the corrected mean difference (9.104-6.642 = 2.462), but now corrected for multiple covariates.

The regression weights tell and test the slope of each quantitative covariate for both groups, correcting for the other variables in the model.

rural_urban

			95% Confidence Interval				
rural_urban	Mean	Std. Error	Lower Bound	Upper Bound			
rural	6.642 ^a	.400	5.855	7.429			
urban	9.104 ^a	.357	8.402	9.806			

a. Covariates appea following values: a support = 5.6233.

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 both the corrected group means for each of the categorical variables (rural_urban and marital status) that go with the ANCOVA F-tests for these variables and the *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.

×

×

Compare main effects

ta Univariate: Model

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Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image: Specify Model Image Imag	Display Image: Descriptive statistics Image: Descriptive statistics
	Estimated Marginal Means Eactor(s) and Factor Interactions: (OVERALL) rural_urban marital Display Means for: rural_urban marital

Descriptive Statistics

Dependent Variable:	depression (BDI)
Dependent variable.	uepression (DDI)

rural_urban	marital	Mean	Std. Deviation	Ν
rural	single	7.2459	5.67336	122
	married	6.1064	6.69923	47
	divorced	8.9091	6.18796	11
	Total	7.0500	5.99187	180
urban	single	10.0417	8.10995	120
	married	6.8919	4.57081	74
	divorced	8.3871	5.80044	31
	Total	8.7778	6.95036	225
Total	single	8.6322	7.11327	242
	married	6.5868	5.48281	121
	divorced	8.5238	5.83195	42
	Total	8.0099	6.59019	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 ^a	6	1054.746	37.423	.000
Intercept	11.239	1	11.239	.399	.528
rural_urban	568.049	1	568.049	20.155	.000
marital	47.229	2	23.614	.838	.433
tss	57.999	1	57.999	2.058	.152
ruls	2981.050	1	2981.050	105.769	.000
age	208.332	1	208.332	7.392	.007
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 Interval	
Parameter	В	Std. Error	t	Sig.	Lower Bound	Upper Bound
Intercept	3.207	3.150	1.018	.309	-2.985	9.399
[rural_urban=1]	-2.445	.545	-4.489	.000	-3.515	-1.374
[rural_urban=2]	0ª					
[marital=1]	.298	1.213	.246	.806	-2.087	2.683
[marital=2]	764	.969	789	.431	-2.669	1.141
[marital=3]	0ª					
tss	421	.293	-1.435	.152	997	.156
ruls	.311	.030	10.284	.000	.251	.370
age	114	.042	-2.719	.007	197	032

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

1. rural_urban

Dependent Variable: depression (BDI)

			95% Confidence Interval		
rural_urban	Mean	Std. Error	Lower Bound	Upper Bound	
rural	6.547 ^a	.514	5.535	7.558	
urban	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)

			95% Confidence Interval		
marital	Mean	Std. Error	Lower Bound	Upper Bound	
single	8.222ª	.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.

Notice again that the F-tests and t-tests tell the

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 higher and lower means 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.

same story, except for Marital status