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Gravida and maternal age group effect on the weight of an infant

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Abstract

This paper makes use of Two-way Analysis of Variance approach to check whether significant difference exists in the weight of an infant as it relates to gravida and maternal age or not. Five hundred and thirty-three (533) samples on the weight of an infant, maternal age and gravida sourced from Family Support Programme (FSP) Makurdi Benue State, Nigeria was used. Maternal age was divided into five (14-19, 20-25, 26-31, 32-37 and 38-43); the level of gravida (number of pregnancies) considered are gravida one (1), gravida two (2), gravida three (3) and gravida four (number of pregnancies greater than or equal to four). The results revealed that significant difference exist between the maternal age as it relates to the weight of an infant since the p_value of 0.0001 is less than 0.05 alpha level of significance. Significant difference was also seen in gravida since the p_value of 0.0001 is less than 0.05 alpha level of significance. As a result of significant difference observed in both maternal age and gravida, multiple mean comparison was carried out to identify the mean weight that actually differs. It was discovered that the mean weight of an infant in gravida four (4) is different from that of gravida one (1) and two (2), in addition, gravida 3 and 1 were statistically significant. Maternal age one (14-19) was also found to be different from every other age group.

Keyword: Gravida; Infant weight; ANOVA; Turkey HSD

1 Introduction

Analysis of variance (ANOVA) is a statistical technique that is used to determine whether or not significant differences exist among means of several populations or groups of observations [11]. It is an extension of t-test statistic used to determine whether or not two means differ from each other. It has a wide range of application which include biological, agricultural, social and physical sciences.

One of the critical parameters that was believed to contribute significantly in neonatal healthcare and developmental research is the Infant birth weight as well as environmental factor [6]. This Infant birth weight is said to have been influenced by numerous factors which include age of the mother, Gravida, nutritional content etc. It is a fundamental indicator of a newborn's health, reflecting the interplay of genetic, maternal and environmental factors during pregnancy [2].

[4] revealed that maternal age and Gravida are one of the major factors that influences birth weight of an infant. Birth weight is often considered as an indicator of health status of any society and hence it is a primary determinant of the chance of survival of a newborn baby. Also, maternal lifestyle is another contributory factor to the weight of an infant [12]. Furthermore, low birth weight (LBW) on the other hand is also identified to be associated with deficits in growth and neurocognitive development [1].

Low birth weight is a significant contributor to the overall infant mortality rate and a major factor that cause high neonatal mortality rate in most developing countries, Nigeria inclusive [1][8].

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Gravida is a medical term that refers to the number of times a woman has been pregnant, regardless of the outcome of those pregnancies. It is an important concept in obstetrics and reproductive health as it helps healthcare providers understand a woman's reproductive history, which can influence her current pregnancy and birth outcome [10].

Maternal age has been recognized as a significant determinant of infant birth weight. Two major child bearing age groups that are mostly referred to are adolescent mothers which is the first child bearing age of a woman and are those under the age of 20; whereas those over the age of 35 are refer to as older mothers [4]. Adolescents often face challenges ranging from inadequate prenatal care, limited access to resources as well as the need for their own growth and development. In addition, chronic health conditions and pregnancy complications sometimes occur in advanced maternal age can reduce fetal growth and lower birth weights of an infant [3].

[9] revealed that maternal age is a crucial factor influencing infant birth weight. In addition, adolescent mothers face a higher risk of delivering infants with low birth weights due to challenges related to inadequate prenatal care and socioeconomic factors. Furthermore, pregnancy during adolescence most times presents a unique challenge due to the fact that young mothers are still in the process of physical and emotional development themselves. In contrast, [5] emphasized that advanced maternal age can also contribute to lower birth weights due to the increased prevalence of chronic health conditions and pregnancy complications. The unique physiological adjustment of primiparous during their first pregnancy has great influence on fetal growth pattern [7]. In multiparous, prior experience and physiological development lead to higher birth weight in subsequent pregnancies.

[7] suggested that the previous experience of multiparous women tend to help in slightly higher birth weight in subsequent pregnancies as compared to primiparous women. In addition, Gravida plays a significant role in birth weight outcomes.

The remaining part of this work is divided into material and methods, the result of the analysis, discussion of result and conclusion.

2 Material and methods

2.1 Study Area and Source of Data

Nigeria is one of the West African Country that lies between 4^0N and 14^0N latitude and longitude 4^0E to 14^0E. It Sharing border with Republic of Niger, Cameroon, Benin Republic and Gulf of Guinea. The Republic of Niger is located at the north, to the east is Cameroon, to the west is Benin Republic and finally to south is the arm of Atlantic Ocean.

Benue State is one of the states in middle belt of Nigeria with an approximate population of 4,253,641 as at 2006 census. The state share border with five states which includes Nasarawa (to the north), Taraba (to the east), Kogi (to the west), Enugu (to the south-west), Ebonyi and Cross-Rivers (to the south). It has an international border with Cameroon to the South-East. The data on infant weight, gravida and maternal age were collected from Family Support Programme (FSP), Makurdi, Benue State, Nigeria.

2.2 Analysis of Variance Model

The methods implemented in this paper in order to determine the effect of two dependent factors (gravida and age group) is two-way ANOVA. The two-way analysis of variance models are as follows:

$$Y_{ijk} = \mu + \alpha_i + \beta_j + \epsilon_{ijk} \begin{cases} i = 1,2,\ldots,a \\ j = 1,2,\ldots,b \\ n = 1,2,\ldots,n \end{cases} \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

$$Y_{ijk} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \epsilon_{ijk} \begin{cases} i = 1,2,\ldots,a \\ j = 1,2,\ldots,b \\ n = 1,2,\ldots,n \end{cases} \ldots\ldots\ldots\ldots\ldots (2)$$

Note that $\Sigma\alpha_i = \Sigma\beta_j = \Sigma(\alpha\beta)_{ij} = 0$ and $\varepsilon_{ij} \sim IIDN(0,\sigma^2)$

Where;

Y_{ijk} are independent observations of the i-th treatments of the j-th blocks and the k-th replications, μ is the true mean value of the dependent variable, α_i is the effect due to the i-th level of the treatment effect and β_j is the effect due to the j-th level of the block effect, $(\alpha\beta)_{ij}$ is the effect due to the interaction between the i-th level of the treatment and the j-th level of the block and ε is the random error in the response attributed to the dependent variable.

Equations (1) and (2) above are two-way analysis of variance without and with interaction respectively. In this paper, interactions are not considered because of unequal replications.

Table 1 The General ANOVA Layout

Factors	**Factor B (Gravida)**			
Factor A (Age Group)	1	2	…	b
1	$Y_{111,}Y_{112},\ldots,Y_{11n}$	$Y_{121,}Y_{122},\ldots,Y_{12n}$	…	$Y_{1b1,}Y_{1b2},\ldots,Y_{1bn}$
2	$Y_{211},Y_{212},\ldots,Y_{21n}$	$Y_{221},Y_{222},\ldots,Y_{22n}$	…	$Y_{2b1,}Y_{2b2},\ldots,Y_{2bn}$
3	$Y_{311,}Y_{312},\ldots,Y_{31n}$	$Y_{321},Y_{322},\ldots,Y_{32n}$	…	$Y_{3b1,}Y_{3b2},\ldots,Y_{3bn}$
.	.	.		.
.	.	.	…	.
.	.	.		.
A	$Y_{a11},Y_{a12},\ldots,Y_{a1n}$	$Y_{a21},Y_{a22},\ldots,Y_{a2n}$	…	$Y_{ab1,}Y_{ab2},\ldots,Y_{abn}$

The formula needed for estimating the model parameters is as given below.

The Sum of squares total denoted by SS_T

$$SS_T = \sum_{i=1}^{a}\sum_{j=1}^{b}\sum_{k=1}^{n} y_{ij}^2 - \frac{y_{\ldots}^2}{\mathrm{abn}} \qquad \ldots\ldots\ldots\ldots (3)$$

The sum of squares for the treatment effects denoted by SS_A

$$SS_A = \frac{1}{\mathrm{bn}}\sum_{i=1}^{a} y_{i..}^2 - \frac{y_{\ldots}^2}{\mathrm{abn}} \qquad \ldots\ldots\ldots (4)$$

The sum of squares for the block effects denoted by SS_B

$$SS_B = \frac{1}{\mathrm{an}}\sum_{j=1}^{b} y_{.j.}^2 - \frac{y_{\ldots}^2}{\mathrm{abn}} \qquad \ldots\ldots\ldots\ldots (5)$$

The error sum of squares (SS_E)

$$SS_E = SS_T - SS_A - SS_B \qquad \ldots\ldots\ldots\ldots (6)$$

The ANOVA table (Table 2) below is use to either accept or nullify the null hypothesis.

Honestly Significant Difference (HSD) is used in this paper to perform post hoc (multiple means comparison) and it is as given below. $\mathrm{q} = \frac{\bar{y}_i - \bar{y}_j}{\sqrt{\frac{\mathrm{MS_E}}{n}}}$ where n is the number of observations, $\mathrm{MS_E}$ is the mean square error computed from Table 2, $\bar{y}_i$is the mean of the i-th treatment and $\bar{y}_j$ is the mean of the j-th block to be compared.

Table 2 Analysis of Variance Table (ANOVA)

Source of Variation	Sum of squares	Degree of Freedom	Mean square	F-Ratio
Factor A	SS_A	(a - 1)	$\frac{SS_A}{(a - 1)}$	$F = \frac{MS_A}{MS_E}$
Factor B	SS_B	(b - 1)	$\frac{SS_B}{(b - 1)}$	$F = \frac{MS_B}{MS_E}$
Error	SS_E	(N - ab)	$\frac{SS_E}{N - ab}$	
Total	SS_T	(N - 1)		

3 Results

The following Tables display the results of analysis discussed in material and methods above

Table 3 Descriptive Statistics

Gravida	Age Group	N	Mean	Std Dev	Minimum	Maximum
Gravida_1	Age_14_19	33	2.638	0.475	1.5	3.5
	Age_20_25	78	2.836	0.343	1.5	3.5
	Age_26_31	26	2.869	0.312	2.4	3.6
	Age_32_37	2	2.750	0.212	2.6	2.9
Gravida_2	Age_14_19	6	2.767	0.476	2.2	3.4
	Age_20_25	93	2.953	0.438	1.1	4.0
	Age_26_31	45	2.822	0.473	1.6	3.5
	Age_32_37	5	3.260	0.207	3.0	3.5
	Age_38_42	1	3.400	0.000	3.4	3.4
Gravida_3	Age_14_19	2	2.350	0.354	2.1	2.6
	Age_20_25	51	2.949	0.430	1.7	3.7
	Age_26_31	54	3.056	0.465	2.3	4.3
	Age_32_37	7	3.100	0.443	2.6	4.0
Gravida_>=4	Age_14_19	32	3.116	0.430	2.3	4.0
	Age_20_25	62	3.171	0.380	2.4	4.2
	Age_26_31	30	3.090	0.578	1.5	5.2
	Age_38_42	6	3.083	0.591	2.4	3.9

Table 4 ANOVA Result for Weight of an Infant

Source of Variation	Sum of squares	Degree of Freedom	Mean square	F-Ratio	P_value
Gravida	8.21	3	2.74	14.77	0.0001
Age Group	5.77	4	1.44	7.78	0.0001
Error	95.57	516	0.19		
Total	107.73	632			

Table 5 Multiple Means Comparison for Gravida Using Tukey HSD

Gravida Comparison	Difference between means	Simultaneous 95% Confidence Limits	
Gravida_>=4 - Gravida_3	0.13637	-0.00596	0.27870
Gravida_>=4 - Gravida_2	0.21528	0.08236	0.34820 ***
Gravida_>=4 - Gravida_1	0.34073	0.20539	0.47607 ***
Gravida_3 - Gravida_>=4	-0.13637	-0.27870	0.00596
Gravida_3 - Gravida_2	0.07891	-0.05891	0.21674
Gravida_3 - Gravida_1	0.20436	0.06420	0.34452 ***
Gravida_2 - Gravida_>=4	-0.21528	-0.34820	-0.08236
Gravida_2 - Gravida_3	-0.07891	-0.21674	0.05891
Gravida_2 - Gravida_1	0.12545	-0.00515	0.25604
Gravida_1 - Gravida_>=4	-0.34073	-0.47607	-0.20539 ***
Gravida_1 - Gravida_3	-0.20436	-0.34452	-0.06420 ***
Gravida_1 - Gravida_2	-0.12545	-0.25604	0.00515

Comparisons significant at the 0.05 level are indicated by ***.

Table 6 Multiple Means Comparison for Age Group Using Tukey HSD

Age Group Comparison	Difference between means	Simultaneous 95% Confidence Limits	
Age_38_43 - Age_32_37	0.03312	-0.44628	0.51252
Age_38_43 - Age_26_31	0.11681	-0.33674	0.57035
Age_38_43 - Age_20_25	0.19196	-0.25942	0.64334
Age_38_43 - Age_14_19	0.48589	0.00409	0.96769 ***
Age_32_37 - Age_38_43	-0.03312	-0.51252	0.44628
Age_32_37 - Age_26_31	0.08369	-0.11371	0.28109
Age_32_37 - Age_20_25	0.15884	-0.03354	0.35122
Age_32_37 - Age_14_19	0.45277	0.19704	0.70850 ***
Age_26_31 - Age_38_43	-0.11681	-0.57035	0.33674
Age_26_31 - Age_32_37	-0.08369	-0.28109	0.11371
Age_26_31 - Age_20_25	0.07515	-0.03837	0.18867
Age_26_31 - Age_14_19	0.36908	0.16592	0.57224 ***
Age_20_25 - Age_38_43	-0.19196	-0.64334	0.25942
Age_20_25 - Age_32_37	-0.15884	-0.35122	0.03354
Age_20_25 - Age_26_31	-0.07515	-0.18867	0.03837
Age_20_25 - Age_14_19	0.29393	0.09565	0.49222 ***
Age_14_19 - Age_38_43	-0.48589	-0.96769	-0.00409 ***
Age_14_19 - Age_32_37	-0.45277	-0.70850	-0.19704 ***
Age_14_19 - Age_26_31	-0.36908	-0.57224	-0.16592 ***
Age_14_19 - Age_20_25	-0.29393	-0.49222	-0.09565 ***

Comparisons significant at the 0.05 level are indicated by ***.

4 Discussion

This paper used data on birth weight and age of a mother sourced from Family Support Programme (FSP) Makurdi, Benue State, Nigeria. The Maternal age was divided into five (5) groups which includes 14-19, 20-25, 26-31, 32-37 and 38-43 and also the gravida which is the number of pregnancies, were also divided into four (4) which includes gravida one (1), gravida two (2), gravida three (3) and gravida four (4) (women with number of pregnancies greater than or equal to four (4)). Two-way classification is used in this work. One of the factors is gravida and the second is the maternal age. Interactions between the age and the gravida were not considered because replications are not the same across. Observe from Table 3 that gravida one (1) has the highest occurrence of 78 observations in age group 20-25 with a mean weight of 2.84; closely followed is that of age 14-19 which is 33 with the mean of 2.64 (this age group is the least bearing age according to our data). Age 26-31 has a mean weight of 2.87 with 26 observations and finally age group 32-37 with a mean weight of 2.75 with 2 observations. In gravida one (1) age group 26-31 has the highest mean weight of 2.87 whereas age 14-19 is the least with a mean weight of 2.64.

It then now followed for gravida two (2), gravida three (3) and gravida four (4) where age 38-43 has the highest mean weight of 3.40 though it has one observation and age 14-19 is the least with a mean weight of 2.77. Age 32-37 has the highest mean weight of 3.10 while that of age group 14-19 is the least (2.35). There are no age group of 14-19 that belong to gravida four (4) which are the group of women that has at least four (4) pregnancies. In general, 93 is the highest observations which is found in 20-25 age group in gravida two (2).

Table 4 is the analysis of variance table which is the result of significance difference between the mean weight of an infant across the age group and gravida. Observe that the p_value (0.0001) for maternal age group is less than the 0.05 alpha level of significance. This means that there is a significant difference across the mean weight of an infant; furthermore, significant difference is seen in gravida since the p_value of 0.001 is less than the alpha level of 0.05. It is clear that significant difference exists across the maternal age group and the gravida and hence the need for multiple means comparison also known as post hoc in order to determine the means that differs.

Tables 5 and 6 are the tables for multiple means comparison using Tukey honestly significance differences (HSD) for gravida and age group respectively. Significant difference was observed for gravida which means that the weight of an infants for various pregnancies are not the same. This implies that the weight of infant for gravida one (1) is different from that of gravida two (2), gravida three (3) and gravida four (4). The essence of multiple means comparison is to see the mean weight of an infant that differs across gravida. Observe from Table 5 that the mean weight of an infant in gravida four (4) differs greatly from gravida one (1) and two (2) as pointed out by the double asterisk (**). The difference between the means of gravida four (4) and gravida two (2) is 0.215 with a confidence interval (CI) of 0.0824 (lower) and 0.348 (upper) which doesn't include zero. Similarly, for that of gravida four (4) and one (1) is 0.341 whereas the confidence interval (CI) is 0.205 (lower) and 0.476 (upper). In addition, gravida three (3) and gravida one (1) are statistically significant with a mean difference of 0.204 and a CI of 0.0642, 0.345. Any other pairs in the gravida such as gravida two (2) and gravida three (3) are not statistically significant and so it follows for others.

The result of multiple means comparison for maternal age group is as seen in Table 6. This age group were divided into five (5) as mentioned above. Maternal age one (14-19) is found to differ greatly from every other age groups. This means that, the weight of an infant given birth to by those age group are significantly different from others. Also, the CI for those age group that are significant doesn't include zero. The mean difference between the weight of an infant in age 14-19 and 38-43 is 0.486 with a CI of [0.00409, 0.968]. It then follows for 32-37, 26-31 and 20-25 with the means differences of 0.453, 0.369 and 0.294 respectively. Furthermore, the CI are respectively [0.197,0.709], [0.166, 0.572] and [0.0957, 0.492]. In summary, the means differences are in order of magnitude starting with 38-43 with the highest value of 0.486, followed by 32-37 (0.453), 26-31 (0.369) and the least is 0.294 for 20-25.

5 Conclusion

This Study makes used of data on infant weight, maternal age and gravida sourced from Family Support Programme (FSP) in Makurdi, Benue State, Nigeria. Analysis of Variance (ANOVA) Model was carried out using SAS version 9.0. The result revealed that significance difference exists between the maternal age of the infant since the p_value of 0.0001 is less than alpha level of 0.05. The result of multiple means comparison also known as post hoc revealed that age group 14-19 is significantly different from the rest of the group. The mean difference between the age group 14-19 and 38-43 has the highest mean weight whereas 14-19 and 20-25 has the least mean weight.

Multiple mean comparison results also show significance difference across various gravida. Four (4) different gravida were considered. Gravida four (4) which is the group of women that have at least four (4) pregnancies is found to be statistically different from gravida one (1) and gravida two (2). Gravida four (4) and gravida two (2) has the highest mean difference of 0.341. In addition, significance difference is also observed between gravida three (3) and gravida one (1) with a mean difference of 0.204.

Observe that the highest mean weight of an infant within the period under consideration is 3.40 which is found in the 38-43 age group in gravida two (2) whereas the least mean weight of 2.35 is found in gravida three (3) and age group 14-19. The implication of this result is that infant with least mean weight is given birth to by those in age group ranging from 14-19 and also by those that have pregnancy number unto three (gravida 3) why those with the highest mean weight to the tune of 3.4 is in the age group 38-43 and are pregnancies number up to two (gravida 2).

Gravida two (2) and age group 20-25 has the highest occurrence (93) of birth with a mean weight of 2.95. This means that more infants are given birth to by those age group and gravida two (2) with a mean weight as compared to the rest of the groups and gravida. Closely followed is that of gravida one (1) which is 78 with the same age group (20-25) and the mean weight of 2.84. Observe also that 20-25 age group have the highest number of observations as compared to the rest of the group exception of gravida four (4) where 26-31 have the highest observations of 60 but closely followed is 20-25 with 30 observations.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare that there is no conflict of interest concerning this work.

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Appendix 1

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              The SAS System        08:32 Friday, January 22, 2024   1

                                The MEANS Procedure

                              Analysis Variable : weight

                             N
Gravida       AgeGroup      Obs    N          Mean       Std Dev       Minimum       Maximum
ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ
Gravida_1     Age_14_19      33   33     2.6378788     0.4751694     1.5000000     3.5000000

              Age_20_25      78   78     2.8358974     0.3433881     1.5000000     3.5000000

              Age_26_31      26   26     2.8692308     0.3121144     2.4000000     3.6000000

              Age_32_37       2    2     2.7500000     0.2121320     2.6000000     2.9000000

Gravida_2     Age_14_19       6    6     2.7666667     0.4760952     2.2000000     3.4000000

              Age_20_25      93   93     2.9526882     0.4380270     1.1000000     4.0000000

              Age_26_31      45   45     2.8222222     0.4733291     1.5000000     3.9000000

              Age_32_37       5    5     3.2600000     0.2073644     3.0000000     3.5000000

              Age_38_43       1    1     3.4000000             .     3.4000000     3.4000000

Gravida_3     Age_14_19       2    2     2.3500000     0.3535534     2.1000000     2.6000000

              Age_20_25      51   51     2.9490196     0.4295917     1.7000000     3.7000000

              Age_26_31      54   54     3.0555556     0.4652719     2.3000000     4.3000000

              Age_32_37       7    7     3.1000000     0.4434712     2.6000000     4.0000000

Gravida_>=4   Age_20_25      32   32     3.1156250     0.4303857     2.3000000     4.0000000

              Age_26_31      62   62     3.1709677     0.3795541     2.4000000     4.2000000

              Age_32_37      30   30     3.0900000     0.5779572     1.5000000     5.2000000

              Age_38_43       6    6     3.0833333     0.5913262     2.4000000     3.9000000
ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ
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Appendix 2

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                                  The ANOVA Procedure

                                Class Level Information

         Class         Levels    Values
```

Gravida	4	Gravida_1 Gravida_2 Gravida_3 Gravida_>=4
AgeGroup	5	Age_14_19 Age_20_25 Age_26_31 Age_32_37 Age_38_43

Number of observations 533

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The ANOVA Procedure

Dependent Variable: weight

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	16	12.1597785	0.7599862	4.10	<.0001
Error	516	95.5710095	0.1852151		
Corrected Total	532	107.7307880			

R-Square	Coeff Var	Root MSE	weight Mean
0.112872	14.55906	0.430366	2.956004

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Gravida	3	8.20567261	2.73522420	14.77	<.0001
AgeGroup	4	5.76600066	1.44150016	7.78	<.0001
Gravida*AgeGroup	9	0.00000000	0.00000000	0.00	1.0000

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Appendix 3

The ANOVA Procedure

Tukey's Studentized Range (HSD) Test for weight

NOTE: This test controls the Type I experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	516
Error Mean Square	0.185215
Critical Value of Studentized Range	3.64509

Comparisons significant at the 0.05 level are indicated by ***.

Gravida Comparison	Difference Between Means	Simultaneous 95% Confidence Limits		
Gravida_>=4 - Gravida_3	0.13637	-0.00596	0.27870	
Gravida_>=4 - Gravida_2	0.21528	0.08236	0.34820	***
Gravida_>=4 - Gravida_1	0.34073	0.20539	0.47607	***
Gravida_3 - Gravida_>=4	-0.13637	-0.27870	0.00596	
Gravida_3 - Gravida_2	0.07891	-0.05891	0.21674	
Gravida_3 - Gravida_1	0.20436	0.06420	0.34452	***
Gravida_2 - Gravida_>=4	-0.21528	-0.34820	-0.08236	***
Gravida_2 - Gravida_3	-0.07891	-0.21674	0.05891	
Gravida_2 - Gravida_1	0.12545	-0.00515	0.25604	
Gravida_1 - Gravida_>=4	-0.34073	-0.47607	-0.20539	***
Gravida_1 - Gravida_3	-0.20436	-0.34452	-0.06420	***
Gravida_1 - Gravida_2	-0.12545	-0.25604	0.00515	

Appendix 4

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                        The ANOVA Procedure

           Tukey's Studentized Range (HSD) Test for weight

    NOTE: This test controls the Type I experimentwise error rate.


            Alpha                                   0.05
            Error Degrees of Freedom                 516
            Error Mean Square                   0.185215
            Critical Value of Studentized Range  3.87136


   Comparisons significant at the 0.05 level are indicated by ***.


                           Difference
          AgeGroup            Between     Simultaneous 95%
         Comparison             Means    Confidence Limits

    Age_38_43 - Age_32_37       0.03312    -0.44628  0.51252
    Age_38_43 - Age_26_31       0.11681    -0.33674  0.57035
    Age_38_43 - Age_20_25       0.19196    -0.25942  0.64334
    Age_38_43 - Age_14_19       0.48589     0.00409  0.96769  ***
    Age_32_37 - Age_38_43      -0.03312    -0.51252  0.44628
    Age_32_37 - Age_26_31       0.08369    -0.11371  0.28109
    Age_32_37 - Age_20_25       0.15884    -0.03354  0.35122
    Age_32_37 - Age_14_19       0.45277     0.19704  0.70850  ***
    Age_26_31 - Age_38_43      -0.11681    -0.57035  0.33674
    Age_26_31 - Age_32_37      -0.08369    -0.28109  0.11371
    Age_26_31 - Age_20_25       0.07515    -0.03837  0.18867
    Age_26_31 - Age_14_19       0.36908     0.16592  0.57224  ***
    Age_20_25 - Age_38_43      -0.19196    -0.64334  0.25942
    Age_20_25 - Age_32_37      -0.15884    -0.35122  0.03354
    Age_20_25 - Age_26_31      -0.07515    -0.18867  0.03837
    Age_20_25 - Age_14_19       0.29393     0.09565  0.49222  ***
    Age_14_19 - Age_38_43      -0.48589    -0.96769 -0.00409  ***
    Age_14_19 - Age_32_37      -0.45277    -0.70850 -0.19704  ***
    Age_14_19 - Age_26_31      -0.36908    -0.57224 -0.16592  ***
    Age_14_19 - Age_20_25      -0.29393    -0.49222 -0.09565  ***
```

Appendix 5

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                        The ANOVA Procedure

                      Class Level Information

  Class         Levels    Values

  Gravida            4    Gravida_1 Gravida_2 Gravida_3 Gravida_>=4

  AgeGroup           5    Age_14_19 Age_20_25 Age_26_31 Age_32_37 Age_38_43


                     Number of observations    533
                             The SAS System       01:32 Tuesday, January 19, 2024  37

                        The ANOVA Procedure

Dependent Variable: weight

                                           Sum of
       Source                      DF         Squares     Mean Square    F Value    Pr > F

       Model                       16      12.1597785       0.7599862       4.10    <.0001
```

Source	DF	Sum of Squares	Mean Square
Error	516	95.5710095	0.1852151
Corrected Total	532	107.7307880	

R-Square	Coeff Var	Root MSE	weight Mean
0.112872	14.55906	0.430366	2.956004

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Gravida	3	8.20567261	2.73522420	14.77	<.0001
AgeGroup	4	5.76600066	1.44150016	7.78	<.0001
Gravida*AgeGroup	9	0.00000000	0.00000000	0.00	1.0000

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Appendix 6

The ANOVA Procedure

Tukey's Studentized Range (HSD) Test for weight

NOTE: This test controls the Type I experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	516
Error Mean Square	0.185215
Critical Value of Studentized Range	3.64509

Comparisons significant at the 0.05 level are indicated by ***.

Gravida Comparison	Difference Between Means	Simultaneous 95% Confidence Limits		
Gravida_>=4 - Gravida_3	0.13637	-0.00596	0.27870	
Gravida_>=4 - Gravida_2	0.21528	0.08236	0.34820	***
Gravida_>=4 - Gravida_1	0.34073	0.20539	0.47607	***
Gravida_3 - Gravida_>=4	-0.13637	-0.27870	0.00596	
Gravida_3 - Gravida_2	0.07891	-0.05891	0.21674	
Gravida_3 - Gravida_1	0.20436	0.06420	0.34452	***
Gravida_2 - Gravida_>=4	-0.21528	-0.34820	-0.08236	***
Gravida_2 - Gravida_3	-0.07891	-0.21674	0.05891	
Gravida_2 - Gravida_1	0.12545	-0.00515	0.25604	
Gravida_1 - Gravida_>=4	-0.34073	-0.47607	-0.20539	***
Gravida_1 - Gravida_3	-0.20436	-0.34452	-0.06420	***
Gravida_1 - Gravida_2	-0.12545	-0.25604	0.00515	

Appendix 7

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The ANOVA Procedure

Tukey's Studentized Range (HSD) Test for weight

NOTE: This test controls the Type I experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	516
Error Mean Square	0.185215
Critical Value of Studentized Range	3.87136

Comparisons significant at the 0.05 level are indicated by ***.

AgeGroup Comparison	Difference Between Means	Simultaneous 95% Confidence Limits		
Age_38_43 - Age_32_37	0.03312	-0.44628	0.51252	
Age_38_43 - Age_26_31	0.11681	-0.33674	0.57035	
Age_38_43 - Age_20_25	0.19196	-0.25942	0.64334	
Age_38_43 - Age_14_19	0.48589	0.00409	0.96769	***
Age_32_37 - Age_38_43	-0.03312	-0.51252	0.44628	
Age_32_37 - Age_26_31	0.08369	-0.11371	0.28109	
Age_32_37 - Age_20_25	0.15884	-0.03354	0.35122	
Age_32_37 - Age_14_19	0.45277	0.19704	0.70850	***
Age_26_31 - Age_38_43	-0.11681	-0.57035	0.33674	
Age_26_31 - Age_32_37	-0.08369	-0.28109	0.11371	
Age_26_31 - Age_20_25	0.07515	-0.03837	0.18867	
Age_26_31 - Age_14_19	0.36908	0.16592	0.57224	***
Age_20_25 - Age_38_43	-0.19196	-0.64334	0.25942	
Age_20_25 - Age_32_37	-0.15884	-0.35122	0.03354	
Age_20_25 - Age_26_31	-0.07515	-0.18867	0.03837	
Age_20_25 - Age_14_19	0.29393	0.09565	0.49222	***
Age_14_19 - Age_38_43	-0.48589	-0.96769	-0.00409	***
Age_14_19 - Age_32_37	-0.45277	-0.70850	-0.19704	***
Age_14_19 - Age_26_31	-0.36908	-0.57224	-0.16592	***
Age_14_19 - Age_20_25	-0.29393	-0.49222	-0.09565	***