ANOVA: Comparing More Than Two Means

10.1 ANOVA: The Completely Randomized Design

1. Is there a difference between the calorie content of sandwiches at the three biggest burger chains? Use the data provided below and a 1% significance level to test the claim that at least one of the chains has a different calorie count from the others. (Note: $\sum y_i = 23,480, \sum y_i^2 = 15,733,800$)

McDonald's		Wendy's		Burger King	
350		290		760	
440		570		520	
750		300		1140	
330		800		340	
390		330		750	
330		290		1040	
510		400		820	
460		660		260	
390		400		1230	
620		250		800	
540		330		520	
380		580		1270	
410		260		460	
800		510		520	
380					
n = 15		n = 14		n = 14	
Sum = 7080		Sum = 5970		Sum = 10430	

2. When a person wants to lose weight they are usually interested in minimizing the loss of lean mass fat loss, while maximizing fat loss. In 2005, researchers had previously untrained women participate in a 16 week study to determine the effects of four weight loss strategies on body composition. A summary of their findings is given below. Use a 2.5% level of significance to test the claim that each of the four strategies produces the same amount of fat loss.

   Note: $\sum y_i = 302.4, \sum y_i^2 = 2053.92$

Low Fat	Low Carb	Low Fat + RE	Low Carb + RE
$n = 12$	$n = 12$	$n = 12$	$n = 12$
$T = 60$	$T = 70.8$	$T = 66$	$T = 105.6$

   *RE = resistance training

3. The fuel consumption of an automobile is affected by the way it is driven. Researchers ran a series of tests involving three different driving styles. The fuel consumption was tracked during 18 fifty-mile trips using the three different styles. Use the results below and a 5% significance level to test the claim that the three different driving styles burn different average amounts of fuel

   $\sum y_i = 32.39, \sum y_i^2 = 58.3747$

Style A	Style B	Style C
1.75	1.85	1.85
1.65	1.81	1.85
1.71	1.79	1.90
1.66	1.78	1.89
1.76	1.86	1.85
1.76	1.83	1.84

$T_A = 10.29, T_B = 10.92, T_C = 11.18$

Answers:

1. Claim: At least one of the chains has a different calorie count from the others.

$H_0 : \mu_M = \mu_B = \mu_W$

H_a : At least one of the chains has a different average calorie count.

$CF = 12,821,172.09$

Source	DF	SS	MS	F
Chain	2	836,716.478	418,358.239	8.061
Error	40	2,075,911.429	51,897.786	
Total	42	2,912,627.907		

$Test\ Stat : F = \frac{418,358.239}{51,897.786} \approx 8.061$

$Critical\ Value(s) : f_{2,40,0.01} = 5.179$

$Initial\ Conclusion$: Reject the null, support the alternative

$Final\ Conclusion$: The sample data support the claim...

This implies at least one of the fast-food chains has a significantly different calorie count than the others.

2. Claim: Each of the four strategies produces the same amount of fat loss.

$H_0 : \mu_{LF} = \mu_{LC} = \mu_{LFR} = \mu_{LCR}$

H_a : At least one of the strategies causes a different average fat loss.

$CF = 1,905.12$

Source	DF	SS	MS	F
Diet Strategy	3	104.88	34.96	35.023
Error	44	43.92	0.9982	
Total	47	148.8		

$Test\ Stat : F = \frac{34.96}{0.9982} \approx 35.023$

$Critical\ Value(s) : f_{3,44,0.025} = 3.4633$ (since we don't have d.f. 44, we used 40)

$Initial\ Conclusion$: Reject the null, support the alternative

$Final\ Conclusion$: The sample data rejects the claim...

This implies at least one of the weight-loss strategies has a significantly different fat loss than the others.

3. Claim: The three different driving styles burn different average amounts of fuel.

$H_0 : \mu_A = \mu_B = \mu_C$

H_a : At least one of the driving styles lead to different fuel consumption.

$CF = 58.284$

Source	DF	SS	MS	F
Driving Style	2	0.069811	0.034906	25.0758
Error	15	0.020883	0.001392	
Total	17	0.090694		

$Test\ Stat : F = \dfrac{0.0349055}{0.001392} \approx 25.07579$

$Critical\ Value(s) : f_{2,15,0.05} = 3.6823$

$Initial\ Conclusion$: Reject the null, support the alternative

$Final\ Conclusion$: The sample data support the claim...

This implies at least one of the driving styles has a significantly different fuel consumption than the others.