1. Click on “Begin Assessment” button.
2. Scroll down to begin quiz.
1. TRUE or FALSE: The Analysis of Variance (ANOVA) approach for comparing 4 different means will require all of the following separate comparisons: $\bar{x}_1 - \bar{x}_2$, $\bar{x}_1 - \bar{x}_3$, $\bar{x}_1 - \bar{x}_4$, $\bar{x}_2 - \bar{x}_3$, $\bar{x}_2 - \bar{x}_4$, and $\bar{x}_3 - \bar{x}_4$.
   True
   False

2. TRUE or FALSE: The alternative hypothesis in ANOVA is $H_a: \mu_1 \neq \mu_2 \neq \cdots \neq \mu_k$.
   True
   False
3. TRUE or FALSE: If the null hypothesis is false, the observed variability in the sample means will be greater than the variability you would expect if the means are equal.

   True
   False

4. The P-value for an ANOVA will be small when the $F$ statistic is large.

   True
   False
Researchers performed a double-blind study on the effects of a nonsteroidal anti-inflammatory drug (NSAID) given before and after arthroscopic knee surgery. A sample of 83 patients undergoing elective knee arthroscopy were randomly divided into three treatment groups. Group 1 was given the drug before and after surgery. Group 2 was given a placebo before surgery and the drug after. Group 3 was given the placebo before and after surgery. Researchers compared the mean pain scores of the patients in the three treatment groups one day after surgery. (Data from EESEE.)
Self Assessment for Lesson 83

5. What is the appropriate null hypothesis for this study?

\[ H_0: \mu_1 = \mu_2 = \mu_3 \]
\[ H_0: \mu_1 = \mu_2, \mu_1 = \mu_3, \text{ and } \mu_2 = \mu_3 \]
\[ H_0: \bar{x}_1 = \bar{x}_2 = \bar{x}_3 \]
\[ H_0: \bar{x}_1 = \bar{x}_2, \bar{x}_1 = \bar{x}_3, \text{ and } \bar{x}_2 = \bar{x}_3 \]

6. What is the appropriate alternative hypothesis for this study?

\[ H_a: \mu_1 \neq \mu_2 \neq \mu_3. \]
\[ H_a: \mu_1 \neq \mu_2, \mu_1 \neq \mu_3, \text{ and } \mu_2 \neq \mu_3 \]
\[ H_a: \bar{x}_1 \neq \bar{x}_2 \neq \bar{x}_3. \]
\[ H_a: \bar{x}_1 \neq \bar{x}_2, \bar{x}_1 \neq \bar{x}_3, \text{ and } \bar{x}_2 \neq \bar{x}_3 \]
\[ H_a: \text{at least one mean is different from the others.} \]
7. What is the F-statistic for the ANOVA comparing the mean pain scores of the three knee surgery treatment groups one day after surgery?
8. What is the P-value for the ANOVA comparing the mean pain scores of the three knee surgery treatment groups one day after surgery?
9. On the basis of the ANOVA computer output given above, which one of the following conclusions is correct? Use $\alpha = 0.05$.

The mean pain score one day after surgery does not differ significantly among the three treatment groups.

The mean pain score one day after surgery differs significantly among all three treatment groups.

The mean pain score one day after surgery for treatment group 1 is significantly lower than treatment group 3.

The mean pain score one day after surgery for treatment group 1 is significantly lower than treatment group 2.
Click on the “Grade Quiz” button to see how you did.

Questions correct:

Percentage correct:

Click on the “Correct” button to highlight your correct answers in green and wrong answers in red. For question solutions either:

- shift-click on the “Ans” button that appears next to the free-response box or

- shift-click on the correct answer for the multiple choice questions.
Solutions to Quizzes

Solution to Quiz: 1. The ANOVA approach allows us to test for equality of means in one combined comparison.
Solution to Quiz: 2. The alternative hypothesis is: “$H_a$: at least one mean differs from the others.”
Solution to Quiz:  3. When the null hypothesis is true, we expect that the sample means will be close to each other and the variability in the sample means will be small. When the alternative hypothesis is true, the variability in the sample means will be large.

End Quiz
Solution to Quiz: 4. No additional information.

End Quiz
Solution to Quiz:  5. The null hypothesis comparing the mean pain scores from the three knee surgery treatment groups is $H_0: \mu_1 = \mu_2 = \mu_3$.  

End Quiz
Solution to Quiz: 6. The alternative hypothesis is written: “$H_a$: at least one mean is different from the others.”
Solution to Quiz: 7. The F-statistic in the ANOVA table is given below “F” as 4.79.

Analysis of Variance for Pain Score

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<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
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<td>5107</td>
<td>2553</td>
<td>4.79</td>
<td>0.012</td>
</tr>
<tr>
<td>Error</td>
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<td>34146</td>
<td>534</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>66</td>
<td>39252</td>
<td></td>
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</tr>
</tbody>
</table>

Individual 95% CIs For Mean
Based on Pooled StDev

Pooled StDev = 23.10
Solution to Quiz: 8. The P-value in the ANOVA table is given below “P” as 0.012.

Analysis of Variance for Pain Score

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Individual 95% CIs For Mean Based on Pooled StDev

Pooled StDev = 23.10

End Quiz
Solution to Quiz: 9. Because the P-value is less than 0.05, we reject the null hypothesis and conclude that at least one mean pain score is different among the three treatment groups. We then look at the 95% confidence intervals for the three means and look for the intervals that do not overlap. The confidence intervals for treatments 1 and 3 do not overlap, therefore, we conclude that the mean pain score one day after surgery for treatment group 1 is significantly lower than treatment group 3. The confidence intervals overlap for treatment groups 1 and 2 and for treatment groups 2 and 3. We cannot conclude that the mean pain score for treatment group 2 differs significantly from groups 1 and 3.

End Quiz