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Modelling Predictors of Weight Gain of Children Under-Five

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Abstract: This study examined the determinants of weight gain by children less than five years in the Kintampo municipality of the Bono East Region of Ghana using multivariate analysis of variance (MANOVA) procedure and profile analysis. The study revealed that the minimum weight gain at the first month for males and females are 1.8kg and 1.6kg respectively and that mean weights gain by children under five years was not the same across feeding type. Profile plots of main effect revealed that baby's age group 0-6, Exclusive Breast Feeding (EBF), parity levels 6, 7 and mothers who were formally employed are associated with lower mean effects since they fall below the average mean weight. However, child age group 13-18, breast milk substitute and parity 7 are above the average mean weight line of 7.5, indicating significant effect. Interaction plots indicated that the relationship between parity, mother's age group, employment type and weight depend on other predictor variables. Parity depends on mother's age but mother's age does not depend on the child age group with respect to weight gain. Also, employment type neither depend on religion nor child age group but it depends on educational level with respect to weight gain. The MANOVA results showed that feeding type, parity and child age are the influential factors in determining the weight gain of children less than five years. Further, the study revealed that there exists some relationship between feeding type and mother's education, parity and mother's age group and between occupation and mother's age group with respect to weight gain confirming the profile results. It is therefore recommended that nursing mothers should be encouraged to feed their children themselves since feeding practice has a great influence in the growth of the child at the infant stage.

Keywords: MANOVA, Feeding Type, Weight Gain, Interaction, Profile Plot

1. Introduction

A number of researches have been carried out on weight for age in babies using different methodologies. According to United Nations International Children and Education Fund [1], globally, one out of seven infants is born with low birth weight. The incidence has not declined in the last decade in Sub-Saharan Africa (SSA) and Asia. It has also been estimated that the prevalence of low-birth-weight babies in Ghana is 13.0%. Maternal age (<20 years and >35 years), stress during pregnancy, maternal under nutrition before pregnancy and first parity may lead to low birth weight [2]. Other evidence adduced by considering factors related to birth weight, they may be classified as demographical, physical, psychosocial, nutritional, behavioral, previous obstetric history, morbidity during pregnancy and antenatal care. Demographic factors pertain to the age, religion, place of residence, socio-economic status (income, education and occupation).

The physical factors include the maternal height, pre-pregnancy weight, paternal height and weight. Nutritional factors consist of food intake as well as weight gain during pregnancy. Psychosocial factors comprise of the psychological make-up of the mother during pregnancy as well as the social factors having an effect on the mother. Health behaviors affecting birth weight include smoking as well as passive smoking and physical activity. Previous obstetric history encompasses the details of previous pregnancies as well as any previous adverse outcomes. Maternal morbidity during pregnancy checks for general morbidity or any episodic illness during pregnancy and any significant complication during pregnancy. Antenatal care focuses on the month of initiation as well as the number of visits and quality of the care.

Maternal age is considered to be a very important aspect in the area of birth weight studies. Leppert *et al* [3] in a study conducted among adolescents and older mothers in New York reported maternal age as a significant predictor of birth weight. Also, a study by Abel, Kruger and Burd [4] discovered a U-shaped relationship between age and low birth weight. Considering the effect of religion on birth weight, Dhall and Bagga [5] revealed a significant effect of religion on birth weight among babies born in North India.

Socio-Economic status (SES) mainly comprises of factors relating to education, occupation and income. Parker and Schoendorf [6], found that maternal and paternal education levels were the best overall predictors of reproductive outcomes like birth weight. Low SES was seen to be significantly related to low birth weight in a study by Deshmukh *et al.* [7], conducted in an urban area in India. However, a study in Thailand by Tuntiseranee *et al.* [8] observed that among the SES indicators, only family income correlated with birth weight.

Langhoff *et al.* [9] studied the relation between hereditary factors with birth weight and concluded that maternal and paternal birth weights were poor predictors of infant birth weight. Also, in a study from India conducted by Mavalankar *et al.* [10] showed that attributable risk for low birth weight contributed by low maternal weight was much more than that by low maternal height.

Studies have shown that rapid weight gain in infancy is essentially correlated to an increased risk of obesity during childhood and in later life [11, 12], and where as children showing poor weight gain is a sign of malnutrition [13]. Malnutrition has over the years and still remains a major public health problem. An estimated figure of about 45% of under five years children mortality are linked to malnutrition [14]. Early detection of risk factors for constant unnecessary weight gain is essential, as there is evidence that prevention and treatment of obesity at early stage of life prove to be most efficient [15, 16].

Examining of factors associated with weight gain, especially the relationship between child feeding practice and weight gain as it is one of the few possibly adjustable risk of malnutrition or childhood obesity is key in policy formulation. The study therefore seeks to establish the relationship between monthly mean weight gain and some maternal and child level factors. Further, it is also aimed at examining the differences between level means for one or more factors.

2. Materials and Methods

2.1. Source of Data and Variables

Data for this study was derived from a retrospective monthly repeated measurement of 145 under five-year children recorded over the period of seven months, out of which 115 observations has all required variables for the study. Variables considered in the study includes sex, baby's age, mother's age, educational level, parity, religion, occupation, marital status and feeding type and a repeated measurement of individual infant weight was recorded at seven specific time points (monthly); weight1, weight2, weight3, …, weightt7.

2.2. Multivariate Analysis of Variance (MANOVA)

MANOVA involves analysis of several population means. This technique provides a multivariate test to compare the mean vectors of k random samples for significant differences when the levels of the grouping variables are two or more. MANOVA is used to investigate whether the populations mean vectors are the same and, if not, which mean components differ significantly. Consider k independent random samples of size n obtained from p – variate normal populations. The model for each observation is;

$$X_{ij} = \mu + \mu_i + \varepsilon_{ij}, j = 1,,2, \dots, n, \text{ and } i = 1,2, \dots, g. \quad (1)$$

Where ε_{ij} are independent $N_p(0, \Sigma)$ variables while the vector μ is an overall mean and τ_i represent the i^{th} treatment effect with $\sum_{i=1}^{g} n_i \tau_i = 0$. The components of X_{ij} is a sample of $N_p(0, \Sigma)$ populations and that the random samples are independent. Each observation vector X_{ij} in model (1) can be decomposed into components of treatment and residuals effects as;

$$X_{ij} = \bar{x} + (\bar{\bar{x}}_\iota - \bar{\bar{x}}) + (x_{ij} - \overline{\overline{x_{\iota j}}}) \quad (2)$$

Johnson and Wichern [17].

2.3. Model Accuracy

1. Normal distribution: The Kolmogorov - Smirnov and Shapiro – Wilk's tests were used to test the assumption that the dependent variables are normally distributed within groups
2. Linearity: Scatter plots were used test for linearity
3. Multicollinearity: We run correlation test to test the strength and correlations among the dependent variables.
4. Homogeneity of variance-covariance matrix: Box's M Test was used to check the assumption of homogeneity of covariance matrices across the groups.

3. Results

The descriptive statistics of baby's weight over the factor levels are presented in Table 1. The result revealed that the mean weights are not the same across all factor levels. For instance, in weight1 within feeding type, exclusive breast feeding (EBF) and complementary feeding (CF) had higher mean effect compared to breast milk substitute (BS). However, in weigh6, CF and BS had relatively higher mean effect than EBF. Meanwhile BS has higher standard deviation than CF and EBF in weight1.

***Table 1.** Descriptive Statistics of Baby's Weight over the factors' levels.*

Weight Gain	Feeding Type	Mean	Std Dev.
Weight1	EBF	3.017	0.6293
	CF	3.062	0.6491
	BS	2.762	0.7512
Weight2	EBF	4.421	0.8412
	CF	4.375	0.7566
	BS	4.131	0.7901
Weight3	EBF	5.279	0.9283
	CF	5.267	0.8382
	BS	5.146	0.7423
Weight4	EBF	6.098	0.9291
	CF	6.065	0.869
	BS	5.785	0.7358
Weight5	EBF	6.714	0.8844
	CF	6.793	0.9165
	BS	6.646	0.624
Weight6	EBF	7.181	0.8713
	CF	7.322	1.0345
	BS	7.308	0.717
Weight7	EBF	7.71	0.9039
	CF	7.883	1.0251
	BS	7.738	0.7171

The summary statistics of children weights over time grouped by gender is presented in Table 2 below. The minimum weights at the first month for males and females are 1.8kg and 1.6kg respectively with female babies recording the lower minimum weight compared to their counterpart. However, at the end of the seventh month period the female babies recorded the higher minimum weight than the male babies. The standard deviations for male and female children at month one was 0.6053 kg and 0.6995 kg respectively with the male babies recording the higher mean weight of 3.064kg than their counterpart female of 2.961kg. Meanwhile the female children recorded a larger standard deviation compared to the male children. The results also revealed that the mean weight gain of children for the seven months period generally exhibited a nonlinear growth over time. This followed that the weight of a child does not essentially depend on the time the individual child was born.

***Table 2.** Descriptive Statistics of baby weight over time (in months) by sex.*

Time (months)	Minimum		Maximum		Mean		Sd. Deviation	
	Male	Female	male	Female	Male	Female	Male	Female
1	1.8	1.6	4.5	4.9	3.064	2.961	0.6053	0.6995
2	1.6	2.9	6.4	6.0	4.448	4.285	0.9189	0.6427
3	3.0	3.4	7.6	6.8	5.343	5.176	0.9605	0.7433
4	3.7	4.5	8.7	7.5	6.134	5.961	0.9649	0.7812
5	4.5	5.0	8.8	8.0	6.857	6.644	0.9115	0.8263
6	4.8	5.2	9.6	9.2	7.329	7.212	0.9682	0.9192
7	5.2	5.6	10.0	9.7	7.895	7.717	0.9651	0.9317

3.1. Model Adequacy

The Kolmogorov - Smirnov and Shapiro – Wilk's tests were used to test the assumption that the dependent variables are normally distributed within groups. The results of (Table 3) Kolmogorov-Smirnov and Shapiro–Wilk's clearly indicates that the populations were normally distributed since both tests have p – values greater than 0.05.

***Table 3.** Kolmogorov – Smirnov and Shapiro – Wilk's tests of Normality.*

	Kolmogorov-Smirnov			Shapiro – Wilk's		
	Statistic	Df	Sig.	Statistic	Df	Sig.
Weight 1	0.065	115	0.2000	0.983	115	0.166
Weight 2	0.063	115	0.2000	0.983	115	0.143
Weight 3	0.062	115	0.2000	0.991	115	0.619
Weight 4	0.06	115	0.2000	0.994	115	0.904
Weight 5	0.065	115	0.2000	0.991	115	0.645
Weight 6	0.075	115	0.1590	0.988	115	0.402
Weight 7	0.081	115	0.0600	0.989	115	0.513

***Table 4.** Levene's Test of Equality of Error Variances.*

	F	Df 1	Df 2	Sig.
Weight 1	1.063	1	113	0.305
Weight 2	4.668	1	113	0.033
Weight 3	2.154	1	113	0.145
Weight 4	0.318	1	113	0.157
Weight 5	0.000	1	113	0.998
Weight 6	0.000	1	113	0.928
Weight 7	0.283	1	113	0.596

Further, the Levene's Test of equality of variance was insignificant ($P > 0.05$) implying that the variances are equal across the groups (Table 4). Also, Box's M Test of homogeneity of covariance matrices across the groups was highly insignificant (Box M = 50.371, F-value =1.68, df1 = 28, df2 = 44237.233 and P value = 0.014), indicating that the covariance matrices of the dependent variables are equal across groups.

Also, Figure 1 present the scatter plots of the dependent variables. Clearly, the scatter plots revealed evidence of a positive correlation between the variables. The scatter plots do not show any evidence of nonlinearity, hence the assumption of linearity is satisfied.

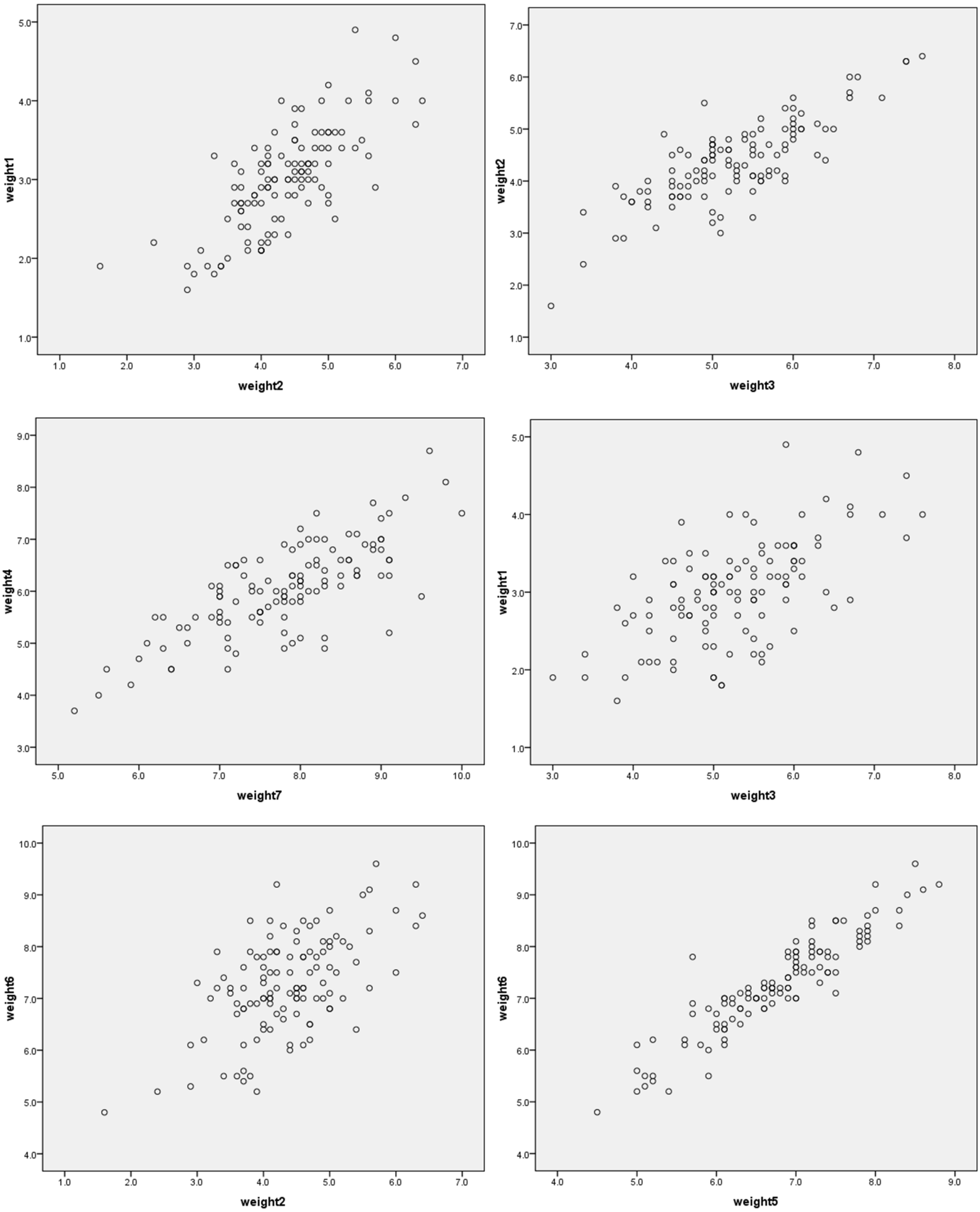


Figure 1. *Scatter plots of Dependent Variables.*

Further, a diagnostic test (Table 5) of multicollinearity by means of Pearson correlation test gave a *p*-value less than 1% level of significance, indicating that all the dependent variables are moderately correlated. The Pearson correlation appears to be positively high correlations. However, all the Pearson correlation values are below 0.9 except correlation between weight7 and weight 6 of (0.922) indicating that the variables are moderately correlated.

Table 5. *Pearson correlation for Dependent variables.*

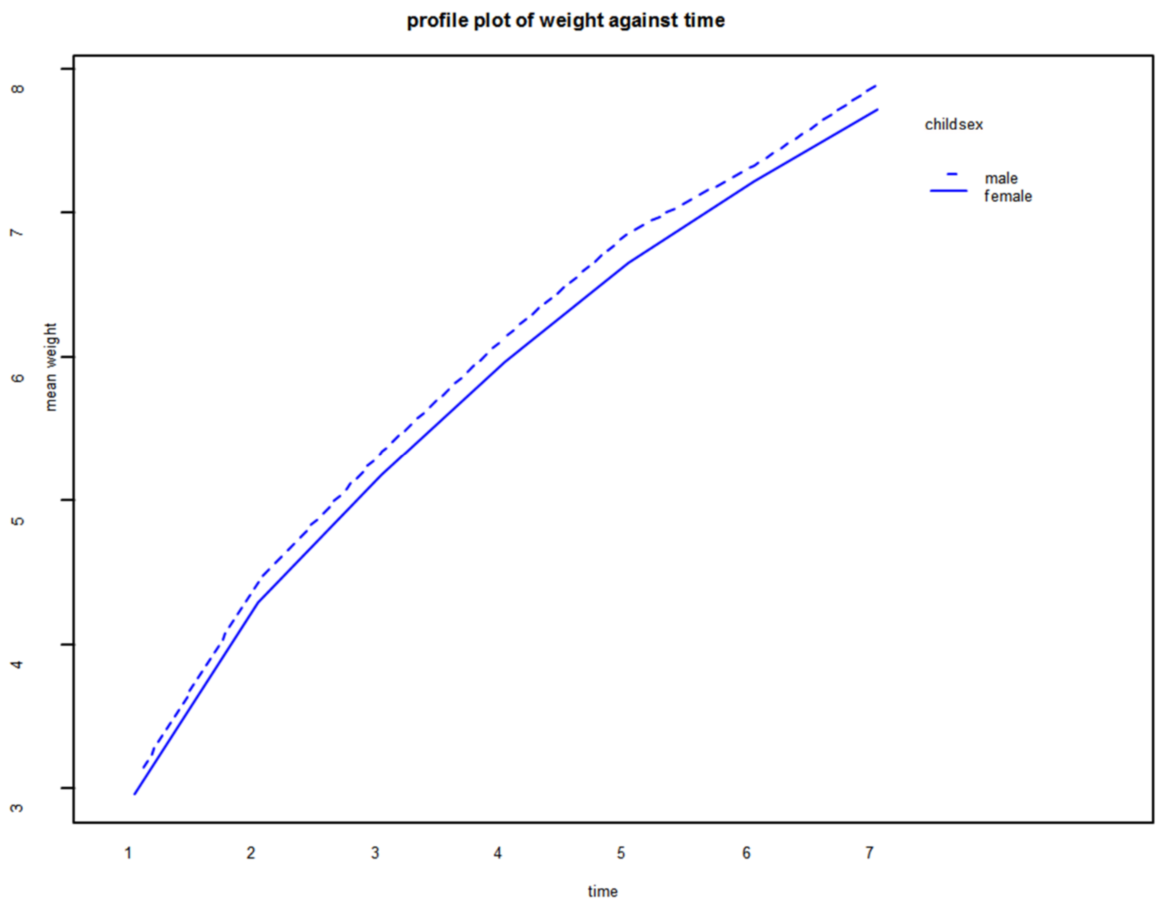
Correlations									
		Weight 1	Weight 2	Weight 3	Weight 4	Weight 5	Weight 6	Weight 7
Weight 1	Pearson Correlation	1	0.743	0.607	0.529	0.463	0.395	0.415
	Sig. (2-tailed)		0.000	0.000	0.000	0.000	0.000	0.000
Weight 2	Pearson Correlation	0.743	1	0.798	0.724	0.633	0.583	0.579
	Sig. (2-tailed)	0.000		0.000	0.000	0.000	0.000	0.000
Weight 3	Pearson Correlation	0.607	0.798	1	0.878	0.743	0.676	0.666
	Sig. (2-tailed)	0.000	0.000		0.000	0.000	0.000	0.000
Weight 4	Pearson Correlation	0.529	0.724	0.878	1	0.85	0.766	0.756
	Sig. (2-tailed)	0.000	0.000	0.000		0.000	0.000	0.000
Weight 5	Pearson Correlation	0.463	0.633	0.743	0.85	1	0.923	0.896
	Sig. (2-tailed)	0.000	0.000	0.000	0.000		0.000	0.000
Weight 6	Pearson Correlation	0.395	0.583	0.676	0.766	0.923	1	0.922
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000		0.000
Weight 7	Pearson Correlation	0.415	0.579	0.666	0.756	0.896	0.922	1
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	

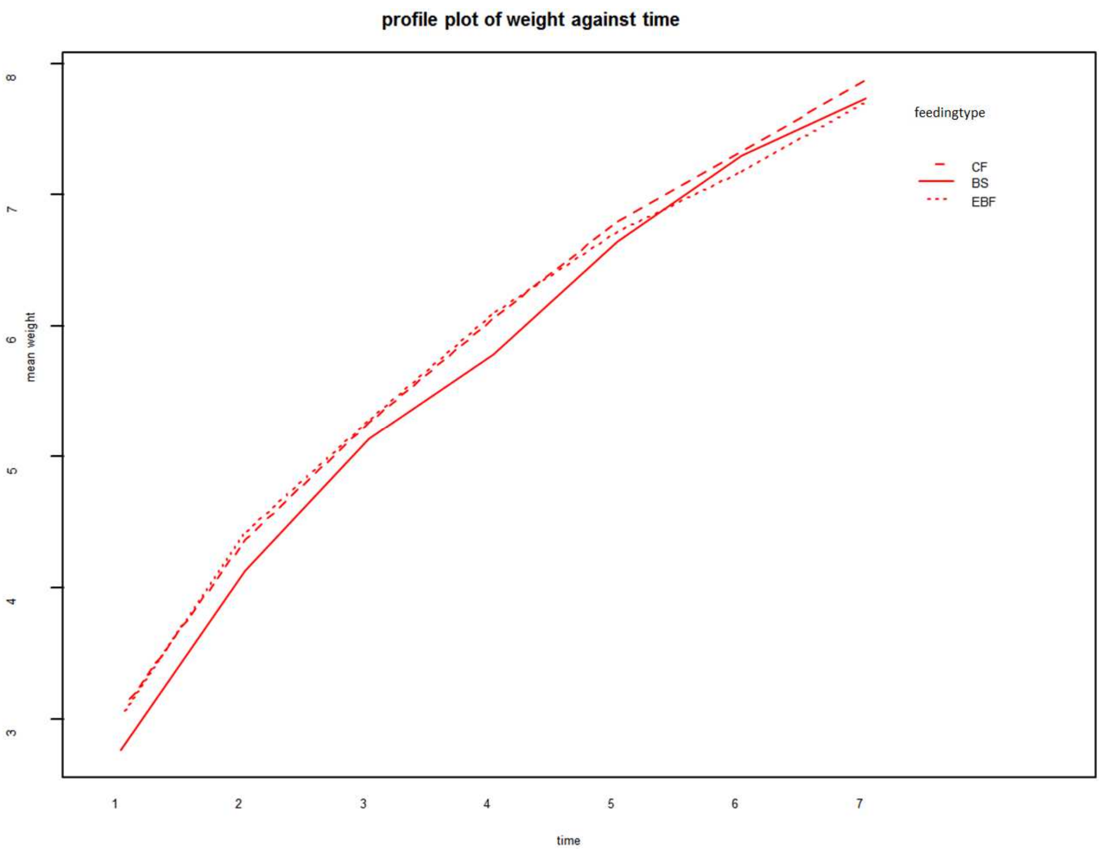
Correlation is significant at the 0.01 level (2-tailed).

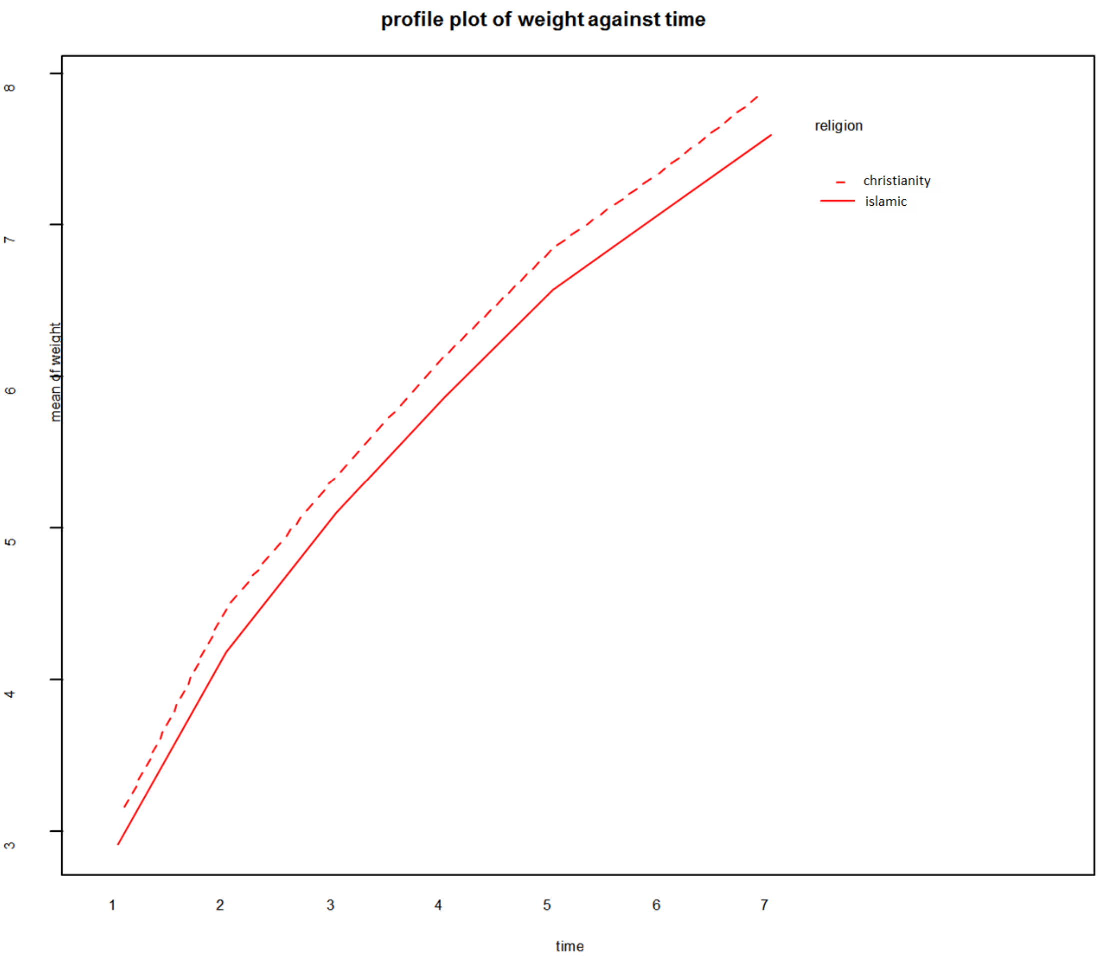
3.2. Profile Analysis of Mean Weight of Babies

The data for the study was first subjected to profile analysis in order visually compare the mean weight of babies across factor levels (see Figure 2). The profiles revealed that the mean change in baby's weights for both males and females over time followed the same patterns, indicating that the average change in weights of babies by gender may be the same or similar. However, average change in weights of babies for feeding type, change over time. Exclusive Breast Feeding (EBF) interacted with both Breast milk substitute (BS) and complementary Feeding (CF). This shows that feeding types may not be parallel. In other words, feeding type may have some effect on weights of babies.

Figure 2 further shows that the mean change in the weight of babies with respect to the mother's religious affiliation change over time and follows the same pattern. This may imply that the mean change in the weight of babies across maternal religion is similar. It is also observed that, the mean change in weights of babies over the seven-month period for maternal age group were changing over time and follows the same pattern. This implies that, the mean change in weight of babies maybe parallel irrespective of the maternal age group.




profile plot of weight against time
feedingtype
CF
BS
EBF
mean weight
time
1
2
3
4
5
6
7
3
4
5
6
7
8


profile plot of weight against time
religion
christianity
islamic
mean of weight
time
1
2
3
4
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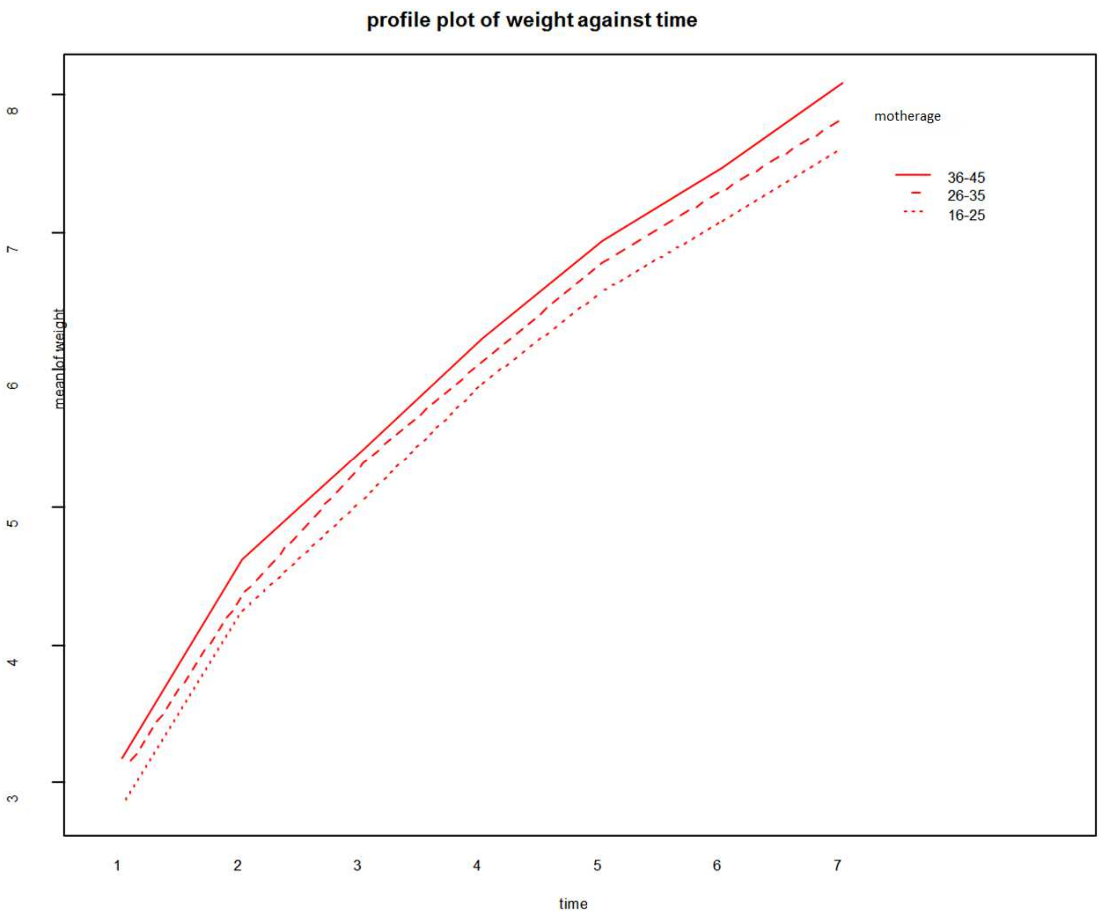

Figure 2. *Profile Plot of Mean Weight of Babies by Baby's Gender, Feeding Type, Religion and Maternal Age Group.*

3.3. Main Effects Plots for Weights of Babies

The main effects plot displays the means for each group within a categorical variable. When the line is horizontal, there is no main effect present, implying that the response mean is the same across all factor levels. However, when the line is not horizontal, there is a main effect present, indicating that the response mean is not the same across all factor levels. The steeper the slope of the line, the greater the magnitude of the main effect.

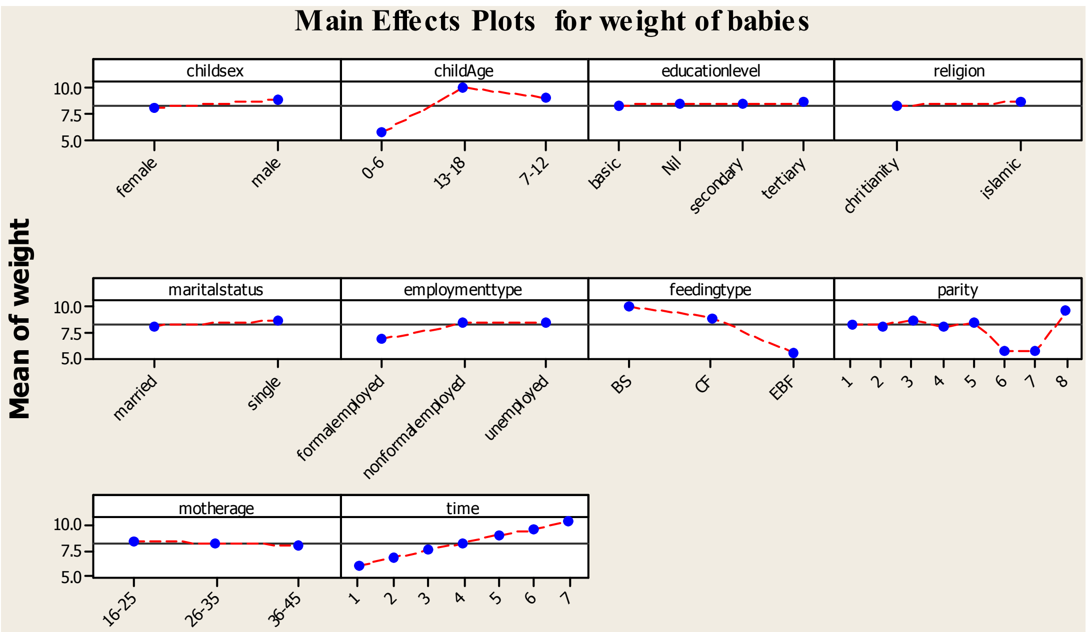

Figure 3. *Main Effects Plot for Weights of Babies.*

From figure 3, it appears that baby's age group 0-6, Exclusive Breast Feeding (EBF), parity levels 6, 7 and mothers who were formally employed are associated with lower mean effects since they fall below the average mean weight. However, child age group 13-18, breast milk substitute and parity 7 are above the average mean weight line of 7.5, indicating that they are significant. Meanwhile, the response mean is the same across all the factor levels of child sex, mothers' educational level, religion, marital status and mothers' age, indicating that the mean weight of babies is the same across all their factors' levels.

3.4. Interactions Plot

Interaction plot compares the relative strength of the effects across factors. It is used to show how the relationship between one categorical factor and a continuous response, depends on the value of the second categorical factor. In interaction plot, parallel lines show no interaction whilst non parallel lines indicate that interaction occurs. The more non parallel the lines are, the greater the interaction.

The interactions plot shown in figure 4 revealed that the relationship between educational level, religion, marital status, feeding type and weight does not depend on the other predictors since their lines are parallel, thus no interaction. However, the relationship between parity, mother's age group, employment type and weight depend on other predictor variables. That is interaction occurs. For instance, parity depends on mother's age but mother's age does not depend on the child age group with respect to weight gain. Also, employment type neither depend on religion nor child age group but it depends on educational level with respect to weight gain.

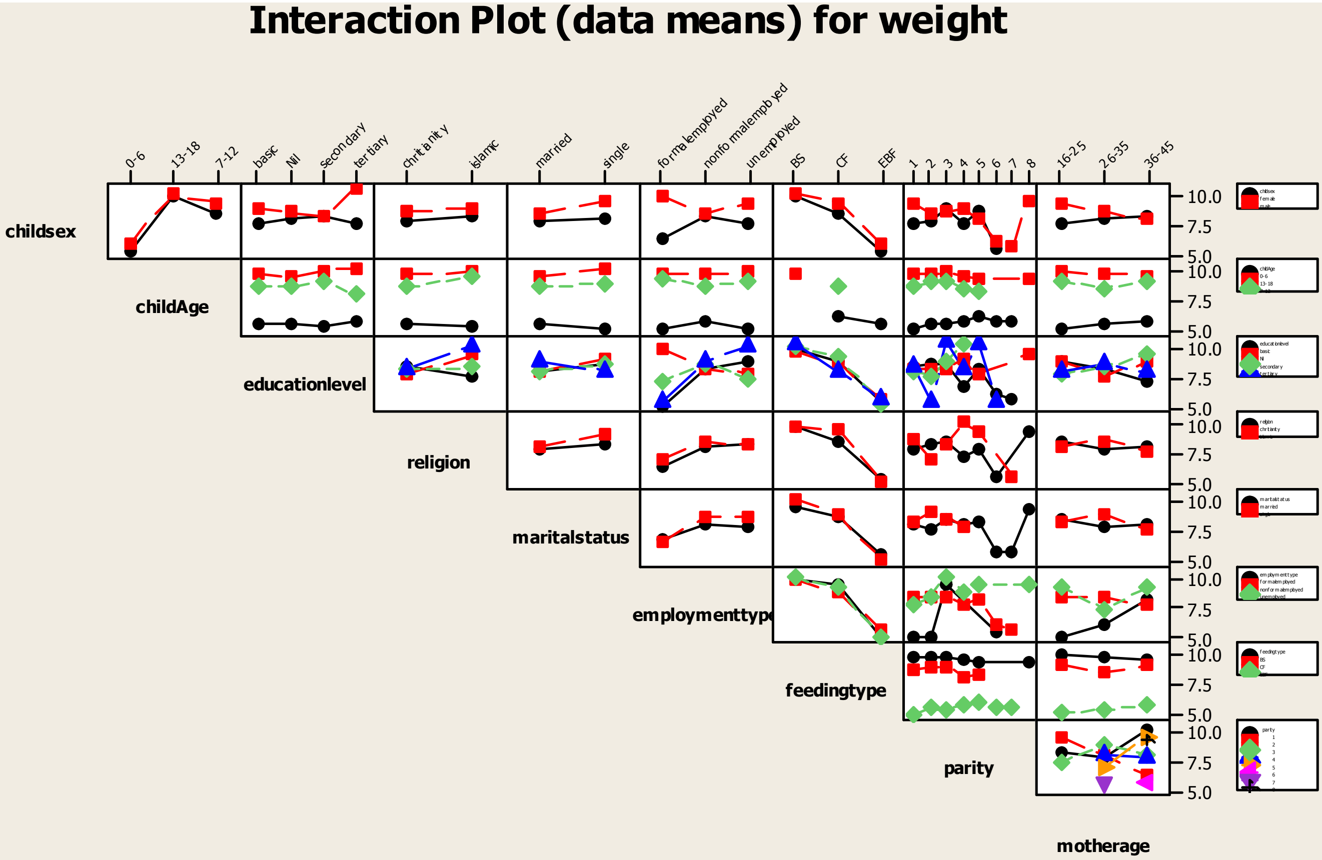

Figure 4. *Interactions plot for weight of babies.*

3.5. Main Effects Test for Weights of Babies (MANOVA)

In order to investigate the determinants of monthly mean weight gain, the MANOVA procedure was used. The results in Table 6 indicated that feeding type, parity and child age are the influential factors in determining weight gain of children less than five years, since there were significant at 5% level. This implies that feeding type given to children at their infant level and the baby's gender have significant impact on weight gain, and hence, are influential factors in determining the weight gain of children under five years whilst the other factors such as mother's age, marital status, mothers' religious affiliation etc. have no direct influence on weight gain of children less than five years. This agrees with Dinesh *et al.* assertion that deprivation of colostrum and improper complementary feeding were found to be significant risk factors for underweight among children less than five years [18].

Table 6. *Multivariate Analysis of Weight Gain.*

Effect	Statistic	Value	*F-Value*	Hyp. Df	Error df	*P-Value*
Intercept	Pillai's Trace	0.975	350.389	7	62	0.000*
	Wilks' Lamda	0.025	350.389	7	62	0.000*
	Hostelling's Trace	39.56	350.389	7	62	0.000*
	Roy's Largest Root	39.56	350.389	7	62	0.000*
Child Sex	Pillai's Trace	0.1	0.98	7	62	0.454
	Wilks' Lamda	0.9	0.98	7	62	0.454
	Hostelling's Trace	0.111	0.98	7	62	0.454
	Roy's Largest Root	0.111	0.98	7	62	0.454
Mother's Educ.	Pillai's Trace	0.24	0.796	21	192	0.722
	Wilks' Lamda	0.776	0.785	21	178.581	0.735
	Hostelling's Trace	0.268	0.774	21	182	0.749
	Roy's Largest Root	0.147	1.34	21	64	0.246
Marital Status	Pillai's Trace	0.24	0.219	7	62	0.98
	Wilks' Lamda	0.976	0.219	7	62	0.98
	Hostelling's Trace	0.025	0.219	7	62	0.98
	Roy's Largest Root	0.025	0.219	7	62	0.98
Feeding Type	Pillai's Trace	1.252	24.864	14	208	0.000*
	Wilks' Lamda	0.56	47.427	14	208	0.000*
	Hostelling's Trace	11.342	82.635	14	208	0.000*
	Roy's Largest Root	10.835	160.979	14	104	0.000*
Occupation	Pillai's Trace	0.185	0.919	14	126	0.541
	Wilks' Lamda	0.822	0.913	14	124	0.547
	Hostelling's Trace	0.208	0.906	14	122	0.554
	Roy's Largest Root	0.15	1.349	14	63	0.243
Mother's Age	Pillai's Trace	0.079	0.442	14	150	0.958
	Wilks' Lamda	0.922	0.439	14	148	0.959
	Hostelling's Trace	0.084	0.437	14	146	0.96
	Roy's Largest Root	0.068	0.729	7	75	0.648
Parity	Pillai's Trace	0.496	0.871	49	560	0.72
	Wilks' Lamda	0.575	0.893	49	148	0.678
	Hostelling's Trace	0.623	0.92	49	506	0.63
	Roy's Largest Root	0.392	4.48	7	80	0.000*
Religion	Pillai's Trace	0.048	0.446	7	62	0.869
	Wilks' Lamda	0.952	0.446	7	62	0.869
	Hostelling's Trace	0.05	0.446	7	62	0.869
	Roy's Largest Root	0.05	0.446	7	62	0.869
Child Age	Pillai's Trace	0.933	198.302	7	100	0.000*
	Wilks' Lamda	0.067	198.302	7	100	0.000*
	Hostelling's Trace	13.881	198.302	7	100	0.000*
	Roy's Largest Root	13.881	198.302	7	100	0.000*

*.= Significant at 5%

Furthermore, to test whether there were interactions among the factors on monthly mean weight gain, the MANOVA procedure was once again used. The results (Table 7) revealed that there exists a statistically significant interaction effect, between mothers' education and feeding type, mother's age and between occupation and mother's age group and parity on the combined dependent variables (weight gain). This implies that there are relationship between parity and mother's age group, occupation type and maternal age group and between mothers' education and feeding type on weight gain of children less than five years. However, test of significance of the other parameters of the model revealed that there were no significant interactions between them at 5% level of significance.

Table 7. *Results of MANOVA for Interactions.*

Effect	Statistic	Value	*F Value*	*P-Value*
ChildSex*FeedingType	Pillai's Trace	0.047	0.36	0.984
	Wilks' Lamda	0.953	0.358	0.984
	Hostelling's Trace	0.049	0.356	0.985
	Roy's Largest Root	0.037	0.553	0.792
Childsex*mothersedu	Pillai's Trace	0.133	0.68	0.852
	Wilks' Lamda	0.872	0.674	0.857
	Hostelling's Trace	0.141	0.669	0.863
	Roy's Largest Root	0.087	1.286	0.265
Mothersedu*feedingtype	Pillai's Trace	0.433	1.135	0.263
	Wilks' Lamda	0.627	1.144	0.254
	Hostelling's Trace	0.506	1.148	0.246

Effect	Statistic	Value	*F Value*	*P-Value*
	Roy's Largest Root	0.242	3.526	0.002*
occupation*mothersage	Pillai's Trace	0.334	1.343	0.117
	Wilks' Lamda	0.7	1.342	0.119
	Hostelling's Trace	0.38	1.336	0.121
	Roy's Largest Root	0.188	2.76	0.011*
Mothersage*parity	Pillai's Trace	0.313	0.762	0.863
	Wilks' Lamda	0.718	0.756	0.867
	Hostelling's Trace	0.351	0.754	0.871
	Roy's Largest Root	0.187	2.589	0.017*
Maritalstatus*childage	Pillai's Trace	0.148	1.19	0.284
	Wilks' Lamda	0.856	1.187	0.288
	Hostelling's Trace	0.162	1.182	0.291
	Roy's Largest Root	0.114	1.699	0.117

* =Significant at 5%

The Multivariate analysis of variance results confirm the profile plots. Since factors such as mother's occupation, child's sex, religion, marital status and mother's age were not significant in the MANOVA results hence, require test of parallelism equality and flatness.

The results of Table 8 indicated that both tests of parallelism and equality were not significant (p- values > 0.05). Hence, we fail to reject the hypothesis of same profiles and conclude that the change in weights of babies were parallel and equal for both test of parallelism and equality. However, the test of flatness revealed that the four multivariate tests had p-values < 0.05 and thus we reject the hypothesis that the profiles are the same.

Table 8. *Test of Parallelism, equality and flatness by mother's education.*

Test of Parallelism					
Variable		**Value**	**F - Value**		**Sig.**
Mother's Education	Pillai's Trace	0.118	0.740		0.769
	Wilks' Lamda	0.885	0.733		0.776
	Hotelling's Trace	0.125	0.727		0.783
	Roy's Largest Root	0.071	1.277		0.274

Test of Equality					
Source	Type lll Sum of Square	Df	Mean Square	F - Value	Sig.
Intercept	21077.941	1	21077.941	5542.1177	0.000*
Mother's Education	8.127	3	2.709	0.7120	0.547
Error	422.158	111	3.803		

Test of Flatnesss				
		Value	F - Value	Sig.
Mother's Education	Pillai's Trace	0.959	413.01	0.000*
	Wilks' Lamda	0.041	413.01	0.000*
	Hotelling's Trace	23.378	413.01	0.000*
	Roy's Largest Root	23.378	413.01	0.000*

*=Significant at 0.05%

Table 9 presents the test of parallelism, equality and flatness which revealed that there no significant difference (*P*-values > 0.05) and hence we fail to reject the hypothesis of the same profiles and conclude that the mean change in weights of babies did not differ by mother's age group over time. Hence, the test of flatness was carried out. The result of the flatness tests revealed that all the multivariate tests were significant, with p- values< 0.05.

Table 9. *Test of parallelism, Equality and Flatness by Maternal Age Group.*

Test of Parallelism					
Variable		**Value**	**F – Value**		**Sig.**
Mother's Education	Pillai's Trace	0.118	0.740		0.769
	Wilks' Lamda	0.885	0.733		0.776
	Hotelling's Trace	0.125	0.727		0.783
	Roy's Largest Root	0.071	1.277		0.274

Test of Equality					
Source	**Type lll Sum of Square**	**Df**	**Mean Square**	**F - Value**	**Sig.**
Intercept	21077.941	1	21077.941	5542.1177	0.000*
Mother's Education	8.127	3	2.709	0.7120	0.547
Error	422.158	111	3.803		

Test of Flatness				
		Value	**F – Value**	**Sig.**
Mother's Education	Pillai's Trace	0.959	413.01	0.000*
	Wilks' Lamda	0.041	413.01	0.000*
	Hotelling's Trace	23.378	413.01	0.000*
	Roy's Largest Root	23.378	413.01	0.000*

*. Significant at 5%

4. Discussion

The records of one hundred and fifteen (115) weights of babies from the Kaintampo Reproductive and Child Health (RCH) weighing center, the only weighing center that serve the whole Kintampo town in the Kintampo municipality were retrospectively monitored from June, 2014 to March, 2016. Out of the one hundred and fifteen babies, 56 were males whilst 59 were females. The result revealed that the mean weights gain of children depends on feeding type (exclusive breast feeding (EBF), complementary feeding (CF) and breast milk substitute (BS)).

The minimum weights at the first month for males and females are 1.8kg and 1.6kg respectively with female babies recording the lower minimum weight compared to their counterpart. However, at the end of the seventh month period the female babies recorded the higher minimum weight than the male babies.

The parallelism and equality tests were statistically insignificant, indicating that the pattern of growth for both male and female babies are the same and identical with the mean weight gain over time. The parallelism and equality tests for mother's age group was not statistically significant ($P>0.05$). This indicated that the profiles of average weights gain for the different age group are approximately the same. The flatness test however, was significant, meaning the mean weight gain with respect to mother's age does not remain the same overtime. Also, parallelism and equality tests for mother's educational level showed no significant effect ($P>0.05$), indicating that the mean weights gain of babies follows the same pattern by mother's educational level for both parallel and equal profile tests. A subsequent test for flatness showed that all the four multivariate tests were significant (p-values < 0.05). Hence, the reject the hypothesis of same profiles and conclude that the pattern of change in the weights of babies were not constant (not flat) with respect to mother's education overtime. This may implied that older mothers are more experience in taking good care of their children than their younger counterparts.

The MANOVA results revealed that feeding type, parity and child age are the influential factors in determining the weight gain of children less than five years, since there were significant at 5% level. This result is consistent with Maahi and Haadi, and Küpers *et al.* whose findings revealed that age, Birth weight and feeding practice are the most influential factors for determining children weight gain ([13], [19]). It however, disagrees with Akansuke *et al.* assertion that breast feeding type was not significantly different at 5% significant level for average weight change and De Jesus *et al.* that primiparity and maternal employment outside the home were associated with overweight in children ([20], [21]). The other factors such mothers education, marital status, occupation religion and mothers age were not significant in determining children under five years weight gain.

The study further revealed that, there exists some relationship between feeding type and mother's education, parity and mother's age group and between occupation and mother's age group with respect to weight gain. Thus, their interactions were significant, ($P<0.05$), as shown in Table 6. This suggests that the feeding type given to children in terms of weight gain depends on the mother's educational level thus confirming the results of the profile analysis. Therefore, we may conclude that high educated mothers are able to feed well and take good care of their children than low educated mothers, perhaps, because they are able to understand better and adhere to maternal and child health care educations offered by the midwives and other service providers.

Moreover, the parity group of the children on weight gain depends on the maternal age. This may also suggest that mothers who fall within higher age group are able to give birth many children than mothers who fall within lower age group. However, there were no relationships between the other categorical factors such as child's sex and feeding type, child's sex and educational level of the mother and between marital status and child s age, (P-values >0.05), in relation to weight gain.

5. Conclusions and Recommendations

In this study, the determinants of weight gain by children under-five years in the Kintampo municipality of the Bono East Region of Ghana were investigated. The result showed that the mean weights gain of children depends on feeding type (exclusive breast feeding (EBF), complementary feeding (CF) and breast milk substitute (BS)).

The results revealed that feeding type, parity and child age were useful in explaining weight gain of children less than five years. The study revealed that there exist some relationship between feeding type and mother's education, parity and mother's age group and between occupation and mother's age group with respect to weight gain. However, the studies revealed that the pattern of weight gain by babies were not constant with respect to mother's education and mother's age group overtime. It is therefore recommended that medical experts should continue encouraging nursing mothers to feed their children themselves and pay regular visits to weighing center and seek child health care to avoid complications during the infant stage.

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