

TOPIC: MULTIPLE COMPARISONS: TUKEY-KRAMER

Tukey-Kramer Test

◆ ANOVA compares 3+ means. If H_0 is rejected, **Post-hoc** tests can tell you *which* means are different.

► Post-Hoc Tests, like **Tukey-Kramer**, test _____ of means against each other.

EXAMPLE

In an ANOVA test on mean weekly study time for different grade levels, you reject H_0 : Students in grades 10-12 study for the same amount of time. Determine which pair(s) of means are different with $\alpha = 0.05$.

$N =$ _____ $k =$ _____

$df =$ _____ Critical Value = _____

MSE = _____

| Grade | 10 | 11 | 12 |
|-------------|----|-----|----|
| Study Time | 3 | 4.3 | 6 |
| Sample Size | 10 | 10 | 10 |

| 10 th & 11 th Grade | 11 th & 12 th Grade | 10 th & 12 th Grade |
|---|--|--|
| H_0 : | $H_0: \mu_{11} = \mu_{12}$ | $H_0: \mu_{10} = \mu_{12}$ |
| H_a : | $H_a: \mu_{11} \neq \mu_{12}$ | $H_a: \mu_{10} \neq \mu_{12}$ |
| $q_0 =$ | $q_0 =$ | $q_0 =$ |
| — | — | — |
| $\sqrt{\left(\frac{\text{—}}{2}\right) \cdot \left(\frac{1}{\text{—}} + \frac{1}{\text{—}}\right)}$ | $\sqrt{\left(\frac{4.448}{2}\right) \cdot \left(\frac{1}{10} + \frac{1}{10}\right)}$ | $\sqrt{\left(\frac{4.448}{2}\right) \cdot \left(\frac{1}{10} + \frac{1}{10}\right)}$ |
| q_0 [> <] Crit. Val. [REJECT FTR] H_0 . | q_0 [> <] Crit. Val. [REJECT FTR] H_0 . | q_0 [> <] Crit. Val. [REJECT FTR] H_0 . |



HOW TO: Perform Tukey-Kramer Test

- 1) Verify: ANOVA H_0 was rejected? ☐
- 2) Crit. Val.: Studentized Range q -table
 $df = N - k$
 $N = \#$ of total obs. $k = \#$ of groups
- 3) Get MSE from ANOVA readout
One-way ANOVA
✓ Error MS=
For each pair of groups:
4) $H_0: \mu_1 = \mu_2, \quad H_a: \mu_1 \neq \mu_2$
5) Test Statistic: q_0
6) Interpret: Compare q_0 & Crit. Val.

New

$$q_0 = \frac{\bar{x}_2 - \bar{x}_1}{\sqrt{\left(\frac{s^2}{2}\right) \cdot \left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

$s^2 = \text{MSE from one-way ANOVA}$

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EXAMPLE

A nutritionist wants to compare the effectiveness of three different diet plans (Diet A, Diet B, and Diet C) in terms of weight loss over a 6-week period. She randomly assigns 15 participants to one of the three diet groups, with 5 participants per group. After 6 weeks, the amount of weight (in pounds) lost by each participant is recorded. A one-way ANOVA test showed that at least one plan led to a different average weight loss. Perform a Tukey-Kramer Test using $\alpha = 0.05$ to see which pair(s) of means are different.

| Plan | Weight Loss (lbs) | | | | |
|------|-------------------|----|---|----|----|
| A | 8 | 9 | 6 | 10 | 7 |
| B | 4 | 5 | 6 | 5 | 4 |
| C | 10 | 12 | 9 | 11 | 13 |

$$q_0 = \frac{\bar{x}_2 - \bar{x}_1}{\sqrt{\left(\frac{s^2}{2}\right) \cdot \left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$