MANOVA

A researcher wants to examine the potential benefits of diet and exercise on two commonly used markers of health, weight and cholesterol levels. Participants were assigned to one of four combinations of diet/exercise (2 x 2) and had their weight (pounds) and cholesterol (LDL) measured.

Run as a factorial design with a covariate (weight) and interpret the results.

Tests of Between-Subjects Effects

Dependent Variable: Cholesterol

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	27985.635[a]	4	6996.409	9.351	.000	.405
Intercept	132325.099	1	132325.099	176.855	.000	.763
WeightLost	264.918	1	264.918	.354	.554	.006
Diet	20262.854	1	20262.854	27.082	.000	.330
Exercise	5194.159	1	5194.159	6.942	.011	.112
Diet * Exercise	39.105	1	39.105	.052	.820	.001
Error	41151.615	55	748.211			
Total	1954191.000	60				
Corrected Total	69137.250	59				

a. R Squared = .405 (Adjusted R Squared = .361)

4. Diet * Exercise

Dependent Variable: Cholesterol

Diet	Exercise	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
No Diet	No Exercise	186.348[a]	8.563	169.187	203.509
	20 min cardio 3x/week	207.439[a]	7.390	192.629	222.249
Reduced Calorie Diet	No Exercise	149.104[a]	7.795	133.483	164.725
	20 min cardio 3x/week	166.109[a]	7.091	151.899	180.319

a. Covariates appearing in the model are evaluated at the following values: WeightLost = 5.8333.

Part 2: Question 5: Interpretation

Analysis of covariance (ANCOVA) was conducted. The independent variables, diet, included two levels: no diet and reduced calorie diet, and exercise, included two levels: no exercise and 20 min cardio 3x/week. The dependent variable was taken to be the cholesterol and the covariant was weight. The output of the analysis indicated that the relationship between the covariant (weight) and the dependent variable (cholesterol) was nonsignificant as a function of the independent variables (diet*exercise), F(1, 55) = 0.052, p(0.820) > 0.05, partial η^2 = 0.01. However, the relationship between the dependent variable and exercise was significant, *F*(1, 55) = 6.942, p(0.011) <0.05, partial η^2 = 0.112. Furthermore, after accounting for covariant, the relationship between the dependent variable and diet was also significant, F(1, 55) = 27.082, p(0.000) <0.05, partial η^2 = 0.330. The means of the weight adjusted for the cholesterol indicated that, reduced

calorie diet with 20min cardio 3x/week, yields a lesser and more reasonable cholesterol reduction (M = 166.11).

Run as a MANOVA with weight and cholesterol as the dependents and interpret the results.

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Intercept	Pillai's Trace	.982	1490.594[b]	2.000	55.000	.000	.982
	Wilks' Lambda	.018	1490.594[b]	2.000	55.000	.000	.982
	Hotelling's Trace	54.203	1490.594[b]	2.000	55.000	.000	.982
	Roy's Largest Root	54.203	1490.594[b]	2.000	55.000	.000	.982
Diet	Pillai's Trace	.414	19.392[b]	2.000	55.000	.000	.414
	Wilks' Lambda	.586	19.392[b]	2.000	55.000	.000	.414
	Hotelling's Trace	.705	19.392[b]	2.000	55.000	.000	.414
	Roy's Largest Root	.705	19.392[b]	2.000	55.000	.000	.414
Exercise	Pillai's Trace	.153	4.951[b]	2.000	55.000	.011	.153
	Wilks' Lambda	.847	4.951[b]	2.000	55.000	.011	.153
	Hotelling's Trace	.180	4.951[b]	2.000	55.000	.011	.153
	Roy's Largest Root	.180	4.951[b]	2.000	55.000	.011	.153
Diet * Exercise	Pillai's Trace	.376	16.561[b]	2.000	55.000	.000	.376
	Wilks' Lambda	.624	16.561[b]	2.000	55.000	.000	.376
	Hotelling's Trace	.602	16.561[b]	2.000	55.000	.000	.376
	Roy's Largest Root	.602	16.561[b]	2.000	55.000	.000	.376

a. Design: Intercept + Diet + Exercise + Diet * Exercise

b. Exact statistic

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	WeightLost	133.533[a]	3	44.511	14.767	.000	.442
	Cholesterol	27720.717[b]	3	9240.239	12.494	.000	.401
Intercept	WeightLost	2041.667	1	2041.667	677.330	.000	.924
	Cholesterol	1885053.750	1	1885053.750	2548.813	.000	.979
Diet	WeightLost	24.067	1	24.067	7.984	.007	.125
	Cholesterol	21319.350	1	21319.350	28.826	.000	.340
Exercise	WeightLost	8.067	1	8.067	2.676	.107	.046
	Cholesterol	5980.017	1	5980.017	8.086	.006	.126
Diet * Exercise	WeightLost	101.400	1	101.400	33.640	.000	.375
	Cholesterol	421.350	1	421.350	.570	.454	.010
Error	WeightLost	168.800	56	3.014			
	Cholesterol	41416.533	56	739.581			
Total	WeightLost	2344.000	60				
	Cholesterol	1954191.000	60				
Corrected Total	WeightLost	302.333	59				
	Cholesterol	69137.250	59				

a. R Squared = .442 (Adjusted R Squared = .412)

b. R Squared = .401 (Adjusted R Squared = .369)

Multivariate Tests

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Pillai's trace	.414	19.392[a]	2.000	55.000	.000	.414
Wilks' lambda	.586	19.392[a]	2.000	55.000	.000	.414
Hotelling's trace	.705	19.392[a]	2.000	55.000	.000	.414
Roy's largest root	.705	19.392[a]	2.000	55.000	.000	.414

Each F tests the multivariate effect of Diet. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Exact statistic

4. Diet * Exercise

Dependent Variable	Diet	Exercise	Mean	Std. Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
WeightLost	No Diet	No Exercise	3.533	.448	2.635	4.431
		20 min cardio 3x/week	6.867	.448	5.969	7.765
	Reduced Calorie Diet	No Exercise	7.400	.448	6.502	8.298
		20 min cardio 3x/week	5.533	.448	4.635	6.431
Cholesterol	No Diet	No Exercise	183.467	7.022	169.400	197.533
		20 min cardio 3x/week	208.733	7.022	194.667	222.800
	Reduced Calorie Diet	No Exercise	151.067	7.022	137.000	165.133
		20 min cardio 3x/week	165.733	7.022	151.667	179.800

Part 2: Question 6: Interpretation

A multivariate analysis of variance (MANOVA) was conducted to determine the effect of diet (i.e., no diet or reduced calorie diet) and exercise (i.e., no exercise or 20 min cardio 3x/week) on two dependent variables, weight loss (kg) and Cholesterol (LDL) level. A significant differences were found among the two factors and their levels on the dependent measures, Wilks's $\wedge$ =0.586, $F(2, 55) = 19.392$, $p < .05$. The multivariate η^2 based on Wilks's $\wedge$ was quite strong, 0.414. Table 2.3 below contains the mean and standard deviation on the dependent variable for the two factors and their level.

Table 2.3: Means and Standard Deviations on the Dependent Variables for Each Factor/Levels

Diet	Exercise	Weight Lost		Cholesterol	
		M	SD	M	SD
No Diet	No Exercise	3.5333	1.64172	183.4667	34.52508
	20 min cardio 3x/week	6.8667	1.76743	208.7333	25.42908
Reduced Calorie Diet	No Exercise	7.4000	2.09762	151.0667	26.11094
	20 min cardio 3x/week	5.5333	1.35576	165.7333	20.92663

Analysis of variance (ANOVA) on the dependent variables were conducted as follow-up tests to the MANOVA. Each ANOVA was tested the 0.05 level. The ANOVA on the weight lost with respect to diet was significant, $F(1, 56) = 7.984$, $p(0.007) < 0.05$, $\eta^2 = 0.125$ level, likewise, the ANOVA on the cholesterol with respect to diet was significant, $F(1, 56) = 28.826$, $p(0.000) < 0.05$, $\eta^2 = 0.340$ level. However, The ANOVA on the weight lost with respect to exercise was nonsignificant, $F(1, 56) = 02.676$, $p(0.107) > 0.05$, $\eta^2 = 0.046$ level, but, the ANOVA on the cholesterol with respect to exercise was significant, $F(1, 56) = 8.086$, $p(0.006) < 0.05$, $\eta^2 = 0.126$ level. In term of interaction between diet and exercise, The ANOVA on the weight lost with respect to the interaction was significant, $F(1, 56) = 33.640$, $p(0.000) < 0.05$, $\eta^2 = 0.375$, while the ANOVA on the cholesterol with respect to the interaction was nonsignificant, $F(1, 56) = 0.570$, $p(0.454) > 0.05$, $\eta^2 = 0.010$.
Post hoc analyses consisted of conducting pairwise comparison to find which combination of diet or exercise practices enhances weight lost or cholesterol reduction most strongly. Reduced calorie diet and 20 min cardio 3x/week enhances weight lost and cholesterol reduction compared to other combinations of practices (see Table 2.6 above).

How does this interpretation differ from question 5?

In question 5, covariant was accounted for and the only one dependent variable (cholesterol) was under consideration. However, in this question two dependent variables are being considered (weight and cholesterol).

Should it differ?

Yes, because they the are two separate analysis, one is testing covariant (ANCOVA) and the other testing for multiple dependent variable (MANOVA).