Chapter 11 – Analysis of Variance

Using your College Student data file, do the following problems. Print your outputs after typing your interpretations on them. Please circle the key parts of the output that you use for your interpretation.

11.1. Identify an example of a variable measured at the scale/normally distributed level for which there is a statistically significant overall difference (*F*) between the three marital status groups. Complete the analysis and interpret the results. Do appropriate post hoc tests.

11.2. Use the Kruskal-Wallis test, with Mann-Whitney post hoc follow-up tests if needed, to run the same problem as 11.1. Compare the results.

11.3 Do gender and marital status seem to have an effect on student's height and do gender and marital status interact? Run the appropriate SPSS analysis and interpret the results.

Selection of the Statistic

Another type of ANOVA, factorial univariate analysis of variance is an appropriate statistic to choose to analyze Problem 11.3. The interaction between the independent variables will be graphed in the so-called Profile Plot. This plot can help you see what's going on with the variables.

Key elements include:

- Two independent variables each with a few levels (in this case gender and marital status). The variables can be nominal (which is the case in this example) or ordinal, with a few levels.
- One scale, dependent variable (in this case student's height)

How to Produce the Selected SPSS Output

To answer Problem 11.3 with Windows:

- Click on Analyze ⇒ General Linear Model ⇒ Univariate.
- Highlight student height in inches and move it into the Dependent variable box
- Highlight gender of student and marital status and move them into the Fixed Factor box

- Click on Plots. This will open the Univariate: Profile Plots window
- Highlight marital under Factors and move it into the Horizontal Axis box
- Highlight gender under Factors and move it into the Separate Lines box
- Click on Add
- Click on Continue
- Click on Options. This will open the Univariate: Options window
- Select Descriptive statistics and Estimates of Effect size
- Click on Continue and O.K

How to answer Problem 11.3 with syntax:

```
UNIANOVA
  height  BY gender marital
  /METHOD = SSTYPE(3)
  /INTERCEPT = INCLUDE
  /PLOT = PROFILE( marital*gender )
  /PRINT = DESCRIPTIVE ETASQ
  /CRITERIA = ALPHA(.05)
  /DESIGN = gender marital gender*marital .
```

SPSS Output for Problem 11.3

Univariate Analysis of Variance

Between-Subjects Factors

		Value Label	N
gender of student	1	males	26
	2	females	23
marital status	1	single	20
	2	married	18
	3	divorced	11

Number of observations in each level of each independent variable

Levels of the two independent variables

Two independent variables, gender and marital status.

Descriptive Statistics

This table has divided the observations into six groups; males who are single, males who are married, males who are divorced, females who are single, females who are married, and females who are divorced. There are also totals.

Dependent Variable: student height in inches

gender of student	marital status	Mean	Std. Deviation	N
males	single	69.7143	2.6437	14
	married	72.1429	2.1931	7
	divorced	69.0000	3.1623	5
	Total	70.2308	2.8044	26
females	single	64.6667	1.7512	6
	married	63.9091	1.5783	11
	divorced	63.5000	3.0166	6
	Total	64.0000	2.0226	23
Total	single	68.2000	3.3498	20
	married	67.1111	4.4969	18
	divorced	66.0000	4.0988	11
	Total	67.3061	3.9802	49

Always check the interaction effect first, then the significance levels of the independent variables. Ignore the corrected model and intercept lines.

Interaction

The *F* or ANOVA value

The *p* value

Tests of Between-Subjects Effects

Dependent Variable: student height in inches

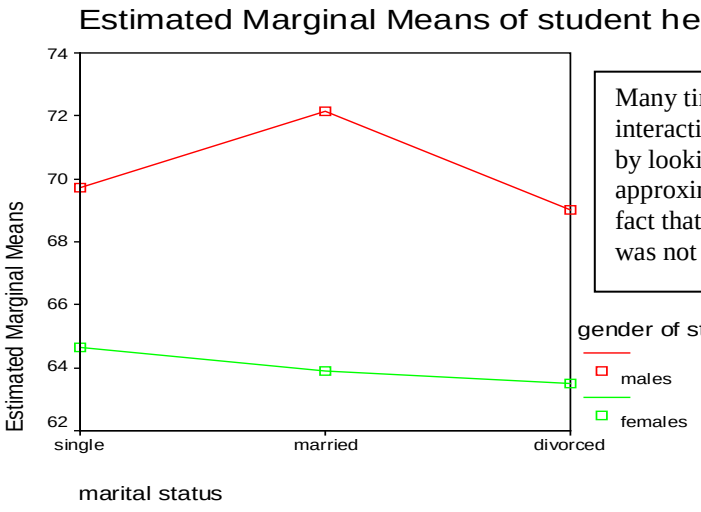
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Eta Squared
Corrected Model	514.951[a]	5	102.990	18.042	.000	.677
Intercept	193618.932	1	193618.932	33918.869	.000	.999
GENDER	420.666	1	420.666	73.694	.000	.632
MARITAL	21.230	2	10.615	1.860	.168	.080
GENDER * MARITAL	24.268	2	12.134	2.126	.132	.090
Error	245.457	43	5.708			
Total	222736.000	49				
Corrected Total	760.408	48				

a. R Squared = .677 (Adjusted R Squared = .640)

This indicates the percent of variance in the dependent variable predictable from both of the independent variables and the interaction.

This indicates the amount of variance in the dependent variable that can be explained by each source. Eta is one measure of effect size.

Profile Plots



Many times it is easier to see the interaction (and what is really going on) by looking at the plot. These lines are approximately parallel, as indicated by the fact that the gender* marital interaction was not significant, $F = 2.13$, $p = .132$.

Description of Output 11.3

The first table shows the number of students in each level of the two independent variables. The second table shows the means, *SD*'s, and *n*'s for each of the six cells as well as for total. The third table is the factorial ANOVA table. Note, from the significance column, that the Sig. for the interaction (GENDER*MARITAL) is not significant (p =.132). Gender is significant ($p < .001$) and eta^2 for gender is .63. Thus, sixty-three percent of the variance in student height in inches can be predicted from gender. Eta (not squared) for gender is about .795. This is an effect size measure. Because the interaction was not significant, the Profile Plot shows that the lines for males and females are approximately parallel. You can also see that the line for males' heights is consistently higher than the one for females. This shows graphically what the ANOVA (F) and eta for gender indicated. Males are significantly taller and there is a very large effect of gender on height.

Example of APA Tables, Results and Discussion for Problem 11.3

Results

Table 11.3a shows the means and standard deviations for the levels of marital status by gender. Table 11.1b shows that there was not a significant interaction between gender and marital status on student height ($p < .132$). Looking at the main effect of gender, there was a significant difference between the genders on student height in inches, F (1,43) = 73.69, $p < .001$. Males were taller than females by approximately 6 inches in this sample (see Table 11.1a). Eta for gender was about .795, which according to Cohen (1988) is a large effect.

Table 11.3a

Means, Standard Deviations, and n for Student Height as a Function of Gender and Marital Status

	Males			Females			Total	
Marital Status	*n*	*M*	*SD*	*n*	*M*	*SD*	*M*	*SD*
Single	14	69.71	2.64	6	64.67	1.75	68.20	3.34
Married	7	72.14	2.19	11	63.91	1.58	67.11	4.50
Divorced	5	69.00	3.16	6	63.50	3.02	66.00	4.10
Total	26	70.23	2.8	23	64.00	2.02	67.31	3.98

These are the average student heights for each gender group.

The information in this table is from the ANOVA table in the SPSS output.

Table 11.3b

Two-Way Analysis of Variance for Student Height as a Function of Gender and Marital Status

Variable and source	*df*	*MS*	*F*	η^2
Student Height				
Gender	1	420.67	73.69**	.632
Marital	2	10.62	1.86	.080
Gender*Marital	2	12.13	2.13	.090
Error	43	5.71		

Note. η = .79 = effect size.
**p < .001

Asterisk footnotes are used because *p* (Sig.) is not included in the table as a separate column.

Discussion

As seen in previous literature, there is a relationship between gender and student height, with males taller than females (Jones, 1999; Blake, 2000). This might be explained by evolutionary tendencies for males to be taller than females. As seen from other articles, it was not unexpected that there was no relationship between marital status and student height and no interaction of marital and gender.

11.4. Do gender and having children interact and do either seem to affect current GPA?

11.5. Are there differences between the age groups in regard to the average number of hours they a) study, b) work, and c) watch TV?