C.3 Repeated Measures ANOVA

A study was conducted to find the effect of yoga on lowering the total serum cholesterol level in newly diagnosed patients of hypercholesterolemia. Thirty patients were selected having total serum cholesterol between the 200mg/dl to 250 mg/dl and not taking any drug to lower the cholesterol. Each subject was given yoga therapy for 3 months and cholesterol level measured at 5 time-points, namely, baseline, after 15 days, 1 month, 2 months, and 3 months. The objective of the study is to find overall effect of yoga on lowering the cholesterol level and whether the mean cholesterol level is significantly different from baseline to 15days, 15 days to 1 month, and so on.

Command to run one factor repeated measures ANOVA:

```
GLMbaseline days_15 month_1 month_2 month_3
/WSFACTOR = cholesterol 5 repeated
/METHOD = SSTYPE(3)
/EMMEANS = TABLES(cholesterol) COMPARE ADJ(BONFERRONI)
/PRINT = DESCRIPTIVE
/CRITERIA = ALPHA(.05)
/WSDESIGN = cholesterol.
```

Observations at different time points are within subjects (WS) and have to be so specified in the above command. The command gives output for both univariate and multivariate analysis of the repeated measures analysis. It runs Mauchly test for sphericity by default and provides Huynth-Feldt correction for the degrees of freedom. The output gives certain other corrections also. The above command also asks for means at different time points and their Bonferroni comparison.

The following confirms 5 repeated measures within subjects (WS), and gives the mean and SD of total cholesterol level at different time points.

Within-Subjects Factors

Measure: MEASURE_1

cholesterol	Dependent Variable
1	baseline
2	days_15
3	month_1
4	month_2
5	month_3

Descriptive Statistics

	Mean	Std. Deviation	N
baseline	226.67	14.337	30
1month	222.13	13.733	30
2month	218.27	13.318	30
3month	213.83	13.613	30
6month	206.57	13.234	30

The following table gives results of multivariate tests and shows there is significant ($P < 0.001$) difference in mean cholesterol levels at different time points.

Multivariate Tests(b)

Effect		Value	F	Hypothesis df	Error df	Sig.
cholesterol	Pillai's Trace	.795	25.220(a)	4.000	26.000	.000
	Wilks' Lambda	.205	25.220(a)	4.000	26.000	.000
	Hotelling's Trace	3.880	25.220(a)	4.000	26.000	.000
	Roy's Largest Root	3.880	25.220(a)	4.000	26.000	.000

a Exact statistic
b Design: Intercept
Within Subjects Design: cholesterol

Mauchly test is significant as given in the following table. Sphericity assumption is violated. Correction to the degrees of freedom is required.

Mauchly's Test of Sphericity[b]

Measure: MEASURE_1

					Epsilon[a]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
cholesterol	.154	51.310	9	.000	.559	.608	.250

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

b. Design: Intercept
Within Subjects Design: cholesterol

Huynth-Feldt correction to the dfs is 0.608. With this correction, the numerator degree of freedom of F-test is $4\times0.608=2.432$ and denominator degree of freedom is $116\times0.608=70.528$. These automatically come in the following table although slightly different due to decimal approximation. This test finds significant difference in mean cholesterol level at time points.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
cholesterol	Sphericity Assumed	7171.960	4	1792.990	62.011	.000
	Greenhouse-Geisser	7171.960	2.237	3206.204	62.011	.000
	Huynh-Feldt	7171.960	2.433	2948.128	62.011	.000
	Lower-bound	7171.960	1.000	7171.960	62.011	.000
Error(cholesterol)	Sphericity Assumed	3354.040	116	28.914		
	Greenhouse-Geisser	3354.040	64.870	51.704		

	Huynh-Feldt	3354.040	70.549	47.542		
	Lower-bound	3354.040	29.000	115.657		

Various types of comparisons can be made between time points. The following compares mean level at any time point with its value at preceding time point as per the objective of the study. All these are statistically highly significant (*P*< 0.001).

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	cholesterol	Type III Sum of Squares	df	Mean Square	F	Sig.
cholesterol	Level 1 vs. Level 2	616.533	1	616.533	21.872	.000
	Level 2 vs. Level 3	448.533	1	448.533	16.774	.000
	Level 3 vs. Level 4	589.633	1	589.633	27.878	.000
	Level 4 vs. Level 5	1584.133	1	1584.133	38.805	.000
Error(cholesterol)	Level 1 vs. Level 2	817.467	29	28.189		
	Level 2 vs. Level 3	775.467	29	26.740		
	Level 3 vs. Level 4	613.367	29	21.151		
	Level 4 vs. Level 5	1183.867	29	40.823		

The following table shows the mean, SE and 95% confidence interval of cholesterol level at each time point.

Estimated Marginal Means

Estimates

Measure: MEASURE_1

cholestrol	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	226.667	2.618	221.313	232.020
2	222.133	2.507	217.005	227.261
3	218.267	2.432	213.294	223.240
4	213.833	2.485	208.750	218.917
5	206.567	2.416	201.625	211.508

The following table shows the comparison of mean cholesterol level at each time point with all other time points using Bonferroni adjustment.

Pairwise Comparisons

Measure: MEASURE_1

(I) cholestrol	(J) cholestrol	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
1	2	4.533*	.969	.001	1.588	7.478
	3	8.400*	1.353	.000	4.289	12.511
	4	12.833*	1.690	.000	7.700	17.967
	5	20.100*	1.911	.000	14.295	25.905
2	1	-4.533*	.969	.001	-7.478	-1.588
	3	3.867*	.944	.003	.998	6.735
	4	8.300*	1.429	.000	3.959	12.641
	5	15.567*	1.690	.000	10.434	20.699
3	1	-8.400*	1.353	.000	-12.511	-4.289
	2	-3.867*	.944	.003	-6.735	-.998
	4	4.433*	.840	.000	1.882	6.984
	5	11.700*	1.465	.000	7.250	16.150
4	1	-12.833*	1.690	.000	-17.967	-7.700
	2	-8.300*	1.429	.000	-12.641	-3.959
	3	-4.433*	.840	.000	-6.984	-1.882
	5	7.267*	1.167	.000	3.723	10.811
5	1	-20.100*	1.911	.000	-25.905	-14.295
	2	-15.567*	1.690	.000	-20.699	-10.434
	3	-11.700*	1.465	.000	-16.150	-7.250
	4	-7.267*	1.167	.000	-10.811	-3.723

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

a. Adjustment for multiple comparisons: Bonferroni.

All differences are statistically significant. Yoga has been able to make a significant change in cholesterol level at each time point of observation as far as these data are concerned.

The following command prints the line and bar with ±1*SD (Figure C.3):

```
GRAPH
  /LINE(SIMPLE)=MEAN(baseline) MEAN(days_15) MEAN(month_1) MEAN(month_2)
MEAN(month_3)
  /MISSING=LISTWISE
  /INTERVAL SD(1.0).

GRAPH
  /BAR(SIMPLE)=MEAN(baseline) MEAN(days_15) MEAN(month_1) MEAN(month_2)
MEAN(month_3)
  /MISSING=LISTWISE
  /INTERVAL SD(1.0).
```

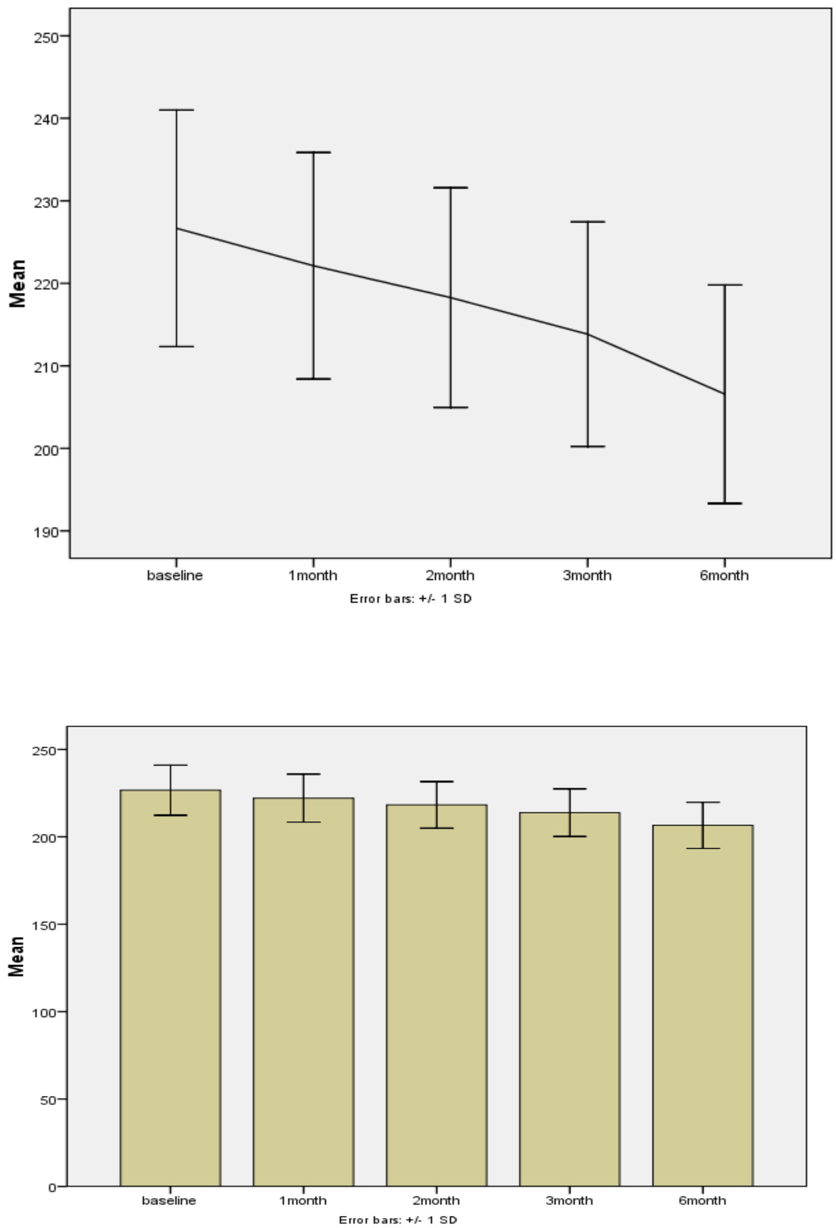

FIGURE C.3 Line and bar diagrams of mean TC at five time points