

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 $\alpha = 0.05$.

$N = \underline{\hspace{2cm}}$ $k = \underline{\hspace{2cm}}$

$df = \underline{\hspace{2cm}}$ Critical Value = $\underline{\hspace{2cm}}$

MSE = $\underline{\hspace{2cm}}$

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 :	$H_a: \mu_{11} \neq \mu_{12}$	$H_a: \mu_{10} \neq \mu_{12}$
$q_0 =$	$q_0 =$	$q_0 =$
—	—	—
$\sqrt{\left(\frac{\hspace{1cm}}{2}\right) \cdot \left(\frac{1}{\hspace{1cm}} + \frac{1}{\hspace{1cm}}\right)}$	$\sqrt{\left(\frac{4.448}{2}\right) \cdot \left(\frac{1}{10} + \frac{1}{10}\right)}$	$\sqrt{\left(\frac{4.448}{2}\right) \cdot \left(\frac{1}{10} + \frac{1}{10}\right)}$
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) $H_0: \mu_1 = \mu_2$, $H_a: \mu_1 \neq \mu_2$
- 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

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