# Growth faltering and Under five mortality in Uganda;

## Determinants, Trends and Millennium Development Goal four.

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## Abstract

This research focused on causality relationships of growth faltering with nutrient deficiency and immunization as well as describing trends/patterns of under five mortality since 1988 DHS. It is grounded on the Mosley & Chen model (1984). Secondary data collected on birth and survival histories from retrospective DHS available in Uganda Bureau of Statistics was used for analysis. DHS data of 1988, 1994/5, 2000/1 and 2006 was used for analysis. Binomial logistic regression analysis techniques were used to obtain the relationships and Synthetic cohort life tables to estimate under five mortality. Linear extrapolation was implored to determine the possibility of achieving Millennium Development Goal four of reducing under five mortality by two-thirds.

Nutrient deficiencies played a major role in causing grow faltering in children exhibited through size of a child at birth, anaemia, and iron deficiency. Immunization through polio vaccination at 6 weeks had a minor effect on growth faltering.

On the other hand, the under five mortality rates have been decreasing in the last four surveys of 1988, 1995, 2000 and 2006 but the decline is insignificant. Uganda is practically not on target in achieving Millennium Development Goal four and no sudden change in programming will be feasible to attain the target by 2015.

A wide policy mix from socio-economic women empowerment to adequate child nutrition is necessary to address growth faltering and under five mortality in Uganda.



**Key Words**: Under five mortality, growth faltering, nutrient deficiency, immunization, Uganda

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## 1.0 Introduction

## 1.1 Background

### 1.1.1 Growth faltering and under five mortality

Mortality in demography is a final event that occurs after a number of definitive events experienced by a subject. Some have lived long to experience those events along their life lines, others hardly celebrate their fifth birthday. A majority (one out of six) of children in Sub-Saharan Africa experience mortality after a short period of five years after birth (World Vision, 2009). Child survival has been made a priority, by not only governments, but also by Non Governmental Organizations (NGOs). Many resources have been invested in implementing child survival programmes and in academia through research, but under five mortality still remains high in Sub-Saharan Africa and Uganda in particular. The stagnant under five mortality rates in Sub Saharan Africa, especially in Uganda, needs re-visiting, most especially in understanding its key determinants and patterns. In research, varieties of studies and methodologies have focused a lot of effort to study child survival and its networks both in social and medical discipline. There is currently a wave of improving child survival through a set of Millennium Development Goals (MDGs) agreed upon by world leaders. The concern of achieving millennium development goals in Uganda has somehow redirected research to more quantitative (trends) rather than qualitative contents in exploring causal relationships. Few studies have been conducted on the direct relationship between child survival, immunization, and malnutrition among other factors. The few studies on the determinants of child mortality and its levels are also hindered by the methodological constraints in estimating child mortality. The Inter-Agency Group for Child Mortality Estimation (2006) reported a disagreement in methods of estimating child mortality levels and trends. Preference is directed on the child survival status, i.e. child died or alive with scanty retrospective data on dead children (Inter-Agency Group of Child Mortality Estimation, 2006). This is due to weak vital registration systems in developing countries. Since data on dead children is missing, understanding immediate causes of death before it occurs has proved a big challenge in studying under five mortality in developing countries. This therefore opens a gap in child mortality studies. It is difficult to study it from DHS though. The methodology of observing living children, estimating their survival chances has not fully penetrated academic circles involved in child mortality estimation. None the less, child mortality is a result of cumulative abuses and insults from various phenomena inflicted upon children under five. It is associated to stunting, underweight and wasting, conditions resulting from growth faltering. Growth faltering, being presented as either stunting, underweight, or wasting is associated with high child mortality (Moore et al, 2001). Due to methodological constraints in estimating child survival, growth faltering conditions in children are important in estimations of child mortality and its determinants. As death being a final event, growth faltering as a risk factor of death in children provides empirical strength in studying risk of mortality among children.

### 1.1.2 Growth faltering, under five mortality and nutrient deficiency

There is a variety of causes of mortality as they range from socio economic determinants to environmental contamination as well as disease infections. These are classified into proximate determinants and underlying causes contributing to the proximate causes of mortality (Mosley & Chen, 1984). According to Fillol et al (2009), malaria and malnutrition are major causes of morbidity and mortality in children less than five years of age in Sub Saharan Africa. Malnutrition is as a result of nutrient deficiency.

A significant relationship between nutrition deficiency and deaths in children at infant stages was also reported. This time it is caused by mother's dietary intake during and before pregnancy. Shrimpton (2003, p.39) in his study of preventing low birth weight and reduction of child mortality revealed what he called a biological significance of maternal food supplements and child mortality. He asserted that, "An increase of 100 g in mean birth weight is associated with a 30–50 percent reduction in neonatal mortality." According to him, a mother's diet determines child's size at birth, which influences chances of dying at an infant stage thus children with small birth weight are more likely to die compared to average and larger than average children.

According to a study on the solutions to nutrition-health related problems of pre-school children, Darnton et al (2004) note that more than half (56 percent) of all child deaths have under nutrition as a contributing factor. They further observed that the most common causes of under five mortality in low-income countries have been identified as neonatal disorders, diarrhoea, respiratory infections, malaria, measles, and in some developing countries, HIV/AIDS. Uganda is one of the developing countries experiencing a wide range of causes of under five mortality observed by Darnton et al (2006). The World Bank statistics also in addition to Darnton et al (2004) report, "every year six million children die from malnutrition before their fifth birthday."

Nutrient deficiency leads to the deterioration of child health with symptoms that generate into physical signs of wasting, stunting and underweight that are as the result of impaired growth. It must be noted here that under nutrition or nutrient deficiency refer to inadequate dietary food intake that leads to reduced child immunity degenerating into sickness and growth faltering. This is highly evident in the vicious circle of malnutrition.

Nutrient deficiency slows the ability of the body to fight infections, which accelerates mortality and morbidity in children. It is noted by the CSAE (2005, p.151) that, "Micronutrient deficiency is a serious contributor to childhood morbidity and mortality. Vitamin A deficiency can cause eye damage and can increase severity of infections such as measles, diarrhoeal diseases in children and slows recovery from illness" They add that iron deficiency can impair cognitive development, stunted growth, and increase morbidity from infectious diseases. Insufficient iodine in the diet can cause mental and neurological disorders in children." Zinc deficiency predisposes to stunting, protein-energy deficiency to underweight and wasting.

Paoloni et al (2005) in their study on morbidity and growth of infants in a Mexican village also add that in an environment where conditions are generally poor, nutrition inadequate, and infections more frequent and severe, illness may have more marked effects on growth. They observed that under nutrition can greatly increase the severity of infections 23- 25 percent and may limit the amount of "catch-up growth" following illness. Under these circumstances, illness may play a significant part in retarding children's growth. In the vicious circle of malnutrition, it is believed that as a child grows at infancy with the weak immunity gained from the mother's inadequate nutrition, illness weakens further the immunity. This leaves a child's normal growth and development further at stake of faltering.

In support of the above, the World Health Organization in their bulletin of 1995 also revealed that nutrient deficiency, because of its relationship with infectious diseases has a powerful impact on child mortality with a total population attributable to risk is 56 percent. In addition, one that is much larger than suggested by category of "nutritional deficiencies" in most routine

reporting system. The combined effect of immunization and nutrient deficiency is on child mortality is clearly shown by the vicious cycle of infectious diseases and malnutrition.
The World Health Organization (WHO) compiles and disseminates data on child survival in developing countries and attributes under five mortality to malnutrition.

Furthermore, in a study of child mortality in relation to nutritional status and socio economic background in Tanzania, Villamor et al (2004) found that anaemia was one of the risk factors of child mortality among other factors like HIV/AIDs and age. The retrospective study revealed the high risk of death among wasted and stunted children. Tanzania is among developing countries in sub-Saharan Africa and it borders Uganda in the south.
However, other studies have also shown the effect of diarrhoea on morbidity and mortality (EDHS 2005), even though the condition can be treated easily with Oral Rehydration Salts (ORS). But in a medical sense, dehydration in children is because of poor nutrition.
Also in Uganda, survey data show that there has been little improvement since 1995 in children's nutritional status (UDHS Report, 2000/1). Nevertheless, it is interesting to note that, slow declining trends in under five mortality as well as in malnutrition have been in the picture shown from previous studies conducted. Those patterns suggest that child nutrition and growth faltering have a significant relationship with under five mortality in Uganda.

In addition to previous studies, a study in western Uganda, mortality was reported to be significantly higher at low levels of weight-for-age and weight-for-height but remained the same at different values of height-for-age (Vella et al, 1992). Chronic (stunting) and acute (wasting) malnutrition and general health and nutritional status (underweight is also an acute state) are assessed at population level in Uganda through the Demographic and Health Surveys in the past. Stunting, wasting, and underweight are consequences of growth faltering that can be measured anthropometrically. Growth faltering is the process of inadequate growth that can result in stunting, wasting or underweight. Growth is monitored by the weight and height as parameters. Low weight-for-age (underweight) and weight-for-height (wasting), and height for age (stunting) are measures of growth faltering. These have shown relationships between malnutrition and child survival in Uganda (Vella et al, 1992). Stunting is very often not recognized by medical staff, since the child can have an appropriate weight for its height, and look proportional. However, stunting has a severe effect on cognitive development of a child, thereby having a negative impact on the economic productivity of a nation where stunting is prevalent (Ssewayana and Younger, 2005).

### 1.1.3 Growth faltering, under five mortality and immunization

Studies have associated under five mortality to other factors other than Nutrient deficiency also in a micro level sense. Studies have also been done to explore the linkage between Immunization and growth faltering and under five mortality in children. Immunization campaigns against vaccine-preventable diseases like measles, diphtheria, whooping cough, polio and tetanus is crucial in reducing growth faltering and under five mortality. Children who are not fully vaccinated especially from Polio suffer physical disabilities, affecting their normal growth. Immunization campaigns are held in Uganda regularly and it is in the government’s calendar, as its priority in the fight against child killer diseases. In Uganda immunization, coverage has been estimated to be more than 90 percent. According to WHO guidelines, children are considered fully vaccinated when they have received a vaccination against tuberculosis (BCG), three doses each of DPT (diphtheria, whooping cough, and tetanus), polio, and a measles vaccination by the age of 12 months. Satiro et al (2008) confirmed in a study in Brazil that immunization reduced infant mortality by 20 percent.

In support of what was described above, Ogbe (2008, p.35) related that Immunization is another factor that can reduce child and maternal mortality rates. He adds "With the prevention of childhood diseases, child mortality rates can be reduced to the minimum, not only for the child but also for the mother." Clinical scientists have always known that improvement in immunization for childhood diseases and in general, health care services have caused significant reductions in under five mortality.

In a case control study in Gambia, Rutherford et al (2009, p.152), confirms the association of Immunization and child mortality and further reveals that, "Our finding on the association between vaccination status and child death is also consistent with other studies conducted in Africa. Vaccinations given during infancy were shown to be protective against child death from a series of cross sectional surveys in Zaire'. Zaire is now known as the Democratic Republic of Congo and it borders Uganda from the West.

On the other hand, under five mortality in Uganda has been linked to HIV AIDS with empirical studies giving trends with less relation to immunization as an indicator of child mortality (Okuonzi, 2002). Immunization of HIV/AIDS infected children is very important since they immune systems are highly compromised. The World Health Organization also recommends that HIV infected children be vaccinated with Polio vaccine especially the asymptomatic children (Calles & Schultz, 2000). Immunization therefore as proposed, contributes to under five mortality especially in areas with high HIV prevalence rates like Uganda.

In addition, other sources which have conducted previous research in Uganda have linked the variations in child mortality to the HIV/AIDS epidemic (Ntozi and Nakanaabi, 1997). However, Okuonzi (2002) argues persuasively against HIV/AIDS, that the association between the trends in HIV/AIDS prevalence and infant mortality is contrary to expectations. HIV prevalence was increasing in the late 1980s, precisely the time when infant mortality was falling in Uganda. Okuonzi (2002) compares the prevalence and incidence patterns of HIV/AIDS and infant mortality in Uganda to support his argument. Yet, patterns are not enough to scientifically prove causal relationships.

Furthermore, evidence in support of the role of HIV/AIDS in child mortality was documented by Villamor et al (2004) in Tanzania. They conducted a retrospective study on children under five years and made a follow up. Villamor et al (2004, p.61) further reported that, "HIV infection was associated with an adjusted 4-fold higher risk of mortality [relative risk (RR) = 3.92…." They also asserted that children with low weight for height (wasting) showed significant high risk of mortality than normal children. As noted above, wasting is one the indicators of growth faltering. This may explain the role for breastfeeding and vitamin A status of the mother, and so again adequate nutritional status may prevent children of HIV+ mothers to become malnourished and enter the cycle of malnutrition and infectious diseases.

Although, studies reviewed above have not concluded clearly to relate immunization to growth faltering, this study will ascertain the possible link if evident. Never the less, immunization is highly considered in previous research as major cause of under five mortality. Under five mortality significantly links to growth faltering. A scientific explanation needs to be explicitly given, regarding causal relationships of immunization and grow faltering.

### 1.1.4 Trends in under five mortality and Millennium Development Goal four in Uganda.

Studying levels and trends of under five mortality are important not only in tracking progress but also as policy checks. Most studies have been conducted in Uganda to study trends of under five mortality rates and explicitly use them to forecast the possibility of achieving MDG targets.

In the 2006 DHS survey report, the most current, comparisons of under five mortality rates between surveys were made. UBOS (2006, p.112) further revealed that, "…..the situation of childhood mortality in Uganda stayed about the same, or perhaps worsened slightly, between the 1995 UDHS and the 2000-2001 UDHS, the condition improved between the last two surveys." It adds that under five mortality rate dropped from 158 to 137 deaths in a thousand. The 2006 DHS identifies more less stagnant rates since independence until the early twenty first century when they began to drop significantly.

Ayiko et al (2009), in their study of trends and determinants of child mortality in Uganda put more light on past under five mortality trends. In support of the 2006 DHS report, their findings revealed that under five mortality remained unchanged from 1991 to 2001. They began to decline in the years of 2001 to 2006. Ayiko et al (2009) used the DHS datasets in their study.

In addition to Ayiko et al (2009), another study on the levels and trends of under five mortality was also carried out. Nuwaha & Mukulu (2009) conducted a retrospective study of under five mortality rates since pre-independence in 1954. They calculated percentage Annual Average Reduction Rate (AARR) between the years 1954- 2000. Their results revealed that under five mortality rates declined between 1954 and 1975 only to increase after wards till 1988 to AARR of -0.11%. The rates however remained stagnant before slightly declining until 2000.
Unlike Ayiko et al (2009) who used DHS data, Nuwaha and Mukulu used census data that was collected since colonial times.

On the other hand, besides trends in under five mortality, world leaders put their commitment in global partnership to development and poverty eradication during the 2000 world summit in New York. They set a number of goals and targets, which came to be commonly known as the Millennium Development Goals. One of the goals was to reduce child mortality. In order to achieve this goal, a target to reduce under five-mortality rate by two-thirds by 2015 was set (United Nations, 2009).

Many studies have been conducted to track the progress of Millennium Development Goals. In Uganda, child mortality patterns indicated by previous surveys show no improvement in mortality rates in Uganda (Sewanyana and Younger, 2005). To add more light on under five mortality trends and Millennium Development Goals in Uganda, Kirunga and Ogwal (2003, p.36) reported that, "With 88 infant deaths per 1,000 live births in 2001, government missed the Poverty Eradication Action Plan (PEAP) target of 78 deaths per 1,000 live births by 2002. The new PEAP target of 68 deaths per 1,000 live births by 2005 was ambitious, but can potentially be attained if serious policy action is taken." The PEAP was one of the programmes set by government of Uganda to address and achieve the Millennium Development Goals.

Using previous trends in under five and child mortality rates in Uganda, Kirunga et al (2003) noted a possibility of achieving millennium goal four by 2015 in Uganda.

However, other studies still disagree with the possibility of Uganda achieving the MDG targets by 2015. According to Nuwaha and Mukulu (2009, p.127), they argued that, “In order to be able to reach the U5MR MDG4 target for Uganda of 65 deaths per 1000 live births the Average Annual Rate of Reduction in the remaining seven years will have to increase from 2.46 to 8.92 percent.” They agreed that it is unrealistic to expect that Uganda can meet the 2015 MDG4 of U5MR target in the remaining time given the current trends. The MDG four target aims at reducing the under five-mortality rate by two-thirds between 1990 and 2015. It must be noted here that, despite the disagreements on the possibility of Uganda achieving the MDG four, data on the 2006 Demographic survey has not been used in extrapolating trends.

In Literature summary, many resources have been invested in malnutrition and immunization in combating growth faltering and under five mortality and yet more deaths still occur. More effort is required in identifying crosscutting linkages that still sustain the course of events in Uganda and developing countries at large. As Pelletier says in his paper, a lot of attention and money is being paid on severe malnutrition, whereas more children die of moderate malnutrition. This is in conformity with Pelletier et al (1995, p443) who argued that “According to conventional methods of classifying causes of death, an estimated 70 percent of the deaths of children (aged 0-4 years) worldwide are due to diarrheal illnesses, acute respiratory infection, malaria and immunizable diseases. These methods do not strengthen Nutrient deficiency as a major cause of death in developing countries, despite its high prevalence and despite the long- recognized synergism between malnutrition and infection in child mortality”.
UNDP (2002) further argues that child mortality has been related to immunization factors, nutrition related indicators and antenatal care. Limited studies have been conducted on the magnitude *per se*, the above indicators contribute to child mortality, and previous focus has been on trends of Under Five mortality. The trend analysis has also indicated slow decreasing, almost stagnant trends since the first DHS survey in Uganda. However, there was disagreement in the possibility of achieving MDG4 target from previous studies; they hinted on the limited success of child survival programmes to meet national targets especially the PEAP and the MDG target.

According to Mosley & Chen (1984), social research on child mortality and growth faltering has based on developing correlation between socio economic determinants and patterns in mortality. They are used to generate causal inferences about the determinants of growth faltering and child mortality.
With the above, this study develops an adaptation of a Mosley & Chen model to relate and strengthen if identified, the role of nutrient deficiency and immunization as key and immediate determinants of growth faltering which leads to low levels of child survival in Uganda. The choice of studying nutrient deficiency and immunization here only, resonates to the fact that child survival programming in Uganda and other developing countries directly focus on immunization and nutritional campaigns. These indicators can be easily viewed and adapted by stakeholders especially the community during implementation of proposed interventions. For that reason, I have chosen to focus on these two determinants of growth faltering and child survival. Other determinants like maternal factors, injury and environment, during interventions are overlooked by the community as high level that will not immediately address growth faltering and child mortality as a priority in their communities. Maternal interventions are regarded as part of women empowerment rather than child survival project, yet they are equally or even more significant in improving child survival.

**Research objectives**

**Main objective:**
To explore the role of nutrient deficiency and immunization as determinants of growth faltering and under five mortality and their trends in Uganda.

**Specific objectives:**
1. To understand the magnitude of growth faltering caused by nutrient deficiency.
2. To understand the magnitude of growth faltering attributed to low immunization coverage.
3. To explore trends in under five mortality rates from 1988 – 2006 stating on the possibility of achieving Millennium Development Goal four.

The study seeks to address the above objectives by answering the following research questions.

## 1.3 Research questions

**Research question:**
What is the role of nutrient deficiencies and immunization in the prevalence of growth faltering and under five mortality rates in Uganda and their trends since 1988 basing on DHS data?

**Specific research questions:**

a) What is the effect of immunization and nutrient deficiencies on growth faltering of under five children?
b) What are the trends of growth faltering and under five mortality rates in Uganda since 1988 in Uganda?

c) Can the Millennium Development Goal of reducing child mortality be achieved in Uganda?

## 1.4 Research hypotheses

From theory and literature review, the hypotheses stated are given below and the study will test them giving inferences in each case.
a) There is a significant effect of nutrient deficiency on growth faltering.
b) There is a significant effect of immunization on growth faltering.

## 1.5 Structure of the Paper

The thesis is presented into five chapters. The background information of previous studies conducted in line with the research topic is reviewed in the first chapter as an introduction. The research objectives, questions and hypotheses to be achieved, answered and tested respectively; follow the background of the study. Furthermore, chapter two presents the frameworks in which the study is embedded. The Mosley & Chen theoretical framework is briefly explained and its adaptation fully conceptualised.

In addition, the data and methods chapter (three) explains the methodologies used in answering the research questions. Data variables and concepts are explained in this chapter describing the Synthetic Cohort approach of estimating child mortality, Binary logistic regression method, and linear extrapolation. Chapter four follows the data and methods chapter, presenting key findings after running the analysis. It is presented in Tables, graphs and explanatory statements. Finally, the conclusions and discussions along with recommendations are presented in the chapter five. Possible interventions and future research areas are also proposed in the final chapter.

## 2.0 Theoretical framework and conceptual Model

### 2.1 **Theoretical framework**

The study attempts to study trends and the relationship between nutrient deficiency, immunization, and growth faltering. In order to investigate the latter, the study adopts the Mosley & Chen model (1984) in relating child survival to nutrient deficiency, immunization, growth faltering and under five mortality. The model explains child survival as caused by proximate determinants or underlying factors of malnutrition, illness control, injury, maternal factors and environmental Factors. The socio-economic determinants work through the proximate determinants to influence mortality as shown in the framework below.

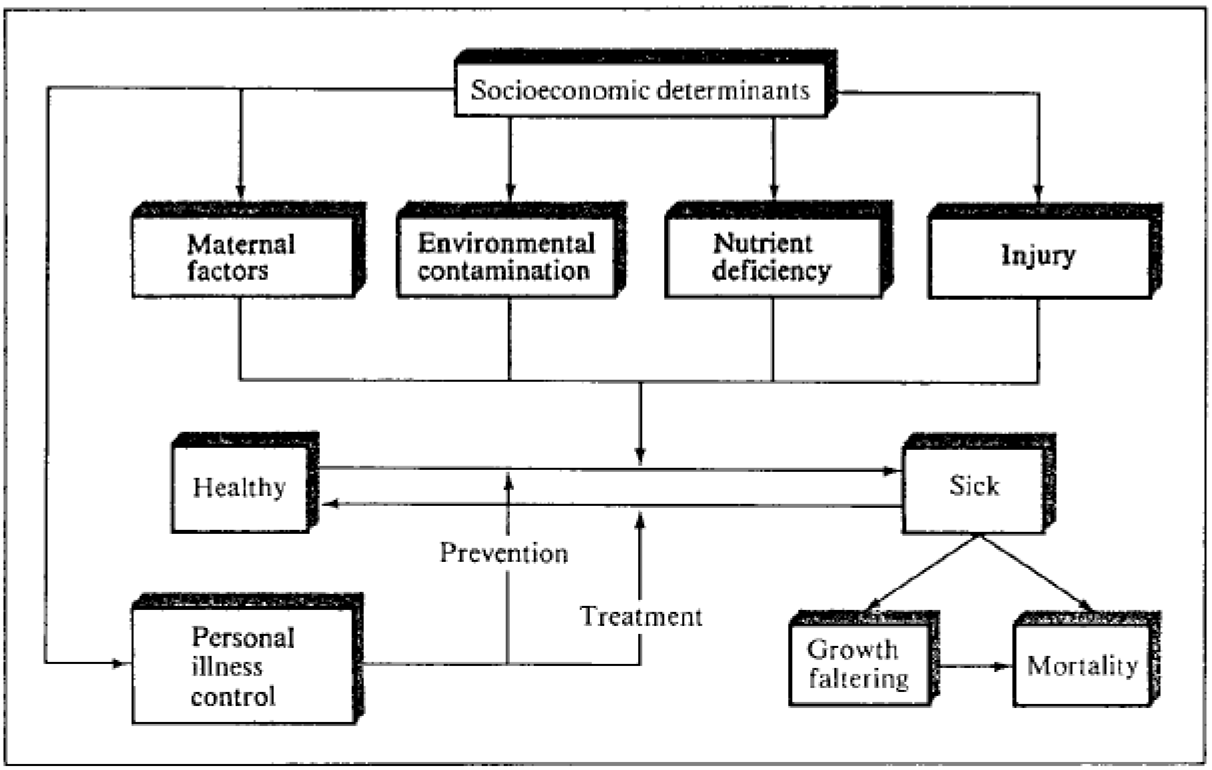


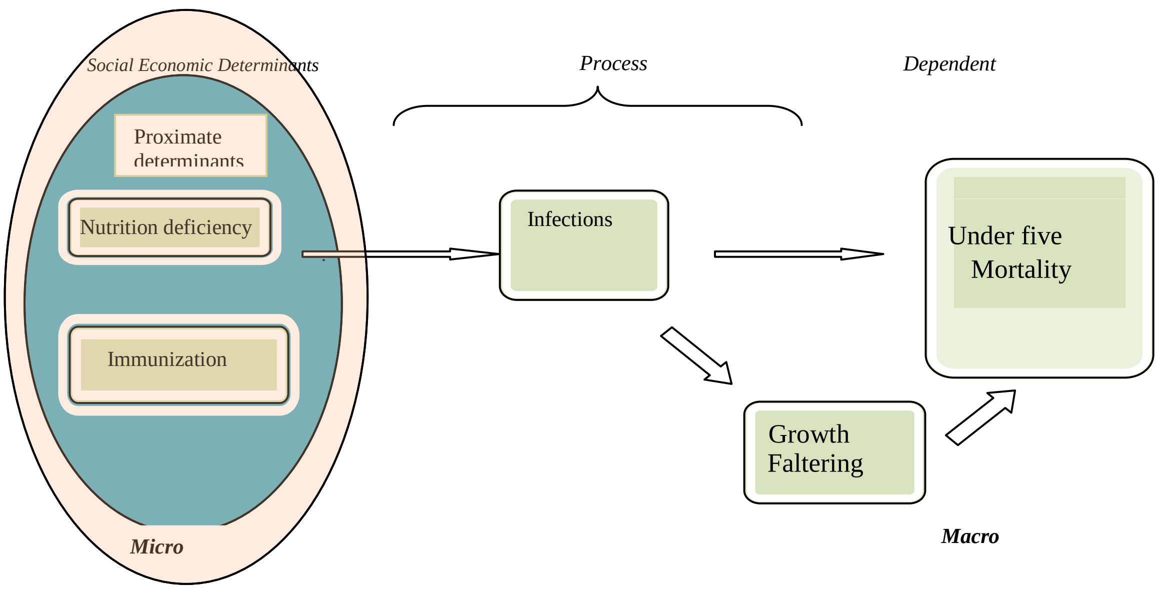

**Figure 2.1: Theoretical framework: Mosley and Chen, 1984.**

Mosley and Chen (1984, p.29) pointed out that, "the problems posed by mortality analysis, however, are far more complex because a child's death is the ultimate consequence of cumulative series of biological insults rather than the outcome of a single biological event". They therefore combined the medical and social science approach of studying counts of dead with observations of the living in a unified scale. He proposed combining a measure of growth faltering with mortality to generate a single dependent variable that can be scaled over all members of the population of interest. Therefore he recommended that the dependent variable in studying mortality using this approach is growth faltering and the independent variables the proximate determinants. Growth faltering is therefore used as a dependent variable; nutrient deficiency and immunization (personal illness control in the model) are used as proximate determinants of main interest. Previous studies have focused more on using growth faltering as a measure of malnutrition than as an index of estimating child survival.

However, according to Mosley & Chen (1983), it must not be confused, that growth faltering is malnutrition but more a relative risk as it indicates a health status of the population. They further add that it is a useful relative measure of current health status of the population cohort. Since it reflects cumulative past morbidity experience, it is suitable for single round retrospective surveys that search for the determinants of child survival. It therefore fits this study since results will be based on the secondary data of single round retrospective DHS surveys.

## 2.2 Conceptual framework

The conceptual framework is adopted from Mosley and Chen (1984) framework. It concentrates on studying nutrient deficiency and immunization and its causal links with growth faltering. Maternal factors, injury, and environmental contamination have been dropped as proximate determinants in the model because they are not viewed positively by other research stakeholders especially the community in regards to addressing the vice. More focus is also invested in the process of mortality through growth faltering as clearly indicated in the vicious cycle of malnutrition. The conceptual framework still maintains that the socio-economic variables operate through nutrient deficiency and immunization to influence under five mortality through growth faltering. The effect of how socio-economic variables influence mortality and whether this influence will be different between groups will not be studied.




*Adapted from Mosley & Chen (1983)*

**Figure 2.2: The Conceptual framework**

It must be noted that the dependent variable is growth faltering and relates to under five mortality when the condition is irreversible. In order to understand the conceptual model the definition and conceptualization of the model is presented in the next chapters.

### 2.3 Operationalization of dependent variable.

In the theoretical framework, growth faltering is proposed to study child mortality. For the current study the child survival status is used to calculate the under five mortality rates using the synthetic cohort method and levels of growth faltering, is used to relate to under five mortality rates. Binary variable of growth faltering is adopted as the dependent variable to study the relationship between nutrient deficiency, immunization, and growth faltering.

According to Caulfield et al (2006, p.551)**, “.....**children’s growth, under nutrition is generally characterized by comparing the weights or heights (or lengths) of children at a specific age and sex with the distribution of observed weights or heights in a reference population of presumed healthy children of the same age and sex.” The z-scores are then calculated from the difference of a child’s weight or height and the median value at that age and sex in the reference population, divided by the standard deviation (SD) of the reference population.

$$\text{i.e. } Z = \frac{X - \mu}{\sigma}$$

A child whose height for age, weight for age and weight for height are less than -2 SD is considered stunted, underweight, and wasted respectively. These are three possible outcomes of growth faltering, and they depend on the type of nutrient deficiency amongst others.

Weight for Age measurements were taken for every living child in the study and standard deviations from the normal weight recoded. Underweight was classified into four categories namely; Grade I, Grade II, Grade III, and Grade IV using the Waterlow and the Gomez classification. Grade I are normal children within $-1<SD<+1$, Grade II classified as moderately malnourished within $-2<SD<-1$. Severely Malnourished children with low survival probabilities were categorized as Grade III within $-3<SD<-2$. The last category is Grade IV, at this level, the child has limited chances of survival and is classified as very severely malnourished with $SD<-3$ from the Normal. 2,372 children were measured to determine their health status. In studying relationships Grade II, Grade III and Grade IV are combined to make one category i.e. growth faltering.

### 2.4 Operation of proximate determinants.

Mosley named five proximate determinants of child mortality of personal illness control, maternal factors, environmental contamination, injury, and nutrient deficiency. The study focuses on personal illness control and nutrient deficiency here in referred commonly as immunization and nutrient deficiency. As mentioned earlier, they are easily perceived by the community during the implementation of the proposed interventions. Data, time, and methodological constraints also limited studying environment, maternal and Injury factors.

#### 2.4.1 Nutrient deficiency

This refers to inadequate nutritional status, being caused by poor protein, energy, or micronutrient intake. Nutritional status is influenced by factors like child’s birth weight, drank from a bottle, vitamin A deficiency, anaemia level, zinc supplements and taking iron pills and syrup.

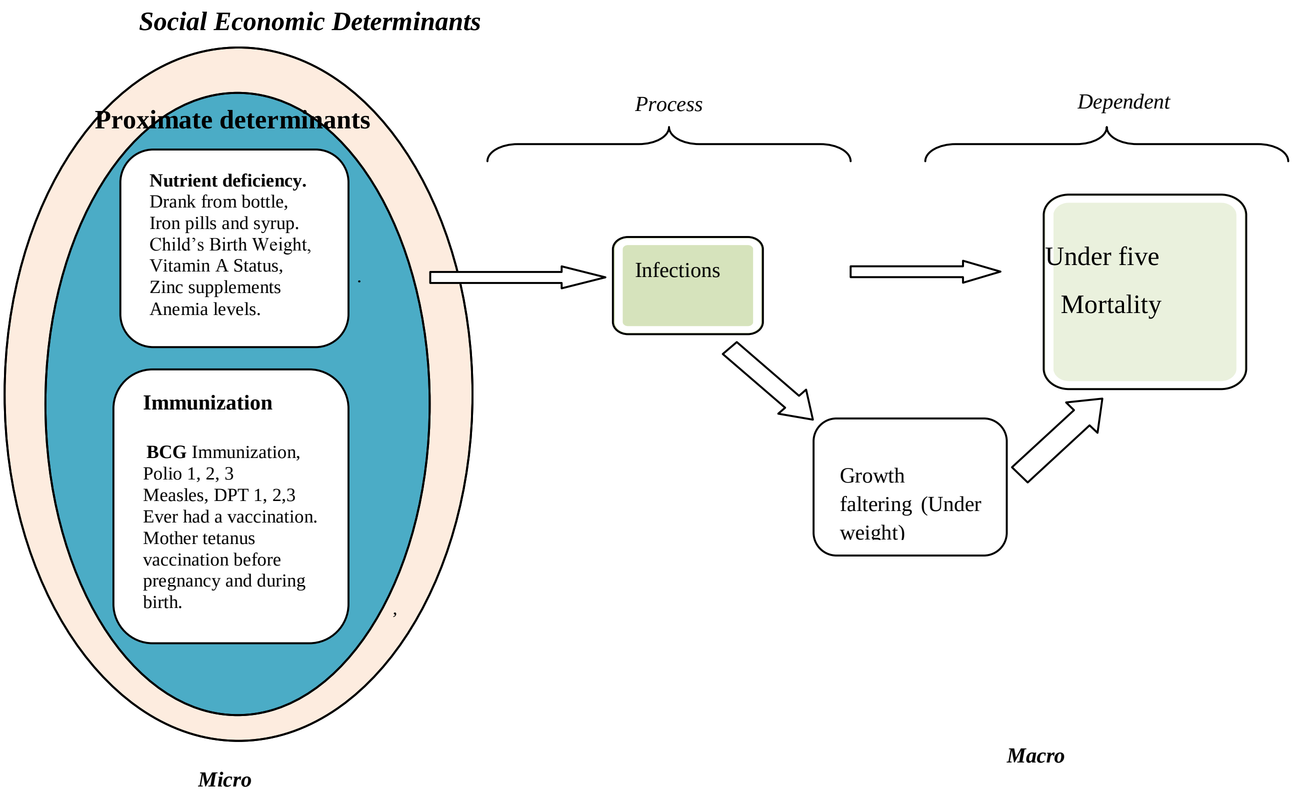
### 2.4.2 Immunization.

Immunization is defined as the process of inducing immunity, usually through inoculation or vaccination (WHO, 2003). These vaccines are administered to both mother and child. Children are inoculated against the killer diseases of Polio, Measles, Diphtheria, Pertusis (whooping cough), Tuberculosis, and Tetanus. Mother's are administered Tetanus vaccine before giving birth and during pregnancy. Vaccines (Polio and BCG) are administered at different ages for children. In a country with a high prevalence of infectious diseases, such as Uganda, failure for a mother or a child to receive or miss any of the vaccines is likely to influence a child's course of growth and eventually will influence his/her survival.

## 2.5 Operationalization of the conceptual model

The conceptual model is developed from the conceptual framework. It includes the concepts in the model and their relationship. More information included was developed from the background and previous research conducted in line of this research.

The Operationalized framework as seen in figure 2.5 indicates the dependent variable growth/health status of a child. It was derived from the concept of growth faltering in the research theoretical model/conceptual framework and is / will be measured by a variable underweight. The key proximate determinants of nutrient deficiency and immunization are indicated under the socio economic indicators.




*Adapted from Mosley & Chen (1984)*

**Figure 2.5: Operationalization framework**

## 3.0 DATA AND METHODS.

### 3.1 DATA

The data and study design is elaborated here. This chapter gives brief description of the sources of the data and DHS districts sampled in each survey by year. It further highlights sampling criteria and quality of data variables used. Ethical considerations under taken are also summarised here forth.

#### 3.1.1 Source

The study will use secondary data from past standard DHS surveys conducted by the Uganda Bureau of Statistics (UBOS). The data collection was done in Uganda and through collaboration, the datasets shared with measure-dhs. The data sets were requested from measure DHS. Measure DHS is a project supported by United States Agency for International Development (USAID). It provides technical support in implementing and disseminating nationally representative data through collaboration. Since 1984, measure-dhs has provided technical assistance to 84 countries for the implementation of 240 surveys in more than 30 countries (measuredhs.com). Uganda is one of the countries that have been receiving support from Measure DHS. The datasets of 1988/9, 1995, 2000, and 2006 DHS surveys were downloaded from www.measuredhs.com upon request.

#### 3.1.2 Description of datasets

In the DHS surveys, three questionnaires were used namely; Household, Women and Men. These questionnaires were developed for developing countries based on the measure-dhs models. The questionnaires were pre-tested before administering to the respondents (UDHS, 2006).
The household questionnaire provided information on a list of members in the household and their demographics. Women questionnaires provided information on reproductive history, child, and maternal health, nutrition, family planning and many more indicators. The women questionnaire was used for this study. According to the UDHS report, 2000/1, the men's questionnaire was shorter since it contains information same for women but did not contain information on reproductive history, nutrition, child and maternal health.
The children module contain questions asked women aged 15-49 years about the health and nutrition of their children. This was done after listing eligible members in the household to give information about children.

The organization of the DHS dataset is mainly structured into four, namely: household, individual, births, and children recodes. Others may include service availability, couples, and other tailored structures depending on purpose intended and the unit of analysis. For this study, the unit of analysis will be a child aged 0-59 months and data about children can be found in children's recode. The children's recode was chosen for this survey because it provides all the variables of antenatal care, child health care, and immunization, child growth status, and survival status needed for the study.

The study will use datasets of previous surveys since 1988/9 to 2006 to calculate the under five mortality rates. The 2006 dataset will be used to describe relationships between nutrient deficiency and immunization. Being the recent DHS survey, it will provide updated magnitude of under five mortality trends and the relationship between and nutrient deficiency and immunization among children under five years of age. Binary logistic regression analysis would be used to study relationship over a period and would use the survey dataset of 2006.

### 3.1.3 Description of DHS study area

The data description here includes the sample size, the response rate, and the objective of the survey. Data description by year of survey implementation is given further on in this section.

The 1988/9 DHS was the first survey conducted in Uganda. It was conducted at the height of insecurity in the Northern districts, which led to some Northern districts to be eventually left out in the sample. 25 districts were selected out of 33 districts. The survey omitted 9 districts that had a population of 20 percent of the nationally population. 4,730 women were interviewed who provide health information for more than 4,000 children. Height and weight measurements of 3,140 children were taken with a 95 percent response rate (UDHS report, 1989).

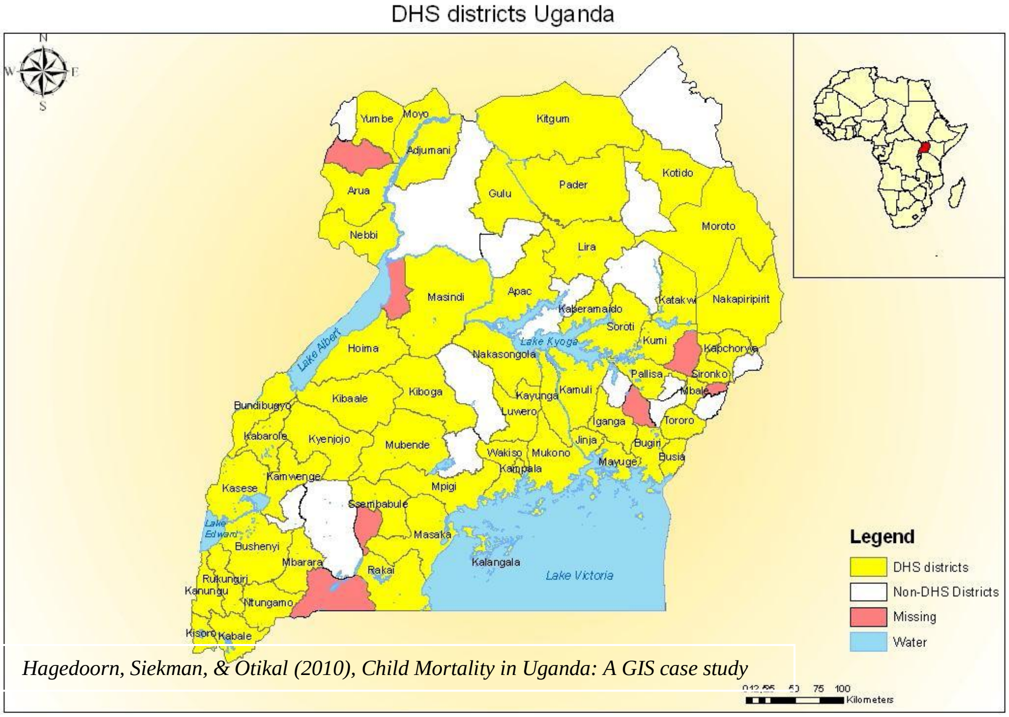
The 1995 DHS was the second to be conducted after the 1988/9 DHS. As with the 1988/9 DHS in Uganda, the 1995 DHS was designed to provide information on the levels and patterns and fertility, infant and child mortality, family planning, maternal and child health among other indicators (UDHS report, 1996). A nationally representative sample of 7,070 women aged 15-49 and 1,996 men aged 15-54 where interviewed to give information about child health. The report adds that unlike the 1988 survey, the 1995 survey was nationally representative and covered the whole country except Kitgum district.

The DHS survey of 2000/1 was completed amidst many improvements from previous DHS. It was also a follow up of 1988 and 1995 surveys and was designed to provide information on demographic, health, family status and trends in the country (UDHS report, 2001). 7,246 women aged 15-49 years and 1,962 men were interviewed to give information about child health and care as well as survival status of their children. This gave a response rate of 96 percent. Out of the 45 districts in Uganda by then, 41 districts were interviewed. The four districts excluded in the sample included Bundibugyo, Kasese, Kitgum, and Gulu mainly due to insecurity in the areas.

The 2006 survey is also the follow up of previous surveys implemented by Uganda Bureau of Statistics (UBOS) in 1988, 1995, 2000/1. The major objective of the survey was designed to provide information on demographics, health and family planning status and trends specifically on fertility, nutrition, sexual activity, child health, and mortality (DHS Survey, 2007). The 2006 DHS had more indicators and a large sample compared to previous indicators.

A nationally representative sample of 8,531 women, age 15–49 (95 percent of those eligible) and 2,503 men age 15–54 (91 percent of those eligible) were interviewed. It had a response rate of 98 percent. This sample provides representative estimates of health and demographic indicators at the national and regional levels, and for rural and urban areas. According to the 2006 DHS report, districts that were excluded in the previous surveys were included in the 2006 surveys in order to generate regional comparable estimates with other previous surveys.

The figure 3.1.2 shows the representativeness of the DHS surveys. The map is of the 2006 DHS survey districts developed in a case study report of child mortality in Uganda during a GIS course.




*Hagedoorn, Siekman, & Otikal (2010), Child Mortality in Uganda: A GIS case study*

**Figure 3.1.2: Map showing 2006 DHS study area**

The sample size of DHS surveys has been increasing since 1988 and the creation of new districts, current government phenomena dictates the selection of the study area among other considerations. The table 3.1.2 below summarizes the study area and sample size.

**Table 3.1.2: Distribution of DHS study areas/districts**

| DHS Year | Total Districts | Districts Sampled | Women (15-49) interviewed | Men( 15-54) Interviewed | Total Response rate (%) |
|---|---|---|---|---|---|
| 1988/9 | 33 | 25 | 4,730 | - | 95 |
| 1995 | 34 | 33 | 7,070 | 1,996 | - |
| 2000/1 | 45 | 41 | 7,246 | 1,962 | 96 |
| 2006 | 56 | 56 | 8,531 | 2,503 | 98 |

### 3.1.4 Selections of Subjects

DHS are sample surveys nationally implemented across the country. Two stage-sampling designs were used for all the surveys used in this study. Two stage sampling design involves dividing the study population into two clusters. The first clusters are called enumeration areas (EAs). Enumeration areas are administrative units like Sub counties, parishes, and Villages. According to the UDHS (2000/1), the first stage-sampling frame for the survey is the list of enumeration areas in the frame. Enumeration areas are grouped by parish within a sub county and sub counties within districts. In the second stage, households in each selected cluster were selected based on a complete list of households. A household selected into the sample consisted of women, children, visitors, and men. Residency was taken seriously for one to be eligible for an interview. Women age 15-49 and all men in a sub sample who were either permanent residents of the households in the 2006 UDHS sample or visitors present in the household on the night before the survey were eligible to be interviewed (UDHS 2006).

### 3.1.5 Quality

The Uganda DHS surveys are widely implemented with collaboration with international partners. The international partners include United Nations, USAID, and Measure-dhs etc. They provide technical guidance in areas like choosing the most acceptable representative sample, dealing with missing values, achieving an acceptable response rate, reliability checks and ensuring comparability among populations. Data quality of DHS because of its extensive use especially in developing policy instruments are implemented within international standards. DHS data quality is affected both by sampling and non-sampling error which translates to estimated figures.

For under five mortality estimations, retrospective reporting of deaths gives a direction of bias in underestimating infant mortality because there are no adequate techniques to correct for under reporting of births. According to Sullivan (2008), the most important quality issues concerning the mortality data collected in the DHS birth histories are of four kinds: errors in the recorded dates of birth of children, underreporting of deceased children, sampling problems (e.g., un representativeness of the selected sample) and failure to give accurate information on age at deaths for under fives.

This quality issues lead to underestimation or over estimation of Infant and under five mortality. Feasible techniques of adjusting estimates to accommodate the serious quality issues have been adopted in estimating mortality for children under five years of age. To minimize errors in the reporting of age at death, the UDHS interviewers were instructed to record the age at death in days if the death took place within one month after birth, in months if the child died within 24 months, and in years if the child was two years or older (UDHS 2000/1). However, misreporting of age of death is common in of ages of 12 months and this will not affect our estimates of under five mortality.

Another source of error not documented by Sullivan(2008) is reporting of birth histories for only surviving women aged 15-49 year implying that no data is available for children whose mother have died. This will under estimate under five mortality rates in countries like Uganda where there are high maternal mortality and deaths because of HIV/AIDS.

Furthermore, Preston et al (2008) reported changes in fertility and mortality levels as another source of errors when estimating under five mortality. He argues that it would be necessary to observe the reproductive history of women aged 15-49 who participates in the survey, but this information would be lacking. However, the changes in fertility and mortality have no significant bias in the estimation method but on the nature of analysis.

And finally, Sullivan et al (1994) also reported a bias in mortality estimation when considering women of age (15-49) as one category. He argued that child mortality is affected by mother's age of births with child survival lower with younger ages of women. This quality issues affect mortality estimation but a low scale.

### 3.16 Ethical consideration.

The datasets used for analysis are secondary; the first or primary user was the Uganda Bureau of Statistics. The data considerations during field data collection, editing and processing are assumed, to be taken care of by the Uganda Bureau of Statistics.

However, the data was obtained from measure-dhs after seeking permission from the Uganda

Bureau of Statistics on condition that the copy of the final report is submitted to measure-dhs. Research guidelines on citations and references during the course of preparation of the report have been and will be acknowledged to avoid plagiarism.

## 3.2 Operationalization of concepts.

The Operationalization and definition of concepts involves selection of variables that would measure the concepts defined. Selection of variables in the study depends on the research questions to be answered. The study will involve developing relationships and generating trends. The 2006 dataset will be used for generating relationship between under five mortality and immunization and Nutrient deficiency. Generating trends of under five mortality involves computation of under five mortality rates of different years. The four data sets of 1988/9, 1995, 2000/1 and 2006 DHS will be used. The operationalization will specify the measurements and recoding of variables to be used in the study by research question to be answered. A description of variables stratified by research question is given below.

***a) What is the effect of immunization and nutrient deficiency on growth faltering of under five children?***

This research question generates the relationship between growth faltering and immunization and nutrient deficiency. The dependent variable will be of growth faltering as measured by weight for age. The independent variables will be categorized under nutrient deficiency and immunization. The study will use the 2006 dataset to study these relationships. It is permitted by the method of analysis to be discussed in the next chapter.

### Immunization

Immunization is the process of inducing immunity usually through inoculation or vaccination (WHO, 2003) and is measured using the type and number of vaccinations administered to both Mother's and children. Mothers are immunized with tetanus vaccine before pregnancy and before birth. From the immunization schedule of Ministry of Health Uganda (2009), DPT 1, 2, 3 and POLIO 1, 2, 3 are administered to children at different age intervals of 6, 10 and 14 weeks. BCG and Measles are administered at birth and nine months respectively. Mothers were also asked whether a child was immunized or not. This will also be used to test whether immunization has a significant relationship with growth faltering. The variables in dataset will be recoded into binary variables with codes 1 'Yes' and 0 'No'. This will facilitate a better interpretation of value labels in the dataset. Initially the primary interest was to study the influence of immunization on child survival, but that there were no such data on dead children. Therefore, for relationships in the study, growth faltering is used as the outcome.

### Nutrient deficiency

Nutrient deficiency refers to inadequate nutrition or under nutrition always confused as growth faltering but is not necessary because growth faltering has been proved a consequence of other factors, let alone nutrient deficiency given evidence from other studies. To measure nutrient deficiency variables like anaemia level, vitamin A and child's weight at birth, zinc deficiency, and iron supplements will be used. Anaemia, vitamin A, and child's weight are determinants of anthropometric measures among others but will be treated independently. Studying them independently will inform policy and programming specifically on underlying causes. Vitamin A deficiency is administered at different age levels; first 2 months after birth and last 6 months of the survey. Vitamin A status will also be recoded into 0 'No' and 1 'Yes' in order to remove the category 8 'DK'.

***What are the Trends of Malnutrition and Immunization related under five mortality in Uganda since 1988 in Uganda?***

In order to answer this research question, the study will involve computation of under five-mortality rate for each survey year of 1988/9, 1995, 2000/1, and 2006. In order to calculate the under five-mortality rate, there are two methods used. Direct and indirect methods are internationally agreed in the calculation of child mortality rates. In this study, the direct method will be used. The direct method is used to estimate under five mortality by using the synthetic cohort life-table approach. It involves dividing the number of deaths of a specific cohort by the total exposure to deaths of that cohort within a specific time interval. The variables used to estimate under five mortality using this method are child's date of birth, survival status, age at death if died, date of interview, and the sample weight.

***c) Can the Millennium Goal of Reducing Child Mortality be achieved in Uganda?***

To study the possibility of achieving the millennium goal of achieving child mortality, trends of under five mortality rates will be reviewed. This relates to the second research question and data will be the under five mortality rates generated to answer the research question. The under five mortality rates of the years 1988/9, 1995, 2000/1 and 2006 will therefore be used to extrapolate trends to 2015. The under five mortality rate will be used as a baseline in determining the MDG target.

## 3.3 Methods

### 3.3.1 Introduction

The data to be used in this study include continuous and categorical variables. Dates have been converted to CMC codes. Studying child mortality in developing countries has been a challenge given data and capacity limitations without stating methodological concerns of reliable estimates. A number of techniques have been proposed by various international scholars to give estimates of under five mortality. This sub chapter describes the appropriate statistical methods and techniques used to answer the research questions advanced given the data descriptions.

### 3.3.2 The Synthetic Cohort method of estimating under five mortality rates

According to Preston et al (2008), a rate is the number of deaths to a birth cohort between ages 0 and x divided by the number of person years lived by the same cohort between ages x denoted as ${}_nM_x$. Under five mortality rate is, then, conventionally defined as the number of deaths to a specific birth cohort aged below 5 years divided by the number of person years lived by the same cohort between 0 and 5 years. See formula,

$${}_0M_5^C = \frac{\text{Number of deaths between ages 0 and 5}}{\text{Number of Person Years Lived between ages 0 and 5}}$$

Under five mortality rates are normally misinterpreted as probabilities. Preston et al defines a probability that a birth in a cohort would die before reaching age five, as the number of deaths to a specific birth cohort between ages 0 and 5 divide by the number of births in that cohort denoted as ${}_0q_5$ where 0 and 5 are exact ages. Rates are however measured using death exposure unlike probabilities. The person years lived is the unit of measuring exposure to death. It is normally expressed in thousands.

According to Shea and Guillermo (2006), direct and indirect estimation methods are commonly used for estimating infant and child mortality rates. Both methods of calculation use data on birth histories of women. Indirect methods of estimating under five mortality require information on survival status of children to specific age cohorts of mothers. Shea and Guillermo (2006, p.93) add that, “Unlike the direct methods, the indirect methods are very dependent upon several assumptions that may or may not hold true. Little or no change in fertility levels and age patterns, no change or a linear decline in mortality, and a pattern of mortality by age that conforms to known “families" basically derived from European experience.” The indirect methods employ so many assumptions mentioned above which need to be addressed in order t o have reliable estimates. It also does not give a lot of information as reported by Shea et al (1984).

The direct estimation method is used conventionally to estimate under five mortality rates in DHS surveys due to data specifications. It needs data that is only found in specifically designed surveys like DHS. DHS are designed to gather data on women’s birth histories. It is actually the driving cause for using direct estimation method in this study as well as in DHS analysis to estimate under five mortality rates.

There are three methods of estimating under five mortality using the direct method. They include the synthetic cohort method, true cohort life-table approach, and vital statistics approach. The vital statistics approach estimates under five mortality by dividing number of deaths of children aged 5 years and below by the number of births in the same period. This approach is limited to developing countries due to weak vital registration system. The number of births may also change with time hence changing the rate but not probabilities. Shea and Guillermo (2006) revealed that to correct this variation, separation factors would be needed which can only be obtained from other approaches.

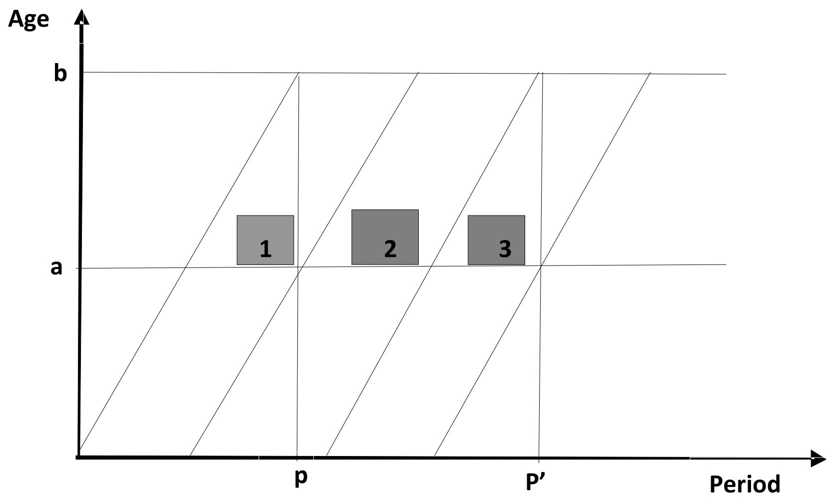
A true cohort life-table approach extends the vital statistics approach by considering a specific cohort. Besides rates, it also estimates true deaths probabilities unlike the vital statistics approach. However, it limits full exposure to deaths and the rates estimated are not specific to a period at death.

The synthetic cohort method computes mortality probabilities by small age segments thus catering for full exposure to deaths. It is due to these strengths that the study and DHS adopted the synthetic cohort to estimate under five mortality rates. More details of direct methods for estimation of under five mortality can be found in Shea and Guillermo (2006) guide to DHS statistics.

In this study, the under five mortality rates for different years are calculated from direct method using the synthetic cohort life-table approach based on the principles developed by Shea (1984). The probability of death for a cohort for a given period is the result of dividing the number of deaths for that period occurring between the limits of the subinterval by children who were exposed to death during the period.

The under five mortality rates are computed from component death probabilities of small age segment. These mortality probabilities of small age segment are death experiences of subintervals of 0, 1-2, 3-5, 6-11, 12-23, 24-35, 36-47 and 48-59 months of exposure. Component death probability are computed from deaths and corresponding exposure occurring in sub intervals of the study period. It must be noted that children contribute to exposure in the interval when they enter the interval alive and deaths in the intervals in which they die. This can be illustrated in the lexis diagram, figure 3.2.2 below.

**Figure 3.2.2: The Lexis diagram illustrating Synthetic cohort method.**




Adopted from Shea & Guillermo's Guide to DHS Statistics, 2006

The lexis diagram above represents children who die between ages a and b during the study period p and p'. Children born between the dates [p-a] and [p'-b] representing cohort 1 and between dates [p'-a] and [p'-b] representing cohort 3 are partially exposed to mortality between ages [a – b] during study period [p – p']. These reflect partial exposure, which must be taken into account. Therefore, half the deaths and exposure are assigned to the period [p-p'] and the preceding period unless [p-p'] is the last period that is when all deaths are assigned to that period. For cohort 2, all the deaths and exposure are assigned to the period [p-p']. The procedure of estimating under five mortality rates using synthetic cohort method is summarised below,

1 From the Lexis diagram the total number of deaths between ages a and b will be the sum of half the number of deaths of children aged a and b of cohort 1, all deaths of children aged a and b of cohort 2 and half number deaths of children aged a and b of cohort 3.

2 The total number of survivors between ages a and b will be the sum of half the number of survivors in cohort 1 and 3 and all the survivors in cohort 3 aged a and b.

3 The under five-mortality rate is then calculated using the component survival probability of the children of all of the relevant age segments, which is one minus the component death probability of each of these segments. The mortality rate is then calculated from the following formula:

4 ${}_nM_x = 1 - \prod(1- q_i)$

5 Where $q_i$ is the probability of dying in age segment i, and i ranges from x to x+n.

The under five mortality rates are calculated for every DHS year representing 0-4 years preceding the survey i.e. under five mortality rate of 2006 is mortality rate of 2001-2006.

### 3.3.3 Binomial Logistic Regression Analysis

Studying relationships between variables depends on the type of your dependent variables. The choice of the analytical technique also extends to the kind of interpretation of the relationships, nature, and number of variables. The study uses the categorical dependent variable with two categories of growth faltering. The dependent variable is binary and the common statistical technique of modelling a binary dependent variable is binary logistic regression.

The binary logistic regression model is given by the following logit function.

$$Logit\ (y) = a + ß_1 X_1 + ß_2 X_2 + \ .....\ + ß_k X_k$$

and its probability estimates is given by

$$P(y = 1) = \frac{1}{1 + EXP\ (a + ß1\ X1 + ß2\ X2 + .... + ßk\ Xk)\}}$$

where, y is a dichotomous dependent variable defined by ;

y={1, Yes ; 0 No}

$X_i$ is covariates (nutrient deficiency and immunization indicators ) ;

$ß_i$ is coefficients of the covariates to measure effect of $X_i$ on the log odds of growth faltering (y=1) after controlling other independent variables ;

The parameters of the model are estimated by using the Maximum likelihood method.

According to Hosmerslow and Lemeshow (2003), interpretation of the parameters of the model involves determining functional relationship of the dependent and Independent variable. Of importance to the interpretation is appropriately defining a unit of change for the independent variable. In order to have a meaningful interpretation of the model, exponentials of the coefficients will be computed. The exponentials are called the Odds.

The Odds is defined as probability of success over failure;

$$Odds = \frac{success}{failure} = \frac{P(x = 1)}{1 - P(x = 1)} = Exp(\beta)$$

If Odds < 1, it indicates that the odds of growth faltering decrease and the p(y=1) becomes smaller.

Odds > 1, the odds of growth faltering increase and the p(y=1) becomes larger.

Odds =1, the odds of growth faltering and p(y=1) do not change.

According to Homerslow and Lemeshow (2003), the Odds approximates how much more likely (or unlikely) it is for an outcome to be present among those with x=1. For example if y is growth faltering and x denotes whether a child has been immunized with polio vaccine, then the Odds=2 estimates that growth faltering is twice more likely to occur in polio non-immunized children than immunized children in our data are.

If the Odds =0.6 then growth faltering in 40 percent less likely to occur in un immunized children against polio compared to the immunised children.

The results of the Odds will be presented in tables with logistic regression coefficients with their respective Odds. This will represent the relationship between the dependent variable and the independent variable i.e. growth faltering and immunization or nutrient deficiency indicators.

### 3.3.4. Linear extrapolation.

Linear extrapolation is a process of constructing new data points outside the discrete set of known data points. It will be used to answer the fourth research question, 'Can the millennium goal of reducing child mortality be achieved in Uganda'.

The target of achieving this millennium goal is to reduce under five mortality by two-thirds by 2015. The two-third target implies that the under five-mortality rate by 2015 should drop to 59 deaths in a thousand using the 1988 rate as a base. In this study, under five mortality rates will be plotted for each year of DHS Surveys. A point will plotted outside the data range to represent the target to achieve and inference will be drawn then. The U5MR function will be estimated whether it will pass above or below the target. If it passes above the target, then the target has not been met. The results that will answer this question will be presented in a graph with a projected target to achieve the millennium development goal.

## 4.0 Results

## 4.1 Introduction

The study aims to answer three questions, which involve describing relationships, generating and studying trends and patterns of under five mortality in relation to growth faltering. In order to answer research question one; "What is the effect of immunization and nutrient deficiency on growth faltering." Relationships between nutrient deficiency, immunization and growth faltering were generated. Nutrient deficiency indicators include variables used to measure malnutrition e.g. anaemia level, vitamin A deficiency, birth weight etc. Immunization will be studied using status of vaccination against each disease. Relations are first presented using descriptive (univariate analysis) involving chi square tests for the four levels of growth faltering to give much details about the dependent variable. Descriptives for the two categories of dependent variable of growth faltering are then provided to select significant variables for the binary regression model. It paves way for answering the first research question. Three models of nutrient deficiency, immunization and a combination, each with growth faltering were developed. Parameters for the binomial regression model are the presented on separate tables to reveal the relationships. Relationships are using odds of child growth faltering to normal growth. Odds provide estimates of increased risk or probability as measured by the odds of growth faltering over normal.

In addition, research question two; "what are the trends of growth faltering and under five mortality in Uganda since 1988?", will be answered by developing patterns of under five mortality rates and growth faltering in Uganda. Rates were developed for all years in which the surveys have been undertaken. Deaths of children under five and their exposure were summarized in the lexis diagrams and finally used to calculate the under five mortality rates presented in one figure. Proportions of children who suffered different levels of growth faltering were generated.

Finally to answer the research question three thus; "Can the millennium goal of reducing child mortality be achieved in Uganda?", trends developed to answer research question two will be used to extrapolate under five mortality rates to 2015, a year in which the millennium goal of achieving the target of reducing child mortality by two-thirds is to be met.

This chapter therefore presents key findings of the study that relate to the research objectives and answers the research questions. It includes univariate analysis of descriptive statistics on all variables, Graphs showing patterns of under five mortality rates and growth faltering since 1988. The odds are also presented in table by independent variables and finally the analysis of the possibility of achieving millennium goal four. The results are presented in tables and charts.

## 4.2 Descriptive results

Cross tabulations with chi-squares were generated for immunization and nutrition deficiency disaggregated by levels of growth faltering. The results are presented in tables with accompanying statements by variable.

### 4.2.1 Growth faltering and nutrient deficiency indicators

Cross tabulations generated as shown in the table 4.2.1A below, revealed an insignificant relationship between growth faltering and drinking from a bottle, ever-received vitamin A, vitamin A status of a child. Zinc supplements were significant at $p<0.1$. Size of a child at birth, anaemia level and taking iron pills was significant at $p<0.05$. In addition, the chi-square tests revealed a difference in the levels of growth faltering between groups of children. The significant variables are further discussed below.

Also, in table 4.2.1A, the proportion of very malnourished children increased as the size of the child at birth decreased. 7.4 % of smaller than average sized children were very severely malnourished children compared to 9.1% very small. 59.7 percent and 50.2 % of very large and average size at birth had normal growth. It decreased to 38.3 % and 33.3% for children with smaller than average and very small size at birth. Moderately malnourished children were well distributed in proportion with at least 30 percent for all sizes of child at birth. The proportion of severely malnourished children also increased as the size of child decreased i.e. 5.9 % of the children were born very large, 10.3% larger than average, 13% average and 21.2 percent very small.

Furthermore, in the table 4.2.1A, 140 children were severely anaemic compared to 449 mild and 555 normal. Of 2,074 children, 47.6% were normal, 34.1 % moderately malnourished, 13.6% severely malnourished and only 4.8% severely malnourished. The proportion of children who were not anaemic declined with the level of growth faltering.

In addition to anaemia levels, iron supplements are given to children to eliminate iron deficiency. 2,250 children received no iron supplements compared to only 116 who received. Of those who received 32.7%, 12.9%, 4.6% were moderately, severely, and very severely malnourished respectively.

**Table 4.2.1A: Univariate results of levels of growth faltering and nutrient deficiency indicators, 2006.**

| | Growth Faltering | | | | | Chi-Square Test | | |
|---|---|---|---|---|---|---|---|---|
| | Grade I | Grade II | Grade III | Grade IV | Total | Value | df | p-value |
| **Drank from Bottle** | | | | | | **4.34** | **3** | **0.23** |
| No | 938 (48.3%) | 645 (33.2%) | 267(13.7%) | 94 (4.8%) | **1,944** | | | |
| Yes | 203 (52.7%) | 122 (31.7%) | 40 (10.4%) | 20 (5.2%) | **385** | | | |
| **Total** | **1141 (49%)** | **767 (32.9%)** | **307(13.2%)** | **114 (4.9%)** | **2,329** | | | |
| **Size of child at birth** | | | | | | **68.81** | **12** | **0.00** |
| Very Large | 111 (59.7%) | 59 (31.7%) | 11 (5.9%) | 5 (2.7%) | **186** | | | |
| Larger than average | 348 (53.7%) | 211 (32.6%) | 67 (10.3%) | 22 (3.4%) | **648** | | | |
| Average | 521 (50.2%) | 334 (32.2%) | 135 (13%) | 48 (4.6%) | **1,038** | | | |
| Smaller than average | 134 (38.3%) | 119 (34%) | 71 (20.3%) | 26 (7.4%) | **350** | | | |
| Very small | 44 (33.3%) | 48 (36.4%) | 28 (21.2%) | 12 (9.1%) | **132** | | | |
| **Total** | **1158 (49.2%)** | **771 (32.8%)** | **312(13.3%)** | **113 (4.8%)** | **2,354** | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Ever Received Vitamin A** | | | | | | **0.93** | **3** | **0.82** |
| No | 352 (49.6%) | 222 (31.3%) | 101(14.2%) | 34 (4.8%) | **709** | | | |
| Yes | 528 (47.9%) | 367 (33.3%) | 152(13.8%) | 56 (5.1%) | **1,103** | | | |
| **Total** | **880 (48.6%)** | **589 (32.5%)** | **253 (14%)** | **90 (5%)** | **1,812** | | | |
| **Anaemia Level** | | | | | | **41.24** | **9** | **0.00** |
| Severe | 56 (40%) | 42 (30%) | 32 (22.9%) | 10 (7.1%) | **140** | | | |
| Moderate | 403 (43.1%) | 343 (36.7%) | 133(14.2%) | 55 (5.9%) | **934** | | | |
| Mild | 220 (49%) | 157 (35%) | 53 (11.8%) | 19 (4.2%) | **449** | | | |
| Not anaemic | 311 (56%) | 166 (29.9%) | 63 (11.4%) | 15 (2.7%) | **555** | | | |
| **Total** | **990 (47.6%)** | **708 (34.1%)** | **281(13.5%)** | **99 (4.8%)** | **2,078** | | | |
| **Vitamin A Status** | | | | | | **3.98** | **3** | **0.26** |
| No | 871 (47.3%) | 630 (34.2%) | 248(13.5%) | 93 (5%) | **1,842** | | | |
| Any Vitamin A deficiency | 119 (51.3%) | 73 (31.5%) | 34 (14.7%) | 6 (2.6%) | **232** | | | |
| **Total** | **990 (47.7%)** | **703 (33.9%)** | **282(13.6%)** | **99 (4.8%)** | **2,074** | | | |
| **Given zinc** | | | | | | **6.74** | **3** | **0.08** |
| No | 258 (41%) | 208 (33%) | 114(18.1%) | 50 (7.9%) | **630** | | | |
| Yes | 0 (0%) | 3 (50%) | 3 (50%) | 0 (0%) | **6** | | | |
| **Total** | **258 (40.6%)** | **211 (33.2%)** | **117(18.4%)** | **50 (7.9%)** | **636** | | | |
| **Taking iron pills, sprinkles for syrup** | | | | | | **12.99** | **3** | **0.00** |
| No | 1121 (49.8%) | 735 (32.7%) | 290 (12.9%) | 104 (4.6%) | **2,250** | | | |
| Yes | 42 (36.2%) | 40 (34.5%) | 24 (20.7%) | 10 (8.6%) | **116** | | | |
| **Total** | **1,163(49.2%)** | **775 (32.8%)** | **314(13.3%)** | **114 (4.8%)** | **2,366** | | | |

**Grade I - Normal, Grade II-Moderately malnourished, Grade III Severely malnourished, Grade IV- Very severely malnourished**

The table 4.2.1A above, gives univariate analysis of growth faltering at four levels of normal, moderately, severely malnourished and very severely malnourished. The last three levels were grouped into one category to make one compound variable growth faltering with only two categories (yes/no). The table 4.2.1B below shows the univariate results of growth faltering and nutrient deficiency, where growth faltering is binary i.e. two categories.

**Table4.2.1B:Univariate results of growth faltering and nutrient deficiency indicators, 2006.**

| | Growth Faltering | | | Chi-Square test | | |
|---|---|---|---|---|---|---|
| | No | Yes | Total | Value | df | p-value |
| **Drank from Bottle** | | | | **2.57** | **1** | **0.108** |
| No | 938 (48.2%) | 1006 (51.7%) | **1,944** | | | |
| Yes | 203 (52.7%) | 182 (47.3%) | **385** | | | |
| **Total** | **1141 (49%)** | **1188 (51%)** | **2,329** | | | |
| | | | | | | |
| **Size of child at birth** | | | | **43.85** | **4** | **0.00** |
| Very Large | 111 (59.7%) | 75(40.3%) | **186** | | | |
| Larger than average | 348 (53.7%) | 300 (46.3%) | **648** | | | |
| Average | 521 (50.2%) | 517 (49.8%) | **1,038** | | | |
| Smaller than average | 134 (38.2%) | 216 (61.7%) | **350** | | | |
| Very small | 44 (33.3%) | 88 (66.7%) | **132** | | | |
| **Total** | **1158 (49.2%)** | **771 (50.8%)** | **2,354** | | | |
| | | | | | | |
| **Ever Received Vitamin A** | | | | **0.546** | **1** | **0.46** |
| No | 352 (49.6%) | 357 (50.4%) | **709** | | | |
| Yes | 528 (47.9%) | 575 (52.1%) | **1,103** | | | |
| **Total** | **880 (48.6%)** | **932 (51.4%)** | **1,812** | | | |
| **Anaemia Level** | | | | | | |
| Severe | 56 (40%) | 42 (60%) | **140** | **26.84** | **3** | **0.00** |
| Moderate | 403 (43.1%) | 531 (56.9%) | **934** | | | |
| Mild | 220 (49%) | 229 (51%) | **449** | | | |
| Not anaemic | 311 (56%) | 244 (44.0%) | **555** | | | |
| **Total** | **990 (47.6%)** | **1088 (52.4%)** | **2,078** | | | |
| | | | | | | |
| **Vitamin A Status** | | | | **1.326** | **1** | **0.249** |
| No | 871 (47.3%) | 971 (52.3%) | **1,842** | | | |
| Any Vitamin A deficiency | 119 (51.3%) | 113 (48.7%) | **232** | | | |
| **Total** | **990 (47.7%)** | **1084 (52.3%)** | **2,074** | | | |
| | | | | | | |
| **Given zinc** | | | | **4.134** | **1** | **0.042** |
| No | 258 (41.0%) | 372 (59.0%) | **630** | | | |
| Yes | 0 (0%) | 6(100%) | **6** | | | |
| **Total** | **258 (40.7%)** | **378 (59.4%)** | **636** | | | |
| | | | | | | |
| **Taking iron pills, sprinkles for syrup** | | | | **8.182** | **1** | **0.004** |
| No | 1121 (49.8%) | 1129 (50.2%) | **2,250** | | | |
| Yes | 42 (36.2%) | 74 (63.8%) | **116** | | | |
| **Total** | **1163 (49.2%)** | **1203 (50.8%)** | **2,366** | | | |

Table 4.2.1B shows descriptives of growth faltering with nutrient deficiency factors. It reveals that vitamin A status, ever received vitamin A and drank from the bottle still remained insignificant at $p<0.05$. However, zinc then became significant at $p<0.05$ than it was in table 4.2.1A with four levels of growth faltering. Size of a child at birth, anaemia level and taking iron pills remained very significant at $p<0.05$.

The proportion of children who suffered growth faltering increased as the size of a child at birth decreased. The reverse was true for normal children, the percentage of normal children decreased as the size of a child at birth decreased from very large to very small. The chi-square value was large and very significant at p<0.05 revealing a difference between sizes of a child at birth and growth faltering.

Further in the table 4.2.1B, the proportion of normal children increased as the level of anaemia deficiency declined. 40% of the normal children were severely anaemic, 43.1% moderate, 49% mild, and 56% not anaemic. On the other hand, the proportion of children who suffered growth faltering and were severely anaemic was high at 60% dropping down to 44% not anaemic.
It is surprising to note in table 4.2.1B that no normal child was given zinc supplements and a majority 59% who suffered growth faltering also did not receive zinc. Only 6 children who suffered growth faltering received zinc, though not enough to conclusively relate to growth faltering. This reveals that children receive zinc supplements after suffering growth faltering.

There was the same pattern for zinc supplements. A high proportion (63.8%) of children who took iron pill and sprinkles for syrup suffered growth faltering. In addition, a majority who did not receive iron pills and sprinkles for syrup suffered growth faltering. The results revealed a possible reverse association than expected of iron and zinc supplements with growth faltering. Could this be that children receive iron and zinc supplements when sick?

### 4.2.2 Growth faltering and immunization indicators

Immunization as a determinant of growth faltering is measured at different levels of growth and administered to both mother and child. Mother's are immunized before pregnancy and during pregnancy. Children are vaccinated at birth and thereafter in their course of growth. DPT, Polio, and DPT-HepB-Hib are administered at three stages of growth namely 8 weeks, 10 weeks, and 14 weeks. Polio is administered earlier at birth.

Table 4.2.2A shows the association between the four levels of growth faltering and immunization indicators. It explores mother's tetanus injection before pregnancy, measles, Polio, BCG, DPT and DPT-HepB-Hib, a combination of vaccines to include DPT.

**Table 4.2.2A: Univariate results of levels of growth faltering and immunization indicators, 2006**

| | Growth Faltering | | | | | Chi-Square Test | | |
|---|---|---|---|---|---|---|---|---|
| | Grade I | Grade II | Grade III | Grade IV | Total | Value | df | p-value |
| **Tetanus injections before pregnancy** | | | | | | **2.53** | **3** | **0.47** |
| No | 101 (44.1%) | 76 (33.2%) | 36 (15.7%) | 16 (7%) | **229** | | | |
| Yes | 237 (46.4%) | 183 (35.8%) | 61 (11.9%) | 30 (5.9%) | **511** | | | |
| **Total** | **338 (45.7%)** | **259 (35%)** | **97 (13.1%)** | **46 (6.2%)** | **740** | | | |
| **Received BCG** | | | | | | **5.59** | **3** | **0.13** |
| No | 132 (47.7%) | 82 (30%) | 49 (17.7%) | 13 (4.7%) | **277** | | | |
| Yes | 1031 (49.3%) | 695 (33.2%) | 265 (12.7%) | 101 (4.8%) | **2,092** | | | |
| **Total** | **1163 (49.1%)** | **778 (32.8%)** | **314 (13.3%)** | **114 (4.8%)** | **2,369** | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Received DPT 1** | | | | | | **4.09** | **3** | **0.25** |
| No | 716 (49.1%) | 463 (31.8%) | 208 (14.3%) | 70 (4.8%) | **1,457** | | | |
| Yes | 449 (49.2%) | 313 (34.3%) | 106 (11.6%) | 44 (4.8%) | **912** | | | |
| **Total** | **1165 (49.2%)** | **776 (32.8%)** | **314 (13.2%)** | **114 (4.8%)** | **2,369** | | | |
| **Received POLIO 1** | | | | | | **3.92** | **3** | **0.27** |
| No | 159 (51.3%) | 92 (29.7%) | 48 (15.5%) | 11 (3.5%) | **310** | | | |
| Yes | 1,007 (48.8%) | 686 (33.3%) | 266 (12.9%) | 103 (5%) | **2,062** | | | |
| **Total** | **1166 (49.2%)** | **778 (32.8%)** | **314 (13.2%)** | **114 (4.8%)** | **2,372** | | | |
| **Received DPT 2** | | | | | | **4.45** | **3** | **0.22** |
| No | 794 (49.3%) | 514 (31.9%) | 228 (14.2%) | 75 (4.7%) | **1,611** | | | |
| Yes | 371 (48.9%) | 262 (34.6%) | 86 (11.3%) | 39 (5.1%) | **758** | | | |
| **Total** | **1165 (49.2%)** | **776 (32.8%)** | **314 (13.3%)** | **114 (4.8%)** | **2,369** | | | |
| **Received POLIO 2** | | | | | | **6.88** | **3** | **0.08** |
| No | 308 (53%) | 168 (28.9%) | 81 (13.9%) | 24 (4.1%) | **581** | | | |
| Yes | 858 (47.9%) | 610 (34.1%) | 233 (13.0%) | 90 (5.0%) | **1,791** | | | |
| **Total** | **1166 (49.2%)** | **778 (32.8%)** | **314 (13.2%)** | **114 (4.8%)** | **2,372** | | | |
| **Received DPT 3** | | | | | | **1.31** | **3** | **0.73** |
| No | 915 (49.6%) | 597 (32.3%) | 248 (13.4%) | 86 (4.7%) | **1,846** | | | |
| Yes | 250 (47.8%) | 179 (34.2%) | 66 (12.6%) | 28 (5.4%) | **523** | | | |
| **Total** | **1165 (49.2%)** | **776 (32.8%)** | **314 (13.3%)** | **114 (4.8%)** | **2,369** | | | |
| **Received POLIO 3** | | | | | | **5.15** | **3** | **0.16** |
| No | 571 (50.5%) | 347 (30.7%) | 160 (14.1%) | 53 (4.7%) | **1,131** | | | |
| Yes | 595 (47.9%) | 431 (34.7%) | 154 (12.4%) | 61 (4.9%) | **1,241** | | | |
| **Total** | **1166 (49.2%)** | **778 (32.8%)** | **314 (13.2%)** | **114 (4.8%)** | **2,372** | | | |
| **Received MEASLES** | | | | | | **9.90** | **3** | **0.02** |
| No | 437 (48.8%) | 270 (30.2%) | 140 (15.6%) | 48 (5.4%) | **895** | | | |
| Yes | 724 (49.4%) | 502 (34.3%) | 173 (11.8%) | 66 (4.5%) | **1,465** | | | |
| **Total** | **1161 (49.2%)** | **772 (32.7%)** | **313 (13.3%)** | **114 (4.8%)** | **2,360** | | | |
| **Received POLIO 0** | | | | | | **2.27** | **3** | **0.52** |
| No | 629 (48.6%) | 430 (33.3%) | 178 (13.8%) | 56 (4.3%) | **1,293** | | | |
| Yes | 537 (49.8%) | 348 (32.3%) | 136 (12.6%) | 58 (5.4%) | **1,079** | | | |
| **Total** | **1166 (49.2%)** | **778 (32.8%)** | **314 (13.2%)** | **114 (4.8%)** | **2,372** | | | |
| **Ever had vaccination** | | | | | | **1.72** | **3** | **0.63** |
| No | 86 (47.5%) | 59 (32.6%) | 29 (16.0%) | 7 (3.9%) | **181** | | | |
| Yes | 422 (48.7%) | 292 (33.7%) | 110 (12.7%) | 43 (5.0%) | **867** | | | |
| **Total** | **508 (48.5%)** | **351 (33.5%)** | **139 (13.3%)** | **50 (4.8%)** | **1,048** | | | |
| **Received DPT-HepB-Hib 1** | | | | | | **0.65** | **3** | **0.88** |
| No | 597 (49.2%) | 404 (33.3%) | 155 (12.8%) | 57 (4.7%) | **1,213** | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Yes | 569 (49.1%) | 374 (32.3%) | 159 (13.7%) | 57 (4.9%) | **1,159** | | | |
| **Total** | **1166 (49.2%)** | **778 (32.8%)** | **314 (13.2%)** | **114 (4.8%)** | **2,372** | | | |
| **Received DPT-HepB-Hib 2** | | | | | | **0.40** | **3** | **0.94** |
| No | 668 (49.7%) | 439 (32.6%) | 175 (13.0%) | 63 (4.7%) | **1,345** | | | |
| Yes | 498 (48.5%) | 339 (33.0%) | 139 (13.5%) | 51 (5.0%) | **1,027** | | | |
| **Total** | **1166 (49.2%)** | **778 (32.8%)** | **314 (13.2%)** | **114 (4.8%)** | **2,372** | | | |
| **Received DPT-HepB-Hib 3** | | | | | | **0.55** | **3** | **0.09** |
| No | 738 (49.4%) | 489 (32.7%) | 193 (12.9%) | 74 (5.0%) | **1,494** | | | |
| Yes | 428 (48.7%) | 289 (32.9%) | 121 (13.8%) | 40 (4.6%) | **878** | | | |
| **Total** | **1166 (49.2%)** | **778 (32.8%)** | **314 (13.2 %)** | **114 (4.8%)** | **2,372** | | | |

**Grade I - Normal, Grade II-Moderately malnourished, Grade III Severely malnourished, Grade IV- Very severely malnourished**

Table 4.2.2A above reveals that all the immunization indicators except received measles vaccine were not significant at $p<0.05$. Polio2 and DPT-HepB-Hib 3 were significant at $p<0.1$.
49.4% percent of normal children had not received measles vaccine compared 49.6% who received. The proportion of children who received the vaccine was however high with children who suffered severe and very severe malnutrition. This also reveals a possible reverse association than expected. It was also noted with zinc and iron pills in table 4.2.1B.
In addition, the percentage of the children who did not receive polio 2 vaccine was low among groups who were moderately and very severely malnourished.

**Table 4.2.2B: Univariate results of growth faltering and Immunization indicators.**

| | Growth faltering | | | Chi Square test | | |
|---|---|---|---|---|---|---|
| | **No** | **Yes** | **Total** | **Value** | **df** | ***p-value*** |
| **Tetanus injections before pregnancy** | | | | **0.33** | **1** | ***0.566*** |
| No | 101 (44.1%) | 128 (55.9%) | **229** | | | |
| Yes | 237 (46.4%) | 274 (53.6%) | **511** | | | |
| **Total** | **338 (45.7%)** | **402 (54.3%)** | **740** | | | |
| **Received BCG** | | | | **0.26** | **1** | ***0.16*** |
| No | 132 (47.7%) | 145 (52.3%) | **277** | | | |
| Yes | 1,031 (49.3%) | 1,061 (50.7%) | **2,092** | | | |
| **Total** | **1,163 (49.1%)** | **1,206 (50.9%)** | **2,369** | | | |
| **Received DPT 1** | | | | **0.002** | **1** | ***0.966*** |
| No | 716 (49.1%) | 741 (50.9%) | **1,457** | | | |
| Yes | 449 (49.2%) | 463 (50.8%) | **912** | | | |
| **Total** | **1165 (49.2%)** | **1204 (50.8%)** | **2,369** | | | |
| **Received POLIO 1** | | | | **0.649** | **1.00** | ***0.42*** |
| No | 159 (51.3%) | 151 (48.7%) | **310** | | | |
| Yes | 1007 (48.8%) | 1055 (51.2%) | **2,062** | | | |
| **Total** | **1,166 (49.2%)** | **1,206 (50.8%)** | **2,372** | | | |
| **Received DPT 2** | | | | **0.024** | **1** | ***0.877*** |

| | | | | | | |
|---|---|---|---|---|---|---|
| No | 794 (49.3%) | 817 (50.7%) | **1,611** | | | |
| Yes | 371 (48.9%) | 387 (51.1%) | **758** | | | |
| **Total** | **1,165 (49.2%)** | **1,204 (50.8%)** | **2,369** | | | |
| **Received POLIO 2** | | | | **4.576** | **1** | ***0.032*** |
| No | 308 (53%) | 273 (47.0%) | **581** | | | |
| Yes | 858 (47.9%) | 933 (52.1%) | **1,791** | | | |
| **Total** | **1,166 (49.2%)** | **1,206 (50.8%)** | **2,372** | | | |
| **Received DPT 3** | | | | **0.508** | **1** | ***0.476*** |
| No | 915 (49.6%) | 931 (50.4%) | **1,846** | | | |
| Yes | 250 (47.8%) | 273 (52.2%) | **523** | | | |
| **Total** | **1,165 (49.2%)** | **1,204 (50.8%)** | **2,369** | | | |
| **Received POLIO 3** | | | | **1.529** | **1** | ***0.216*** |
| No | 571 (50.5%) | 560 (49.5%) | **1,131** | | | |
| Yes | 595 (47.9%) | 646 (52.1%) | **1,241** | | | |
| **Total** | **1,166 (49.2%)** | **1,206 (50.8%)** | **2,372** | | | |
| **Received MEASLES** | | | | **0.078** | **1** | ***0.78*** |
| No | 437 (48.8%) | 458 (51.2%) | **895** | | | |
| Yes | 724 (49.4%) | 741 (50.6%) | **1,465** | | | |
| **Total** | **1,161 (49.2%)** | **1,199 (50.8%)** | **2,360** | | | |
| **Received POLIO 0** | | | | **0.296** | **1** | ***0.586*** |
| No | 629 (48.6%) | 664 (51.4%) | **1,293** | | | |
| Yes | 537 (49.8%) | 542 (50.2%) | **1,079** | | | |
| **Total** | **1,166 (49.2%)** | **1,206 (50.8%)** | **2,372** | | | |
| **Ever had vaccination** | | | | **0.081** | **1** | ***0.776*** |
| No | 86 (47.5%) | 95 (52.5%) | **181** | | | |
| Yes | 422 (48.7%) | 445 (51.3%) | **867** | | | |
| **Total** | **508 (48.5%)** | **540 (51.5%)** | **1,048** | | | |
| **Received DPT-HepB-Hib 1** | | | | **0.004** | **1** | ***0.952*** |
| No | 597 (49.2%) | 616 (50.8%) | **1,213** | | | |
| Yes | 569 (49.1%) | 590 (50.9%) | **1,159** | | | |
| **Total** | **1,166 (49.2%)** | **1,206 (50.8%)** | **2,372** | | | |
| **Received DPT-HepB-Hib 2** | | | | **0.322** | **1** | ***0.571*** |
| No | 668 (49.7%) | 677 (50.3%) | **1,345** | | | |
| Yes | 498 (48.5%) | 529 (51.5%) | **1,027** | | | |
| **Total** | **1,166 (49.2%)** | **1,206 (50.8%)** | **2,372** | | | |
| **Received DPT-HepB-Hib 3** | | | | **0.094** | **1** | ***0.76*** |
| No | 738 (49.4%) | 756 (50.6%) | **1,494** | | | |
| Yes | 428 (48.7%) | 450 (51.3%) | **878** | | | |
| **Total** | **1,166 (49.2%)** | **1,206 (50.8%)** | **2,372** | | | |

Table 4.2.2B above explores the association of two levels of growth faltering and immunization factors. The chi-square tests reveal that only received Polio2 is significant in its binary association with growth faltering. All the other vaccines of measles, DPT (all levels), ever received vaccination, BCG, DPT-HepB-Hib (all levels) and mother tetanus injection at birth were not significant at $p<0.05$.
However, measles vaccine previously at table 4.2.2B was significant at $p<0.05$ but not anymore. This is because of the powerful effect in combining categories. Polio2 improved in its association from $p<0.1$ to $p<0.05$ level of significance. This is because of combining categories of the levels of growth faltering to two categories.

Surprisingly, the table still revealed the reverse association than expected. 47% of children who suffered growth faltering did not receive the polio2 vaccine fairly lower than 52.1% who received the vaccine. In addition, the proportion (53%) of normal children who did not receive polio2 vaccine was higher than those who received (47.9%). The same reverse association reported with four levels with growth faltering.

**4.3 Binomial logistic regression results**

The results of parameter estimates of a binomial logistic regression model of the two categories of growth faltering (yes/no) and nutrient deficiency are given in table 4.3.1 and 4.3.2 below.
The results will answer research question one; what is the effect of nutrient deficiency and immunization on growth faltering. The model was fit by including the significant variables with $p<0.05$ from univariate analysis in section 4.2.

### 4.3.1 Nutrient deficiency and growth faltering (model 1)

Size of the child at birth, anaemia level, received zinc and taking iron pills were included in the models because they were significant during the univariate analysis.
The -2 log likelihood estimate was 732.092 with the model accounting for 7% of the variation. However, zinc and anaemia were not significant at $p<0.05$ with zinc and anaemia having 0.999 and 0.810 level of significance.

Zinc supplements was removed and the model was re-run and it significantly improved. Anaemia categories became all significant and the -2 log likelihood estimate increased from 732.092 to 2775.44. However, the level of variation dropped from 7 percent to 4.6 percent explaining the power Zinc supplements in influencing growth faltering.
The overall model fit has an explanatory power of 4.6 percent as indicated by the Nagelkerke pseudo R square. This implies that the model accounts for approximately 4.6 percent of variation in growth faltering among other explanatory variables not identified and included in the model. The best model fit revealed size of a child at birth, anaemia and taking iron pills, significant explanatory nutrient deficiency indicators influencing growth faltering among under five year olds in Uganda.

**Table 4.3.1: Parameter estimates of nutrient deficiency and growth faltering, 2006 (N=2,057)**

| | B | S.E. | Wald | df | Sig. | Exp(B) |
|---|---|---|---|---|---|---|
| **Size of a child birth** | | | 38.450 | 4 | .000 | |
| Very Large | -1.070 | .255 | 17.577 | 1 | .000 | .343 |
| Larger than average | -.817 | .216 | 14.276 | 1 | .000 | .442 |
| Average | -.652 | .210 | 9.631 | 1 | .002 | .521 |
| Smaller than average | -.145 | .234 | .383 | 1 | .536 | .865 |
| Very Small | Reference | | | | | |
| **Anaemia level** | | | 25.636 | 3 | .000 | |
| Severe | .644 | .196 | 10.779 | 1 | .001 | 1.904 |
| Moderate | .521 | .110 | 22.492 | 1 | .000 | 1.684 |
| Mild | .312 | .130 | 5.800 | 1 | .016 | 1.366 |
| Not anaemic | Reference | | | | | |
| **Taking iron pills, sprinkles for syrup** | | | | | | |
| No | -.517 | .207 | 6.244 | 1 | .012 | .597 |
| Yes | Reference | | | | | |
| Constant | .864 | .293 | 8.683 | 1 | .003 | 2.374 |

### 4.3.2 Immunization and growth faltering (model 2).

In order to answer part of the research question one; "what are the effects of immunization on growth faltering of under five children?" the second binary logistic model was run. The model was developed using only significant variables i.e. variables with $p<0.05$ from the univariate analysis in section 4.2.2. Polio2 was the only significant variable and was used to generate the model.

Table 4.3.2 shows the model parameter estimates of immunization and growth faltering.

**Table 4.3.2: Parameter estimates of immunization and growth faltering, 2006 (N=2,372)**

| | B | S.E. | Wald | df | Sig. | Exp(B) |
|---|---|---|---|---|---|---|
| **Received POLIO 2** | | | | | | |
| No | .204 | .096 | 4.569 | 1 | .033 | 1.227 |
| Yes | Reference | | | | | |
| Constant | -.121 | .083 | 2.106 | 1 | .147 | .886 |

The -2 log likelihood estimate for the above model is 3283.04 and polio 2 accounted for 0.3 percent of the variation in growth faltering. The explanatory power of polio2 is less that 1 percent which is extremely low. Polio2 was significant at $p<0.05$ and it explained growth faltering in children under five years of age. The odds of growth faltering increased by 1.227 for children who did not receive polio2 vaccine compared to those who received.

### 4.3.3 Nutrient deficiency, immunization and growth faltering (final model).

This model answers our first research question; "what are the effects of immunization and nutrient deficiency on growth faltering among children under five in Uganda."

The model is generated by combining model 1 and 2 in the above sections. The significant variables of Polio2, Size of a child at birth, anaemia level and taking iron pills and syrup were combined in one model.

The final model has the -2 log likelihood estimate of 2774.31 and explained 4.6 percent of the total variation in growth faltering.
The table 4.3.3 below shows the parameter estimates of the final model.

**Table 4.3.3: Parameter estimates of nutrient deficiency, immunization and growth faltering, 2006 (N=2,057)**

| | B | S.E. | Wald | df | Sig. | Exp(B) |
|---|---|---|---|---|---|---|
| **Received POLIO 2** | | | | | | |
| No | .123 | .116 | 1.127 | 1 | .288 | 1.131 |
| Yes | Reference | | | | | |
| **Size of a child birth** | | | 38.663 | 4 | .000 | |
| Very Large | -1.068 | .255 | 17.515 | 1 | .000 | .344 |
| Larger than average | -.823 | .216 | 14.476 | 1 | .000 | .439 |
| Average | -.658 | .210 | 9.792 | 1 | .002 | .518 |
| Smaller than average | -.146 | .234 | .389 | 1 | .533 | .864 |
| Very Small | Reference | | | | | |
| **Anaemia Level** | | | 26.409 | 3 | .000 | |
| Severe | .658 | .197 | 11.197 | 1 | .001 | 1.931 |
| Moderate | .531 | .110 | 23.174 | 1 | .000 | 1.701 |
| Mild | .316 | .130 | 5.952 | 1 | .015 | 1.372 |
| Not anaemic | Reference | | | | | |
| **Taking iron pills, sprinkles for syrup** | | | | | | |
| No | -.514 | .207 | 6.174 | 1 | .013 | .598 |
| Yes | Reference | | | | | |
| Constant | .883 | .294 | 9.021 | 1 | .003 | 2.418 |

The model above reveals that polio2 was insignificant at p<0.05 when combined with nutrient deficiency indicators than in isolation when it was significant. In the final model, children who did not receive polio2 vaccine were 13 percent more likely to suffer growth faltering than children who received. The odds increased with the factor 1.13 for children who did not receive the polio vaccine.
The size of a child at birth was very significant for very large, larger than average, average than very small. The odds of children with very large size at birth decreased by a factor of 0.344 compared to very small children.
The figure 4.3.3 below reveals the relationship between the odds and size of a child at birth.

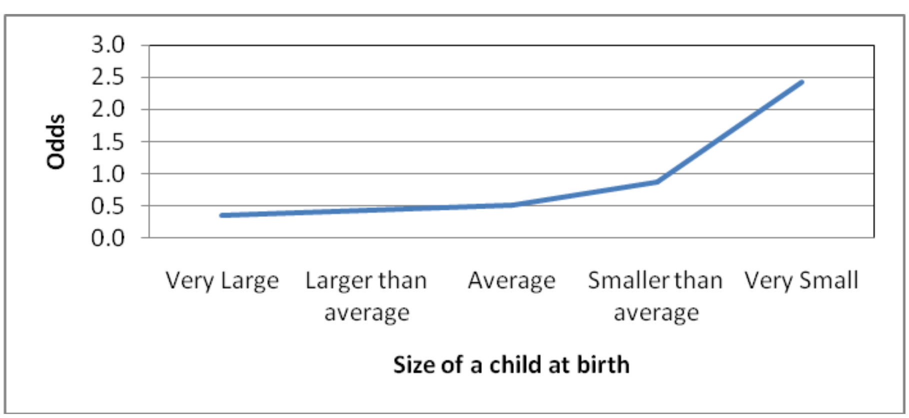



**Figure 4.3.3: Odds of growth faltering by size of a child at birth, 2006.**

The figure reveals increasing odds of growth faltering with the decrease in size of a child at birth. The odds were high for children with a very small size at birth.

In addition, the odds of growth faltering increased with the level of anaemia in children. The odds of growth faltering increased by 1.931 in severely anaemic children compared to non anaemic children. The odds were however only 1.372 higher in mildly anaemic children than non anaemic**.** The figure 4.3.4 shows the patterns of the changes in odds of growth faltering on the levels of anaemia compared to the non anaemic.

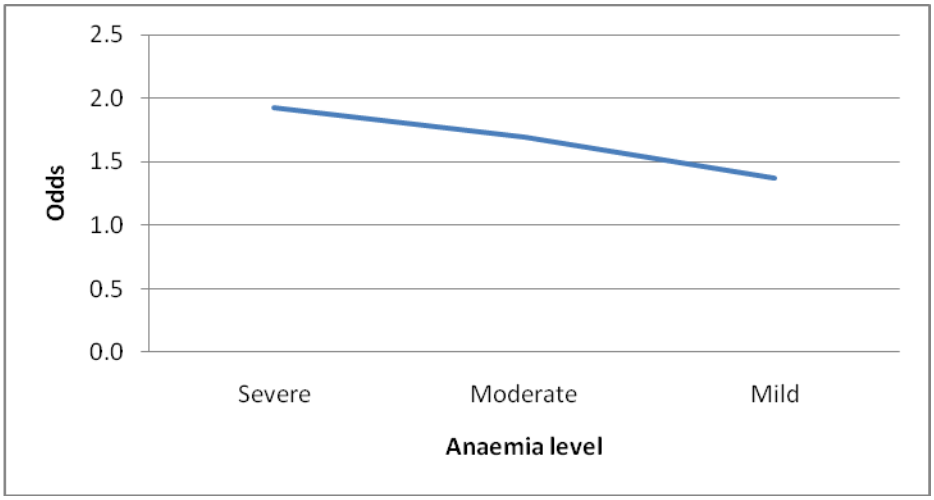



**Figure 4.3.4: Odds of growth faltering by anaemia level, 2006.**

The figure shows linearly decreasing pattern of the odds of growth faltering among children with the level of anaemia compared to non anaemic. The relationship between anaemia level and growth faltering was significant at $p<0.05$.

Table 4.3.3 also revealed the negative relationship between growth faltering and iron pills and Sprinkles for syrup. The odds of growth faltering decreased among children who did not receive iron pills compared to those who received. It was a little strange as it was un expected that growth faltering was 40 percent less likely among children who did not receive Iron pills and syrup.

## 4.4 Patterns of under five mortality and growth faltering.

This section answers the second research question; what are the trends of nutrient deficiency and immunization related growth faltering and under five mortality in Uganda since 1988 in Uganda? Under five mortality and growth faltering rates were calculated from the four DHS datasets of 1988, 1995, 2001, and 2006 with N= 4,959, 5,756, 7,113 and 8,369 respectively.

For every year of the survey, under five rates were estimated for 20 years with 5 year periods before the survey was taken. The patterns are presented in the figure 4.6a below.

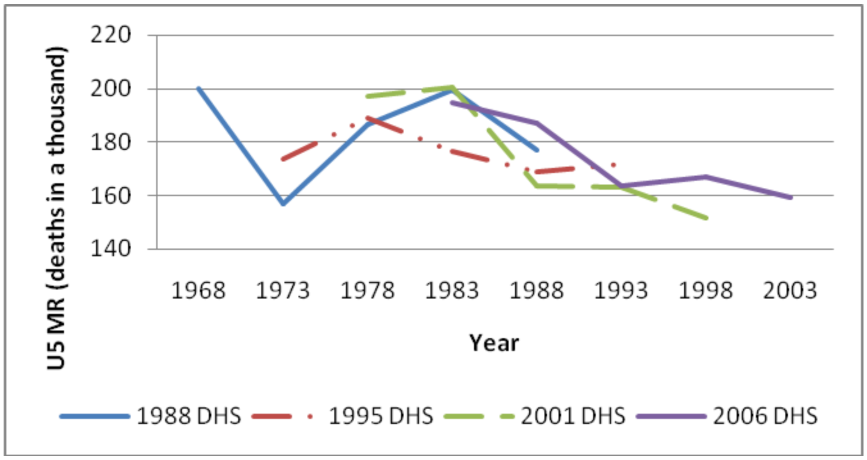



**Figure 4.6a: Patterns in Under five mortality (1968 – 2003).**

The 1988 survey recorded the highest ever under five mortality rates at 200 deaths in a thousand in 1968 and 1983. The lowest ever registered was 151 deaths in a thousand in 1998 by the 2001 survey. The 2006 survey registered a consistent but insignificant decreasing pattern from 195 deaths in a thousand in 1983 to 159 in 2001. There was a small rise in the rates from 164 to 167 in 1991 and 1996 before declining again to 159 deaths in a thousand.

Furthermore, the general trend indicates a reduction of deaths among under-five children, from 177 to 159 deaths in a thousand from 1988 to 2006 respectively. The general trend was generated using the under five mortality rates of each survey 5 years before it was under taken. All the patterns indicate fluctuating under five mortality rates between 150 and 200. The declining trends are however negligible.

The figure 4.6b below show growth faltering patterns exhibited among children in Uganda. The patterns are proportions of different levels of growth faltering i.e. moderately malnourished, severely malnourished and very severely malnourished from DHS of 1988 to 2006.

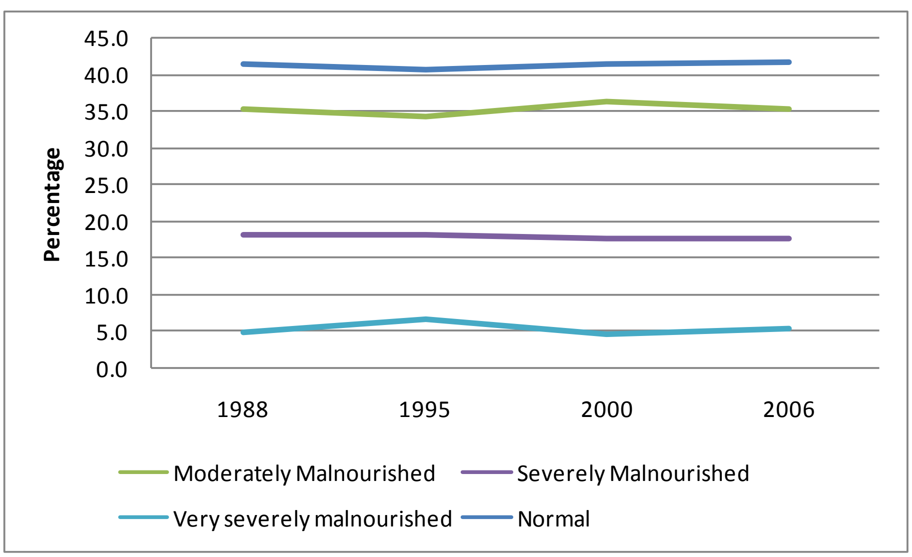



**Figure 4.6b: Growth Faltering patterns: 1988-2006.**

Growth faltering patterns among children indicate less significant decreasing rates since 1988. The trends are very sluggish within the two decades because of the patterns observed above. The proportion of children who were normal is stagnant with minor decrement from 41.5 percent to 46 percent. Grade IV children who are very severely malnourished increased from 4.9 percent to 6.7 in 1995 before dropping a little to 5.4 percent in 2006.

Surprisingly, the growth faltering patterns share the same characteristics with the under five mortality rates above. Under five mortality rates have been insignificantly decreasing. The decline in both charts is almost negligible if scaled across the whole population. This relates to under five mortality when looking at categories of severely, moderately malnourished and very severely malnourished. The proportions indicate stagnant changes since 1988.

### 4.5 Extrapolation of line in relation to the Millennium Development Goal.

The results presented in this section answer the third research question; "Can the Millennium Development Goal of reducing child mortality be achieved in Uganda?"

The Millennium Development Goal four strives to improve child survival in developing countries with the target of reducing deaths in under five children by two-thirds by 2015 from 1990 onwards. Using the baseline of 1988 DHS, where the under five mortality rate was 177 deaths in a thousand, to achieve the Millennium Development Goal four, the under five mortality rate would decrease to 59 deaths in a thousand by 2015.

It is remarkable; the Average Annual Reduction Rate (AARR) of the under five mortality rate has been fluctuating between -4.0 and 1.6 percent in 1998 and 2006. The lowest ever was -4.0 percent when the under five mortality rate increased from 151 to 159 deaths in a thousand from 2001 to 2006.

The figure 4.7 below presents the under five mortality patterns since 1988 and the millennium goal target of 2015.

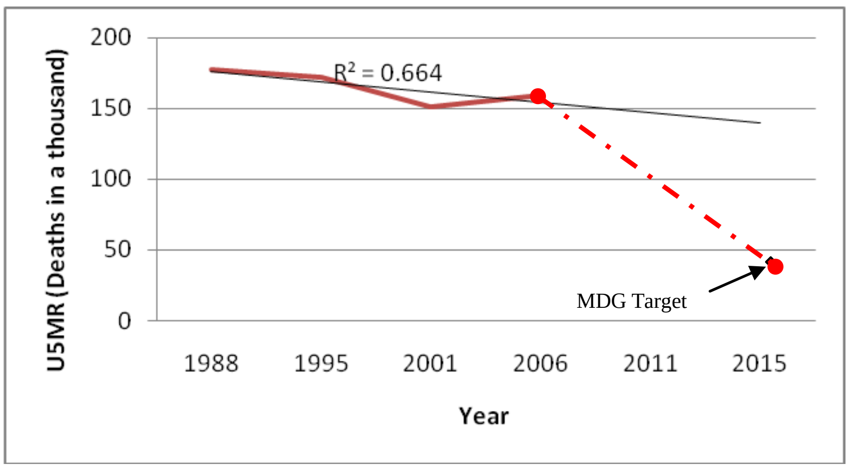



**Figure 4.7: Under five Mortality Rates (1988-2006) and MDG target.**

From child survival patterns provided in the previous subsection, the trends have been decreasing but insignificantly. When extrapolated the MDG target will be at 59 deaths in a thousand by 2015.

The trend line fixed is linear which applies to data points that appear to increase or decrease uniformly. It also exhibited the higher R-squared = 0.664 which indicate the best expected fit. It gives the most feasible and reliable forecast in the future. The graph reveals a gap of about 78 deaths in a thousand between the MDG four target and the 2015 forecast.

## 5.0 Conclusion and Discussion

### 5.1 Overview

Under five mortality is the probability of dying before reaching age five. Growth faltering is referred as a deviation of a child's growth from expected. The two are known to be related both in theory and practice. In spite of the major breakthrough of research, implicitly, in child mortality and its causality, it is still high in developing countries, especially in Uganda. Most studies in Uganda have not used the available DHS data to study relationships between Nutrient deficiency, immunization, growth faltering and under five mortality. This is because of preference on studying socio-economic indicators and trends. The present study attempts to address that gap created.

The main objective of this study is to investigate the role of nutrient deficiency and immunization on growth faltering and under five mortality patterns since 1988. In order to achieve that objective, it answers the research questions; what are the effects of Nutrient deficiency and immunization on growth faltering?, what are the trends of under five mortality rates since the 1988 survey? And can Uganda achieve the Millennium Development Goal four by 2015. The detailed description of research questions have been described in chapter one.

In the second part of this study, the theory used for guiding the study is elaborated. Basically is grounded in a Mosley & Chen (1984) model. The model focuses on five proximate determinants of maternal health, immunization, nutrient deficiency, injury and environment. Due to time, data and technical constraints, not all the five determinants were studied. Data constraints especially on injury and environment were limited in the DHS. On the technical aspect, the community as stakeholders does not view maternal health, injury and environment as very important factors in child survival during implementation of policy interventions. For example, policies to address maternal factors are regarded as women empowerment than child survival.

Furthermore, to answer the research questions fronted, binary logistic regression and univariate analysis were employed to investigate determinants of growth faltering. The synthetic cohort method and linear extrapolation were used to generate trend in under five mortality and estimate the possibility of achieving the Millennium Development Goal four. The data and methodology are fully described in chapter three.

The univariate and multivariate analyses are presented in chapter four. Trends and an extrapolation were also shown explicitly. The major findings are now discussed and summarised giving relevant future research areas, policy implications and recommendations.

### 5.2 Data and methodological constraints.

Data constraints were experienced during the analysis. Zinc supplements where only administered to only six children and it was however impractical to infer to a population of more than seven million children in Uganda. During the univariate analysis, children did not receive vaccination progressively for vaccines that were administered at different stages of growth. There was a lot of fall out for example in table 4.2.2A, 2,062 children received polio vaccine at 6 weeks (polio1) and dropped to 1,791 at 8 weeks (polio2) and dropped further to 1,241 at 14 weeks (polio3). It is not noted that the difference in the number vaccinated at 6 weeks, 8 weeks and 14 weeks respectively are as a result of deaths. They need to be accounted for and this calls for a further or integrated investigation on the causes and consequences of fall outs during immunization campaigns. The fall out rates may have affected the analysis and may need adjustments in the estimation techniques.

Also to add on data and methodological constraints, initially, the study intended to use child survival status to estimate the effect of nutrient deficiency and immunization on under five mortality, but there was no data available for dead children on immunization indicators. DHS does not collect retrospective data on the immunization history of dead children. It reveals a critical weakness of DHS as it hampers studying direct relationship between immunization and child mortality. This may be the reason why there is more preference in studying socio-economic indicators and child mortality. These data limitations explain the strength of prospective studies, which is recommended in this study to effectively explore the effect of immunization on child mortality in Uganda. However, an effort should be under taken to improve DHS women questionnaire to include a dead child immunization history.

In estimation of child mortality rates, relying on retrospective birth histories of children from mother's is prone errors, thus, explaining quality constraints. Direct estimation methods are reliably inevitable for quality estimates. This limitation in estimating under five mortality rates can be addressed by improving vital registration systems in Uganda.

Finally, during the univariate analysis in tables 4.2.2B and 4.2.1B some variables became significant. Zinc became significant when three levels of growth faltering were combined. Measles which was the only significant variable became insignificant and only polio2 became insignificant. This explains the power in combining categories of the dependent variable. But the earlier significance explains the possibility of association at different levels of growth faltering. It would be very important to study effect of nutrient deficiency and immunization on different levels of growth faltering.

### 5.3 The role of nutrient deficiency and immunization on growth faltering.

Most studies have confirmed the effect of nutrient deficiency and immunization on growth faltering and under five mortality. Among the indicators tested, size of a child at birth, anaemia level, iron supplements and polio at 10 weeks had a significant effect on growth faltering in children.

Children who were born with low birth weight had a higher risk of suffering growth faltering compared to those with high birth weight. The size of the child at birth is determined by mother's health during pregnancy. Healthy mothers give birth to healthy children. This is further explained by the vicious cycle of malnutrition. A malnourished mother with inadequate nutrition during pregnancy will transfer the low immunity to her unborn child. This results into an already malnourished child which is shown by the size of the child at birth. A child with a weak immunity at birth succumbs to infections during it early periods of growth. If he/she survives he will grow up to an adult struggling with the weak immunity from the mother unless adequately taken care of.

Growth faltering was also found to be highly associated to anaemia levels. Severely anaemic children suffered a high risk (93 percent) of growth faltering compared to non anaemic children. This was clearly shown in the results in figure 4.3.4; Odds of growth faltering by anaemia level. Anaemia is caused by many deficiencies but the common one is iron deficiency. Iron is highly needed at infancy to stimulate growth and development. Iron deficiency impairs development causing stunted growth. The study also revealed the effects of taking iron pills in children, but revealed a negative association, with children who did not receive iron pills having low risks of growth faltering compared to those who received. This reverse relationship is grounded on the fact that iron pills are used for curative rather than preventive means of growth faltering. Thus children are given iron pills and syrups after they have suffered growth faltering.

Polio at 10 weeks was found to be very significant during the univariate analysis. In table 4.3.2; Parameter estimates of immunization and growth faltering (model 2), children who did not receive polio vaccine at 10 weeks were 23 percent more likely to suffer growth faltering than those who received. It implies polio vaccinations at age of 10 weeks helped reduce risk of growth faltering among children. It could also mean that the mother's who take children for vaccination take good care of them. Surprisingly, polio 2 had 0.3 percent explanatory power, which is extremely low to support variation in growth faltering. When combined with nutrient deficiency factors in the final model, polio2 became insignificant. It gave room for nutrient deficiency factors to play an ultimate role in determining growth faltering.
This directly answered our first research question. Nutrient deficiency therefore plays a major role in determining growth faltering. Immunization indicators play as a catalyst and also in isolation play a limited role. This could also imply the role of other factors like maternal education and social-economic status of women. Conclusively, we reject the null hypotheses that nutrient deficiency and immunization has no significant effect on growth faltering.

These findings have been consistent with previous studies which have reported the association of nutrient deficiency and immunization on growth faltering. They are consistent with Shrimpton et al (2003) who related nutrient deficiency to under five mortality through growth faltering. Paoloni et al (2005) also reported nutrient deficiency and illness to increase morbidity and hamper child's progressive growth, which was consistent with the findings in this study. In addition to the literature reviewed, the findings supported Mosley & Chen (1984), the theory adopted. The results are also in line with Villamor et al (2004) and others whose findings exposed nutrient deficiency to accelerate severity of infections by lowering body immunity to fight infections.
However findings have revealed that nutrient deficiency overlaps maternal health which was not studied here. Nutrient deficiency and maternal health are at the same proximate level in the theoretical model. Mother's health which included her nutrition status contributes to growth faltering through size of a child at birth. The model may need in future to come out clearly to express nutrient deficiency as more proximate than maternal heath and immunization. Further, the model needs to acknowledge nutrient deficiency as both preventive and curative. It has been revealed by results and supported by the vicious circle of malnutrition.

**5.4 Under five mortality and growth faltering patterns**
The results in chapter four indicate findings on under five mortality and growth faltering patterns since the 1988 survey. In spite of the fair decline, under five mortality rates have remained high since 1968, the post colonial days in Uganda. Under five mortality rates in Uganda have been fluctuating between 150 and 200 deaths in a thousand. The highest under five mortality rates ever recorded in the history of DHS was in 1968 and 1983 with 200 deaths in a thousand.

In addition, between 1978 and 1988, under five mortality rates have consistently remained high. These periods were characterised by political turmoil that plagued the country. The volatile political environment did not provide a safe haven for child survival. Insecurity worsens living conditions of children, denying them exclusive rights to adequate nutrition, complete immunization and a healthy environment. With such conditions, death in under fives will be accelerated. During the post war period of 1988, patterns began to drop fairly but still remained high. The lowest ever recorded under five mortality rate was in 1998 by the 2001 DHS survey. It must be noted here that due to political conflicts in particular regions, sampling was only limited to areas with prevailing peace, except the most recent survey of 2006 which covered all regions. Nevertheless the under five mortality trends remained high.

On the other hand growth faltering patterns have shown almost no significant changes in all surveys. Proportions of moderately and severely malnourished children have remained more or less at 35 percent and 18 percent. The percentage of children who are severely malnourished slightly increased from 4.9 in 1988 to 6.7 in 1995 before stabilizing again. This implies that children's growth and health have remained unchanged since 1988.
The under five mortality rates and growth faltering share the same patterns and therefore relates growth faltering to under five mortality. Still, future efforts need to be directed to investigate patterns by socio economic indicators especially region and sex as this may not show the same pattern.

Notably, the findings in this study were consistent with other studies of Nuwaha and Mukulu (2009) and Ayiko et al (2009) including part of the 2006 DHS survey report, which noticed slack or no decline at all until 1995. The DHS report (2000/1) highlighted little improvement in children health and nutritional status which concur with the findings in this study However, the present study disagrees with the drop in mortality rates to 137 in the 2006 DHS survey. The results indicate that in 2006 the under five mortality rate was 159 deaths in a thousand. This could be as a result of rate-adjustments and weights assigned to individual cases commonly made in DHS to cater for external influences like adult HIV/AIDS and also to ease comparisons with previous DHS. But if adjustments were to be made with respect to HIV/AIDS, figures would be scaled upwards rather than downwards.

**5.5 Millennium Development Goal four in Uganda.**

The results in chapter four showed the trends and patterns in under five mortality. The trends were more or less stagnant with no evidence of a significant decline in the last decade. The patterns present a frail future on the possibility of reducing deaths among children age under five. The Millennium Development Goal (MDG) four targets to reduce under five mortality rate by two thirds in 2015. Using the 1988 under five mortality rate as a baseline, it implies that by 2015, Uganda need to register 59 deaths in a thousand. A linear extrapolation shown in figure 4.7 reveals that by 2015 the under five mortality rate will be 147 exposing a gap of 78 deaths in a thousand. In addition to that, Uganda needed an Average Annual Reduction Rate (AARR) of 4.4 percent to achieve the target of 59 deaths in a thousand. But its AARR has been fluctuation between -4.0 and 1.6 percent between 1988 and 2006. Not nearing the expected 4.4 percent.

However, to achieve the MDG four, the AARR has to more than triple to 17.5 percent between 2006 and 2015. This is only not feasible but also unrealistic. The extrapolation was based on previous trends and the assumptions that the birth rate remains the same and child survival programmes remain unchanged.

However, even if there is a change in child survival programmes, the remaining 8 years are too short for Uganda to achieve the Millennium Development Goal four. Uganda is therefore off track in achieving Millennium Development Goal four. These findings are consistent with Nuwaha and Mukulu (2009) but disagree with Kirunga et al (2003). For some reason, Kirunga et al (2003) did not use the recent DHS data of 2006.

### 5.6 Future research areas.

Although this study has answered some important areas within under five mortality in Uganda, it has exposed other areas to direct future research. Consequently, the following areas have been proposed for future studies namely;

First, in order to compliment on the findings of the fall out rates during vaccination campaigns, keen interest must taken to establish the reasons as to why and consequences of children aged under five who missed full vaccination or part of it. It could as well explain the role of other factors like socio-economic status of women. This will also explore the role of measles which was reported first to be significant during univariate analysis of the four levels of growth faltering.

Secondly, growth faltering being an outcome that is continuous and progressive in different stages or level, it is important to determine factors that contribute or degenerate to its different levels. During the univariate analysis of the four levels of growth faltering, some nutrition and immunization indicators were found to be significant. Studying growth faltering in different levels as an ordinal variable will extend these findings to detail.

Thirdly, research exploring under five mortality and growth faltering patterns by socio-demographic indicators of region, sex and settings like urban/rural. Then further, examining their interactions between determinants of growth faltering. These determinants would include environment, maternal health and injury, which were not studied here. In addition, trends would be broken into infant and child mortality rates. Infant and child mortality do have different determinants and studying them separately will deepen the understanding of under five mortality; its determinants and the necessary policy implications.

Finally, although this study has shown DHS as useful tools in estimating under five mortality, growth faltering and their causal relationships, they also pose weaknesses. The absence of immunization data on dead children and few reported children vaccinated makes single-retrospective surveys like DHS less suited to study impact of health related programmes. They add more weight to longitudinal (follow-up) surveys and clinical trials. Future efforts need to be done to improve DHS tools.

## 5.7 Policy implications and recommendations.

The primary role of research was to test theories, agreeing with or modifying them. But current studies are not only undertaken to add knowledge to the field of research but also to suggest and inform policies that would help the stake holders involved in its research. This research study contributes to a review of policies and programming in Uganda given its findings.
It revealed the primary role of nutrient deficiency in causing growth faltering in children. It also adds immunization as a catalyst, capable of contributing to the vice. Further, the study exposed the stagnant growth faltering rates and more or less weak declines in under five mortality rates. Thereby concluding on the off-track direction Uganda is taking in achieving Millennium Development Goal four.
This study proposes policies that are in line with its findings and the theory it is grounded on.

In a nutshell, interventions should focus on improving nutrition programmes across the country. Iron pills and syrups should be available not to be administered after a child has growth faltered. Health education programmes on adequate nutrition be delivered to pregnant mothers. It must be routine and in line with other maternal education programmes. Sensitization of communities on iron and zinc rich foods to reduce anaemia prevalence and iron deficiencies is made a priority during nutrition education programmes.

Immunization campaigns with more emphasis on Polio vaccination at 10 weeks should be emphasised to the community. Community health teams need to be mobilised and informed on the importance of full immunization. They take enforcement on follow-up of un vaccinated children and drop-outs.

These interventions are feasible and easy to implement but it necessitates other factors to come into play. Nutrition programmes normally fail in famine stricken areas with low women emancipation. Immunization programmes are also less successful in areas with poor maternal education. These programmes require sufficient levels of socio-economic status of women. These policies therefore need not to be implemented in isolation but complimentary.
Therefore success in child survival programmes requires a wide policy mix ranging from socio-economic status of women to child nutrition.

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