UNIVERSITY FOR DEVELOPMENT STUDIES

STATISTICAL ANALYSIS OF WEIGHTS OF BABIES UNDER DIFFERENT FORMS OF FEEDING PRACTICES - A CASE STUDY OF MAMPONG MUNICIPALITY

EMMANUEL ADJEI

Thesis Submitted to the Department of Statistics, Faculty of Mathematical Sciences, University for Development Studies in Partial Fulfillment of the Requirement for the Award of Master of Science Degree in Applied Statistics

2013

UNIVERSITY FOR DEVELOPMENT STUDIES

STATISTICAL ANALYSIS OF WEIGHTS OF BABIES UNDER DIFFERENT FORMS OF FEEDING PRACTICES

- A CASE STUDYOF MAMPONG MUNICIPALITY

By

EMMANUEL ADJEI (BSc. STATISTICS)

(UDS/MAS/0016/11)

Thesis Submitted to the Department of Statistics, Faculty of Mathematical Sciences, University for Development Studies in Partial Fulfillment of the Requirement for the Award of Master of Science Degree in Applied Statistics

OCTOBER, 2013

DECLARATION

Student

I hereby declare that 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 except the references to other researchers or writers which have been duly acknowledged.

Candidate's Signature: .... **Date:** 15/11/13

Name: Emmanuel Adjei

Supervisor

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

Supervisor's Signature: .... **Date:** 15/11/2013.

Name: Rt. Rev. Dr. Albert Luguterah

ABSTRACT

Regular assessment of weight gain among babies has been a way of assessing their health status and growth. This study assessed the weight gain among babies under different forms of feeding practices for the first nine months after birth. The feeding practices focused on in this study are Exclusive Breastfeeding (EBF), Breastfeeding with water only (BFW), Breastfeeding with any other food including water (BFWO) and Non-Breastfeeding (NBF). Data was obtained from Mampong Babies Home, the Mampong Technical College of Education Primary School and the Akyeremade weighing centers, all at the Mampong Municipality in the Ashanti Region of Ghana. The data was analysed using repeated measures univariate ANOVA, repeated measures MANOVA and linear models analysis of longitudinal data. The Results indicated that weights of babies were different under different forms of feeding practices although there was a general increasing trend (an increase in weight with time) for all the practices. The results showed that Exclusive Breastfeeding babies gained more weight than the others in the first six months of life.

ACKNOWLEDGEMENT

Unto God be the glory and honor for His countless blessings, gracefulness and mercies without which I could not have come this far and done this much.

It would be ungrateful if appreciation is not expressed to the following who helped in many and diverse ways in making this thesis a success. My profound gratitude goes to my lecturer and supervisor Rev. Dr. Albert Luguterah for availing his expertise, helpful comments, suggestions, incessant advice and constructive criticisms to the successful completion of this work. I am grateful to Dr. Ibrahim Yakubu Seini (PG Coordinator) for his encouragement, Dr. A.Y. Omari Sasu and all the Lecturers of the Department of Statistics whose tuition equipped me with the requisite knowledge required for the study.

A special note of appreciation also goes to Mr. Tuahiru Maahi, Mr. Hardi and Mr. Abdul-Aziz (Chief) of the Department of Mathematics and Statistics, Tamale Polytechnic, Mr. Napoleon Bellua Sam (UDS, Central Administration) and Suleman Nasiru (my course mate) who assisted me in diverse ways.

Finally I wish to place on record my heartfelt thanks to the nurses of Mampong Babies Home, especially Mrs. Margaret Addai (the Head of the Home) and Miss Anita Djan (a student of St. Monica's Nursing Training College), for their co-operation and assistance during the data gathering process.

DEDICATION

This work is dedicated to my wife, Mrs. Mary Kruwa Adjei, and my children.

TABLE OF CONTENTS

CHAPTER TWO LITERATURE REVIEW

CHAPTER THREE METHODOLOGY

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS AND ACCRONYMS

GDS	Ghana Demographic Survey
GDHS	Ghana Demographic and Health Survey
CDC	Center for Disease Control
UNICEF	United Nations Children's Fund
IMMPaCt	International Micronutrient Malnutrition Prevention and Control Programme
AAP	American Academy of Pediatrics
USAID	United States Agency of International Development
GAIN	Global Alliance fo r Improved Nutrition
FFI	Flour Fortification Initiative
IVP	Irrigation Village Perimeters
GSS	Ghana Statistical Service
MI	Macro International Incorporated
ICDS	Integrated Child Development Services
UDHS	Uganda Demographic and Health Survey
AIC	Akaike's Information Criterion
BIC	Bayesian Information Criterion
WHO	World Health Organization
ANOVA	Analysis of Variance
MANOVA	Multivariate Analysis of Variance
ANCOVA	Analysis of Covariance
MANCOVA	Multivariate Analysis of Covariance

CHAPTER ONE

INTRODUCTION

1. 1 Background of the study

Health issues have been one of the primary and indeed a paramount concern in man's quest for knowledge since time immemorial. Good health is basic to our survival. Adequate food and sound nutrition are essential to good health. They are crucial not only for human survival, but also for the prevention of, and the recovery from illness (GSS and MI, 2004); this is especially so for newborns. Worldwide, more than 9 million children under 5 years of age die each year (UNICEF, 2008). Malnutrition underlies a majority of these under 5 deaths, 70% of which occur in the first year of life (UNICEF, 2008). Infant and young child feeding practices directly impact their nutritional status and, ultimately, the child survival under 2 years of age. Improving infant and young child feeding is therefore critical to ensuring their optimal health, nutrition and development (UNICEF, 2008).

Appropriate feeding practices are of fundamental importance for the survival, growth, development, health and nutrition of infants and children. Feeding practices are one of the underlying determinants of child's nutritional status which in turn influence the risk of illness and ultimately death (GSS and MI, 2004).

Breastfeeding, according to the Oxford Advanced Learners Dictionary, means giving the baby breast milk soon after birth. Also the Wikipedia (en.wikipedia.org) defined breastfeeding as the feeding of an infant or young child with breast milk directly from female human breast (i.e. via lactation) rather than from a baby bottle or other containers. Breastfeeding is sufficient and beneficial for an infant's nutrition in the first six months of life (WHO, 2003).

Exclusive breastfeeding implies feeding the infant only with breast milk without any additional food or drink, not even water (WHO, 2003). According to UNICEF (2008), high average with optimal breastfeeding practices, especially exclusive breastfeeding for the first six months of life could have the single largest impact on child survival, with the potential to prevent 1.4 million from under five deaths. Yet in 2008, the rate of exclusive breastfeeding were only about 37% in developing countries. The World Health Assembly (WHA), in May 2001 recommended exclusive breastfeeding for the first six months of a child's life. It emphasized the media role in promoting and protecting exclusive breastfeeding to improve child health. Since Ghana adopted this policy (Exclusive breastfeeding for the first six months), various seminars and programs have been held and information spread through Public and Private Television stations, radios and news papers to promote and encourage the practice. Pre-lacteal feeding (that is, given something other than breast milk in the first three days of life) is generally discouraged since it inhibits breastfeeding and exposes the new born infant to illness (GSS and MI, 2004). Despite the recommendation, some infants are still being fed with complementary foods in addition to breast milk. In

Ghana, there are other infants, especially those in orphanage Homes, who do not receive any breast milk.

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 (Kirkland, 2006). Under nutrition is sometimes called a growth deficit or failure to thrive. It is important to recognize and treat children who are not gaining weight normally, because it may be a sign of under nutrition or an underlying medical problem that requires treatment. This, according to Kirkland (2006), is because, each year, under nutrition contributes to the deaths of about 5.6 million children younger than 5 years in the developing world. Another 146 million children within this age group are underweight and are at an increased risk of early deaths, illness, disability and underachievement. In least developed countries, 42 percent of children are stunted and 36 percent are underweight.

1.2 Growth Monitoring In Infants and Children

For a relatively small expenditure per child, growth monitoring can greatly strengthen preventive health programmes. Growth is the best general index of the health of an individual child, and regular measurements of growth permit the early detection of malnutrition, frequently association with diarrhea and other illnesses, when remedial action is relatively easy. Although acute signs of malnutrition are easily noted by health workers, it is often too late, and always more expensive, to help the severely malnourished children (UNICEF, 2006).

For early detection of children with growth retardation and high risk of malnutrition and mortality, health workers need special tools and training in growth monitoring. The growth status of children is a measure of the health and well-being of the whole community. Birth weight is of a particular significance in determining the nutritional status of a community, as low birth weight is a good indicator of subsequent illness and death in children (UNICEF, 2006).

Various body measurements are used to access growth. Some are easier to use, more accurate and more useful than others. Monitoring the growth of a child usually requires taking the same measurements at regular intervals and seeing how they change. A single measurement only indicates the child's size or weight and does not show if the child is increasing, staying the same, or declining in size or weight. Careful repeated measurements and comparisons with previous measurements are necessary because most children will continue to grow a little, unless they are very ill, and it is easy to mistake some growth for adequate growth. Growth measures are usually compared to a reference population. Gathering data to establish a local reference population is a major undertaking. Therefore, western standards are usually used for comparison, such as Tanner and Boston, or more recently, those of the National Centre for Health Statistics (UNICEF, 2006).

In Ghana, mothers and family members have traditionally used a variety of indicators and milestones when assessing their children's growth. Love *et al.*, (1985) conducted a productive community survey in central Ghana that examined closely the growth related beliefs and practices of local mothers and families, in order to suggest ways of applying the information to improve growth monitoring at the local level. One key question of concern is how mothers know when their children are growing or not growing well. A wide range of physical changes both for periods of good and poor growth were mentioned. Children growing well cry and move normally. When growth is poor the abdomen becomes distended, bigger than normal, the hair turns brown or grayish, the face puffy or pale, the fontanel sunken or large. Size was emphasized, with clothing often mentioned as a useful indicator: "In poor growth, 'dresses become loose around the body and clothes bought for a young child are still a good fit many months later (Brownlee, 1990). It is customary in central Ghana, as in many other cultures, to make strings or beads for a newborn and put them around the waist, wrist and legs. They are intended as decoration but used by many parents to assess growth. Other items mentioned included metal bracelets, necklaces and finger rings (Brownlee, 1990).

1.3 Weight-For-Age of Children

To obtain weight-for-age, the weight of the child (in kilograms) 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 per cent of the reference weight-for-age is considered to be severely malnourished. For these reasons, countries have different ways of assessing the growth of children through weight taking and at different places. For instant, in Indonesia 2.5 million infants and young children are being weighed regularly at the traditional monthly meetings of village women. The results are entered on growth charts kept by the mothers themselves. In Thailand, a programme based on the home use of growth charts by parents in several villages, helped to eliminate completely third degree malnutrition, and reduced second degree malnutrition by 44 per cent during 1981 – 1982, even though no additional food was provided. In Colombia, improvements in weight gain for a majority of children suffering from mild, moderate and severe malnutrition have been achieved in poor communities by nutrition programmes incorporating the "Carnet de Salud" or health card kept at home by mothers. In Jamaica, a systematic programme to improve the health and growth of over 6,000 young children using growth charts, immunization and nutrition education, and milk supplements, has resulted in a 40% decline in the prevalence of malnutrition and a 60 percent fall in infant mortality (UNICEF, 1998).

1.4 Interventions to Improve Weight Gain of Infants and Children

In 2000, the Center for Diseases Control (CDC) and Prevention established the International Micronutrient Malnutrition Prevention and Control Program (IMMPaCt) to support the global effort to eliminate vitamin and mineral deficiencies, or hidden hunger in both developed and developing nations. Through the IMMPaCt program, CDC provides funding and/or technical assistance directly to countries through cooperative and interagency agreements with UNICEF, the

World Health Organization (WHO), the U.S. Agency of International Development (USAID), the Global Alliance for Improved Nutrition (GAIN), and the Micronutrient Initiative (MI). With these partners, CDC has assisted countries in assessing the burden of hidden hunger through national surveys and surveillance systems that allow countries to monitor the coverage and impact of their food fortification and micronutrient supplementation programs. In addition, computer and web-based training tools and regional and national training workshops developed by CDC have strengthened the capacity of countries to assess the burden of poor weight gain through malnutrition, track the effectiveness of intervention strategies through surveillance systems, and plan social marketing and health communication strategies to promote the consumption of vitamin- and mineral-fortified foods (CDC, 2007).

To help improve nutrition worldwide, the CDC IMMPaCt Program helped launch the Flour Fortification Initiative (FFI) in 2002. The Initiative was formalized in 2005. FFI supports fortification of flour with essential vitamins and minerals, especially folic acid and iron, as one important way to help improve the nutritional status of populations, especially women and children, around the world (CDC, 2007).

In many Asian and African countries commercially produced infant foods are either not commonly used or readily accessible through markets in remote areas. Through the IMMPaCt program, CDC is actively planning pilot interventions in Kenya and Tajikistan to assess the feasibility of alternative approaches to sustainable distribution, through small local markets and house-to-house sales, of easy-to-use, "in-home" fortificants to enrich baby foods. These efforts will require public-private-civic sector partnerships to be nurtured and strengthened over time (CDC, 2007).

1.5 Statement of the Problem

Weight gain is one of the observable signs of growth especially at the early stages of life. Regular assessment of weight gain among babies has been a way of assessing their health status and growth. Too much of it leads to child obesity while too little is a sign of ill-health. Ghana is more concerned about the health and growth of her children and consequently instituted a monitoring mechanism for babies (both prenatal and postnatal) up to the age of sixty months. This mechanism involves monthly assessment of weight right after birth and compulsory immunization against some diseases (six childhood killer diseases) such as Tuberculosis, Poliomyelitis, Diphtheria, Yellow fever etc at every public or private health center. These weight records are accessible at the various health centers.

Weight change, especially among individual children, could be biological (variation related to genes), due to socio-economic status of the mother or due to child's nutritional status. Children who show poor weight gain could be a sign of malnutrition. Appropriate feeding practices are of fundamental importance for the growth, survival, development, health and nutrition of infants and children (GSS and MI, 2004).

One way of measuring a healthy baby is to look at the weight gain. If the baby gains enough weight during its first year then everything is fine. This study is intended to compare the growth of babies under four forms of feeding practices namely; exclusive breastfeeding, breastfeeding with water, breastfeeding with complimentary foods and feeding without breast milk. This would be done by comparing their weights for the first nine months of their life.

The need to let parents feed their babies under a particular feeding type and to participate in the monthly weighing exercise is of great concern. It is in the light of this that the study seeks to examine the relationship between infant feeding practice and weight gains to enable parents appreciate the feeding practice that is beneficial and results in good health of their babies.

1.6 Research Questions

Some concerns which this study is attempting to address are

(i) Is the monthly increase in weight influenced by the birth weight of a baby?

(ii) Does the type of feeding practice influence the weight of a baby?

(iii) Which age period do we have highest weight gain?

1.7 The Objectives of the Study

The main objective is to find out the effect of different forms of feeding practices on weights of babies (growth of babies). To do this, the study seeks to:

i) Compare the weights of babies under four different forms of feeding practice namely, Exclusive breastfeeding, breastfeeding with water only, breastfeeding with any other food (water inclusive) and feeding without breast milk (non-breastfeeding) .

ii) Investigate how weights vary by months for the four modes of feeding practices.

iii) Find out what happens to the weights for the first three months after introduction of complimentary (other) foods in case of exclusive breastfeeding and breastfeeding with water only.

iv) Compare the weight gains for the age periods 1-3 months, 4-6 months and 7-9 months.

1.8 The Significance of the Study

A baby must have proper nutrition to grow and thrive. According to the Ghana Health Service (GSS and MI, 2004), the most cost effective way to address the pressing public health challenge of malnutrition is to prevent it. That means ensuring that all of the children who are normal weight at birth continue within the normal range, and those who are low birth weight at birth are brought swiftly into a healthy growth range. If the baby weighs too little, it is important to ensure that the nutrition it needs to grow is given.

Many researchers including Ghanaian researchers have shown that food insecurity is not the most important factor that contributes to a high prevalence of under nutrition. Instead, inappropriate feeding and caring practices of children and mothers, poor environment (e.g. poor sanitation and hygiene), and limited utilization of basic health care services are among the most important determining factors (GSS and MI, 2004).

From economic point of view, poor weight gain causes ill-health of babies which is a potential source of drain to the Economy and their Parents' Income. Appropriate feeding method ensures the optimum weight gain for a baby.

This study will provide information that could encourage parents, especially lactating mothers, to use appropriate feeding method for their babies. This will help reduce instance of diseases associated with improper feeding practices and ultimately help reduce infant mortality.

1.9 The Scope of the Study

The retrospective study targeted all babies of not less than nine months from three centers in Mampong in the Ashanti Region of Ghana. The centers were Mampong Babies Home, Mampong Technical College of Education Primary School – New Darman, and Akyeremade - near Birth and Death Registry.

Mampong Babies Home, one of the oldest Homes in Ghana, served as a referral centre for babies who lose their mothers at birth, for seven districts. The Home is a potential source of data for NBF babies which is very scarce, hence the choice of the study area.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

Parents are primarily responsible for their baby's health. It is extremely important for them to understand the unique nutritional requirement and feeding practices of infants. A lot of studies have been carried out concerning nutritional requirements and feeding practices of infants. This chapter presents the review of the relevant literature.

2.1 Feeding Practices of Infants

The two main orthodox ways of feeding infants are Breastfeeding and Non-breastfeeding. Breastfeeding has been the basic norm for humans from the genesis of creation. It is practiced in three main ways. It can be done exclusively or with water only or with water and other foods. The third form, breastfeeding with water and other foods may be due to a baby being considered at risk for malnutrition, lactation insufficiency, decision or preference of parents. Non-breastfeeding is artificial to the human race. It takes place in most cases when breastfeeding is medically not advisable such as health of mother, the baby being unable to breastfeed, absence of mother and other factors such as personal preferences, beliefs and experiences. Non-breastfeeding and breastfeeding with water and other foods are considered automatic, for example bottle-feeding, and have the benefit of allowing freedom to leave the baby with others (Wambach and Koehn, 2004).

2.1.1 Breastfeeding

Breastfeeding was the rule in ancient times up to recent human history and babies were carried with the mothers and fed as required. With the 18th and 19th century industrialization in the Western world, mothers in many urban centers began dispensing with breastfeeding due to work requirement in urban Europe. Breastfeeding declined significantly from 1900 to 1960, due to improved sanitation, nutritional technologies, and increasingly negative social attitude towards the practice (Riordan and Countryman, 1980). By the 1960s the predominant attitude to breastfeeding was that it was something practiced by the uneducated and those lacking temperament of lower classes. However, since the middle 1960s, there has been a steady resurgence in the practice of breastfeeding in Canada and the US, especially among more educated affluent women (Nathoo and Ostry, 2009).

The World Health Organisation (WHO) and the American Academy of Pediatrics (AAP) emphasize the value of breastfeeding for mothers as well as children. Both recommend exclusive breastfeeding for the first six months of life. The AAP recommends that this be followed by supplemented breastfeeding for at least one year, while the WHO recommends that supplemented breastfeeding continues for two years or more. While recognizing the superiority of breastfeeding , regulating authorities also work to minimize the risk of artificial feeding (Nathoo and Ostry, 2009). Scientific researches such as the studies summarized in a 2007 review for the US Agency for Healthcare Research and Quality, AHRQ, (Ip *et al*., 2007) and a

2007 review for the WHO (Horta *et al*., 2007) have found numerous benefits of breastfeeding for the infant. According to AAP, research shows that breastfeeding provides advantages with regard to general health, growth and development. Not breastfeeding significantly increases risks for a large number of acute and chronic diseases including lower respiratory infection, ear infections, bacteremia, bacterial meningitis, botulism, urinary tract infections, and necrotizing enterocolitis (Lucas and Cole, 1990).

Under modern health care, human breast milk is considered the healthiest form of milk for babies (Picciano, 2001). Breastfeeding promotes health for both mother and infant and helps to prevent diseases (Riordan, 1997). Longer breastfeeding has also been associated with better mental health through childhood and into adolescence (Ody and Kendal, 2010). Exclusive breastfeeding for the first six months of life has the single largest impact on child survival (UNICEF, 2008). Supplementing breast milk before six months is unnecessary and is strongly discouraged because of the likelihood of contamination, the unaffordability of breast milk substitutes, and the resulting increased risk of diarrheal diseases. The early introduction of liquids and solids reduces milk output because the production and release of milk is influenced by the frequency and intensity of sucking (GSS and MI, 2004).

Despite the recommendations that babies be exclusively breastfed for the first 6 months, less than 40% of infants below this age are exclusively breastfed worldwide. The overwhelming majority of American babies are not exclusively breastfed for this period. In 2005, under 12% of babies were breastfed exclusively for the first 6 months, with 60% of babies of 2 months of age being fed formula and approximately one in four breastfed infants having infant formula feeding within two days of birth (WHO, 2006).

Despite the high breastfeeding prevalence (97%) in Ghana, the majority of infants are not fed in compliance with WHO / UNICEF recommendations (World Health Assembly, 2001). The recommendations call for a period of exclusive breastfeeding for six months and the introduction of complementary foods after the age of six months. Fifty-three percent (53%) of children under six months of age are exclusively breastfed in Ghana as at 2003 (GSS and MI, 2004). This is a slight increase over the proportion reported in the 1998 GDHS (GSS and MI, 1999). Exclusive breastfeeding drops sharply from 65% at age 2 – 3 months to 39% at age 4 – 5 months. Further, 6% of children aged 2 – 3 months and 32% of children aged 4 – 5 months are receiving complementary foods in addition to breast milk. This indicates that there are many infants who are at risk of being exposed to bacterial contamination and poor quality foods, even if they started out well with early initiation of breastfeeding (GSS and MI, 2004).

2.1.2 Artificial Feeding

Artificial Feeding involves not breastfeeding and supplementing breastfeeding with other foods. Experts agree that breastfeeding is beneficial and have concerns about the effects of artificial formulas. Artificial feeding is associated with more deaths from diarrhea in infants in both developing and developed countries. There are few exceptions, such as when the mother is taking certain drugs or is infected with hum T – lymphotropic virus, or has active untreated tuberculosis. In developed countries, with access to infant formula and clean drinking water, maternal HIV infection is an absolute contraindication to breastfeeding (regardless of maternal HIV viral load or antiretroviral treatment) due to the risk for mother – to – child HIV transmission (Horton *et al*., 1996).

Infant formula is a manufactured food designed and marketed for feeding babies and infants under 12 months of age, usually prepared for bottle – feeding or cup – feeding from powder (mixed with water) or liquid (with or without additional water). The US Federal Food, Drug and Cosmetic Act (FFDCA) defines infant formula as a food which purports to be or is represented for special dietary use solely as a food for infants by reason of its simulation of human milk or its suitability as a complete or partial substitute for human milk (Wells, 1996).

A 2001 WHO report found that infant formula prepared in accordance with applicable Codex Alimentarius Standards was a safe complementary food and a suitable breast milk substitute. In 2003, the WHO and UNICEF published their Global Strategy for infant and young child feeding which restated that processed – food products for infants and young children should when sold or otherwise distributed, meet applicable standards recommended by the Codex Alimentarius Commission, and also warned that "lack of breastfeeding – and especially lack of exclusive breastfeeding during the first half – year of life – are important risk factors for infant and childhood morbidity and mortality". In particular, the use of infant formula in under developed countries is linked to poorer health outcomes because of the prevalence of unsanitary preparation conditions, including lack of clean water and lack of sanitizing equipment (WHO, 2003). UNICEF (2008) estimates that a formula – fed child living in unhygienic conditions is between 6 and 25 times more likely to die of diarrhea and four times more likely to die of pneumonia than a breastfed child.

Throughout history, mothers who could not breastfeed their babies either employed a wet nurse or less frequently, prepared food for their babies, a process known as "dry nursing" (Schuman, 2003). As early as 1846, scientists and nutritionists noted that an increase in medical problems and infant mortality was associated with dry nursing. Improvement of quality of manufactured baby foods gave birth to Raw milk formulas (mixture of cow milk, water, cream, and sugar or honey in specific ratios) to achieve the nutritional balance believed to approximate human milk reformulated in such a way as to accommodate the believed digestive capability of the infant (Fomon, 2001).

In the 1920s and 1930s, evaporated milk began to be widely commercially available at low prices, and several clinical studies suggested that babies fed with evaporated milk formula thrive as well as breastfed babies. Then came commercial formulas followed by generic brand formulas and later follow – on toddler formulas (Fomon, 2001).

Leading health organizations (e.g. WHO, US CDC and Department of Health and Human Services) are attempting to reduce the use of infant formula and increase the prevalence of breastfeeding from birth through 12 to 24 months of age through public health awareness campaigns (CDC, 2007). The specific goals and approaches of these breastfeeding promotion programs, and the policy environment surrounding their implementation, vary by country. As a policy basic framework, the International Code of Marketing of Breast-Milk Substitutes, adopted by the WHO's World Health Assembly in 1981, requires infant formula companies to preface their product information with statements that breastfeeding is the best way of feeding babies and that a substitute should only be used after consultation with health professionals (WHO, 1981).

2.2 Nutritional Status and Prevalence of Underweight Children in Africa

On nutritional status of children in Ghana, according to the 2003 GDHS, 30% of children under five are stunted and 11% severely stunted. Weight – for – age results show that 22% of children under five are underweight, with 5% severely underweight (GSS and MI, 2004).

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 in India. Under-five-years children and their mothers in selected four anganwari areas of urban Allahabad (UP) 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% were underweight (< 2SD weight-for -age), 51.6% stunted (< 2SD height- for- age), and 10.6% wasted (< 2SD weight- for- height). The proportions of underweight (45.5%) and stunted (81.8%) children were found to be highest among children aged 13-24 months. Wasting was most prevalent (18.2%) among children aged 37-48 months. Initiations of breast-feeding after six hours of birth, deprivation from colostrums and improper complementary feeding were found to be significant ($P < 0.05$) risk factors for underweight. Wasting was not significantly associated ($P > 0.10$) with any infant feeding practice studied. ICDS benefits received by children failed to improve the nutritional status. They concluded that delayed initiation of breast-feeding, deprivation from colostrums, and improper weaning are significant risk factors for under nutrition among under-fives.

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 determined 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. They conducted their analysis base on 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.

The analysis of anthropometric data on the prevalence of underweight children (under five) over the period from December 2000 to September 2005 showed that this form of malnutrition continues to be a challenge (with rates > 20%) in the study zone. It reached its peak in June with an average rate varying from 43% to 44% of weighed children. The rate of severely malnourished children (Weight/Age < -3 SD) follows the same trends as that of the rate of global malnutrition. It is largely influenced by the food availability or access at the household level (as shown in fig 2.1). The minimum rate of severe malnutrition is observed in September. The maximum recorded rate is 11% in June 2005. That means that in June 2005, 11 children out of 100 in the project zone should have been referred to hospitals as emergency cases due to severe malnutrition.

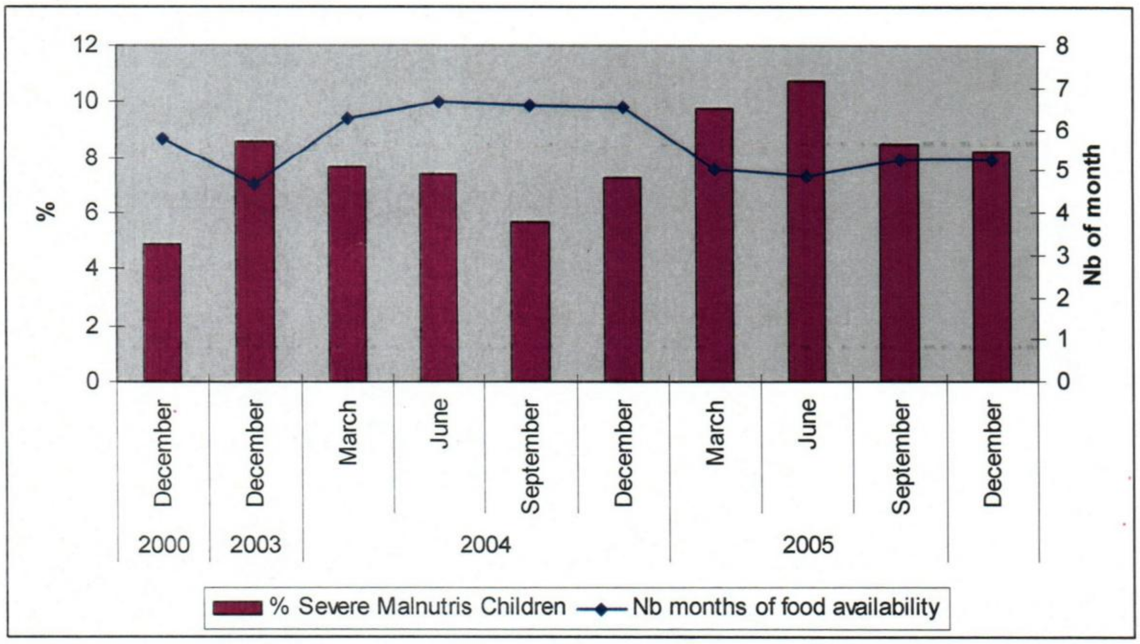

Figure 2.1: Evolution Child Malnutrition and Food Availability

The rate of underweight children under-five is more important among the sedentary population than the pastoralists. The average rate of global (severe + moderate) underweight children under-five in the pastoral zone is 37.5% (CV = 38%) against 36%, 40 %(CV = 26%) and 41% (CV = 37%) for the children under-five in the zones of river, Irrigated Village Perimeters (IVP), and of the Lakes respectively. However the average rate of severely underweight children is higher among the children of pastoralists (8.84%) than those of sedentary IVP cereal producers (7.60%), and flooded rice growers (6.50%). The rate of severely underweight children in the livestock zone remains lower than the rate of malnourished children living in the villages located around the lakes (9.91%).

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 breast-fed 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 showed 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 the breastfed children when compared with the weaned children.

2.3 Factors Affecting the Prevalence of Malnutrition

Salah (2006) noted that malnutrition affects growth, morbidity, mortality, cognitive development, reproduction, and physical work capacity, and it consequently impacts on human performance, health and survival. It is an underlying factor in many diseases for both children and adults, and is particularly prevalent in developing countries, where it affects one out of every 3 preschool-age children. Factors that contribute to malnutrition are many and varied. Their study evaluated the level of malnutrition and the impact of some socio-economic and demographic factors of households on the nutritional status of children less than 3 years of age in Botswana. Factors studied included; the number of children under 3 years of age in the family, occupation of the parents, marital status, family income, parental education, maternal nutritional knowledge, residence location (urban or rural), gender, and breastfeeding practices. The study was a cross-sectional descriptive survey using a structured questionnaire and measurements of weight and height. Four hundred households and mothers of children under three, representing the 23 Health Regions of Botswana participated in the study. Reference standards used were those of the National Center for Health Statistics (NCHS). The results show that the level of wasting, stunting, and underweight in children under three years of age was 5.5%, 38.7%, and 15.6% respectively. Malnutrition was significantly higher among boys than among girls. Underweight was less prevalent among children whose parents worked in the agricultural sector than among children whose parents were involved in informal business. Children brought up by single parents suffered from underweight to a significantly higher level than children living with both parents. The prevalence of underweight decreased significantly as family income increased. The higher the level of the mother's education, the lower the level of child underweight observed. Breastfeeding was found to reduce the occurrence of underweight among children.

Janet and Mabel (2011) used the 1992 Demographic Health Survey data of Malawi to assess the association between breast-feeding practices, socio-economic and morbidity variables, and the nutritional status of children under the age of five years using multilevel models. About 27% of under-five children in Malawi are underweight, and nearly 50% are stunted. The results of this study suggest that socio-economic factors, morbidity, and inappropriate feeding practices are some of the factors associated with malnutrition in Malawi.

Studies done worldwide by UNICEF indicate that Africa has the worst nutritional status with high levels of underweight, stunting and wasting countrywide (UDHS, 2000, 2001 and 1995). UNICEF also estimated that 40% of all deaths among children under five years of age were related to malnutrition, with high levels of underweight up to 12%. The general objective of their study was to assess the nutritional status of children under five years of age in Rweibaare Parish, Bushenyi District. A descriptive cross-sectional study using quantitative data collection methods were used to collect data from mothers or caretakers of 215 children under five years. The results revealed that the rate of malnutrition was high. Of the 215 children assessed, 32% of the children were stunted, 13%

underweight and 2.8% wasted. The factors contributing to this were likely to be related with socio-economic status of the mothers which included age of the mother, education level and main occupation. Lack of information about nutrition was also a contributing factor as evidenced by inadequate breastfeeding, with children that stopped breast feeding at four months and below having a high likelihood of malnutrition. UNICEF (1998) reported that the infant mortality rate was 97/1,000 live births and the under five mortality rate was 141/1,000 live births in Uganda. Thirty to forty percent of the children less than five years of age are malnourished, 38% in the same age group are stunted 5% wasted, and 61% of the population living below the poverty line, (UDHS, 1995). It was therefore concluded that, malnutrition was a significant problem in Rweibaale Parish, Bushenyi district.

According to Khaled (2009), approximately 27% of children under the age of 5 in developing countries are malnourished. His work focused on the childhood malnutrition in Egypt. The study examined the association between bio-demographic and socioeconomic determinants and the malnutrition problem in children less than 5 years of age using the 2003 Demographic and Health survey data for Egypt. In the first step, separate geoadditive Gaussian models with the continuous response variables stunting and underweight were used, and wasting as indicators of nutritional status in the case study. In a second step, based on the results of the first step, we apply the geoadditive Gaussian latent variable model for continuous indicators in which the 3 measurements of the malnutrition status of children are assumed as indicators for the latent variable "nutritional status".

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter reviews the statistical methods and tools used for the study and their underlying concepts and theories. The rational for adopting the methods and the procedures involved in the analyses would be determined. The methods employed are repeated measures analysis of variance and linear mixed model analysis of variance. These methods would be considered under longitudinal data analysis.

3.1 Sampling Procedure

An incidental sampling of all nursing mothers presented at the three Weighing Centers at the Mampong Municipality for scheduled clinic visits were invited to participate in the study. The qualitative strand of the data which involves the feeding practice of the babies was collected using a brief questionnaire, while other data on the weight of the children were collected from their weighing cards.

3.2 Sources and Collection of Data

Data were collected at three Weighing Centers at Mampong namely, Mampong Babies Home, Mampong Technical College of Education Primary School and Akyeremade (near Birth and Death Registry). These Centers have a monthly weighing programme for children of age one month after birth to sixty months (five years) after birth. Every month children within this age group are brought to the Weighing Centers for weighing. It is from this exercise that the data (birth weights and monthly weights of babies for the first nine months) was extracted while the form of feeding the baby was undergoing during that period was solicited from the mother. The child's weighing card was picked to record the weights and the mother supplied a kind of food the baby was given within the first six months after birth. Altogether, a sample of 109 babies was obtained from all the centers and used for the study.

3.3 Data Analyses

Exploratory data analyses were carried out. These were; a summary of the data, some descriptive statistics and graphs. At the inferential analysis stage, longitudinal data analysis (repeated measures analysis of variance) was used. Linear mixed models using PROC MIXED was employed as the explanatory variables involve fixed effects (feeding practice and gender) and random effects (the three centers). Computer software packages were used to aid the analyses of the data.

3.4 Longitudinal Data Analysis Concepts

The objectives of longitudinal data analysis are to examine and compare responses over time. The defining feature of a longitudinal data model is its ability to study changes over time within subjects and changes over time between groups. For example, longitudinal models can estimate individual-level (subject-specific) regression parameters and population-level regression parameters. To illustrate the ability of longitudinal models to study changes over time, consider cross-sectional studies in which a single outcome is measured for each subject. In the figure 3.1 below where each point represents one subject, blood pressure appears to be positively related to age. However, you can reach no conclusions regarding blood pressure changes over time within subjects (Patetta, 2002).

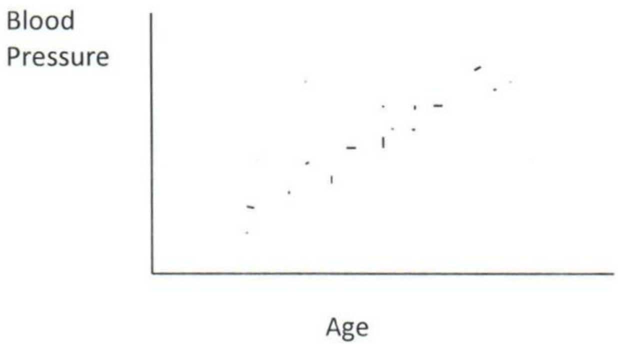

Figure 3.1 Cross-Sectional Analysis

Now expand the cross-sectional study of baseline data to a longitudinal study with repeated measurements over time. The baseline data still shows a positive relationship between blood pressure and age. However, now you can distinguish changes over time within subjects from differences among subjects at their baseline or initial starting values (figure 3.2). Cross-sectional models cannot make this distinction (Diggle *et al*., 1994).

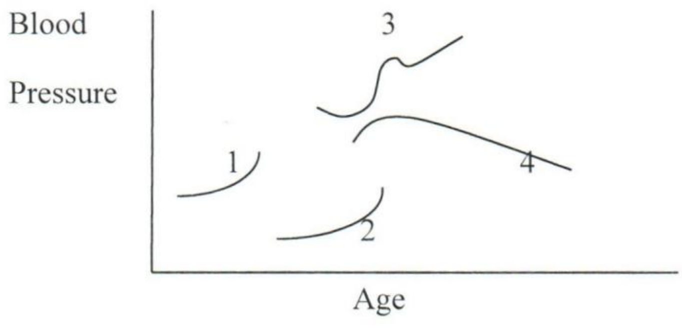

Figure 3.2 Longitudinal analysis

To study the effect of feeding practices on the weight of babies, a longitudinal study where weights of babies are taken every month for nine months is deemed appropriate.

3.4.1 Notation

Let Y_{it} be the response for the i^{th} subject ($i = 1, 2, \ldots, N$) at the t^{th} occasion where $(t = 1, 2, \ldots, n_i)$. The total number of subjects is equal to $\sum_{i}^{N} n_i$, $y_i = n_i \times 1$ is the vector of responses, and $X_i = p \times 1$ is the covariate vector for subject i at time t. The matrix of covariates is $X_i = n_i \times p$ for subject i and will usually include an intercept. For example in a 9 repeated measures data with 4 factors as in this study, if $i = subject$, $t = 1, \ldots 9$ (number of repeated measures), $y_i = 9 \times 1$, $x_{it} = 4 \times 1$ and $X_i = 9 \times 4$. If the fixed effects are feeding practice and gender because they do not change throughout the duration of the study and the within individual effects are time and body weight, the data set will be balanced with time. This meaning that all subjects will be measured at a common set of occasions and there will be no missing data.

3.4.2 Advantages and Disadvantages

There are several advantages and disadvantages to using longitudinal studies.

Some of the advantages are: subjects serving as their own controls which mean the direct study of change can be measured; fewer subjects are required because the measurements are being repeated, between-subject variation is excluded from the error, and longitudinal data can separate aging effects from cohort effects. Some of the disadvantages are: the dependence of the measurements which must be accounted for in the analysis, models are not as well developed; the risk of attrition, carry-over effects, and the improvement or the decline could be caused by treatment or fatigue.

3.4.3 Effect on Time-Independent Predictor Variables

If the observations are positively correlated, which often occurs with longitudinal data, then the variances of the time-independent predictor variables (variables that estimate the group effect (or between-subject effect) such as **gender**, **race**, **treatment**, and so on) are underestimated if the data is analyzed as though the observations are independent. In other words, the Type I error rate is inflated for these variables (Dunlop, 1994).

3.4.4 Effect on Time-Dependent Predictor Variables

For time-dependent predictor variables (variables that measure the time effect (or within-subject effect) such as how the measurements change over time), ignoring positive correlation leads to a variance estimate that is too large. In other words, the Type II error rate is inflated for these variables (Dunlop, 1994).

In view of the fact that the variances of the group effects will be underestimated and the variance of the time effects will be overestimated if positive correlation is ignored, it is evident that correlated outcomes must be addressed to obtain valid analyses. This is among the reasons for employing longitudinal data analysis for this study.

3.4.5 Univariate ANOVA using PROC GLM

Univariate ANOVA for repeated measures data, also called split-plot in time ANOVA, has a data structure where the number of observations equals the number of measurements taken on all subjects. The assumptions are that the measurements have equal variances at all time points and that the correlation between measurements on the same subject is the same regardless of the time lag between measurements. If these assumptions are valid, then univariate ANOVA for repeated measures data is an optimal method of analysis (Littell *et al.*, 1998). However, these assumptions are frequently unrealistic with longitudinal data. Measurements close in time are often more highly correlated than measures far apart in time (which is true about our current study). Therefore, the inferences from univariate ANOVA for repeated measures data may not be valid.

3.4.6 Multivariate ANOVA using PROC GLM

Multivariate ANOVA has a data structure where the rows are subjects and the columns are time points in the study. For example, if there were five time points in the study, then there would be five response variables. For balanced longitudinal data where all subjects have the same number of repeated measurements taken at time points that are the same for all subjects, multivariate ANOVA has some useful features. However, for observational longitudinal studies, this data structure has major limitations. First, it is unreasonable to assume that observational data will be balanced. Second, because PROC GLM uses complete case analysis, if a subject has one missing measurement, then PROC GLM deletes the entire subject (Patetta, 2002).

Multivariate ANOVA uses a covariance structure that assumes that the correlation between every pair of measurements within a subject is unique. For example, if there were five time points, then there would be 15 (((1+5)*5)/2) unique parameters that are estimated. For observational data with many time points, a simpler covariance structure would probably be sufficient to characterize the data. This is a limitation for multivariate ANOVA because if the covariance structure (and thus your model) is more complex than the within-subject correlation structure, then you sacrifice power and efficiency in your statistical tests. In other words, if a simpler covariance structure can be used to model the within-subject correlations, then the inferences in the longitudinal study can be severely compromised if multivariate ANOVA is used (Littell *et al*., 2002).

3.4.7 Linear Mixed Model using PROC MIXED

The linear mixed model allows a very flexible approach to modeling longitudinal data. The data structure is similar to univariate ANOVA where the number of observations equals the number of measurements for all the subjects. This means the data does not have to be balanced. An advantage of fitting linear mixed models is that PROC MIXED uses all the available data in the analysis. PROC MIXED offers a wide variety of covariance structures. This enables the user to directly address the within-subject correlation structure and incorporate it into a statistical model. By selecting a parsimonious covariance model that adequately accounts for within-subject correlations, the user can avoid the problems associated with univariate and multivariate ANOVA using PROC GLM (Littell *et al*., 2002). We therefore employed the linear mixed model using PROC MIXED.

3.5 Model.-Building strategies in Longitudinal Data Analysis

The first step in any model building process is to conduct a thorough exploratory data analysis. For longitudinal data this involves plotting the individual measurements over time and fitting a smoothing spline over time. Plotting different groups over time and illustrating cross-sectional and longitudinal relationships are also important steps in exploratory data analysis.

The second step is to fit a complex mean model in PROC MIXED and output the ordinary least squares residuals. These residuals can be used to create a sample variogram, and the pattern in the sample variogram can be helpful in selecting a covariance structure.

The third step is to fit the linear mixed model in PROC MIXED using the selected covariance structure (which is employed for this study). Eliminating unnecessary terms and fitting a parsimonious model are important steps in the model building process (Patetta, 2002).

3.5.1 General Linear Model

The General Linear Model (GLM) is written as

$$y = \mathbf{X}\boldsymbol{\beta} + \boldsymbol{\varepsilon} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.1)$$

Where y is the matrix of observed responses; X is the design matrix of predictor variables; β is the matrix of regression parameters; ε is the vector of random errors.

The GLM incorporates a number of different statistical models; ANOVA, ANCOVA, MANOVA, MANCOVA, ordinary linear regression, t-test and F-test. The general linear model is a generalization of multiple linear regression model to the case of more than one dependent variable. If y, β, and ε were column vectors, the matrix equation above would represent multiple linear regression.

3.5.2 General Linear Mixed Model

The general linear mixed model is an extension of the general linear model.

General Linear Mixed Model is written as

$$y = \mathbf{X}\boldsymbol{\beta} + \mathbf{Z}\boldsymbol{\gamma} + \boldsymbol{\varepsilon} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.2)$$

where **Z** is the design matrix of random variables; γ is the vector of random-effect parameters; and ε is no longer required to be independent and homogeneous.

The general linear mixed model extends the general linear model by the addition of random effect parameters and by allowing a more flexible specification of the covariance matrix of the random errors. For example, general linear mixed models allow for both correlated error terms and error terms with heterogeneous variances. The matrix **Z** can contain continuous or dummy predictor variables, just like the matrix **X**. The name mixed model indicates that the model contains both fixed-effect parameters and random-effect parameters (Patetta, 2002).

The general linear mixed model can easily be fitted to longitudinal data. The model assumes that the vector of repeated measurements on each subject follows a linear regression model where some of the regression parameters are population-specific (fixed-effects), but other parameters are subject-specific (random-effects). The subject-specific regression coefficients reflect how the response evolves over time for each subject (Verbeke and Molenberghs, 2000).

How the subject-specific regression coefficients relate to known covariates is reflected in the fixed-effect parameter estimates. These parameter estimates represent the population average. A model with the assumption that all variability in subject specific intercepts and slopes is attributed to the fixed-effect variables can be obtained by omitting the random-effect variables. Omitting only the random variables reflecting subject-specific slopes generates a random intercepts model (Patetta, 2002).

In the model proposed by Diggle *et al*., (1994), it is assumed that the error terms have a constant variance and can be decomposed as

$$\varepsilon_i = \varepsilon_{(1)i} + \varepsilon_{(2)i} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.3)$$

where $\varepsilon_{(1)i}$ is the measurement error reflecting the variation added by the measurement process $\varepsilon_{(2)i}$ is the error associated with the serial correlation in which times closer together are more correlated than times further apart and *i* denote the subject. If we assumed that the measurement errors have an independent covariance structure (σ^2I), then our only concern would be the covariance structures that reflect the serial correlation.

3.5.3 Model Assumptions in PROC MIXED

i. Random effects and error terms are normally distributed with means of 0.

ii. Random effects and error terms are independent of each other.

iii. The relationship between the response variable and predictor variables is linear

iv. Variance-covariance matrices for random effects and error terms exhibit structures available in PROC MIXED.

Even with these assumptions, the general linear mixed model is an extremely flexible model. By appropriately defining the model matrices for fixed and random effects, and the covariance structures for the random effects and the error terms, one can perform numerous mixed model analyses.

3.5.4 Linear Mixed Models for Longitudinal Data

$$y = \mathbf{X\beta} + \mathbf{Z\gamma} + \varepsilon \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.4)$$

where γ represents parameters that are allowed to vary over subjects and subject-specific regression coefficients that reflect the natural heterogeneity in the population. **β** represents parameters that are assumed to be the same for all subjects and factors that affect subject-specific regression coefficients; ε represents within-subject variation and has a covariance matrix that is block diagonal with each block corresponding to a subject.

3.6 Selecting the appropriate Covariance Structure

When finding reasonable estimates for covariance structure of the random errors (denoted by **R**), if we choose a structure that is too simple, we risk increasing the Type I error rate; if we choose a too complex structure, we sacrifice power and efficiency. The validity of the statistical inference of the general linear mixed model depends upon the covariance structure we select for **R**.

After a candidate mean model is selected, the information criteria (such as the AIC and BIC) produced by PROC MIXED is used as a tool to help in selecting the most appropriate covariance structure. The smaller the information criteria value, the better the model. This criterion was considered and used in this study.

CHAPTER FOUR

DATA ANALYSIS AND RESULTS

4.0 Introduction

This chapter examines the data collected, the detailed analysis of the data and the presentation of results. Appendix A is a table presenting the data used for the analysis. It contains data on one hundred and nine (109) babies of age nine months old. The data was a primary data from three weighing centers in the Mampong municipality.

4.1 Exploratory Data Analysis

4.1.1 Descriptive Statistics

The birth weight of each of the babies was recorded as the initial weight and their monthly weights were recorded as response variable for the nine months. The sex and feeding practice of the babies (fixed effects) were also recorded as the independent or explanatory variables.

For the random sample of 109 babies obtained for the study, 52 representing 47.71% were females while 57 representing 52.29% were males. Thirty two (32) of the babies, representing 29.36%, were under exclusive breastfeeding, 30 representing 27.52% were under breastfeeding with water only, 26 representing 23.85% were under breastfeeding with water and any other food while 21 representing 19.27% were feeding without breast milk.

Statistics on sex and feeding practice indicates that, for the females, 16 were under exclusive breastfeeding, 16 were under breastfeeding with water only, 13 were under breastfeeding with water and any other food and 7 were under feeding without breast milk. For the males, 16 were under exclusive breastfeeding, 14 were under breastfeeding with water only, 13 were under breastfeeding with water and any other food and 14 were under feeding without breast milk.

4.1.2 Mean Weight of Babies under each feeding practice

A composite line graph for the four modes of feeding practices for the babies using mean weights of the babies is plotted in figure 4.1. From the graph it is observed that weights increase by months for all modes of feeding.

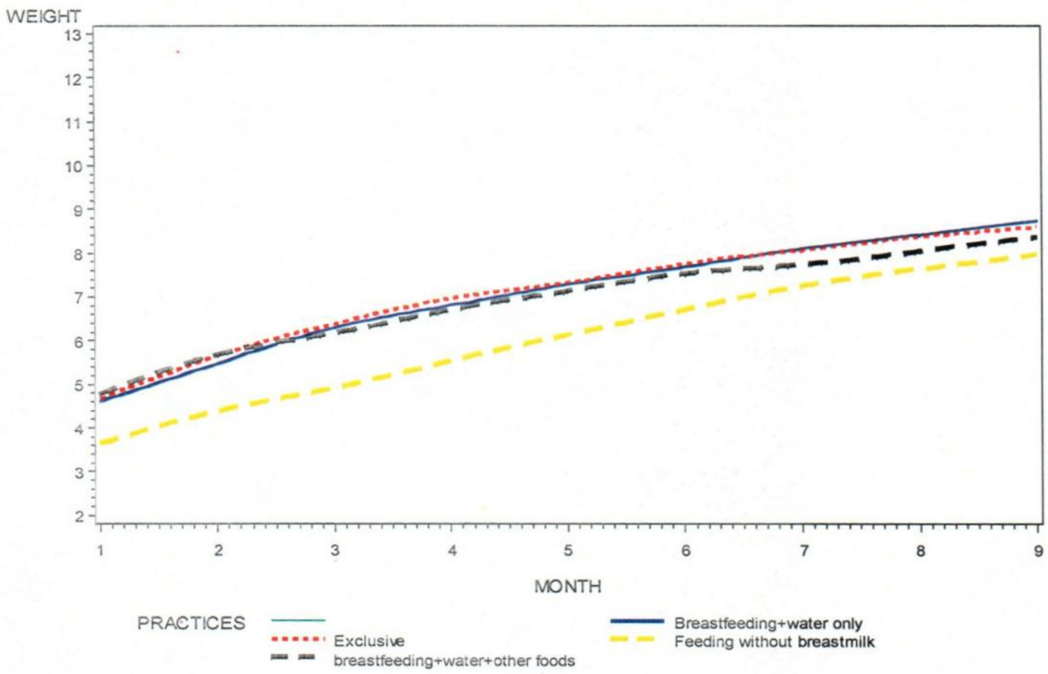

Fig 4.1 Mean weights of Babies by modes of feeding

Weights of exclusive breastfeeding are higher after one month and remain consistently higher than others up to about the seventh month. Feeding without breast milk is the lowest for the whole study period. Breastfeeding with water only is the second highest after the exclusive breastfeeding followed by breastfeeding with any other food throughout the period.

4.1.3 Weight Gain

The mean birth weight for all the 109 babies was 3.068kg. The mean weight gain for the first three months is 2.98kg (6.045-3.068), fourth to sixth month is 1.45kg (7.495-6.045) and for seventh to ninth month is 0.99kg (8.488-7.495). This suggests that the weight gain is higher in the first three months of life.

For various groups of feeding practices the mean birth weights were 3.097kg for EBF, 2.983kg for BFW, 3.162kg for BFWO and 2.981kg for NBF. Appendix C presents the summary statistics (mean, maximum and minimum) for the feeding practices The mean weight gains were respectively 3.31kg (6.409-3.097), 3.34kg (6.323-2.988), 3.02kg (6.177-3.162) and 1.95kg (4.929-2.981) for EBF, BFW, BFWO and NBF for the first three months. The mean weight gains for the next three months, from the 4th to the 6th months, were respectively, as in the same order, 1.35kg (7.763-6.409), 1.38kg (7.7-6.323), 1.38kg (7.554-6.177) and 1.80kg (6.724-4.929).

After the introduction of complimentary foods in the case of EBF and BFW, the mean weight gains were 0.84kg (8.603-7.763) for EBF, 1.06kg (8.760-7.7) for BFW, 0.85kg (8.408-7.554) for BFWO, and 1.3kg (8.024-6.724) for NBF. The result is the reverse order of the mean weight gain by various feeding practices as compared to the first three months. This information suggests that after the introduction of complimentary foods, the EBF babies weight gains slow down as compared to the other forms of feeding practices. For the first six months, EBF babies gained 4.7kg (7.763-3.097), BFW gained 4.7kg (7.7-2.983), BFWO gained 4.4kg (7.554-3.162) and NBF babies gained 3.7kg (6.724-2.98).

A plot of weight by time with respect to gender indicates that males in general have higher rate of weight gain than females. This is especially so for babies of age one to nine months. Figure 4.2 indicates this result. The plot shows the graph of males being consistently higher than that of females, suggesting that males are generally heavier than females at the infant stage of life.

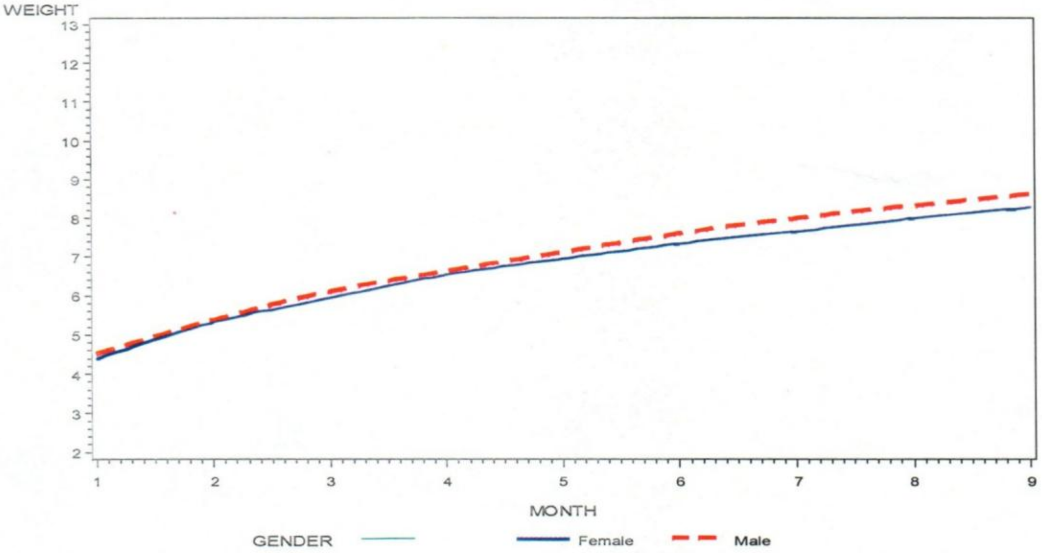

Figure 4.2 Plot of Weight by Month with respect to Gender.

4.2 Inferential Statistics

Taken cognizance of the seeming disparities in the weights of the babies, this section delves into what accounts for the phenomenon and to clarify any perception. The tests were done with the level of significance of 5% (CI = 95%).

The results from the various analyses performed were obtained using the Minitab, SAS and SPSS software.

4.2.1 Covariance Structures

Table 4.1 represents covariance structures investigated in selecting an appropriate covariance structure of the random errors.

Table 4.1 Covariance Structures Investigated

COVARIANCE STRUCTURE	AIC	AICC	BIC
COMPOUND SYMMETRY	2062.8	2062.8	2068.2
UNSTRUCTURED	1271.3	1275.7	1392.4
FIRST ORDER AUTOREGRESSIVE	1407.4	1401.4	1406.7
FIRST ORDER ANTE-DEPENDENCE	**1257.6**	**1258.2**	**1303.3**
HETEROGENEOUS FIRST ORDER AUTOREGRESSIVE	1350.0	1353.2	1379.7
HETEROGENEOUS COMPOUND SYMMETRY	1963.8	1964.1	1990.7
HETEROGENEOUS TOEPLITZ	1333.7	1334.3	1379.4
FIRST ORDER AUTOREGRESSIVE MOVING AVERAGE	1394.8	1394.9	1402.9
HUYNH-FELDT	1974.5	1974.7	2001.4
TOEPLITZ	1373.5	1373.7	1397.7
VARIANCE COMPONENT	2876.3	2876.3	2879.0

From the table the smallest value is 1257.6 which is in the row of the First Order Ante-Dependence corresponding to the AIC column. Thus the best covariance structure to be used is the First Order Ante-Dependence.

4.2.2 Longitudinal Model with Ante-dependence Covariance Structure (Mixed Procedure)

4.2.2.1 Model Information

The Model Information table, Table 4.2, shows the name of the data set, the dependent variable, the covariance structure used in the model, the subject effect, the estimation method to compute the parameters for the covariance structures (the default estimation method is REML), the residual variance method, the fixed effects standard error method and the method to compute the degrees of freedom.

Table 4.2 Model information

Data Set	WORK._AM
Dependent Variable	WEIGHT
Covariance Structure	Ante-dependence
Subject Effect	RESPONDENTS
Estimation Method	REML
Residual Variance Method	None
Fixed Effects SE Method	Model-Based
Degrees of Freedom Method	Satterthwaite

4.2.2.2 Fit Statistics

The Fit Statistics table provides information to be used to select the most appropriate covariance structure. Akaike's Information Criterion (AIC) penalizes -2 residual log likelihood by twice the number of covariance parameters in the model. The smaller the value, the better the model. The finite-sample version of the AIC (AICC) is also included. The Schwarz's Bayesian Information Criterion (BIC) also penalizes the -2 residual log likelihood. In The Fit Statistics table below (Table 4.3) AIC is the best option.

Table 4.3 Fit Statistics

-2 Res Log Likelihood	1224.5
AIC (smaller is better)	1258.5
AICC (smaller is better)	1259.2
BIC (smaller is better)	1304.3

4.2.2.3 Null Model Likelihood Ratio Test

The Null Model Likelihood Ratio Test shows a test that determines whether it is necessary to model the covariance structure of the data at all. The test statistic is -2 times the log likelihood from the null model (model with an independent covariance structure) minus -2 times the log likelihood from the fitted model. The p-value is used to assess the significance of the model fit. Therefore for the p-value of 0.0001, the model is considered significant at 5% level of significant. This is shown in table 4.4.

Table 4.4 Null Model Likelihood Ratio Test

DF	Chi-Square	Pr > ChiSq
16	1643.51	< 0.0001

4.2.2.4 Solution for Fixed Effects

Table 4.5 contains the solution for Fixed Effects. It contains the estimates, standard errors, the degrees of freedom, the t-value and the p-values for each of the fixed effects listed in column one. From the table, the initial weight (birth weight), monthly weight gains, and the gender are shown to be significant. This is so as the p-value for each of the effects mentioned is 0.0001. Feeding without breast milk has p-value 0.03 which shows that the practice is significant using Breastfeeding with other foods as the base. Exclusive breastfeeding and Breastfeeding with water only are found not to be significantly different from Breastfeeding with other foods. The interaction effects are excluded from the table (Table 4.7) as none of them is significant at 5% level indicated by the output of mixed procedure for the Solution for Fixed Effects produced and shown in Appendix C.

Table 4.7 Solution for Fixed Effects

Effect	Gender	Pract.	Estimate	S.E	df	t-value	Pr > |t|
Intercept			1.90	0.40	105	4.91	< 0.00
Birth weight			0.79	0.12	105	6.65	< 0.00
Month			0.43	0.01	157	34.26	< 0.00
Gender	female		-0.21	0.23	105	-0.95	0.03
Gender	male			0		.	.
Pract.		BFW	-0.09	0.21	105	-0.41	0.68
Pract.		EBF	0.01	0.21	105	0.06	0.53
Pract.		NBF	-1.00	0.16	108	-6.15	< 0.00
Pract.		BWFO		0	.	.	.

4.2.2.5 Type 3 Tests of Fixed Effects

The Type 3 Test of Fixed Effects table (Table 4.6) shows the hypothesis test for the significance of each of the fixed effects. A p-value is computed from an F distribution with the numerator and denominator degrees of freedom. The p-values are given as 0.0001 for each of the following fixed effects: Birth weight, monthly weight gain and Feeding Practices. The p-value for Gender is 0.0343. Thus these effects are considered significant under this test. However, the effect of the interaction between feeding practice and gender with p-value of 0.74 is not significant.

Table 4.6 Type 3 Test of Fixed Effects

Effect	Num df	Den df	F-Value	Pr > F
Birth weight	1	105	44.16	< 0.0001
Month	1	157	1173.44	< 0.0001
Gender	1	105	4.60	0.0343
Practices	3	105	15.02	< 0.0001
Prac.*Gender	3	105	0.42	0.7359

4.3 Discussions of the Results

4.3.0 Introduction

The essence of this research work is to come up with information on the four forms of feeding practices as to their effect on the growth and health of babies within the ages 1 to 9 months after birth. Weight gains by the babies, as a measure of growth, was studied over the period with respect to the type of feeding practice each baby was undergoing. The birth weights and sex of the babies were also considered to find out if they contribute to weight gains. At the exploratory stage of the analyses it was found out that there was generally an increasing trend of weights for all the babies. It was also noted that there were differences in weight gains for three monthly age periods considered. These findings were scrutinized for authentication by subjecting them to longitudinal data analysis using linear mixed model.

4.3.1 Effect of Feeding Practice on Weight of Babies

The descriptive statistics of the mean monthly weights of the babies suggested that those under exclusive breastfeeding had higher weights than the others for the first six months after birth (Appendix B). The babies under breastfeeding with water only and breastfeeding with water and any other food were second and third respectively in terms of higher weights. The non-breastfeeding babies had the lowest mean monthly weights throughout the study period. The weight gains for the first six months after birth supported the assertion that exclusive breastfeeding is the best form of feeding for babies. The weight gains were 4.7kg for exclusive breastfeeding and 4.7kg for breastfeeding with water only. Breastfeeding with water and any other food gained 4.4kg while non-breastfeeding gained 3.7kg.

In the further analysis stage, we used the linear mixed model which allows a very flexible approach to modeling longitudinal data. The model validated the graph of the mean monthly weights in the exploratory analysis stage and other assertions such as relationship between feeding practice and weight gain, and monthly weight gains. Thus, it confirmed that the type of feeding practice affect weight of babies. Considering the Test of fixed effects (Table 4.6), feeding practices were found to be highly significant.

4.3.2 Effect of Age on Weights Gains of Babies

Considering the mean monthly weight gain for the three age groups, the babies within ages 1-3 months had 2.98kg while those within 4-6 months and 7-9 months had 1.45kg and 0.99kg respectively. This suggested that the weight gain was higher in the first three months of life and decreased through the next age groups. For the four groups of feeding practices the weight gains were respectively 3.31kg, 3.34kg, 3.02kg and 1.95kg for EBF, BFW, BFWO and NBF for the first three months of life. The mean weight gains for the 4th, 5th, and the 6th months were 1.35kg for EBF, 1.38kg for BFW, 1.38kg for BFWO and 1.80kg for NBF. There was seemingly a drastic decrease in weight gain for babies under EBF from the 7th to the 9th month which was just after the introduction of complimentary foods to the babies although there was general decreasing trend of weight gain. The weight gains as in the same sequence were 0.84kg, 1.06kg, 0.85kg and 1.3kg. The older the baby the heavier the baby, as exposed by the increasing trend in weight by month plot.

4.3.3 Effect of Birth Weight on Weight of Babies

If we consider the tables for Solution for Fixed Effects (Table 4.5) and Type 3 Tests of Fixed Effects (Table 4.6), it is indicated that birth weight affect weight of babies as in both tests the birth weight is significant.

4.3.4 Effect of Gender on Weight of Babies

A Plot of weight by time with respect to gender indicated that males have higher weight gain than females (fig 4.2) as the graph for male was consistently higher.

In Table 4.5, the table of Solution for Fixed Effects, using male as the base, female was found to be significant at 5% α-level confirming that weight gains are different for males and females. Sex was again found to be influential in weight of babies under linear mixed model analysis as indicated in Table 4.6, table of Type 3 Test of Fixed Effects.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

From the analyses of the data the following conclusions can be drawn: The type of feeding practice of a baby affects the weight gain by the baby significantly and consequently the growth and health of the baby. It is therefore important for caretakers to be conscious of the type of feeding practice the babies are put under in order to have optimum weight.

The weight gain for Exclusive Breastfeeding babies is the highest for the first six months after birth. The study has therefore confirmed the claim that Exclusive Breastfeeding is the best form of feeding practice for a baby for the first six months after birth. However, after the introduction of complementary foods which is the period within the 7^{th} to 9^{th} months the weight gain becomes the lowest. Nevertheless, this type of feeding practice is the appropriate choice for babies for good health and growth. Generally, the weight gain for all the babies slows down during this period.

The non-breastfeeding babies have the lowest weight gain throughout the study period. It is not advisable therefore to intentionally put a baby under this feeding practice as weight gain has health and growth implications.

The mean weight gain by a baby is higher in the first three months of life compare to that of $4^{th} – 6^{th}$ and $7^{th} – 9^{th}$ months. Thus, a baby grows much faster in the first three months of life than the subsequent three monthly periods.

In general, the birth weight of a baby was found to be 3.1kg. The birth weight of a baby has a significant influence on weight gain at the early stage of growth. Any measure required for a baby to be borne with an optimum birth weight should be considered.

5.2 Recommendations

i) There is need for promotion and protection of optimal infant feeding practice since feeding practice affect the growth of the baby.

ii) Educational programs on Exclusive Breastfeeding for the first six months of life should be encouraged, for better growth.

iii) The importance of adequate complementary feeding in the 7^{th} to the 9^{th} month of infancy needs to be stressed in nutrition education programmes since the introduction of complementary foods slows down the rate of growth.

iv) Due to the poor weight gain, non-breastfeeding of babies should not be an option or encouraged if it is not on medical grounds.

v) Special attention should be given to fetal and antenatal care so that babies could be borne with optimum birth weights for good start of growth after birth.

REFERENCES

Brownlee, A. (1990). *Growth Monitoring and Promotion: The Behavioral Issues.* USAID – Bureau for Science and Technology, Office of Health.

Center for Disease Control (CDC) and Prevention (May 2007). *Promotion and support of Breastfeeding and obesity Prevention.*

Diggle, P.J., Liang, K., and Zeger, S.L. (1994), *Analysis of Longitudinal Data,* New York: Oxford University Press.

Dinesh K., Goel N.K. and Poonam C. (2006). *Influence of Infant-Feeding Practice on Nutritional Status of Under-Five Children.* Department of Community Medicine, GMCH, Sector 32a, Chandigarh, India.

Dramane, M. and Carolyn, H. (2006). *An Exploratory Analysis of child Nutritional Status in the Sahel. The Goundam Circle Case Study.* Timbuktu Region-Mali.

Dunlop, D.D. (1994). *Regression for Longitudinal Data: A Bridge from Least Squares Regression.* The American Statistician. 48:299-303.

Fawzi, W., Herrera, M.G., Nestel, P., Amin, A. and Mohammed, A. (1998). *Longitudinal study of prolonged breastfeeding in relation to child undernutrition.* Int. J.Epidemiol. 27(2): 255-60.

Fomon, S.J. (2001). *Infant Feeding in the 20th century: Formula and Beikost*. San Diego, CA: Department of Pediatrics, College of Medicine, University of Iowa.

Ghana Statistical Service (GSS) and Macro International Inc. (1999). *Ghana Demographic Survey 1998*. Calverton, Maryland, U.S.A.

Ghana Statistical Service (GSS) and Macro International Inc. (2004). *Ghana Demographic Survey 2003.* Calverton, Maryland, U.S.A.

Horta, B.L., Bahl, R., Martins, J.C. and Victoria, C.G. (2007). *Evidence on the long-term effects of Breastfeeding:* Systematic reviews and meta-analyses. Geneva. Switzerland: WHO ISBN 978-92-4-159523-0

Horton, S., Sanghvi, T., Phillips, M. (1996). *Breastfeeding promotion and priority setting in health*. Health Policy Plan 11(2) : 156- 68 dio:10.1093/heapol/11.2 156 PMID 10158457

Ip, S., Chung, M. and Raman, G. (2007). *Breastfeeding and maternal and infant health outcomes in developed countries*. Evid Rep Technol Assess (Full Rep)(153): 1-186PMID 17764214.

Janet, N.M. and Mabel, M. (2011). *Child Malnutrition and Feeding Practices in Malawi*. University of Southampton, U.K.

Khaled, K. (2009). *Childhood Malnutrition in Egypt using Geoadditive Gaussian and Latent Variable Models*. Institute of Occupational and Social Medicine, Medical School, RWTH Aachen University, Aachen Germany.

Kirkland, R. T.(2006). *Patient information: Poor weight gain in Infants and Children (Beyond the Basics).* Babylor College Medicine. UpToDate 95 Sawyer Road, Waltham MA 02453 USA www.uptodate.com/contents/poor-weight-gain-in-infants-and-children-beyond-the-basics. (accessed 13/04/2013).

Lucas, A. and Cole, T.J. (1990). *Breastmilk and neonatal necrotizing enterocolitis.* Lancet 336 (8730): 1519-152 doi: 10.1016/0140-6736(90)93304-8 PMID 1979363. (accessed 23/11/12)

Littell, R.C., Freund, R.J. and Spector, P.C. (2002) *SAS System for Linear Models, Fourth Edition*, Cary, NC: SAS Institute Inc.

Littell, R.C., Henry, P.R. and Ammerman, C.B. (1998). *Statistical Analysis of Repeated Measures Data Using SAS Procedures.* Animal Journal of Animal Science, 76:1216-1231.

Love, H., De Graat, J. and Gordon, G. (1985). *How Mothers Measure Growth: Results of Survey in Ghana.* Mothers and Children Bulletin on Infant Feeding and Maternal Nutrition 5(1): 1-4.

Nathoo,T. and Ostry, A. (2009). *The one best way? : Breastfeeding History, Politics and Policy in Canada*. Wilfrid Laurier University Press.

Ody, W. H. and Kendall, G.E. (2010). *The long-term effects of breastfeeding on child and adolescent mental health: a pregnancy cohort study followed for 14 years.* The journal of Pedriatrics 156(4): 568-74 doi: 10-1016/j.j peds. 2009. 10.020 PMID 20004910 (accessed 5/03/13)

Patetta, M. (2002). *Longitudinal Data Analysis with Discrete and Continuous Responses Course Notes*. SAS Institute Inc., Cary, NC 27513, USA.

Picciano, M. (2001). *Nutrient composition of Human milk*. Pediatric in North Americal 48(1): 53-67 doi: 10.1016/50031-3955(05)70285-6 PMID 11236733. (accessed 4/11/12)

Riordan, B.A.and Countryman, B.A. (1980). *Basics of breastfeeding. Part 1:Infant feeding patterns past and present.*" JOGN Nurs 9(4):207-210 doi: 10.1111/j 1552-6909.1980.tb 02778 PMID 7001126. (accessed 23/11/12).

Riordan, J.M. (1997). *The cost of not breastfeeding: a commentary*. J Hum Lact 13(2): 93-97 doi: 10.1177/089033449701300202 PMID 9233193. (accessed 13/04/13).

Sala, E.O. (2006). *Factors Affecting Prevalence of Malnutrition among Children under Three years of Age in Botswana.* Rural Outreach Program, Nairobi-Kenya.

Schuman, A. (2003). *A concise history of Infant formula (twists and turns included).* Contemporary Pediatric.

Uganda Demographic and Health survey (1995). Ministry of Finance Planning and Economic Development. Statistics Department. Entebbe and Macro International, Calverton, Maryland.

Uganda Demographic and Health survey (2000/2001). Uganda Bureau of Statistics. Entebbe.

UNICEF. (1998). *A UNICEF Nutrition Information strategy improving decision-making at household, community and national levels.* By U. Jonsson Urban, D. Pelletier and R. Shrimpton. New York.

UNICEF. (2006). *Indicators for assessing Infant and Young Child Feeding Practices.* Geneva. www.unicef.org/progressforchildren/2006n4/index_undernutrition.html (accessed 12/04 /13)

UNICEF. (2008). *Key Facts: Infant and Young Child Feeding and Care* http://www.unicef.org.media/media 30011.html (accessed: 23/09/12)

Verbeke, G. and Molenberghs, G. (2000). *Linear Mixed Models for Longitudinal Data*, New York: Springer-Verlag, Inc.

Wambach K.A and Koehn, M. (2004). *Experiences of infant-feeding decision making among economically disadvantaged pregnant adolescents.* School of Nursing, University of Kansas, Kansas city, Kansas, USA.

Wells, J.C.K. (1996). *Nutritional Considerations in infants formula design.* Seminars in Fetal and Neonatal Medicine, 1(1): 19-26

World Health Assembly (2001) *Global strategy on infant and young child feeding.* Provisional agenda item 13.1. Geneva: WHO.

World Health Organization. (1981). *International Code of Marketing of Breast milk Substitutes*. ISBN 978-92-4-154160-2 (accessed 19/01/13)

World Health Organization (WHO). (2003). *Exclusive Breastfeeding.* New York. http:/www.who:int/nutrition/exclusive breastfeeding/(accessed: 12/01/13)

World Health Organization WHO (2003). *Global strategy for infant and young child feeding*-Geneva.

World Health Organization WHO (2006). *Infant and Young Child Nutrition; Quadrennial Secretariat Report*. 9th World Health Assembly. Geneva

APPENDIX A

DATA COLLECTED FOR THE STUDY

ID	Sex	Prac	B-wt	month 1	Month 2	month 3	month 4	month 5	month 6	month 7	month 8	month 9
1	F	EBF	3.2	5.2	6.5	7.3	7.9	7.8	8.2	8.5	9.1	9.1
2	M	3FW	2.6	3.9	4.8	5.5	6.2	6.9	7.6	7.6	7.8	8
3	M	BFW	3	4.9	5.6	6.8	7.7	8.5	9.6	10.2	10.5	10.9
4	M	EBF	3.3	5	6.4	7.2	8	8.8	9.7	10.5	10.5	10.4
5	M	BFW	3	5	6.5	6.9	7.5	8.3	9.3	10	10	11
6	M	BFW	3.1	4.5	5.1	5.4	6.7	7.8	8.4	8.7	9	9.6
7	F	EBF	3	5.1	6.2	7.3	8.2	8.6	9.4	10.4	11	11
8	F	BFW	2.9	4.8	5.3	6.1	6.8	7.6	8.8	9.9	10.6	11
9	M	BFW	3.2	5.1	5.5	6.5	7.5	8	8.5	9	9	9
10	F	EBF	2.8	3.6	5.1	7	7.5	7.9	7.9	8.3	8.3	9
11	F	EBF	3.2	5.5	6.3	7.1	7.7	7.4	7.9	8.1	8	8.3
12	F	BFWO	4.7	5.4	5.7	5.5	6.2	7	7.4	7.8	8.1	8.5
13	M	EBF	2.6	4	4.2	4.4	4.4	4.3	4.6	4.7	5	5
14	M	BFW	3.1	4.1	5.5	6.1	6.6	6.9	7.2	7	7.5	7.8
15	F	BFW	2.8	4.1	4.9	5.3	5.7	5.7	6.3	6.6	6.7	7.3
16	F	BFW	2.5	3.7	4.8	5.6	6.2	6.9	7.6	7.9	8.3	8.8
17	F	BFW	3.6	5.5	6.3	6.8	7	7.3	7.5	7.8	7.9	8
18	F	EBF	2.5	4.5	5	5.5	6	6.1	6	6.4	6.8	7.2
19	M	EBF	3.4	5.4	6.8	8.1	9.5	10.2	10.5	10.8	11.5	11.7
20	F	BFW	3.7	6.1	8	9.7	10	10.8	11.4	11.9	12.2	11.8
21	F	EBF	2.4	4.2	6.7	7.1	7.5	7.8	8	8.1	8.3	8.5
22	M	EBF	3.2	5.9	6	7	6.7	6.9	7	7.2	7.3	7.1
23	M	EBF	2.6	5	6.6	7.4	8	8.5	8.9	8.7	9.2	9.3
24	M	BFWO	3.6	4.1	5.5	6.7	6.8	7.3	7.8	7.9	7.8	8.1
25	M	EBF	3.4	5.3	7.3	7.9	8.5	8.5	9.8	10	10.4	10.9
26	M	EBF	3.8	5.1	5.9	6.5	7.6	8.5	8.5	9.1	9.5	9.9
27	M	EBF	3	4.9	5.3	5.7	5.8	6	6.9	7.3	7.9	8.4
28	F	EBF	2.8	3.9	4.9	5.5	6.7	7	7.3	8.5	8.6	9.2
29	F	BFWO	2.8	3.8	4.7	5.7	5.8	6	6.8	6.5	6.3	6.6
30	F	BFWO	3.6	4.4	5	6	7	7.9	8.5	8.7	8.9	9.1
31	F	BFWO	3.1	5	5.8	6.1	7.3	7.3	6.7	7	7.3	7.4
32	M	BFWO	2.2	5.1	6.2	6.8	7.1	8.2	8.5	8.7	8.7	9
33	M	BFWO	3.6	5.9	7.2	7.4	7.6	8.9	9.1	9.4	9.6	9.6
34	M	BFW	3	5	6.2	6.3	6.8	7.1	7	7.3	7.6	7.4
35	F	BFW	2.8	4.3	5.3	6.4	7.2	8.2	8.7	8.9	9	9.7
36	M	BFW	2.3	3.1	3.7	4.9	5.2	5.3	5.4	6	6.2	6

37	M	BFWO	3.1	4.5	7.4	7.5	8.4	8.3	9	9.2	9.4	10.1
38	F	EBF	3	3.2	4	5	5	5.7	6.2	6.2	6.5	6.5
39	M	EBF	2.9	4.5	6	7	7.5	8	8.2	8.2	7.6	8.1
40	F	BFW	3.3	4.4	5.4	5.5	5.9	6.1	6.6	7	7	7
41	M	BFWO	3.2	5	6	6.2	7.2	7.5	7.7	8	8.3	8.7
42	M	BFWO	3	4.6	5.7	6.2	7	7.3	7	7.3	7.8	7.8
43	M	BFWO	3	5	5.2	5.5	5.5	6	6.7	6.9	7.3	7.5
44	M	BFW	2.9	5	6.2	7	7	8	8.2	8.5	9	9.1
45	F	EBF	3.1	4.2	6	6.7	6.6	7.6	8	8.5	8.5	8.8
46	F	EBF	3.2	5	6.1	6.8	7.2	7.9	8.6	8.7	9	9.3
47	M	EBF	3.2	4.8	5.4	5.8	6.5	6.1	6.9	7.6	8.4	8.7
48	F	BFW	2.9	4	5.3	6.8	7.5	8	8.6	9	10.9	11
49	F	EBF	3.2	5.2	6	6.3	6.7	7	7.9	7.8	7.7	8
50	F	BFWO	2.5	4.3	5	5.1	5.5	5.6	5.6	5.6	6.6	7
51	F	BFWO	3.1	5.3	6.2	6.5	6.9	7.3	8	8.2	9.1	9.7
52	M	BFWO	3	4.9	5.4	5.9	6.6	6.6	7.1	7.7	7.8	7.9
53	M	BFWO	3.2	4.8	5.5	6.3	7.1	8.1	8.1	8	8.2	8.5
54	F	EBF	3.4	4.6	5.7	6.1	6.8	7.4	8.1	8.9	9.6	10.2
55	F	BFWO	3.7	5.8	7	7.5	7.9	8.5	8.6	9	9.2	9.6
56	F	BFWO	3.2	3.7	5	5.4	5.7	6	6.6	6	6.2	7.5
57	F	BFW	3.2	5.2	5.7	6	6.5	7.1	7.7	8.3	8.9	9.6
58	M	BFWO	3.3	4.8	5.9	5.9	6.4	7.2	7.6	8.1	8.9	9.8
59	F	BFWO	2.8	4.3	5	5.6	6	6.2	6	5.8	5.8	6
60	F	BFW	3.1	5.3	6.2	6.8	7.2	7.2	7.5	7.5	7.8	8
61	F	EBF	3.8	4.6	5	5.9	7.3	8	8	7.9	8.3	8.5
62	F	BFWO	3.7	5.9	6.9	7.1	8.3	9.2	10.1	10	9.8	10.3
63	F	EBF	3.3	4.4	4.5	5.2	6	6.3	6.3	6.4	7	7
64	M	EBF	2.8	3.7	4.7	5	5.5	6.8	7.1	7.3	7.6	7.4
65	M	BFWO	3	4	4.7	6	5.3	5.5	7.5	7.9	7.9	8
66	F	BFW	2.3	4.2	5.3	5.9	6.8	6.8	7.3	8.1	8.1	8.3
67	M	BFWO	3.2	5	5.4	6	6.1	7.1	7.3	7.4	8.7	8.8
68	M	BFW	2.9	4.8	4.8	6.8	7.8	8	8.4	8.9	9.1	9.9
69	M	BFW	3.3	5.3	6	7.9	7.8	8.4	8.4	9.1	9.2	9.9
70	F	BFW	3.7	4.8	5.4	5.7	6.2	6.8	6.9	7.4	7.5	7.9
71	M	NBF	3.4	5	5.2	6.2	6.8	7.4	7.5	8	8.2	8.4
72	F	EBF	4.1	5.2	5.8	6.7	6.8	7.3	7.8	7.8	8.3	8.1
73	M	BFWO	2.1	5.7	5.8	6.3	6.8	7.1	7.7	7.7	7.8	7.9
74	F	BFWO	3.2	4.3	4.9	5.6	6.7	5.8	6.2	6.7	7	7
75	M	EBF	4.3	6.5	7.5	8	8.5	8.7	9	9.5	9.7	9.9

76	F	EBF	2	3.2	4.8	5.3	6.5	7.6	8.2	8.4	8.6	8.5
77	F	BFW	3	4.4	4.9	5.5	6.1	6.4	6.5	6.6	7	7.1
78	F	BFW	3.7	4.7	5.8	6.2	6.7	7.1	7.4	7.6	8	8.2
79	F	BFW	3.2	4.3	5	5.3	5.4	5.6	5.7	5.9	6.5	6.8
80	M	EBF	2.8	3.7	4.3	4.8	5.4	5.7	5.7	6.8	7.7	7.8
81	M	EBF	3.4	4.3	5.4	6.4	5.6	5.9	6.3	6.4	6.1	6.3
82	F	EBF	3.2	4.8	5.5	5.8	7.3	7.6	7.5	8	8.7	8.7
83	M	BFW	2	3.6	4	4.9	5.5	5.9	6.2	6.6	7	7.5
84	F	BFW	2	3.6	4	4.9	5.5	5.9	6.3	6.6	6.9	7.5
85	M	NBF	3.7	4.3	4.6	4.9	5.9	6.3	7.4	7.5	7.8	8.1
86	M	BFW	3.4	5.7	6.1	8.9	7.9	8.1	7	8.1	8.4	8.5
87	M	BFWO	3.5	4	4.2	5.8	6.5	6.4	6.6	7	7.5	8.1
88	M	BFW	3.2	5.5	6.7	7.3	8	8.5	9	9.5	9.7	10.2
89	M	BFWO	2.8	4.6	6	6	7	7.5	8.2	8.8	9.4	10.1
90	M	EBF	2.7	5.5	5.6	7.3	7.8	7.9	8	7.6	8	8.5
91	F	NBF	3	3.2	4.6	5.5	6.5	7.2	7.5	7.8	7.5	8.9
92	M	NBF	2.6	3	3.2	4.1	4.5	5.6	5.8	6.1	7.6	7.3
93	F	NBF	2.8	4	4.8	6.3	6.5	7.1	7	7.2	7.5	7.6
94	F	NBF	2.9	3.2	3.2	3.6	4.6	5.1	6.1	6.8	7.1	7.5
95	M	NBF	3.2	4.2	5.8	6.3	7.4	8.1	8.4	9.8	9.7	9.6
96	M	NBF	3.4	4.4	6	6.6	7.8	8.8	8.8	9.7	9.9	9.2
97	M	NBF	3.3	3.6	4.2	4.9	5.3	5.9	6.7	7.2	7.5	7.4
98	M	NBF	2.7	3.4	4.5	5.1	6	6.8	7.7	7.8	9	9
99	M	NBF	3.5	4.3	5	5.5	7.1	7.3	7.4	8.2	8.6	9.1
100	F	NBF	2.3	3.2	4.1	5.1	5.5	6.1	6.6	6.4	7	7.3
101	M	NBF	3	4	5.2	5.7	6.7	7.3	7.8	8.5	9.2	9.7
102	M	NBF	3.1	4	4.5	4.8	5.4	5.9	6.2	6.5	7	7.7
103	M	NBF	3	3	2.9	3.3	3.7	4.9	5.4	6.1	6.3	7.2
104	F	NBF	2.8	3.3	4.6	4.9	5.1	5.6	6.6	7.2	7.9	8.9
105	M	NBF	3	3.2	4.2	4.2	4	4.1	4.8	5.1	6.4	7.3
106	M	NBF	2.5	3.2	4	4.5	4.9	5.4	7.1	7.8	7	8.4
107	F	NBF	3.6	3.8	4.8	4.2	4.8	5.2	5.6	6.3	6.9	6.8
108	F	NBF	2.4	3.1	3.3	3.6	3.8	4.3	5	5.6	5.6	6.1
109	M	NBF	2.7	3.5	3.8	4.2	4.2	4.6	5.8	7	6.9	7

APPENDIX B

SUMMARY STATISTICS FOR FEEDING PRACTICE

Month	Measure	FEEDING PRACTICE			
		EBF	BFW	BFWO	NBF
1^{st}	Mean	4.688	4.63	4.777	3.662
	Max	6.5	6.1	5.9	5.0
	Min	3.2	3.1	3.7	3.0
2^{nd}	Mean	5.672	5.477	5.665	4.405
	Max	7.5	8.0	7.4	6.0
	Min	4.0	3.7	4.2	2.9
3^{rd}	Mean	6.409	6.323	6.177	4.929
	Max	8.1	9.7	7.5	6.6
	Min	4.4	4.9	5.1	3.3
4^{th}	Mean	6.969	6.83	6.719	5.548
	Max	9.5	10.0	8.4	7.8
	Min	4.4	5.2	5.3	3.7
5^{th}	Mean	7.369	7.307	7.146	6.143
	Max	10.2	10.8	9.2	8.8
	Min	4.3	5.3	5.5	4.1
6^{th}	Mean	7.763	7.700	7.554	6.724
	Max	10.5	11.4	10.1	8.8
	Min	4.6	5.4	5.6	4.1
7^{th}	Mean	8.081	8.117	7.742	7.267
	Max	10.8	11.9	10.0	9.8
	Min	4.7	5.9	5.6	5.1
8^{th}	Mean	8.397	8.443	8.054	7.648
	Max	11.5	12.2	9.8	9.9
	Min	5.0	6.2	5.8	5.6

9^{th}	Mean	8.603	8.760	8.408	8.024
	Max	11.7	11.8	10.3	9.7
	Min	5.0	6.0	6.0	6.1

APPENDIX C

SOLUTION FOR FIXED EFFECTS WITH INTERACTIONS

The Mixed Procedure

Solution for Fixed Effects

Effect	PRACTICE	GENDER	Estimate	Standard Error	DF	t Value
Intercept			1.8982	0.3935	105	4.82
MONTH			0.4268	0.01246	157	34.26
BIRTHWEIGHT			0.7857	0.1182	105	6.65
FEEDING_PRACTICE	BFW		-0.08793	0.2140	105	-0.41
FEEDING_PRACTICE	EBF		0.01202	0.2072	105	0.06
FEEDING_PRACTICE	NBF		-1.0029	0.2134	105	-4.70
FEEDING_PRACTICE	BFWO		0	.	.	.
GENDER		Female	-0.2082	0.2186	105	-0.95

Solution for Fixed Effects

Effect	PRACTICE	GENDER	Estimate	Standard Error	DF	t Value
GENDER		Male	0	.	.	.
PRACT*GENDER	BFW	Female	0.09343	0.2974	105	0.31
PRACT*GENDER	BFW	Male	0	.	.	.
PRACT*GENDER	EBF	Female	-0.2127	0.2947	105	-0.72
PRACT*GENDER	EBF	Male	0	.	.	.
PRACT*GENDER	NBF	Female	0.01082	0.3404	105	0.03
PRACT*GENDER	NBF	Male	0	.	.	.
PRACT*GENDER	BFWO	Female	0	.	.	.
PRACT*GENDER	BFWO	Male	0	.	.	.

Solution for Fixed Effects

Effect	FEEDING PRACTICE		GENDER	Pr > |t|
Intercept				<.0001
MONTH				<.0001
BIRTHWEIGHT				<.0001
FEEDING_PRACTICE	BFW			0.6820
FEEDING_PRACTICE	EBF			0.9539
FEEDING_PRACTICE	NBF			<.0001
FEEDING_PRACTICE	BFWO	.		
GENDER			Female	0.0343
GENDER			Male	.
FEEDING_PRACT*GENDER	BFW		Female	0.7540
FEEDING_PRACT*GENDER	BFW		Male	.
FEEDING_PRACT*GENDER	EBF		Female	0.4721
FEEDING_PRACT*GENDER	EBF		Male	.
FEEDING_PRACT*GENDER	NBF		Female	0.9747
FEEDING_PRACT*GENDER	NBF		Male	.
FEEDING_PRACT*GENDER	BFWO		Female	.