UNIVERSITY FOR DEVELOPMENT STUDIES



# STATISTICAL ANALYSIS OF WEIGHT GAIN OF CHILDREN UNDER-FIVE YEARS IN THE KINTAMPO MUNICIPALITY, GHANA

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2016

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# STATISTICAL ANALYSIS OF WEIGHT GAIN OF CHILDREN UNDER-FIVE YEARS IN THE KINTAMPO MUNICIPALITY, GHANA

BY

ZINGURE ISAAC (B.Sc. in Actuarial Science)

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A THESIS SUBMITTED TO THE DEPARTMENT OF STATISTICS, FACULTY OF MATHEMATICAL SCIENCES, UNIVERSITY FOR DEVELOPMENT STUDIES, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE DEGREE IN BIOMETRY



JULY, 2016

# DECLARATION

**STUDENT:**

I hereby declare that apart from references which I have cited from other people's work, and who have been duly acknowledged, this thesis is the result of my own original work and that no part of it has been presented for another degree in this university or elsewhere.

Candidate‘s Signature:…………………… Date:.……………………

Name: Zingure Isaac

**SUPERVISOR:**

I hereby declare that the preparation and presentation of the thesis was supervised in accordance with the guidelines on supervision of the laid down rules by the University for Development Studies:

Supervisor‘s Signature:…………………… Date:…………….............

Name: Dr Abukari Alhassan

# ABSTRACT

The role of weight-for-age babies in the early childhood and its effects on later lives of children cannot be over emphasized. Birth weight according to Murthy (1991) is a key indicator of the incidence of infant mortality and thus, a reflection of the socio-economic development of a country. The main objective is to use statistical models to assess the change in weight of children over time and to investigate whether maternal characteristics such as marital status, educational level, religion, maternal age, feeding type, parity and baby's gender directly influence those changes. The data used in this study is a retrospective data on relevant variables of delivered mothers and infants or children less than five years, extracted from the weighing cards of the babies in the Kintampo RCH weighing center. Multivariate Analysis of Variance (MANOVA), Profile Analysis and Trend Analysis were employed to ascertain the significant factors of weight and their effect on mean weight of babies over time. The results revealed the differences among level means of the factors, and also identified both significant and insignificant factors that directly and indirectly influence the change in weight of babies. The study revealed that feeding type and parity levels are influential factors in determining weight gain. On the bases of the analysis, it was recommended that stakeholders, policy makers and health professionals in the child Health sector should formulate appropriate strategies by creating awareness on these significant factors.

## DEDICATION

I dedicate this work to my parents Mr. and Mrs. Zingure for their support, care and love towards my entire life and education.

## ACKNOWLEDGEMENT

I am highly indebted to the following individuals who supported or gave me the impetus to write this thesis.

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**TABLE OF CONTENT**

## LIST OF TABLES

## LIST OF FIGURES

## LIST OF ACRONYMS

| | |
|---|---|
| ANOVA | Analysis of Variance |
| BS | Breast milk Substitute |
| CF | Complementary Feeding |
| EBF | Exclusive Breast Feeding |
| EMRO | Eastern Mediterranean Regional Office |
| EPI | Expanded Programme on Immunization |
| GHS | Ghana Health Service |
| GNNHSAP | Ghana National Newborn Health Strategy and Action Plan |
| GSS | Ghana Statistical Service |
| GSCP | Ghana Sustainable Change Project |
| LBW | Low Birth Weight |
| MAD | Mean Absolute Deviation |
| MANOVA | Multivariate Analysis Of Variance |
| MAPE | Mean Absolute Percentage Error |
| MCA | Multiple Correspondence Analysis |
| MDG | Millennium Development Goals |

| | |
|---|---|
| MHD | Municipal Health Directorate |
| MHMT | Municipal Health Management Team |
| MOH | Ministry of Health |
| MSD | Mean Square Deviation |
| NGO | Non-Governmental Organization |
| PCA | Principal Component Analysis |
| RCH | Reproductive and Child Health |
| SES | Socio-Economic Status |
| SSA | Sub-Saharan Africa |
| UNICEF | United Nations International Children and Education Fund |
| USA | United States of America |
| WFP | World Food Programme |
| WHO | World Health Organization |

# CHAPTER ONE

# INTRODUCTION

## 1.1 Background of the Study

Improving child health has been a key concern for many nations and this is evident from observations of numerous international summits and conferences including the Millennium Summit in 2000 (Luguterah and Nokoe, 2013). Taking good care of newborn children is very important for their health and development. Despite the fact that the care for infants is a very important component in the reduction of child mortality, it has not received enough attention.

Infant feeding practices constitute a major component of child caring practices apart from socio -cultural, economic and demographic factors. Recent study has recognized the link between malnutrition and child feeding practice (Kapur *et al.,* 2005).

Proper nutrition of children leading to weight gain as a measure of growth and good health is the essential foundation of human development. Children gain weight and grow more rapidly during infancy and childhood than at any other time in life. However, some children fail to gain weight at a normal rate, either because of expected variations related to genes, being born prematurely, or because of under-nutrition, which may occur for a variety of reasons.

Weight-for-age of babies is an important indicator of reproductive health and general health status of the population. In Ghana, the issue of weight-for-age of babies and factors influencing it has not received much needed attention, especially with respect to the rural areas. This should be an issue of public health concern as a nation because birth weight and it subsequent weights is a strong predictor of an individual baby's survival and a person's personality (Datta 1978, Dhar, G.M. *et al*., 1991). Though the major and primary determinant of birth weight is gestational age (Humphreys 1954) there are other secondary factors that also bear, either directly or indirectly, on determining the weight of a baby at birth. These are maternal age, maternal weight gain, pre-pregnancy weight, maternal height, parity, marital status, placental malfunction, smoking, heredity, gender of baby, working hours, and various socio-economic factors (Hirve *et al*., 1994, Kelly *et al*., 1996, Kumar *et al*., 1987, Kramer 1987).

Birth weights and subsequent weights (weight-for-age of babies) have been found to play a vital role in early childhood development and have profound effect on later lives of children. The weight-for-age of babies, as a measure of child's growth, was found in several literatures as one of the key determinants of under-five mortality. This study therefore deemed it crucial to explore how some prognostic factors can influence infants' growth in the weights of babies under five years in Ghana using Kintampo municipality in the Brong Ahafo region of Ghana as a case study.



## 1.2 Growth Monitoring In Infants and Children

Growth monitoring has been advocated as an effective, simple and inexpensive way of preventing most childhood malnutrition. Growth monitoring and promotion of optimal nutrition are essential components of health care for all children. Monitoring a child's growth helps to confirm a child's healthy growth and development, or identify early a potential nutritional or health problem (Pediatric Child Health, 2010). Growth monitoring is defined as the process of following the growth rate of a child in comparison to a standard by periodic, frequent anthropometric measurements in order to assess growth adequacy and identify faltering early. Growth monitoring is widely accepted and strongly supported by health professionals, and is a standard component of community pediatric services throughout the world (Khadilkar *et al*., 2007).

### 1.3.1 Weight-for-age

Weight-for-age reflects body weight relative to the child's age on a given day. This indicator is used to assess whether a child is underweight, severely underweight or overweight. Because weight is relatively easily measured, this indicator is commonly used, but it cannot be relied upon in situations where the child's age cannot be accurately determined. To obtain weight-for-age, the weight of the child (in kgs) is compared with that of an ideally healthy child of the same age from a reference population. This is the basis of the weight-for-age, or Gomez classification of nutritional status.

A child weighing less than 60 percent of the reference weight-for-age is considered to be severely malnourished (Maahi, 2012). For that matter, countries have different ways of assessing the growth of children through weight taking and at different places. In Ghana, especially in the rural communities, mothers believe that their children are growing well when they are fat or have good appetite. Bead strings tied around the waist, legs or wrists of children are also used as indicators to measure growth. By the time a child is six months old, the bead strings around the waist should have been changed or adjusted six times.

### 1.3.2 Technique of Measuring Weight

Weight is measured with the use of a beam balance or spring balance or calibrated beam or electronic scale. Before weighing a child, the weighing scale should be properly checked to ensure a good working condition; this can be done by weighing a known weight and noting whether the scale has obtained the same weight. It is desirable that two people be involved with infant weight measures. One measurer will weigh the infant and read the weight as it is obtained. The other measurer will immediately note the measurement in the infant's chart.



## 1.4 Interventions to Improve Weight Gain of Infants and Children

The WHO recognizes the need to improve the process by which health-related recommendations are developed using the best available evidence. The WHO established the Guidelines Review Committee in 2007 which has developed and implemented procedures to ensure that WHO guidelines are produced in ways consistent with best practice, emphasizing the appropriate use of evidence (WHO, 2010).

In strengthening its commitment in providing relevant guidance for programmes that support and develop capacity in evidence-informed policymaking to Member States, the WHO Department of Nutrition for Health and Development recently established the WHO Nutrition Guidance Expert Advisory Group with experts from WHO Advisory Panels and other experts in the fields of epidemiology, nutrition, public health, pediatric medicine, and program implementation. The members are from all over the world and represent a wide variety of backgrounds and expertise. Building on the recent focus on the increased need for evidence-informed guidelines to support Member States implement and expand nutrition actions, the Nutrition Guidance Expert Advisory Group has been working diligently to develop and update guidelines in the nutrition field.

In Ghana, a number of initiatives and frameworks have been developed and implemented by the Ministry of Health/Ghana Health Service (MOH/GHS) to address the problem of the high under-five mortality, including the Under-five Child Health Policy: 2007–2015 and Under five Child Health Strategy: 2007–2015, MDG Acceleration Framework and Country Action Plan: Maternal Health (MAF), initiatives of the accelerated phase of WHO's Expanded Programme on Immunization (EPI) (GNNHSAP, 2014).

### 1.5 Measuring nutritional status of children less than five years

Anthropometric measurements provide one of the most important indicators of a child's nutritional status. In combining the infant's spine length, weight and age data, three indices of physical growth used in describing children's nutritional status are height-for-age, weight-for-age and weight-for-height.

**Height-for-age**: This index provides an indicator of linear growth retardation. Children with height-for-age below minus two standard deviations (-2SD) from the median of the reference population, are considered short for their age, or stunted. Children who are below minus three standard deviations (-3SD) from the reference population median are severely stunted. Stunting in children, may be the result of inadequate nutrition over a long period of time or the effects of recurrent or chronic illness. Height for-age, therefore, represents a measure of the outcome of under nutrition in a population over a long period, and does not vary appreciably with the season of data (GSS, 2003).

**Weight-for-age**: This is a composite index of height-for-age. Children whose weight-for-age measures are below minus two standard deviations (-2SD) from the median of reference population are considered underweight for their age while those with measures below minus three standard deviation (-3SD) from the reference population are severely underweight. Being underweight for one's age, could mean that a child is stunted, or wasted, or stunted and wasted (GSS, 2003).

**Weight-for-height:** This measure body mass in relation to body length. Children whose weight-for-height measures are below minus two standard deviations (-2SD) from the median of the reference population, are too thin for their height or wasted, while those with measures below minus three (-3SD) from the reference population are severely wasted (GSS, 2003).

### 1.6 Statement of the Problem

Weight gain at the infant stage of children is an important indication of growth in their early years of life in every society. Children gain weight and grow more rapidly during infancy and childhood than at any other time in life. Regular assessment of weight gain and growth pattern among children are the major tools for detecting and preventing underweight and overweight in the society. Weight change among individual children could be attributed to so many factors, including socio-economic status of parents, mothers marital status or biologically as variation related to genes or premature births. Children who show poor weight could be a sign of malnutrition while those who gain weight rapidly during infancy could be at an increased risk of childhood obesity (Maahi 2012).

Though monthly records have been taken in the Kintampo municipality, the ability to model it and communicate to the people is one thing that is lacking. Parents do not see the need to continue the monthly visit to the weighing centers as important and for that matter often feel reluctant to attend. These occurrences has necessitated immediate scientific research to examine factors associated with weight gain, and specifically the relationship between infant feeding practice and weight gain as it is one of the few potentially modifiable risk of malnutrition or childhood obesity.

It is in this light that this study seeks to take a regular and critical analysis of the monthly repeated measurements of children's weights taken at the weighing centers in the Kintampo municipality and how some maternal and child characteristics may affect weight gain.



### 1.7 Research Questions

- Is there any significant difference in the mean weight over time between male and female children with respect to their feeding levels?
- What are the significant factors that influence weight gain among children less than five years?
- Is there any difference between the level means for one or more factors?
- Does the weight of babies have different patterns of growth over time?

### 1.8 Research Objectives

#### 1.8.1 General Objective

The main objective of this study is to use statistical models to assess the change in weight gain of the children in the Kintampo Municipality of the Brong Ahafo region of Ghana

#### 1.8.2 Specific Objectives

- To determine if there is significant difference in weight gain between male and female children under five (5) years.
- To identify significant factors on weight gain of children under-five years.
- To examine the differences between level means for one or more factors
- To establish the relationship between monthly mean weight gain and factors such as mother's occupation, maternal education, child feeding practice etc.
- To determine the trajectory of change in baby weight over time.

### 1.9 Significance of the Study

Human resource base is generally seen as the backbone of any strong economy. More often than not, the human resource comprises of the energetic young men and women in those economies. Therefore, any event or occurrence that undermines the entire health or the survival of young people in any economy should be a reason for concern to policy makers and all stakeholders. Malnutrition and child obesity have been observed to be some of the factors that slow down economic growth, by reducing the capacity and efficiency of the labor force of a country. It can therefore be argued that, infants‟ poor weight gain (malnutrition) or over weight (child obesity) can affect greatly the future labor force of the country, and reduce the total output of the nation.

Children born underweight also tend to have low IQ and cognitive disabilities, affecting their performance in school and their job opportunities as adults (Boerma *et al.*, 1996). The study therefore seeks to examine factors associated with weight gain, or lost and also to the extent increase its awareness and thereby reduce the rate of low birth weight and overweight. This may directly help the country to build a stronger and healthier human-resource base, coupled with energetic future young men and women.



## 1.10 Limitations

- Several maternity facilities/weighing centers do not keep appropriate historical records of patients who accessed such facilities
- Also most facilites with databases covering their weighing services do not collect uniform variables across-board. This makes it difficult to undertake any appropriate joint study involving all weighing facilities in the country.

## 1.11 Study Organization

The study is organized in five chapters. Chapter one was the introductory chapter of the entire research which covered the problem statement, research objectives and questions, research methodology, significance of the study, as well as the limitations of the study. The related literature based on the objectives and the preferred models in achieving these objectives was reviewed in chapter two. Chapter three described the theory of the models used and formulations. Chapter four dealt with the analysis and results. Lastly, chapter five dealt with the conclusion of the entire study as well as major findings and recommendation of the study.

# CHAPTER TWO

# REVIEW OF RELATED LITERATURE

## 2.1 Introduction

This chapter reviews empirical works done on weight for age babies (underweight) and some relevant multivariate methods that have been used in the study. The chapter is divided into three main headings namely; Review of growth monitoring in the Kintampo municipality, Review of other research works and Review of related models of repeated measurement.

## 2.2 A REVIEW OF GROWTH MONITORING IN KINTAMPO MUNICIPALITY

### 2.2.1 Growth Monitoring by Sub-Municipal 2015

In 2015, the Municipal Health Directorate (MHD) carried out an effective growth monitoring exercise throughout the municipality in both static and outreach clinics during the year under review. Their data gathered continues to be used as an indicator for the assessment of the nutritional status of children less than five years by the Ghana Health Service.

The coverage of growth monitoring in the municipality shows a drastic increase among children within the age group 0-11months in the sub-municipal levels. It however, shows zero or no increase in the number of children for age groups 12-23months and 24-59months. Thus, amount the seven towns monitored for the trend of malnutrition, Kintampo town recorded the highest number of percentage of 120 of coverage of malnutrition for 2015 whiles the least number of coverage of malnutrition was 34%, recorded at Bus (MHD, 2015).

Also, 2015 MHD, report stated that the sub- districts have made some achievements especially, from 2013 to 2014. It is shown from figure 2.1 that most of the Sub-districts recorded an increase in their coverage of monitoring over the years with a drop in 2015 (Figure 2.1). The coverage of growth monitoring in the municipal has seen a tremendous increase from 2013 to 2014 at 56% and 107.7% respectively and that of 2015 is 80%; thus for children within the age group 0-11months. However, the age groups 12-23months and 24-59months recorded very low in terms of monitoring in the municipality.



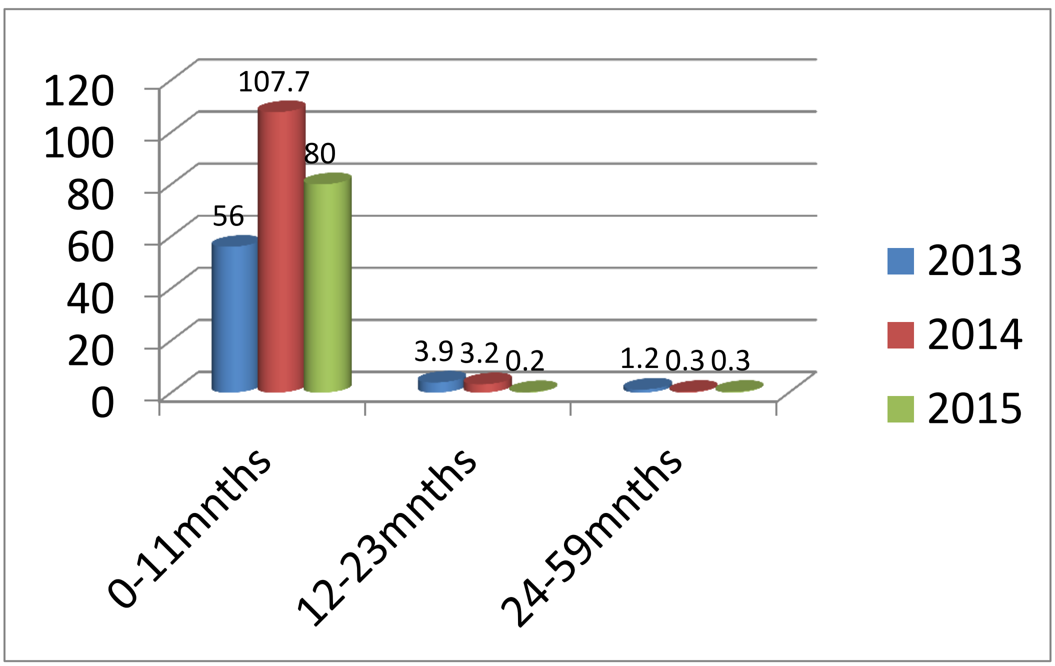


**Figure 2.1 Municipal Growth Monitoring 2013-2015**

### 2.2.2 Prevalence of Under-Five (<5years) Underweight in the Kintampo-North Municipality

Underweight or Weight-for-age is the proportion of under-five falls below minus 2 and minus 3 standard deviations from the median weight-for-age of the WHO/NCHS. The Municipal 2015 MHD report estimated the prevalence of underweight of children less than five years as shown in table 2.1 below.

**Table 2.1 Under-five years' children underweight in the Kintampo municipality 2015**

Under Five Year Underweight in the Municipality

| Month | Attendance | Underweight (%) |
|---|---|---|
| January | 5679 | 0.3 |
| February | 5805 | 0.3 |
| March | 5489 | 13.5 |
| April | 6124 | 12.7 |
| May | 6158 | 13.7 |
| June | 6002 | 12 |
| July | 6426 | 8.3 |
| August | 6156 | 7.1 |
| September | 6086 | 5.5 |
| October | 6210 | 4.9 |
| November | 5454 | 7.5 |
| December | 5452 | 6.1 |

**Source: Kintampo Municipal Directorate**

## 2.3 Review of Other Research Works

### 2.3.1 Birth weight/underweight

A number of researches have been carried out on weight for age babies using different methodologies. According to United Nations International Children and Education Fund (UNICEF) 2013, 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 (Isiugo and Oke 2011). 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.* (1986) 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 *et al*., (2002) discovered a U-shaped relationship between age and low birth weight.

Considering the effect of religion on birth weight, Dhall and Bagga (1995) 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 (1994) 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*., (1998), conducted in an urban area in India. However a study in Thailand by Tuntiseranee *et al*., (1999) observed that among the SES indicators, only family income correlated with birth weight.

Langhoff *et al.*, (1987) 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*., (1994) showed that attributable risk for low birth weight contributed by low maternal weight was much more than that by low maternal height.

There is a growing area of studies concerned with maternal psychosocial stress and the effect on birth weight. Work related stress was seen to be an important factor in the determination of birth weight, especially for those women who did not want to remain in the work force, thus emphasizing the need for personal motivation and physical impact of work to be evaluated, as suggested by (Homer *et al.*, 1990).

Health behaviors affecting birth weight include habits like smoking, presence of passive smoking and also physical activity. Goel *et al*., (2004) studying the adverse health effects of exposure to environmental tobacco smoke, or passive smoking, suggested that there appeared to be a dose response relationship between the quantum of smoke inhaled and the magnitude of weight reduction in the baby. Nutritional status as well as weight gain of the mother during pregnancy has been studied as an important component of prenatal health.



**2.3.2 Malnutrition and causes**

Malnutrition literally means "bad nutrition" and it entails both over and under-nutrition. In relations to trends of malnutrition in nations, the latter is much prevalent in developing countries including Ghana. The World Food Programme (WFP) defines malnutrition as "a state in which the physical function of an individual is impaired to the point where he or she can no longer maintain adequate bodily performance  process such as growth, pregnancy, lactation, physical work or resisting and recovering from disease" (WFP, 2005). Malnutrition can result from a lack of macronutrients (carbohydrates, protein and fat), micronutrients (vitamins and minerals), or both. Macronutrient deficiencies occur when the body adapts to a reduction in macronutrient intake by a corresponding decrease in activity and an increased use of reserves of energy (muscle and fat), or decreased growth. Consequently, malnourished individuals can be shorter (reduced growth over a prolonged period of time) and/or thinner than their well-nourished counterparts.

According to Dramane and Carolyn (2006), malnutrition of children (0-59 months) is a public health concern in Africa, particularly in the Sahelian countries. In their study to evaluate the trends of the malnutrition status of children under five, from the project monitoring /impact indicators, they determine that, nutritional status of children under-five continues to deteriorate in spite of better agro climatic conditions and agricultural production in many of these countries. Using data collected from the GFSI project, they conducted their analysis base on the following indicators such as Underweight (percent of children of a given age range with weight-for-age z score less than -2 or less than –3 standard deviation) and Stunting (percent of children of a given age range with height-for-age z score less than -2 standard deviation). In the first exploratory phase of the analysis, descriptive statistics and factor analyses (Principal Component Analysis - PCA, Multiple Correspondences Analysis - MCA) were used. The PCA was used for the analysis of underweight children data and for the analysis of the stunted children under-five data, the use of the MCA was chosen. In conclusion, their findings suggest that the inverse association is not causal, and may be explained by poorer complementary feeding among breastfed compared with weaned children. Children from poorer households and whose parents are illiterate are more likely to have less than adequate complementary feeding.



### 2.3.3 Feeding practices

Feeding practices have a lot of implication for the nutritional status of the child. WHO recommends that complementary feeding should be timely, adequate, and safe and appropriate (PAHO 2003). Timely introduction of complementary foods means giving children the first foods from six months onwards. Complementary foods should meet the nutritional needs of the growing child and their variety, amounts, consistency and feeding frequency should be adequate. All measures should be taken to prevent contamination with pathogens. The texture of the foods should be appropriate for the child's age, and they should be fed by being sensitive to the child's cues.

In India, an interventional study where nutritional education was given to mothers to improve awareness about infant feeding in the variety, quantity, quality and consistency of complementary feeding showed that, 80% initiate breast feeding after 3 days of birth, 54.3% absence of exclusive breastfeeding, 86% delayed complementary feeding practices which were inadequate in quality, quantity, frequency and consistency (Sethi and Kashyap., 2003).

Another study conducted by Ghana Sustainable Change Project (GSCP) in 2006 showed that there were no firm rules to the frequency of feeding children on complimentary foods in northern Ghana. Mothers and caregivers are often of the opinion that children should be fed as many times as the child wants while others maintain that it should be four times daily. According to

Fawzi *et al*. (1998) studied the relationship between prolonged breastfeeding and child growth by examining prospectively among 28,753 Sudanese children less than 36 months of age enrolled in a broader cohort study of child health and nutrition. 81% of children were breastfed at 12 months, but this prevalence declined to 62% at 18 months and 27% at 24 months. At baseline and at each of three 6-monthly follow-up visits breastfeeding status was assessed and all subjects were weighed and measured. Their results show that undernourished children were more likely to be breastfed for a longer period of time compared with normal children. They found a small difference between breastfed and fully weaned children in the gain in height over the following 6-month period. However, breastfed children were likely to gain significantly less weight, particularly among children who were aged 6-12 months. Similar findings were noted when these associations were examined among children who were normally nourished at the time of breastfeeding assessment. The inverse association between breastfeeding status and weight gain was significantly larger among children of poor or illiterate mothers compared with children of relatively more affluent or literate mothers, respectively. In conclusion, their findings suggest that the inverse association is not causal, and may be explained by poorer complementary feeding among breastfed compared with weaned children. Children from poorer households and whose parents are illiterate are more likely to have less than adequate complementary feeding.

The importance of adequate complementary feeding in the second half of infancy needs to be stressed in nutrition education programmes.

Dinesh *et al*., (2006) studied the nutritional status of under-five children and whether infant feeding practices are associated with the under nutrition in anganwari (AW) areas of urban Allahabad. Under-five-years children and their mothers in selected four anganwari areas of urban Allahabad participated in the study. Nutritional assessment by WHO criterion (SD-classification) using summary indices of nutritional status: weight-for-age, height-for-age and weight-for-height were done. Normal test of proportions, Chi-square test for testing association of nutritional status with different characteristics and risk analysis using odds ratios with 95% confidence intervals was also done. Among all under five children surveyed, 36.4% underweight (<2SD weight-for-age), 51.6% stunted

(<2SD height-for- age), and 10.6% wasted (<2SD weight-for-height). Proportions of underweight (45.5%) and stunting (81.8%) were found maximum among children aged 13-24 months. Wasting was most prevalent (18.2%) among children age 37-48 months.

#### 2.3.4 Diseases and Infections

Under-nourished children often come from poor families, with crowded houses and poor hygiene, so they are exposed to more infections. Micro-organisms are more likely to get into the child's body and multiply in it. The immune system is less able to fight infection in an under nourished child than it is in a healthy child (Morley and Woodland, 1992).

Dewey *et al*., (1999), also revealed that exclusive breastfeeding provides protection against mild upper respiratory tract infections, inflammation of the middle ear, urinary tract infections, bone and joint infections and diarrhoeal illness. Malnutrition is a multisystem disorder when severe, immunity is impaired, wound healing is delayed and operative morbidity and mortality increased. Malnutrition worsens the outcome of illness, example; malnourished children are susceptible to diseases and more apathetic.

Undernourished children have lowered resistance to infection; they are more likely to die from common childhood ailments like diarrhoeal diseases and respiratory infections, and for those who survive, frequent illness saps their nutritional status, locking them into a vicious cycle of recurring sickness and faltering growth. Their plight is largely invisible: three quarters of the children who die from causes related to malnutrition were only mildly or moderately undernourished, showing no outward sign of their vulnerability (UNICEF, 2006).

Markestad *et al.,* (1997) tried to compare the growth patterns and psychomotor development of healthy SGA and AGA infants, and identified factors predictive of outcome at 13-14 months of age. By that age, SGA infants had showed partial catch-up in growth, but they still had smaller weight, crown-heel length, and head circumference than AGA infants. SGA children scored as well as AGA children on the motor, but lower on the mental scale.

Finally, some traditional infant feeding practices that impair the nutritional status of young children have been identified, such as giving herbal teas, water, and other foods to babies at young age (UNICEF 2009).

**2.4 Review of Related Models of Repeated Measurements**

Repeated-measures designs are very common in many fields of study because of their logistical and statistical efficiency. A repeated-measures design measures each subject or unit two or more times. For example, one might record weights of children subjected to different diets at several different time points. Or, one might record the heights of a plants to which herbicides have been applied every week for six weeks. This is the basic reason why a special analysis is required to analyze these types of data. The approaches used to model repeated measures data vary from one to another, depending on the purpose of the study and data availability.

Akansuke *et al*., (2015) used profile Analysis to examine the Determinants of Baby Weights in Bolgatanga Municipality of Ghana. Their results showed that breastfeeding was not a significant determinant of baby weight 5% significance level. Liu and Cox (1993) studied the relationship between sport, nationality, and gender and psychological skills of 158 American and 192 Chinese collegiate level athletes participating in track and field, basketball, volleyball, or swimming. A multivariate analysis of variance (MANOVA) resulted in significant main effects for nationality, sport, and gender and for the interactions between nationality and sport and between sport and gender.

Further, Maahi (2012) studied repeated measurements of weights of children under five years. The data were analyzed using multivariate analysis of variance (MANOVA). His results indicated that feeding practice was statistically significant determinant of baby's weight.

**2.5 Study Gap**

The works I have reviewed, to the best of my knowledge, mostly focused much on maternal characteristics to examine their effects on weight of babies. Besides, the statistical technique extensively used for identifying significant difference and determining effect of factors of weight gain in children were mostly ANOVA/ MANOVA or profile analysis.

The current study considered newborn and maternal characteristics such as baby's age, baby's gender, mother's marital status, mother's educational level, parity etc. and examine their effects on birth weight and subsequent weights of children under-five years in the Kintampo municipality in the Brong Ahafo region of Ghana. The study employed multivariate methods such as MANOVA and Profile Analysis to comprehensively determine significant factors and establish the relationship between monthly mean weight gain and the factors. The current study also employed trend analysis, main effect plots and interaction plot to determine the trajectory or pattern of change in baby weight over time and examine the differences between level means for one or more factors. In this study, data on birth weights and subsequent weights of children under-five years, child characteristics, mother's demographic and socio-economic factors were collected from RHC weighing center in the Kintampo municipality. Beside, statistics on underweight, overweight, and weight monitoring were collected from the municipal health directorate to complement the current research work.

# CHAPTER THREE

# RESEARCH METHODOLOGY

## 3.1 Introduction

The chapter mainly presents the fundamental theory of repeated measures models. It again presents the nature of the data used for the study and specifies multivariate analysis of variance (MANOVA) and other multivariate methods for repeated measures data. The chapter further shows the procedure for evaluating the MANOVA models used for the study.

## 3.2 Source of Data

The research considered data obtained from the Reproductive and Child Health (RCH) weighing center in the Kintampo Municipality of Ghana, the only but large center that served the whole Kintampo Township. The data consists of monthly weights of 115 under five year's children, measured for each child repeatedly over the period of seven months. The following prognostic factors were considered in the data: sex, mother's age, mother's educational level, parity, religion, occupation, marital status and baby's feeding type.

## 3.3 Study Design/Methods of Data Collection

The study design is a repeated measures case study. The data used in this study was secondary data extracted from the weighing cards of children whose mothers accessed the weighing services at the center during the study period. The extracted data obtained from the Kintampo Reproductive and Child Health weighing center covers records of delivered women, who accessed weighing services from July 2014 to March 2016.

### 3.4 Data Variables

Key variables on delivered mothers and their respective children less than five years were captured in the extracted data. All subjects in the study were measured at the same set of time point. Thus, no missing data were involved in this study. Measurements for each subject repeatedly over the period of seven months (seven specific time points); weight1, weight2, weight3,……., weightt7 were obtained. Also, the child and mother's characteristics such as child's age, child's gender, marital status of the mother, occupation of the mother, mother's religion, mother's educational level, mother's age, feeding type and parity were recorded.

### 3.5 Data Analysis Techniques

The study employed multivariate analysis of variance (MANOVA) and profile analysis to obtain the determinant factors influencing weight gain.

The MANOVA model is expressed as:

$$Y_{ij} = \mu + \alpha_i + \varepsilon_{ij}$$

$$= \mu_i + \varepsilon_{ij}, i = 1, 2, \dots \dots . k; j = 1, 2, \dots \dots n \quad (3.1)$$

Where k is the groups of multivariate observations with $n_i$ observations in group $i$ , $Y_{ij}$ is the vector of p responses observed on the experimental unit j of level k, $\mu_i$ is the population mean for population $i$, $\alpha_i$ is the effect due to factor at level $i$ and $\varepsilon_{ij}$ is the error term.

### 3.6 Statistical Assumptions

1. **Normal Distribution**: The dependent variables should be normally distributed within groups.

2. **Linearity:** MANOVA assumes that there are linear relationships among all pairs of dependent variables, all pairs of covariates and all dependent variable covariates.

3. **Homogeneity of variances**: Homogeneity of variances assumes that the dependent variables exhibit equal level of variance across the range of predictor variables.

4. **Homogeneity of variance-covariance matrix**: Since there are multiple dependent variables, it is also required that their inter-correlations (covariance) are homogeneous across the cell of the design.

**5 Multicollinearity and singularity**: MANOVA works best when the dependent variables are only moderately correlated. With low correlations one should consider running separate univariate analysis of variance for the various dependent variables. When the dependent variables are highly correlated this is referred to as multicollinearity

#### 3.6.1 Shapiro-Wilk's Test for Normality

The Shapiro-Wilk's test utilizes the null hypothesis principle to check whether a sample $x_1, x_2, \dots \dots \dots x_n$ came from a normal distributed population. The null hypothesis is that the population is normally distributed. If the P-value is less than the chosen alpha level, the null hypothesis is rejected, and there is evidence that the data tested are not from normally distributed population and vice versa. Given the observation $\bar{x}_1$, $\bar{x}_2$,

$\bar{x}_3, \dots \dots \dots, \bar{x}_n$ sorted in either ascending or descending order. The test statistic of the Shapiro–Wilk's, W is defined as:

$$W = \frac{\left(\sum_{i=1}^{n} a_i x_i\right)^2}{\sum_{i=1}^{n}(x_i - \bar{x})^2} \tag{3.2}$$

Where $\bar{x} = \frac{1}{2}\sum_{i=1}^{n} x_i$ is the sample mean and $a_i\ for\ i = 1, 2, 3, \dots \dots, n$ are a set of weights whose values depend only on the sample size n. (Shapiro and Wilks, 1980).

### 3.6.2 ARCH-LM Test for Conditional Heteroscedasticity

This occurs when the variance of the residuals is not constant. To ensure that the fitted model is adequate, the assumption of constant variance must be achieved. The ARCH-LM test was used to test for the presence of conditional heteroscedasticity in the model residuals. The test hypothesis is as follows;

$H_O$: There is no heteroscedasticity in the model residuals

$H_1$: There is heteroscedasticity in the model residuals

The test statistic is

$$LM = nR^2 \tag{3.3}$$

where n is the number of observations and $R^2$ is the coefficient of determination of the auxiliary residual regression given as

$$e_t^2 = \beta_0 + \beta_1 e_{t-1}^2 + \beta_2 e_{t-2}^2 + \cdots + \beta_q e_{t-q}^2 + v_t \tag{3.4}$$

where $e_t$ is the residual. The null hypothesis is rejected when the $p$-value is less than the level of significance and is concluded that there is heteroscedasticity.

The null hypothesis is rejected when the p-value is less than the level of significance (5%) and is concluded that there is heteroscedasticity Engle (1982).

### 3.7 Repeated Measures Data



Repeated measures are consecutive data obtained over time from the same experimental units such as people, plant and animals. It is usually plausible to assume that observations on the same unit are correlated. Hence, statistical analysis of repeated measures data must address the issue of covariation between measures on the same unit. In some experiments, the repeated measures factor can be randomized, while in others, the repeated measures factor is time or space and cannot be randomized. In addition, the response variable or variables may be continuous, discrete, or a combination of the two, leading to different possibilities for making inference from the experiment or survey.

When time is the repeated measures factor, we are unable to randomize the order of time itself. There is a strong tendency for measurements on the same subject made near in time to be more highly associated than measurements made further apart in time. When the measurements represent quantitatively different things, such as weights, lengths, and widths, the correlation is best taken into account by the use of multivariate methods, such as Multivariate Analysis of Variance (MANOVA). MANOVA is a technique that measures the differences of two or more metric dependent variables based on a set of categorical (nonmetric) variables acting as independent variables. There are two major situations in which MANOVA is used. The first is when there are several correlated dependent variables, and the researcher desires a single, overall statistical test on this set of variables instead of performing multiple individual tests. The second, and in some cases, the more important purpose is to explore how independent variables influence some patterning of response on the dependent variables. It was observed from a study by Gurbuz et al., (2003) that multivariate methods gave more reliable results than univariate methods.

Eyduran *et al.,* (2008) reported that profile analysis was more informative than repeated ANOVA. Profile analysis is the multivariate equivalent of repeated measures or mixed ANOVA for comparing the same dependent variables between groups over several time-points and second, when there are several measures of the same dependent variable (E.g. several different psychological tests that all measure depression). Profile analysis uses plots of the data to visually compare across groups. The pattern of mean change in baby weight is portrayed through the profile analysis.

When the measurements represent responses to treatments or levels of the experimental factor of interest, such as time, the correlation can best be accounted for by performing a repeated measures analysis of variance. An experimental design that accommodates this type of measurement is the repeated measures experimental design. Repeated measures experimental design refers to studies in which the same measures are collected a multiple of times for each subject, but under different conditions.

### 3.8 Data Structure for a Repeated Measures Analysis

Often data are collected on several occasions on the same experimental unit (often referred to as subject). This is the case, where, for instance, a child's weight is recorded at several specific times. In other instances data are collected on the same experimental unit under different experimental conditions, such as different doses of a drug in a clinical trial. These types of designs require an analysis method that can account for two sources of response variability - within-subject variability, and between-subject variability (Lipka and Tyner 2004).

In this study, the weight of the baby is measured at several specific time points, the child is a subject. Sex (males and females) is specified as between-subject variables. The weights measured for each subject (child) repeatedly were grouped to define the within-subject variables. Thus: weight1, weight2, weight3,……., weight7. This is due to the fact that measurements collected repeatedly on a given experimental unit are usually more similar than measurements taken across different experimental units. That is to say, observations measured repeatedly on a given subject are correlated.

The data set can be organized in two different ways. For example, a researcher who wants to compare different treatments for diabetes has taken 4 weekly measurements of blood sugar to a series of patients. The researcher would have one variable for blood sugar taken at time 0, another for blood sugar at time 1 and so on up to 4 dependent variables (one row of data per subject and four variables to record the four scores). This format is often referred to as the wide or multivariate format. Another way to organize the data is to use four rows of data per subject and only one variable to record the score and an additional variable to indicate the four occasions (where each repeated measure occupies a separate row and there is only one column for the dependent variable). This is often called the long, or univariate format (Koh and Sadigov 2010). Both these methods of structuring the data preserve the connection between the information on the child level and the information on the time level. Which set-up of the data is best in a given situation will depend on a number of factors, including the assumptions to be made, presence of missing data, balance of the design, and software available for analysis.

The MANOVA approach, using the data in wide format, takes advantage of a general modeling technique used to model several response variables simultaneously. In order to be flexible to accommodate various designs it assumes the most unrestrictive covariance structure between responses – namely an unstructured covariance.

A univariate method is also used when analyzing the data in the long format. An advantage of this method is the ability to model several types of covariance structures on repeated measurements. Choice of a specific covariance structure for the model will depend on the experimental design.

An advantage of the univariate approach with the data in the long format is the approach taken to handle missing data. Subjects that have some missing observations for one of the repeated measures will still be preserved in the analysis. In contrast, in analyzing data in wide format, subjects with even only one missing repeated measurement will be completely excluded from the analysis.

When analyzing data in the wide format, both univariate and multivariate analysis of variance (MANOVA) methods are available and are often presented simultaneously in the same output. Univariate analysis methods using wide format data require variances of all pair-wise differences in repeated measurements to be equal - a constraint called a sphericity assumption. In addition, tests for sphericity have been shown to have low power for small sample sizes and may falsely indicate lack of sphericity when sample sizes are very large (Koh and Sadigov 2010). When the assumption of sphericity is badly violated, the F-statistics and the associated p-values for the within-subject hypotheses have been shown to be inflated, leading to false rejections of the null hypotheses. In such instances either adjustment can be made to the univariate test degrees of freedom (such as the Greenhouse-Geisser or Huynh-Feldt corrections), or one should use the MANOVA results.

Some statistical packages require data to be entered in a particular shape. For example, SPSS requires wide format to conduct repeated measures MANOVA. Other packages such as R allow you to use the anova command and declare repeated measures as part of the command options. This command requires your data structure to be long. This current study employed the R software and the SPSS to construct the profile plots and the MANOVA respectively. Minitab was also used for the trend analysis.

Finally, an important thing to take into account when working with repeated measures is defining the structure for the covariance matrix. The simplest structure is the *Identity*, which assumes that repeated measures of a same subject are independent and with constant variance across time. This is not very realistic assumption since you would expect that measures taken from the same subject should have some degree of dependency. The second simplest structure is called *Compound Symmetry* or variance components, which requires the estimation of two parameters. This structure assumes constant variance and covariance. The latter means that the correlation between two observations of a same subject is equal for all pairs, it does not depend on the lag between them. This is not a very realistic assumption either. A more realistic structure is the autoregressive order 1 (AR (1)), which also assumes homogeneous variance across time but where the covariance between the observations on the same subject decrease as the lag between them increases. Finally, the *unstructured* covariance structure specifies different variance and covariances. It is the most general of the structures but demands the estimation of a large number of parameters (Lipka and Tyner 2004).

This study required the autoregressive order 1 (AR (1)) covariance structure since, it satisfied the assumption of constant variance across time. This structure was reported by Maahi (2012) that it is only appropriate when the measurements are made at equal time intervals, and the current study again met this condition because repeated measurements of the babies were taken at equal time intervals (monthly).



## 3.9 Methods

Multivariate data analyses such as Multivariate Analysis Of Variance (MANOVA), profile analysis and Trend Analysis were employed as the statistical methods for analyzing the data to achieve the objectives of the research.

### 3.9.1 Multivariate Analysis Of Variance (MANOVA)

MANOVA investigates the effects of a categorical variable (the groups, i.e. independent variables) on a continuous outcome, but in this case the outcome is represented by a vector of dependent variables.

We could simply perform multiple ANOVA's, one for each dependent variable, but this would have two disadvantages: it would introduce additional experiment-wise error and it would not account for the correlations between the dependent variables. It is therefore possible that MANOVA shows a significant difference between the means while the individual ANOVA do not.

Also MANOVA can be used in place of ANOVA with repeated measures; in which case no sphericity assumption needs to be met when using MANOVA. In this case, we treat the repeated levels as dependent variables. With MANOVA one evaluates mean differences on two or more dependent variables simultaneously. A MANOVA is a way to test the hypothesis that one or more independent variables, or factors, have an effect on a set of two or more dependent variables.

In MANOVA, we usually test the null hypothesis to see if the vector of means of the dependent variables is equal for multiple independent groups, and the model is given as:

$$H_O: \begin{bmatrix} \bar{X}_{11} \\ \bar{X}_{21} \\ \vdots \\ \bar{X}_{p1} \end{bmatrix} = \begin{bmatrix} \bar{X}_{12} \\ \bar{X}_{22} \\ \vdots \\ \bar{X}_{p2} \end{bmatrix} = \cdots = \begin{bmatrix} \bar{X}_{1k} \\ \bar{X}_{2k} \\ \bar{X}_{pk} \end{bmatrix} \quad (3.5)$$

For MANOVA, the month was the **factor** defined to have seven (7) levels. Each child is a **subject.** Sex (males and females) is specified as **between-subject factor.** The weights measured for each subject repeatedly were grouped to define the **within-subject factor**. The mother's characteristics such as mother's educational level, marital status, religion, mother's age, parity, feeding type and baby's gender were considered as the grouping variables.

**Dependent and independent variables of MANOVA**

Between-group variables: Sex (male and female)

Within-group variables: (measurement taken for each child repeatedly) e.g. weight1, weight2,……, weight7)

Dependent variables (DV): Weight with Time points (month1, month2, month3……month7)

Independent variables (DV): Feeding practice, mother's age, mother's educational level, marital status etc.

### 3.9.1.1 MANOVA Test Statistics

Unlike the univariate situation in which there is only one statistical test available (the F-ratio), the multivariate situation provides several alternative statistical tests.

The two estimates of the population variance in a one-way ANOVA are termed mean squares. Computationally, mean squares denote the quantity resulting from dividing the sum of squares by its associated degrees of freedom. The between group mean squares-which is called the hypothesis mean squares, is

$$MS_h = \frac{SS_h}{df_h} \quad (3.6)$$

and the within group mean squares--which is be called the error mean squares, is

$$MS_e = \frac{SS_e}{df_e} \quad (3.7)$$

F-Statistic,

$$F = \frac{MS_h}{MS_e} = \frac{\frac{SS_h}{df_h}}{\frac{SS_e}{df_e}} = \frac{df_e}{df_h}\frac{SS_h}{SS_e} \quad (3.8)$$

The role of mathematical laziness comes about by developing a new statistic called the A statistic, that simplifies matters by removing the steps of calculating the mean squares. The A statistic is simply the F statistic multiplied by the degrees of freedom for the hypothesis and divided by the degrees of freedom for error, or

A-Statistic,

$$A = \frac{df_h}{df_e} = \frac{df_h}{df_e}\left(\frac{df_e}{df_h}\right)\frac{SS_h}{SS_e} = \frac{SS_h}{SS_e} \qquad (3.9)$$

The main advantage of using the A statistic is that one never has to go through the trouble of calculating mean squares. The A statistic developed is simply the ratio of the sum of squares for an hypothesis and the sum of squares for error.

Let H denote the hypothesis sums of squares and cross products matrix, and let E denote the error sums of squares and cross products matrix.

The multivariate equivalent of the A statistic in (3.9) is the matrix A which is

Matrix $A,\ A = HE^{-1}$ (3.10)

Parenthetically, note that because both H and E are symmetric, $HE^{-1} = E^{-1}H$. This is one special case where the order of matrix multiplication does not matter.

All current MANOVA tests are made on $A = HE^{-1}$. However there are four different multivariate tests that are made on $HE^{-1}$. Each of the four test statistics has its own associated F ratio. In some cases the four tests give an exact F ratio for testing the null hypothesis and in other cases the F ratio is approximated. In terms of notation, assume that there are q dependent variables in the MANOVA, and let $\lambda_i$ denote the $i^{th}$ eigenvalue of matrix A which, of course, equals $HE^{-1}$.

The first statistic is Pillai's trace. Some statisticians consider it to be the most powerful and most robust of the four statistics. The formula is

**Pillai's trace = trace** $[\boldsymbol{H}(\boldsymbol{H}+\boldsymbol{E})^{-1}] = \sum_{i=1}^{q} \frac{\lambda_i}{1+\lambda_i}$ (3.11)

The second test statistic is Hotelling-Lawley's trace.

**Hotelling-Lawley's trace = trace (A) = trace (** $\boldsymbol{HE^{-1}}$**)** $= \sum_{i=1}^{q} \boldsymbol{\lambda_i}$**.** (3.12)

The third is Wilk's lambda (Λ). Wilk's Λ was the first MANOVA test statistic developed and is very important for several multivariate procedures in addition to MANOVA.

**Wilk's lambda = Λ = =** $\prod_{i=1}^{q} \frac{1}{1+\lambda_i}$ (3.13)

The fourth and last statistic is Roy's largest root. This gives an upper bound for the F statistic.

**Roy's largest root = max**$(\boldsymbol{\lambda_i})$ (3.14)

Or the maximum eigenvalue of $A = HE^{-1}$. (That is a "root" is another name for an eigenvalue.) Hence, this statistic could also be called Roy's largest eigenvalue.

### 3.9.2 Profile Analysis Approach

Profile analysis is the multivariate equivalent of repeated measures or mixed ANOVA. Profile analysis is most commonly used in two cases:

1) Comparing the same dependent variables between groups over several time-points.

2) When there are several measures of the same dependent variable

Profile analysis uses plots of the data to visually compare across groups.

The pattern of mean change in baby weight would be portrayed through the profile analysis. The following covariates; sex of the baby, marital status, breast feeding type, maternal educational level, and mother's religious affiliation were used to construct the profile plots. Profiles for the means of baby weight were plotted against the time points for the various groups.

Profile analysis asks three basic questions about the data plots:

1) Are the groups parallel between time points or observations?

2) Are the groups at equal levels across time points or observations?

3) Do the profiles exhibit flatness across time points or observations?

If the answer to any of these questions is no (i.e. the specific null hypothesis is rejected) then there is a significant effect.

### 3.9.3 Trend Analysis

In statistics, trend analysis often refers to techniques for extracting an underlying pattern of behaviour in a time series which would otherwise be partly or nearly completely hidden by random fluctuations of data. The trend of a series refers to the long term growth of the time series over time. A time series variable may exhibit different type of trends; the linear, exponential growth, quadratic, S-Curve among others. This study evaluated the above different types of trend models for the weights of babies.

**3.9.3.1 Trend Models**

If the trend in the time series is a linear function of time *t*, then

$$Y_t = \beta_0 + \beta_1 t + \varepsilon_t \quad (3.15)$$

where, $Y_t$ are the observations of the time series, $t$ is a time dummy $(t = 1,2, \dots, n-1, n)$ and $\varepsilon_t$ is a random error component. When the series exhibit quadratic trends, the model is given as;

$$Y_t = \beta_0 + \beta_1 t + \beta_2 t^2 + \varepsilon_t \quad (3.16)$$

For a polynomial of order *k*

$$Y_t = \beta_0 + \beta_1 t + \beta_2 t^2 + \dots + \beta_k t^k + \varepsilon_t \quad (3.17)$$

If the trend is characterized by an exponential growth, then the equation is

$$Y_t = \beta_0 * \beta_1^t * \varepsilon_t \quad (3.18)$$

S-Curve (Pearl Reed logistic) form can be written as

$$Y_t = \frac{K}{1 + e^{a+\beta t}} \quad , b > 0 \quad (3.19)$$

Where $K,\ a,\ \beta$ are the parameters of the curve, $K = \max(Y_t)$, ie the maximum value which the variable can take over all of time t.

The coefficients in the trend model equations are obtained by applying the principles of Ordinary Least Squares (OLS).

**3.9.3.2 Measures of Accuracy**

The comparison of a measurement with a known standard, used to determine whether the measurement is reliable. In this study, three measures of accuracy of the fitted model were computed: MAPE, MAD, and MSD.

**MAPE**, or Mean Absolute Percentage Error, measures the accuracy of fitted time series values. It expresses accuracy as a percentage.

$$MAPE = \frac{\sum_{t=1}^{n} \left| \frac{(y_t - \hat{y}_t)}{y_t} \right|}{n} \times 100\% \, , (y_t \neq 0) \qquad (3.20)$$

where $y_t$ equals the actual value, $\hat{y}_t$ equals the fitted value, and n equals the number of observations.

**MAD**, which stands for Mean Absolute Deviation, measures the accuracy of fitted time series values. It expresses accuracy in the same units as the data, which helps conceptualize the amount of error.

$$MAD = \frac{\sum_{t=1}^{n} |y_t - \hat{y}_t|}{n} \qquad (3.21)$$

where $y_t$ equals the actual value, $\hat{y}_t$ equals the fitted value, and n equals the number of observations.

**MSD** stands for Mean Squared Deviation. MSD is always computed using the same denominator, n, regardless of the model, so you can compare MSD values across models. MSD is a more sensitive measure of an unusually large forecast error than MAD.

$$MSD = \frac{\sum_{t=1}^{n} |y_t - y_t|^2}{n} \tag{3.22}$$

where $y_t$ equals the actual value, $\hat{y}_t$ equals the forecast value, and n equals the number of forecasts.

### 3.9.4 Post Hoc Procedures

Post hoc procedures are often necessary after the null hypothesis is rejected in an ANOVA (Thompson, 2006) or a MANOVA (Stevens, 2002). This is because the null hypotheses for these procedures often do not provide researchers with all the information that they desire (Huberty & Morris, 1989; Thomas, 1992). Tukey's HSD test was developed to specifically contrast Significant factor levels and studies have shown that the procedure accurately maintains alpha levels at their intended values as long as statistical model assumptions are met (i.e. normality, homogeneity, independence). Turkeys' HSD was designed for a situation with equal sample sizes per group, but can be adapted to unequal sample sizes as well (the simplest adaptation uses the harmonic mean of n-sizes as n*).

The formula for Tukey's HSD is given as:

$$HSD = q\sqrt{\frac{MSE}{n^*}} \tag{3.23}$$

Where q = the relevant critical value of the studentized range statistic and $n^*$ is the number of scores used in calculating the group means of interest and MSE is the mean square error.

# CHAPTER FOUR

# ANALYSIS AND DISCUSSION OF RESULTS

## 4.1 Introduction

This chapter deals with the analysis and discussion of the results obtained from the study. The presentation and analysis of the study's results are being put into five main captions: Descriptive Analysis, Profile Analysis, Multivariate Analysis of Variance (MANOVA), Trend Analysis and Discussions of Results.

## 4.2 Descriptive Analysis

The study revealed that out of a total of 115 mothers, 42 of them practice exclusive breastfeeding, indicating an estimated percentage of 36.5 whiles mothers who practice complementary feeding were 60 with an estimated percentage of 52.2 and those who used breast milk substitute were 13 indicating 11.3%. Mothers who belong to the age group of 26 – 35 years were 67 representing approximately 56.5% and those between 36 – 45 years had the least value of 18 with approximately 15.7%.

On the category of education, mothers who attained basic school level was the highest with a value of 45 approximately representing 39.1%, those who completed senior high school as well as those who had tertiary education were 27 and 12 respectively. Meanwhile mothers who did not receive any formal level of education emerged the second highest with a value of 31, which indicated an approximate percentage of 27%. Mothers who had given birth for the first time were 45 corresponding to 39.1% and those who delivered 7 and 8 times recorded the same figure indicating and estimated percentage of 0.9 each.

On employment type, 90 out of 115 mothers were self – employed, those who were unemployed had an approximate percentage of 12.2. Meanwhile only 9.6% of the mothers were government employees. That attributed to the fact that majority of the people in the municipality are traders and farmers. Out of the 115 babies measured, 56 were male whilst 59 were females. Eighty (80) mothers were recorded married whilst 35 of them were singles.



**Table 4.1 Descriptive Statistics of Mother's Characteristics and Baby**

| Variable | | Frequency | Percent |
|---|---|---|---|
| Sex | Male | 56 | 48.7 |
| | Female | 59 | 51.3 |
| Mother's education | Nil | 31 | 27 |
| | Basic | 45 | 39.1 |
| | Secondary | 27 | 23.5 |
| | Tertiary | 12 | 10.4 |
| Mother's Religion | Christianity | 73 | 63.5 |
| | Islamic | 42 | 36.5 |
| Marital Status | Married | 80 | 69.6 |
| | Single | 35 | 30.4 |
| Mother's Employment Type | Formal Employment | 11 | 9.6 |

| | | | |
|---|---|---|---|
| | Non Formal Employment | 90 | 78.3 |
| | Unemployment | 14 | 12.2 |
| Feeding Type | Exclusive Breast Feeding | 42 | 36.5 |
| | Complementary Feeding | 60 | 52.2 |
| | Breast Milk Substitute | 12 | 11.3 |
| Mother's Age Group | 16-25 | 32 | 27.8 |
| | 26-35 | 65 | 56.5 |
| | 36-45 | 18 | 15.7 |
| Parity | 1 | 45 | 39.1 |
| | 2 | 26 | 22.6 |
| | 3 | 24 | 20.9 |
| | 4 | 11 | 9.6 |
| | 5 | 5 | 4.3 |
| | 6 | 2 | 1.7 |
| | 7 | 1 | 0.9 |
| | 8 | 1 | 0.9 |

An investigation of the result of the data showed that the least mean weight (3.0 kg) was recorded in the first month whilst 7.8kg was the highest mean weight recorded in the seventh month. The minimum and maximum weight at month one were 1.6kg and 4.9 kg respectively whereas the maximum weight values at the seventh month (half a year) were 5.2kg and 10.0kg respectively with an approximate standard deviation of 0.9481. Furthermore, it was observed that the weight of age babies recorded was found to be fairly negatively skewed and leptokurtic in nature. Thus, the fifth and seventh months were platykurctic in nature, indicating that the weights of the babies were widely distributed around their mean value whilst the rest of the months were leptokurtic in nature, showing the weight were closely distributed around the means value as shown in table 4.2 below.

**Table 4.2 Descriptive Statistics of Baby's Weight over Time (Months)**

| Time (months) | Min | Max | Mean | Sd | Skewness | Kurtosis |
|---|---|---|---|---|---|---|
| 1 | 1.6 | 4.9 | 3.011 | 0.6545 | 0.2010 | 0.121 |
| 2 | 1.6 | 6.4 | 4.364 | 0.7901 | -0.0440 | 1.111 |
| 3 | 3.0 | 7.6 | 5.257 | 0.8563 | 0.1840 | 0.327 |
| 4 | 3.7 | 8.7 | 6.045 | 0.8759 | 0.0044 | 0.341 |
| 5 | 4.5 | 8.8 | 6.748 | 0.8716 | -0.1280 | -0.176 |
| 6 | 4.8 | 9.6 | 7.269 | 0.9410 | -0.1830 | 0.066 |
| 7 | 5.2 | 10.0 | 7.803 | 0.9481 | -0.2760 | -0.026 |

Std. Error of Skewness = 0.226

The descriptive statistics of baby weights over time grouped by sex is shown in table 4.3 below. The minimum weights at the first month, males and females were 1.8kg and 1.6kg respectively with female babies recording the lower minimum weight compared to their counterpart male babies. However, at the end of the seventh month period the female babies recorded the higher minimum weight than the male babies. The standard deviations of the male and female babies at the same month one were 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 babies recorded the greater standard deviation compared to the male babies. It was also realized that the mean change in weight of babies for the seven months period (half a year) generally exhibited nonlinear growth over time. This followed that the weight of a baby does not necessarily depend on the time the individual baby was born.

**Table 4.3 Descriptive Statistics of Baby Weight over Time (in Months) by Sex**

| Time | Minimum | | Maximum | | Mean | | Sd. Deviation | |
|---|---|---|---|---|---|---|---|---|
| (months) | 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 |

## 4.3 Model Adequacy

### 4.3.1 Test of Linearity

The hypothesis of the linearity assumption is that there are linear relationships of all pairs of dependent variables.



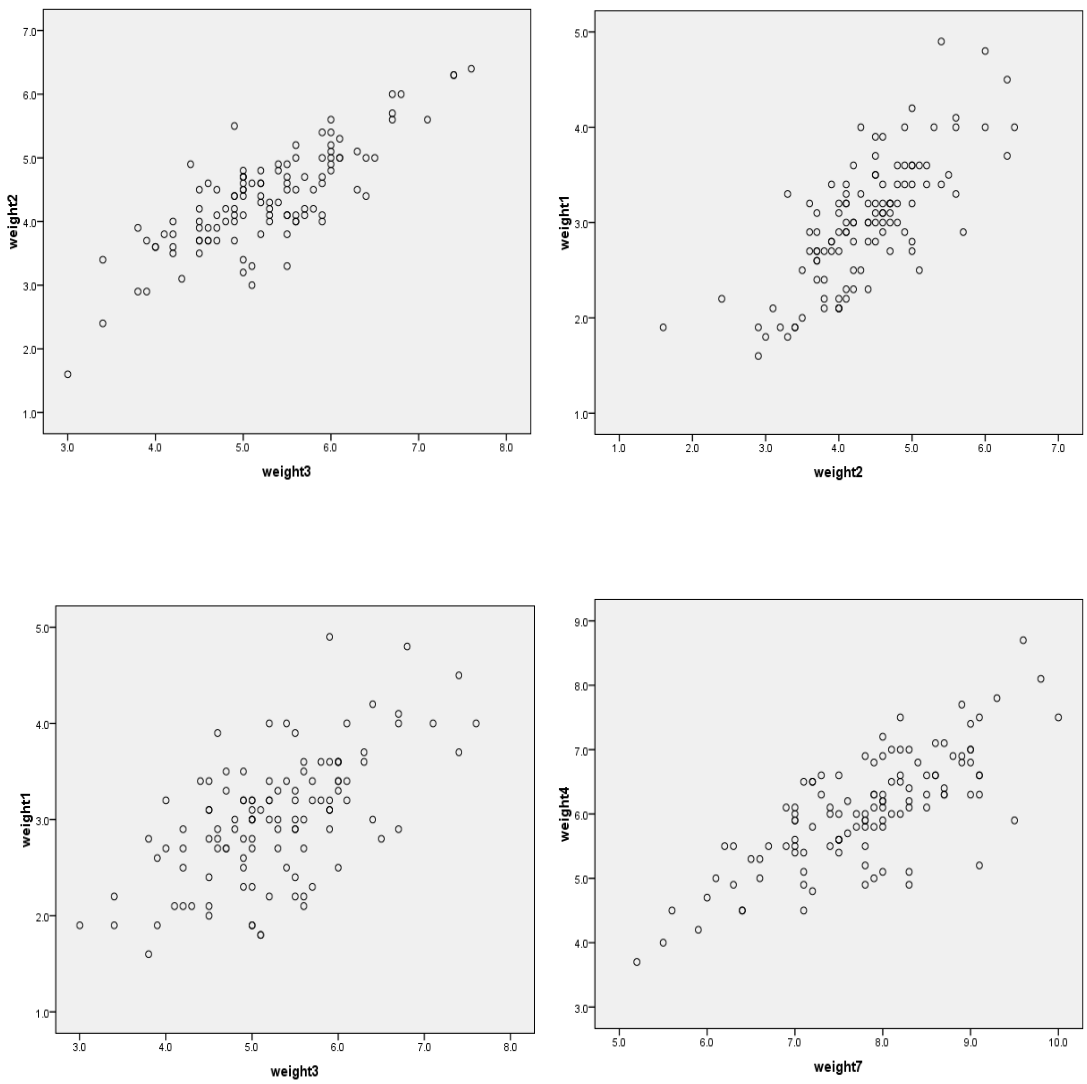


**Figure 4.1 Scatter plots of test of linearity**

From the output above, there appeared a positive correlation between the variables. The scatter plots do not show any evidence of nonlinearity, hence the assumption of linearity is satisfied.

### 4.3.2 Test of Normality of the Dependent Variables

The Kolmogorov - Smirnov and Shapiro - Wilk Tests were used to test the assumption that the dependent variables are normally distributed within groups.



**Table 4.4 Kolmogorov – Smirnov and Shapiro – Wilk Tests of Normality**

| | Kolmogorov-Smirnov | | | Shapiro - Wilk | | |
|---|---|---|---|---|---|---|
| | 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 |

From the Kolmogorov - Smirnov[a] and Shapiro – Wilk's table above, it is clear that both tests have p – values greater than 0.05, which indicates normality distribution of data.

### 4.3.3 Homogeneity of Variances

The Levene's Test of equality of variance tests the assumption of MANOVA that the variances are equal across the groups.

**Table 4.5 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 |

From the levene's test (table 4.5), apart from weight 2, all the dependent variables are not significant, $P>0.05$, hence, the assumption is not violated.



### 4.3.4 Homogeneity of Variance – Covariance Matrices

Box's M Test checks the assumption of homogeneity of covariance matrices across the groups. Box's M is sensitive, so unless $p < 0.001$, and the sample sizes are unequal, ignore it. However, if significant and have unequal sample sizes, the test is not robust (Tabachnick and Fiddel, 2001).

The hypothesis of this assumption is that the observe covariance matrices of the dependent variables are equal across groups.

**Table 4.6 Box's M Test of Equality of Covariance Matrices**

| | |
|---|---|
| Box's M | 50.371 |
| F | 1.68 |
| Df 1 | 28 |
| Df 2 | 44237.233 |
| Sig. | 0.014 |

From table 4.6, the output of Box's M (50.371) is not significant, P (0.014) > & (0.001), indicating the covariance matrices of the dependent variables are equal across groups.

**4.3.5 Multicollinearity**

When the dependent variables are highly corrected, this is called multicollinaerity. Correlations of equal to or greater than 0.9 are reason for concern (Pallant, 2005).

**Table 4.7 Pearson Correlation for the 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).

From the Pearson correlation in table 4.7, there appears to be positive high correlation. However, all the Pearson correlation values are below 0.9 except correlation between weight7 and weight 6 of (0.922). Therefore, the variables are moderately correlated.

### 4.4.0 Profile Plots of Mean Weight of Babies

### 4.4.1 Profile Plot of Mean Weight of Babies by Baby's Gender

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.

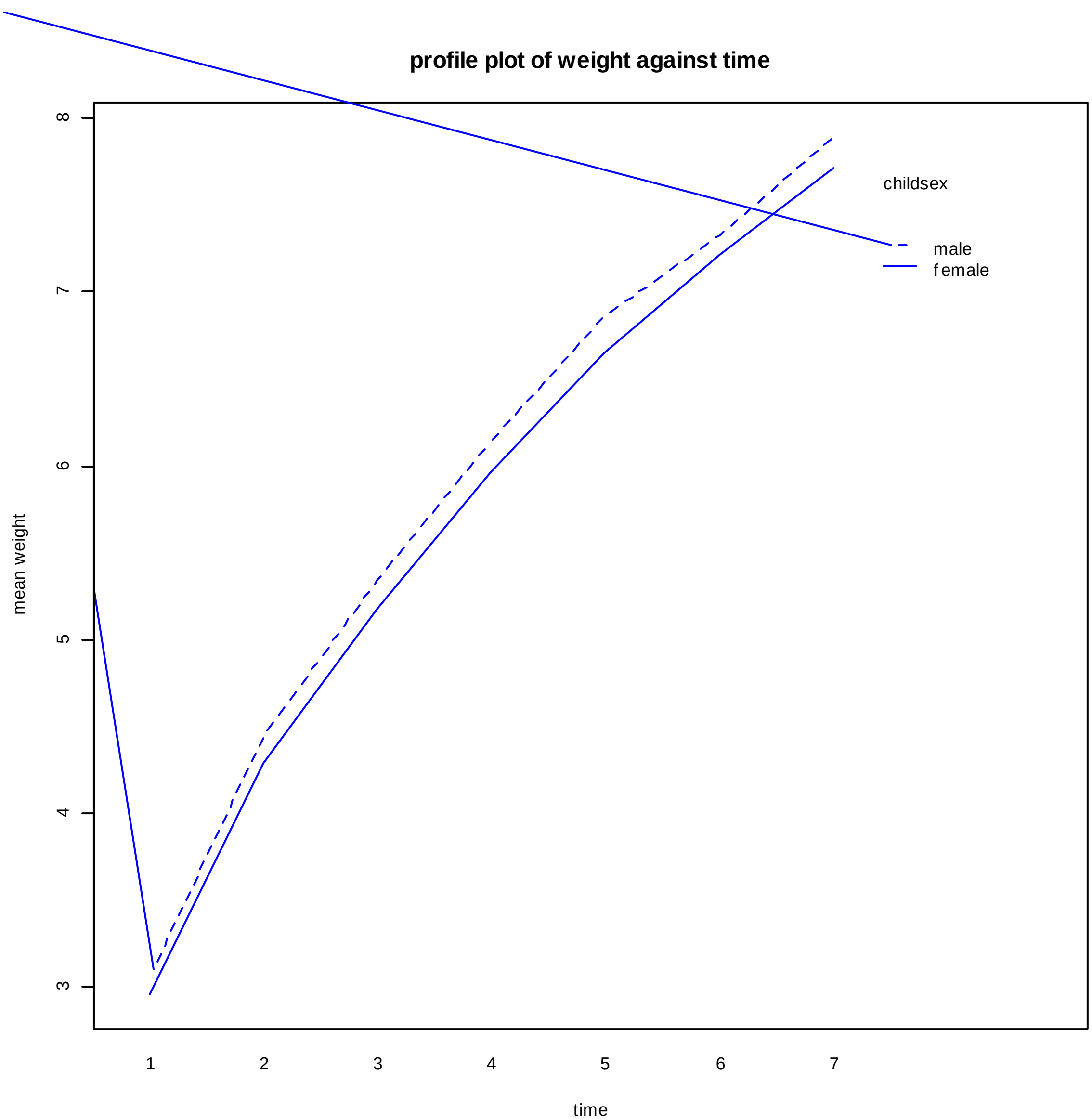


figure 4.2 Profile plot of mean weight babies by child sex

### 4.4.2 Profile Plot of Mean Baby's Weights by Feeding Type

Figure 4.3 revealed that the average change in weights of babies for the 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.

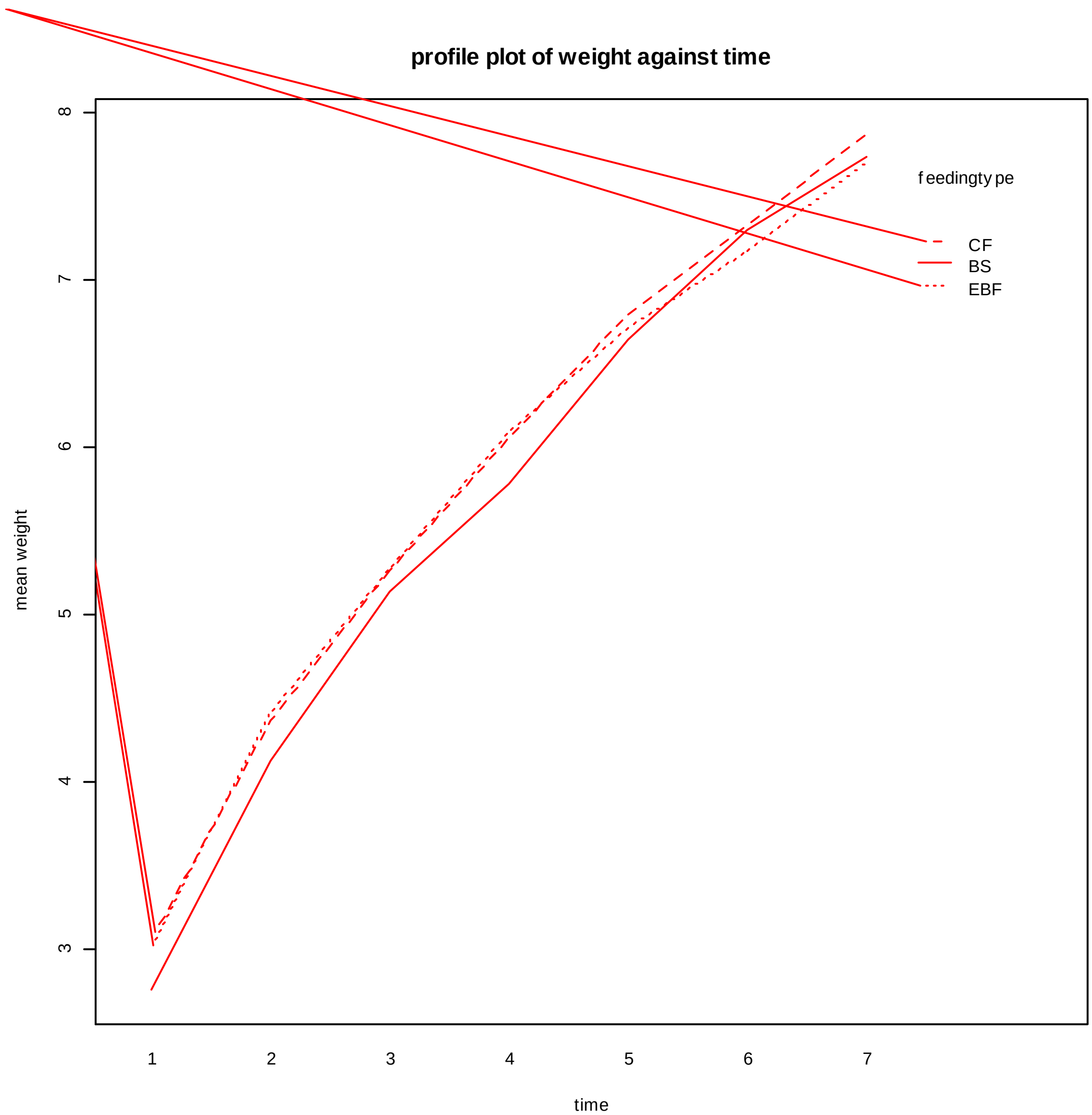


figure 4.3 Profile plot of mean weight babies by feeding type

### 4.4.3 Profile Plot of Mean Weight Babies by Mother's Educational Level

The profiles by educational level of the mother show some interaction between tertiary and the other educational level, with tertiary consistently leading up to the fifth month and then falling behind secondary. However, they all follow similar pattern of growth.

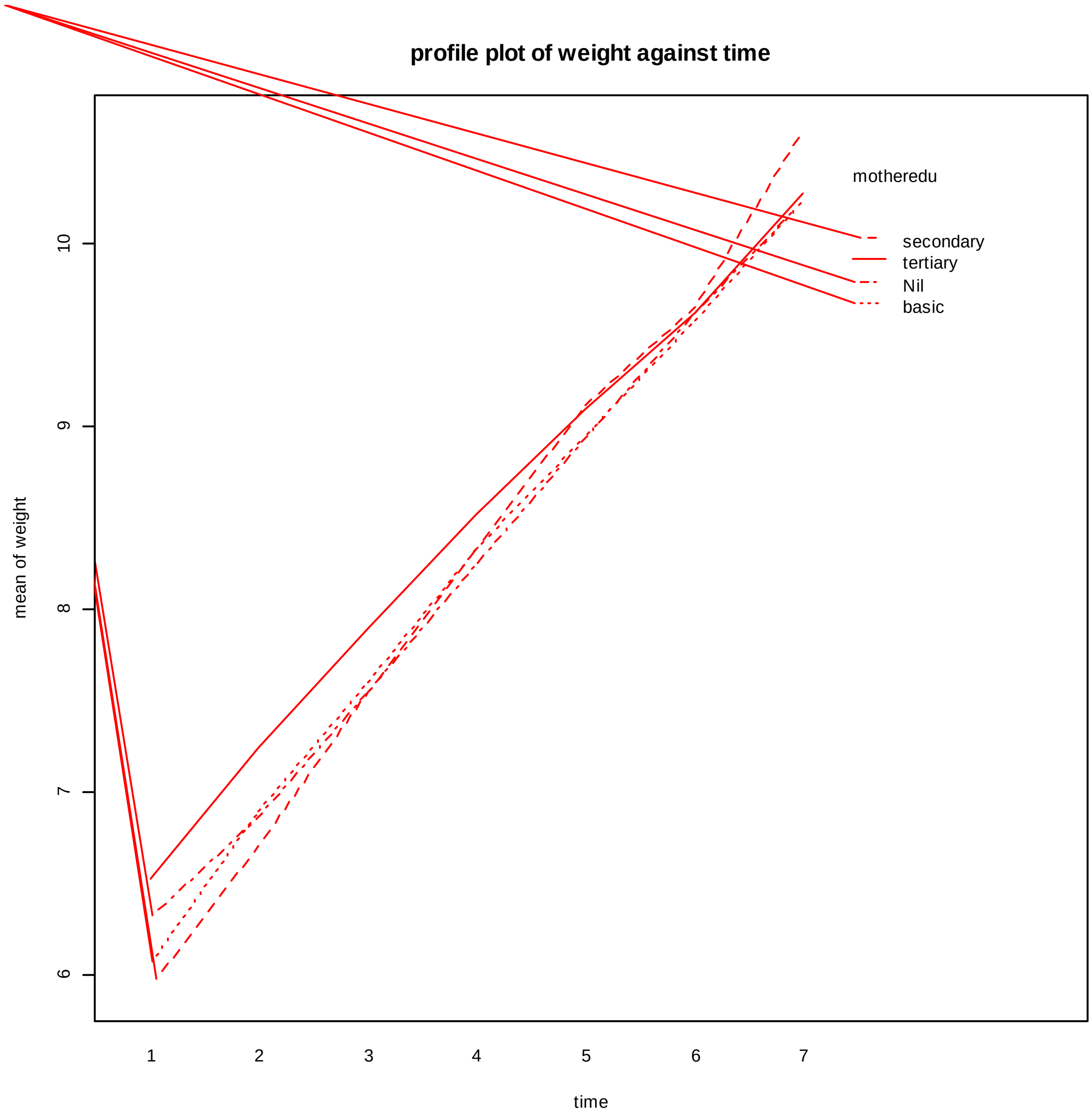


figure 4.4 Profile plot of mean weight babies by mother's educational level

### 4.4.4 Profile Plot of Mean Weight Babies by Mother's Religion

The profile plot in figure 4.5 shows that the mean change in the weight of babies with respect to the mother's religious affiliation had change over time and follows the same pattern. This can be implied that the mean change in the weight of babies across maternal religion may be similar.

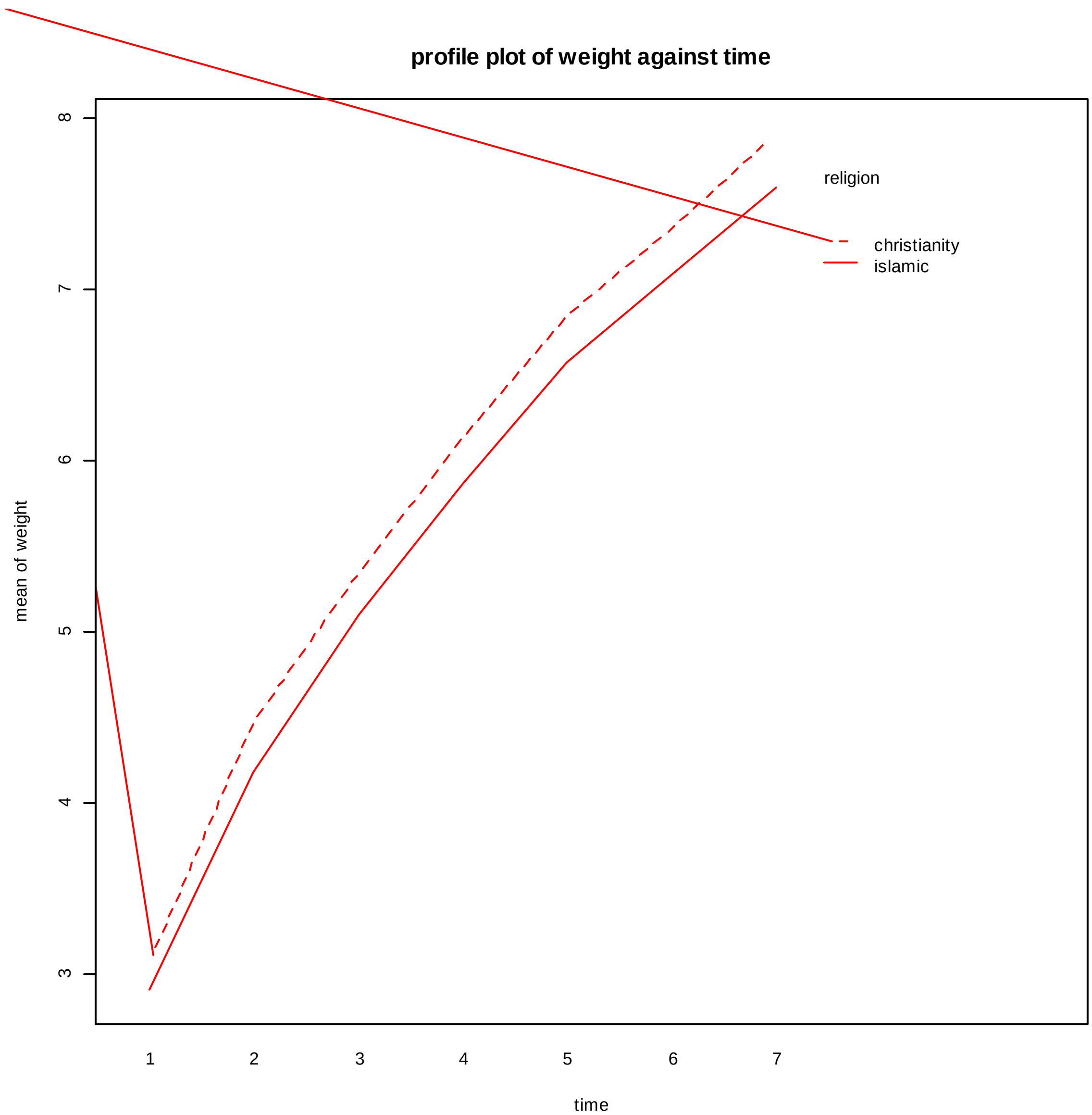


figure 4.5 Profile plot of mean weight babies by mother's religion

### 4.4.5 Profile Plot of Mean Weight Babies by Maternal Age Group

The profile plot as indicated in figure 4.7 bellow, revealed that the mean change in weights of babies over the seven month period of observation 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.



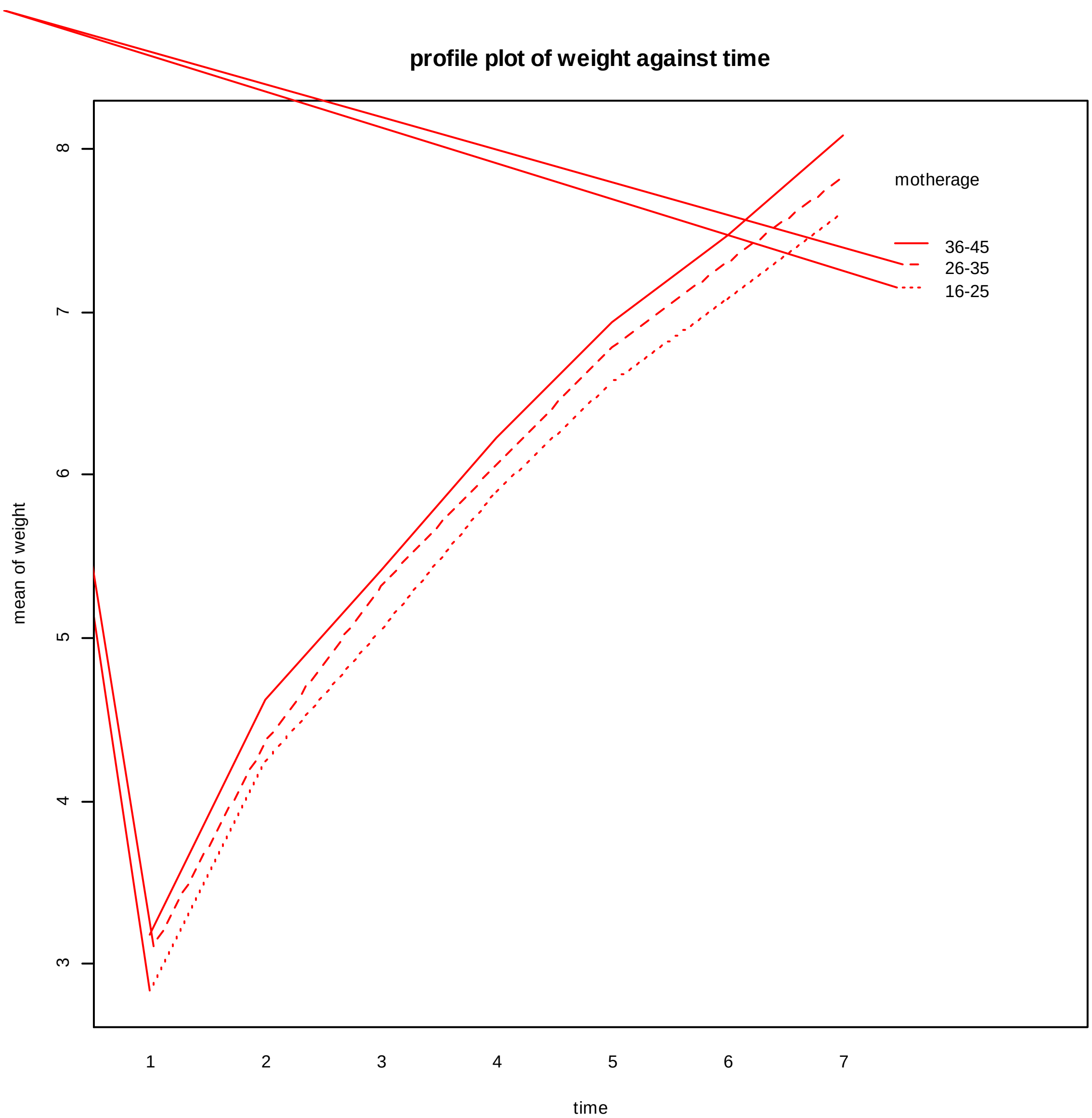


figure 4.6 Profile plot of mean weight babies by mother's age group

### 4.5 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.

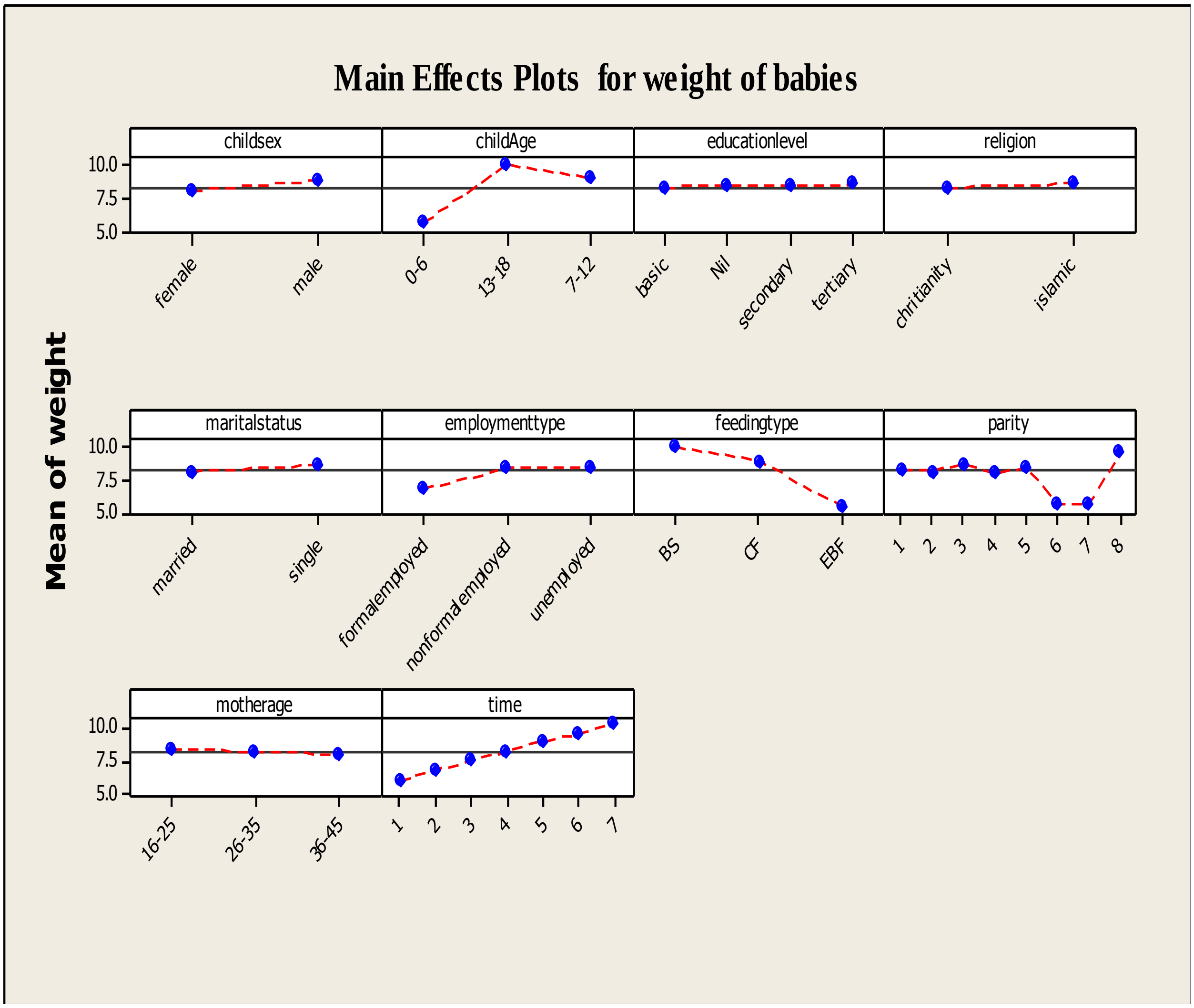


**Figure 4.7 Main Effects Plot for Weights of Babies**

From figure 4.7, 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. Further analysis was conducted to confirm this (See GLM results in table 4.8 and 4.9).



### 4.6 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.

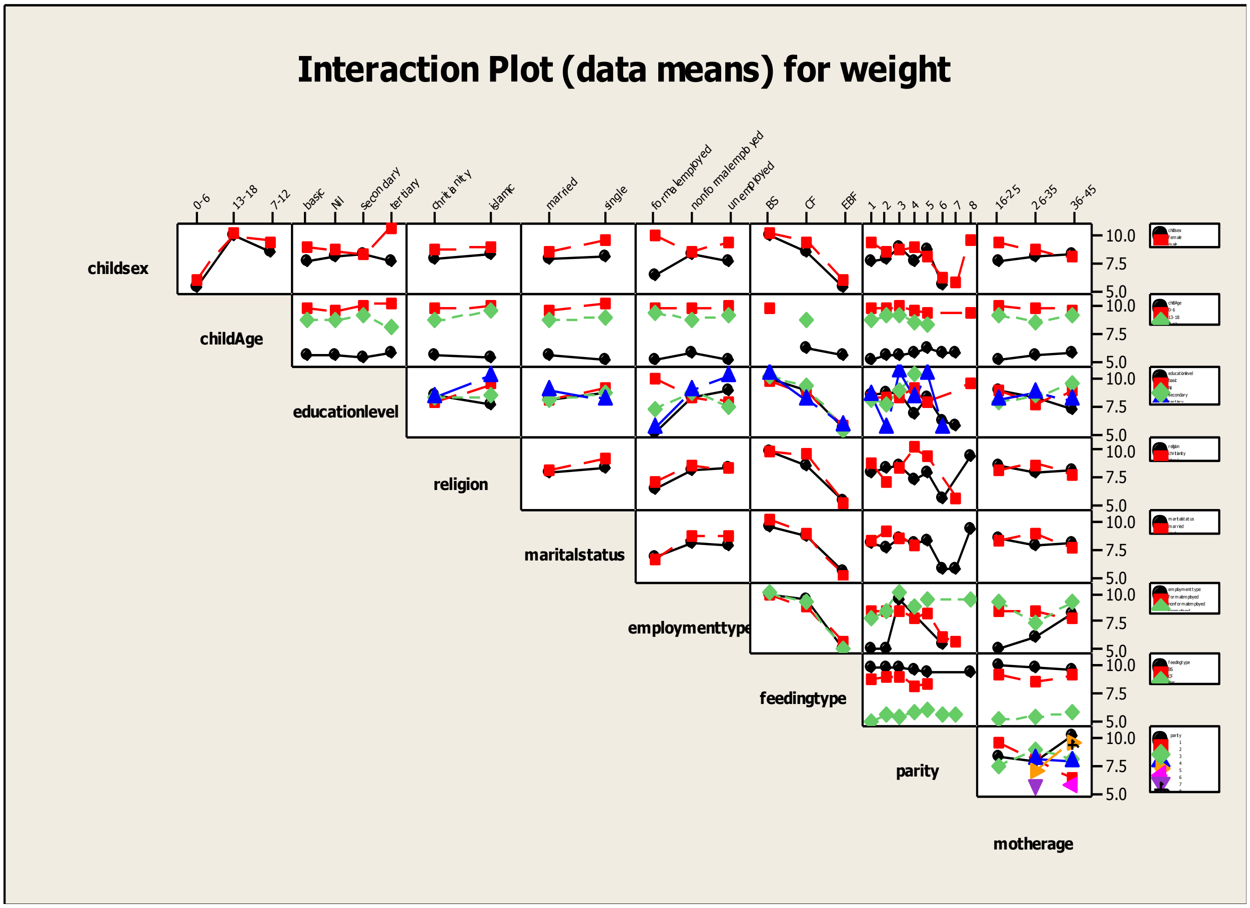


**Figure 4.8 Interactions plot for weight of babies**

The interactions plot shown in figure 4.8 reveals 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 depends 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.

### 4.7 Multivariate Analysis of Variance (MANOVA)

### 4.7.1 Multivariate Analysis of Variance (MANOVA) Test for Groups

In order to determine the factors that have significant effect on weight gain, MANOVA was carried out, making use of the following factors and covariances ; baby's gender, mother's educational level, marital status, feeding type given to babies, mother's employment type and the age of the mother. The tests show the effects of the factors on weight gain tested at 5% significance level as shown in table 4.8 below.

**Table 4.8 Multivariate Analysis of Variance Test Factors (Groups)**

**Multivarite Tests[c]**

| Effect | | Value | F | Hyp. Df | Error df | Sig. |
|---|---|---|---|---|---|---|
| Intercept | Pillai's Trace | 0.975 | 350.389 | 7.000 | 62.000 | 0.000* |
| | Wilks' Lamda | 0.025 | 350.389 | 7.000 | 62.000 | 0.000* |
| | Hostelling's Trace | 39.56 | 350.389 | 7.000 | 62.000 | 0.000* |
| | Roy's Largest Root | 39.56 | 350.389 | 7.000 | 62.000 | 0.000* |
| Child Sex | Pillai's Trace | 0.100 | 0.980 | 7.000 | 62.000 | 0.454 |
| | Wilks' Lamda | 0.900 | 0.980 | 7.000 | 62.000 | 0.454 |
| | Hostelling's Trace | 0.111 | 0.980 | 7.000 | 62.000 | 0.454 |
| | Roy's Largest | 0.111 | 0.980 | 7.000 | 62.000 | 0.454 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Root | | | | | |
| Mother's Education | Pillai's Trace | 0.240 | 0.796 | 21.000 | 192.000 | 0.722 |
| | Wilks' Lamda | 0.776 | 0.785 | 21.000 | 178.581 | 0.735 |
| | Hostelling's Trace | 0.268 | 0.774 | 21.000 | 182.000 | 0.749 |
| | Roy's Largest Root | 0.147 | 1.340 | 21.000 | 64.000 | 0.246 |
| Marital Status | Pillai's Trace | 0.240 | 0.219 | 7.000 | 62.000 | 0.980 |
| | Wilks' Lamda | 0.976 | 0.219 | 7.000 | 62.000 | 0.980 |
| | Hostelling's Trace | 0.025 | 0.219 | 7.000 | 62.000 | 0.980 |
| | Roy's Largest Root | 0.025 | 0.219 | 7.000 | 62.000 | 0.980 |
| Feeding Type | Pillai's Trace | 1.252 | 24.864 | 14.000 | 208.000 | 0.000* |
| | Wilks' Lamda | 0.560 | 47.427 | 14.000 | 208.000 | 0.000* |
| | Hostelling's Trace | 11.342 | 82.635 | 14.000 | 208.000 | 0.000* |
| | Roy's Largest Root | 10.835 | 160.979 | 14.000 | 104.000 | 0.000* |
| Occupation | Pillai's Trace | 0.185 | 0.919 | 14.000 | 126.000 | 0.541 |
| | Wilks' Lamda | 0.822 | 0.913 | 14.000 | 124.000 | 0.547 |
| | Hostelling's | 0.208 | 0.906 | 14.000 | 122.000 | 0.554 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Trace | | | | | |
| | Roy's Largest Root | 0.150 | 1.349 | 14.000 | 63.000 | 0.243 |
| Mother's Age | Pillai's Trace | 0.079 | 0.442 | 14.000 | 150.000 | 0.958 |
| | Wilks' Lamda | 0.922 | 0.439 | 14.000 | 148.000 | 0.959 |
| | Hostelling's Trace | 0.084 | 0.437 | 14.000 | 146.000 | 0.960 |
| | Roy's Largest Root | 0.068 | 0.729 | 7.000 | 75.000 | 0.648 |
| Parity | Pillai's Trace | 0.496 | 0.871 | 49.000 | 560.000 | 0.720 |
| | Wilks' Lamda | 0.575 | 0.893 | 49.000 | 148.000 | 0.678 |
| | Hostelling's Trace | 0.623 | 0.920 | 49.000 | 506.000 | 0.630 |
| | Roy's Largest Root | 0.392 | 4.480 | 7.000 | 80.000 | 0.000* |
| Mother's Religion | Pillai's Trace | 0.048 | 0.446 | 7.000 | 62.000 | 0.869 |
| | Wilks' Lamda | 0.952 | 0.446 | 7.000 | 62.000 | 0.869 |
| | Hostelling's Trace | 0.050 | 0.446 | 7.000 | 62.000 | 0.869 |
| | Roy's Largest Root | 0.050 | 0.446 | 7.000 | 62.000 | 0.869 |
| Child Age | Pillai's Trace | 0.933 | 198.302 | 7.000 | 100.000 | 0.000* |
| | Wilks' Lamda | 0.067 | 198.302 | 7.000 | 100.000 | 0.000* |

| | | | | | |
|---|---|---|---|---|---|
| Hostelling's Trace | 13.881 | 198.302 | 7.000 | 100.000 | 0.000* |
| Roy's Largest Root | 13.881 | 198.302 | 7.000 | 100.000 | 0.000* |

*. Significant at the 0.05 significance level

The MANOVA results in table 4.8 above revealed that feeding type is statistically significant with $F(14, 208) = 47.427$, $p = 0.000$ and Wilk's Lamda = 0.056. Wilk's Lamda is a measure of the percent of variance in the dependent variables that is "not explained" by differences in the level of the independent variable. Also, child age is statistically significant with all multivariate tests significant values less than 0.05, Wilk's lamda = 0.067, F-value = 198.302 and its associated significant value ($p < 0.05$).

For parity, only Roy's Largest Root was significant whilst the rest (Pillai's Trace, Wilk's Lamda and Hotelling's Trace) were not significant at 5% significance level. Roy's larger's Root = 0.392 and has associated $F (7, 80) = 0.392$, which is significant at $p = 0.000$. This shows 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*., (2006) assertion that deprivation of colostrum and improper complementary feeding were found to be significant risk factors for underweight among children less than five years.



### 4.7.2 Weight Gain by Feeding Type between Males and Females

From the MANOVA result, it has been revealed that, feeding type was an influential factor in determining weight gain among children. At this stage, we examined the effect of feeding type on weight between male and female children with respect to the interaction effect of gender and feeding type (Table 4.9).

**Table 4.9 Multivariate Test for Weight Gain by Feeding Type with respect to Child Sex**

| Multivariate Tests | | | | | | |
|---|---|---|---|---|---|---|
| Effect | | Value | F | Hyp. Df | Error df | Sig. |
| Intercept | Pillai's Trace | 0.991 | 1654.186[a] | 7 | 103 | 0.000* |
| | Wilks' Lamda | 0.009 | 1654.186[a] | 7 | 103 | 0.000* |
| | Hotelling's Trace | 112.42 | 1654.186[a] | 7 | 103 | 0.000* |
| | Roy's Largest Root | 112.42 | 1654.186[a] | 7 | 103 | 0.000* |
| Child Sex | Pillai's Trace | 0.141 | 2.420[a] | 7 | 103 | 0.025* |
| | Wilks' Lamda | 0.859 | 2.420[a] | 7 | 103 | 0.025* |
| | Hotelling's Trace | 0.164 | 2.420[a] | 7 | 103 | 0.025* |
| | Roy's Largest Root | 0.164 | 2.420[a] | 7 | 103 | 0.025* |
| Feeding Type | Pillai's Trace | 1.319 | 28.776 | 14 | 208 | 0.000* |
| | Wilks' Lamda | 0.042 | 56.779[a] | 14 | 206 | 0.000* |
| | Hotelling's Trace | 14.077 | 102.56 | 14 | 204 | 0.000* |
| | Roy's Largest Root | 13.442 | 199.714[b] | 7 | 104 | 0.000* |
| Child Sex*Feeding Type | Pillai's Trace | 0.102 | 0.799 | 14 | 208 | 0.670 |
| | Wilks' Lamda | 0.900 | 0.796[a] | 14 | 206 | 0.673 |
| | Hotelling's Trace | 0.109 | 0.794 | 14 | 204 | 0.675 |
| | Roy's Largest Root | 0.082 | 1.219[b] | 7 | 104 | 0.299 |

*. Significant at 5%.

Table 4.9 revealed that there were statistically significant main effects for both gender and feeding types as their p-values < 0.05. However, the interaction effect is not significant (p> 0.05).

This means that the effect of feeding on weight gain is the same for both male and female children less than five years. This is also shown in the profile plot in figure 4.10 which visually compared the growth pattern of males and females by feeding type. It revealed that the mean change in weights of babies for feeding type follows the same pattern for both male and female children less than five years.



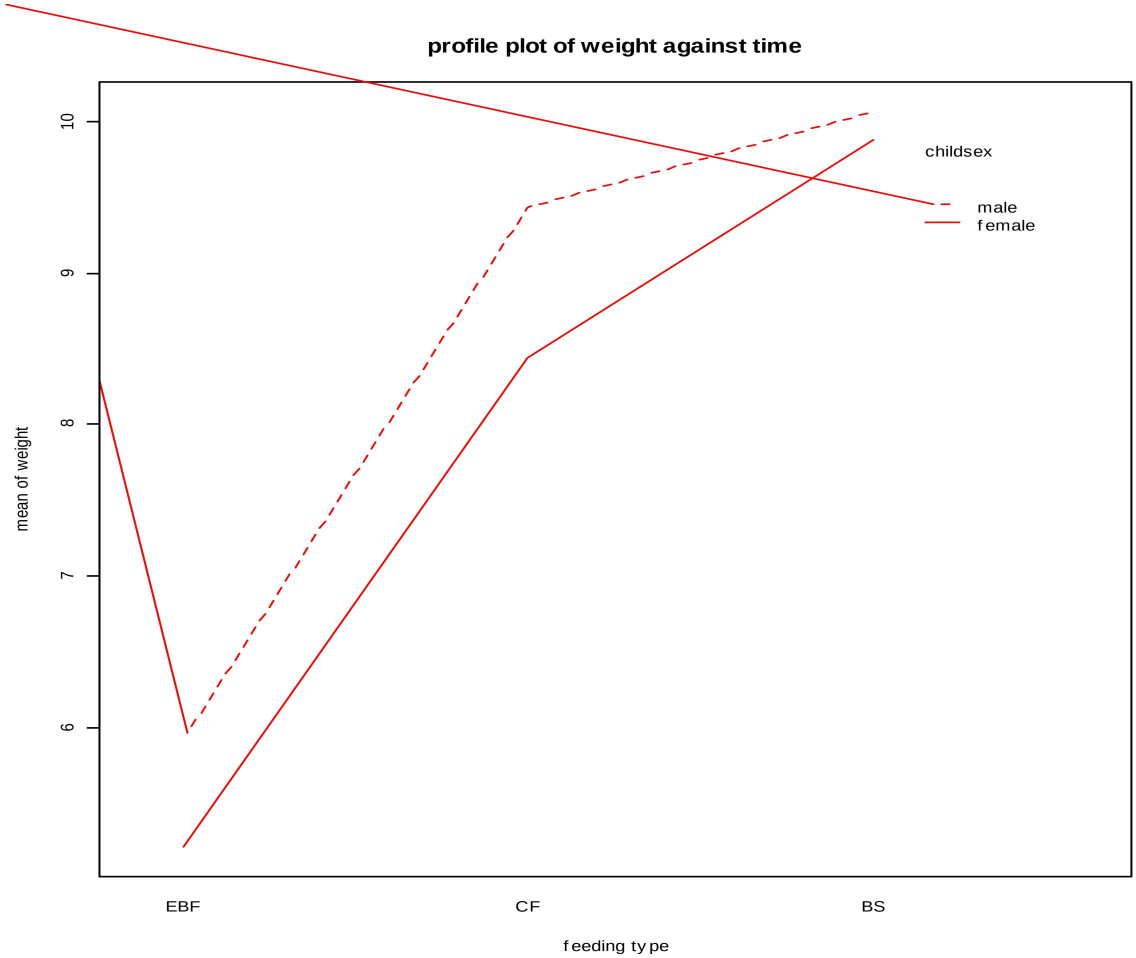


figure 4.9 Profile plot of the paattern of growth for male and female by feeding type

### 4.7.3 Profile Test of Parallelism

Multivariate analysis of variance MANOVA was performed to complete and confirm the profile plots of test of parallelism. The MANOVA tests revealed that the profiles for different levels of feeding type differed and are therefore not parallel. The other factors such as marital status, parity, mother's age, mother's educational level, religion, mother's occupation and baby's gender did not show significant difference at 5% significance level and hence, require test of parallelism.

#### 4.7.3.1 Test of Parallelism, Equality and Flatness by Mother's Education.

From table 4.10, the tests of parallelism and equality in each case are not significant with p- values greater 0.05. Considering the statistic Lamda with respect to parallelism for mother's education, Wilk's Lamda = 0.885 F(18, 300.299) = 0.733, P = 0.776 > 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 less than 0.05. Wilks Lamda = 0.041 with F (6, 106) = 413.01, P = 0.000 thus, we reject the hypothesis that the profiles are the same and conclude that the pattern of change in the weights of babies were not constant (not flat) with respect to mother's education overtime

**Table 4.10 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 the 0.05 significance level.

### 4.7.3.2 Test of Parallelism, Equality and Flatness by Parity

The multivariate tests of parallelism and equality by parity as shown in table 4.11 showed P - value greater than 0.05. Therefore, we fail to reject the hypothesis of same profiles and conclude that the mean change in weights of babies follows the same pattern by parity for both parallel and equal profile tests. A subsequent test for flatness indicated that all the four multivariate tests showed p - values < 0.05. Thus, Wilk's Lamda = 0.147, F(6,102) = 98.720, with significance P = 0.000. Hence, we reject the hypothesis that the profiles are flat and conclude that the pattern of change in babies weights were not constant over time by parity group.

**Table 4.11 Test of Parallelism, Equality and Flatness by Parity**

| **Test of Parallelism** | | | | |
|---|---|---|---|---|
| Variable | | Value | F - Value | Sig. |
| Parity | Pillai's Trace | 0.350 | 0.947 | 0.569 |
| | Wilks' Lamda | 0.688 | 0.952 | 0.560 |
| | Hotelling's Trace | 0.400 | 0.957 | 0.551 |
| | Roy's Largest Root | 0.219 | 3.350 | 0.003* |

| **Test of Equality** | | | | | |
|---|---|---|---|---|---|
| Source | Type lll Sum of Square | df | Mean Square | F - Value | Sig. |
| Intercept | 5264.425 | 1 | 5264.425 | 1343.435 | 0.000* |
| Parity | 10.992 | 7 | 1.570 | 0.401 | 0.900 |
| Error | 419.293 | 107 | 3.919 | | |

| Test of Flatnesss | | | | |
|---|---|---|---|---|
| | | Value | F - Value | Sig. |
| Parity | Pillai's Trace | 0.853 | 98.720 | 0.000* |
| | Wilks' Lamda | 0.147 | 98.720 | 0.000* |
| | Hotelling's Trace | 5.807 | 98.720 | 0.000* |
| | Roy's Largest Root | 5.807 | 98.720 | 0.000* |

*. Significant at the 0.05 significance level.



#### 4.7.3.3 Profile Test of Parallelism, Equality and Flatness by Sex

The outputs for the multivariate tests of parallelism and equality shown in Table 4.12 revealed 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 sex of the baby 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. Hence we reject the hypothesis that the profiles are flat and state that the weight of babies did not have the same effect over time.

**Table 4:12 Test of Parallelism, Equality and Flatness by Baby's Sex**

| Test of Parallelism | | | | |
|---|---|---|---|---|
| Variable | | Value | F - Value | Sig. |
| Sex | Pillai's Trace | 0.290 | 0.534 | 0.781 |
| | Wilks' Lamda | 0.688 | 0.534 | 0.781 |

| | | | | |
|---|---|---|---|---|
| | Hotelling's Trace | 0.400 | 0.534 | 0.781 |
| | Roy's Largest Root | 0.219 | 0.534 | 0.781 |

**Test of Equality**

| Source | Type lll Sum of Square | df | Mean Square | F - Value | Sig. |
|---|---|---|---|---|---|
| Intercept | 26945.634 | 1 | 26945.634 | 7161.08 | 0.000* |
| Sex | 5.091 | 1 | 5.091 | 1.353 | 0.247 |
| Error | 425.195 | 113 | 3.763 | | |

**Test of Flatnesss**

| | | Value | F - Value | Sig. |
|---|---|---|---|---|
| Sex | Pillai's Trace | 0.967 | 521.577 | 0.000* |
| | Wilks' Lamda | 0.033 | 521.577 | 0.000* |
| | Hotelling's Trace | 28.977 | 521.577 | 0.000* |
| | Roy's Largest Root | 28.977 | 521.577 | 0.000* |

*. Significant at the 0.05 significance level.



#### 4.7.3.4 Test of Parallelism, Equality and Flatness by Marital Status

For the category of marital status, the tests of parallelism and equality as shown in the table 4.13 below showed P-values greater than 0.05, indicating no significant difference. Consequently, we fail to reject the null hypothesis of same profiles and made a conclusion that the change in mean weights of babies follows the same pattern by marital status over time. As a result the flatness test was performed. The result of the flatness test revealed that all multivariate tests had significant values less than 0.05, with wilk's lamda = 0.039, F-value = 448.714 and with associated significant value 0.000. For this reason, we reject the null hypothesis and infer that the mean weights of babies were not constant over time by marital status (Table 4.3).

**Table 4.13 Test Parallelism, Equality and Flatness by Marital Status**

| **Test of Parallelism** | | | | | |
|---|---|---|---|---|---|
| Variable | | Value | F - Value | | Sig. |
| Marital Status | Pillai's Trace | 0.012 | 0.224 | | 0.781 |
| | Wilks' Lamda | 0.988 | 0.224 | | 0.781 |
| | Hotelling's Trace | 0.012 | 0.224 | | 0.781 |
| | Roy's Largest Root | 0.012 | 0.224 | | 0.781 |
| **Test of Equality** | | | | | |
| Source | Type lll Sum of Square | df | Mean Square | F - Value | Sig. |
| Intercept | 22921.904 | 1 | 2294.904 | 6030.277 | 0.000* |
| Marital Status | 0.757 | 1 | 0.757 | 0.199 | 0.656 |
| Error | 429.528 | 113 | 3.801 | | |
| **Test of Flatnesss** | | | | | |
| | | Value | F - Value | | Sig. |
| Marital Status | Pillai's Trace | 0.961 | 448.714 | | 0.000* |
| | Wilks' Lamda | 0.039 | 448.714 | | 0.000* |

| | | | | |
|---|---|---|---|---|
| | Hotelling's Trace | 24.929 | 448.714 | 0.000* |
| | Roy's Largest Root | 24.929 | 448.714 | 0.000* |

*. Significant at the 0.05 significance level.

#### 4.7.3.5 Test of Parallelism, Equality and Flatness by Mother's Religion

The results of the tests for parallelism, equality and flatness for mother's religious afflictions are presented in table 4.14. The tests of parallelism and equality showed statistically insignificant. However, the hypothesis $H_O$: vectors of means are equal for the groups were rejected since the multivariate tests are significant at 5% significant level, indicating that there is difference in the mean change of weights in babies.

**Table 4.14 Test of Parallelism, Equality and Flatness by Mother's Religion**

| **Test of Parallelism** | | | | |
|---|---|---|---|---|
| Variable | | Value | F - Value | Sig. |
| Mother's Religion | Pillai's Trace | 0.02 | 0.362 | 0.901 |
| | Wilks' Lamda | 0.98 | 0.362 | 0.901 |
| | Hotelling's Trace | 0.02 | 0.362 | 0.901 |
| | Roy's Largest Root | 0.02 | 0.362 | 0.901 |

**Test of Equality**

| Source | Type lll Sum of Square | df | Mean Square | F - Value | Sig. |
|---|---|---|---|---|---|
| Intercept | 22682.42 | 1 | 24682.42 | 6681.172 | 0.000* |
| Mother's Religion | 12.827 | 1 | 12.827 | 3.472 | 0.065 |
| Error | 417.459 | 113 | 3.694 | | |

**Test of Flatnesss**

| | | Value | F - Value | Sig. |
|---|---|---|---|---|
| Mother's Religion | Pillai's Trace | 0.964 | 482.139 | 0.000* |
| | Wilks' Lamda | 0.036 | 482.139 | 0.000* |
| | Hotelling's Trace | 26.786 | 482.139 | 0.000* |
| | Roy's Largest Root | 26.786 | 482.139 | 0.000* |

*. Significant at the 0.05 significance level.



### 4.6.3.6 Test of Parallelism, Equality and Flatness by Mother's Employment Type

At 5% significant level, parallelism and equality tests showed that the pattern of change in mean weights of babies is parallel and approximately the same. In flatness test however, we reject the null hypothesis that there is no difference in mean change in weights of babies since the P-value (0.000) is less than 0.05 (Table 4.15)

**Table 4.15 Test of Parallelism, Equality and Flatness by Mother's Employment Type**

**Test of Parallelism**

| Variable | | Value | F - Value | Sig. |
|---|---|---|---|---|
| Occupation | Pillai's Trace | 0.063 | 0.588 | 0.850 |
| | Wilks' Lamda | 0.937 | 0.588 | 0.850 |
| | Hotelling's Trace | 0.067 | 0.588 | 0.510 |
| | Roy's Largest Root | 0.058 | 1.048 | 0.380 |

**Test of Equality**

| Source | Type lll Sum of Square | df | Mean Square | F - Value | Sig. |
|---|---|---|---|---|---|
| Intercept | 11588.01 | 1 | 11588.01 | 3106.519 | 0.000* |
| Occupation | 12.501 | 1 | 6.25 | 1.676 | 0.192 |
| Error | 147.785 | 113 | 3.73 | | |

**Test of Flatnesss**

| | | Value | F - Value | Sig. |
|---|---|---|---|---|
| Occupation | Pillai's Trace | 0.928 | 228.269 | 0.000* |
| | Wilks' Lamda | 0.072 | 228.269 | 0.000* |
| | Hotelling's Trace | 12.8 | 228.269 | 0.000* |
| | Roy's Largest Root | 12.8 | 228.269 | 0.000* |

*. Significant at the 0.05 significance level.

#### 4.7.3.7 Test of Parallelism, Equality and Flatness by Mother's Age

The parallelism and equality tests are not statistically significant at 5% level. This implies, the profiles of average change in weights for the different age group are approximately the same. Flatness test however, is significant, meaning the mean change in weight with respect to mother's age does not remain the same overtime as shown in table 4.16 below.

**Table 4.16 Test of Parallelism, Equality and Flatness by Maternal Age Group**

**Test of Parallelism**

| Variable | | Value | F - Value | Sig. |
|---|---|---|---|---|
| Mother's Age | Pillai's Trace | 0.052 | 0.480 | 0.925 |
| | Wilks' Lamda | 0.948 | 0.478 | 0.926 |
| | Hotelling's Trace | 0.054 | 0.476 | 0.927 |
| | Roy's Largest Root | 0.044 | 1.795 | 0.576 |

**Test of Equality**

| Source | Type lll Sum of Square | df | Mean Square | F - Value | Sig. |
|---|---|---|---|---|---|
| Intercept | 20776.397 | 1 | 20776.937 | 5570.626 | 0.000* |
| Mother's Age | 12.567 | 1 | 6.283 | 1.685 | 0.190 |
| Error | 417.719 | 112 | 3.730 | | |

**Test of Flatnesss**

| | | Value | F - Value | Sig. |
|---|---|---|---|---|
| Mother's Age | Pillai's Trace | 0.958 | 402.62 | 0.000* |
| | Wilks' Lamda | 0.042 | 402.62 | 0.000* |
| | Hotelling's Trace | 22.577 | 402.62 | 0.000* |
| | Roy's Largest Root | 22.577 | 402.62 | 0.000* |

*. Significant at the 0.05 significance level.

### 4.8 Post Hoc Tests

Post hoc test is a follow up analysis following a significant multivariate effect. From the MANOVA test (Table 4.8), feeding type and baby's gender were found to be statistically significant at 5% percent significant level and hence, the null hypothesis, that there is no significant effect of one or more independent variables on two or more dependent variables was rejected. Therefore, the post hoc tests were carried out to test or explore the source of significant differences in the factor levels of the feeding type and baby's gender.

**Table 4.17 Tukey Post Hoc Tests for the Feeding Type.**

| | (I) Feeding type | (J) Feeding type | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound |
| Tukey HSD | EBF | CF | -3.4368* | 0.1569 | 0.000 | -3.805 | -3.068 |
| | | BS | -4.4760* | 0.1553 | 0.000 | -4.841 | -4.111 |
| | CF | EBF | 3.4368* | 0.1569 | 0.000 | 3.068 | 3.805 |
| | | BS | -1.0392* | 0.1494 | 0.000 | -1.390 | -0.688 |
| | BS | EBF | 4.4760* | 0.1553 | 0.000 | 4.111 | 4.841 |
| | | CF | 1.0392* | 0.1494 | 0.000 | 0.688 | 1.390 |

*. The mean difference is significant at the 0.05 level.



Tukey post hoc tests were performed to specifically contrast the feeding types on weight gain. All the contrasts were found to be statistically significant (p-values = 0.000). The mean difference (I-J) values were as follows: EBF vr CF = 3.4368, EBF vr BS = 4.4760 and CF vr BS = 1.0392.Thus, there was significant difference between the level means. Therefore, we conclude that all the feeding levels; Exclusive Breast Feeding (EBF), Complementary Feeding (CF) and Breast milk Substitute (BS) were all statistically significant.

**Table 4.18 Tukey Post Hoc Tests for the Baby's Age.**

| (I) Childage | (J) Childage | Mean Diff. (I-J) | Std. Error | Sig. | 95% Confidence Interval Lower Bound | Upper Bound |
|---|---|---|---|---|---|---|
| 0-6 | 7-12 | -3.4445 | 0.1566 | 0.000* | -3.812 | -3.077 |
| | 13-18 | -4.4734 | 0.1548 | 0.000* | -4.837 | -4.110 |
| 7-12 | 0-6 | 3.4445 | 0.1566 | 0.000* | 3.077 | 3.812 |
| | 13-18 | -1.0289 | 0.1493 | 0.000* | -1.380 | -0.678 |
| 13-18 | 0-6 | 4.4734 | 0.1548 | 0.000* | 4.110 | 4.837 |
| | 7-12 | 1.0289 | 0.1493 | 0.000* | 0.678 | 1.380 |

*. The mean difference is significant at the 0.05 level.

Again, the Tukey post hoc tests were performed to specifically contrast the child age groups on weight gain. All the contrasts were found to be statistically significant (p-values = 0.000). The mean difference (I-J) values were as follows: Child Age Group 0-6 vrs 7-12 = 3.445, 0-6 vrs 13-18 = 4.445 and 7-12 vrs 13-18 = 1.029. Also, there was statistically significant difference between the level means of the child age groups.



## 4.9 Trend Analysis

From the results, it was realized that a constant trend exists in the weight of the babies even though the period under the study was not long enough. Hence, the general trend of weight change over time for the period of observation was investigated using linear model, quadratic model, exponential trend model and the S-Curve model (Pearl Reed logistic trend model). Three measures of accuracy were applied on the fitted models; Mean Absolute Percentage Error (MAPE), Mean Absolute Deviation (MAD) and Mean

Square Deviation (MSD. The model with the smallest measures of accuracy values is considered the best fit for predicting the trend of the weight of babies. If a single model does not have the lowest values for all the three accuracy measures, MAPE is usually the preferred measurement. MAPE measures the size of error in percentages and hence, easy to understand and interpret compare to the other two statistics. The result of the trend analysis is shown in table 4.19 below.



**Table 4.19 Trend Analysis**

| Model | MAPE | MAD | MSD |
|---|---|---|---|
| Linear | 34.7075 | 2.1071 | 6.4749 |
| Quadratic | 34.6983 | 2.1011 | 6.4549 |
| Exponential | 33.6033 | 2.1833 | 6.7131 |
| S - Curve | 33.2521 | 2.3617 | 7.7520 |

From Table 4.19, It was realized that the general pattern or trend produced S-Curve (Pearl Reed logistic trend) function, since the S-Curve model have the highest MAPE value, (MAPE value =33.2521) among the four (4) trends models tested. A summary measure of error should meet five basic criteria; measure of validity, reliability, ease of interpretation, clarity of presentation and support of statistical evaluation (Swanson *et al., 1999*). MAPE met most of these criteria. Hence, preferred to the other two measures.

### 4.9.1 The S-Curve Trend Model Diagnosis

To diagnose the fitted model, we test the model assumptions. Thus, the normality of the model residuals must be confirmed. In this test the hypotheses are stated below:

$H_O$: The residuals of the model are normally distributed

$H_1$: The residuals of the model are not normally distributed.

**Table 4.20 Trend Model Diagnosis**

| | Statistic | P - Value |
|---|---|---|
| Shapiro - Wilks | 0.988 | 0.484 |
| ARCH - LM | 2.267 | 0.687 |

The adequacy of the S – Curve model was tested using Shapiro-Wilk and ARC-LM tests as shown in (Table 4.20). The Shapiro-wilks test of normality indicated that the residuals of the model were normally distributed ($p$-value = 0.484) greater than 0.05 and the W = 0.988, thus confirming the earlier test for normality of the dependent variables. For the ARCH-LM, $p$-value = 0.687 > 0.05, therefore we fail to reject the null hypothesis and conclude that the model residuals were free from conditional heteroscedasticity. Hence the diagnostic test indicated that the model is adequate for prediction of weight of babies.

### 4.10 Discussion of Results

The records of one hundred and fifteen (115) weights of babies from the Kintampo Reproductive Health Care (RHC) weighing center, the only but large weighing center that serve the whole Kintampo town in the Kintampo municipality were retrospectively monitored from June, 2015 to December, 2015. Out of the one hundred and fifteen babies, 56 were males whilst 59 were females. For the mean birth weight, males weigh slightly higher than females. The birth weight for both males and females, (1.8kg and 1.6kg respectively), could be considered as low birth weights which were not good enough because they are lower than the recommended standard for normal birth weights of 2.5kg by the World Health Organization (WHO). Among the three main feeding types, complementary feeding has the highest percentage of 52.2 whilst breast milk substitute recorded the least with only 11.3%. The high percentage of complementary feeding may be due to the campaign and intervention, that complementary feeding should be introduced into a child's diet starting around the age of six months (WHO1995, 1998; Agnerson *et al.*, 2005). The leptokurtic nature of the data shown in the descriptive statistics revealed how the weights were distributed around their mean value. The close distribution of weights around their mean value indicates statistical power. That is the power to detect a main or interaction effect. Also, the data was examined to determine whether or not a pattern or a trend exists. It was realized from the results that the weight of babies exhibited S-Shape Curve trend or pattern. The S-Curve trend model showed that the weights of babies increase and fall slightly, then rise again (figure 4.2). The statistical assumptions of the multivariate methods were satisfied, and hence, the profile analysis was carried out. For the category of occupation or employment types, mothers who were self-employed (78.3%) were almost three times as mothers who were government employees together with those who were not employed (12.2%). The very high number of self-employed mothers may be due to the fact that Kintampo municipality is predominated with major farming activities and trading and hence, many women involved in these activities rather than to be employed by government or other NGOs. The males and female babies slightly differed in their mean weights as well as minimum and maximum weights. The males recorded the higher minimum weight (1.8kg) and mean weight (3.064kg) at the initial month than their female counterpart of minimum weight and mean weight of 1.6kg and 2.961kg respectively, and they (males) consistently lead throughout the period of observation where both male and female children recorded a mean weight of 7.895kg and 7.717kg respectively at the seventh month, suggesting that the change in weight for both males and females do not differ but seem to follow the same pattern of growth during the infant stage (Table 4.3, Figure 4.3).

The profile plot of the mean weights of babies with respect to baby's gender had change over time. 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 of change over time. The profiles in mother's education on mean change in weight showed that the four main educational levels: nil, basic secondary and tertiary showed change in weight over time and follows the same pattern of growth. Mothers who attained tertiary education slightly lead compared with the other levels. The educational pattern of profiles with consistent lagging nature of weight change, with mothers who had no education, basic education and secondary education may suggest that their understanding of maternal and child health care educations is low compared to those who attained tertiary education. That is to say high educated mothers fed well and took good care of their children, probably due to the fact that, they were able to understand better and adhere to maternal and child health care educations offered by the midwives and other service providers. The general pattern however, appeared to be approximately the same among the educational profiles.

The profiles for the effect of feeding type on change of weight indicated that the three main feeding types have change over time and followed different pattern of growth as shown figure 4.4. The profiles suggest that these feeding types improved change of weight over time. Hence, the MANOVA results confirmed that feeding type is important in infant growth as reported by Maahi., (2012) that feeding practice is significant at 5% significance level, and therefore a factor for determining weight gain. It however, disagrees with Akansuke *et al*., (2015) assertion that breastfeeding type was not significantly different at 5% significant level for average weight change. The profiles of occupation (mother's employment type) revealed no significant difference. The profile plot showed close similarities exhibited by maternal employment type or occupation.

Obviously, the results proved that factors such as baby's gender and feeding type practice by the nursing mothers were statistically significant at 5% significance level. This implies that, the mean weight of a baby can significantly be predicted by baby's gender and feeding type. In other words, baby's gender and feeding type are influential factors in determining the weight change of children less than five years. Therefore, both baby's gender and feeding type are significant predictors of weight of children less than five years in the Kintampo municipality.

# CHAPTER FIVE

# CONCLUSION AND RECOMMENDATIONS

## 5.1 Introduction

This chapter presents a summary of the findings from the study. The conclusion discusses whether the findings support the proposed hypothesis and achieve the objectives of the research. Recommendations and suggestions for future works are also presented in this chapter.

## 5.2 Conclusion

Based on the results of the study involving weight of age babies, mother's characteristics and child's characteristics, it was found generally that, male and female children less than five years do not differ significantly in terms of weight gain. Thus, from the MANOVA interaction results, the main effects for both feeding and sex were significant ($Pv < 0.05$) but their interaction effect was insignificant, ($Pv > 0.05$).

Also, the results revealed that feeding type was significant ($Pv < 0.05$), however, Breast milk substitute and complementary feeding had the highest mean effect compared to Exclusive breast feeding. Besides, child's age was statistically significant ($Pv < 0.05$), with child's age group 13-18months showing the highest mean effect compared to the age groups 0-6months and 7-12months. This confirmed a report by Maahi (2012) that, baby's age and feeding practices were significant predictors of weight gain, but disagrees with Akansuke *et al*., (2014) assertion that breastfeeding type was not significantly different at 5% significant level for average weight change. Further, it was realized that parity showed some impact on weight gain, with Roy's Largest Root=0.392, F-value = 4.48, with associated significant value, ($Pv < 0.05$). Nevertheless, parity level 8 was associated with the highest mean effect compared to the other levels. There was however, no statistically significant difference between weight gain and mother's age, religion, maternal educational level, marital status, occupation and baby's gender.

From the analysis, feeding type, baby's age and parity are influential factors for determining baby's weight whiles the other grouping variables such as marital status, child sex, religion, maternal age and educational level are not. Therefore, the mean weight of a baby can be modeled for prediction using child's age, parity and feeding type given to the child.

Moreover, the pattern of weight change of the babies showed S – Curve function; the S – Curve trend model has the lowest MAPE value (MAPE = 33.3%). The general S - Curve pattern of growth by the effects of the maternal characteristics such as mother's educational level, religion, maternal age group, parity, marital status and baby's gender on the weight of babies can be significantly improved if the midwives, enrolled nurses, municipal nutrition officer intensify their education on child health care using the significant determinants.

In conclusion, feeding type, age of the baby and parity place significantly different roles or importance in influencing weight gain in children less than five years. Hence, there is sufficient evidence against the null hypothesis that there is no significant difference between one or more predictor variables and weight gain. Thus, the null hypothesis is rejected.

## 5.3 Recommendations

i) According to the study findings, both significant and insignificant factors were identified. Moreover, the differences among the level means for the factors were also identified. Hence, the health professionals, stakeholders and policy makers can make use of these findings to tailor their health care education strategies and health service provisions with potential risk children's health care needs.

ii) The technical officer and the municipal nutrition technical officer should teach the women's organizations in the municipality on how to prepare food supplement to feed their children alongside with breast milk during their infant stage.

iii) Nursing mothers are to at regular time send their babies to the weighing center for their weight to be examined and also seek child health care to avoid complications during the infant stage.

## 5.4 Future Directions

It is suggested that any further work on this study should be focused on:

i) the psychological make-up of the mother during pregnancy and the physical factors such as maternal height, pre-pregnancy weight and paternal height and weight.

ii) Blocking factor; Explore the blocking effect (Time in this case) on weight gain.

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