Test of Mean Differences Series Part 5: One-way ANCOVA

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Introduction to the One-way ANCOVA

• Analysis of covariance is a multivariate statistical method in which the dependent variable is a quantitative variable and the independent variables are a mixture of nominal variables and quantitative variables (Sage Publication).

• Analysis of covariance is used to test the main and interaction effects of categorical variables on a continuous dependent variable, controlling for the effects of selected other continuous variables, which co-vary with the dependent. The control variables are called the "covariates" (lehigh.edu).

• The one-way ANCOVA is used to determine whether there are any significant differences between two or more independent (unrelated) groups on a dependent variable. However, whereas the ANOVA looks for differences in the group means, the ANCOVA looks for differences in adjusted means (Laerd Statistics).
Examples appropriate for the One-way ANCOVA

• In experimental designs, to control for factors which cannot be randomized but which can be measured on an interval scale.

• In observational designs, to remove the effects of variables which modify the relationship of the categorical independents to the interval dependent.

• In regression models, to fit regressions where there are both categorical and interval independents.
Statistical Assumptions of the One-way ANCOVA

- Dependent variable and covariate variable(s) should be measured on a continuous scale.
- Independent variable should consist of two or more categorical, independent groups.
- Independence of observations.
- No significant outliers in the differences between the two related groups.
- Residuals should be approximately normally distributed for each category of the independent variable.
- There needs to be homogeneity of variances.
- Covariate should be linearly related to the dependent variable at each level of the independent variable.
- Homoscedasticity of the standardized residuals.
- Homogeneity of regression slopes.
Research Scenario

A research is conducting a pilot study to determine if an oral treatment intervention will have an effect on the oral condition of cancer patients.
Research question No. 1

Does the treatment intervention, aloe juice, predict the oral condition of cancer patients?
Research question No. 2

Is initial cancer stage a contributing predictor of oral condition of cancer patients receiving aloe juice treatment?
SPSS > Analyze > General Linear Model > Univariate
Dependent List: Week 6 oral condition (TOTAL CW6)
Fixed Factor: treatment group [TRT]
Descriptive
Dependent Variable: Week 6 oral condition

<table>
<thead>
<tr>
<th>treatment group</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Placebo</td>
<td>9.93</td>
<td>3.970</td>
<td>14</td>
</tr>
<tr>
<td>aloe juice</td>
<td>8.78</td>
<td>2.635</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td>9.48</td>
<td>3.489</td>
<td>23</td>
</tr>
</tbody>
</table>
## Tests of Between-Subjects Effects

**Dependent Variable:** Week 6 oral condition

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>7.255a</td>
<td>1</td>
<td>7.255</td>
<td>.585</td>
<td>.453</td>
</tr>
<tr>
<td>Intercept</td>
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<td>1</td>
<td>1916.994</td>
<td>154.546</td>
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<tr>
<td>TRT</td>
<td>7.255</td>
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<td>7.255</td>
<td>.585</td>
<td>.453</td>
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<tr>
<td>Error</td>
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<td>21</td>
<td>12.404</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2334.000</td>
<td>23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>267.739</td>
<td>22</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. R Squared = .027 (Adjusted R Squared = -.019)
SPSS > Analyze > General Linear Model > Univariate
Dependent List: Week 6 oral condition (TOTAL CW6)
Fixed Factor: treatment group [TRT]
Covariate(s): initial cancer stage, coded 1 through 4 [STAGE]
Options <click>
Descriptive statistics <click>
Continue <click>, OK <click>
Tests of Between-Subjects Effects
Dependent Variable: Week 6 oral condition

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
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<td>40.073</td>
<td>4.272</td>
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<tr>
<td>Intercept</td>
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<td>24.870</td>
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<tr>
<td>STAGE</td>
<td>72.891</td>
<td>1</td>
<td>72.891</td>
<td>7.771</td>
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<tr>
<td>TRT</td>
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<td>1.854</td>
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<tr>
<td>Error</td>
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<td>20</td>
<td>9.380</td>
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<tr>
<td>Total</td>
<td>2334.000</td>
<td>23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>267.739</td>
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</tr>
</tbody>
</table>

\(^a\) R Squared = .299 (Adjusted R Squared = .229)
An ANCOVA analysis was conducted to investigate if the pilot study of *aloe juice treatment* would improve the oral condition of cancer patients after week 6. The oral condition of the Placebo group \([N = 14, \text{ mean } = 9.93]\) was higher than the Treatment group \([N = 9, \text{ mean } = 8.78]\) indicating an improvement of oral condition. However, the between-subjects effects was not significant \(p = .453, R\text{-squared} = .027\) at the .05 level for this pilot study. Including the covariate, *Initial cancer stage*, into the analysis improved the model \(p = .181, R\text{-squared} = .299\). Even though the addition of *Initial cancer stage* is not statistically significant in the model, there is improvement of the omnibus statistical significance and R-squared value indicating support for further studies.
Questions ???
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