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Univariate and Multivariate Repeated Measure Analysis with Missing Value of the Weight of Broilers (Case Study of Jewel Farm Gombe)

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ABSTRACT
This paper is an attempt to evaluate the difference of ANOVA and MANOVA on the same research using repeated measure data. The data was obtained from the Jewel farm Gombe, Gombe state for broilers which were divided into six (6) group, each group has its own kind of ration for six weeks. The choice of this farm came as a result of the researchers desire to identify the growth of each group by taking the weight of each broilers at the end of each week in grams. The results shows that univariate analysis of variance is significant across the groups which different in ration for each group. Also multivariate analysis of variance shows that there is significant difference between the ration for each group. In addition the analysis shows that the repeated measures assumptions has been satisfied except sphericity, as a result some adjustment has been made for sphericity. The overall result indicates that multivariate repeated measure analysis is more efficient and gives an optimal result than univariate repeated measure analysis as is minimized error and combine multiple ANOVA in one analysis.

KEYWORDS: *Univariate, Multivariate, Repeated Measures, Sphericity, Broilers, Jewel Farm*

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I. INTRODUCTION

Repeated measures are multiple responses taken sequentially from same experimental unit over time. The best example to this data type (trait-time) in animal science is a study of “Growth Curves”, describing growth at certain time period of each experimental unit (Akbas, et al., 2001).Repeated Measures Designs (RMD) is one of the most frequently studied and applied designs in a variety of applied fields. A design in which the same experimental unit is *repeatedly* observed under multiple treatments is called *repeated measures design* (Algina, et al., 2000). This is but a broad concept and in practice a repeated measures design is laid out in a variety of ways, from a very simple setup of one-way repeated measures design to a very complex framework of longitudinal data or some other mixed model set up (Algina, et al., 2000).Although, the advantages of using RMD outweigh its disadvantages, there are some issues to be seriously taken cared of, before planning an RMD. Since the data constitute repeated observations under essentially the same conditions, hence correlated observations, the independence assumption of repeated measures design is no longer viable (Rauf, 2008). In repeated measures experimental design it is possible to use relatively straightforward analysis of variance procedures to analyze the data if the following specific assumptions about the observations are valid:*Normality*: the data arise from populations with normal distributions (i.e. the measurement errors are independent and identically normally distributed with mean 0 and the same variance). *Homogeneity of variance*: the error variances of the assumed normal distribution are equal.*Sphericity*: the variances of the differences between all pairs of the repeated measurements are equal. This condition implies that the correlations between pairs of repeated measures are also equal. Univariate and multivariate analytic approaches have been used for analyzing repeated measures data including between-subject and within-subject factors. Univariate approach includes: “Repeated ANOVA”, “Greenhouse-Geisser Epsilon (G-G) adjusted F test” and “Huynh-Feldt Epsilon (H-F) adjusted F test”. In “Repeated ANOVA”, sphericity assumption is provided. When this assumption is violated, repeated measures design is analyzed using “Greenhouse-Geisser Epsilon (G-G) adjusted F test”, and “Huynh-Feldt Epsilon (H-F) adjusted F test”. In case of violation of the sphericity assumption, different methods of analyses both in multivariate and univariate approaches have been reported in(Huynh & Feldt, 1970);(Nezlek & Robert, 2003);(Barcikowski & Robey, 1984);(Minke, 1997);(Keselman, et al., 1993);(Oshima & Algina, 1994);(Tabachnik & Fidel, 2001);(Gurbuz, et al., 2003);(Eyduran, et al., 2008). Contrary to “Repeated ANOVA”, “Greenhouse-Geisser Epsilon (G-G) adjusted F test”, “Huynh-Feldt Epsilon (H-F) adjusted F test” and Profile analytic approaches, mixed model methodology allows us to directly select different covariance structures for repeated measures design with/without missing data. Univariate method of analysis is a test of hypothesis involving only one variable. Historically, it is the method most commonly applied to repeated measures data that makes comparisonsbetween times. It treats the data as if they were froma split-plot design with the animals as whole-plotunits and animals at particular times as sub-plotunits. This approach also is referred to as asplit plot in timeanalysis (Ergun & Aktas, 2009). Ifmeasurements have equal variance at all times, and ifpairs of measurements on the same animal areequally correlated, regardless of the time lag betweenthe measurements, then the univariate ANOVA isvalid from a statistical point of view, and, in fact,yields an optimal method of analysis. The conditionrequired for validity of the univariate ANOVA tests isthe so-called Huynh-Feldt (H-F) condition(Huynh & Feldt, 1970), which is mathematically lessstringent than equal variances and covariances.However, measurements close in time are oftenmore highly correlated than measures far apart intime, which will invalidate tests for effects involvingtime.The Linear Mixed Models procedure expands the general linear model so that the data are permitted to exhibit correlated and nonconstant variability. Thelinear mixed model, therefore, provides the flexibility of modeling not only the means of the data but their variances and covariances as well.

II. MATERIALS AND METHOD

2.1 Source of Data

The data used for this study was a secondary data, obtained from Jewel Farm Gombe. It composed of ninety broilers which were randomly assigned or grouped into six. Each group was given a different type of ration (food). The six level of ration administered to the broilers were sovet starter (SS), sovet grower (SG), vital starter (VT), vital grower (VG), top feed starter (TFS) and top feed grower (TFG). Each of this ration was also mixed with some local food. The ration was administered as follows; Group (1) received SS, Group (2) received SG, Group (3) received VS, Group (4) received VG, Group (5) received TFS and Group (6) received TFG. The weekly weight of broilers in grams was measured seven times during the experimental period (week 0, 1, 2, 3, 4, 5 and 6).

2.2 Test for Normality

An assessment of the normality of data is a prerequisite for many statistical tests, as normal data is an underlying assumption in parametric testing. There are two main methods of assessing normality - graphically and numerically.In this research numerical method will be used, namely the Shapiro-Wilk Test. Shapiro-Wilk Test is more appropriate for small sample sizes (< 50 participants) but can also handle sample sizes as large as 2000. For this reason, the Shapiro-Wilk test will be our numerical means of assessing normality.

Shapiro – Wilk (SW) Test for Normality can be calculated using the formula below;

$W = \frac{b^2}{ss}$, where $ss = \sum_{i=1}^{n}\left(x_i - \bar{x}\right)^2$ and $b = \sum_{i=1}^{m} a_i\left(x_{n+1-i} - x_i\right)$

If n is even then $m = \frac{n}{2}$, while if n odd then $m = \frac{(n-1)}{2}$

Hypothesis is:

H_0: The data arise from populations with normal distributions.

H_1: The data not arise from populations with normal distributions.

Decision rule: Reject if P<0.05 otherwise accept at the 5% level of significance.

2.3 Levene's Test for Homogeneity of Variances

Levene's test (Levene, 1960)is used to test if *k* samples have equal variances. Equal variance across samples is called homogeneity of variance. Analysis of variance, assume that variances are equal across groups or samples. The Levene test can be used to verify that assumption. The Levene's test statistic(W) is defined as:

$$W = \frac{(N-k)\sum_{i=1}^{k} N_i\left(\bar{X}_{i.} - \bar{X}_{..}\right)^2}{(k-1)\sum_{i=1}^{k}\sum_{j=1}^{N_i}\left(X_{ij} - \bar{X}_{i.}\right)^2} \qquad 1$$

where, $X_{ij} = \left|Y_{ij} - \bar{Y}_{i.}\right|$

$\bar{Y}_{i.}$ is the mean of the i^{th} subgroup.

Y is the dependent variable (weight).
N is the total sample size.
K is the number of subgroup.
N_i is the sample size of the i^{th} subgroup.
The hypothesis is:
H_0: The variance of the dependent variable is equal across groups.
H_1: The variance of the dependent variable is not equal across groups.
Decision rule: The Levene test rejects the null hypothesis that the variances are equal if $P<0.05$ otherwise accept at the 5% level of significance.

2.4 Geisser – Greenhouse Epsilon (G – G)

This is the adjusted univariate F test in which the degree to which the variance-covariance matrix departs from compounded symmetry and sphericity is measured by epsilon (ε) parameter (Winter, 1991).

$$\hat{\varepsilon} = \frac{a^2\left(\bar{E}_{jj}-\bar{E}\right)^2}{(a-1)\left(\left(\sum\sum E_{jk}^2\right)-\left(2a\sum\bar{E}_{j.}^2\right)+\left(a^2\,\bar{E}_{..}^2\right)\right)} \qquad 2$$

Where,
E_{jk} is the element in row j and column k of the sample covariance matrix.
$\bar{E}_{jj}$ is the meanof variances along the diagonal in the sample covariance matrix.
$\bar{E}_{j.}$ is the mean of all entries in j^{th} row of the sample covariance matrix.
$\bar{E}_{..}$ is the mean of all entries in the sample covariance matrix.
a is the number of measurement occasions.

2.5 Huynh – Feldt Epsilon (H – F)

The Huynh-Feldt formula results in a parameter ($\tilde{\varepsilon}$)that identifies the extent to which thecovariance matrix deviates from sphericity (Stevens, 2002).

$$\tilde{\varepsilon} = \frac{n(a-1)\hat{\varepsilon}-2}{(a-1)\left(n-1-(a-1)\hat{\varepsilon}\right)} \qquad 3$$

where,
n is the number of subjects.
a is the number of measurement occasions.
$\hat{\varepsilon}$ is theGreenhouse-Geisser adjustment.

The resulting parameter ($\tilde{\varepsilon}$)is used to correct the degrees offreedom for the measurement occasion and error term.

2.6 Mauchly'sSphericity Test

Maxwell & Delaney, (2004) highlighted that when sphericitytests such as the techniques outlined by Girden, (1992) indicate variance inequalities in thesample; the sphericity assumption is only violated if it holds in the population as well. Theauthors recognized that even if sample variances are unequal, such inequalities might simplyreflect sampling error. Therefore, they recommended that Mauchly's sphericity test (i.e.,Mauchly's *W*) be used to test the null hypothesis that the homogeneity condition holds in the population.

When the sphericity test is significant, SPSS or R Packages offers two ways to test the significance of the within-subject effects. The first way is to adjust the univariate tests themselves, SPSS or R packages prints three such adjustments: Greenhouse – Geisser Epsilon adjusted F test which was developed by (Greenhouse & Geisser, 1959), the less conservative Huynh – Feldt Epsilon adjusted F test which was developed by (Huynh & Feldt, 1976) and the Lower bound Epsilon. The second way involves four different multivariate tests: Wilks'

Lambda, Pillai's Trace, Hotelling-Lawley Trace and Roy's Greatest Root. None of these approaches has been shown to be superior to the others. In addition, all areequivalent to using the Hotelling T^2 statistic.

$$Hotteling's\ T^2 = N\left(GM\right)' S_{wg}^{-1}\left(GM\right) \qquad 4$$

where,
N is the number of segments.
GM is the grand mean of segments.
S*wg* is the within-group variance-covariance matrix.
Wilks' λ can then be calculated from T using the following equation:

$$\lambda = \frac{1}{1+T^2} \qquad 7$$

Hypothesis,
H_0: The variances of the difference between levels of the treatment are significantly the same.
H_1: The variances of the difference between levels of the treatment are significantly different.
Decision rule: Reject if $P<0.05$ otherwise do not reject at the 5% level of significance.

2.7 UnivariateAnova

The repeated measures ANOVA is used to comparegroup means on a dependent variable across repeatedmeasurements of time. Time is often referredto as the within-subjects factor, whereas a fixed ornonchanging variable (groups) is referred to asthe between-subjects factor (Hun, 2008).In this research, there are two factors, group (between-subject factor (A)) and time (within-subject factor (B)).The model is given as;

$$Y_{ijk} = \mu + \alpha_i + \pi_{j(i)} + \beta_k + \left(\alpha\beta\right)_{ik} + \theta x_{ij} + \varepsilon_{ijk} \qquad 8$$

where i = 1,2,…,n, j = 1,2,…,p, k = 1,2,…,q

Y_{ijk} is the dependent variable with θx_{ij} is the missing value. From the above model we make ε_{ijk} subject matter, sum and square both side and differentiate with respect to μ, α_i, $\pi_{j(i)}$, β_k and $\left(\alpha\beta\right)_{jk}$, then equate to zero and find the parameter estimates of $\hat{\mu}$, $\hat{\alpha}_i$, $\hat{\pi}_{j(i)}$, $\hat{\beta}_k$, $\left(\widehat{\alpha\beta}\right)_{jk}$

$$\sum_{ijk}\varepsilon^2 = \sum_{ijk}\left(Y_{ijk} - \mu - \alpha_i - \pi_{j(i)} - \beta_k - \left(\alpha\beta\right)_{ik}\right)^2 \text{ where } \sum_{ijk}\varepsilon^2 = \text{SSE} \qquad 9$$

$$\text{SSE} = \sum_{ijk}\left(Y_{ijk} - \mu - \alpha_i - \pi_{j(i)} - \beta_k - \left(\alpha\beta\right)_{ik}\right)^2 \text{, also } \sum\alpha = \sum\pi = \sum\beta = \sum\left(\alpha\beta\right) = 0 \qquad 10$$

$$\frac{\partial SSE}{\partial\mu} = -2\sum\left(Y_{ijk} - \mu - \alpha_i - \pi_{j(i)} - \beta_k - \left(\alpha\beta\right)_{ik}\right)$$

$$0 = \sum Y_{ijk} - \sum_{jk} n\mu - n\sum_{jk}\alpha_i - n\sum_{ik}\pi_{j(i)} - n\sum_{ij}\beta_k - n\sum_{j}\left(\alpha\beta\right)_{ik} \qquad 11$$

$$\hat{\mu} = \frac{\sum Y_{ijk}}{\sum n} = \bar{Y}_{...}$$

where $\sum_{jk} n = npq = N$

$$\frac{\partial SSE}{\partial\alpha_i} = -2\sum\left(Y_{ijk} - \mu - \alpha_i - \pi_{j(i)} - \beta_k - \left(\alpha\beta\right)_{ik}\right)$$

$$0 = \sum Y_{ijk} - n\hat{\mu} - n\hat{\alpha}_i$$

$$\hat{\alpha}_i = \frac{\sum Y.jk}{n} - \hat{\mu} \qquad 12$$

$$\hat{\alpha}_i = \bar{Y}_{i..} - \bar{Y}_{...}$$

where $\frac{\sum Y_{ijk}}{n} = \bar{Y}_{i..}$

$$\frac{\partial SSE}{\partial \pi_{j(i)}} = -2\sum\left(Y_{ijk} - \mu - \alpha_i - \pi_{j(i)} - \beta_k - (\alpha\beta)_{ik}\right)$$

$$0 = \sum Y_{ijk} - p\hat{\mu} - p\pi_j$$

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$$\hat{\pi}_j = \frac{\sum Y_{ijk}}{p} - \hat{\mu}$$

$$\hat{\pi}_{j(i)} = \bar{Y}_{.j.} - \bar{Y}_{...}$$

where $\frac{\sum Y_{.jk}}{p} = \bar{Y}_{.j.}$

$$\frac{\partial SSE}{\partial \beta_k} = -2\sum\left(Y_{ijk} - \mu - \alpha_i - \pi_{j(i)} - \beta_k - (\alpha\beta)_{ik}\right)$$

$$\hat{\beta}_k = \frac{\sum Y_{ijk}}{q} - \hat{\mu} \qquad 14$$

$$\hat{\beta}_k = \bar{Y}_{..k} - \bar{Y}_{...}$$

where $\frac{\sum Y_{..k}}{q} = \bar{Y}_{..k}$

$$\frac{\partial SSE}{\partial (\alpha\beta)_{ik}} = -2\sum\left(Y_{ijk} - \mu - \alpha_i - \pi_{j(i)} - \beta_k - (\alpha\beta)_{ik}\right)$$

$$0 = \sum Y_{ijk} - nq\hat{\mu} - nq\hat{\alpha}_i - nq\hat{\pi}_{j(i)} - nq\hat{\beta}_k - nq(\alpha\beta)_{ik}$$

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$$\left(\widehat{\alpha\beta}\right)_{ik} = \frac{\sum Y_{ijk}}{nq} - \hat{\mu} - \hat{\alpha}_i - \hat{\pi}_{j(i)} - \hat{\beta}_k$$

$$\left(\widehat{\alpha\beta}\right)_{ik} = \bar{Y}_{i.k} - \hat{\mu} - \hat{\alpha}_i - \hat{\pi}_{j(i)} - \hat{\beta}_k$$

$$\therefore SSE = \sum\left(Y_{ijk} - \hat{\mu} - \hat{\alpha}_i - \hat{\pi}_{j(i)} - \hat{\beta}_k - (\alpha\beta)_{ik}\right)^2 \qquad 16$$

By finding the estimate of the above parameters then we are going to use the relationship below to find the suitable formula for estimating the missing values as;

Using the relationship $\theta = \frac{Exy}{Exx}$ we have

$Y_{ijk}\begin{cases} 0, i^*, j^*, k^* \\ Y_{ijk}, otherwise \end{cases}$ *and* $\qquad x_{ijk}\begin{cases} 0, i^*, j^*, k^* \\ 1, otherwise \end{cases}$

$$Exy = \frac{2Y_{i.k} - qY_{i..} - nY_{..k} + 2Y_{...}}{npq}$$

and

$$Exx = \frac{1}{q} - \frac{1}{pq} - \frac{1}{np} - \frac{1}{nq} + \frac{2}{npq} \qquad 17$$

$$Exx = \frac{npq - n - p - q + 2}{npq}$$

$$\theta = \frac{Exy}{Exx} = \frac{2T_o - pR_o - nC_o + 2G_o}{npq - n - p - q + 2}$$

Hence, the above formula was formulated in order to calculate the repeated measure model with missing observation (value).

2.8 Multivariate ANOVA

Multivariate analysis of variance (MANOVA) is an ANOVA with several dependent variables. MANOVA tests for the difference in two or more vectors of means, it discover which factor is truly important and also protect against type I errors that might occur if multiple ANOVA were conducted independently at the same time reveal differences not discovered by ANOVA test. The statistical model is given below as;

$$Y_{ijk} = \mu + \alpha_i + \beta_j + \gamma_{ij} + \theta_{xijk} + \varepsilon_{ijk} \qquad 18$$

The model can also be written in matrix form as;

$$\begin{pmatrix} Y_{ijk1} \\ Y_{ijk2} \\ \vdots \\ Y_{ijkp} \end{pmatrix} = \begin{pmatrix} \mu_1 \\ \mu_2 \\ \vdots \\ \mu_p \end{pmatrix} + \begin{pmatrix} \alpha_{i1} \\ \alpha_{i2} \\ \vdots \\ \alpha_{ip} \end{pmatrix} + \begin{pmatrix} \beta_{j1} \\ \beta_{j2} \\ \vdots \\ \beta_{jp} \end{pmatrix} + \begin{pmatrix} \gamma_{ij1} \\ \gamma_{ij2} \\ \vdots \\ \gamma_{ijp} \end{pmatrix} + \begin{pmatrix} \theta_{xijk1} \\ \theta_{xijk2} \\ \vdots \\ \theta_{xijkp} \end{pmatrix} + \begin{pmatrix} \varepsilon_{ijk1} \\ \varepsilon_{ijk2} \\ \vdots \\ \varepsilon_{ijkp} \end{pmatrix}$$

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where μ is the overall mean, α_i is the effect of the i^{th} level of A on each of the p variables in $Y_{ijk;}$ β_j is the effect of the j^{th} level of B; γ_{ij} is the AB interaction effect, θ_{xijk} is the missing values (parameter) associated with x_{ijk} and ε_{ijk} is the random error.

III. ANALYSIS

TABLE 1:**Tests of Normality**

RATION		Shapiro-Wilk		
		Statistic	Df	Sig.
Week0	1	.953	15	.570
	2	.975	15	.927
	3	.875	15	.140
	4	.963	15	.745
	5	.863	15	.070
	6	.806	14	.060
Week1	1	.833	15	.100
	2	.927	15	.246
	3	.948	15	.496
	4	.929	15	.265
	5	.868	15	.302
	6	.934	14	.344
Week2	1	.959	15	.680
	2	.978	15	.952
	3	.891	15	.070
	4	.941	15	.396

	5	.936	15	.337
	6	.903	14	.125
Week3	1	.972	15	.885
	2	.956	15	.629
	3	.824	15	.080
	4	.889	15	.064
	5	.963	15	.752
	6	.828	14	.101
Week4	1	.954	15	.598
	2	.970	15	.864
	3	.881	15	.084
	4	.927	15	.242
	5	.865	15	.092
	6	.839	14	.061
Week5	1	.944	15	.431
	2	.949	15	.507
	3	.879	15	.064
	4	.934	15	.311
	5	.851	15	.081
	6	.832	14	.013
Week6	1	.903	15	.104
	2	.918	15	.179
	3	.840	15	.072
	4	.778	15	.062
	5	.916	15	.166
	6	.744	14	.101

Table 1 shows the normality assumption was provided at each period. The effect of ration on live weight at each time period was nonsignificant (P>0.05).

Since, it can be clearly seen that for the "Ration 1, 2, 3, 4, 5, and 6" the dependent variable "Time (week)" was normally distributed. Since the **Sig.** value of the Shapiro-Wilk Test is greater than 0.05, then the data is normal. If it is below 0.05 then the data significantly deviate from a normal distribution likewise kolmogrov-smirnov test.

TABLE 2:Levene's Test of Equality of Error Variances[a]

	F	df1	df2	Sig.
Week0	7.659	5	83	.100
Week1	3.259	5	83	.061
Week2	2.258	5	83	.056
Week3	2.411	5	83	.055
Week4	1.408	5	83	.230
Week5	1.254	5	83	.292
Week6	1.999	5	83	.087

Table 2 Indicates that variances are homogeneous for all levels of the repeated-measures variable (because all significance values are greater than 0.05). If any values were significant, then this would compromise the accuracy of the *F*-test for week, and it would have to consider transforming all of our data to stabilize the variances between groups (one popular transformation is to take the square root of all values). Fortunately, in this data transformation is unnecessary.

Table 3:Mauchly's Test of Sphericity

Within Subject Effects	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
WEEKS	.004	440.232	20	.000	.493	.544	.167

Table 3 shows that the assumption of Sphericity has not been met, since the Sig. value is 0.00 which is less than 0.05, so the null hypothesis that the variances of the difference between levels were significantly the same was rejected. Therefore, since the Mauchly's test is significant, then Greenhouse-Geisser or Huynh-Feldt corrected degrees of freedom must be used in order to assess the significance of the corresponding F.The epsilon (ε) value in above Table will be used to correct or adjust the degree of freedom. For the Greenhouse-Geisser the ε-value use to adjust the degree of freedom is 0.493, forthe Huynh-Feldt the ε- value use to adjust the degree of freedom is 0.544, and for the lower bound i.e the lower value that ε can take is 0.167. Hence, sphericity assumption has been violated adjusted is then necessary.

TABLE 4: Tests of Between-Subjects Effects (ANOVA)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	98439567.550	1	98439567.550	102226.439	.000	.999
Ration	49247.255	5	9849.451	10.228	.000	.381
Error	79925.352	83	962.956			

The Table 4 shows the ANOVA test of main effect of the between subject factor Group (Ration). But before looking at the table lets refer to Table 2 to check the assumption of homogeneity of variances using levene's test. Therefore, Table 2 shows that the variances are homogeneous for all levels of the repeated measure data. Now, Table 4 reveals a significant effect, since the significance value of 0.000 is less than the standard cut-off point of 0.05 level of significance. Hence, we conclude that there is a significant different between the kind of ration given to the broilers on each group for the period of six weeks, a such ration plays important role in the growth of broilers.

TABLE 5: Multivariate Analysis of Variance (MANOVA)

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
WEEKS	Pillai's Trace	.999	12394.754^{b}	6.000	78.000	.000	.999
	Wilks' Lambda	.001	12394.754^{b}	6.000	78.000	.000	.999
	Hotelling's Trace	953.443	12394.754^{b}	6.000	78.000	.000	.999
	Roy's Largest Root	953.443	12394.754^{b}	6.000	78.000	.000	.999
WEEKS * GROUP	Pillai's Trace	1.095	3.830	30.000	410.000	.000	.219
	Wilks' Lambda	.123	7.221	30.000	314.000	.000	.343
	Hotelling's Trace	5.508	14.028	30.000	382.000	.000	.524
	Roy's Largest Root	5.221	71.349^{c}	6.000	82.000	.000	.839

Table 5 shows that, there is strong significant effects between the repeated measures (weeks) and the interaction between the group and weeks, since the **Sig.** value from the above table are less than the value of α at 5% significance level. Hence, we conclude that all the four multivariate anova indicates strong significant relationship for both the main and the interaction effect as well.

IV. CONCLUSION

In this research, the set of data used was found to be normally distributed since the significance value of the Shapiro- Wilk Test is greater than 0.05 (p>0.05). The Levene's test indicates that variances are homogeneous for all levels of the repeated-measures variable (because all **Sig.** values are greater than 0.05).The sphericity assumption was violated according to mauchly statistic result (P<0.05) and evaluating results offixed effects from Repeated ANOVA may be lead tofaulty interpretations(Gurbuz*et al.*, 2003;Eyduran *et al.*, 2008).Therefore, since the Mauchly's test is significant, then Greenhouse-Geisser and Huyn-Feldt corrected degrees of freedom adjustment was used in order to assess the significance of the corresponding F test.The epsilon (ε) values used to correct or adjust the degree of freedom are: For the Greenhouse-Geisser, the ε- value use to adjust the degree of freedom is 0.493, for the Huyn-Feldt, the ε- value use to adjust the degree of freedom is 0.544 and for the lower bound i.e the lower value that ε can take is 0.167. It was found that the effect of within subject (week) and group by week interaction effect is significant, since the **Sig.** value is less than the value of α at 5% significance level. For the between-subject effect it was also found to be highly significant ($p<0.05$). The ANOVA test and MANOVA test are all significant but MANOVA test is more efficient and gives an optimal value than ANOVA test because is minimized error and protect against type I error. IBM SPSS Package version 23.6 was used to run the analysis.

REFERENCES

[1]. Akbas, Y., Firat, M. Z. & Yakupoglu, C., 2001. Comparison of Different Models used in the Analysis of Repeated Measurements in Animal Scienceand their SAS Application. Agricultural Information Technology Symposium, pp. 20-22.

[2]. Algina, J., Wilcox, R. R. & Kowalchuk, R. K., 2000. The Analysis of Repeated Measure. A Quantitative Research Synthetic. British Journal of Mathematical and Statistical Psychology, pp. 1735-1748.

[3]. Barcikowski, R. S. & Robey, R. R., 1984. Decision in Single Group Repeated Measures Analysis: Statistical Test and Three Computer Packages. The American Statistician, pp. 148-150.

[4]. Ergun, G. & Aktas, S., 2009. Comparisons of Sum of Squares Method in Anova Models. Kaftas: Kaftas University, Veterinary Faculty.

[5]. Eyduran, E., Yazkan, K. & Ozdemir, T., 2008. Utilization of Profile Analysis in Animal Science. Journal of Animal Veterinary Advances, pp. 796-798.

[6]. Greenhouse, S. W. & Geisser, S., 1959. On Methods in the Analysis of Profile Data. Psychometrika, pp. 95-112.

[7]. Gurbuz, F. E., Baspinar, H. C. & Keskin, S., 2003. Terkrarlana Oclumlu Deneme Duzenlerinin Analizzzi. YYU: Matbaasi.

[8]. Hun, M. P., 2008. Univariate Analysis and Normality Test Using SAS, Stata, and SPSS. University Information Technology Services Center for Statistical and Mathematical Computing. Indiana University, pp. 278-290.

[9]. Huynh, H. & Feldt, L. S., 1970. Conditions under which Mean Square ratios in Repeated Measurements Design have exact F - Distributions.. Journal of the American Statistical Society, pp. 1582-1589.

[10]. Huynh, H. & Feldt, L. S., 1976. Estimation of the Box Correction for Degrees of Freedom from Sample Data in the Randomized Block and Split Plot Design. Journal of Educational Statistics, pp. 15-51.

[11]. Keselman, H. J., Cariere, K. C. & Lix, L. M., 1993. Testing Repeated Measures Hypotheses when Covariance Matrices are Heterogeneous.. Journal of Educational Statistics, pp. 305-319.

[12]. Levene, H., 1960. Robust testes for equality of variance in contributions to probability and statistics. Palo Alto: Stanford Univ. Press, CA MR0120709.

[13]. Maxwell, S. D. & Delaney, H. D., 2004. Designing Experiments and Analyzing Data: A Model Comparison Perspective. 2nd ed. Mahwah, NJ: Laurence Erlbaum Associated Publishers.

[14]. Minke, A., 1997. Conducted Repeated Measures Analysis: Experimental Design Considerations, Texas: Paper Presented at the Annual Meeting of the Southwest Educational Research Association, Austin.

[15]. Nezlek, J. B. & Robert, S., 2003. Using Multilevel Random Coefficient Modelling to Analyze Social Interaction Diary Data. Journal of Social Relation, pp. 437-469.

[16]. Oshima, T. C. & Algina, J., 1994. Type 1 Error Rates for Huynh's General Approximation and Improved General Approximation Tests.. British Journal of Mathematical and Statistical Psychology, pp. 151-165.

[17]. Rauf, N. K., 2008. Classification of Multivariate Repeated Measures data with Temporal Autocorrelation. Advances in Data Analysis and Classifiation, pp. 175-199.

[18]. Stevens, J. P., 2002. Applied Multivariate Statistics for the Social Science 4th edition. Lawrence Erlbaum Associates Publishers .

[19]. Tabachnik, B. G. & Fidel, L. S., 2001. Using Multivariate Statistics. U.S.A: Allyn & Bacon.

[20]. Winter, W. R. D., 1991. Conducting Repeated Measures Analyses using Regression , New Orleans, Louisiana: The General Linear Model Lives. Paper Presented at the annual meeting of the Mid - South Educational Research Association.

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