University of Alberta

Nutrient Intake Adequacy and Child Stunting Status in Kabarole District, Western Uganda

by

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Dedication

A special thanks to my family and friends for all of the love and support that has made this endeavor possible.

Abstract

Using a cross-sectional design in which a questionnaire was administered to 213 child caregivers, we have attempted described the nutrient intake adequacy and prevalence of stunting amongst children 6 to 59 months of age in rural Kabarole District and evaluated the adequacy of their nutrient intake. We have found the prevalence of stunting to be 45% (37 to 52%). Children with a nutrient intake adequacy score of less than 6 out of 10 were 14 times more likely to be stunted in comparison to children with scores of 8 or better (1.29 to 144.28, p=0.032).We have found a discrepancy in stunting prevalence between the 24 to 41 and the 42 to 59 month age groups, which was associated with protein intake. The prevalence of stunting is very high in Kabarole District and must be addressed.

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List of Acronyms

FAO – The Food and Agricultural Organization of the United Nations

FVS – Food Variety Score

HAZ - Height-for-age z-score

IMCI – Integrated Management of Child Illness

INCAP - The Institute of Nutrition of Central America and Panama

LC1 – Local Chairperson at the village level

LGV – Leafy Green Vegetable

MAR – Mean Adequacy Ratio

NAR – Nutrient Adequacy Ratio

PEM – Protein-Energy Malnutrition

QFFQ – Quantitative Food Frequency Questionnaire

RDI – Recommended Daily Intake

SES - Socioeconomic Status

UNICEF – United Nations Children's Fund

WAZ- Weight-for-age z-score

WHO – World Health Organization

WHZ - Weight-for-height z-score

Chapter 1: Outline and Research Questions

1.1 Introduction

The prevalence of stunting in western Uganda is high in comparison to the national figures and rurally located children are most at risk (see Appendix 5 and Appendix 6). Our population at risk is rural children of 6 to 59 months in Kabarole District (see Appendix 1 and Appendix 2 for maps of the study location). The administrative centre of Kabarole District is the town of Fort Portal, located 320 km southwest of Ugandan's Capital city, Kampala. The 2002 census reported Kabarole had a population of 356,914 people with a population density of 200 persons/km^2. The District consists of 2 counties and 1 municipality; the counties are further divided into 10 sub-counties. Sub-counties contain parishes and within parishes are the smallest administrative units, villages. Ethnically, the Batooro comprise the majority of the population, out numbering the Bakiga 4:1. The remaining ethnicities in descending order of numbers are the: Bakhonzo, Banyakole, Baganda, and Bafumbira. Subsistence farming is the main livelihood for 69.3% of people and 83.5% of woman living in rural areas[1]. The present study took place in all 10 sub-counties and data was collected during a period covering most of one rainy season from September to December, 2006. The prevalence of stunting was recently reported at 55.1% in a rural/urban study in Kabarole District[2].

Stunting has been shown to be a sensitive tool for studying correlations between environmental factors and child nutritional status. Stunting is determined by comparing a child's Height-for-age z-score (HAZ) to the mean HAZ of a Universal Growth Reference population. A child with a HAZ of less than minus 2 is defined as stunted. While somewhat controversial, this practice is endorsed by the World Health Organization (WHO) and is widely employed for studying child nutritional status. Child height, weight and age data can be used to calculate other anthropometric indicators but we chose to measure stunting as it measures chronic under-nutrition. There are many factors associated with stunting status including those related to socioeconomic status (SES) and to home environment. Nutrient consumption is considered a proximate determinate of stunting because it directly impacts child nutritional status. Food inventories conducted in Kabarole have shown that there are a wide range of foods potentially available to those who are rurally located. Kabarole is fortunate to have a climate conducive to the cultivation of a variety of fruits and vegetables. However, it is known that child nutrient consumption is not adequate in Kabarole District. That is, children are not consuming the recommended complement of macro and micronutrients. Our purpose was to investigate the correlation between the determinants of stunting, specifically nutrient intake adequacy, and child stunting status in Kabarole District.

1.2 Research Questions

1. What is the prevalence of stunting, wasting and underweight status in Kabarole District amongst rurally located children, 6 to 59 months of age?
2. What is the nutrient intake adequacy of rurally located children, 6 to 59 months of age, in Kabarole District?
3. Is there a relationship between nutrient intake adequacy and child stunting status after controlling for confounding factors in Kabarole District?

4. What factors are associated with nutrient intake adequacy in Kabarole District?

Chapter 2: Literature Review

2.1 Anthropometric References

2.2.1 Weight-for-height Z-score (WHZ)

Weight-for-height z-score (WHZ) and Height-for-age z-score (HAZ) explain two basically different physiological and biological processes[3]. The present study utilized z-scores to calculate all anthropometric indictors, justification for which is provided in Appendix 3. In developing countries, failures in good record keeping can make it difficult to know the exact age of a child being evaluated. An advantage of WHZ is that it is calculated without reference to age. A low WHZ indicates an acute loss in weight or the failure of a child to gain appropriate weight[4]. A child with a Weight-for-height z-score of less than minus 2 is defined as being wasted. In Kabarole District, the WHZ values are basically normal (the prevalence of wasting is less than 5%) [2].

While the prevalence of severe malnutrition is low in Kabarole, a brief mention of Protein-Energy Malnutrition (PEM), a serious form of malnutrition, is warranted. PEM, as the name implies, is a result of deficiencies in protein and energy as well as several micronutrients. Primary PEM stems from inadequate nutrient intake and absorption while secondary PEM develops as a result of persistent disease. The onset may be gradual due to prolonged periods of inadequate food intake or sudden as a result of a quick upset in food security. Two conditions characterize severe PEM: marasmus and kwashiorkor. Marasmus is a nonedematous condition of starvation associated with emaciation and energy deficiency; whereas, kwashiorkor is associated with protein deficiency and bipedal edema. Children suffering from marasmic kwashiorkor exhibit the wasting associated with chronic energy deficiency and the swelling characteristic of acute or chronic protein deficiency. It has been suggested that the prevalence of stunting is a good indicator for the prevalence of more advanced forms of malnutrition[93].

2.2.2 Height-for-age Z-score (HAZ)

A child with a Height-for-age z-score of less than minus 2 is defined as stunted. Stunting is high in places of social disparity. Actions geared at addressing socioeconomic inequality with regard to food availability, dietary quality, hygiene, availability of adequate supplies of potable water, and prevention and treatment of infectious disease are thought to have the potential to improve the situation within the population over time. Stunted children less than two years of age can benefit from interventions that address stunting and these interventions have been shown to improve population HAZ. However, some believe that those older than two years can no longer 'catch-up' on growth; they will not benefit from interventions and they will permanently have a low HAZ[4]. Yet, others have shown that the potential for recovery, at least until the age of 5 years, is the same in all age groups[5]. Regardless, at the community level, it is cautioned that unless there is an overall improvement in the SES of the population, little improvement may be gained. In this sense, stunting may be thought of as an index for social deprivation[4]and may be used as an indicator to evaluate the effectiveness of interventions directed toward the population[6].

Stunting prevalence between 30-39.9% is considered "high" while above 40 is "very high"[4]. An examination of Appendix 4 indicates that the prevalence of stunting in Uganda is very high. Appendix 5 suggests that while the prevalence of stunting in the country as a whole reduced from 1988 to 1995, the prevalence in the Western/South-Western Region did not reduce. The majority of the census sample is of rural origin. Appendix 6 shows that while the prevalence of stunting reduced nation wide and in the rurally located cohort from 1988 to 1995, the rural nation wide sample consistently had a higher prevalence of stunting suggesting disparity between urban and rural dwellers. The concentration of stunting in the rural cohort has motivated the present study to focus exclusively on that group.

2.2.3 Weight-for-age Z-score (WAZ)

The final anthropometric indicator to be discussed, Weight-for-age z-score (WAZ), is considered a composite index of both WHZ and HAZ. It is criticized because it fails to distinguish tall, thin children from those who are short with adequate weight[4]. A World Health Organization (WHO) ecological assessment of WHZ, HAZ and WAZ in 22 African countries found that WAZ correlated positively with stunting and wasting (0.64 and 0.61 respectively) but that wasting and stunting did not strongly correlate (0.1). WAZ was shown to have a low sensitivity and specificity in three US populations for predicting and identifying wasted children. However, WAZ may be useful for following a child over time to identify a downward trend, since this often depicts acute changes associated with wasting[4].

2.2 The Validity of Using a Universal Growth Reference

The present study classified children as stunted or not stunted using height references endorsed by the World Health Organization (WHO). Nutritional status indices such as a HAZ, WAZ and WHZ are widely employed in research and public health. These enable stake holders to examine both trends in a population's nutritional status and the nutritional status of individual children. In emergency situations, growth references are employed to identify the children most in need of support[7]. Despite the wide use of these indices, it has been questioned whether universal references for nutritional status are a valid way to assess individual and population nutritional status in developing countries[8]. Yet, current evidence supports the universal adoption of a global growth reference.

Ethnicity is a factor for child growth potential but not a barrier to the universal adoption of a growth reference. It is true that the Batwa pygmy people of the Semuliki valley in southwestern Uganda have an average height that is noticeably less than that of the average population; a portion of this difference is arguably explained by genetic endowment. To a lesser extreme, it is widely held in Kabarole that the Bakonjo, a minority group, are also shorter on average than the dominant Batooro people. Informally, it has been argued that genetics, not environmental factors are the cause of Kabarole's reported high rates of stunting.

However, previous studies have shown that children of different ethnicities grow in a pattern similar to the NCHS reference when environmental conditions are optimal. A study conducted in Malawi compared the growth of upper class urban children to poor rural children. It was found that the distribution of HAZ of high SES children resembled the NCHS reference while by 59 months of age, the rural children were on average 11.1 cm shorter[9].

The adoption of the universal growth reference was challenged in an Israeli study, a country said to be of high immigration and good SES. However, the study found only a small difference between the HAZ of ethnically different groups, including those of African heritage[10]. Environmental factors were shown to explain the majority of variation between study groups and the growth references. In Papa New Guinea, assessment of four ethnically diverse populations found a negative correlation between SES and persistent disease and a positive correlation between SES and nutritional status but no correlation between SES and ethnicity[11]. Habicht concluded in 1974 that "racial or ethic effect on child growth status was marginal in comparison to the effect of environmental factors" [12] and has since been widely referenced. In this research, it was shown that the heights of healthy children of various ethnicities only varied by 3%.

On the other hand, Van loon studied four ethnically different groups of children with no clinical signs of malnutrition and found that there were substantial differences in growth[8]. However, none of the groups represented children coming from socioeconomic conditions conducive to optimal growth. Thus, while the sample was of healthy children, differences in growth may have come as a result of previous nutritional assaults. Evidence from studies where children are given optimal opportunities to thrive prompted the 1996 World Health Organization (WHO) steering committee on global growth references to recommend that healthy children from various ethic backgrounds have similar growth potential[13]. Thus, the genetic arguments do not substantiate a barrier to the adoption of a universal reference standard.

What use is an international growth reference in an African country where children do not have the opportunity to fully thrive? Pragmatically, advocates for the adoption of local references argue that striving for these utopian standards in impoverished countries would quickly overrun healthcare resources[14]. Mbarara District is located southeast of Kabarole District. Mbarara health authorities developed local growth reference values in order to set more realistic program targets. Only children surviving one year post assessment were included in the dataset. They found that healthy children from 1 to 5 years of age differed by 4 to 7 cm from the growth median of the NCHS reference group[14]. This comes as no surprise considering differences in environmental factors acting on this cohort. These local reference values may guide realistic use of resources but they set a low bar for child nutritional status and mask the impact of environmental factors[15]. Aiming for survival, while necessary in the short term, cannot be anything more than a resource allocation stepping stone. Use of the universal growth references allows us to quantify how far the mean height of a population of children is falling from that of a reference population[16] and using the NCHS reference permits comparison between our figures and previous research findings from Uganda.

It is important to note that the 1978 CDC/WHO reference population is a reference and not a standard. It has been used extensively in research to compare anthropometric indicators of one country to those of another. In 2006, a reference called the WHO 2006 growth standard was released by the WHO. The standard population is multi-racial comprising children from 6 different countries, including those that are developing and developed. The children were said to have been able to grow under conditions permitting unconstrained growth and caregivers followed current WHO child feeding recommendations. This new population is considered a standard and populations of interest may be compared to it to assess how far their child growth is falling from genetic potential. The WHO is encouraging immediate adoption of the new growth standards in all future research[108].

However, the present study has not utilized the new standard to assess child nutritional status. Many operational implications of the new standard have not been assessed and Seal and Kerac advocate that until the behaviour of the new standard is fully understood, both the 1978 and the 2006 reference should be applied to feeding programs and research. They found, amongst children in refugee camps, that important differences existed in the Weight-for-height z-score cut-offs used for defining acute malnutrition obtained from the WHO standards and NCHS reference data. These varied according to a child's height and according to whether z-score or percentage of the median cut-offs were used. They suggested that if applied and used according to current practice in nutrition programmes, the WHO standards would result in a higher measured prevalence of severe acute malnutrition during surveys but, paradoxically, a decrease in the admission of children to emergency feeding programmes and earlier discharge of recovering patients. Therefore, they state that a full assessment of the appropriate use of the new WHO standards in the diagnosis of acute malnutrition is urgently needed[109]. We felt it was also appropriate to exercise caution with the new standards for Kabarole's climate of chronic malnutrition. In addition, previous research conducted in Uganda has utilized the 1978 CDC/WHO reference[32,33,42,44]. Therefore, the present study utilized the 1978 reference so that our results could be compared with those of previous studies in Uganda and because the time allotted for data analysis for this dissertation did not permit a second analysis with the new standards.

In closing, a child may be stunted at 4 years of age but have a normal WHZ (and therefore not be considered wasted) and have no signs of clinical malnourishment. In 1977, J.C. Waterlow helped to spear head the discussion on the use of anthropometric indictors for assessing malnutrition and social disparity. He offered an "operational" definition of malnutrition: "A state of ill-health which can be improved by qualitative and quantitative changes for the child." Given that the effects of stunting become permanent at some point in older children he subsequently asked "If this is not the case for the chronically stunted [that they are not sick and they will not benefit from intervention], are they really malnourished?" He suggested that we need to distinguish between categorical malnutrition and a true handicap; he concludes that in a community where there are many stunted children, rehabilitation needs to be aimed at social rather than purely nutritional rehabilitation.[15] If over half of children are, in fact, not reaching their full growth potential but few children in comparison are actually clinically malnourished, is this practically invisible high prevalence of stunting really an issue of concern?

2.3 The Individual and Societal Consequences of Endemic Stunting in Kabarole District

Kabarole District has high rates of stunting (high prevalence of children with a HAZ of less than -2) amongst children less than 5 years of age[2]. At the individual level, stunting is associated with impaired recovery from illness, while at the societal level stunting limits economic growth. It is difficult to causally associate stunting with negative outcomes. However, where there is stunting, there is also a high prevalence of social deprivation. Stunting is implicated with directly and/or indirectly causing numerous negative outcomes at the level of the individual and society at large.

Stunting may be considered a marker of a child's overall vulnerability to a new aggression[17]. A stunted body is one deprived of the nutrients necessary to maintain normal cellular functions and permit growth, ensure development and body repair. The integrity of nonspecific, antibody and cell mediated immune defense as well as gut mucosa are jeopardized in stunted children. It is hypothesized that the gut mucosa of stunted children to do not repair as quickly[18]. Diseases leave stunted children in a state of increased weakness and vulnerability to subsequent infectious assault; cycles that can have negative health consequences including prolonged recovery time or death.

Stunted children are particularly vulnerable to persistent diarrheal episodes. In two separate studies conducted in Malumfashi[19] and Bangladesh[20], diarrhea as a result of an enteropathogen was shown to persist 30% and 26% longer respectively in stunted children. A study conducted in Kampala found that stunted children infected with cryptosporidium parvum experiencing persistent diarrhea were 2 times more likely to die before a 2 week follow-up in comparison to children who were not stunted. In Papa New Guinea, among children 6-60 months of age, children who were thin (90% WHZ) as well as stunted were 3 times more likely to die within 18 months of measurement. It is important to note that in all cases, environmental criteria were important determinants of illness outcome. Access to nutritious foods and medical care were important components of positive outcome. Socio-environmental factors may be systematically related to stunted children receiving treatment more slowly than children who are of normal height, who come from better educated parents, who have more time to nurture[19]. Stunting seems to be a marker of this vulnerability.

Anemia is a known cause of morbidity. In a case-control study conducted in rural western Kenya, stunted children were shown to have markedly lower hemoglobin than their non-stunted counterparts[21]; that same study showed that stunted children were at greater risk of having the malarial parasite. In a longitudinal study conducted throughout the rainy season in rural Gambia, stunted children were shown to be 1.35 times more at risk of having a malarial episode in comparison to non-stunted children; stunting status did not fluctuate between the beginning and end of the study[22]. Hemoglobin concentrations are linked to many factors including genetic blood disorders, hookworm infection and inadequate nutrient intake[21]. A body weakened under chronic nutritional deprivation is at greater risk of a poor disease outcome including prolonged recovery time and death. There is a clear link between the factors associated with stunting and those that cause low blood hemoglobin concentration. At the population level, addressing the factors associated with stunting also addresses anemia and all its immediate health consequences.

Stunted children mature more slowly that those who are non-stunted. Stunted boys have significantly delayed growth spurts and sexual maturation[23] and the age of menarche was shown to be 1.3 years later in stunted girls[24]. Stunted children who continue to be undernourished in adulthood, as shown by low body mass index and blood concentration of various nutrients, were also shown to have decreased skeletal maturity[25]. Such suboptimal development has individual and social consequences.

Childhood stunting puts children at a disadvantage physically and mentally in adulthood. There is evidence that children can experience catch-up growth if negative circumstances are reversed in sufficient time[24]. Those who are stunted in adulthood risk both suboptimal physical output and employment opportunity. Many employment opportunities in developing countries involve general labour. Amongst healthy adult individuals, physical output per unit body muscle may be similar. In situations where payment depends on total output, however, a stunted individual would have less output and therefore, reduced earning potential. Regarding cognitive impacts, Cravioto and DeLicardie found that children who survive a severe episode of malnutrition early in life were handicapped in developing skills in reading and writing[26]. This may lead to defective functioning, school failure, and subnormal adaptation.

The Institute of Nutrition of Central America and Panama (INCAP) conducted a nutrition intervention in 4 villages in Guatemala, which became known as the INCAP study, from 1966 to 1977. In 2 villages, a protein rich drink called Atole was available to everyone and consumption was recorded for all children of 0 to 7 years of age. A beverage called Fresco was served in the two other villages; it was a sweet drink of similar nutrient content save protein, which was totally absent. At 3 years of age, children served Atole were taller on average than children served Fresco. During 1988 and 1989, a follow-up found that children from the villages served Atole were taller, heavier and had a greater proportion of fat-free muscle mass (1.2 kg difference in males and 2.2 kg in females) at follow-up in comparison to children from the Fresco village. Researchers found that the children served Atole were healthier at follow-up, benefiting during adulthood from the gains made during the first 3 years of life. In addition to physical benefits, children served Atole had greater arithmetic, reading, vocabulary, and information processing abilities at the time of follow-up. It may be inferred that retarded growth during the first 3 years of life was linked with other physical and cognitive deficiencies[27]. This may suggest a role for anthropometric measurements, mainly stunting status, as a means of approximating other aspects of child development.

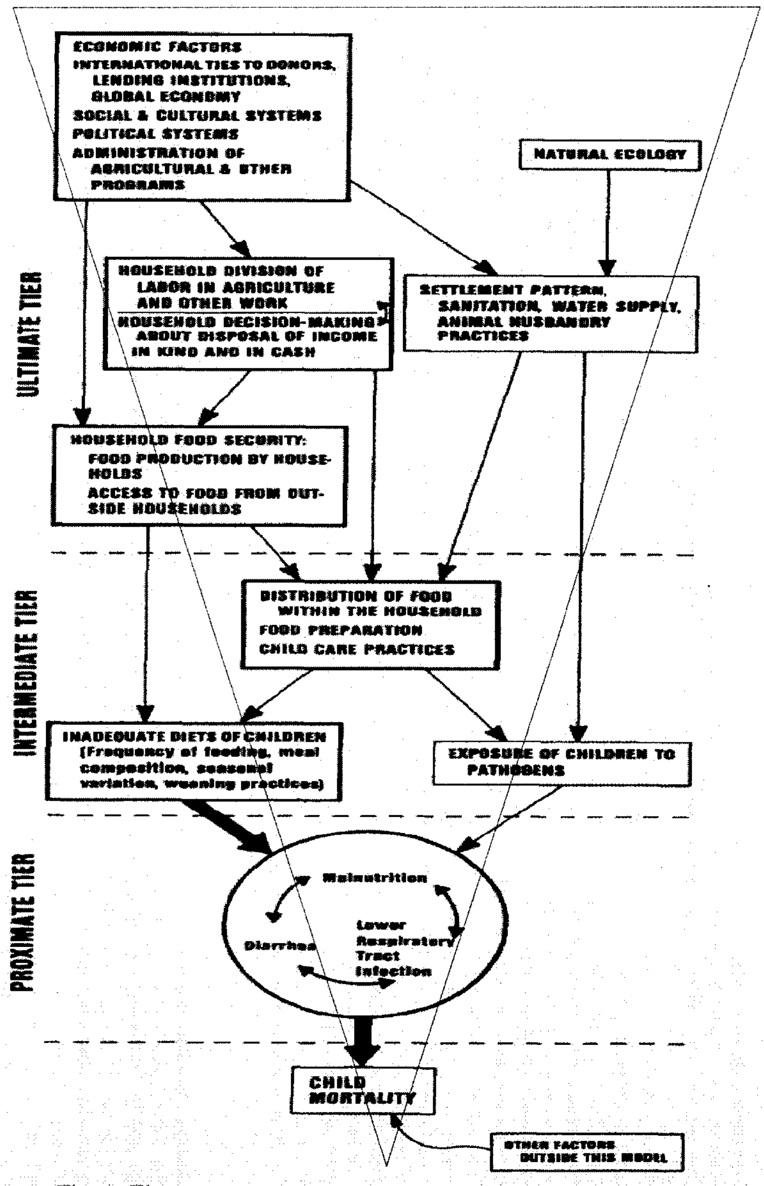
Stunting appears to have intergenerational consequences. Espo et al. found that stunted maternal size was a risk factor for baring a baby of low birth weight[28]. Such a child begins life at a deficit. In addition, mothers less than 145 cm are at increased risk of obstetric complications according to international agencies[29]. It is probable that such children are also born into poverty, compounding the difficulty of recovering from such a deficit. These children are at an increased risk of reaching only suboptimal potential. Not surprisingly, low-level parental employment is a risk factor for childhood stunting[29]. Children of stunted parents are more likely to be stunted themselves and live in poverty; thus, the cycle perpetuates.

"A community in which there is a high proportion of stunted children and adults is likely to be a community in which human resources are of poor quality"[29]. In Kabarole, stunting is endemic. It is hardly noticeable and we may be tempted to see it as a form of normal adaptation in an impoverished environment. The enormous cost of stunting to society has been discussed previously. Gopalan argues that adaptation is hardly the word to describe those who have fortunately been able to scrape through the "valley of death" in the early preschool years[29].

There is not a strong causal link between stunting and mortality. However stunting and mortality are linked by poverty. It seems that the same factors that lead to the onset of stunting such as inadequate nutrient intake, poor home/community hygiene, and inadequate access to healthcare resources and poor parental response to illness are the same socioeconomic factors that inhibit a child's ability to recuperate quickly from infection and grow. Surely, a developing society needs to benefit from the maximal intellectual and physical contribution of all its members. Directly and indirectly, stunting presents a barrier to societal progress.

2.4 Factors Associated With Stunting In Kabarole District

Two factors are causally related to stunting: persistent disease and inadequate nutrient intake. We call these *proximal determinants* because as Figure 1 demonstrates, they impact the child most directly. While at the cellular level, stunting is a result of the insufficient availability of essential nutrients required for growth, development, and maintenance, the factors associated with stunting at the level of the child are much broader. Martorell attributes the proliferation of stunting to the "poverty scheme". He says that villages where stunting rates are high are invariably of low SES. These villages generally have poor home and community sanitary conditions, poor parental education level, parents who mainly do low paid, unskilled or semi-skilled manual occupations, children are inadequately nourished, income levels are poor, family sizes are large, there are high rates of morbidity and clinical under-nutrition. The magnitude of impact made by each factor varies by community but generally, these factors work in concert to disrupt or inhibit the well-being of children[30]. While our research will focus on the relationship between nutrient intake adequacy and child stunting status, we will first review the present understanding of the poverty scheme's impact on stunting in Kabarole District.



Source: Millard (1994)[110]

Figure 1: Three Tiers of Causes of High Rates of Childhood Mortality

The factors associated with stunting may be thought of as an inverted pyramid like that depicted in Figure 1. Morbidity and inadequate nutrient intake are direct determinants of stunting so they are at the bottom. Above those two proximal determinants are intermediate variables such a caregiver factors and household food distribution practices. At the broad top of the pyramid is inadequate SES. A review of the literature indicates that 8 peer reviewed studies have been conducted in Uganda since 1988 addressing underlying factors associated with stunting. In addition, various government publications and foreign research has been reviewed.

2.4.1 Distal Factors

2.4.1.1 Socioeconomic Status (SES)

Poverty undoubtedly contributes to stunting but in Kabarole, the relationship between stunting and SES is not clear. A baseline report published in 2000 found little difference in the prevalence of stunting amongst children from the poorest quintile (50% of children stunted) and richest quintile (56% of children stunted). In fact, the poorest quintile had the lowest rate of stunting in the district[31]. This begs the question: what other factors may explain stunting in the district?

2.4.1.2 Access to Potable Water and Preventive Hygiene Practices

Stunting is positively associated with homes lacking adequate sanitation, good hygiene practices and clean water. In Mbarara District, on average, child HAZ was 0.163 less in homes lacking a latrine[32] while in Hoima District homes without a latrine were 2.7 times more likely to have a stunted child[33]. A rural Sudanese prospective study found that children stunted at outset were 1.17 times more likely to have recovered at 18 months follow-up if the home had an inside water supply and a private latrine[34]. Homes with a latrine are able to contain waste and reduce the risk of food and water contamination. Therefore, children were less exposed to pathogens, less likely to experience serious illness and less likely to suffer an outcome of stunting.

In Kabarole, it was found that housing construction correlated with stunting. Children from homes made of 'basic materials'[a] were found to be 1.5 times more likely to be stunted[35]. It is possible that children from homes made of basic materials are stunted because sitting on mud surfaces exposes them to more pathogens. On the other hand, the type of material a family's home is constructed from may be an indicator of SES. Such children may be more stunted because their families cannot afford proper food and medical care.

In Mbarara, it was found that children from homes with 3 or more person per room had HAZ that were 0.122 less on average in comparison to homes with less than 3 people per room[32]. Children from such homes may be living in less hygienic conditions and be exposed to more pathogens. Such children may also have to compete more for food and caregiver nurturing with other siblings. Both these factors would tend to increase the risk of stunting.

Children from homes with domesticated animals living in close proximity to the home were at a higher risk of stunting in rural Ecuador. Such children were 2 to 5 times more likely to be carrying the gardia protozoa and such carriers were 2 times more likely to be stunted and have lower hemoglobin than their non-infected counter parts[36]. These sorts of animal husbandry practices are also common place in rural Kabarole. Therefore, this medium may expose children to infectious diseases and increase their risk of stunting.

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[a] Basic materials in Kabarole means walls made with a bamboo frame, packed with mud and smeared with cow dung, a mud floor smeared with cow dung and a corrugated iron sheet roof.

2.4.1.3 Material and Financial Resources

Appendix 13 explains how the accumulation of assets over time may be considered an approximation for the increasing SES of a family. For example, ownership of a bicycle may be considered an indicator of a higher level of wealth and a means to earn money. Children in homes without a bicycle were found to be 1.4 times more likely to be stunted in Kabarole[35]. The radio also represents both a higher level of wealth and a medium through which to hear important health messages and obtain a sense of connection to one's community. Children in homes without a radio were 1.3 times more likely to be stunted in Kabarole[35]. Durable assets represent wealth as well as a higher degree of self-sufficiency.

Land ownership is an important indictor of wealth. Since 97% of caregivers are subsistence farmers, owning land permits more of the profits to go back into the family. In Kabarole, caregivers stated that renting land was a barrier to meeting the needs of their children[35]. First, paying a landlord reduces the profit made from cultivating vegetables. Secondly, caregivers generally have to walk a distance to get to their rental land and must leave their children while doing so. During that time, weaning children may not be properly feed or children without proper supervision may be exposed to pathogens.

In Mpigi, central Uganda, a study found that "there is enough land to meet the needs of people; however, the practice of fragmenting land for future generations was leading to poor land management and yield."[37] While child stunting status has been found to be predicted by land ownership, the relationship is confounded by SES. After adjusting for SES, no relationship was observed between land ownership and child stunting status in Hoima[38]. Regardless of whether or not a family of high SES owns land, wealthier families may be more able to buy the food they need to nourish their children and do not need land on which to do so. Therefore, land ownership is a predictor of child stunting status when the children come from families of lower SES.

The quantity of food harvested from land has been correlated with child stunting status. In rural Chad, child HAZ was shown to increase by 0.88 per adult equivalent of cereals harvested[39]. Increased production may have influenced HAZ in two ways: through having increased money for purchasing other foods, paying for transportation or healthcare costs or through providing more food directly for children's consumption.

Families with livestock have been found to have healthier children. HAZ was 0.298 higher on average amongst children from families who owned a cow in comparison to those who did not[32]. Livestock enables caregivers to provide meat for their children while giving them capital to sell in times of poor harvests so that adequate food and basic necessities can be purchased.

In Mbarara, homes in which members of the family worked on other people's land had children who had a HAZ that was 0.027 less on average than homes in which family members did not work on other people's land. Causal labourers rely on meager earnings to provide for the families[32]. This work is also usually seasonal and does not provide a steady source of income. Therefore, children are vulnerable during periods of low income because their may not be sufficient food available to meet their needs.

Bridge, A. found that the inability to find employment is a barrier to providing food and basic necessities for families[35]. In rural Chad, HAZ was 0.60 lower on average amongst the children of mothers engaged in the work making and selling handicrafts in addition to their subsistence farming activities[39]. A caregiver's need to engage in extra work is an indicator of a family's stressed financial situation, which may result in the under-fulfillment of children's needs. On the other hand, it seems important for child nutritional status that fathers have income in addition to that earned from subsistence farming activities to provide for the family. The Chad study found that fathers who had no income other than revenue earned from subsistence farming had children who were more at risk of being stunted. Families without extra income may be forced to go without certain basic necessities, which may compromise the nutrient intake adequacy of their children. While the children of mothers engaged in craft work were found to have a lower HAZ in Chad, it was found in rural Nigeria that the children of mothers who worked were less stunted if the children were brought to the mother's place of employment. The authors found that so long as the mother's work did not impede her ability to meet the child's feeding needs, then the extra income reaped positive benefits for the child[40]. Thus, children require a steady supply of good food and services to meet their basic needs but attaining the money to meet basic needs must not compromise the nutrition and nurturing they receive from their mother.

Child stunting status has been shown to vary with tribe. The Bakiga are a tribe making up a minor percentage of the population in both Mbarara and Kabarole. In 1995 in Mbarara, it was found that being Bakiga was positively correlated with child stature. It was suggested that the Bakiga may be of higher SES because of specific micro-culture behavioral factors that explain the variation in child stunting status[32]. For example, the Bakiga may use harvesting techniques that are more efficient causing less wastage and may use preservation practices that enable them to sell their produce when prices are higher. It is often commented by Batooro persons, who make up the majority of Kabarole, that the Bakiga are an aggressive and hardworking people. Perhaps this cultural work ethic manifests in better health for their children?

Polygamy is a cultural practice that was found to have negative consequences for child nutritional status. In rural Chad, it was found that HAZ was 0.89 less on average amongst children from families in polygamous relationships[39]. It may be that such families have fathers who divide their resources, perhaps unequally, amongst their wives resulting in some children not obtaining sufficient nutrition and nurturing.

2.4.1.4 Parental Education

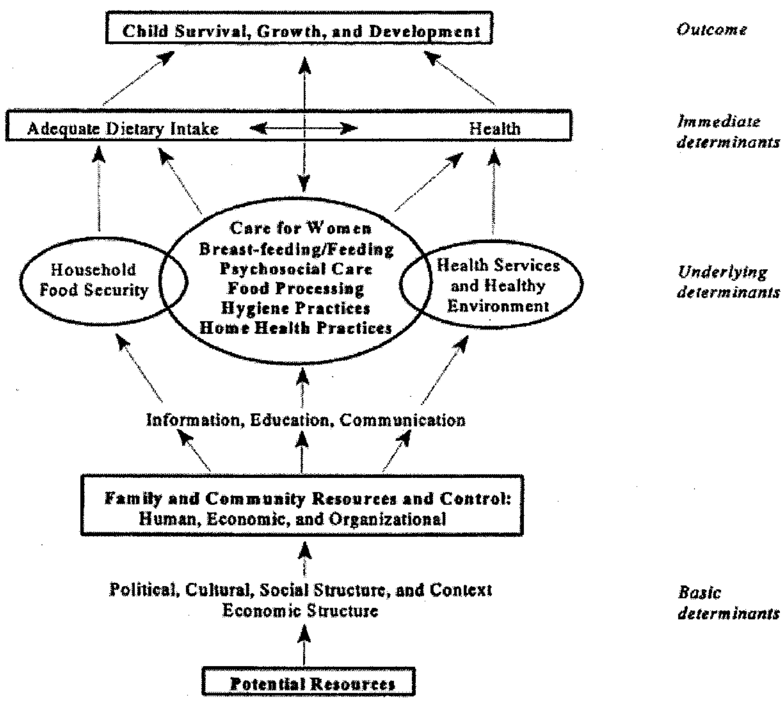
The mother's level of education is a determinant of child stature. In Arua, in northwest Uganda, on average, children of mothers with no education had a HAZ of 0.940 less than children of mothers who were educated, after controlling for SES[41]. An educated mother may be likely to access healthcare services because of learning about such services in school. Therefore, she will be able to offer a more timely response when her child becomes ill. In Hoima, Tuwime et al. confirmed the importance of education: a mother who does not complete primary school is 2.1 times more likely to have a child who is stunted[38]. They stated that since a mother's level of education is a determinant of child stunting status, gender balanced education must be ensured[33]. Concerning the father, Tumwine et al. found in the western District of Kasese that children of fathers who had not completed primary education were 1.78 times more likely to be stunted[42]. An educated father is able to earn more money and provide more for his family. However, Wamani et al. did not find father's education to be of significance in Hoima[38].

In this instance, the significance of education may have been explained by other factors in their model such as SES.

2.4.2 Intermediate Factors

2.4.2.1 Caregiver Health and Well-being

The caregiver is the intermediate between the child and nutritional status. The holistic health of the caregiver is critical for enabling her to "make things happen for the child."[39,43] From the age of 6 to 24 months, a child is at the greatest risk of becoming stunted[32,33,35,42,44-46]. This is the period through which weaning is happening and poor weaning practices are widely held accountable for the high rates of child stunting in Kabarole District. The middle circles of Figure 2 depict factors related to the caregiver that can modulate her child's nutritional intake. For example, if a caregiver has poor physiological health, she may not feed her child adequately resulting in her child having an inadequate transition to solid foods.



Source: Engle (1999)[43]

Figure 2: UNICEF's Conceptual Framework: Care For Child

The mother's health status during gestation and child infancy are correlated with stunting status. The National Nutrition and Health Survey conducted in 1995 found that half of woman giving birth to underweight babies are underweight themselves[46]. Likewise, a study from India concluded that inadequate maternal nutrition is the main reason for children of poor nutritional status. They found that poor growth in utero led to altered child liver function as well as poor neonatal growth[47]. Two questions on the 1995 Ugandan national survey of children 0 to 47 months addressed babies born underweight. The prevalence of stunting amongst children who were reported by their mothers to have been of small size at birth was 46.6% in comparison to 36.3% in children not reported as such. The prevalence of stunting amongst children actually weighed at birth who were underweight was 44.9% in comparison to 29.3% amongst babies of normal birth weight[46]. Therefore, efforts to address stunting must also address the physical well-being of mothers during pregnancy.

Bridge found that caregivers who were ill were less able to care for their children. Caregivers reported to her that: "we are sick and weak and therefore, we cannot dig in the gardens."[35] Since the majority of caregivers rely on the fruits and vegetables of their labour to feed their children, an inability to work is an inability to adequately nourish. Both physical integrity and the psychosocial well-being are important elements of maternal health. In rural Chad, for a unit increase in a caregiver's sense of satisfaction with life, child HAZ increased by 0.50[39]. Moreover, a longitudinal study from Pakistan demonstrated that children of physically well but pre-natally depressed mothers were 4.4 times at 6 months and 2.5 times at 12 months, more likely to be stunted in comparison to children of psychologically well mothers[48]. Perhaps mothers who are depressed are less motivated to work hard to ensure their children consume an adequate diet. However, the relationship between caregiver psychosocial health and child illness could be confounded. If mothers of sick children are depressed because their children are sick, then child illness could be a confounding factor for the relationship between caregiver psychosocial health and child stunting status.

The degree of support a caregiver receives was found to be an important determinant of her psychosocial health. A mother having help available for at least 2 tasks a day, such as fetching water and preparing meals, had children whose HAZ was on average 0.50 higher than mothers with less than that support[39]. Caregivers who have the support of their partners or older children to help with chores have more time to feed and nurture younger children; caregivers who can offer younger children more attention can feed them better and respond in a more timely fashion to illness. Therefore, the support a caregiver receives is an important determinant of both her psychological well-being and the stunting status of her children.

2.4.2.2 Correlation of Stunting with Child Age

There is a relationship between caregiver factors, the circumstances that surround child weaning and the age of stunting onset. Appendix 4 presents a summary of stunting by age, reported from various studies conducted in Uganda. The tables indicate that the highest prevalence of stunting occurs between 12 and 23 months of age. Vella et al. found that the prevalence of stunting in a cohort less than 6 months of age was 6%, which became 35% at 2 years of follow-up. They found that in the first 2 to 3 years of life, the prevalence of stunting increased and then remained steady; in the first few years of life, the probability of recovery from stunting was less than the probability of becoming stunted so the prevalence rose. They concluded the younger age group was more vulnerable than the slightly older children and the younger children may benefit from targeted intervention[5]. Such interventions may include regular anthropometric and dietary monitoring facilitated by the local health unit.

However, some confuse high prevalence of stunting in older cohorts with the inability of those older children to recover from stunting once they have passed a certain age. Vella et al. found this to be not true. The odds ratio of recovering from stunting was the same in the oldest (54-59 months) as it was in the youngest (<6 months) group, consistently around a 25% chance[5]. This was a crucial finding for policy makers wanting to target interventions: while younger children may benefit from specific targeted interventions, older children may also recover from stunting if programs address the high prevalence of stunting in their ranks as well. Of course, preventing stunting during weaning is an important objective. The circumstances surrounding child weaning offer explanation for the relationship between age and stunting status.

2.4.2.3 Weaning

Breastfeeding for too long is correlated with the onset of child stunting. Children from a 1988 rural study in Ghana who were breastfed beyond 19 months of age were more likely to have a low WHZ[49]. In their study group, a closer examination of 15 wasted children between 12 to 24 months revealed that the protein and energy intakes of those still breastfeeding was about half of that of 5 normal children of the same age who were completely weaned. Therefore, it was recommended that children who are older than 12 months but eat well may continue to breastfeed until 18 months of age; however, those who are reluctant to take solid foods at 12 months should be weaned completely to encourage them to eat solid foods[49].

The consequences of breastfeeding for too long have been observed in Uganda as well. In Mubende District, it was found that children still breastfeeding between 18 and 24 months were 6.69 times as likely to be stunted; above 24 months of age, this risk dropped to 0.06. Vella et al. conducted research in Mbarara and found a similar result to that found in Mubende. They offered two explanations for the outcome they observed: first, partially weaned children may prefer to breastfeed than eat complementary foods; this results in inadequate nutrient intake because as a child grows, nutrient requirements increase as breast milk production and nutritional value decrease. Second, caregivers may think that children who are still at the breast do not need the same quantity of complementary foods as those who are fully weaned; therefore they are not fed as much[32].

On the other hand, some would argue that prolonged breastfeeding does not cause malnutrition. Simondon et al. found that breastfeeding continued because mothers perceived their children to be malnourished and felt their children needed to continue breastfeeding in order to help them along[50]. "The habit of postponing the weaning of stunted children most likely explains why prolonged breastfeeding is associated so strongly with stunting."[51] The causality of this association could not be evaluated because of the cross-sectional study design. It is logical, however, that mothers would continue to breastfeed if they felt such action may improve the status of their malnourished children. That is not to say, however, it is the correct thing to do. Brakohiapa et al. found that wasted children, above 12 months of age, needed to be fully weaned in order to force them onto the richer nutrition found in complementary foods. Such action could be counter-intuitive for caregivers willing to go to any length to help their children, explaining why so many would continue to breastfeed small children.

The previous three paragraphs have interpreted the findings of several isolated studies and have offered suggestions regarding breastfeeding guidelines. However, these studies are outdated and the WHO now endorses breastfeeding guidelines that contradict some of the previously mentioned findings. The WHO recommends that children be exclusively breastfed until 6 months of age at which time complementary foods should be introduced while breastfeeding continues until 2 years of age or older. These policies are supported by a wealth of research, which is discussed in a systematic review[111].

However, advocating this policy in a country such as Uganda, endemic with HIV amongst sexually reproductive individuals is not indicated. The current prevalence of HIV/AIDS in Kabarole is 11.6% amongst adults 15 to 45 years of age[112]. Amongst women infected with HIV who have a child who is not affected, if replacement feeding is acceptable, feasible, affordable, sustainable and safe, avoidance of all breastfeeding is recommended. Otherwise, exclusive breastfeeding is recommended for the first 6 months of life unless replacement feeding meets the previously mentioned criteria for them and their infants before that time. At six months, if replacement feeding does not meet the previously mentioned criteria, continuation of breastfeeding with additional complementary foods is recommended, while the mother and baby continue to be regularly assessed by healthcare officials. All breastfeeding should stop once a nutritionally adequate and safe diet without breast milk can be provided[113].

The onset of stunting is associated with the circumstances surrounding the introduction of solid foods. Table 1 describes the prevalence of stunting assessed in a 1995 national survey of 4737 children age 0 to 47 months, stratified by the caregiver's motivation for weaning. The data would be more descriptive if it were stratified by age of weaning; for example, the interruption of nurturing induced by a subsequent pregnancy would not affect a child of 30 months as much as a more vulnerable child of 7 months. In addition, since both illness and inadequate nutrient intake are positively correlated with stunting, the fact that 48.6% of children who were weaned because of illness were also stunted masks the degree to which illness is responsible for stunting. The table does imply, however, that children who are weaned for any of the specified reasons are worse off than children who are not weaned at all.

Table 1: The prevalence of stunting amongst children 0-47 months by reason for being fully weaned

Reason for full weaning	Currently breast feeding	Child ill or died	Maternal and child factors*	Child's age	Mother ill	Pregnancy
% stunted	31.6	48.6	40.4	40.2	41.2	54.4

*Maternal and child factors include: breast problems, no milk, working, or child refuses; source: Macro International Inc (1996)[46]

2.4.2.4 The Importance of the Mother as an Attentive and Exclusive Caregiver

Factors that interrupt the mother's ability to nurture threaten the nutritional status of her child. Research suggests that male caregivers cannot adequately fill the role of the mother. In Kabarole, male caregivers were 1.3 times more likely to have a stunted child[35]. Fathers may not spend as much time nurturing children as mothers do; on the other hand, fathers cannot breastfeed children as mothers can inhibiting their ability to meet their child's nutritional needs.

The risk of stunting is reduced when children are cared for by their mothers and when their mothers care for them exclusively. One would think the support of a large extended family such as grandmothers and aunts helping the mother nurture the child would benefit the child; however, in Mexico, it was shown that children with such support networks were more likely to be stunted[51]. A child who is cared for by multiple women may be fed an inconsistent diet rendering the overall diet inadequate to meet the child's needs. If the child is not being cared for exclusively by the mother during the first 6 months of life, the child may be weaned prematurely and fail to benefit from exclusive breastfeeding during that time.

On the other hand, the association between the support of extended family and child stunting status is not necessarily causal. Caregivers may have to exploit family support networks because they are in dire conditions. The support of the family network may be necessary to fill the care deficit left by a sick mother or an absent father. Nonetheless, homes in which the mother assertively nurtures her children have children of better health. In rural Chad, it was shown that children from homes in which the mother had strong influence over feeding decisions had children with a HAZ that was, on average, 0.55 higher in comparison to homes where the mother did not have strong influence over child feeding decisions[39]. It was shown in Nicaragua that the children of caregivers who actively monitored their growth were 1.96 times less likely to be stunted in Nicaragua. Such action is thought to be an indicator of the mother's interest in her child's healthy development[52]. Mothers who monitor their children's growth are also more likely to recognize nutritional deprivation and respond. Dr. Bachou of Mulago Hospital in Kampala recognized the importance of such attentiveness and encouraged the Ministry of Health to systematically encourage mothers to do so under the Integrated Management of Childhood Illness program (IMCI)[53].

Such attentiveness becomes harder when more young ones are in the homes. It was reported above that children less than 4 years of age, whose mother ceased breastfeeding because of pregnancy, had a 54.4% prevalence of stunting. Bridge reported that mothers in Kabarole feel that "it is especially hard to provide food if there are a lot of children and orphans in the home"[35]. The more mouths there are to feed, the further stretched the mother's time and food resources must become. It was found in a study conducted at Mulago Hospital pediatric ward that children from homes with more than 3 children are 1.96 times more likely to be stunted[54]. The problem is doubled when twins are born. It was found in a national survey that while the prevalence of stunting amongst singletons was 38.1%, it was 48.6% amongst twins. It seems that anything threatening the exclusivity of the mother's ability to nurture her child, even a sibling of equal age, threatens the child's nutritional status.

2.4.3 Proximal Factors

2.4.3.1 Fulfillment of The Child's Needs Are Inadequate

There are two proximal, direct causes of child stunting: 1) persistent disease and 2) inadequate nutrient intake; factors which expose a child to pathogens, failures to exploit preventive medicine and poor nutritional provision threaten to decrease a child's HAZ. Since 1987 in Uganda, it has been recommended that children, regardless of intensity of parasite infection, be given de-worming medication periodically[55]. In Hoima, the consequences of not exploiting de-worming medication were shown amongst children less than 24 months of age: children not de-wormed regularly were 1.7 times more likely to be stunted[33]. Such children may suffer from persistent helmith infections which reduce nutrient absorption, cause anemia and/or reduce appetite. A child who does not regularly receive a de-worming pill may also have a caregiver who is more likely to neglect other important elements of nurturing such as feeding the child adequately, responding in a timely fashion to illness and ensuring the child receives preventative healthcare interventions.

An important healthcare intervention is receiving the full compliment of vaccines that are universally available in Uganda. In 1999, only 33% of children in Kabarole between 12 and 24 months were adequately immunized for their age[31]. Failure to adequately immunize may result from any number of a constellation of barriers to healthcare access depicted in Figure 3.

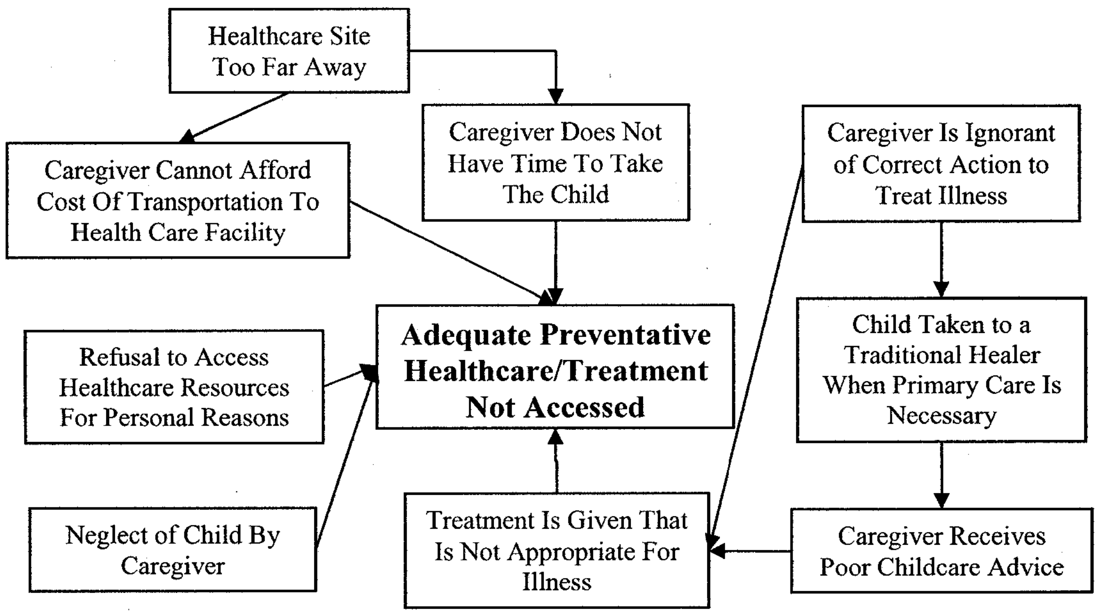


Figure 3: Conceptual Framework of Healthcare Access Barriers in Kabarole District, Uganda

In a national survey in 2002, 7.4% of LC1 Chairpersons reported they felt child abuse[b] occurred "very commonly" in their village[1]. Among other negative effects of neglect, necessary access to healthcare may be ignored. A second reason healthcare may not be accessed is due to ignorance of adequate response to illness. This could cause a child to receive inappropriate care or no care at all. Under *Parental Education,* we discussed that caregivers with more education were more likely to have children of better nutritional status; perhaps education mediates its impact on child nutritional status by improving caregiver's knowledge of when it is necessary to access healthcare services. Finally, reaching care is difficult for caregivers who cannot afford transportation costs to clinics. Such barriers may result in prolonged fever, diarrhea or late treatment of malaria.

Disease status is an important determinant of child nutritional status. In a nationwide survey of 4756 children, the prevalence of stunting was 43.7% amongst

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[b] Child abuse can be defined as intentionally causing or permitting any harmful or offensive contact on a child's body; and, any communication or transaction of any kind that humiliates shames or frightens the child. Major types of child abuse include physical, emotional, sexual and neglect. The effects of child abuse can lead to short and long-term vulnerability.

children who were reported to have had diarrhea in the last 2 weeks and only 36.6% in those who did not. In Mbarara, children who had diarrhea in the last two weeks had a HAZ, on average that was 0.491 less than children who had not had diarrhea in the last 2 weeks. In the national survey, the prevalence of stunting was 40.9% amongst children reported to have had fever in the last two weeks whereas it was 35.8% amongst those who had not. Children having had fever in the last two weeks in Kasese District had a HAZ, on average that was 0.528 less than children with no episode of fever in the last 2 weeks[42]. In Hoima, children with reported fever in the previous two weeks were 1.7 times more likely to be stunted. Children who had eye infections in the last two weeks had HAZ that were, on average, 0.699 less than children who did not. Finally, children positive for HIV/AIDS were 6.62 times more likely to be stunted than negative children. Thus, there is a clear trend with stunting and illness: children who have been ill are more likely to be stunted than those who have not. The coupling of positive disease status with inadequate treatment contributes to the outcome of stunting.

A synergy exists between the effectiveness of the measles vaccination and nutrient intake adequacy. Waibale et al. found that "Malnutrition [referring to stunting specifically] regardless of it etiology is associated with poor response to measles vaccination."[54] They found that the bodies of malnourished children mounted an insufficient immunological response to the vaccine and were left vulnerable to measles. Therefore, children suffer not only directly from malnutrition but also as a result of the vulnerability ensuing from it.

The relationship between disease and nutrient intake are synergistic: a sick child needs more nutrients to fight an ailment but has a difficult time consuming and absorbing them; on the other hand, a nutritionally deprived child has a weaker immune system and is more susceptible to disease. Thus, disease and poor nutrient intake work in concert to retard a child's growth by minimizing the energy stores necessary for nutrient intake to occur. Appendix 4 shows that the prevalence rate of stunting in children less than 6 months of age is about 10%; however, it rises to between 40 and 50% from 6 and 24 months of age. It is likely that persistent disease, prolonged due to healthcare access barriers (see Figure 2), impairs child growth.

There is also evidence that children are failing to attain adequate nutrient intake. Children who do not consume a sufficient compliment of weaning foods to replace and exceed the energy and nutrients supplied by breast milk will not be able to meet the demands of their growing body.

2.4.3.2 Nutrient Intake Adequacy

A 1991 study, based on clinical data, showed that Ugandan children were not consuming sufficient vitamin A. Of 5074 children of less than 6 years, 5.38% had xerophthalmia, 2.52% had night blindness and 1.74% had corneal scars. A team visiting Uganda in 1999 found that the main source of vitamin A in the Ugandan diet was boiled or steamed leafy green vegetables, with hardly any fat. They found that animal protein intake was scarce, limiting the bioavailability of vitamin A and they concluded that 50% of children consumed inadequate vitamin A in their diet. The ministry of health promised to revisit its protocol to include biannual vitamin A supplementation for all children younger than 5 years[53]. While children are to receive supplementation every 6 months, healthcare access barriers may inhibit the utilization of this preventive measure.

Iron deficiency anemia was reported to be in the top 10 causes of morbidity and mortality of children less than 5 years in Uganda based on a sample of 5 districts. It was concluded that one third of these deaths were the result of inadequate dietary adequacy. A confounding factor was the high prevalence of hookworm, malaria, schistosomiasis, and sickle cell anemia. Iron deficiency is also high among pregnant and lactating woman. Among such woman, anemia inhibits adequate fetal development in utero, the quality of mother's breast milk, and may stifle the mother's energy to care for her new born[53]. Therefore, children are suffering directly as a result of anemia and through the impact anemia has on their mothers.

Several studies have examined the relationship between stunting and nutrient intake in western Uganda. In Mubende in 1998, Kikafunda et al. conducted a dietary assessment of children 0-30 months. Like in Kabarole, the diets of people in Mubende District were found to be high in maize and matooke (a green banana prepared in manners similar to those used for potatoes). The authors were interested in the roll of starchy food (low nutrient density <350 kcal/100g) in determining child nutritional status. A dietary history questionnaire, a 24-hour food recall and a food frequency questionnaire were administered to child caregivers and samples of foods that were 'ready to feed' were requested from mothers for nutrient content analysis. The study found that children fed foods of low energy density had a greater incidence of stunting. In addition, it was found that meal size correlated with stunting: children consuming meals of 121 to 200g experienced a protective effect of being 0.90 times less likely to be stunted in comparison to those consuming meals of less than 120g. Meanwhile, children consuming meals of 201 to 500g experienced a protective effect of being 0.36 times less likely of being stunted in comparison to those consuming meals of less than 120g. The authors conclude that the high rate of stunting and illness were caused by poor immune function resulting from under-nutrition[44].

The link between food consumption patterns and child nutritional status was not as clear in Kasese District. It was found there that children between 6 and 59 months who were consuming legumes were 1.71 times more likely to be stunted in comparison to those who were not[42]. Legumes are a nutritious food and should be beneficial to children. Perhaps those consuming legumes as their primary source of protein are doing so because they cannot afford meat. In a hypothetical situation, perhaps the same reason caregivers cannot afford meat for their children is the same reason they cannot access healthcare services in a timely fashion, the later being the true avenue through which a child arrives at the malnourished state. Therefore, in this case, legume consumption may be an indicator of poor SES which results in an insufficient ability to respond to child disease rather than poor nutrient intake adequacy.

Child stunting status has been shown to vary with milk intake. Amongst children 0 to 2 years of age, it was found in Hoima that children not consuming cow or goat milk in the last 24-hours were 1.8 times more likely to be stunted. Children from families with a cow or that can afford to purchase milk seem to have an advantage over those that cannot.

In 2003, Bridge et al. used a food frequency questionnaire to assess the quantity and frequency of food intake in Kabarole. Participants were asked to estimate the frequency and amount of food intake from a list of commonly available foods covering all food groups. She reported that children's diets were almost sufficient but that the caloric intake of children 12 to 35 months was inadequate. Their case control study did not find any difference in the mean HAZ of children less than 5 years from homes where the caregiver was HIV positive in comparison to homes where she was not. Therefore, they suggested that malnutrition among children may result from three things: 1) a mother's lack of knowledge regarding good feeding practices, 2) food taboos for children and pregnant women which reduce the number of nutritious foods that they are eating and 3) time constraints on women for preparing food due to their many other household obligations. It was recommended that a systematic assessment of feeding practices for young children be conducted in Kabarole and food taboos for women and children be assessed[2].

Yet, in 1998, Kikafunda et al. did not find food taboos a significant predictor of stunting[44] in neighboring Mubende. While Bridge et al. suggested that children's stunting status may vary with a mother's food preparation and feeding competency, Wamani et al. stated: "a widely held misconception in Uganda is that people have food but don't know how to use it for their children." In a 2004 study, Kabahenda sought to understand what caregiver factors predisposed children to malnutrition. She found that the majority of caregivers reported that they had insufficient food available to feed their children. In that study, child nutrient intake was not quantified but using a validated food frequency scoring system, it was found in Kabarole's Gweri and Kiguma villages and surrounding areas that the diets of children were deficient in "energy yielding", "body building" and "protective"[c] foods[45]. Such children would be vulnerable both to stunting caused directly by insufficient protein and energy building blocks necessary for growth as well as through increased susceptibility to disease due micronutrient deficiencies. There is reason to believe that nutrient intake is deficient in Kabarole District. Now, further investigation is necessary to describe the prevalence of nutrient intake adequacy and its relationship to child stunting status.

2.4.3.3 Potential Factors Associated With Nutrient Intake Adequacy

A distal factor associated with poor child nutrient intake adequacy is poor household food security. Household foods security may be defined as "a state in which a household has continuous access to food which can fully satisfy the nutritional needs of all its members…in a stable and sustainable manner in terms of energy and protein requirements[56]. Greer and Throbecke add that a secure supply of micronutrients is an important component of food security as well[57]. Children from homes with steady supply of protein and energy have the macronutrient building blocks necessary for growth; those that are eating an adequate compliment of fruits and vegetables will have the micronutrient supplies necessary to develop a strong immune system to quickly respond to disease. Household food security makes these nutrients available for the child.

Poverty may threaten household food security but one cannot generalize that inadequate nutrient intake is a consequence of poverty. For instance, take Anderson et al.'s 1946 finding about the Otomí people of the Mezquital Valley, north of Mexico City. Grivetti et al. explained that this paper challenged the prevailing views regarding food intake, disease and environmental setting. Despite the poverty and an unsanitary setting, the Otomi were well nourished. The key to the Otomí's survival was that "almost every

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[c] Protective foods supply micronutrients to strengthen the immune system (Kabahenda, 2004)

conceivable edible plant, including many of the cacti, [were] used as food. Many grow without cultivation during the rainy season, and by most [Westerners] would be considered weeds."[5859]. Like the Otomi, the rural poor in Kabarole live a subsistence lifestyle and are cultivating a variety of crops[60]. Intuition suggests that such activities have enabled them to survive for centuries. If we assume that decreasing levels of nutrient intake adequacy are at least, in part, the cause of the rising levels of stunting observed in western Uganda (see Appendix 4 for stunting trends), we may be inclined to ask: are certain factors now threatening the household food security among the people of Kabarole? Has the ability to cultivate and/or gather a sufficient variety and quantity of food stuffs to properly nourish their children decreased? The data necessary to assess nutrient intake adequacy trends is not available but previous studies have identified factors associated with nutrient intake adequacy.

In rural Kenya, household size was found to be a determinant of food energy intake. In a Rift Valley community receiving similar annual rainfall to Kabarole, researchers sampled poor subsistence farming families with 3 acres or less of land under cultivation and grouped them by number of persons living together in the home. They found that those homes with less than 4 persons met 181% of their energy requirements while those with greater than 7 met only 68%. They suggested that households with energy deficits are also likely to be deficient in other nutrients as well. Large families have more labour but they have less farm operating surplus and less land per person. Therefore, not as much can be produced per person[61]. Therefore, it seems that having a large family contributes negatively to child nutritional status.

Land availability is a determinant of child nutrient intake. Land determines the amount of crops that can be produced and the livestock that can be raised at any given time[61]. A qualitative study conducted in Kabarole found that a deceased husband's family could demand ownership of the caregiver's land if the husband did not leave a written will entitling his wife to the land. Even under more stable circumstances, insufficient land upon which to cultivate has been found to be negatively correlated with child energy intake. Several studies have found that malnutrition is more prevalent amongst rural landless people than in landed households[62-64]. Some of these have also reported a positive correlation between household land size and child nutritional status especially in relation to WAZ[62,64]; this relationship is especially true for preschool aged children.

Kigutha et al. studied poor subsistence farming families in rural Kenya in order to see how much land was necessary to adequately meet a family's food security needs. While potentially confounded by the quality of soil, rainfall patterns and family income level, it was found that 3 acres of land was insufficient to sustain the food energy needs of an average size, low income family. The World Bank estimated that the average household in Kenya needed 6.4 acres of good land to produce adequate food and income[65]. However, it was found in Mpigi District in western Uganda that most family land holdings are much smaller than this and continue to reduce in size as population pressure grows[37]. If a caregiver does not have access to adequate land, child nutritional intake adequacy may suffer.

Parental illness and death call on the extended family to offer support to aggrieved children. In the case of the death of a spouse, particularly a husband, a widow must muster her resources to fill the financial and labour gap left by her partner. Kabarole based qualitative research found that the impact on child nutritional status depended on the immediate and extended family's SES, the number of orphaned children and the number of children in the extended family. The study specifically examined the impact of AIDS on families in Kabarole and noted that unlike other diseases or causes of spousal death, AIDS almost always affected young families without any resources to mitigate the loss of a partner. Widows have both less time and less food to prepare a balanced diet for their children. Poverty is the root cause of such a cascade because the caregivers have few resources to draw on in comparison to caregivers not living in poverty.

Kabarole has two wet and two dry seasons which regulate cultivation periods and food availability. In 1994, Topouzis observed that people in the western district of Tororo and the northwestern district of Gulu suffered during the rainy, pre-harvest season; this seasonality generated 'hungry months'. In comparison to Kabarole, Tororo and Gulu have less fertile land and food crops like cassava, sorghum and millet are grown that are more labour-intensive[66]. In Kabarole, however, Matooke can be harvested year round so people rarely experience hungry months. However, satiation does not imply consumption of a balanced diet[66]. Moreover, households in the southern sub-counties, like Rwimi, are more dependent on maize, which is sensitive to rainfall adequacy and could suffer incase of harvest delays or crop failure.

Kigutha et al. observed in Kenya that rural families could secure foods from three places: cultivated and gathered sources and in times of food scarcity, market purchases. Studies in the coastal provinces of Kenya found that homes with a regular supply of money depended on purchases during the months when their own cultivars ran out[67]. This may be applicable for homes with extra cash but those who are lacking will not be able to supplement their diets with such expenditures. While the 'hungry months' are predictable, the timing and duration of the rains varies from year to year and this affects the quality and quantity of farming yields and the quality of pastures upon which animals graze. In the rural area examined by Kigutha et al., maize was the main staple, planted in March or April and harvested 8-9 months later. Only one crop of maize was found to be grown per year[61] as is the case in Kabarole. The maize was found to be generally intercropped with beans, peas and potatoes, which provided a temporary increase in energy midseason but the majority of land was saved for maize. Since the rains directly determined the amount of food that could be harvested, inter-planted, early maturing supplements like peas, beans, potatoes and a variety of vegetables were essential to traverse the 'hungry months' for these communities. In the context of Kabarole, it is thought that the more *local edible vegetables*, in particular, are exploited to supplement the staple, the better the nutritional status of the children will be in Kabarole's seasonal climate.

2.5 What Are Local Edible Food Plants?

In 1989, Goode explained that local edible food plants were:

> Those species of plants that are either indigenous, that is, native to the area, or which have been introduced such a long time ago that they have become accepted as native species. These plant are often referred to as 'traditional' 'wild' or 'local' species, as distinct from 'introduced' 'exotic' or 'western type' plants that are usually cultivated for home consumption but are also grown intensively for the overseas markets. 'Local' refers to the leaves, stems, roots and fruits of plants which are harvest and cooked for human consumption, fruits which are usually

eaten raw and a wide variety of mushrooms. Leaves are the most commonly harvested part of the plant for cooking and these may be plucked from crops which are normally considered to be food crops e.g. sweet potato and cassava. Leaves are also harvested from plants normally grown for their fruits or seeds e.g. beans, cowpeas, and pumpkins. The term 'local', therefore, covers a number of different parts of the plant from a wide variety of species (Goode, 1989).

Many studies show the direct and critical role local edible food plants play in the diets of various groups in developing countries. While the present study presents overall dietary intake results, future analyses of our data may contribute to the understanding of local edible vegetables at the public health level. Grivetti and Ogle explain that anthropologist, geographers, historians and sociologist contribute the first layer of research by performing cultural investigations. These document patterns of selection, preparation, storage and distribution of foods by age, sex or risk group such as lactating woman, young children and the elderly. Descriptive botanical inventories of all locally available plant species may follow[59]. In 1989, Goode published "Edible Food Plants of Uganda" which provided a concise inventory of all food plants used in Uganda by region[68]. Grivetti and Olge offer that food inventories are of limited value to efforts to improve public health unless the descriptive, ecological and systematic data are combined with dietary assessments on current consumption. Without this linkage, inventories seldom permit an understanding of the role certain species play in overall micronutrient intake[59]. The present study capitalizes on Goode's inventory and uses food composition reports published by biochemists, chemists, and nutritionists to quantify child nutrient intake. By comparing a child's nutritional status to the amount of nutrients being consumed from local edible food plants, our study brings local edible food plants research into the realm of public health.

2.5.1 The Role of Local Edible Food Plants in Maintaining Dietary Competency

Studies that are able to combine descriptive work with nutrient intake have been able to show the importance of local foods in the diet of high risk groups such as lactating woman, children, and the elderly. A village based study in rural Bangladesh showed that nutrient intake does not necessarily show a consistent association with SES. For mothers, dark green leafy vegetables and fruits were the main source of vitamin A. During the raining season when local edible vegetables were plentiful, vitamin A intake was actually highest amongst the poorest socioeconomic strata of mothers. This reversed slightly during the dry season when the majority of the vitamin A intake came from purchased fruits which may have been out of reach of poorer mothers. The exploitation of local food plants positively impacted breastfed children: the nutrient consumption portion of the study showed that child who were breastfed had almost 100% of their vitamin A requirement met. The only significant source of vitamin A for children were mangos; it was found that the 14 children that stopped breastfeeding by the end of the study were at risk of vitamin A deficiency. The authors concluded that traditional vegetables, high in local edible plants, should be protected and promoted[69].

In highland Thailand, local fruits were found to be introduced into the infant diet. They were shown to make an important dietary contribution; infants actually had a more diverse diet with higher intakes of vitamins A and C and iron than adults. It was noted that these fruits were introduced earlier than cultivated vegetables and the fruits were important for providing complementary micronutrients during the first year of life[70]. A study amongst the Fulani people of northern Nigeria did not note the use of edible local plants for weaning foods. However, amongst the settled Fulani, the consumption of local edible vegetables was vital for balanced dietary intake. The principle users of edible local plants were woman, children and the elderly. Children exploited local fruits during their 12 hour days away from home while searching for cattle food; they relied on fruit snacks because they were easily consumed[71].

In 1991, direct observation techniques demonstrated that throughout the school day, children in rural Kenya sometimes ate between 3 and 7 fruits snacks. In some cases, this was the only food they had access to throughout the school day. They found that children knew of collectively more than 70 local species. A significant finding was that the local term for fruits did not translate as food. Employing standard food surveys to assess nutrient intake would have resulted in under reporting of "food" consumed throughout the day. It was found that these local fruit snacks were major sources of vitamins and minerals, especially carotenoids and vitamin C[72]. In Uganda, Goode notes that children eat a variety of locally growing fruits on their way to school and while herding cattle. This provides an important supplement for vitamin A intake and needs to be encouraged[68].

Research has further demonstrated the importance of local edible vegetables in Mali, western Africa. The importance of local edible plants was shown there in the rural diet by assessing the seasonality, frequency of use and the nutrient content of various leafy greens and wild gathered vegetables. They found that leaves were an excellent source of vitamin A and a complementary source of protein with the first limiting amino acid being lysine. It was concluded that these traditional and locally available vegetables are valuable and important nutrient contributors to the diet[73].

2.6 Assessment of Child Nutrient Intake Adequacy

There are several tools available to assess child nutrient intake adequacy. In the first type an investigator weighs all foods consumed by the children in the study. This is fairly accurate but time consuming and expensive. The investigator must live with the family for a period, usually limited to one week due to his/her intense and interruptive presence; during that time, he/she records the weights of all foods prepared, the weights of foods served to each child of interest, and the weights of food waste left by the child. The brief duration of the study cannot be representative of the whole year because it does not take seasonal variation and fluctuations in economic circumstances into account. The notion of weighing as a gold standard for nutrient intake is itself fallacious because the quantity and bioavailability of nutrients in stews and porridges fluctuates with the consistency and preparation of the dishes[74].

The second type of study is similar to the first except that in addition to weighing all foods consumed and the portion remaining as waste, exact replicas of meals are taken for chemical analysis. The nutrient value of foods varies with the manner in which it is prepared. Goode described that Amaranthus dubious, a leafy green vegetable consumed in Kabarole District, contained 284 mg of vitamin C if boiled for 4 minutes but this decreased to 71.4 mg when boiled for 10 minutes[68]. Chemical analysis circumvents preparation ambiguity and assesses the exact nutrient value of stews and porridges.

However, the process requires a sophisticated laboratory to carry out the analysis and the collection of samples is time consuming; therefore, it can usually be done on only a limited fraction of subjects surveyed.

An alternative to the intrusive, quantitative nature of the previous two nutrient intake assessment techniques is called diary recording. This data is purely qualitative but Whitehead offers that, when used in conjunction with other techniques, it is effective at validating findings. Whitehead references a study by Rutishauser done in Uganda in 1973 that used a visual system whereby a variety of pictures of foods that could be consumed were pinned along the top of a large calendar and mothers were instructed to pin those food pictures under the day of the week they were consumed[75]. This described the variety of foods in children's diets and the diversity of food groups being accessed but it did not assess nutrient intake.

The semi-quantitative 24-hour child food consumption recall is a simple and widely used technique to estimate nutrient intake[45,76]. The less sophisticated the family's way of life, the more accurate the assessment of nutrient intake generally becomes; reason being, since fewer foods are being consumed, recall is less biased. In 1973, Rutishauser found that the 24-hour recall method and the meal replica method both produced the same results for protein and energy intakes when 6 days of recall were spread evenly over 6 months[75]. Rutishauser found that recall bias was further reduced by referencing an exhaustive list of foods that a mother was likely to be feeding her child. This practice was employed in the present study by referencing the local edible plants inventory compiled by Goode, 1989[68] and the food stuffs list used by Kabahenda, 2004[45]. "Traditional Food Plants"[77] and the staff at the Fort Portal Botanical Gardens were also consulted to ensure a complete list.

The average nutrient intake assessed from several 24-hour recall observations performed on non-consecutive days provides a good estimate of child nutrient intake. In a rural Kenyan study, 24-hour recalls performed on a monthly basis provided information on seasonal fluctuations in child food intake[78]. Should several return visits not be completed, the results may not accurately reflect the dietary pattern of the child of interest. A recent Kabarole based study asked caregivers if food intake reported during a 24-recall reflected the typical diet of the child and 47% said that it did not[45]. A study in rural Papua New Guinea found that food intake patterns seem to fluctuate on a weekly basis and felt it necessary to study food consumption over 12 days in order to accurately assess the pattern of food intake[79]. Exemplary diets described by the German nutritional guidelines assume that dietary requirements are met over a 7-day period[80]. Therefore, while the 24-hour recall is not as demanding as food weighing, the necessity of return visits limited its applicability for our time limited study.

A fifth type of study, not discussed by Whitehead, 1977, is known as a Quantitative Food Frequency Questionnaire (QFFQ) and has also been employed to assess child nutrient intake[81,82]. The period of the present study was restricted to the fall of 2006. Therefore, neither prolonged assessment of sampled households, as is required to take precise weights of food consumption nor return trips to homes, a requisite to control for daily and seasonal fluctuations in food consumption using 24-hour recalls, were possible. The QFFQ satisfied the present study's need for quantitative food intake data to assess the relationship between nutrient intake and child status, while allowing for fluctuations in food consumption patterns both on a daily and seasonal basis. It does not assess meal structure and/or frequency, factors shown to be of importance to child nutritional status[42,76] but like the dairy method described above, it allows investigators to quantify the food variety and food group diversity in children's diets. Both these indices have been shown to be associated with child nutritional status.[78,83,84].

Stunting, like growth, develops gradually. Therefore, the factors thought to be associated with it must be assessed over duration substantial enough to afford measurement of growth; ideally, this is done prospectively and nutrient intake assessment is assessed in each season to control for variations in food availability. Our QFFQ made allowances for seasonal variation in nutrient intake by recording the months during which the food stuff was said to be available. Since data was assessed during only one season, however, our results at best reflect the season of assessment and suggest the pattern of food stuff availability over the preceding 11 months. Intuitively one can reason that caregiver recall was prone to error due to annual fluctuations in market place and subsistence crops timing and quantity. Maxwell et al. conducted a study on urban agriculture in Kampala and controlled for seasonal variation by taking a random sample both in the rainy and dry season "in order to capture any seasonal variation in nutritional status and food availability either through market prices, availability of subsistence food, or incidence of illness."[85] Zeitlin et al. performed a study in rural Bangladesh, examining vitamin A intake from foods, in which they took 7 monthly cross-sectional 24-hour recalls in order to control for seasonal variation in food availability[69].

Yet, perhaps stunting does not vary with seasonal food availability. Onyango et al. also assessed nutrient intake during only one season but found that dietary diversity was "robust enough to hold through seasonal variations because Food Variety and Dietary Diversity (discussed in the following section) were positively associated with indicators of both long-term (HAZ) and short-term (WHZ) indicators of nutritional status"[86]. Nonetheless, performing only one nutrient intake assessment is a limitation of our study that is difficult to mitigate. This limitation must be kept in mind when interpreting the results.

Various methods exist to study child nutrient intake. Onyango advises that researchers chose a method that will best capture the data during the time frame available for study[86]. We felt that in order to capture maximal information about seasonal variability as well as patterns of food intake, a QFFQ was most appropriate.

2.7 Food Security in Kabarole

Research studying the contribution local edible vegetables make to child nutritional status in Uganda and specifically Kabarole District is deficient. However, Goode has provided an excellent understanding of their role in the food system. The common diet of the Ugandans in the western part of the country consists of the starchy staple plantain (cooked green bananas locally known as matooke) accompanied by a side dish, sauce or relish. The sauce generally includes tomatoes, onions, a legume such as groundnuts, peas or beans and leafy green vegetables when available. On occasion, meat is also included. The plantain staple is higher in vitamins A and C than their grain counter parts (such as maize, sorghum or millet) but it lacks calcium, iron, and B vitamins and has only 1.5g of protein per 100g. Therefore, the leafy green vegetable/legume rich sauces are important dietary components. Plantains grow in Kabarole favorably because of its damp climate, a climate equally conducive to the production of vegetables. Goode remarked that it is odd that in a country that can grow vegetables almost year round, they are not more widely consumed. Based on vegetable consumption surveys, Goode noted that consumption of vegetables is not adequate and any attempt to popularize edible wild plants and increase their accessibility will improve nutrient intake[68]. The present study, which aims to identify the relationship between nutrient intake adequacy and child stunting status, may provide further impetus to improve the marketing of local edible vegetable consumption.

Kabarole is politically stable and has progressive agricultural objectives[87]. Such ambitions, however, threaten to disrupt the dietary diversity obtained from local edible vegetables for several reasons. First, policy makers of the past have frequently undervalued local plants as significant sources of nutrition in favour of the eight main cereals and the four main tubers[59]. The risk for Kabarole is that such short sightedness could lead to the disruption rather than improvement of food security. In 1986, Gilliland found that the nutritional content of some local species used by natives in California was not only important to augment their diet but were actually a superior source of vitamin and mineral content to widely raised domesticated field crops[88]. The loss of equivalent species in Kabarole due to mono-cropping of grains could jeopardize dietary diversity.

Secondly, the contested but widely publicized government vision known as "Bona Bagaggawale" or "Wealth for All" promises agricultural modernization. Grivetti and Ogle discuss, however, that many have warned that indiscriminate attempts to "push back forest margins and bring vast regions under cultivation" may result in the extinction of species not previously examined for their potential as food or other products[59]. Paul Lunven, retired director of the Food Policy and Nutrition Division at the Food and Agricultural Organization of the United Nations warned this would be a "serious loss to future generations"[68].

Preserving biodiversity, however, is not sufficient for local edible plants to continue to contribute to people's diets. The third important point made by Grivetti and Olge is that "knowledge [at the population level] of those species may be the most important determinant of whether or not individual families maintain nutritional quality or become malnourished; perhaps the fate of the edible local plants in Kabarole depends on them achieving mainstream acceptance from the media, authorities and the public at large[59]. The dismissal and ultimate loss of local edible plants due to mono-cropping practices could lead to considerable economic loss for Uganda. Lunven comments that "western cultures are increasingly seeing the value in vegetables for their various health benefiting qualities and the demand for them is growing"[68]. Whether or not locals or local authorities or government realize their potential, the World Bank does and is actively gathering information on them in order to disseminate that "Indigenous Knowledge" to local people in order to help them[89]. However, that information may also be beneficial for future commercialization purposes; the act of Ugandans abandoning local vegetables may result in a loss on a claim to a growing market.

The present study focuses on updating our understanding of the role of local edible plants in the food security system of rural families in Kabarole. First, we investigated the prevalence of stunting in Kabarole District. Subsequently, we investigated what foods were being cultivated, gathered and purchased by families in Kabarole District and analyzed the relationship between nutrient intake adequacy and child stunting status.

Chapter 3: Methods

3.1 Population

The present study took place in all 10 sub-counties of Kabarole District. Data was collected from rurally located homes with children less than 5 years of age during a period encompassing the majority of one rainy season from September to December, 2006.

3.1.1 Sample Size Calculation

The primary objective of the survey was to estimate the prevalence of stunting amongst children 6 to 59 months of age and to study the correlation between preschool age stunting and nutrient intake adequacy. The prevalence of stunting was expected to be between 48%[90] and 55%[35]. At an estimated prevalence of 50%, using the StatCalc utility of EpiInfo (Version 3.3.2), we calculated that a sample size of 381 would be needed for a 95% confidence interval of 45 to 55%.

3.1.2 Sampling Procedure

Households were sampled using multi-stage sampling. Parishes were sampled by entering the name of each parish into a Microsoft Excel 2002 spreadsheet. Next, Excel's random number generator was used to assign each parish a random number. Parish numbers were then sorted in ascending order and the first 20 parishes were selected. Villages from these twenty parishes were selected in a similar manner. Two villages were selected from parishes with less than ten villages and three from those with 10 or more villages. This produced a sample of 50 villages. Each village was only visited once and 4 to 6 households were selected in each village. The first household selected was that in closest proximity to the LC1 Chairperson's home that met the inclusion criteria. Subsequent homes were selected by continuing on in the same trajectory from the LC1 Chairperson's home and indiscriminately visiting all homes along that path that met the inclusion criteria. To be included in the study, 1) households had to be located within Kabarole district but outside of Fort Portal Municipality, 2) households had to have at least one child that had either begun the weaning process or was fully weaned from breast milk but who was not older than 60 months of age, 3) the caregiver had to be able to confidently state the child's date of birth; proof of birth date such as a vaccination card was preferable but not required, and 4) the caregiver and child had to have lived in the home for a minimum of one year. A household was defined as a group of people cooking, eating and sleeping under the same roof[44].

3.2 Measurements

All data was collected by the primary investigator and by the same research assistant. Our research assistant was a woman of approximately 40 years, who was trained as a nurse and practiced regularly until approximately 2 years prior to the study. She spoke English and Rutooro, was a resident of Kabarole District, a mother of 8 children and a farmer. A structured questionnaire was used to assess frequency and quantity of food consumption, child anthropometric data, indicators of caregiver well-being and sociodemographic, hygiene and child characteristics (see Appendix 7). The questionnaire was piloted with 21 households that were not included in the analysis. All data was checked for inconsistencies nightly, coded and entered into a Microsoft Access 2002 database.

3.2.1 Anthropometric Measurements and Indices

The weights and heights/lengths of children were measured and their dates of birth were recorded. Child height was measured with a collapsible wooden meter stick to the nearest quarter inch. If children were able to stand, they were measured standing up, otherwise their supine length was taken. Children were weighed to the nearest 0.1 kg on a hanging Salter (UK) spring scale, which was checked daily for accuracy. If suspected, the presence of edema was assessed using the pitting method.

HAZ, our index of primary interest as well as WHZ and WAZ were calculated using the Centre for Disease Control's EpiInfo (Version 3.3.2) nutrition program[114]; the program compared the study population to the NCHS/WHO 1978 reference population[91] recommended by WHO[92]; a child whose z-score was less than minus 2 was considered stunted.

3.2.2 Child Nutrient Intake

A QFFQ (Quantitative Food Frequency Questionnaire) was used to facilitate the collection of all child food intake data. Caregivers reported the frequency (daily, weekly, monthly or yearly), months in which eaten, manner of preparation, means through which the food was secured (cultivated, gathered or purchased) and proportion of consumption for an exhaustive verbal inventory of foods available to the rural population of Kabarole. Food proportions were estimated with reference to commonly available vessels or other household units of measurement in a fashion similar to that used by Bridge, 2005 and Kigutha, 1998 (see Appendix 8 for Unit of Measurement Details). Like Kigutha, our measurements were then converted to weights in grams. A resident of Kabarole (also a child caregiver) prepared many of the foods assessed in the manner commonly used in the villages and the primary investigator weighed and recorded the weights of these foods (see Appendix 9 for scale information) as they were freshly prepared. The weights of foods that were not prepared were estimated based on logical substitutes (see Appendix 11 and Appendix 10 for all weight assumptions made and their application to specific foods). Like Onyango et al., the frequency and quantity of breast milk consumed was not estimated [78]. However, the age of introduction of complementary foods, the types of foods introduced and child breastfeeding status were noted.

3.2.3 Assessment of Food Nutrient Composition

The FAO Food Composition Table for Use in Africa plus several other food composition data sources were used to convert food weights consumed per interval to nutrient intakes per interval for the following 9 nutrients: protein, energy, vitamins A and C, B complex vitamins (riboflavin, thiamine and niacin), calcium and iron. These were selected based on a study conducted by Hatloy et al. in Mali to assess the overall adequacy of nutrient intake[84]. The limitations of these tables required that assumptions (see Appendix 12) be made regarding nutrient values. The table contained exact matches (genus/species and preparation method) for some foods inventoried. Due to data unavailability, the nutrient composition for some foods was based on preparations methods other than those commonly used in the village; in such cases, most often the nutrient composition of a food was indexed in a raw form. A limitation of particularly the FAO database was that the names of some foods, particularly fruits, were listed in the database but nutrient composition data was not provided while other foods in our inventory were not in the composition databases at all; in both cases, the food nutrient composition was estimated based on an average of the nutrient composition of foods in the same genus. The same solution was applied to instances in which foods were identified in the field but the variety was not certain; this averaging technique was also used by Hongo et al. when they assessed child nutrient intake in rural Papua New Guinea[79].

3.2.4 Adequacy of Daily Nutrient Intake

Children's nutrient intakes for our 9 nutrients of interest during October were converted to daily values; that is, for foods consumed on a weekly or monthly basis, their nutrient contribution was divided by 7 or 31 respectively. A ratio of total daily nutrient intake to sex and age specific recommended daily intakes[93] was computed in order to evaluate the adequacy of children's diets for specific nutrients. This comparison is called the Nutrient Adequacy Ratio (NAR)[83,94].

3.2.5 Quantitative Proxy for Dietary Adequacy: Construction of the Mean Adequacy Ratio

The mean Adequacy Ratio (MAR) is a proxy for overall nutrient intake adequacy. It was calculated as described by Madden et al.: the sum of the NARs (each truncated at 1) was divided by 9, the number of nutrients considered in the adequacy assessment[94]. Each NAR was truncated at 1 so that nutrients with high NARs could not compensate for nutrients with low NARs.

3.2.6 Semi-Quantitative Proxies for Dietary Adequacy: Construction of Food Variety Score and Dietary Diversity Score

The Food Variety Score (FVS) was defined as the number of different foods consumed by a child, regardless of frequency or quantity, during a specified period while the Dietary Diversity Score was defined as the number of 'food groups' from which foods were consumed during the specified period[84,95,96]. The food groups were defined with reference to those used in the 1968 Food composition table for use in Africa (FAO)[99]; the groups included in the dietary diversity score were: cereals and grain products; fruits; grain legumes and legume products; leafy green vegetables; meats, poultry and insects; milk; starchy roots, tubers and fruits; and vegetables and vegetable products permitting a maximum score of 8; the following food groups were not included: beverages, milk products, nuts and seeds, oils and fats, sugars and syrups. These groups were not included because of limitations in quantifying their consumption. For example, the main product made from milk in Kabarole District is ghee. Ghee is a butter-like spread and is a way to preserve milk. It is used in different sauces to enhance flavour and consistency. However, we did not attempt to quantify the proportion of ghee used in sauces because of difficulty in estimating such proportions. This is a clear limitation of our study because the proportion of fat and other nutrients ghee is contributing to children's diet was not accounted for in our assessment of the adequacy of children's diets.

3.2.7 Potentially Confounding Factors – Socioeconomic/Household, Subsistence Farming, Caregiver and Child Health Variables

The United Nations Children's Fund (UNICEF) conceptual model for determinants of child nutrition status[43] guided data collection concerning potential confounders to the present study's relationship of interest. Those factors found to be significantly correlated with stunting status were controlled for in the analysis.

Nineteen variables were collected to describe the socioeconomic/household resources at the disposal of a surveyed household and the living conditions of the children. A subgroup of these, known as household "assets" were collected specifically to develop an "asset index" to approximate family SES. Appendix 13 discusses the rational for an asset index and principles of construction considered in the present study. Assets assessed were: the construction of the dwelling roof (corrugated iron sheets or thatched), construction of dwelling walls (mud or brick), construction of dwelling floor (mud or cement), the type of bed the observed children slept upon (foam mattress or grass/seed bag mat), and whether or not the household had: a personal latrine, couch cushions, a bicycle, a motor cycle, a radio, a television, a mobile or fixed location phone and an improved stove. The following information was also collected: whether or not the children used soap daily for bathing, the distance from dwelling to the nearest health facility (miles) and source of water (minutes), the main type of fuel used for cooking (charcoal, firewood or paraffin) and lighting (diesel, paraffin, electricity or a combination of electricity and paraffin), the main source of drinking water (tap/piped water, borehole, protected well/spring, rain water, gravity flow scheme or open water sources), the total income brought into the household by all working family members and the number of people currently living in the home.

A series of subsistence farming indicators were collected. These may be considered a subset of both socioeconomic indicators and indicators of child nutrient intake from local edible plants. Specifically, these were: the number of acres under cultivation, the amount of farm land and the number of domesticated animals owned by the caregiver's immediate family, the time (in minutes) to reach the gardens and the caregiver's impression of the integrity of her land tenure.

Caregiver data was collected that describes the caregiver's ability to provide both nutrition and nurturing/caring time for her children; these variables are related to the subsistence farming variables because the caregiver most often provides the majority of labour for subsistence farming efforts. Moreover, caregiver variables are related to SES; for example, the latter may influence the caregiver's educational achievement and/or access to/use of birth control measures. Caregiver indicators were specifically: age, number of children borne, age of first pregnancy, present ailments, religion, tribal group, marital status, level of education achieved, ability to read/write, occupation, the proportion of labour contributed to family subsistence farming, languages spoken, and relationship to the children.

Finally, indicators specific to individual child health were gathered. These included: child sex, the availability of the vaccination card for review at the time of the survey, the age of introduction of complementary foods and the foods first introduced, completed immunizations and whether or not the child slept under a bed net or had any sign or symptoms of eye pathology.

3.3 Analysis

Dietary data was processed in a Microsoft Access 2002 database and statistical analyses were performed in Stata Intercooled Version 9 and study design was controlled for using Stata's "survey" features.

3.3.1. What is the prevalence of stunting amongst children less than 5 years of age in rural Kabarole District?

A descriptive summary of child stunting, wasting and underweight prevalence, by age group, including mean and 95% confidence intervals was compiled.

3.3.2 What is the nutrient specific and overall dietary adequacy amongst children less than 5 years of age in rural Kabarole District?

The mean adequacies of intake were tabulated for each nutrient of interest by age group. MAR or overall nutrient intake adequacy was also tabulated by age group.

3.3.3 Is child stunting status associated with the adequacy of children's diets after controlling for confounding factors?

Univariate analysis of child stunting status was performed with MAR as well as household/SES, caregiver, subsistence farming and child health variables to check for significant associations. Multivariate analysis was performed with the previously mentioned variables, significant at a p-value of 0.2 or less, controlling for child age group and sex. The qualitative hierarchical modeling technique described by Wamani et al[33,d] was employed and model building preceded using backward elimination logistic regression. First, distal determinants were added to the model. The socioeconomic variables that were significant, together with child's age, were maintained for the subsequent model in which all intermediate determinants were added. In the next step, intermediate predictor variables that were significant plus child's age and all distal predictor variables included in the previous model were maintained for the final model, which introduced child illness and the nutrient intake adequacy variable.

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[d] According to the conceptual framework developed by Engel et al.[43], distal determinants such as household SES may influence child growth directly or indirectly through determinants at the intermediate and proximate levels of the hierarchy. In turn, the intermediate determinants may influence child growth directly and/or indirectly through proximal determinates. Hierarchical analysis procedures prevent distal and intermediate factors from confounding the effect of intermediate and proximal factors on child nutritional status; likewise, if hierarchical analysis is not employed, intermediate and proximal factors might mediate the effects of those at a more distant level. The use of Engel et al.'s conceptual framework helps avoid the possibility that mediating variables mask the explanatory power of more distant determinants. For example, part of the effect of SES on child nutritional status could be mediated through feeding practices. The overall effect of SES should, therefore, be evaluated in a model that excludes feeding practices. Otherwise, it role could be underestimated.

3.3.4 What factors are associated with nutrient intake adequacy?

Univariate analysis of nutrient intake adequacy was performed with household/SES, caregiver, subsistence farming and child health variables to check for significant associations.

3.4 Ethical Considerations

The rural poor are vulnerable to coercion from individuals and groups with financial resources. The following steps were taken to ensure the present study would not negatively affect the communities or individuals visited during or after data collection: approval of study methodology was sought and granted from the Health Research and Ethics Board at the University of Alberta, the Ugandan Council for Science and Technology, and the LC1 Chairperson of each village visited, prior to commencing interviews. In addition, informed consent was obtained from each caregiver prior administering the questionnaire.

Chapter 4: Results

One hundred percent of the caregivers approached consented to be our study. A record was not kept of the number of homes approached but not surveyed due an absent caregiver.

4.1 Research Question 1: Descriptive Analysis of Anthropometric Indicators

- What is the prevalence of stunting, wasting, and underweight children as well as the mean HAZ, WHZ and WAZ amongst children 6-59 months of age in rural Kabarole District who have begun weaning, lived with their present caregiver in their present home for a minimum of one year and where the caregiver could positively state the child's date of birth?

4.1.1 Anthropometric Indices by Traditional Age Groups

We sampled 322 children from 213 homes. However, the count for each variable is not consistently out of 322 or 213 (depending on whether a child or household factor was being evaluated) because of random errors in recording or accidental omissions of data. The prevalence of stunting, wasting and underweight amongst children 0 to 59 months of age may be categorized according to the traditional age groupings of 0 to 5 months (children predominately breastfeeding), 6 to 11 months (children beginning to wean) and children 12 to 23, 24 to 35, 36 to 47 and 48 to 59 months of age. Using these groups, the overall prevalence of stunting in our sample was found to be 43% (36 to 50%). The prevalence of stunting increased in a linear fashion from the 0 to 5 age group to the 12 to 23 month age group at 50% (37 to 63%). In the 24 to 35 month age group it dropped to 36% (18 to 54%), then rose again to 44% (30 to 58%) in the 36 to 47 month group, reaching 54% (31 to 78%) in the 48 to 59 month age group.

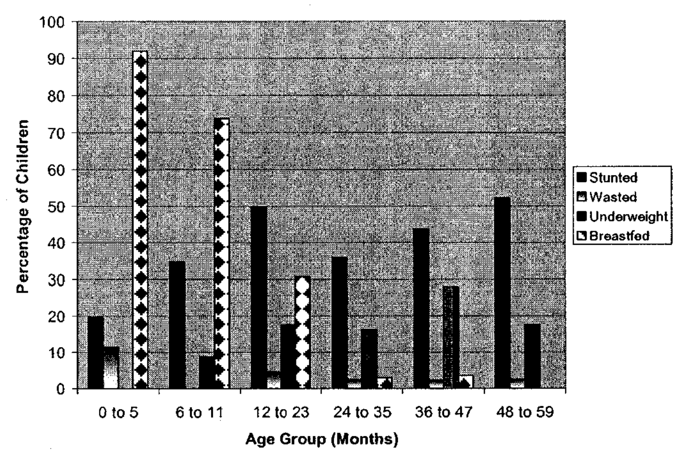

Figure 4: The proportion of children who are stunted, wasted, underweight and breastfed by traditional age groups in rural Kabarole District

The overall prevalence of wasting was found to be lower than that of stunting at 3.5% (0.7 to 6.3%). The prevalence of wasting was found to be highest amongst children 12 to 23 months of age (4.6%, 0.1 to 9.8%), declining to 2.5% (0.1 to 5.6%) and 2.0% (0.1 to 5.0%) across the 24 to 35 and 36 to 47 month age groups respectively and to 3.4% (0.1 to 10%) amongst children in the final age group.

The overall prevalence of underweight children was in between that of stunted and wasted children at 17% (7.7 to 27%). We found that it rose to 17% (6.8 to 29%)

amongst children 12 to 23 months of age, dropped to 16% (0 to 35%) in the 24 to 35 month age group and subsequently rose again to 23% (9.4 to 37%) and 23% (8.5 to 37%) respectively amongst children 35 to 47 and 48 to 59 months of age. These values are all tabulated in Appendix 14.

4.1.2 Anthropometric Indices by Purposeful Age Grouping

Examination of the logistic regression ß coefficients for the regression of child age group on stunting status showed that stunting does not follow a linear trend with age. A plot of the regression ß coefficients for 10 age group categories of equal frequency vs. the inter-categorical age midpoints suggested that the relationship between age and stunting was cubic. Regressing the continuous variables age, age^2 and age^3 against stunting status demonstrated a significant relationship, confirming our suspicion. In order to group children into the most meaningful age categories for the study of the relationship between nutrient intake adequacy and child stunting status, we created age categories by grouping similar regression coefficients. Therefore, in all further descriptive and univariate analysis involving child age, children were group as follows: 6 to 11, 12 to 23, 24 to 41 and 42 to 59 months of age. Nutrient intake adequacy data was collected for children 0 to 5 months of age who had begun the weaning process. However, of the 23 children studied in this age group, the majority were still mainly consuming breast milk with only a few consuming more than cows milk as a complementary food. Therefore, they were not included in the analysis.

The forthcoming graphs and paragraphs almost unanimously describe growth inadequacies with reference to the 1978 NCHS reference population[91]. The prevalence of obesity was not assessed and children did generally show above average Weight-for-height z-scores. However, none of the 322 children sampled appeared to be obese so obesity was not considered in the results or discussion.

4.1.3 Stunting

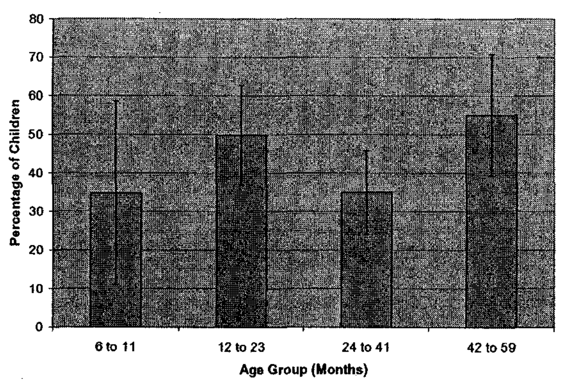

Figure 5: The proportion of children who are stunted by age group in rural Kabarole District

Categorizing children according to purposeful age groups clarifies the periods during which stunting prevalence increases most. Examining only children 6 to 59 month of age, Figure 5 shows that the overall prevalence of stunting was shown to rise to 45% (37 to 52%) in comparison to our previously mentioned traditional grouping, which included children age 0 to 5 months. Figure 5 depicts that from 35% (11 to 59%) amongst children 6 to 11 months, the prevalence of stunting rises to 50% (37 to 63%) amongst children 12 to 23 months. The prevalence then declines back to 35% (24 to 46%) amongst children 24 to 41 months but rises to a peak of 55% (39 to 71%) amongst children in our final age group of 42 to 59 months. Twenty percent of children were found to be severely stunted (that is, found to have a HAZ of less than minus 3).

Table 2 presents the prevalence of stunting amongst rurally located children of 6 to 59 months of age in Kabarole District by sub-county. The southern sub-county of Rwimi in Kabarole District avidly produces maize. We considered that children consuming a diet composed more of maize may be more at risk of stunting than children whose diets were less composed of maize. The results presented in the table do not suggest a large difference in the prevalence of stunting amongst children from Rwimi in comparison to children from the other sub-counties. Moreover, the difference in the prevalence of stunting amongst children from Rwimi in comparison to children from the other sub-counties was found to be non-significant.

Table 2: Prevalence of Stunting among rural children 6-59 months of age by Sub-county in Kabarole

Sub-county	Percent Stunted	95 % CI		Count
Buheesi	50.0	0.40	0.60	6
Bukuuku	52.3	0.33	0.72	26
Busoro	37.0	0.24	0.50	33
Hakibale	55.0	0.32	0.78	35
Karambi	53.3	0.45	0.62	15
Kibiito	45.8	0.31	0.60	39
Kicwamba	53.8	0.37	0.71	17
Kisomoro	28.4	0.04	0.52	18
Mugusu	27.5	0.15	0.40	35
Ruteete	45.1	0.27	0.63	40
Rwimi	49.4	0.38	0.61	35

4.1.4 Wasting

The prevalence of wasting was found to be 3% (1 to 5%) amongst children 6 to 59 months of age. Figure 6 shows that like stunting, it is highest amongst children 12 to 23 months of age at 5% (0.1 to 10%); it then decreases to 2% (0.1 to 5%) amongst the 24 to 41 month age group and finally rises to 3% (0.1 to 7%) in the final age group. Wasting is absent in the 6 to 11 month age group. The presence of edema may overestimate the nutritional status of a child. Only two children in our data set were found to have edema. Since the prevalence of edema was so low, the two children with edema were not treated any differently in the analysis than the other children.

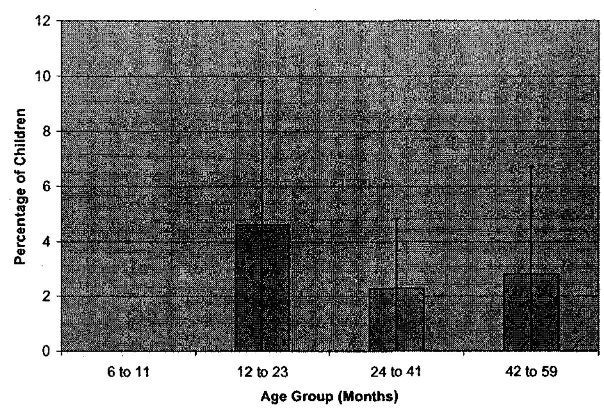

Figure 6: The proportion of children who are wasted by age group in rural Kabarole District

4.1.5 Underweight

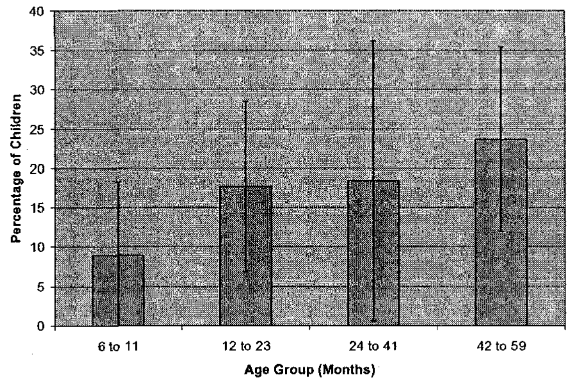

Figure 7: The proportion of children who are underweight by age group in rural Kabarole District

The prevalence of underweight children falls between that of stunted and wasted at 19% (9 to 29%) amongst children 6 to 59 months. Figure 7 shows that the prevalence of underweight follows a stepwise trend, steadily increasing from the 6 to 11 month age group at 9% (0.1 to 18%) up to the 42 to 59 month age group at 24% (12 to 35%).

4.1.6 Height-for-age Z-score (HAZ)

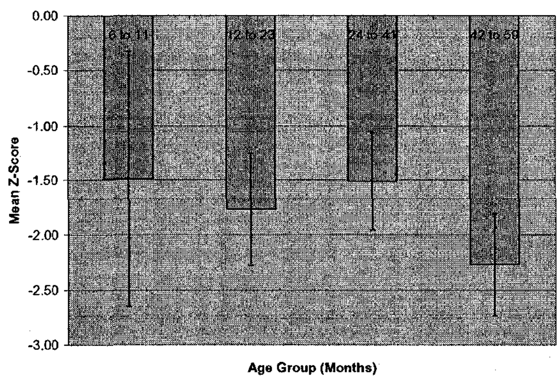

Figure 8: The Mean HAZ for children by age group in rural Kabarole District

The mean HAZ was -1.79. Figure 8 shows that children age 42 to 59 months of age had the poorest mean HAZ at -2.27 (-2.73 to -1.81) followed by children in the 12 to 23 month age group at -1.77 (-2.28 to -1.26). The 6 to 11 and 24 to 41 month age groups had similar mean HAZ at -1.49 (-2.65 to -0.33) and -1.51 (-1.96 to -1.07) respectively.

Table 3 presents HAZ by sub-county. The southern sub-county of Rwimi in Kabarole District avidly produces maize. We considered that children consuming a diet composed more of maize may be more at risk of stunting than children whose diets were less composed of maize. The results presented in the table do not suggest a large difference in the HAZ of children from Rwimi in comparison to children from the other sub-counties.

Table 3: HAZ among rural children 6-59 months of age by Sub-county in Kabarole

Sub-county	Mean HAZ	95 % CI		Count
Buheesi	- 2.31	- 2.51	- 2.11	6
Bukuuku	- 2.18	- 2.88	- 1.48	26
Busoro	- 1.73	- 2.44	- 1.03	33
Hakibale	- 1.98	- 3.19	- 0.78	35
Karambi	- 1.79	- 2.07	- 1.51	15
Kibiito	- 2.02	- 2.60	- 1.43	39
Kicwamba	- 1.80	- 2.57	- 1.02	17
Kisomoro	- 1.51	- 1.98	- 1.05	18

Sub-county	Mean HAZ	95 % CI		Count
Mugusu	- 1.07	- 1.52	- 0.62	35
Ruteete	- 1.55	- 2.06	- 1.05	40
Rwimi	- 1.82	- 2.16	- 1.49	35

4.1.7 Weight-for-height Z-score (WHZ)

The overall WHZ was found to be 0.24, which is a positive change in relation to the negative values consistently found using the HAZ index. Figure 9 shows that children age 6 to 11 months had the highest WHZ at 1.14 (0.56 to 1.71) followed by children age 12 to 23 months at 0.69 (0.19 to 1.19), while children age 24 to 41 months, who are tied for having the highest HAZ, have the lowest WHZ at -0.18 (-0.47 to 0.10).

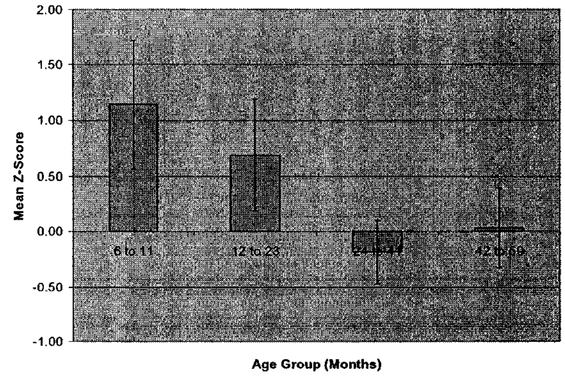

Figure 9: The Mean WHZ for children by age group in rural Kabarole District

4.1.8 Weight-for-age Z-score (WAZ)

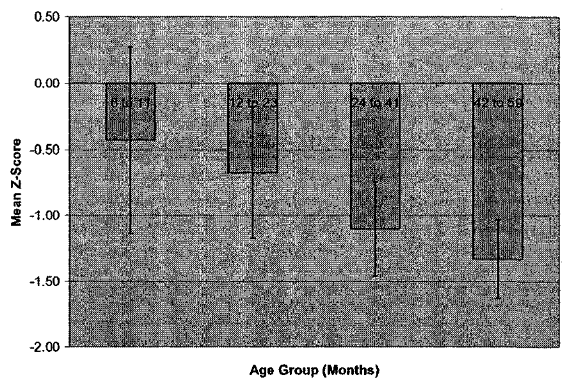

Figure 10: The Mean WAZ for children by age group in rural Kabarole District

Figure 10 shows that WAZ declines in a linear fashion from -0.43 (-1.14 to 0.27) amongst children 6 to 11 months down to -1.33 (-1.63 to -1.03) amongst children 42 to 59 months. We found the overall mean WAZ to be -0.98 (-1.26 to 0.71) amongst children 6 to 59 months.

Please see Appendix 15 for the tabulated anthropometric results by age group.

4.2 Research Question 2: Descriptive Analysis of Nutrient Intake Adequacy

- What is the nutrient specific and overall dietary adequacy amongst children 6 to 59 months of age in rural Kabarole District who have begun the weaning process, have lived with their present caregiver in their present home for a year or more and where the caregiver could positively state the child's date of birth?

4.2.1 Descriptive Analysis of Nutrient Intake Adequacy for our Nine Nutrients of Interest and Overall Nutrient Intake Adequacy

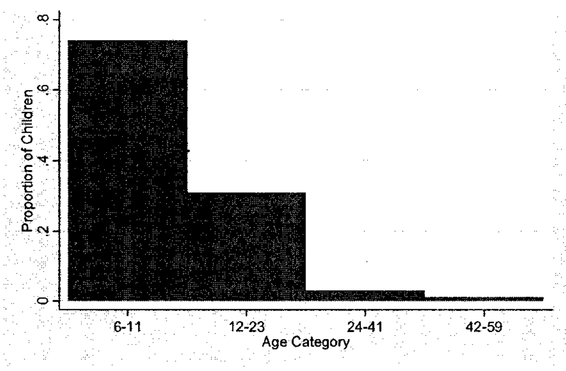

Figure 11: The proportion of children who are breastfeeding by age group in rural Kabarole District

Nutrient intake adequacy[e] was assessed for protein, energy, iron, calcium, vitamins A and C, thiamine, riboflavin and niacin (See Appendix 16 for RDI values). While no attempted was made to quantify the contribution breast milk was making to the children's diets, breastfeeding status was noted. Figure 11 depicts the proportion of children breastfeeding amongst our sample age groups. The majority of children are breastfeeding in the 6 to 11 month age group at 74% (55 to 93%) and this rapidly declines to 31% (15 to 46%) amongst children 12 to 23 months, down to just 2.9% (0 to 6.3%) and 1.3% (0.1 to 4.2%) amongst children 24 to 41 and 42 to 59 months of age, respectively.

4.2.2 Protein

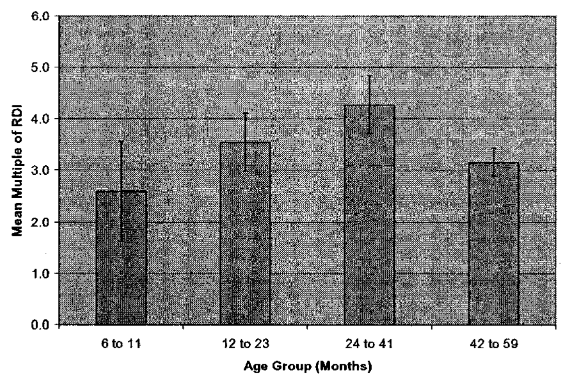

Figure 12: The mean multiple of recommended daily intake for protein consumed by children per age group in rural Kabarole District

The mean Nutrient Intake Adequacy (NAR) for protein intake was found to be 3.6 (3.3 to 3.9) amongst children 6 to 59 months of age. Figure 12 depicts that the majority of children consuming the higher ratio of intake are in the 24 to 41 month age group where the mean NAR was found to be 4.3 (3.7 to 4.8). Children in the 12 to 23 month group rank second at 3.5 (3.0 to 4.1) with the 42 to 59 month group in third at 3.2 (2.9 to 3.4) and the 6 to 11 month group last at 2.6 (1.6 to 3.6).

[e] For the purpose of the present study, dietary *adequacy* refers to a diet that meets or exceeds the recommended daily intake for a particular nutrient.

4.2.3 Energy

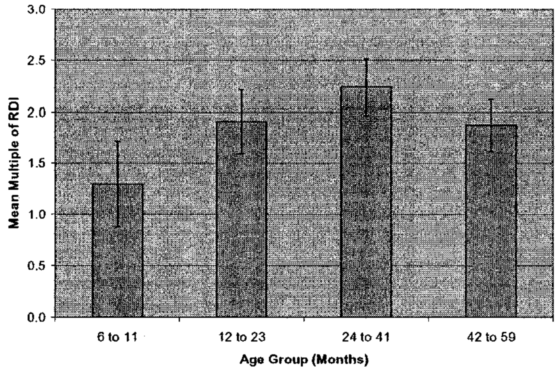

Figure 13: The mean multiple of recommended daily intake for calories consumed by children per age group in rural Kabarole District

Energy intake shows a similar trend to protein intake across the age groups. The mean adequacy of energy intake was found to be 2.0 (1.8 to 2.2). Figure 13 depicts that again, the 24 to 41 month age group consumed the highest adequacy at 2.2 (2.0 to 2.5) with the 12 to 23 month age group at 1.9 (1.6 to 2.2), closely followed by the 42 to 59 month age group at 1.9 (1.6 to 2.1) with the 6 to 11 month age group again having the lowest adequacy ranking at 1.3 (0.9 to 1.7).

4.2.4 Iron

We see the familiar trend once again with iron intake adequacy. Figure 14 shows us that children age 24 to 41 months again rank highest for iron intake at 3.4 (2.9 to 4.0) with children 12 to 23 months ranking second at 2.8 (2.2 to 3.3), children 42 to 59 months third at 2.7 (2.3 to 3.0) and children 6 to 11 months last at 0.86 (0.46 to 1.3). The overall adequacy of iron intake for all groups was found to be 2.8 (2.5 to 3.1).

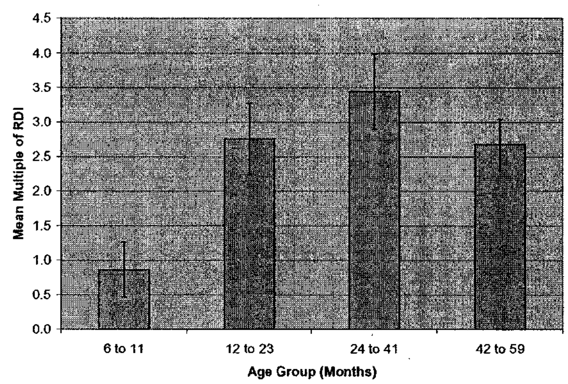

Figure 14: The mean multiple of recommended daily intake for iron consumed by children per age group in rural Kabarole District

4.2.5 Calcium

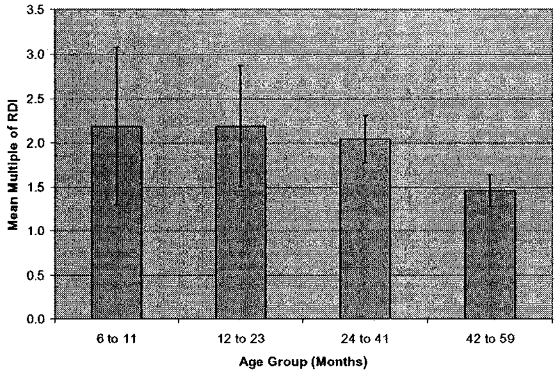

Figure 15: The mean multiple of recommended daily intake for calcium consumed by children per age group in rural Kabarole District

The rankings for the adequacy of calcium intake break the trend previously seen with protein, energy and iron intake adequacy. Figure 15 shows that children age 6 to 23 months are consuming the same adequacy level for calcium with both consuming 2.2 times their nutrient adequacy levels with 1.3 to 3.1 and 1.5 to 2.9 95% confidence levels respectively. Children in the 24 to 41 month group rank a close third at 2.0 (1.8 to 2.3) while children in the 42 to 59 group fall far behind at 1.5 (1.3 to 1.6). The overall NAR for all age groups was found to be 1.9 (1.7 to 2.2).

4.2.6 Vitamin A

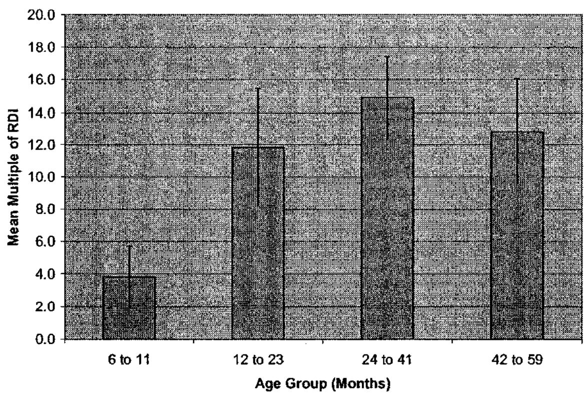

Figure 16: The mean multiple of recommended daily intake for vitamin A consumed by children per age group in rural Kabarole District

Vitamin A intake adequacy bears a familiar theme once again; Figure 16 shows that children in the 24 to 41 month group claim the highest rank for intake adequacy at 14.9 (12.4 to 17.4); however, children age 42 to 59 months climb to second place for the first time consuming 12.8 (9.6 to 16.1). Children age 12 to 23 months rank third at 11.8 (8.2 to 15.5) and those in the 6 to 11 month group are consuming the lowest multiple of their nutrient adequacy ratio at 3.8 (1.9 to 5.7). The overall adequacy of vitamin A intake was found to be 12.5 (10.4 to 14.6).

4.2.7 Vitamin C

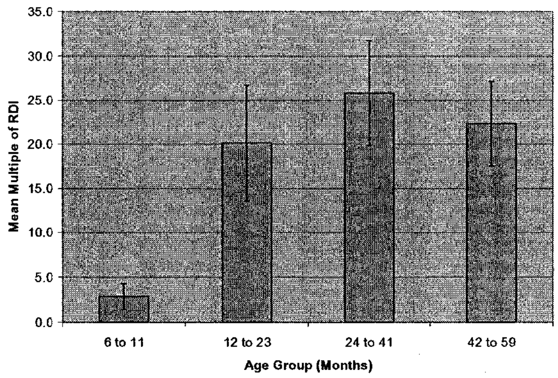

Figure 17: The mean multiple of recommended daily intake for vitamin C consumed by children per age group in rural Kabarole District

Figure 17 demonstrates that the vitamin C adequacy rankings follow an identical trend to that for vitamin A. The overall intake adequacy was found to be 21 (18 to 25) with children 24 to 41 months consuming the highest adequacy at 26 (20 to 32). The second highest ranking is taken by the 42 to 59 month age group at 22 (18 to 27) closely followed by children in the 12 to 23 month age group at 20 (14 to 27). Children in the 6 to 11 month group are consuming an adequacy multiple far lower than the other groups at 2.8 (1.4 to 4.3).

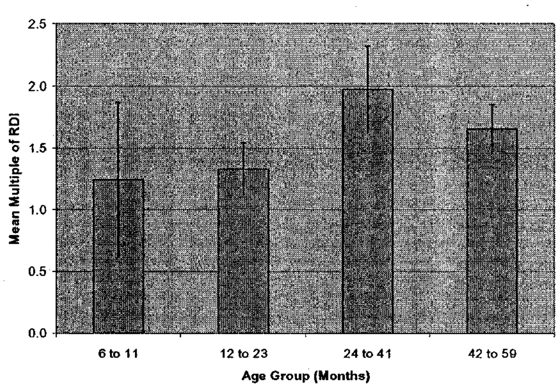

Figure 18: The mean multiple of recommended daily intake for thiamine consumed by children per age group in rural Kabarole District

4.2.8 Thiamine

The thiamine intake adequacy follows the same trend as vitamins A and C, as demonstrated in Figure 18, with children of 24 to 41 taking the highest ranking at 2.0 (1.6 to 2.3); children in the 42 to 59 group follow with 1.7 (1.5 to 1.9) trailed by the 12 to 23 month group at 1.3 (1.1 to 1.5) and the 6 to 11 month group with the lowest calculated adequacy at 1.2 (0.62 to 1.9). Overall, children are consuming 1.6 (1.5 to 1.8) times their recommended daily intake for thiamine.

4.2.9 Riboflavin

Quite similar to the previous 4 nutrients, Figure 19 shows that the 24 to 41 group takes the highest adequacy spot for riboflavin at 2.1 (1.7 to 2.5) followed by the 42 to 59 month group at 1.7 (1.5 to 2.0); the 12 to 23 age group take in about half as much as the previous at 1.3 (1.1 to 1.5) and the 6 to 11 month group are consuming the lowest recorded adequacy at 0.94 (0.39 to 1.5). Overall, our results suggest that children are consuming 1.7 times the recommended daily intake for riboflavin.

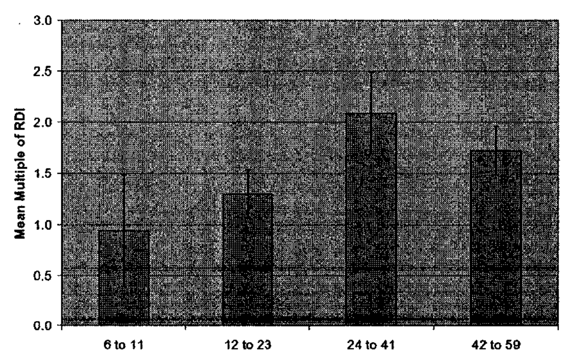

Figure 19: The mean multiple of recommended daily intake for riboflavin consumed by children per age group in rural Kabarole District

4.2.10 Niacin

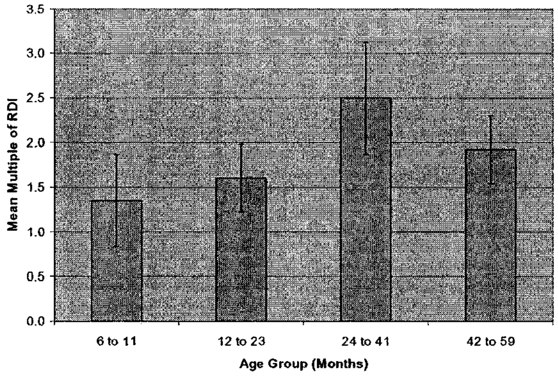

Figure 20: The mean multiple of recommended daily intake for niacin consumed by children per age group in rural Kabarole District

Niacin mirrors the trend of our previous 5 nutrients. Overall, children are consuming 2.0 times their requirement for niacin (1.7 to 2.3) with, as is displayed in Figure 20, children in the 24 to 41 month group consuming 2.5 (1.9 to 3.1) following by children in the 42 to 59 month group at 1.9 (1.5 to 2.3); amongst children 12 to 23 months, intake adequacy is 1.6 (1.2 to 2.0) while children 6 to 11 months are consuming 1.4 (0.83 to 1.9).

4.2.11 Overall Dietary Adequacy: The Mean Adequacy Ratio (MAR)

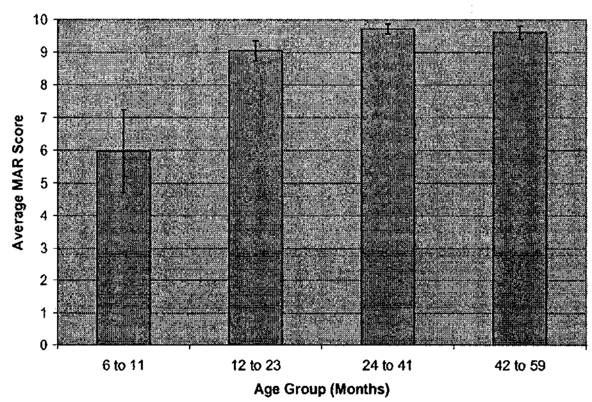

Figure 21: The average Mean Adequacy Ratio (MAR) score for children per age group in rural Kabarole District

The MAR score by age group follows, as is shown in Figure 21, the same trend defined by vitamins A and C, thiamine, riboflavin and niacin. The overall adequacy of children' diets in Kabarole between the ages of 6 and 59 months was found to be 9.1 out of 10. Children in the 24 to 41 month group placed first for adequacy for 8 of the 9 nutrients studied and it is of no surprise they have the highest MAR score as well at 9.7 (9.5 to 9.9). Children 42 to 59 months place second at 9.6 (9.4 to 9.8) while children 12 to 23 are at 9.1 (8.7 to 9.4) and amongst children 6 to 11 months, the adequacy score was 7.2 (6.0 to 8.5), which does not account for the contribution of breast milk to the diet.

4.2.12 FVS

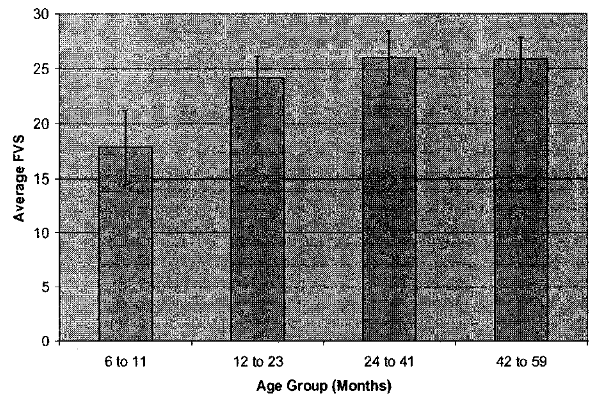

Figure 22: The average Food Variety Score (FVS) for children per age group in rural Kabarole District

Figure 22 depicts that those children who are consuming the highest mean adequacy ratio (MAR) of nutrient intake are also consuming the greatest variety of foods in their diet. Of course, this refers to children age 24 to 41 months who consumed 26 (24 to 28) different foods during October. Second place (which is not evident due to our rounding) is closely held by children age 42 to 59 months who consumed 26 (24 to 28) different foods while children age 12 to 23 consumed 24 (22 to 26) and amongst children 6 to 11 months, the average food variety score was 18 (15 to 21). Overall, rural children in Kabarole District were found to consume 25 (23 to 27) different foods on a monthly basis.

See Appendix 17 for tabulated nutrient intake adequacy results by age group.

4.3 Research Question 3: Modeling the Relationship between Nutrient Intake Adequacy and Child Stunting Status

- Is there a relationship between nutrient intake adequacy and child stunting status after controlling for confounding factors in Kabarole District?

4.3.1 Descriptive Analysis of Socioeconomic, Demographic and Child Health Factors

We collected data on distal, intermediate and proximal factors thought to be associated with stunting status that may confound stunting status' relationship with nutrient intake adequacy. We present a descriptive analysis of those factors, thematically, in the following paragraphs.

4.3.1.1 SES Indicators and Household Enabling Factors

Table 4 summarizes our socioeconomic and household enabling factor findings. We found that the majority of our study population lived in a home made of basic materials defined as having a corrugated iron sheet roof (91%, 86 to 96%), mud walls reinforced with eucalyptus tree polls and bamboo ribbings (93%, 88 to 97%) and a mud floor (89%, 84 to 95%). Within 28% of those homes, there were 3 or more persons per room (21 to 36%). In 28% (16 to 40%) of homes, the family and guests enjoyed couch cushions upon the wooden couches while in 84% of homes (77 to 92%), the children sleep upon a foam mattress as opposed to a grass or seed bag mat. Ninety-one percent of homes had a latrine (86 to 96%) but only 2.9% (0.1 to 6.1%) were found to have an improved stove, which improves fuel efficiency by enclosing the portion of the stove in which the firewood burns. Ninety-nine percent of caregivers were found to be cooking with firewood as there is an abundant source of eucalyptus trees for such purposes in Kabarole while the remainder used charcoal or gas.

We found that 96% of caregivers were subsistence farmers (92 to 98%) and were cultivating an average of 2.2 acres (interquartile range: 1 to 3) of land each. Eighty-four percent of caregivers (78 to 91%) reported that their family owned land and the average amount of land owned by a family was 1.6 acres (interquartile range: 0.5 to 2.5). Some caregivers had incorporated various livestock into their farming activities. Seventy-nine percent of households had chickens (64 to 82%), 71% had goats (62 to 80%), 36% had cows (22 to 50%), 35% had pigs (21 to 49%), 22% had ducks (5.5 to 39%), 17% had sheep (1.8 to 33%), 16% had turkeys (0.1 to 32%) and 16% had rabbits (0.1 to 32%).

We collected data on various household enabling factors thought to be associated with a family's ability to thrive. We found that 15% of fathers had no formal education (7.3 to 22%), 51% stopped going to school sometime during primary school (35 to 67%), 14% completed their primary education and then stopped (7.7 to 21%) while 20% went on to complete secondary level 1 or higher (11 to 29%). The prevalence of scholastic achievement was lower amongst caregivers: 30% of caregivers had no formal education (24 to 36%), 44% stopped their education sometime during primary school (33 to 55%), 16% (6.4 to 25%) stopped after completing primary school and 10% (0.05 to 16%) went on to complete secondary 1 or higher. While the majority of caregivers were working as subsistence farmers, fathers were found to have other income generating occupations. Thirty-one percent of fathers were business owners (23 to 40%), 25% were subsistence farmers (14 to 36%), 24% were employees of someone else (13 to 36%), 10% were doing "other" things (5.6 to 15%) and 9% (4.1 to 14%) were deceased. Based on the total income brought into the home by all contributing members, 35% of households (27 to 44%) in Kabarole were found to be earning more than 1 US dollar per day. Income was enabling some families to acquire a range of durable assets: we found that 78% of homes (71 to 85%) had a radio, 52% (39 to 65%) had a bicycle, 22% (14 to 30%) had a mobile phone and 1% (0.1 to 2.2%) had a motorcycle (boda boda).

Data on two distal health indicators was collected. We found that 18% of homes were located more than 5 miles from the nearest health unit (9.6 to 25%) with the average home being 3.1 miles from a health unit (interquartile range: 1 to 3). We also found that caregivers were getting water from three main types of sources: those of infrastructure type such as piped in town water or a gravity flow scheme (28%, 12 to 45%), 49% were getting water from a protected well (33 to 65%) while 23% were having to use water from an unprotected well (12 to 32%). Caregivers reported that 95% of children were bathed daily with soap (91 to 99%).

Table 4: Descriptive statistics of Socioeconomic and Household Enabling Factors

Variable	Average or Percentage	95% CI	Count
Durable Assets			
Total number of acres owned by family	1.62	0.50-2.5*	200
Family owns land (ref: Family does not own land)	84%	78-91%	200
Have iron roof (ref: Thatched roof)	91%	86-96%	199
Have latrine (ref: No latrine)	91%	86-96%	200
Children sleep on a foam mattress (ref: Children sleep on a polythene bag)	85%	77-92%	200
Have radio (ref: No radio)	78%	71-85%	200
Have bicycle (ref: No bicycle)	52%	39-65%	200
Have couch cushions (ref: No couch cushions)	28%	16-40%	200
Have phone (ref: No phone)	22%	14-30%	200
Has cement floor (ref: Mud floor)	11%	5-16%	199

Variable	Average or Percentage	95% CI	Count
Has brick home wall construction (ref: Mud and poll home wall construction)	7%	3-12%	199
Have improved stove (ref: Don't have improved stove)	3%	0.1-6%	213
Have boda (ref: No boda)	1%	0.1-2%	213
Livestock			
Have chicken(s) (ref: No chickens)	73%	64-82%	200
Have goat(s) (ref: No goats)	71%	62-80%	200
Have pig(s) (ref: No pigs)	35%	21-49%	200
Have duck(s) (ref: No ducks)	22%	6-39%	200
Have sheep (ref: No sheep)	17%	2-33%	200
Have turkey(s) (ref: No turkeys)	16%	0.1-32%	200
Have rabbit(s) (ref: No rabbits)	16%	0.1-32%	200
Household Enabling Factors			
Total number of acres cultivated by family	2.21	1-3*	195
Distance to health unit (miles)	3.10	1-3*	185
Greater than 5 miles from a health unit (ref: Less than or equal to 5 miles from a health unit)	18%	10-25%	200
Household income average greater than or equal to 1 USD/day (ref: Household income less than 1 USD per day)	35%	27-44%	200
Crowding: 3 or more person's per room (ref: Less than 3 person's per room)	28%	21-36%	200
Father's job (ref: Business owner):	31%	23-40%	71
Dead	9%	4-14%	17
Employee	24%	13-36%	41
Other	11%	6-15%	22
Subsistence farmer	25%	14-36%	49
Father's level of education (ref: None):	15%	7-22%	28
Mid primary	51%	35-67%	69
Completed primary	14%	8-21%	32
S1 or above	20%	11-29%	36
Caregiver's level of education (ref: None):	30%	24-36%	57
Mid primary	44%	33-55%	91
Completed primary	16%	6.4-25%	29
S1 or above	10%	5.0-16%	23
Water source (ref: Infrastructure type)	28%	12-45%	50
Protected well	49%	33-65%	94
Unprotected well	23%	13-32%	56

*Interquartile Range

4.3.1.2 Caregiver Variables

The well-being of the caregiver is central to the well-being of her children. Table 5 describes our caregiver sample. Forty-five percent (31 to 58%) of caregivers reported feeling unwell for various reasons on the day of the interview. Adding up to that 45%: 40% reported having malaria (27 to 53%), 2.5% stated they had headache (0.1 to 6.1%), 1.5% reported being HIV positive (0.1 to 3.4%), 0.4% had filarial disease (0.1 to 1.1%) and 0.3% had backaches (0.1 to 1%). The average age of a caregiver was 30 years old (interquartile range: 23 to 32), caregivers reported having had their first child at an average age of 17 (interquartile range: 16 to 19), the average number of children a caregiver had given birth to was 4.6 (interquartile range: 2 to 6) and 99% of the caregivers were female (97 to 99.9%). Ninety-two percent of caregivers were found to be the biological mother of the children being assessed (88 to 96%), 7.1% (3 to 11%) were members of the children's extended family while 1.1% of caregivers were of no relation to the children (0.1 to 2.6%). Caregivers came from 3 main tribal groups: 75% were Batooro (61 to 88%), 16% were Bakiga (3.2 to 28%), 5.9% were Bakonjo (3 to 12%) and 3.9% were from other tribal groups (3.0 to 7.4%). We found that 70% (62 to 78%) of caregivers had the support of a husband in marriage while 19% were single (12 to 26%)

and 11% were separated from their spouse either through death or divorce (4.4 to 18%). Concerning spiritual support: 40% of caregivers stated they were of the protestant faith (31 to 49%), 39% were Catholic (28 to 49%), 18% were of other Christian faiths (9.8 to 26%) and 3.8% were Muslim (0.7 to 6.9%).

Table 5: Descriptive statistics of Caregiver Attributes

Variable	Average or Percentage	95% CI	Count
Caregiver Attributes			
Caregiver age in years	30.16	23-32*	198
Caregiver less than 30 years of age (ref: Caregiver greater than 30 years)	43%	3450%	200
Caregiver sex male (ref: Female)	1%	0.1-2.6%	200
Caregiver age (in years) of first pregnancy	17.03	16-19*	195
First pregnancy age less than 18 (ref: Age of first pregnancy great than or equal to 18)	53%	42-63%	200
Caregiver children borne	4.64	2-6*	199
Children born less than 5 (ref: Children born greater than or equal to 5)	40%	32-48%	200
Tribal group (ref: Batooro):	75%	61-88%	145
Bakiga	16%	3.2-28%	35
Bakonjo	6%	0.3-12%	12
Other	4%	0.3-7.4%	8
Caregiver marital status (ref: Partner dead, separated or divorced)	11%	4.4-18%	16
Married	70%	62-78%	141
Single	19%	12-26%	40
Caregiver Religion (ref: Catholic):	39%	28-49%	80
Muslim	4%	0.7-6.9%	6
Other Christian	18%	9.8-26%	30
Protestant	40%	3149%	84
Caregiver subsistence farmer (ref: other):	96%	92-99.7%	209
Caregiver has illness (ref: No)	45%	31-58%	200
Caregiver illness status (ref: Caregiver well):	55%	42-69%	105
HIV/AIDS positive	1.5%	0.1-3.4%	3
Has backaches	0.3%	0.1-1.0%	1
Has filarial disease	0.4%	0.1-1.1%	1
Has headache	2.5%	0.1-6.1%	3
Has malaria	40%	27-53%	87
Caregiver's relationship to child: biological mother	92%	88-96%	179
Extended family	7.1%	3.0-11%	15
No relation	1.1%	0.1-2.6%	2
Child uses soap daily for bathing (ref: No)	95%	91-99.1%	200

*Interquartile Range

4.3.1.3 Biologically Significant Factors

Table 6 displays those factors of biological significance. The mean child age of our sample was 28 months. In terms of our age groupings: 10% were in the 6 to 11 month group, 31% were in the 12 to 23 month group, 36% were in the 24 to 41 month group and 23% in were the 42 to 59 month group. Forty-five percent of the children we assessed were male (37 to 53%) and 17% of children assessed were still breastfeeding (11 to 22%).

Table 6: Descriptive statistics of Biologically Significant Factors

Variable	Average or Percentage	95% CI	Count
Biological Factors			
Age in months (ref: 6-11)	10%	4.8-15%	31
12-23	31%	22-39%	85
24-41	36%	27-46%	101
42-59	23%	16-31%	82
Age in months	28	N/A	322
Male sex (ref: Female)	45%	37-53%	299

4.3.1.4 Disease Status and Adequacy of Nutrient Intake

A number of variables related to disease susceptibility and episodes as well as nutrient intake adequacy are presented in Table 7. We found that 9% of children were sleeping under a mosquito bed net and 50% of children were adequately immunized for their age (42 to 58%). However, 62% of caregivers could produce their child's immunization record on demand for review at the time of the interview (54 to 71%). Caregivers reported that their children had faced a number of illnesses in the 3 months preceding the interview: 63% reported their child had been sick in the previous 3 months (56 to 70%) with 29% reporting malaria (19 to 37%), 28% (21 to 36%) reporting cough, 5.5% stated their child had diarrhea (2.4 to 8.6%), 4.3% reported a skin pathology such as a rash (0.8 to 7.7%), 2.1% of the children had had chickenpox (0.01 to 4.9%) and 6.9% (3.6 to 10%) reported the child had been sick with something other than those things previously mentioned in the previous 3 months.

The majority of children were introduced to complementary foods within the first year of life: 45% (35 to 56%) within the first 6 months and 46% (38 to 54%) between 6 and 11 months with only 9% (0.01 to 18%) between 12 and 18 months. Fifteen percent of caregivers reported that their children have to go hungry from time to time (8.1 to 22%) for reasons not further explored. The adequacy of dietary intake was found to be quite high: 91% of children obtained a calculated Mean Adequacy Ratio (MAR) Score of 8 or greater (86 to 96%) out of 10 while only 6.8% scored between 6 and 7.9 (2.5 to 11%) and 2.5% scored less than 6 (0.3 to 4.6%).

Table 7: Descriptive statistics of Disease Status and Adequacy of Nutrient Intake Variables

Variable	Average or Percentage	95% CI	Count
Proximal Level Variables			
MAR score of less than 8 (ref: MAR score of 8 or better)	12%	7.1-17%	297
MAR score (ref: ≥8):	91%	86-96%	257
MAR score ≥6 and <8	7%	2.5-11%	27
MAR score <6	3%	0.3-4.6%	13
Currently breastfed (ref: No)	17%	11-22%	299
Children go hungry from time to time (ref: No)	15%	8.1-22%	299
Children are immunized adequately for their age (ref: No)	50%	42-58%	299
Child bed net use (ref: Not used)	30%	11-49%	99
Unknown	68%	48-87%	191
Yes	3%	0.2-5.5%	9
Child weaning age (ref: 0-5 months):	45%	35-56%	130
6-11 months	46%	38-54%	149
12-18 months	9%	0.1-18%	14
Vaccination card available for review at time of interview (ref: No)	62%	54-71%	299
Weaning age less than 6 months (ref: Greater than 6 months)	23%	13-33%	293
Child sick with...in the previous 3 months:			
Chickenpox (ref: No)	2%	0.1-4.9%	299
Malaria (ref: No)	29%	19-37%	299
Cough (ref: No)	28%	21-36%	299
Skin pathology (ref: No)	4%	1.0-8.0%	299
Diarrhea (ref: No)	6%	2.4-9.0%	299
Child sick with something other than those ailments (ref: No)	7%	3.6-10%	299
Child sick in the previous 3 months (ref: No)	63%	56-70%	299

4.3.2 Univariate Analysis of Factors Associated With Child Stunting Status

4.3.2.1 Biological Factors

Child age category was found to be borderline associated with stunting. Table 8 presents the results from dividing child age into four categories: in relation to children 6 to 11 months of age, children 12 to 23 were 1.9 (0.55 to 6.2), children 24 to 41 were 1.0 (0.29 to 3.5) and children 42 to 49 were 2.3 (0.67 to 7.8) times more likely to be stunted (p=0.058). Child sex was not significantly associated with stunting status.

Table 8: Univariate Logistic Regression of Biological Factors on Child Stunting Status

Variable	OR	95% CI	p-value
Biological Factors			
Age in months (ref: 6-11)	1.00		
12-23	1.86	0.56-6.23	0.295
24-41	1.01	0.29-3.46	0.989
42-59	2.29	0.67-7.76	0.172
Male sex (ref: Female)	0.97	0.51-1.85	0.931

4.3.2.2 Socioeconomic Status Indicators

The results of the relationship between SES variables and child stunting status are presented in Table 9. Several durable assets owned by households were related to stunting status; of the 10 that were associated, 4 of the associations were statistically significant. Whether or not a household was found to have couch cushions was most significantly associated with child stunting status: children from homes with couch cushions were 0.34 times less likely to be stunted (0.19 to 0.68, p=0.004). Children from homes with iron roves were 0.33 times less likely to be stunted in comparison to children from homes with thatched roves (0.13 to 0.87, p=0.027). Children from homes with at least 1 cow were 0.58 times less likely to be stunted (0.35 to 0.96, p=0.035) while children from homes with mobile phones were 0.52 times less likely to be stunted (0.28 to 0.99, p=0.046) in comparison to homes with no phone at all. Six other durable assets were found to have p-values between 0.2 and 0.05: a child from a home with a mud floor was 0.45 times more likely to be stunted (0.19 to 1.1, 0=0.073), children from a home with a bicycle were 0.57 times less likely to be stunted (0.30 to 1.1, p=0.077), children from homes with brick walls were 0.50 times less likely to be stunted (0.23 to 1.1, p=0.085), children who slept on foam mattress were found to be 0.62 times less likely to be stunted (0.31 to 1.3, p=0.17), children whose family owned land were found to be 1.8 times more likely to be stunted (0.76 to 4.35, p=0.17) and children from homes with a latrine were 1.7 times more likely to be stunted (0.75 to 3.8, p=0.19). In addition to the ownership of at least one cow, the association between the ownership of at least one turkey, chicken, pig, rabbit, duck, sheep or goat and child stunting status was assessed and none were significantly associated. Principle component analysis was used to weight the couch cushions, roof type, cow ownership, phone possession, floor type, wall type, and bicycle ownership variables and an asset ownership score was calculated for each household. Homes were divided by their scores into the lowest 40%, the middle 40% and the upper 20%. Children from homes in the middle 40% were 0.61 times less likely to be stunted (0.34 to 1.1) while children in the top 20% were 0.24 times less likely to be stunted (0.11 to 0.51) in comparison to children whose homes scored in the lowest 40% (p=0.005).

Table 9: Univariate Logistic Regression of Socioeconomic Indicators on Child Stunting Status

Variable	OR	95% CI	p-value
Durable Assets			
Have couch cushions (ref: No couch cushions)	0.36	0.19-0.68	0.004
Have iron roof (ref: Thatched roof)	0.33	0.13-0.87	0.027
Have cow(s) (ref: No cows)	0.58	0.35-0.96	0.035
Have phone (ref: No phone)	0.52	0.28-0.99	0.046
Has cement floor (ref: Mud floor)	0.45	0.19-1.08	0.073
Have bicycle (ref: No bicycle)	0.57	0.30-1.07	0.077
Has brick home wall construction (ref: Mud and poll home wall construction)	0.50	0.23-1.11	0.085
Child sleeps on a foam mattress (ref: Child sleeps on a polythene bag)	0.62	0.31-1.25	0.17
Family owns land (ref: Family does not own land)	1.81	0.76-4.35	0.171
Have latrine (ref: No latrine)	1.69	0.75-3.81	0.194
Have boda (ref: No boda)	0.46	0.04-5.47	0.517
Have radio (ref: No radio)	0.81	0.37-1.76	0.568
Livestock			
Have turkey(s) (ref: No turkeys)	0.76	0.38-1.52	0.413
Have chicken(s) (ref: No chickens)	1.24	0.71-2.19	0.429
Have pig(s) (ref: No pigs)	0.80	0.45-1.43	0.438
Have rabbit(s) (ref: No rabbits)	0.79	0.40-1.55	0.468
Have ducks(s) (ref: No ducks)	0.82	0.44-1.53	0.513
Have sheep (ref: No sheep)	0.85	0.43-1.67	0.616
Have goat(s) (ref: No goats)	0.94	0.55-1.60	0.809
Socioeconomic Status			
Asset index (ref: Lowest 40% of asset index score)	1.00		
Middle 40% of asset index score	0.61	0.34-1.09	0.091
Top 20% of asset index score	0.24	0.11-0.51	0.001

4.3.2.3 Household Enabling Factors

A second set of socioeconomic variables are here termed *household enabling factors*; these are the attributes of a home and the people within it that modulate the caregiver's capacity to provide for the children. Of the wide variety of such attributes studied, Table 10 presents that none were significantly associated with child stunting status and only two had a p-value between 0.2 and 0.05. Children living in households greater than 5 miles from the nearest health unit were found to be 1.9 times more likely to be stunted (p=0.089). The level of education achieved by the father was also of borderline significance: children were 1.1 times more likely to be stunted if their father stopped education mid-primary (0.43 to 2.7), 1.7 times more likely to be stunted if education stopped after completing primary (0.62 to 4.5) and 0.48 times less likely to be stunted if their father achieved senior level 1 or above (0.17 to 1.4), with an overall level of significance of 0.110.

A subset of the household enabling factors are those specifically related to the caregiver. While many variables were studied to describe the caregiver, we found that only children of caregivers reporting feeling ill on the day of the interview were 1.8 times more likely to be stunted (1.0 to 3.1, p=0.038). These illnesses included being HIV positive, having malaria, backaches or headaches.

Table 10: Univariate Logistic Regression of Household Enabling Factors on Child Stunting Status

Variable	OR	95% CI	p-value
Household Enabling Factors			
Greater than 5 miles from a health unit (ref: Less than or equal to 5 miles from a health unit)	1.91	0.90-4.05	0.089
Father's level of education (ref: None):	1.00		
Mid primary	1.08	0.43-2.69	0.862

Variable	OR	95% CI	p-value
Completed primary	1.68	0.62-4.55	0.287
S1 or above	0.48	0.17-1.37	0.158
Crowding: 3 or more person's per room (ref: Less than 3 person's per room)	1.46	0.76-2.80	0.237
Water source (ref: Infrastructure type)	1.00		
Protected well	0.92	0.41-2.03	0.82
Unprotected well	1.64	0.80-3.35	0.161
Household income average greater than or equal to 1 USD/day (ref: Household income less than 1 USD per day)	0.75	0.39-1.42	0.354
Father's job (ref: Business owner):	1.00		
Dead	1.03	0.26-4.01	0.968
Employee	1.23	0.52-2.90	0.625
Other	0.62	0.22-1.74	0.339
Subsistence farmer	1.51	0.705-3.25	0.278
Caregiver Attributes			
Caregiver's level of education (ref: None):	1.00		
Mid primary	0.71	0.35-1.46	0.333
Completed primary	1.66	0.43-6.46	0.44
S1 or above	0.56	0.21-1.48	0.225
First pregnancy age less than 18 (ref: Age of first pregnancy great than or equal to 18)	1.29	0.66-2.49	0.434
Children born less than 5 (ref: Children born greater than or equal to 5)	0.84	0.50-1.41	0.488
Caregiver less than 30 years of age (ref: Caregiver greater than 30 years)	0.83	0.46-1.49	0.505
Caregiver marital status (ref: Partner dead, separated or divorced)	1.00		
Married	1.58	0.39-6.36	0.501
Single	1.83	0.45-7.51	0.378
Not Of Batooro Tribe (ref: Of Batooro Tribe)	1.11	0.59-2.11	0.732
Caregiver sex male (ref: Female)	1.20	0.09-17.03	0.887
Caregiver Religion (ref: Catholic):	1.00		
Muslim	1.45	0.34-6.29	0.598
Other Christian	1.30	0.48-3.56	0.588
Protestant	1.13	0.56-2.25	0.724

4.3.2.4 Disease Status and Adequacy of Nutrient Intake

Caregivers reported that their children had been affected by a variety of ailments in the previous three months including malaria, rashes and diarrhea but Table 11 presents that none were significantly associated with child stunting status. Nutrient intake was assessed in several ways: we found that there was no significant difference in stunting status between children who were breastfeeding and children who were not. Caregivers also reported if their child had to go hungry from time to time due to inadequate food supplies or time to prepare it; however, this was not significantly associated with child stunting status. The only variable found to be significantly associated with child nutritional status at the proximal level of stunting determinants was the child's Mean Adequacy Ratio (MAR) Score. We found that children scoring between 6 and 7 out of 10 were 2.6 times more likely to be stunted (1.1 to 6.1) while children scoring 5 or less out of 10 were 4.9 times more likely to be stunted (1.2 to 19) in comparison to children scoring 8 or higher out of 10 (p=0.016).

Table 11: Univariate Logistic Regression of Disease Status and Adequacy of Nutrient Intake Factors on Child Stunting Status

Variable	OR	95% CI	p-value
Intermediate Level Variables			
Caregiver has illness (ref: No)	1.79	1.04-3.09	0.038
Children are immunized adequately for their age (ref: No)	1.29	0.77-2.15	0.311
Child weaning age (ref: 0-5 months):	1.00		
6-11 months	0.75	0.40-1.39	0.337
12-18 months	1.29	0.44-3.77	0.626
Weaning age less than 6 months (ref: Greater than 6 months)	1.28	0.602.71	0.501
Vaccination card available for review at time of interview (ref: No)	1.05	0.561.96	0.878
Proximal Level Variables			

Variable	OR	95% CI	p-value
MAR score of less than 8 (ref: MAR score of 8 or better)	2.77	1.395.53	0.006
MAR score (ref: ≥8):	1.00		
MAR score ≥6 and <8	2.61	1.116.15	0.03
MAR score <6	4.89	1.2019.91	0.029
Currently breastfed (ref: No)	1.11	0.582.12	0.737
Protein Adequacy of Intake*	0.51	0.330.77	0.003
Energy Adequacy of Intake*	0.68	0.441.04	0.071
Vitamin A Adequacy of Intake*	0.65	0.500.85	0.003
Riboflavin Adequacy of Intake*	0.60	0.450.80	0.001
Children go hungry from time to time (ref: No)	0.76	0.411.41	0.362
Child sick with...in the previous 3 months:			
Malaria (ref: No)	1.30	0.702.41	0.384
Skin pathology (ref: No)	0.62	0.162.41	0.472
Diarrhea (ref: No)	1.29	0.364.60	0.677
Child sick with something other than those ailments (ref: No)	1.12	0.502.49	0.778
Cough (ref: No)	0.95	0.541.67	0.838
Child sick in the previous 3 months (ref: No)	1.00	0.541.85	0.999

*Ln Transformed

4.3.2.5 Breastfeeding Status

We reported a non-significant relationship between breastfeeding status and stunting status in Table 11 in which the directionality of the relationship suggested that children who were breastfeeding were more at risk of being stunted. Table 12 presents a sub-group analysis of the risk of being stunted by age group amongst breastfed children. Once again, we did not find that breastfeeding status was a significant determinant of child stunting status amongst any of the age groups in which we found children still at the breast. However, the directionality of the relationship changed for the 6 to 11 month age group: our results suggest that breastfeeding amongst children 6 to 11 months of age is protective against stunting but if carried into the second year of life, it becomes a risk factor.

Table 12: The Risk of Being Stunted By Age Group Amongst Breastfed Children

Age Group (in months)	OR	95% CI	p-value
6-11	0.69	0.09-5.17	0.704
12-23	1.24	0.45-3.48	0.659
24-41	2.56	0.24-26.94	0.413

4.3.3 Modeling the Relationship between Nutrient Intake Adequacy and Child Stunting Status

Table 13 presents our findings of a significant relationship between the nutrient intake adequacy variable and child stunting status after adjusting for all factors studied with a p-value of less than 0.2 in univariate analysis. In the analysis, we adjusted for: child age group, SES, father's level of educational achievement, whether or not the family had a latrine, whether or not the family owned land, whether or not the family home was within 5 miles of the nearest health unit, whether or not the caregiver was feeling ill on the day of the interview and whether or not the child was currently breastfed. Upon adjusting for those factors, children with a MAR score of 6 or 7 were 1.5 times more likely to be stunted (0.41 to 5.4, p=0.53) while children with an MAR score of 5 or less were 14 times more likely to be stunted (1.3 to 144, p=0.032). SES was also significantly associated with child stunting in our multiple variable model: after adjusting for all other variables in the model, children from families scoring in the top 20% of our asset index ranking were 0.24 times less likely to be stunted (0.095 to 0.61) in comparison to children from a family scoring in the lowest 40% of our asset index ranking (p=0.005). After adjusting for all other factors in the model, at 5.1 times (0.83 to 31, p=0.077), children of 12 to 23 months of age were found to be of borderline higher likelihood of being stunted while children of 42 to 59 months of age, at 7.0 times (0.93 to 52, p=0.057) were also of borderline higher likelihood of being stunted in comparison to children of 6 to 11 months.

Table 13: Multivariate Logistic Model of the Relationship Between Nutrient Intake Adequacy and Child Stunting Status After Controlling for Distal, Intermediate and Proximal Factors

Variable	OR	95% CI	p-value
Biological Factors			
Age in months (ref: 6-11)	1.00		
12-23	5.07	0.83-31.17	0.077
24-41	2.69	0.36-20.04	0.314
42-59	7.00	0.93-52.41	0.057
SES			
Asset index (ref: Lowest 40% of asset index score)	1.00		
Middle 40% of asset index score	0.91	0.46-1.81	0.778
Top 20% of asset index score	0.24	0.10-0.61	0.005
Household Enabling Factors			
Greater than 5 miles from a health unit (ref: Less than or equal to 5 miles from a health unit)	1.74	0.68-4.45	0.232
Family owns land (ref: Family does not own land)	1.60	0.52-4.91	0.389
Have latrine (ref: No latrine)	1.45	0.53-3.95	0.448
Father's level of education (ref: None):	1.00		
Mid primary	1.16	0.42-3.20	0.769
Completed primary	2.22	0.77-6.39	0.129
S1 or above	0.96	0.27-3.46	0.949
Intermediate Level Variable			
Caregiver has illness (ref: No)	1.75	0.83-3.70	0.132
Proximal Level Variables			
Currently breastfed (ref: No)	0.70	0.26-1.88	0.454
MAR score (ref: ≥8):	1.00		
MAR score ≥6 and <8	1.48	0.41-5.36	0.528
MAR score <6	13.66	1.29-144.28	0.032

We adjusted our model with 6 factors found to be confounders of the relationship of adequacy of nutrient intake and children stunting status. Whether or not a home was located more than 5 miles from the nearest health unit was found to be a confounder of the 24 to 41 month age group category, the SES category defined as households scoring between the 40th and 80th percentile, whether or not the father stopped formal education in mid-primary and whether or not he stopped formal education sometime after entering senior level 1 or above. Whether or not the family owned land was a confounder of being in the middle SES category and of all the educational achievement categories. Whether or not the family had a personal latrine was found to be a confounder of the father's education level. The father's level of educational achievement was found to be a confounder of all the age categories and of both of the SES categories. Whether or not the caregiver was ill on the day of the interview was found to be a confounder of both the SES categories, the father having stopped education mid-primary or after completing a year of senior 1 and the family owning land. Finally, the child's breastfeeding status was found to be a confounder of the child age category of 42 to 59 months. Several logical interactions were tested but after excluding those exhibiting multiple co-linearity with other variables in the model, none of the interactions were significant. The overall significance of the model was found to be p=0.68.

4.4 Research Question 4: Predictors of Nutrient Intake Adequacy in Kabarole District

4.4.1 Univariate Analysis of Factors Associated With Nutrient Intake Adequacy

A range of factors including those of biological significance, socioeconomic indicators and disease and other proximal determinants of child stunting status were regressed on a dichotomized nutrient intake adequacy variable. MAR was found to have a non-normal distribution that could not be transformed due to the ceiling effect imposed by truncating all the individual nutrient intake adequacies used to construct it off at 1. Therefore, it was dichotomized into children with a MAR scores of less than 8 or greater than/equal to 8 out of 10.

4.4.1.1 Biological Factors

Child age was found to be significantly associated with nutrient intake adequacy. As is shown in Table 14, children age 12 to 24 months were found to be 0.30 times less likely to have a MAR score of less than 8 (0.099 to 0.90), children age 24 to 41 months were 0.063 times less likely to have an MAR score of less than 8 (0.017 to 0.24) and children age 42 to 59 months were 0.14 times less likely (0.039 to 0.51) to have a MAR score of less than 8 in comparison to children in the 6 to 11 month age group (p=0.008). Like the association between age and child stunting status, child gender was not found to be associated with nutrient intake adequacy.

Table 14: Univariate Logistic Regression of Biological Factors on Child Nutrient Intake Adequacy

Variable	OR	95% CI	p-value
Biological Factors			
Age in months (ref: 6-11)	1.00		
12-23	0.30	0.10-0.90	0.033
24-41	0.06	0.02-0.24	0.000
42-59	0.14	0.04-0.51	0.005
Male sex (ref: Female)	1.14	0.48-2.72	0.75

4.4.1.2 Socioeconomic Status Indicators

Unlike the range of durable assets that were significantly correlated with child stunting status,

Table 15 presents that only household bicycle ownership was of borderline significance with nutrient intake adequacy. Children from homes with a bicycle were found to be 0.45 times less likely to have a score below 8 in comparison to homes without a bicycle (0.17 to 1.2, p=0.091). Two types of livestock, out of the eight that were assessed were found to be of borderline significance for predicting nutrient intake adequacy: children from homes with at least 1 chicken were 0.52 times less likely to have a nutrient intake score below 8 (0.23 to 1.2, p=0.10) while children from homes with at least 1 goat were found to be 0.24 times less likely to have an MAR score below 8 (0.24 to 1.3, p=0.162). The asset index variable created to describe the wealth of a household was not found to be a significant determinant of MAR score (p=0.981).

Table 15: Univariate Logistic Regression of Socioeconomic Status Factors on Child Nutrient Intake Adequacy

Variable	OR	95% CI	p-value
Durable Assets			
Have bicycle (ref: No bicycle)	0.45	0.17-1.15	0.091
Have cow(s) (ref: No cows)	0.50	0.17-1.51	0.207
Have iron roof (ref: Thatched roof)	3.05	0.38-24.42	0.276
Have latrine (ref: No latrine)	0.58	0.19-1.75	0.314
Have boda (ref: No boda)	0.34	0.03-4.08	0.377
Family owns land (ref: Family does not own land)	1.70	0.49-5.90	0.382
Have phone (ref: No phone)	1.35	0.42-4.32	0.592
Child sleeps on a foam mattress (ref: Child sleeps on a polythene bag)	0.90	0.36-2.24	0.808
Have radio (ref: No radio)	0.89	0.32-2.52	0.82
Have couch cushions (ref: No couch cushions)	1.11	0.38-3.30	0.838
Livestock			
Have chicken(s) (ref: No chickens)	0.52	0.24-1.16	0.103
Have goat(s) (ref: No goats)	0.56	0.24-1.29	0.162
Have pig(s) (ref: No pigs)	0.75	0.27-2.10	0.569
Have turkey(s) (ref: No turkeys)	0.77	0.18-3.21	0.7
Have rabbit(s) (ref: No rabbits)	0.79	0.18-3.38	0.731
Have sheep (ref: No sheep)	0.85	0.22-3.33	0.809
Have ducks(s) (ref: No ducks)	0.90	0.24-3.33	0.871
Socioeconomic Status			
Asset index (ref: Lowest 40% of asset index score)	1.00		
Middle 40% of asset index score	0.96	0.32-2.88	0.944
Top 20% of asset index score	0.90	0.30-2.67	0.842

4.4.1.3 Household Enabling Factors

Three household enabling factors, as shown in Table 16, were of noteworthy impact on MAR score. The only one of significance described a household's proximity to the nearest health centre: children from homes greater than 5 miles from a health centre were found to be 2.8 times more likely to have a MAR score below 8 (1.2 to 6.8, p=0.024). Concerning the caregiver, the caregiver's religious affiliation and age were of borderline significance. Children of caregivers practicing the Muslim faith were 6.8 times more likely to have a MAR score below 8 (1.5 to 31), children of caregivers who were Protestants were 0.82 times less likely to have a MAR scores of less than 8 (0.3 to 2.2) while children of caregivers practicing other Christian religions were 1.3 times more likely to have an MAR score of less than 8 (0.4 to 4.1) (p=0.076). Of all the other caregiver variables studied, only age also approached significance: children of caregivers of less than 30 years of age were found to be 0.60 times less likely to have an MAR scores of less than 8 in comparison to children of caregivers 30 or over (p=0.191).

Table 16: Univariate Logistic Regression of Household Enabling Factors on Child Nutrient Intake Adequacy

Variable	OR	95% CI	p-value
Household Enabling Factors			
Greater than 5 miles from a health unit (ref: Less than or equal to 5 miles from a health unit)	2.82	1.17-6.78	0.024
Crowding: 3 or more person's per room (ref: Less than 3 person's per room)	1.70	0.69-4.19	0.232
Father's job (ref: Business owner):	1.00		
Dead	0.24	0.03-1.93	0.167
Employee	0.36	0.09-1.40	0.132
Other	0.95	0.23-3.86	0.934
Subsistence farmer	0.69	0.28-1.71	0.407
Household income average greater than or equal to 1 USD/day (ref:	1.20	0.59-2.46	0.599

Variable	OR	95% CI	p-value
Household income less than 1 USD per day)			
Not Of Batooro Tribe (ref: Of Batooro Tribe)	0.82	0.31-2.20	0.676
Water source (ref: Infrastructure type)	1.00		
Protected well	0.89	0.28-2.85	0.842
Unprotected well	1.25	0.46-3.39	0.643
Father's level of education (ref: None):	1.00		
Mid primary	0.71	0.18-2.76	0.598
Completed primary	1.00	0.24-4.23	0.997
S1 or above	1.17	0.37-3.69	0.784
Caregiver Attributes			
Caregiver Religion (ref: Catholic):	1.00		
Muslim	6.80	1.48-31.25	0.017
Other Christian	1.29	0.41-4.05	0.651
Protestant	0.82	0.30-2.20	0.673
Caregiver less than 30 years of age (ref: Caregiver greater than 30 years)	0.60	0.28-1.32	0.191
Caregiver marital status (ref: Partner dead, separated or divorced)	1.00		
Married	6.85	0.74-63.55	0.086
Single	5.83	0.49-69.10	0.152
Mother's level of education (ref: None):	1.00		
Mid primary	1.51	0.53-4.33	0.422
Completed primary	0.48	0.11-2.15	0.32
S1 or above	0.85	0.24-2.98	0.785
First pregnancy age less than 18 (ref: Age of first pregnancy great than or equal to 18)	0.82	0.34-2.02	0.654
Children born less than 5 (ref: Children born greater than or equal to 5)	0.72	0.31-1.69	0.431

4.4.1.4 Disease Status and Adequacy of Nutrient Intake

Table 17 shows that at the intermediate level, just one factor was significantly associated with nutrient intake adequacy: children who were found to be adequately immunized for their age were 0.37 times less likely to have a MAR score of less than 8 in comparison to children who were not adequately immunized (p=0.027). Those who were weaned against guidelines at less than 6 months were found, albeit not significantly, to be 2.1 times more likely to have an MAR score of less than 8 (p=0.162); however, children who were breastfeeding were found to be 4.4 times more likely to have an MAR score of less than 8 (p=0.004). Regarding food consumption, the children of caregivers who reported that their child must go hungry from time to time for various reasons were 2.7 times more likely to have an MAR score of less than 8 (p=0.053).

More diseases correlated with MAR score than with child stunting status. Caregivers reporting that their children were sick with any number of ailments in the previous three months were 2.2 (0.98 to 5.1) times more likely to have an MAR score less than 8 (p=0.057). While also of only borderline significance, children who had a cough in the previous three months were 2.2 times (0.89 to 5.2) more likely to have a MAR scores less that 8 (0.085), children with malaria were 0.51 times less likely to have an MAR score less than 8 (p=0.176) and children with an ailment other than those already mentioned (excluding diarrhea and rash) were 2.6 times more likely to have a MAR scores of less than 8 (p=0.124).

Table 17: Univariate Logistic Regression of Disease Status and Adequacy of Nutrient Intake Variables on Child Nutrient Intake Adequacy

Variable	OR	95% CI	p-value
Intermediate Level Variables			
Children are immunized adequately for their age (ref: No)	0.37	0.15-0.88	0.027
Weaning age less than 6 months (ref: Greater than 6 months)	2.09	0.72-6.05	0.162
Vaccination card available for review at time of interview (ref: No)	0.62	0.28-1.37	0.221
Child weaning age (ref: 0-5 months):	1.00		
6-11 months	0.80	0.38-1.67	0.526
12-18 months	0.56	0.09-3.57	0.519

Variable	OR	95% CI	p-value
Caregiver has illness (ref: No)	1.08	0.47-2.46	0.849
Proximal Level Variables			
Currently breastfed (ref: No)	4.48	1.74-11.58	0.004
Children go hungry from time to time (ref: No)	2.66	0.99-7.18	0.053
Child sick in the previous 3 months (ref: No)	2.23	0.98-5.09	0.057
Child sick with...in the previous 3 months:			
Cough (ref: No)	2.16	0.89-5.25	0.085
Child sick with something other than those ailments (ref: No)	2.53	0.76-8.46	0.124
Malaria (ref: No)	0.51	0.18-1.40	0.176
Diarrhea (ref: No)	2.84	0.54-14.97	0.205
Skin pathology (ref: No)	0.94	0.13-7.06	0.95

4.4.1.4.1 Breastfeeding Status

We found, as is reported in Table 17, that breastfed children were 4.4 times more likely to be in the lower nutrient intake adequacy category in comparison to children who were not breastfed. In order to clarify the nature of this relationship by age group, we analyzed the relationship between nutrient intake adequacy and breastfeeding status by age group. Table 18 presents that children in the 6 to 11 month and 12 to 23 month age groups who are breastfed are no more at risk of consuming a less adequate diet than children who are in the higher age group. However, children who are still breastfeeding between the ages of 24 and 41 months are 16 times more likely to consume a less adequate diet than children who do not breastfeed (p=0.052). The confidence interval around this relationship is quite wide as there were only 4 children who were found to be both between 24 and 41 months and still breastfeeding.

Table 18: The Risk of Being in the Lower Nutrient Intake Adequacy Category (0-7 as opposed to 8-10) By Age Group Amongst Breastfed Children

Age Group	OR	95% CI	p-value
6-11	1.03	0.18-6.05	0.973
12-23	1.22	0.21-7.00	0.818
24-41	15.94	0.97-261.51	0.052

4.4.1.5 Using the 24 to 41 Month Age Group as the Reference Age Group in Place of the 6 to 11 Month Group

When the 6 to 11 month age group acts as the reference group, we found that age was a significant determinant of MAR (p=0.008); all age groups experienced a protective effect. In order to clarify the disparity in Nutrient Adequacy Ratio Scores (Figure 12 through Figure 18) in the descriptive analysis, between the 24 to 41 month age group and the other age groups, we set the 24 to 41 month age group as the reference age group and age was regressed once again on MAR. In univariate analysis, we found that children in the 42 to 59 month age group were not significantly more likely to be in the lower MAR score group in comparison to children in the 24 to 41 month age group (a significant difference was observed for children in the 12 to 24 month age group (4.7 times, 1.5 to 14, p=0.010) and the 6 to 11 month age group (16 times, 4.2 to 60, p<0.001)). With reference to MAR alone, it appeared that diet could not explain the cubic relationship observed in Figure 5 between age and stunting status in which the prevalence of stunting was found to be 50% in the 12 to 23 month group, dropping to 35% in the 24 to 41 month group and peaking at 55% in the final age group.

4.4.1.6 Examining the Relationship Between Protein/Energy Intake Adequacy and Child Age Group/Family SES

It did not seem logical that diet was not associated with the difference in the prevalence in stunting between the final two age groups. Therefore, we regressed age on what we felt to be important nutrients for the promotion of growth including protein and energy as well as vitamin A and riboflavin (to have micronutrient representation). Unlike MAR, we found that children in the 24 to 41 month age group were consuming a significantly higher adequacy of protein and energy than children in the 42 to 59 month age group.

Table 19 shows that on average, children of 42 to 59, 12 to 23 and 6 to 11 months consumed a significantly lower adequacy of protein and energy intake in comparison to children in the 24 to 41 month group. With the exception of the relationship between age and vitamin A intake in the 42 to 59 month group, the same is true for vitamin A and Riboflavin. Therefore, contrary to our findings based on MAR score, age is a determinant of nutrient intake adequacy between the final two age groups for important nutrients.

Table 19: Univariate Regression of Child Age Group (With Children 24 to 41 months of Age as the Reference) and SES on Protein, Energy, Vitamin A and Riboflavin, one at a time.

	Protein NAR*			Energy NAR*		
Variable	**Coef**	**95% CI**	**p-value**	**Coef**	**95% CI**	**p-value**
Age						
Age in months (ref: 24-41)						
42-59	-0.26	-0.41 to -0.11	0.002	-0.20	-0.34 to -0.05	0.012
12-23	-0.26	-0.46 to -0.06	0.014	-0.22	-0.42 to -0.01	0.040
6-11	-0.73	-1.24 to -0.22	0.008	-0.72	-1.15 to -0.28	0.003
SES						
Asset index (ref: Lowest 40% of asset index score)						
Middle 40% of asset index score	0.18	-0.06 to 0.43	0.128	0.21	-0.02 to 0.43	0.075
Top 20% of asset index score	0.27	0.10 to 0.44	0.003	0.19	0.02 to 0.37	0.030
	Vitamin A NAR*			**Riboflavin NAR***		
	Coef	**95% CI**	**p-value**	**Coef**	**95% CI**	**p-value**
Age						
Age in months (ref: 24-41)						
42-59	-0.22	-0.47 to 0.02	0.074	0.65	0.04 to 1.26	0.038
12-23	-0.43	-0.73 to -0.12	0.009	1.24	0.61 to 1.87	0.001
6-11	-1.89	-2.86 to -0.91	0.001	1.03	0.44 to 1.63	0.002
SES						
Asset index (ref: Lowest 40% of asset index score)						
Middle 40% of asset index score	0.14	-0.28 to 0.56	0.504	0.17	-0.15 to 0.48	0.288
Top 20% of asset index score	0.30	0.06 to 0.55	0.018	0.21	-0.03 to 0.44	0.078

*Ln Transformed

4.4.1.7 Modeling the Relationship between Protein and Energy Intake Adequacy and Child Stunting Status

The previously described model was used to test the significance of protein intake adequacy and energy intake adequacy, one at a time, as determinants of child stunting status adjusted for other important variables. Unadjusted for confounding factors, Table 11 shows that for a unit increase in protein intake adequacy, children were found to be 0.51 times less likely to be stunted (0.33 to 0.77, p=0.003); Table 20 shows that when adjusted for all other variables in the model, the relationship became of borderline significance. After controlling for socioeconomic, intermediate and proximal determinants of stunting status, children were found to be 0.58 times less likely to be stunted for a unit increase in protein intake adequacy (0.31 to 1.1, p=0.087).

Table 20: Model of the Association Between Stunting Status and Adequacy of Protein Intake After Controlling For Significant Factors

Variable	OR	95% CI	p-value
Biological Factors			
Age in months (ref: 24-41)	1.00		
42-59	2.22	1.07 -4.61	0.034
12-23	1.60	0.64 -4.04	0.298
6-11	0.42	0.07 -2.63	0.335
Socioeconomic Status			
Asset index (ref: Lowest 40% of asset index score)	1.00		
Middle 40% of asset index score	0.96	0.49 -1.90	0.908
Top 20% of asset index score	0.26	0.10 -0.67	0.008
Household Enabling Factors			
Father's level of education (ref: None):	1.00		
Mid primary	1.06	0.39 -2.87	0.9
Completed primary	2.32	0.84 -6.41	0.098
S1 or above	0.89	0.25 -3.15	0.846
Have latrine (ref: No latrine)	1.49	0.60 -3.70	0.365
Family owns land (ref: Family does not own land)	1.76	0.71 -4.37	0.211
Greater than 5 miles from a health unit (ref: Less than or equal to 5 miles from a health unit)	1.36	0.49 -3.76	0.535
Intermediate Level Variable			
Caregiver has illness (ref: No)	1.57	0.77 -3.19	0.198
Proximal Level Variables			
Currently breastfed (ref: No)	0.85	0.34 -2.13	0.713
Protein Intake Adequacy*	0.58	0.31 -1.09	0.087

*Ln Transformed

Table 11 shows that the unadjusted regression of energy intake adequacy on stunting status was of borderline significance. We found that for a unit increase in energy adequacy ratio, children were 0.68 times less likely to be stunted (0.44 to 1.1, p=0.071); Table 21 shows that when adjusted for all other variables in the model, the relationship became much less significant. After controlling for socioeconomic, intermediate and proximal determinants of stunting status, children were found to be 0.74 times less likely to be stunted for a unit increase in energy intake adequacy (0.35 to 1.6, p=0.42).

Table 21: Model of the Association Between Stunting Status and Adequacy of Caloric Intake After Controlling For Significant Factors

Variable	OR	95% CI	p-value
Biological Factors			
Age in months (ref: 24-41)	1.00		
42-59	2.35	1.15 -4.83	0.022
12-23	1.68	0.66 -4.26	0.258
6-11	0.53	0.10 -2.98	0.451
Socioeconomic Status			
Asset index (ref: Lowest 40% of asset index score)	1.00		
Middle 40% of asset index score	0.95	0.47 -1.90	0.867
Top 20% of asset index score	0.25	0.10 -0.64	0.006
Household Enabling Factors			
Father's level of education (ref: None):	1.00		
Mid primary	1.06	0.39 -2.91	0.9
Completed primary	2.18	0.77 -6.17	0.132
S1 or above	0.85	0.23 -3.11	0.791
Have latrine (ref: No latrine)	1.48	0.59 -3.72	0.381
Family owns land (ref: Family does not own land)	1.82	0.72 -4.59	0.191
Greater than 5 miles from a health unit (ref: Less than or equal to 5 miles from a health unit)	1.60	0.56 -4.59	0.364
Intermediate Level Variable			

Variable	OR	95% CI	p-value
Caregiver has illness (ref: No)	1.66	0.82 -3.36	0.149
Proximal Level Variables			
Currently breastfed (ref: No)	0.89	0.34 -2.38	0.812
Caloric Intake Adequacy	0.74	0.35 -1.57	0.417

4.4.1.8 Comparing Protein Consumption Of Children 12 to 41 months with Children 41 to 59 months

Table 22 presents the actual amount of protein that we found caregivers were feeding their children each day. Unlike protein intake adequacy, which showed that children in the 24 to 41 month age group were consuming the highest adequacy of protein, Table 22 shows that children in the 42 to 59 month age group actually consumed the most protein but were closely followed by children in the 24 to 41 month age group. It appears that caregivers continue to feed their children the same amount of protein as they age from the 24 to 41 month age group into the 42 to 59 month age group.

Table 22: The Average Consumption of Protein in Grams Per Day By Age Group

Protein Intake by Age Group	Mean g/day	95% CI	Count
6-11	42.16	30.14-54.19	31
12-23	49.14	41.45-56.84	85
24-41	63.58	54.86-72.30	101
42-59	64.38	56.27-72.50	82

Chapter 5: Discussion

5.1 Study Limitations

The first research question describes the prevalence of stunting as well as wasting and underweight and their corresponding HAZ, WHZ and WAZ amongst preschool aged children by age group. The procedure used to measure child height deviated from that prescribed by the United Nations[98] which suggests procedures that mimic the methods used to measure children during the development of the reference group heights. The reference was developed by measuring all children older than 2 years of age standing up and taking the supine length of children less than 2. Our measurements will underestimate the heights of children less than 2 if they were measured standing up (no children older than 2 years of age were measured lying down). This will introduce random error into our results by underestimating the Height-for-age of children measured improperly, biasing our findings toward the null. Secondly, we only took one measurement of height and weight. Taking two measurements would have helped to minimize measurement error.

We visited each household only once and in the event that no caregiver was available at the home, we did not make any effort to return to that household. This may have introduced systematic bias into our sample. We attempted to take a representative sample of preschool age children in rural Kabarole District. However, if children of caregivers who were not available for interview during the day when we arrived to interview were more likely to be in the higher or lower nutrient intake adequacy group or more or less likely to be stunted, we would have reduced the internal validity of our sample. It would have been an improvement on our methodology to have revisited homes where no caregiver was initially present in order to try again to interview. However, time constraints did not permit such backtracking. It is difficult to postulate the effect of such systematic bias. Perhaps children in homes with no caregiver present were less likely to be stunted because the caregiver was working hard to earn money and/or produce food to care for the child? On the other hand, such homes may have been more likely to have a stunted child due to the child's needs being neglected while the caregiver was away? It is difficult to speculate the direction of this bias; however, as most homes had caregivers available for interview, its magnitude was likely not great.

There is good reason to suspect that the child nutrient intake adequacies calculated based on caregiver reported food consumption may have overestimated children's actual nutrient intake adequacy. Calculating nutrient intake was a multi-step process, each step with its own assumptions that may have introduced error into the measurement of nutrient intake. Table 23 presents an example calculation of how one child's French Beans consumption contributes to protein intake adequacy. First, we asked caregivers to report the frequency of their child's intake of a given food. We assumed that caregivers understood that we wanted them to report frequency of food intake while considering all other foods consumed as well. For example, if a particular food is consumed 6 times a week but only during weeks that it is purchased, and an alternate food that fulfills the same role in the diet is consumed during other weeks, we expected caregivers to report that food's frequency of consumption on a monthly basis, rather than weekly basis so that its monthly consumption frequency was not erroneously high. It is possible that some caregivers did not make this distinction and therefore the dietary contributions of some foods were overestimated.

Table 23: Example nutrient intake adequacy calculation based on the protein contribution from French Beans (Ebhimba)

Food:	French beans (English)/Ebhimba (Rutooro)
Serving size and frequency:	1 small bowl/day
*Mass per small bowl:	285g
**Protein Composition:	0.025 g protein/g of raw beans
Total protein intake from French beans per day:	7.1g
Child age and gender:	8 months and male
***Recommended daily intake for protein:	11g
Proportion of recommend daily intake for protein yielded from small bowl French Beans:	0.65

*See **Appendix 10**
See **Appendix 12
***See **Appendix 16**

We asked caregivers to report the volume of consumption of a particular food with reference to either the *smaller bowl* or the *larger bowl* we brought to each interview. These bowls were similar to those commonly used by rural people in their homes; nonetheless, lack of familiarity with the bowls could have caused some caregivers to under or overestimate the food volume consumed by their children. It would have been beneficial to have validated our estimates of daily nutrient intake with 24-hour food recalls; however, our limited resources neither afforded us extra interview time nor time for extra home visits in order to conduct such 24-hour recalls. Fortunately, such over estimation, if it did indeed occur, would have occurred systematically permitting a valid comparison between adequacy of overall nutrient intake child stunting status.

The quantitative food frequency data was first processed by converting the food volumes to weights with reference to food weight estimates. We created these estimates for the purpose of this study by preparing and weighing the foods ourselves. One draw back to this method is that food weights could vary with ones perception of what constitutes a “full bowl” of a particular food. Weights for a particular volume could also vary with the preparation of the food including length of cooking and ratio of dry food stuff to water mixed. For example, a full bowl of leafy green vegetable cooked for 10 minutes would be heavier than the same leafy green cooked for 2 minutes because that cooked longer would be more dense. Food preparation followed methods commonly used in the villages and foods were prepared by a member of one such village. Given the foods were prepared by a village woman, not unlike many of the caregivers interviewed, and that same chef also conducted all the interviews, we feel confident that her understanding of what preparation steps were necessary and what constituted a full bowl were accurate.

The nutrient compositions of a type of food varies by food variety. Our primary food nutrient composition reference was the 1968 Food Composition Table for Use in Africa[99]. Information on the nutrient composition for foods exactly matching the preparation and variety of foods in our inventory were few in number so assumptions had to be made regarding nutrient composition. Those assumptions are all discussed in Appendix 12. An accurate way of assessing nutrient composition is to ask for food samples and use laboratory analyses to assess food nutrient value[76]. The present study was not capable of going to such lengths and relied on published food compositions tables including the FAO Food Composition Table for Use in Africa to assess nutrient value[99]. This table has inaccuracies that may have underestimated the nutrient contribution of certain foods to the diet; mainly nutrient composition data was incomplete for many foods. Over sixteen hundred foods are addressed in their inventory but only 70% of nutrients are accurately reported. Specific nutrients of specific food groups do much worse than this; only 40% of fruits have vitamin C composition that is accurately reported and only 20% of vegetables have vitamin A that is accurately reported. We did not attempt to fill in individual missing or inaccurate nutrients from food samples; however, we filled in composition information for foods that were completely blank with alternate references, which are listed in Appendix 12, converting composition values to the same units as our table.

Previous research has suggested that zinc may be a growth limiting nutrient, essential for both human growth and development[115, 116] and immunocompetence[117, 118]. Yet, concentrations of this important nutrient were not reported for foods inventoried in the 1986 Food Composition Table. Ideally, zinc should have been a component of our nutrient intake adequacy score (MAR); however, recent research suggests that zinc may be of secondary importance as a determinant of nutritional status to other nutrition factors and therefore, its absence is not confounding.

Zinc may be under available to Ugandan preschool age children. As we have discussed previously, they have a predominately vegetarian diet, high in fibre and phytates[119,120], which reduces the bioavailability of zinc. However, despite the evidence that zinc is a growth limiting factor and children may absorb an insufficient amount of it, Kikafundá et al. found neither a significant correlation between zinc supplementation and Weight-for-age nor Height-for-age amongst urban preschool age children of medium, low and/or very low socioeconomic status. They suggest that zinc may not be the most limiting nutrient for weight gain in children of poor SES but may become more important as SES and child nutritional status improve[44]. Therefore, amongst our rural cohort of children from mainly low socioeconomic status, the impacts of zinc deficiency on child nutritional status are likely secondary to deficiencies in other nutrients.

Following the quantification of food nutrient contribution, daily nutrient intakes were estimated based on monthly quantitative food frequency data. The adequacy of nutrient intake for each nutrient was estimated by dividing the estimated daily nutrient intake by the recommended daily intakes for protein, energy, iron, calcium, vitamin A and C, thiamine, riboflavin and niacin. The recommended daily intake values used are based on the nutritional needs of healthy children, which are known to be higher in sick children[100]. Should a child have been sick, our adequacy score would have underestimated his or her nutrient requirements.

A systematic limitation of our nutrient adequacy score is that it underestimated the nutrient intake of breastfeeding children. Ninety-two, 74 and 42 percent of children age 0 to 5, 6 to 11 and 12 to 18 months respectively in our sample population were still breastfeeding. Intuitively, breastfeeding will be making a greater contribution to nutrient intake in the lowest age group; however, the nutrient contribution of breast milk is not quantified in the present study and therefore, we cannot make an accurate comparison of nutrient intake adequacy between the lowest age group, which is mostly breastfeeding and the highest age group in which no children are breastfeeding. Therefore, our nutrient adequacy estimates will understate nutrient intake amongst children less than 18 months.

Only nutrient intake data for the month of October was analyzed. The months of food availability was collected for each food from each caregiver but it was felt food frequency data for October would have the least caregiver recall error as it was the most recent month for all households. October is in the middle of the rainy season; therefore, nutrient intake adequacy estimates based on foods available in October may over estimate or under estimate nutrient intake adequacy as a result of foods available during this month, which is in the middle of the rainy season.

Stunting develops over an extended period of time but our nutrient intake estimate is representative of the most recent month in the child's life. In order to compare dietary adequacy to child stunting status, we made the assumption that nutrient intake adequacy during October was representative of a child's intake adequacy, regardless of season, over the entire period preceding the interview. Of course, this may not be true. A hypothetical child may have become stunted as a result of poor weaning practices in the first year of life; that child, now at 36 months, has not recovered height, but is healthy and eating an adequate diet.

In modeling the relationship between nutrient intake adequacy and stunting status, we took steps to control for important confounding factors. Stunting is directly caused by both inadequate nutrient intake and persistent disease; these two factors work synergistically to cause child stunting. Efforts were made to assess recent child illness and control for various illnesses in our model; however, childhood illness may have been under-reported. Caregivers were asked if their children had been sick in the previous three months and what action the caregiver took to help the child. However, recall error may have grossly biased the results of this question rendering it ineffective. In addition, no effort was made to quantify the severity of the illness in order to distinguish severely ill children from those who were mildly sick. Illness is a confounder for the relationship between nutrient intake and stunting because illness can both directly cause stunting by increasing the body's nutrient requirements and can also cause poor nutrient intake by decreasing the child's appetite or impairing the absorption of nutrients. For example, we attempted to control for child HIV/AIDS status by asking caregivers if the children we were assessing were HIV positive. It is well known that HIV/AIDS decreases appetite while impairing nutrient absorption. In the event that HIV status was incorrectly reported as negative where a child was in fact positive, we may have over-estimate the impact of child nutrient intake inadequacy on child stunting status. Ineffectively controlling for illness as a confounding factor may have systematically biased our relationship between nutrient intake and stunting status.

Inaccurate age determination may have introduced random bias into our results. Children of caregivers who could not report their children's ages confidently were excluded from the study. An inaccurate age assessment would cause a child's Height-for-age to be under or overestimated. However, there is no reason to believe that caregivers of children who were found to score in the less adequate nutrient intake category were more likely to inaccurately report their children's ages than caregivers of children scoring in the more adequate nutrient intake category. Therefore, this would be a random error and, if present, would bias our results toward the null.

It is recognized that children who are born with low birth weight in Uganda are at higher risk of becoming stunted than children who are not of low birth weight[46]. A limitation of our study is that we have not controlled for birth weight in our analysis. In the early 1990's, the prevalence of low birth weight births was around 20% for children born in hospital in Kabarole District[123]. Therefore, the high prevalence of low birth weights could explain a portion of the stunting observed in our sample and be confounding the association between nutrient intake adequacy and child stunting status.

Due to time and resource limitations, we were not able to collect our target of 381 observations (which we calculated based on a simple random sampling design and would itself have been insufficient due to the design effect associated with multi-stage survey sampling). Therefore, some tests of association may have been underpowered, possibly explaining why we were not able to detect certain associations. The Stat Calc utility bundled with Epi Info[114] was used to assess our study's power (that is, our study's ability to detect an association between child stunting status and nutrient intake adequacy). Based on an alpha level of 95%, an unexposed to exposed ratio of 6:1 (where the exposed group was in the lower nutrient intake adequacy group; that is, those with a MAR below 8 out of 10), with a stunting prevalence of 44.5% in the unexposed group and 66.2% in the exposed group, a sample size of 322 child observations yielded a power of 74%. While our study was underpowered, we did not fall far from our goal of 80% power.

Despite the many limitations acknowledged above, our study provides interesting insights into the state of child nutritional status, the adequacy of nutrient intake and the association between the two in Kabarole District.

5.2 Research Question 1: The Prevalence of Stunting in Kabarole District

Our study found that the prevalence of stunting amongst rurally located children age 6 to 59 months who have begun the weaning process was 45% (37 to 52%). This is comparable with results from a 2001 study of Uganda's Western Regions which found that the prevalence of stunting amongst children 0 to 59 months was 48%[90]and lower than the prevalence observed by Bridge et al. in a case-control study conducted amongst both urban and rural children in 2003.

Bridge et al. included both urban and rural children in their sample. The higher prevalence of stunting observed in their study may have been a result of children from the town of Fort Portal having had a higher prevalence of stunting in comparison to children from the villages. This would increase the overall prevalence of stunting in their study in comparison to our purely rural sample.

The prevalence of stunting was found to be high in comparison to other anthropometric indicators of nutritional status. The prevalence of wasting was found to be 3% (1 to 5%) while the prevalence of underweight children was found to be 19% (9 to 29%). We found that the prevalence of stunting was 35% (11 to 59%) amongst children 6 to 11 months of age and 50% (37 to 63%) amongst children in the second year of life. We found that the prevalence dropped back down to 35% (24 to 46%) amongst children age 24 to 41 months of age but increased up to 55% (39 to 71%) in the final age group of 42 to 59 months.

The stunting trend we observed between 0 and 24 months of age, which suggests that children in this age group are at increasingly greater risk of stunting, has been previously reported[32,33,35,42,44-46]. Most of the studies found that the prevalence of stunting peaked amongst children 12 to 23 months of age, followed by either a plateau or a slight reduction in prevalence as children approached 59 months of age. However, our results are similar to those described by Tumwine et al. in Kasese and results from a 1995 national survey[4246]. Both studies found that the prevalence of stunting increased up to the 12 to 23 month age group, reduced through a middle group and then rose again as children's age approached 5 years.

An examination of the WHZ trend suggests that children in the 24 to 41 month age group may be benefiting from a period of rapid growth. Children in the 24 to 41 month age group have the lowest mean WHZ at -0.18 (-0.47 to 0.10). Perhaps children in this age group are leaning out as they undergo a period of rapid growth, which accounts for their relatively low prevalence of stunting, their high mean HAZ and their low WHZ.

On the other hand, this was a cross-sectional study and we may be witnessing a cohort effect amongst children in the older age groups. Most of the previous research discussed in the preceding few paragraphs has suggested that the prevalence of stunting increases through to 24 months of age and then levels off or rises slightly more. Therefore, it is reasonable to suspect that perhaps a factor not accounted and controlled for in the present study affected children in the 24 to 41 month age group differently than children in the 12 to 24 or the 42 to 59 month age groups. The cubic trend we have observed may be an artifact of the isolated impact of other factors on the older children in our study. Therefore, what we may be seeing is a cohort affect independent of nutrient intake.

5.3 Research Question 2: Nutrient Intake Adequacy in Kabarole District

The majority of children are breastfeeding in the 6 to 11 month old age group making it difficult to evaluate the adequacy of their diets based on the complementary food nutrient intake data collected. It is quite probable that the reason they ranked lowest for nutrient intake adequacy for all nutrients studied (with the exception of calcium) was because the present methodology was inadequate to assess the true adequacy of their diets. Breast milk is making a substantial contribution to the diets of these children so nutrient intake adequacy based on solid foods provides a poor estimate of nutrient intake adequacy.

However, by the second year of life, we found that only 31% (15 to 46%) of children were breastfed. This is almost a third of that cohort but we assume that by the second year, nutrients from breast milk are making up a small fraction of the total nutrients being consumed. So, focusing on the last three age groups, we observed two nutrient intake trends. For protein, energy and iron, the 24 to 41 month age group is always consuming the highest adequacy, followed by the 12 to 23 month group and then by the 42 to 59 month group. For vitamins A and C as well as thiamine, riboflavin and niacin, the 24 to 41 month age group is consistently consuming the highest adequacy followed this time by the 42 to 59 month age group and then the 12 to 23 month group. It is of no surprise that calcium does not follow this same pattern. While the data is not presented in the results section, calcium is mainly consumed through milk, which is largely drank by children in the younger age groups.

We found that the protein, energy and iron adequacy of intake trend described above was exactly opposite the stunting prevalence pattern. While all nutrients are important for optimal body functioning, protein and energy, in substantial proportions, are particularly important for growth. Therefore, it is of little surprise that the children who are least stunted are also consuming the highest adequacies of these macronutrients. That iron follows this pattern in also not surprising because iron is high in meats which are a substantial source of protein.

We observed a curious age related pattern between stunting and protein/energy intakes: stunting is relatively low and protein and energy intakes are high in the 24 to 41 month group; however, this pattern reversed amongst children in the 42 to 59 month group. The overall dietary adequacy for the children in the 24 to 41 month group, at 9.66 (interquartile range: 9.72 to 10) is almost exactly the same as children in the 42 to 59 month group at 9.56 (interquartile range: 9.65 to 10). However, the MAR score of the latter age group must benefit substantially from the impact of vitamins A and C as well as thiamine, riboflavin and niacin. The 42 to 59 month age group still consumes a lower protein and energy intake adequacy than the 24 to 41 month age group and consumption of these two macronutrients seems to make the difference in terms of the increase in stunting prevalence observed amongst children 42 to 59. This begs the question: why are children in the 24 to 41 month group consuming a higher protein and energy intake adequacy in comparison to children in the last age group? Do children in this age range out-compete children in the 42 to 59 month age group at the dinner table? Alternatively, perhaps caregivers continue to feed children the same proportions as they age from 2 to 5 years, failing to meet children's body's increasing demand for protein and energy as it develops?

We have not found any studies in western Uganda reporting a similar pattern of stunting prevalence and nutrient intake adequacy. Bridge et al. found that children in their 12 to 23 month age group were slightly deficient in caloric intake but otherwise, nutrient intake was adequate for all age groups. They reported that HAZ increased as children aged from 12 to 59 months[2]. We found that children were receiving 1.96 times their RDI for caloric intake but we recognized that our finding is questionable for reasons discussed in the *Limitations* sections. Moreover, we found that HAZ was worst in the oldest age group of children. The urban component of their sample of children may explain the discrepancies observed.

Kabahenda found that children in Gweri and Kiguma villages and surrounding areas, using a food frequency questionnaire, did not regularly consume a variety of foods[45]; however, we found that based on the month of October, children were consuming, on average, 25 different food stuffs not including beverages, oils and fats or sugar. Interpretation of our findings is difficult due to the limited, one month period over which food intake adequacy was based. October is in the middle of the rainy season and more leafy green vegetables are available for consumption during that time of year. Both duration and month of observation may explain why we found children consuming such a variety of foods in comparison to Kabahenda.

FVS is a semi-quantitative measure of nutrient intake adequacy and may be used to generate estimates of nutrient intake adequacy more quickly than traditional quantitative methods of assessing nutrient intake adequacy; however, greater standardization of the methods used to calculation FVS are called for[69]. While analyses conducted in the present study have not compared FVS to child stunting status, it appears that the high average FVS score obtained by children in Kabarole (which suggests that children are consuming a diverse diet during the rainy season month of October) agrees with the high average MAR score (which implies the adequacy of children's diets in Kabarole is high). Therefore, FVS shows promise as a less involved method of assessing nutrient intake adequacy amongst poor rural people who consume diets compose of relatively few items.

5.4 Research Question 3: Nutrient Intake Adequacy as a Determinant of Child Stunting Status

5.4.1 Univariate Analysis of Various Factors Associated with Child Stunting Status

5.4.1.1 Child Age

We found that child age in months had a significant cubic relationship with stunting status. Since the relationship between age and stunting status was found to be non-linear, we purposefully grouped children into month of age groups representing the peaks and valleys of this cubic relationship. We found that the prevalence of stunting rose from the 6 to 11 month group to the 12 to 23 month group. The prevalence then dropped in the 24 to 41 month group only to rise again in the 42 to 59 month group. Overall, we found that these age groups predicted child stunting status with borderline significance (p=0.058).

5.4.1.2 Breastfeeding Status

Stunting has been previously associated with children who are still breastfeeding in their second year of life[49,44]. We assessed the impact of breastfeeding status on stunting status by age group and did not find a significant relationship between breastfeeding status and any of the age groupings. However, the directionality of our odds ratios support the findings of the previously mentioned researchers. That is, we also found that breastfeeding between 6 and 11 months was protective against stunting but became a risk factor for stunting above 1 year of age. Vella et al. have suggested that children who are still breastfeeding above 1 year of age may be reluctant to consume complementary foods in the same quantity as children who are not breastfeeding. On the other hand, they also suggested that caregivers may think that children who are still breastfeeding do not require the same amount of complementary feeding as children who are not breastfed[32]. Either scenario may precipitate a child who is not consuming an adequate compliment of nutrients to grow.

5.4.1.3 Socioeconomic Status (SES) Indicators

We found that SES predicted stunting status (p=0.005). A 1999 study found that stunting was not higher amongst children from lower SES families[31]. The fact that our SES variable only had 3 categories where the previously mention study had 5 may explain why our study did not find the same non-linear relationship between stunting and SES.

Similar to findings from research in Mbarara, we found children from homes with a cow to be nutritionally better off. Vella et al. found that families with a cow had children with a HAZ that was, on average 0.30 greater than families that did not have a cow[32]. We confirm those results and report that children from homes without a cow were significantly more likely to be stunted than homes with a cow (p=0.035). However, we did not find that ownership of any other livestock predicted child stunting status. Despite the fact that many families owned chickens and goats, ownership of these animals did not reduce child stunting status. It appears that these livestock, which are of lower financial value than cattle, mediate their effects on children through alternate means such as through improving nutrient intake adequacy.

Like Bridge et al., we found that living in a home made of basic materials was associated with increased probability of child stunting[35]. Children from such households are more poor than children from homes made of brick walls and/or cement floors. It is likely their caregivers have fewer resources to meet children's needs, treat illness in a timely fashion and provide adequate nutrition on a consistent basis. Therefore, such children are more at risk of becoming stunted.

Crowding within the home may also be an indicator of lower SES. We found that HAZ decreased by 0.37 (0.15 to 0.90), on average, amongst children from homes with 3 or more persons per room (p=0.0086). These results support findings from Mbarara where Vella et al. found that homes with 3 or more persons per room had children that, on average, had lower HAZ[32]. However, household crowding was not found to be a determinant of child stunting status. It may be that crowding increases the exposure of a child to unhygienic conditions and pathogens; children in such environments may be more likely to be sick. The quality of care may also be lower in crowded homes: children may not be as adequately cared for in comparison to children from non-crowded homes and caregivers may not be able to respond to and seek treatment for illness in as timely a fashion as in homes that are less crowded. All these factors may work in synergy to increase the probability of an outcome of stunting in a crowded home.

Land ownership is considered an important indicator of SES and is therefore usually treated independently in regression models studying child stunting. However, we did not find it to be a significant predictor of child stunting status. The directionality of the relationship was counter-intuitive as well. We found that children from homes that owned land were actually more likely to be stunted than children from homes not owning land. However, the relationship was non-significant and no other studies support such a finding. It may be that the relationship was confounded by other factors. Moreover, it appears that the univariate relationship is confounded by other factors because in the multivariate model, significance of the relationship decreases to p=0.389.

5.4.1.4 Household Enabling Factors

Household enabling factors are a subset of socioeconomic variables that describe the attributes of a home and the people within it that modulate a caregiver's capacity to provide for her children. Access to healthcare services is one such example. We found that homes located further than 5 miles from a health unit had children that were of borderline higher likelihood of being stunted (p=0.089). It has been shown previously that children who experience prolong bouts of illness are more likely to be stunted[21]. Perhaps children who live in excess of 5 miles from healthcare services have caregivers who are less likely to seek professional healthcare services when children become ill. This prolongs the duration of children's illnesses and increases the severity of illnesses' impact on the children.

Caregiver psychological and physical well-being is known to be an important determinant of child stunting status[101]. Caregivers who reported feeling ill from any one of a wide range of illnesses on the day of the interview were 1.8 times more likely to have a child who was stunted in comparison to those reporting feeling well (p=0.038). We know that a child requires a caregiver's exclusive and attentive care in order to thrive[39,43,53]. Mothers who are not psychologically and or physically well may not have the strength to cultivate and prepare food for their children. At the same time, other needs such as adhering to vaccination programs and responding in a timely fashion to child illness may be neglected. Therefore, our results confirm previous findings that the physical integrity of the mother is an important requirement for a healthy child.

5.4.1.5 Disease Status and Adequacy of Nutrient Intake

We found that there was no significant difference between the stunting status of children who were reported by caregivers to have been sick in the previous three months and those that were not. Since it has been previously established that previous illness is a determinant of child stunting status[42,32], we are forced to question the validity of the interview question used to assess previous illness status. A caregiver was asked to report if her child had been ill with diarrhea, fever, malaria or any other ailment in the previous three months and we suspect that recall bias diminished the accuracy of the reported findings. Therefore, our results for child illness status may not be sufficient to control for child illness as a confounder of the relationship between nutrient intake adequacy and child stunting status.

We found that nutrient intake adequacy was significantly associated with child stunting status. After controlling for breastfeeding status, we found that children who had a nutrient intake adequacy of less than 6 were 5.9 times more likely to be stunted (1.2 to 29) while children with an MAR score of 6 to 7 were 2.7 times more likely to be stunted (1.1 to 6.3) in comparison to children in the 8 to 10 category (p=0.0485). Before adjusting for confounders, nutrient intake is a determinant of child stunting status in Kabarole. This makes logical sense because a child's body requires nutrition to grow and it is also supported by findings from Mubende District. Kikafunda found that children fed diets composed mainly of low nutrient dense foods were more likely to be stunted[44]. Our univariate findings support that result.

5.4.1.6 Modeling the Relationship between Nutrient Intake Adequacy and Child Stunting Status

There is a significant relationship between nutrient intake adequacy and child stunting status after adjusting for confounding factors. We constructed our model using the backward elimination procedure describe by Wamani et al. [33]: all distal determinants of child stunting status with a univariate p-value of 0.2 or less were added to the model and then all those a with p-value of greater than 0.05 were removed one at a time beginning with the least significant variable. Then, all variables, one a time, were considered for re-entry into the model and checked to see if they were confounders for any other variables in the model. To this model, the intermediate level variable, caregiver illness status, was added. It was found to be non-significant but a confounder and carried forward with all the previously included distal variables to the final stage. In the final model building stage, breastfeeding status and MAR were introduced into the model. Adjusting for the effects of confounding factors in the manner described resulted in a MAR variable that was less significant than in the multivariate regression model that only adjusted for child breastfeeding status. However, we found that children scoring a MAR of less than 6 out of 10 were 14 times more likely to be stunted in comparison to those who scored 8 or better.

5.5 Research Question 4: Predictors of Nutrient Intake Adequacy

5.5.1 Univariate Analysis of the Relationship Between Environmental Factors and Child Nutrient Intake Adequacy as well as Protein Intake Adequacy

We have made the assumption that a child's present nutrient intake adequacy is an estimate of the child's nutrient intake adequacy throughout the period through which the child has been becoming stunted or not stunted as the case may be. Our nutrient intake adequacy estimate was based on the preceding month but stunting progresses over an extended period of time. We recognize that our assumption may not be valid, which would make our interpretation of our results inaccurate. However, we found that nutrient intake adequacy was a borderline predictor of child stunting status. Since nutrient intake adequacy appears to be a predictor of child stunting status in Kabarole, we examined the predictors of nutrient intake adequacy in order to clarify its relationship with environmental factors.

5.5.1.1 Child Age

We found that child age was significantly associated with the nutrient intake adequacy score (p=0.008). However, we used children 6 to 11 months as our reference and this age group was predominantly breastfeeding. Since we did not account for the contribution of breast milk to the diet, we recognized that the nutrient intake adequacy score of the 6 to 11 month age group was underestimated and therefore, their nutrient intake adequacy score is systematically biased. Setting the 24 to 41 month group as the reference, we found that there was no difference in the nutrient intake adequacy between the 24 to 41 month group and the 42 to 59 month group; however, we did find that children of 12 to 23 months and 6 to 11 months were significantly more likely to be in the lower MAR score group in comparison to children in the 24 to 41 month group. Several other studies have reported a relationship between nutrient intake and age. Bridge found that children in the 12 to 23 month age group were consuming fewer calories that children in the older age group[35]. Furthermore, Kabahenda found that children from the 24 to 35 month age group were consuming a larger number of foods from of the "energy yielding" type while children from the 12 to 23 month group consumed a greater variety protein rich "body-building" foods. Since age group definitions are not identical, a direct comparison of our results to those referenced is not possible. But, these studies appear to support our finding that children in the 24 to 35 through 41 month age bracket have a higher adequacy of nutrient intake in comparison to the other age groups.

5.5.1.2 Socioeconomic Status (SES) Indicators

We found that few indicators of SES predicted nutrient intake adequacy. Unlike child stunting status, neither our SES variable derived from our household asset score nor cow ownership were found to predict nutrient intake adequacy. We did find that ownership of at least one chicken or goat were of borderline significance for predicting the higher nutrient intake adequacy score. Since the SES variable was not a significant predicator of child intake adequacy, it is not surprising that none of the variables used to construct that variable (couch cushion ownership, type of roof and floor, etc) were significant predictors of nutrient intake adequacy. Only bicycle ownership was a borderline predictor of nutrient intake adequacy. Despite the fact that the majority of caregivers are subsistence farmers and rely on their produce to either purchase or provide food for their children, land ownership was not associated with nutrient intake adequacy either. Nutrient intake adequacy scores are based on the month of October which is not a period of harvest. Perhaps land ownership may be a stronger predictor of nutrient intake adequacy during the months following harvest? Nonetheless, it does not appear that socioeconomic status is a predictor of nutrient intake adequacy. This suggests that some poor families are able to provide adequately for their children while other poor families are failing to thrive given similar economic resources.

5.5.1.3 Household Enabling Factors

Religious affiliation was a borderline determinant of child nutrient intake adequacy. The risk of being in the lower MAR category for children of caregivers of Christian affiliation were all around 1. Children of Muslim caregivers, however, were 6.8 times more likely to have a lower nutrient intake score. However, the confidence intervals around this estimate were quite wide because there were few observations in the Muslim category. In addition, religion was only of borderline significance as a predictor of nutrient intake adequacy ($p = 0.076$). Our results suggest that Muslims are feeding their children a less adequate diet in comparison to caregivers of Christian affiliation. However, the findings are based on a small sample size and these results have not been reported amongst any other recent nutritional status studies in Uganda.

We found that homes located beyond 5 miles from the nearest health centre were 1.2 times more likely to have a child with a low MAR score ($p=0.024$). As was previously mentioned, we also found that children further from health centres were more likely to be stunted. Perhaps children from homes located beyond 5 miles from health centres are also more likely to experience prolonged bouts of illness. Queen-Samour reference research that found that a child's resting energy expenditure increases by 13% for every degree centigrade of fever[100]. Therefore, the nutrient intake requirements increase when children are sick because their bodies require more calories to fight the illness. Depending on the nature of the illness, as is the case with diarrhea, nutrient absorption may also be impaired. Illness may also reduce a child's appetite. Children living beyond 5 miles from a health unit may be sick more frequently and unable to consume as much food as children who are not sick. Therefore, these children become nutrient deprived and become stunted.

5.5.1.4 Disease Status and Adequacy of Nutrient Intake

We found that children who were sick with any number of different illnesses were more likely to be in the lower nutrient intake category. Unlike the relationship between stunting status and illness in which none of the illnesses were associated with child stunting status (with the exception of malaria) sick children were found to be more likely to be in the lower nutrient intake category in comparison to children who were well (p=0.057). This corresponds to our findings about proximity to the nearest health unit in which children who were within 5 miles of a health unit were found to be more likely to be in the higher nutrient intake category. Therefore, it seems there is a triangle around illness, healthcare access and nutrient intake adequacy: we know that those children who have higher nutrient intake adequacy are also located closer to health units and are less likely to be sick. But, the causality of this relationship cannot be ascertained from this data.

We observed that 50% (42 to 58%) of children were adequately immunized for their age. This is an increase from the 33% reported in the baseline assessment done in Kabarole in 1999[31]. We did not find immunization adequacy status to be significantly associated with stunting status but we did find that children who were adequately immunized for their age were more likely to be in the higher nutrient intake adequacy category (p=0.027). It could be that in this sense, immunization adequacy approximates the level of nurturing a caregiver offers her child. That is, caregivers that ensure their children receive their immunizations by the correct age are also more likely to take the time to feed their children adequately.

Caregivers were asked if their children had to go hungry from time to time. Reasons for having to go hungry included the caregiver having inadequate food to prepare and/or insufficient time to prepare it. We found that 15% of children had to go hungry from time to time and having to go hungry was a borderline predicator of nutrient intake adequacy as such deprived children were 2.7 times more likely to be in the lower nutrient intake adequacy category (p=0.057). No attempt was made to control for the frequency of times in the preceding month that children had to go hungry. However, this result suggests that irregular feeding is associated with children not receiving an adequate diet. Tumwine et al. and Kikafunda et al. approximated nutrient intake adequacy by examining the number of meals children were having each day. Tumwine et al. found that 76% of children were consuming 3 meals a day in Kasese District while Kikafunda et al. found, in Mubende District, the same outcome in only 45% of children[42,44]. The fact that 15% of caregivers reported that their children go hungry from time to time does not imply they go hungry everyday. Therefore, it seems that children in Kabarole are generally consuming enough bulk to feel satiated. The notion that they are satiated suggests that children are generally consuming meals at a sufficient frequency.

5.5.1.5 The Relationship Between Stunting and MAR and Two Predictors: SES and Proximity to Healthcare

It does not appear that SES mediates its effects on child stunting through nutrient intake adequacy. While SES was found to be a predictor of child stunting status, it did not predict nutrient intake adequacy. Therefore, children from families of lower SES may be able to eat as adequately as those children who come from families of higher SES. A baseline study conducted in Kabarole in 1999[31] did not find an association between SES and stunting status. Given that nutrient intake adequacy is a predicator of child stunting status, perhaps children from homes of lower SES are able to consume diets of comparable adequacy to children of higher SES homes because access to nutritious foods is not dictated by financial resources. For example, a variety of nutritious leafy green vegetables grow in Kabarole during the rainy season that are a good source of protein[68]; perhaps nutrient intake adequacy varies with the utilization of these plants, which readily grow and are free. Perhaps it is knowledge of these nutritious foods and not financial resources that dictates whether or not a caregiver prepares them and feeds them to her child.

A comparison of the association between stunting status and cow ownership to that between nutrient intake adequacy and goat/chicken ownership reinforces the idea that SES is not mediating its effect on stunting through nutrient intake. Cow ownership, while associated with stunting status, was not associated with nutrient intake adequacy. If a cow's milk or meat was the means through which it reduced stunting, one would think that it would significantly predict child nutrient intake adequacy. On the contrary, it seems that cow ownership is only an indictor of the broader influence of SES. On the other hand, goats and chickens are of lesser value and did not predict stunting status but did predict nutrient intake adequacy.

It seems that a home's proximity to the nearest health unit may be mediating its effect, at least in part, on child stunting through nutrient intake adequacy. As was discussed previously, perhaps children who are ill and live a greater distance from healthcare services are not able to get treatment in as timely a fashion as children who live closer. Given that various illnesses are known to reduce the desire or capability to eat, perhaps prolong illness as a result of not seeking treatment in a timely fashion, is causing stunting. Sick children neither desire nor are able to consume food in the same magnitude as children that are well. Meanwhile, the basal metabolic requirements for energy increase as their body mounts a response to the infection[100]. Thus, we have a synergy occurring between illness and food intake which may precipitate stunted status.

5.5.1.6 Univariate Analysis of the Predictors of Protein Intake

First, we found that children in the 42 to 59 month age group were consuming significantly less protein than children in the 24 to 41 month group. We also found that protein intake was of borderline significance as a predictor of child stunting status after being adjusted for confounding factors. Therefore, it seems that increasing the adequacy of protein intake amongst children of 42 to 59 months of age may address the discrepancy in stunting status observed between those children and children in the 24 to 41 month group. Second, we found that SES significantly predicted protein intake adequacy. Children in the top 20% of our SES index variable were more likely to have children with greater protein intake adequacy, on average, in comparison to children from homes in the lowest 40% of households. However, there was no significant protein intake difference between children from families in the bottom 40% and the middle 40%. Therefore, it seems that only children from the most wealthy families consume more protein than other children. Therefore, for the most part, SES does not predict protein intake.

5.6 Dissecting the Underwhelming Response to Uganda's Chronic Malnutrition

Regardless of how the prevalence of stunting correlates with age or any other factor, our research supports the overwhelming body of evidence suggesting that chronic malnutrition is persisting in Kabarole District. Based on references from the WHO's Gortein at al., it is clear that the prevalence of stunting in Kabarole District is "very high"[4]. Yet, this condition has persisted unabated since at least 1988, from when we can first reference national anthropometric data[90]. Why has there been such an underwhelming response to chronic malnutrition despite clear evidence of its persisting presence?

Our literature review suggests that Kabarole may be home to many factors which predispose children to higher risks of experiencing persistent disease episodes and inadequate nutrition intake, which culminate in chronic malnutrition. Perhaps chronic malnutrition is not being adequately addressed because the balance of its causes do not fall specifically in the mandate of any one authoritative body? Considering just nutrient intake adequacy, perhaps neither the Ministry of Agriculture nor the Ministry of Health are embracing responsibility for ensuring children are getting adequate nutrition because of poor communication regarding to whom such responsibility belongs? Nutrient intake adequacy requires specific government attention.

Kabarole's Distrist Agricultural Officer told us in a personal communication that "Generally not much is done on nutrition in Uganda."[121] A meeting with the Agricultural Officer/Gender Coordinator of Crop Production and Marketing at the Ugandan Ministry of Agriculture, Animal Industry and Fisheries, shed light on the strong nutrition policies Uganda once employed. From the 1960's through to 1987, the Ministry of Agriculture had a Department of Home Economics that focused on child nutrition. When government restructuring occurred in the ministry of Agriculture, however, reductions in funding resulted in nutrition programs no longer receiving adequate resources. Also, issues of decentralization caused a decline in the quantity and quality of nutritional programs delivered at the district level. In our interview, we were told that the government used to have direct links at the district level but these have since been lost due to decentralization. For example, there used to be home economics officers at the sub-county level. We understand that there is still an extension link at the district level but these positions are predominately male and the value of female agricultural economics staff has been undermined and many of the female staff have been let go[122].

Lack of education and passing on of knowledge has resulted in a loss of knowledge concerning good food preparation and consumption practices. We were told that there is now an intergenerational gap. That is, children born from the 1960's onward have not received the same home economics knowledge regarding food preservation and preparation as the previous generation; they were not equipped to know how to preserve food for times when foods are less plentiful as the older generation was. For example, mothers used to boil and dry leafy vegetables but these practice are rarely exploited presently. Such practice were taught through home economics classes in schools but Idi Amin dropped them from the curriculum. Now, there is a 25 year gap in nutritional knowledge[122].

Kabarole's District Agricultural Officer told us that there is no official policy on nutrition and nutritional education in Uganda. From that discussion, we understand that a nutrition bill was introduced in 1967 but was tabled due to political upset. It was revived in 1998 but had not yet made it to parliament for debate. In his opinion, malnutrition persists because there is confusion over who should take responsibility for nutrition[121].

The Ministry of Agriculture's Coordinator provided slightly different information. She informed us that there is currently a food and nutritional policy that passed in 2003 but that a food security and nutrition bill is still pending approval. She has found such delays unacceptable and believes that the government needs to stop giving lip service to nutrition programs and actually fund good nutritional programs and extension staff. For example, she offered that Uganda used to have good programs at Kyamobogo University where a home economics program coincided with teacher education. Some teachers would go on into schools and learn how to prepare institutional meals. Colleges also provided important education on nutrition programs. Bukonison, Aripi Agricultural College, and Cerebe were all under the Ministry of Nutrition. These colleges would provide society with trained catering people. The Ministry of Agriculture's Coordinator stated years of lost graduates from these institutions has resulted in many academic institutions, such as boarding schools, no longer providing balanced menus to their students[122].

Kabarole's District Agricultural Officer discussed the relationship between primary healthcare and nutrition. He stated that policies have mainly focused on hunger and famine but policy based on nutrition for health, such as getting enough vitamins, has not been emphasized. He said:

> It is a problem to only seek to resolve malnutrition at the clinics. Nutrition programs need to focus on prevention and maintenance of good health through healthy eating. Not through giving out vitamins to children who are deficient. Those vitamins could easily be obtained from nutritious foods if all children would eat them. Giving out multivitamins at clinics to only those who are sick enough to present is a band aid solution that only addresses the tip of the iceberg.

According to the District Agricultural Officer, it is not acceptable to look at only the clinical aspects of malnutrition. While primary care is best suited to respond to Protein-Energy Malnutrition (PEM), the Ministry of Agriculture is well poised to encourage the preventative aspects of nutrition by fostering adequate nutrient intake through education at various levels. However, at present, he does not feel either ministry is adequately addressing nutrient intake adequacy. "Caregivers receive a little nutritional training at antenatal clinics but overall, nutritional education by the health sector and agricultural sectors is weak." Both of these government officials recognized that chronic malnutrition is a large problem in Uganda and government policies need to move forward to address it in terms of prevention and treatment.

5.7 Conclusions

The prevalence of malnutrition in Kabarole is high and reflects a chronic under-fulfillment of children's nutritional needs. The prevalence of wasting is low, which suggests that there have been no recent upsets to the food supply or environmental factors. The steady, high prevalence of stunting observed in both previous studies and the present study suggest that children are suffering due to prolonged societal conditions that are inhibiting their growth. Our results suggest that at the household level, family SES is a predictor of child nutritional status. However, while wealth does explain a portion of the variance in stunting status, child nutrient intake adequacy also explains a portion of the variance in stunting status and it was not predicted by indicators of SES. Thus, a reduction in the prevalence of stunting may be realized without directly targeting family SES.

We have found that the discrepancy between child stunting status observed between the 24 to 41 month age group and the 42 to 59 month group may be due, in part, to a discrepancy in protein intake adequacy between the two groups. Children in the 42 to 59 month group require more protein than they did at a younger age and we theorize that caregivers are failing to increase protein intake sufficiently enough to meet the children's increasing physiological demands. We found that the age related pattern of protein is mainly independent of SES; that is, the relationship between age group and protein is largely independent of the family's ability to buy expensive protein sources such as various meats to nourish their children.

In the literature review, we discussed the contribution local edible food plants are making to the diets of subsistence farming peoples around the world. At the outset of the study, it had been our ambition to "compare a child's nutritional status to the amount of nutrients being consumed from local edible food plants and therefore, bring local edible food plants research [working from Goode's tremendous 1989 inventory[68]] into the realm of public health." (page 25) However, it is quite clear that our analysis has not focused on the contribution of specific local edible food plants in the slightest. Despite preliminary efforts to assess the correlation between local edible plants and child nutritional status (whose results are not presented here), we found it was imperative to first describe the adequacy of nutrient intake based on a holistic assessment of the home food system, prior to looking specifically at the nutrients contributed from local edible plants. Such an assessment may calculate a MAR score based only on the nutrients contributed by local edible food plants. The present dataset may be used to conduct such an analysis in the future and we feel that results from such a process will be more descriptive now that the data presented in the present study is available as a point of comparison.

Environmental factors not adequately addressed in the present study may also be causing children of 41 to 59 months to be more susceptible to stunting. For example, at the age of 3.5 years of age, children may be more mobile and at higher risk of exposure to pathogens, which may cause them to become sick. However, our child illness data does not show a strong positive relationship between illness and child stunting status. Future studies wishing to control for the impact of previous illness on child nutritional status must take steps to address the recall bias associated with asking caregivers to report previous child illness. Otherwise, such results may prove unreliable.

We found that child caregivers, who were mainly the children's biological mothers, carried the majority of the responsibility for looking out for the well-being of the children. For most children, it was their mother's labour that produced and prepared the food. It is of no surprise that previous research has emphasized the importance of caregiver psychological and physical well-being for the health of the child. Mothers who are not psychologically and or physically well may not have the strength to cultivate and prepare food for their children. At the same time, other needs such as adhering to vaccination programs and responding in a timely fashion to child illness may be neglected. Therefore, our results confirm previous findings that the physical integrity of the mother is an important requirement for a healthy child. The local, district and national administrations must make mother's needs a priority and assist them as is necessary if Kabarole is going to have thriving next generation to build a stronger economy.

For example, we found that homes located beyond 5 miles from the nearest health centre were 1.2 times more likely to have a child with a low MAR score. We also found that children further from health centres were more likely to be stunted. Likely, children from homes located beyond 5 miles from health centres are also more likely to experience prolonged bouts of illness. The more sick a child becomes, the less he can eat and the more his body requires nutrition to fight the disease process. As it stands, children living beyond 5 miles from a health unit may be sick more frequently and unable to consume as much food as children who are not sick. Therefore, these children become nutrient deprived and become stunted. To break this cycle, caregivers require assistance from the community to get their children to medical help. Caregivers require financial support to use local transportation to get to medical help and they need to be taught when it is necessary to seek medical help. This sort of support from society may help address the high rates of stunting observed in the district.

5.8 Recommendations

5.8.1 Research

Since SES is not significantly related with protein intake for the poorest 80% of households, it would be prudent to further analyze the present data to elucidate what protein rich foods are enabling some impoverished families to more adequately provide protein for children while others falter.

The majority of caregivers in Kabarole are subsistence farmers and it is probable that nutrient intake adequacy varies with subsistence farming productivity. In the present analysis, we looked at the relationship between whether or not the family owned land and nutrient intake adequacy. In order to improve nutrient intake adequacy, it would be informative to further analysis data in the present dataset, which includes additional information to characterize family subsistence farming practice, in order to determine what subsistence farming variables predict nutrient intake adequacy.

It would also be informative to study the relationship between nutrient intake adequacy and child stunting status throughout the other months of the year. The dataset used to draw the present conclusions contains such data. An analysis of intake adequacy data from months during the dry season may offer support to the current findings, which are based on the rainy season month of October.

Accurate food nutrient composition data is a necessity for programs monitoring the nutrient intake adequacy of children in Kabarole. We recommend that a comprehensive database of food nutrient composition be developed for western Uganda based on traditional preparation practices. Such a database would improve the accuracy of future nutrient intake adequacy studies.

5.8.2 Practice

Our work offers support to an overwhelming body of evidence, which suggests that the prevalence of stunting is very high in Kabarole District. The consequences of stunting are serious: woman who are stunted are more prone to adverse pregnancy outcomes and stunted children have decreased arithmetic, reading, vocabulary and information processing abilities. Furthermore, many of the employment opportunities available in Kabarole District involve manual labour: stunted children become adults whose physical work capacity and therefore, earning potential, is less than children who are not stunted. Stunting is also an indicator of social deprivation and approximates more severe forms of malnutrition such as marasmus, which may not be as prevalent. Our findings call on government officials to respond to the very high prevalence of endemic stunting present in Kabarole District and western Uganda. The Ministry of Agriculture and the Ministry of Health must work together to address the determinants of stunting by supporting community based preventive measures such as nutritional education programs and programs which locate stunted children and offer direct treatment and counseling. Uganda has a political commitment to modernizing agriculture and developing a stronger economy but to do so, it will need to capitalize on the intellectual and physical creativity and strength of its children and youth. Therefore, mitigating the high rates of stunting must be a government priority.

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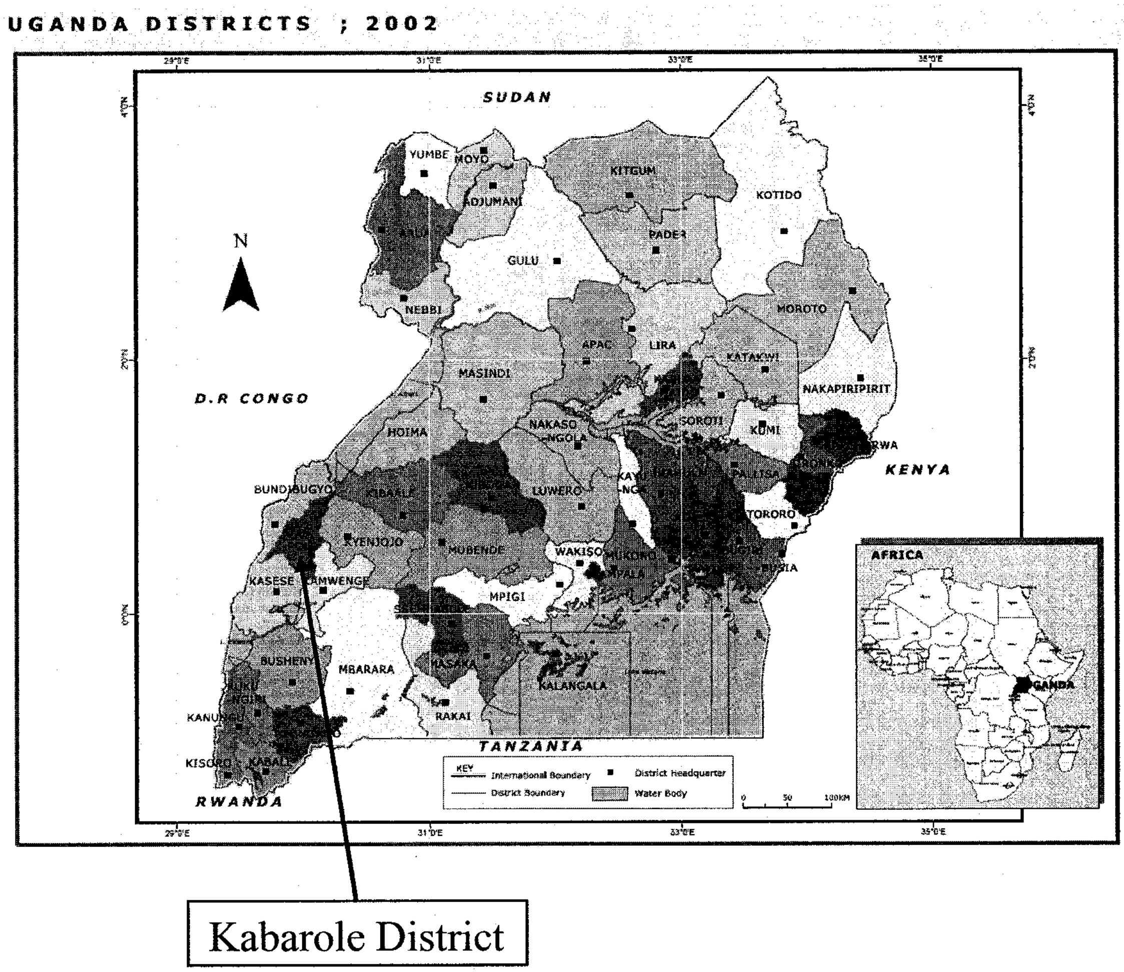
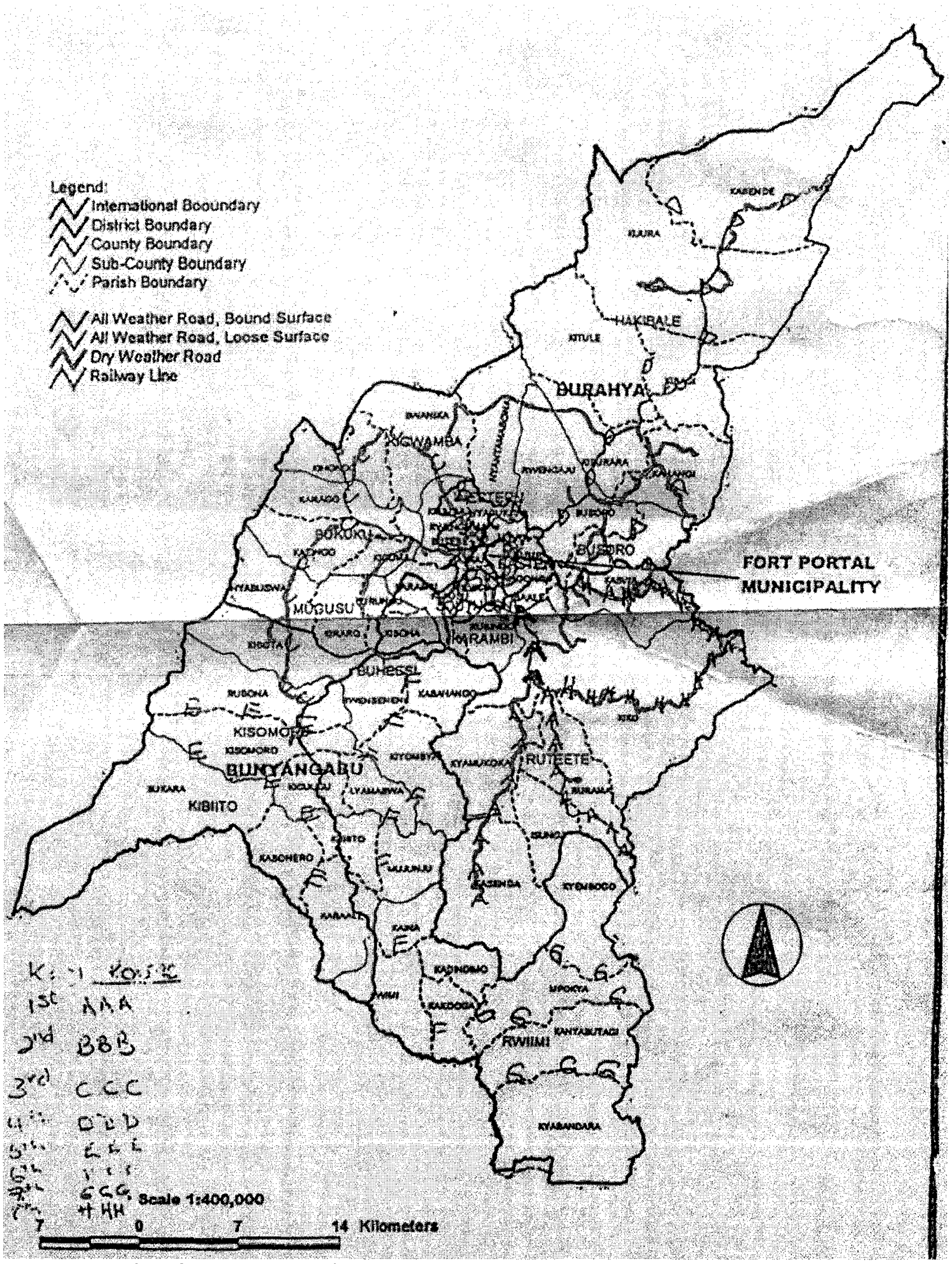
Appendices

Appendix 1: District Map of Uganda, East Africa



Source: Uganda Bureau of Statistics. 2002 Uganda Population and Housing Census. 2005 March.

Appendix 2: Sub-county Map of Kabarole, Western Uganda



Source: National Biomass Study, Forest Department, P.O. Box 1613, Kia.

Appendix 3: *What Is The Best Scale To Use To Establish Cut-Offs?*

A child is classified as malnourished when his/her height or weight is shown to fall below arbitrary cut-offs based on the universal growth reference of choice[f]. The *Z-score,* for the purpose of the present study, is the most appropriate of the three available scales used to compare a study population or individual to the reference population. One may compare the Weight-for-height (WHZ), the Height-for-age (HAZ) or the Weight-for-age (WAZ) z-score of a population or individual with the universal reference median using a *Percentile*, a *Percentage-of-Median* or a *Z-score.*

First, the heights and weights of children in a population of a given age are normally distributed; this is advantageous from a statistical point of view because it permits the use of tests that assume normality such as regression and the t-test. Now, the *Percentile* is based on normalized curves and is easy to interpret but the percentiles are usually not normally distributed; therefore, they cannot not be described in terms of means and standard deviations. This makes them less useful for describing the extremes of distribution. The anthropometric data of many individuals in Kabarole is at the extremes of the distribution; therefore, Percentiles are not very useful.

The *Percentage-of-Median* can be useful if the distribution around the median value is unknown or if the reference population distribution has not been normalized; however, the interpretation of an arbitrary fixed cut-off value for low anthropometry expressed as a *Percent-of-Median* differs according to the index (in our case, age group).

The *Z-score* is based on normalized curves. In the reference population, the percentage of children outside 2 standard deviations (in other words, with a z-score less than -2) is 2.3%. This can be compared with the prevalence of anthropometric values below this cut-off in the study population. There are several advantages to using z-scores beginning with the fact that a consistent cut-off is used for all the age groups in the study population. Secondly, it also permits the examination of extreme anthropometric values. Thirdly, the number of observations below the cut-off may be converted to a percentage in order to report the prevalence of stunted children in a population[4]. Finally, in studying the relationship between HAZ and environmental factors (such as hygiene practices or recent illness) of interest, z-scores may be used as a continuous variable[6]. Thus, z-scores are the most feasible scale for assessment. A child with WHZ, HAZ or WAZ below -2 is considered wasted, stunted or underweight, respectively.

[f] There are two universal growth reference that might be used in a study: the 1978 NCHS/WHO and the 2006 WHO.

Appendix 4: National, Regional and Local Child Stunting and Height-for-age Z-score Data

Table 24: Stunting Prevalence in Preschool Age Children-Nation Wide, Rural Nation Wide, Western Region and Available District Data From 1988 to 2002

Prev. < -2	Prev. < -3	0-5 months	6-11 months	12-23 months	24-35 months	36-47 months	48-59 months	Location	Date	Ref.
44.4 %	19.0 %	9.9%	30.1%	52.9%	52.2%	50.1%	52.6%	Nation Wide	1988-89, Sept. to Feb.	90
46.3 %	19.9 %	-	-	-	-	-	-	Rural Nation Wide	1988-98, Sept. to Feb.	90
46.5 %	16.7 %	-	-	-	-	-	-	Western Region	1988-1989, Sept. to Feb.	90
53.7 %	25.8 %	-	-	-	-	-	-	South-western Region	1988-89, Sept. to Feb.	[illegible]
32.5 %	-	10%	23.9%	38.1%	32.6%	38%	36.8%	Mbarara District	1988, April/May	[illegible]
38.3 %	15%	6.8%	26.5%	45.5%	45%	49.8%	-	Nation wide	1995, March – Aug.	46
40.3 %	15.9 %							Rural Nation Wide	1995, March – Aug.	90
42.8 %	17.4 %	-	-	-	-	-	-	Western Region	1995, March – Aug.	90
49.8 %	21.9 %	-	32%	52.2%	44.6%	49.5%	64.4%	Kasese District	1998, Sept.	[illegible]
23.8 %	6.9%	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Mubende District	Before [illegible]	[illegible]
39.1 %	15.3 %	7.7%	26.3%	46.4%	41.4%	44.8%	44.9%	Nation Wide	2000-01, Sept.-March	90
40.4 %	16.2 %	-	-	-	-	-	-	Rural Nation Wide	2000-01, Sept.-March	90
48%	21%	-	-	-	-	-	-	Western Region	2000-01, Sept.-March	90
24.6 %	[illegible]	11.6%	18.6%	34.5%	[illegible]	[illegible]	[illegible]	Hoima District	200[illegible], Sept.	[illegible]

Table 25: The Mean HAZ from Fort Portal Town and Surrounding Area Collected in 2003 Amongst Children 12 to 59 Months of Age

Prevalence < -2	Prevalence < -3	12-23 months	24-35 months	36-47 months	48-59 months	Location	Date	Ref.
55.1%	24.4%	-2.4 z-score	-2.17 z-score	-2.29 z-score	-1.96 z-score	Fort Portal Town and surrounding area	Sept-Nov 2003	35

Table 26: The Prevalence of Stunting In Gweri and Kiguma Villages, Kabarole District Amongst Children 6 to 47 Months of Age

Prevalence < -2	Prevalence < -3	6-11 months	12-23 months	24-35 months	36-47 months	Location	Collection Date	Ref.
18.4%	6.0%	25.6%	28.1%	11.6%	8.3%	Gweri and Kiguma villages	Not stated	45

Appendix 5: *Comparison of Nation Wide and Western Region Stunting Prevalence amongst Preschool Age Children From 1988 to 2002*

Study group (months)	Prev. < -2	Location	Sample Size	Collection Date	Author(s)
0-60	44.4 %	Nation Wide	3743	Sept. to Feb., 1988-89	[90]
0-60	46.5 %	Western Region	237	Sept. to Feb., 1988-1989	[90]
0-60	53.7 %	South-western Region	1203	Sept. to Feb., 1988-89	[90]
0-48	38.3 %	Nation wide	4775	March – Aug., 1995	[46]
0-48	42.8 %	Western Region	1354	March – Aug. 1995	[90]
0-60	39.1 %	Nation Wide	6074	Sept.-March, 2000-01	[90]
0-60	48%	Western Region	1534	Sept.-March, 2000-01	[90]

Appendix 6: *Comparison of Nation Wide and Rurally Located Nation Wide Stunting Prevalence amongst Preschool Age Children From 1988 to 2002*

Study group (months)	Prev. < -2	Location	Sample Size	Collection Date	Author(s)
0-60	44.4 %	Nation Wide	3743	Sept. to Feb., 1988-89	[90]
0-60	46.3 %	Rural Nation Wide	3408	Sept. to Feb., 1988-98	[90]
0-48	38.3 %	Nation wide	4775	March – Aug., 1995	[46]
0-48	40.3 %	Rural Nation Wide	4239	March – Aug., 1995	[90]
0-60	39.1 %	Nation Wide	6074	Sept.- March, 2000-01	[90]
0-60	40.4 %	Rural Nation Wide	5509	Sept.- March, 2000-01	[90]

Appendix 7: Structured Research Questionnaire

Introductory Child Data:

1) Introductory Data on Children under 5 years in home:

ID#'s	Names of children under 5 years:	Sex:	Date of Birth:	Verification? (ex. Vacs record)
1				
2				
3				
4				

2) Please describe the layout and size of your gardens:

Area Under Cultivation:	Crops being grown in this area:	Which are purchased seeds?	How long does it take to walk to your garden?	Do you own this land? (Y/N)

Itemized Fruits and Vegetables List:

Cantaloupe		Ekifenensi		Mandarin oranges		Ebikeke	
Amakerre		Emiterme		Matooke		Ebisunsa	
Amatehe		Emiyembe		Mistaferi		Ebosokoro	
Obtunguru		Emyongo		Mushrooms		Vocado	
Amoozi		Enderema		Mutere		Watermelon	
Bamia		Enjagi		Nakasugga		Swiss chard	
Beets		Enkomanyangwa		Nakati		Lemons or limes	
Biringanyi		Ensaali		Nakati mmme y'akyalo		Lentils	
Black berries		Enswiga		Nyabutongo		Lumare	
Bogoya		Entutu		Obuhoro		Tomatoes	
Broccoli		Enyamusiri		Obujabara		Sombe	
Brussels sprouts		Eteke		Obusukaali		Squash	
Cabbage, red and green		Eyobyo		Omubwiga		Squash, white	
Carrots		Fruit juice, canned		Omukondwa		Strawberries	
Cauliflower		Fruit juice, fresh		Omuyonza		Sugar Cane	
Celery		Garlic		Omweronde			
Collard greens		Ginger		Oranges			
Cucumber		Green onions		Passion fruits			
Dates		Green peppers (STATE TYPE)		Paw paws			
Desert fruit		Amapeera		Pineapples			
Doodo		Kamulali		Obutere			
Ebidodoima		Leeks		Radish			

3) Protective Foods Intake:				
Fruit/Vegetable	Cultivated, Gathered or Purchased?	Months during which food item consumed:	Portion consumed by family:	Consumption/child/day
				1 - This has been the consumption rate over last: Week Month Year
Preparation:				
				1 - This has been the consumption rate over last: Week Month Year
Preparation:				
				1 - This has been the consumption rate over last: Week Month Year
Preparation:				
				1 - This has been the consumption rate over last: Week Month Year
Preparation:				
				1 - This has been the consumption rate over last: Week Month Year
Preparation:				
				1 - This has been the consumption rate over last: Week Month Year
Preparation:				

6) **Child Health Information:**

ID#'s	Age of Weaning*	First Foods introduced?	Does child sleep under a bednet? Y/N	Vacs? Are the Child's Vacs complete to date?	Child Sickness in last 3 months?	Did you seek med help? Y/N**	Has child been tested for HIV? HIV positive?	Height (cm) / Weight (kg)
1				**BCG (birth) ▮** **Polio 0 ▮** Polio 1 (6 weeks) ▯ DPT-HebB+Hib 1 ▯ **Polio 2 (10 weeks) ▮** **DPT-HebB+Hib 2 ▮** Polio 3 (14 weeks) ▯ DPT-HebB+Hib 3 ▯ **Measles (9 months) ▮**	Diarrhea ▯ Cough ▯ Malaria ▯ Skin rash ▯ other:			H: W: K▯
2				**BCG (birth) ▮** **Polio 0 ▮** Polio 1 (6 weeks) ▯ DPT-HebB+Hib 1 ▯ **Polio 2 (10 weeks) ▮** **DPT-HebB+Hib 2 ▮** Polio 3 (14 weeks) ▯ DPT-HebB+Hib 3 ▯ Measles (9 months) ▯	Diarrhea ▯ Cough ▯ Malaria ▯ Skin rash ▯ other:			H: W: K▯
3				**BCG (birth) ▮** **Polio 0 ▮** Polio 1 (6 weeks) ▯ DPT-HebB+Hib 1 ▯ **Polio 2 (10 weeks) ▮** **DPT-HebB+Hib 2 ▮** Polio 3 (14 weeks) ▯ DPT-HebB+Hib 3 ▯ Measles (9 months) ▯	Diarrhea ▯ Cough ▯ Malaria ▯ Skin rash ▯ other:			H: W: K▯

***Put a 'B' if currently still breastfed;**
****If no, why not?**

5) Do your children have enough to eat to be satisfied after every meal? ▯ yes ▯ no
6) Do your children ever go hungry? ▯ yes ▯ no
If yes, how often and during what time of the year specifically?

____
____
____
____

Distal Child Health Indicators:

7) How far away is your nearest health unit (in miles)? ________________
8) Where does your water come from?

____
9) How long does it take to bring water to your home from your water source (minutes)?

____
10) Does your home have a latrine? ▯ yes ▯ no
11) Do your children use soap daily when bathing? ▯ yes ▯ no

12) Energy Food Information:

Food Item	Cultivated or Purchased or not consumed?	Months during which food item consumed:	Amount Harvested:	Consumption/child/day
Irish potatoes				**1 –** **2 –** **3 –**
Maize				**1 –** **2 –** **3 –**
Millet				**1 –** **2 –** **3 –**
Red Skinned Sweet Potatoes				**1 –** **2 –** **3 –**
Rice				**1 –** **2 –** **3 –**
Sorghum				**1 –** **2 –** **3 –**
Sweet potatoes				**1 –** **2 –** **3 –**
Yam				**1 –** **2 –** **3 –**
Wheat (Bread, cakes, muffins, Chapati, Tea Biscuits)				**1 –** **2 –** **3 –**
Butter or magarine				**1 –** **2 –** **3 –**
Cooking spread (*Cowboy*)				**1 –** **2 –** **3 –**
Lard (*Kimbo* etc)				**1 –** **2 –** **3 –**
Blue Bird				**1 –** **2 –** **3 –**
USA Vegetable Oil				**1 –** **2 –** **3 –**
Cassava				**1 –** **2 –** **3 –**

13) Protein Food Information:

Food Item	Cultivated or Purchased or not consumed?	Months during which food item consumed:	Amount Harvested:	**Consumption/child/day**
Chick Peas				**1** – **2** – **3** –
Ebhimba (French Beans, Phaseolus vulgaris)				**1** – **2** – **3** –
Ebisobooza (French Beans, Phaseolus vulgaris)				**1** – **2** – **3** –
Soy beans				**1** – **2** – **3** –
Entendigwa (Tree beans)				**1** – **2** – **3** –
Obuhindihindi (Lima Beans)				**1** – **2** – **3** –
Omugobe (Cowpeas, vigna unguiculata)				**1** – **2** – **3** –
Beef				**1** – **2** – **3** –
Chicken				**1** – **2** – **3** –
Duck				**1** – **2** – **3** –
Eggs				**1** – **2** – **3** –
Fish				**1** – **2** – **3** –
Game				**1** – **2** – **3** –
Goat				**1** – **2** – **3** –
Pork				**1** – **2** – **3** –
Rabbit				**1** – **2** – **3** –
Turkey				**1** – **2** – **3** –
Ensenene (grasshoppers)				**1** – **2** –

Food Item	Cultivated or Purchased or not consumed?	Months during which food item consumed:	Amount Harvested:	Consumption/child/day
Milk				1 – 2 – 3 –
Ground Nuts				1 – 2 – 3 –
Palm Nuts				1 – 2 – 3 –
Sim Sim				1 – 2 – 3 –

Socioeconomic Indicators

14) What do you and your children sleep upon? ____________________________________

15) How many children in the home attend primary school? __________

16) How many children in the home attend secondary school? ________

17) How many children in the home attend post secondary school? ________

18) How much do you spend per year on school related expenses (fees, uniforms, books, supplies, etc.)? __________

19) Socioeconomic Status Indicators:				
Number of building on compound:	Number of rooms in dwelling:	Roof construction:	Wall construction:	Floor construction:

20) What is the annual income of each adult in home?						
Relation to Children:						
Activity / Annual Income						

21) Does your home have a bicycle? □ yes □ no

22) Does your home have a radio? □ yes □ no

23) Does your home have a television? □ yes □ no

24) What kind of fuel do you use for cooking? □ firewood □ gas □ charcoal □ paraffin

25) other: ____

26) What do you use for lighting? ____________________________________

27) Do you own a phone – mobile or land? □ yes □ no

28) Do you have an improved stove? □ yes □ no

29) Please state how many cows, chickens, pigs, goats and any other live stock you have:

Caregiver Info

30) Age of caregiver: ____________________
31) Sex of caregiver: ▯ male ▯ female
32) Number of children caregiver has given birth to: ____________________________
33) At what age did you have your first pregnancy? ____________________
34) What is your religion? ________________________
35) Tribal Group: ▯ Batooro (Rutooro) ▯ Bakiga (Rukiga) ▯ Bakonjo (Lukonjo) ▯ Bamba (Luamba) ▯ Banyankole (Runyankole) (▯ Banyarwanda (Nyarwanda) ▯ Baganda ▯ Nubians (Nubi) ▯ Bahiima (Runyankole)
36) Languages spokens: ▯ Rutooro ▯ English ▯ other: ____________________________________
37) Currently Ill: ▯ yes ▯ no; if yes, with what? ▯ disability ▯ malaria ▯ epilepsy ▯ filarial ▯ measles ▯ Tuberculosis ▯ HIV/AIDS
38) Marital Status: ▯ Single ▯ Married ▯ Divorced ▯ Separated ▯ Widowed
39) Caregiver's highest level of education achieved: _____________
40) Can you: ▯ read ▯ write
41) Caregivers occupation: ____
42) Relation to Child Under 5: ▯ Parent ▯ Sibling ▯ Aunt, Uncle, Grandparent ▯ No relation
43) Please briefly explain your daily activities and the time spent on each:
____
____
____
____
44) How many people live in your home? _____________________
45) Father's Occupation: ____
46) Father's highest level of education achieved: ______________
47) Have anyone in the home been for HIV testing (VCT)? ______________

Relationship to Children:	Age:	Sex:	Date of Diagnosis:	On ARVs? (Y or N)

Garden Info

48) Do your own the land you farm on? ☐ yes ☐ no; if no, describe arrangement for using land:

____

____

49) Do you try to maximize tuber crops in an effort to demonstrate claim on land year round When sacrificing growing crops like millet and maize? ☐ yes ☐ no

50) Do you have a problem with people stealing food out of your garden or storage? ☐ yes ☐ no

51) Is the garden disturbed by pests (ex. Monkeys, wild pigs, etc.) or people walking through it? ☐ yes ☐ no

52) Are there any seeds you would like to have but you cannot afford to purchase? ☐ yes ☐ no; If yes, what?

____

____

____

53) Describe your storage practices for your fruits and vegetables.

____

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____

____

54) Is what you are growing now different from what you were growing one year ago? ☐ yes ☐ no; If yes, what was grown one year ago? _______________

55) Two years ago? _______________

56) Three years ago? _______________

57) Do you apply any sort of organic or synthetic fertilizer? ☐ yes ☐ no; If yes, what?

____

____

____

58) Do you apply any sort of organic or synthetic pesticides, herbicides or insecticides (ex. sulfur, copper, marigolds have chemicals that may kill root cysts)? ☐ yes ☐ no; If yes, what?

____

____

59) Are the crops irrigated? ☐ yes ☐ no; If yes, how?

____

60) What ratio best describes the female to male labour input into subsistence farming activities? ☐ 50/50 ☐ 60/40 ☐ 70/30 ☐ 80/20 ☐ 90/10 ☐ 100% done by female

61) Do you have foods associated only with certain celebrations/events? ☐ yes ☐ no

____

DAX'S COMMENTS ON INTERVIEW:

Husband present during interview? ☐ yes ☐ no

How close is home to main road? ☐ Foot Path far from road ☐ path wide enough for car ☐ Path wide enough for two cars

Are there couch cushions? ☐ yes ☐ no

What other home issues may be contributing to poor nutritional status of child?

____

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Appendix 8: *Units of Measurement Reported by Caregivers to Describe Child Food Intake*

Unit of Measurement	Food example(s)	Volume (mL)	Measurement Classification
Big Size, Whole Food	A couple of foods		Relative Size
Bite Size of Meat	All meats		Relative Size
Cup, Nice	Milk	400	Commonly used vessel
Cup, Tumpeco	Milk	500	Commonly used vessel
Inner Fruit	Jack Fruit		Relative Size
Large Bowl	Cooked Enjagi, matooke	620	Research Tool
Little Size, Whole Food	A couple of foods		Relative Size
Medium Size, Whole Food	Many foods		Relative Size
Segment	Sugar Cane		Common Size
Small Bowl	Prepared Cassava, Green Pepper	260	Research Tool
Tablespoon	Prepared Biringanya, Doodo	20*	Research Tool

*The standard volume of a tablespoon is 15 mL but this differs from the way it was used in Kabarole

Appendix 9: *Information on Scales Used to Weigh Food Stuffs*

Max Load	Name	Type	Model	Country
100 kg x 1 kg	Pocket Balance	Spring		
25 kg x 100 g	Salter Spring Scale	Spring	235 6S	England
2 kg x 10 g	Avery	Spring	1107 4B	Birmingham, England
200 g	Mettle	Electronic	PC 180	

Appendix 10: *Weights used to convert quantitative food frequency data to food intake weights for each food in the inventory*

Primary Name	Food Preparation Method	Unit of Measurement	Weight (g)	Scale Used	Notes (Assumptions are explained in Appendix 11)
AMAKERRE	Fresh	Tablespoon(s)	20	Estimated.	Assumption #2
AMAKERRE	Fresh	Small Bowl(s)	159.8	Mettler	Raspberries purchased and weighed in Canada were substituted.
AMAKERRE	Fresh	Medium Size, Whole Food(s)	5.3	Estimated.	The weight of a small bowl of berries was divided by the total number of berries in the bowl.
Amatehe	Fresh	Medium Size, Whole Food(s)	0		
Amoozi	Boiled	Medium Size, Whole Food(s)	3440	2	Actually weighed 1/4 of Medium Size Whole amoozi multiplied by 4.
Amoozi	Boiled	Tablespoon(s)	0	Estimated.	2,3
Amoozi	Boiled	Little Size, Whole Food(s)	1720	Estimated.	Assumption #1
Amoozi	Boiled	Small Bowl(s)	688	Estimated.	Estimated based on the primary investigators assumption that a small bowl can hold 1/5 of a medium size whole amoozi.
Ants	Fried	Small Bowl(s)	0		
BAMIA	Boiled	Tablespoon(s)	0		
BAMIA	Boiled	Medium Size, Whole Food(s)	0		
Banana Juice	Fresh	Nice Cup(s)	400		Volume in mililitres.
Banana Juice	Fresh	Cup(s), Tumpeco	500		Volume in mililitres.
Beef	Cooked	Bite Size(s) of Meat	12.5	Estimated.	Estimated based on the weight of a bite size of cooked pork.
Beef	Cooked	Small Bowl(s)	160	Estimated.	Estimated based on the weight of a small bowl of goat meat.
Biringanya	Fresh	Heap(s)	595	2	
Biringanya	Steamed	Small Bowl(s)	210	Estimated.	Assumption #3
Biringanya	Fried	Tablespoon(s)	26.25	Calculated.	Assumption #2
Biringanya	Fried	Little Size, Whole Food(s)	105		Using the estimated weight of a fried medium size, whole biringanya, assumption #1 was then applied.
Biringanya	Boiled	Tablespoon(s)	26.25	Estimated.	2, 3.
Biringanya	Steamed	Medium Size, Whole Food(s)	210	Estimated.	Using the estimated weight of a fried medium size, whole biringanya, assumption #4 was then applied.
Biringanya	Fresh	Medium Size, Whole Food(s)	149	Calculated.	Calculated based on a heap of 4.
Biringanya	Fried	Large Bowl(s)	504	Calculated.	Assumption #6
Biringanya	Fried	Medium Size, Whole Food(s)	210	Estimated.	Estimated based on primary researcher's assumption that one boiled medium sized whole biringanya can fit into a small bowl.
Biringanya	Steamed	Tablespoon(s)	26.25	Estimated.	2, 3.
Biringanya	Mixed in sauce	Tablespoon(s)	26.25	Estimated.	Assumption #5
Biringanya	Boiled	Small Bowl(s)	210	Estimated.	Assumption #3
Biringanya	Mixed in sauce	Small Bowl(s)	210	Estimated.	Assumption #5
Biringanya	Fried	Small Bowl(s)	210	2	
Biringanya	Mixed in sauce	Large Bowl(s)	504	Estimated.	Assumption #5
Blackberry	Fresh	Medium Size, Whole Food(s)	0		
Blackberry	Fresh	Small Bowl(s)	0		
Bogaya	Fresh	Bunch(s)	34000	100	
Bogaya	Fresh	Little Size, Whole Food(s)	100	2	
Bogaya	Fresh	Oruko	1670	2	

Primary Name	Food Preparation Method	Unit of Measurement	Weight (g)	Scale Used	Notes (Assumptions are explained in Appendix 11)
Bogaya	Fresh	Medium Size, Whole Food(s)	119	Calculated.	Calculated based on 14 in oruko.
Bwaise	Boiled	Tablespoon(s)	15.75	Estimated.	The assumption was made that bwaise are significantly similar in density to yams; therefore, the weight of small bowl of boiled yams was said to be similar to a small bowl of boiled bwaise and then assumption #2 was applied.
Bwaise	Boiled	Medium Size, Whole Food(s)	140	Estimated.	Estimated based on assumption that bwaise are significantly similar in density to yams.
CABBAGE, Green	Boiled	Small Bowl(s)	105	Estimated.	Assumption #3
CABBAGE, Green	Fresh	Small Bowl(s)	105	Estimated.	Assumption #3
CABBAGE, Green	Fried	Medium Size, Whole Food(s)	1270	Estimated.	Assumption #4
CABBAGE, Green	Fried	Large Bowl(s)	528	Calculated.	Assumption #6
CABBAGE, Green	Mixed in sauce	Large Bowl(s)	360	Estimated.	Assumption #'s 3, 6 & 5.
CABBAGE, Green	Fried	Tablespoon(s)	27.5	Calculated.	Assumption #2
CABBAGE, Green	Mixed in sauce	Small Bowl(s)	105	Estimated.	Assumption #'s 3 & 5
CABBAGE, Green	Fried	Small Bowl(s)	220	2	
CABBAGE, Green	Steamed	Large Bowl(s)	280	2	
CABBAGE, Green	Fresh	Medium Size, Whole Food(s)	1270	2	
CABBAGE, Green	Steamed	Small Bowl(s)	105	2	
CABBAGE, Green	Boiled	Tablespoon(s)	13.1	Estimated.	Assumption #'s 3 & 2
Cakati/Obujorra	Fresh	Small Bowl(s)	0		
Carrots	Boiled	Large Bowl(s)	600	25	
Carrots	Fresh	Medium Size, Whole Food(s)	128	Calculated.	Calculated based on bundle of 5.
Carrots	Fresh	Small Bowl(s)	208	Estimated.	Assumption #6
Carrots	Fresh	Little Size, Whole Food(s)	64	Estimated.	Assumption #1
Carrots	Fresh	Bundle(s)	640	2	
Carrots	Fresh	Tablespoon(s)	26	Calculated.	Assumption #'s 6 & 2
Carrots	Boiled	Small Bowl(s)	300	25	
Carrots	Fried	Small Bowl(s)	300	Estimated.	Assumption #3
Carrots	Fresh	Large Bowl(s)	500	25	
Casasva	Fresh	Medium Size, Whole Food(s)	460	2	
Casasva	Boiled	Little Size, Whole Food(s)	108	Estimated.	1
Casasva	Boiled	Small Bowl(s)	54	Estimated.	
Casasva	Boiled	Medium Size, Whole Food(s)	108	2	
Casasva	Boiled	Tablespoon(s)	6.75	Estimated.	
Casasva	Fresh	Heap(s)	2300	25	
Cassava Flour	Mixed in sauce	Small Bowl(s)	20.3	Estimated.	Estimated using the weight of the maize meal added to a tumpeco cup of maize porridge.
Cassava Flour	Mingled	Small Bowl(s)	20.3	Estimated.	Estimated using the weight of the maize meal added to a tumpeco cup of maize porridge.
Cassava Flour	Mixed in sauce	Large Bowl(s)	55.3	Estimated.	Estimated using the weight of the maize meal added to a tumpeco cup of maize porridge.
Cassava Flour	Mingled	Tablespoon(s)	2.61	Estimated.	Estimated using the weight of the maize meal added to a tumpeco cup of maize porridge.
Cauliflower	Boiled	Small Bowl(s)	140	Estimated.	Assumption #3
Cauliflower	Mixed in sauce	Small Bowl(s)	150	Estimated.	Assumption #5
Cauliflower	Fresh	Medium Size, Whole Food(s)	890	2	

Primary Name	Food Preparation Method	Unit of Measurement	Weight (g)	Scale Used	Notes (Assumptions are explained in Appendix 11)
Cauliflower	Fried	Medium Size, Whole Food(s)	890		Assumption #4
Cauliflower	Steamed	Small Bowl(s)	140	2	
Cauliflower	Fried	Large Bowl(s)	384	Estimated.	Assumption #6
Cauliflower	Fried	Small Bowl(s)	160	2	
Cauliflower	Fresh	Tablespoon(s)	18.75	Estimated.	Assumption #'s 2 & 3
Cauliflower	Mixed in sauce	Tablespoon(s)	18.75	Estimated.	Assumption #'s 2 & 5
Cauliflower	Fried	Tablespoon(s)	20	Estimated.	Assumption #2
Chick Peas	Fried	Small Bowl(s)	200	Estimated.	Assumption #3
Chick Peas	Boiled	Tablespoon(s)	25	Calculated.	Assumption #2
Chick Peas	Boiled	Small Bowl(s)	200	2	
Chick Peas	Fresh	Heap(s)	360	2	
Chick Peas	Boiled	Large Bowl(s)	480	Calculated.	Assumption #6
Chicken	Cooked	Bite Size(s) of Meat	12.5	Estimated.	Estimated based on the weight of a bite size of cooked pork.
Cow peas	Boiled	Small Bowl(s)	200	Estimated.	Estimated based on the assumption that the weight of a small bowl boiled of cow peas is similar to the weight of a small bowl of boiled chick peas.
Cucumber	Fresh	Heap(s)	455	2	
Cucumber	Fresh	Medium Size, Whole Food(s)	114	Calculated.	Calculated based on a heap of 4.
DOODO	Steamed	Large Bowl(s)	290.52	Estimated.	Using the estimated weight of a small bowl of steamed doodo, assumption #6 was then applied.
DOODO	Boiled	Tablespoon(s)	37.5		Assumption #2
DOODO	Steamed	Small Bowl(s)	121.05	Estimated.	The steamed weights of a small bowl of ebisunsa, enswiga, enyamusiri, omubwiga, nakati and eyobyo were collected; the steamed weight for a small bowl of doodo was estimated using the average weight of the aforementioned leafy greens.
DOODO	Fried	Small Bowl(s)	300	Estimated.	Assumption #3
DOODO	Fried	Tablespoon(s)	37.5		3, 2.
DOODO	Steamed	Tablespoon(s)	37.5		2, 3.
DOODO	Mixed in sauce	Tablespoon(s)	37.5		5, 2.
DOODO	Fresh	Bundle(s)	500	25	
DOODO	Mixed in sauce	Small Bowl(s)	300		Assumption #5
Duck	Cooked	Bite Size(s) of Meat	12.5	Estimated.	Estimated based on the weight of a bite size of cooked pork.
Duck	Cooked	Medium Size, Whole Food(s)	0		
EBHIMBA	Boiled	Tablespoon(s)	35.6	Calculated.	Assumption #2
EBHIMBA	Fresh	Cup(s), Tumpeco	375	2	
EBHIMBA	Boiled	Large Bowl(s)	684	Calculated.	Assumption #6
EBHIMBA	Fresh	Small Bowl(s)	712.5	Calculated.	Assumption #8
EBHIMBA	Boiled	Small Bowl(s)	285	2	
Ebidodoima	Fresh	Small Bowl(s)	186.7	Estimated.	Estimated using the estimated weight of a small bowl of fresh enjagi.
Ebidodoima	Boiled	Small Bowl(s)	186.7	Estimated.	Estimated using the weight of a small bowl of boiled enjagi.
Ebidodoima	Fresh	Medium Size, Whole Food(s)	32.5	Estimated.	Estimated using the estimated fresh weight of a medium size whole enjagi.
Ebikeke	Boiled	Tablespoon(s)	0		
Ebikeke	Boiled	Medium Size, Whole Food(s)	0		
Ebisobyo (Ebikaga)	Boiled	Large Bowl(s)	1000	25	
Ebisobyo (Ebikaga)	Boiled	Small Bowl(s)	500	25	
Ebisokoro	Steamed	Nice Cup(s)			

Primary Name	Food Preparation Method	Unit of Measurement	Weight (g)	Scale Used	Notes (Assumptions are explained in Appendix 11)
Ebisokoro	Steamed	Small Bowl(s)	121.05	Estimated.	The steamed weights of a small bowl of ebisunsa, enswiga, enyamusiri, omubwiga, nakati and eyobyo were collected; the steamed weight for a small bowl of ebisokoro was estimated using the average weight of the aforementioned leafy greens.
Ebisokoro	Steamed	Tablespoon(s)	15.1	Estimated.	Using the estimated weight of a small bowl of steamed ebisokoro, assumption #2 was applied.
Ebisunsa	Steamed	Large Bowl(s)	312	Calculated.	Assumption #6
Ebisunsa	Steamed	Tablespoon(s)	16.25	Calculated.	Assumption #2
Ebisunsa	Boiled	Small Bowl(s)	130	Estimated.	Assumption #3
Ebisunsa	Mixed in sauce	Small Bowl(s)	130	Estimated.	Assumption #5
Ebisunsa	Fresh	Bundle(s)	230	2	
Ebisunsa	Steamed	Small Bowl(s)	130	2	
Eggs	Fried	Tablespoon(s)	21	Estimated.	Estimated based on the primary investigator's assumption that a tablespoon is 1/3 the weight of a medium size whole egg.
Eggs	Boiled	Medium Size, Whole Food(s)	63	2	
Eggs	Fried	Medium Size, Whole Food(s)	63	Estimated.	Assumption #4
Emitenne	Fresh	Bundle(s)	160	2	
Emitenne	Mixed in sauce	Tablespoon(s)	37.5	Estimated.	Using the steamed weight of a small bowl of emitenne, assumption #'s 5 & 2 were applied.
Emitenne	Mixed in sauce	Small Bowl(s)	300	Estimated.	Using the steamed weight of a small bowl of emitenne, assumption #5 was applied.
Emitenne	Steamed	Tablespoon(s)	37.5	Calculated.	Using the steamed weight of a small bowl of emitenne, assumption #'2 was applied.
Emitenne	Steamed	Small Bowl(s)	121.05	Estimated.	The steamed weights of a small bowl of ebisunsa, enswiga, enyamusiri, omubwiga, nakati and eyobyo were collected; the steamed weight for a small bowl of emitenne was estimated using the average weight of the aforementioned leafy greens.
Emiyembe	Fresh	Heap(s)	1085	2	
Emiyembe	Fresh	Medium Size, Whole Food(s)	155	Calculated.	Calculated based on heap of 7.
Emyongo	Boiled	Little Size, Whole Food(s)	3440	Estimated.	Estimated based on the weight of a medium sized boiled amoozi; actually weighed 1/4 of Medium Size Whole amoozi; 1.
Emyongo	Fresh	Tablespoon(s)	86	Estimated.	Estimated based on the estimate for the weight of a small bowl of amoozi, 3, 2.
Emyongo	Boiled	Medium Size, Whole Food(s)	3440	Estimated.	Estimated based on the weight of a medium sized boiled amoozi; actually weighed 1/4 of Medium Size Whole amoozi.
Emyongo	Boiled	Tablespoon(s)	86	Estimated.	Estimated based on the estimate for the weight of a small bowl of amoozi, 3, 2.
Emyongo	Steamed	Small Bowl(s)	688	Estimated.	Estimated based on the estimate for the weight of a small bowl of amoozi.
Enderema (Nderema)	Steamed	Small Bowl(s)	121.05	Estimated.	The steamed weights of a small bowl of ebisunsa, enswiga, enyamusiri, omubwiga, nakati and eyobyo were collected; the steamed weight for a small bowl of enderema was estimated using the average weight of the aforementioned leafy greens.
Enderema (Nderema)	Mixed in sauce	Small Bowl(s)	121.05	Estimated.	Using the estimated weight of a small bowl of steamed enderema, assumption #5 was then applied.
Enderema (Nderema)	Mixed in sauce	Tablespoon(s)	15.13	Estimated.	Using the estimated weight of a small bowl of steamed enderema, assumption #'s 5 and 2 were then applied.
Enjagi	Fresh	Medium Size, Whole Food(s)	32.5	Estimate.	Assumption #4
Enjagi	Boiled	Small Bowl(s)	186.7	2	

Primary Name	Food Preparation Method	Unit of Measurement	Weight (g)	Scale Used	Notes (Assumptions are explained in Appendix 11)
Enjagi	Fresh	Heap(s)	235	2	
Enjagi	Boiled	Little Size, Whole Food(s)	5	2	
Enjagi	Steamed	Medium Size, Whole Food(s)	32.5	Estimate	Assumption #4
Enjagi	Fried	Medium Size, Whole Food(s)	10	Estimate	Assumption #1
Enjagi	Fresh	Small Bowl(s)	186.7	Estimate.	Assumption #3
Enjagi	Boiled	Medium Size, Whole Food(s)	32.5	2	
Enjagi	Mixed in sauce	Small Bowl(s)	186.7	Estimate	Assumption #5
Enkombe	Fresh	Nice Cup(s)	0		
Ennanansi	Fresh	Glass(es)	0		
Ennanansi	Fresh	Small Bowl(s)	103.3	Mettle PC 180 Electronic Balance.	
Ennanansi	Fresh	Medium Size, Whole Food(s)	2600	2	
Ennanansi	Fresh	Nice Cup(s)	0		
Ensaali	Fresh	Medium Size, Whole Food(s)	0		
Ensaali	Fresh	Small Bowl(s)	0		
Ensaali	Boiled	Small Bowl(s)	0		
Ensaali	Boiled	Medium Size, Whole Food(s)	0		
Ensaali	Steamed	Small Bowl(s)	0		
Ensenene	Fried	Medium Size, Whole Food(s)	0		
Ensenene	Fried	Tablespoon(s)	0		
Ensenene	Fried	Small Bowl(s)	0		
Enswiga	Steamed	Tablespoon(s)	12.5	Calculated.	Assumption #2
Enswiga	Fresh	Bundle(s)	435	2	
Enswiga	Boiled	Small Bowl(s)	100	Estimated.	Assumption #3
Enswiga	Steamed	Large Bowl(s)	240	Calculated.	Assumption #6
Enswiga	Steamed	Small Bowl(s)	100	2	
Enswiga	Boiled	Tablespoon(s)	12.5	Estimated and calculated.	Assumption #2 & 3
Entendigwa	Boiled	Tablespoon(s)	0		
Entendigwa	Boiled	Small Bowl(s)	0		
Entutu	Fresh	Medium Size, Whole Food(s)	0.36	Estimated.	Estimated based on the weight of a boiled medium size, whole obujabara.
Entutu	Fresh	Small Bowl(s)	240	Estimated.	Estimated based on the weight of a small bowl of fresh obujabara.
Enyamusiri	Steamed	Small Bowl(s)	260	2	Mixture: two bundles emittene plus one bundle of enaymsiri.
Enyamusiri	Boiled	Small Bowl(s)	260	Estimated.	Assumption #3
Enyamusiri	Fried	Tablespoon(s)	32.5	Estimated.	Assumption #'s 3 & 2
Enyamusiri	Fresh	Bundle(s)	80	2	
Enyamusiri	Mixed in sauce	Small Bowl(s)	260	Estimated.	Assumption #5
Enyamusiri	Steamed	Tablespoon(s)	32.5	Calculated.	Assumption #2
Eteke	Mixed in sauce	Tablespoon(s)	30	Estimated.	Using the estimated weight of a small bowl of boiled eteke, assumption #'s 2 & 5 were then applied.
Eteke	Boiled	Medium Size, Whole Food(s)	0.36	Estimated.	Estimated based on the weight of a boiled medium size, whole obujabara.
Eteke	Boiled	Small Bowl(s)	240	Estimated.	Estimated based on the weight of a small bowl of boiled obujabara.
Eteke	Mixed in sauce	Medium Size, Whole Food(s)	0.36	Estimated.	Using the estimated weight of a boiled medium size eteke, assumption #5 was then applied.

Primary Name	Food Preparation Method	Unit of Measurement	Weight (g)	Scale Used	Notes (Assumptions are explained in Appendix 11)
Eteke	Boiled	Tablespoon(s)	30	Estimated.	Using the estimated weight of a small bowl of boiled eteke, assumption #2 was then applied.
Eteke	Steamed	Small Bowl(s)	240	Estimated.	Using the estimated weight of a small bowl of boiled eteke, assumption #3 was then applied.
Eteke	Mixed in sauce	Small Bowl(s)	240	Estimated.	Using the estimated weight of a small bowl of boiled eteke, assumption #5 was then applied.
Eyobyo/Ejjobyo	Steamed	Tablespoon(s)	6.25	Calculated.	Assumption #2
Eyobyo/Ejjobyo	Steamed	Small Bowl(s)	50	2	
Eyobyo/Ejjobyo	Fresh	Bundle(s)	100	2	
Fene	Fresh	Small Bowl(s)	130	2	
Fene	Fresh	Inner Fruit(s)	7	Calculated.	Calculated based on 19 inner fruits in small bowl.
FISH	Cooked	Tablespoon(s)	27	Estimated.	Assumption #2
FISH	Cooked	Large Bowl(s)	522	Estimated.	Assumption #6
FISH	Cooked	Medium Size, Whole Food(s)	145	2	
FISH	Cooked	Bite Size(s) of Meat	12.5	Estimated.	Estimated based on the weight of a bite size of cooked pork.
FISH	Cooked	Little Size, Whole Food(s)	29	Estimated.	Estimated based on Christine's assumption that a little fish is one quarter the size of medium.
FISH	Cooked	Big Size, Whole Food(s)	290	Estimated.	Estimated based on Christine's assumption that a big fish is two times the size of medium.
FISH	Cooked	Small Bowl(s)	217.5	Estimated.	Estimated based on the Principle Investigator's assumption that a small bowl of fish weighs the same as 1.5 cooked medium size whole fish.
Fruit juice, canned	Fresh	Cup(s), Tumpeco	500		Volume in mililitres.
Fruit juice, canned	Fresh	Glass(es)	0		
Fruit juice, canned	Fresh	Feeding Cup	0		
Fruit juice, canned	Fresh	Nice Cup(s)	0		
Fruit juice, fresh	Fresh	Cup(s), Tumpeco	500		Volume in mililitres.
GAME	Cooked	Bite Size(s) of Meat	12.5	Estimated.	Estimated based on the weight of a bite size of cooked pork.
Garlic	Fresh	Tablespoon(s)	23.6	Mettle PC 180 Electronic Balance.	
Ghee	Fresh	uSh	0.1	2	200 UGX portion; therefore, ghee is 0.1 g/UGX
Ginger	Boiled	Cup(s), Tumpeco	500		Volume in mililitres.
Goat	Cooked	Bite Size(s) of Meat	12.5	Estimated.	Estimated based on the weight of a bite size of cooked pork.
Goat	Cooked	Small Bowl(s)	160	2	Includes broth.
Green peppers	Fresh	Medium Size, Whole Food(s)	12.5	Estimated.	Assumption #4
Green peppers	Boiled	Tablespoon(s)	28.75	Calculated.	Assumption #2
Green peppers	Fried	Tablespoon(s)	18.75	Calculated.	Assumption #2
Green peppers	Mixed in sauce	Medium Size, Whole Food(s)	12.5	Estimated.	Assumption #'s 4 & 5
Green peppers	Mixed in sauce	Small Bowl(s)	150	Estimated.	Assumption #'s 3 & 5
Green peppers	Boiled	Small Bowl(s)	230	2	
Green peppers	Fresh	Small Bowl(s)	230	Estimated.	Assumption #3
Green peppers	Fried	Small Bowl(s)	150	2	
Green peppers	Steamed	Medium Size, Whole Food(s)	12.5	Estimated.	Assumption #4
Green peppers	Fresh	Heap(s)	375	2	
Green peppers	Boiled	Medium Size, Whole Food(s)	12.5	2	
Green peppers	Mixed in sauce	Tablespoon(s)	18.75	Estimated.	Assumption #'s 2, 3 & 5

Primary Name	Food Preparation Method	Unit of Measurement	Weight (g)	Scale Used	Notes (Assumptions are explained in Appendix 11)
Green Squash	Boiled	Small Bowl(s)	248.4	Mettle PC 180 Electronic Balance.	
Green Squash	Boiled	Medium Size, Whole Food(s)	438.8	Mettle PC 180 Electronic Balance.	
Ground Nuts	Fresh	Glass(es)	130	2	
Ground Nuts	Mingled	Large Bowl(s)	672	Calculated.	Assumption #6
Ground Nuts	Mingled	Tablespoon(s)	35	Calculated.	Assumption #2
Ground Nuts	Mingled	Small Bowl(s)	280	2	
Ground Nuts - Seasonal Edition	Mixed in sauce	Small Bowl(s)	280	Estimated.	Assumption #5
Ground Nuts - Seasonal Edition	Mingled	Small Bowl(s)	280	2	
Guavas	Fresh	Little Size, Whole Food(s)	35	Estimated.	Using the weight of a medium size, fresh mandarin orange; Assumption #1.
Guavas	Fresh	Medium Size, Whole Food(s)	70	Estimated.	Using the weight of a medium size, fresh mandarin orange.
IRISH POTATOES	Boiled	Little Size, Whole Food(s)	55	Estimated.	Assumption #1
IRISH POTATOES	Fresh	Basin(s)	16000	100	
IRISH POTATOES	Fresh	Basket(s)	16000	100	
IRISH POTATOES	Boiled	Large Bowl(s)	530	2	
IRISH POTATOES	Boiled	Small Bowl(s)	220	Calculated.	Assumption #6
IRISH POTATOES	Fresh	Basket(s), Small Size	3900	25	
IRISH POTATOES	Boiled	Medium Size, Whole Food(s)	110	Estimated.	Estimated by making the reasonable assumption that 3 Medium Size Irish Potatoes can fit in a small bowl.
Kamulali Leaves	Fried	Small Bowl(s)	121.05	Estimated.	The steamed weights of a small bowl of ebisunsa, enswiga, enyamusiri, omubwiga, nakati and eyobyo were collected; the steamed weight for a small bowl of kamulali leaves was estimated using the average weight of the aforementioned leafy greens.
Leeks	Boiled	Medium Size, Whole Food(s)	121.6	Mettle PC 180 Electronic Balance.	
Lemon	Fresh	Nice Cup(s)	400		Volume in mililitres.
Lemon	Fresh	Heap(s)	450	2	
Lemon	Fresh	Medium Size, Whole Food(s)	89	2	
MACRONS	Boiled	Large Bowl(s)	408.8	Mettle PC 180 Electronic Balance.	
MACRONS	Boiled	Small Bowl(s)	170.3	Calculated.	Assumption #6
Maize	Boiled	Medium Size, Whole Food(s)	109.1	Mettle PC 180 Electronic Balance	The weight is of the kernels only; the weight of the entire cob of maize was 171.6g. This later weight was measured by cutting the cob of corn in half, weighing half of it and multiplying the recorded weight by 2.
Maize	Boiled	Big Size, Whole Food(s)	163.65	Estimated.	Assumption #7
Maize	Fresh	Medium Size, Whole Food(s)	109.1	Estimated.	Assumption #4
Maize	Boiled	Little Size, Whole Food(s)	54.55	Estimated.	Assumption #1
Maize porridge	Mingled	Cup(s), Tumpeco	38.4	Estimated.	The majority of caregivers estimated adding 3 'tablespoons' (found to be about 20mL each) per tumpeco cup (500mL) of water; it was found on the FAO site (http://www.fao.org/docrep/S4314E/s4314e0q.htm; accessed May 2007) that maize meal has a density of 0

Primary Name	Food Preparation Method	Unit of Measurement	Weight (g)	Scale Used	Notes (Assumptions are explained in Appendix 11)
Maize porridge	Mingled	Large Bowl(s)	55.3	Estimated.	Estimated using the weight of the maize meal added to a tumpeco cup of maize porridge.
Maize porridge	Mingled	Nice Cup(s)	30.72	Estimated.	Estimated using the weight of the maize meal added to a tumpeco cup of maize porridge.
Maize porridge	Mingled	Small Bowl(s)	20.3	Estimated.	Estimated using the weight of the maize meal added to a tumpeco cup of maize porridge.
Maize porridge	Mingled	Tablespoon(s)	2.61	Estimated.	Estimated using the weight of the maize meal added to a tumpeco cup of maize porridge.
Mandarin oranges	Fresh	Heap(s)	420	2	
Mandarin oranges	Fresh	Medium Size, Whole Food(s)	70	Calculated.	Calculated based on a heap of 6.
Matooke	Fresh	Bunch(s)	32000	100	
Matooke	Boiled	Large Bowl(s)	325	2	
Matooke	Boiled	Small Bowl(s)	175	2	
Matooke	Fresh	Medium Size, Whole Food(s)	135	2	
Matooke	Boiled	Medium Size, Whole Food(s)	81	Calculated.	Calculated based on the weight of 4 matooke bananas.
Matooke	Fresh	Large Bowl(s)	420	Estimated.	Assumption #6
Matooke	Boiled	Big Size, Whole Food(s)	135	Estimated.	Assumption #7
Matooke	Boiled	Little Size, Whole Food(s)	60	2	
Milk	Fresh	Glass(es)	208.73	Estimated.	Estimated based on the primary investigators assumption that a glass cup is half the size of a nice cup.
Milk	Fresh	Feeding Cup	208.73	Estimated.	Estimated based on the primary investigators assumption that a feeding cup is half the size of a nice cup.
Milk	Fresh	Nice Cup(s)	417.461		
Milk	Fresh	Cup(s), Tumpeco	521.827		
Millet	Mingled	Tablespoon(s)	5	Estimated.	Using the estimate for a small bowl of mingled millet, assumption #2 was applied.
Millet	Mingled	Large Bowl(s)	100	Estimated.	Estimated using the weight of the maize meal added to a tumpeco cup of maize porridge; this was multiplied by 2 to account for the stiff nature of millet bread.
Millet	Mingled	Cup(s), Tumpeco	66.67	Estimated.	Estimated using the weight of the maize meal added to a tumpeco cup of maize porridge; this was multiplied by 2 to account for the stiff nature of millet bread.
Millet	Mingled	Nice Cup(s)	53.33	Estimated.	Estimated using the weight of the maize meal added to a tumpeco cup of maize porridge; this was multiplied by 2 to account for the stiff nature of millet bread.
Millet	Mixed in sauce	Small Bowl(s)	40	Estimated.	Estimated using the weight of the maize meal added to a tumpeco cup of maize porridge; this was multiplied by 2 to account for the stiff nature of millet bread.
Millet	Mingled	Small Bowl(s)	40	Estimated.	Estimated using the weight of the maize meal added to a tumpeco cup of maize porridge; this was multiplied by 2 to account for the stiff nature of millet bread.
Mistaferi	Fresh	Medium Size, Whole Food(s)	0		
Mushrooms	Mixed in sauce	Small Bowl(s)	180.6	Estimated.	Assumption #3
Mushrooms	Fresh	Small Bowl(s)	91.2	Mettle PC 180 Electronic Balance.	
Mushrooms	Fried	Medium Size, Whole Food(s)	13.7	Mettle PC 180 Electronic	

Primary Name	Food Preparation Method	Unit of Measurement	Weight (g)	Scale Used	Notes (Assumptions are explained in Appendix 11)
				Balance.	
Mushrooms	Mixed in sauce	Tablespoon(s)	22.6	Estimated.	Assumption #'s 3 and 2
Mushrooms	Fried	Large Bowl(s)	219	Estimated.	Assumption #6
Mushrooms	Fried	Tablespoon(s)	22.6	Calculated.	Assumption #2
Mushrooms	Fried	Little Size, Whole Food(s)	0		
Mushrooms	Fried	Small Bowl(s)	180.6	Mettle PC 180 Electronic Balance.	
NAKATI (Obogorra)	Steamed	Small Bowl(s)	93	2	
NAKATI (Obogorra)	Fresh	Bundle(s)	150	2	
NAKATI (Obogorra)	Steamed	Tablespoon(s)	11.6	Calculated.	Assumption #2
Nyabutongo (Enyabutongo)	Fried	Small Bowl(s)	121.05		Using the estimated weight of a small bowl of steamed nyabutonga, assumption #3 was applied.
Nyabutongo (Enyabutongo)	Steamed	Tablespoon(s)	15.1	Estimated.	Using the estimated weight of a small bowl of steamed nyabutonga, assumption #2 was applied.
Nyabutongo (Enyabutongo)	Steamed	Small Bowl(s)	121.05	Estimated.	The steamed weights of a small bowl of ebisunsa, enswiga, enyamusiri, omubwiga, nakati and eyobyo were collected; the steamed weight for a small bowl of nyabutongo was estimated using the average weight of the aforementioned leafy greens.
Nyabutongo (Enyabutongo)	Mixed in sauce	Small Bowl(s)	121.05		Using the estimated weight of a small bowl of steamed nyabutonga, assumption #5 was applied.
Nyabutongo (Enyabutongo)	Steamed	Large Bowl(s)	291.6	Estimated.	Using the estimated weight of a small bowl of steamed nyabutonga, assumption #6 was applied.
OBUHINDIHINDI	Boiled	Small Bowl(s)	0		
Obujabara/Entura	Mixed in sauce	Medium Size, Whole Food(s)	0.36	Estimated.	Assumption #5
Obujabara/Entura	Boiled	Tablespoon(s)	30	Estimated.	Assumption #'s 3 & 2
Obujabara/Entura	Boiled	Small Bowl(s)	240	Estimated.	Assumption #3
Obujabara/Entura	Mixed in sauce	Small Bowl(s)	240	Estimated.	Assumption #3
Obujabara/Entura	Boiled	Medium Size, Whole Food(s)	0.36	Calculated.	Calculated based on boiled weight of 10 grams worth.
Obujabara/Entura	Fresh	Small Bowl(s)	240	2	
Obushera	Fresh	Cup(s), Tumpeco	500		Volume in mililitres.
Obushera	Fresh	Nice Cup(s)			
Obusukaali	Fresh	Oruko	685	2	
Obusukaali	Fresh	Medium Size, Whole Food(s)	58	2	
Obusukaali	Fresh	Little Size, Whole Food(s)	50	2	
Obusukaali	Fresh	Bunch(s)	7000	100	
Obutere	Boiled	Nice Cup(s)		Estimated.	Given that a small bowl containing a mixture of sorghum, millet, and cassava flour (1:1:21) mingled together weighs 270 g and a small bowl of mingled fresh ground nuts (ground down) weighs 280 g, an estimate of 275 was assumed for the weight of a small bowl of mingled obutere; then, assumption #???? was applied.
Obutunguru	Fried	Tablespoon(s)	9.6	Calculated.	Assumption #2
Obutunguru	Mixed in sauce	Tablespoon(s)	9.6	Estimated.	Assumption #2
Obutunguru	Fresh	Tablespoon(s)	16.9	Calculated.	Assumption #2
Obutunguru	Mixed in sauce	Small Bowl(s)	76.3	Estimated.	Assumption # 3
Obutunguru	Fried	Small Bowl(s)	76.3	Mettle PC 180 Electronic	

Primary Name	Food Preparation Method	Unit of Measurement	Weight (g)	Scale Used	Notes (Assumptions are explained in Appendix 11)
				Balance.	
Obutunguru	Fresh	Small Bowl(s)	122.4	Mettle PC 180 *Electronic* Balance.	
Obutunguru	Fresh	Medium Size, Whole Food(s)	135.1	Mettle PC 180 Electronic Balance.	
Obutunguru	Fresh	Little Size, Whole Food(s)	67.6	Calculated.	Assumption #1
Omubwiga	Boiled	Tablespoon(s)	100.15	Estimated.	The boiled weight for a small bowl of omubwiga was estimated using the average weight of a small bowl of steamed and a small bowl of fried omubwiga.
Omubwiga	Fresh	Small Bowl(s)	93.3	Estimated.	Assumption #3
Omubwiga	Boiled	Small Bowl(s)	93.3	Estimated.	Assumption #3
Omubwiga	Fresh	Bundle(s)	115	2	
Omubwiga	Steamed	Small Bowl(s)	93.3	2	
Omubwiga	Steamed	Tablespoon(s)	11.66	Calculated.	Assumption #2
Omubwiga	Fried	Small Bowl(s)	107	2	
Omugombe	Boiled	Tablespoon(s)	15.13	Estimated.	Using the estimated weight of a small bowl of steamed omugombe, assumption #'s 3 & 2 were then applied.
Omugombe	Steamed	Large Bowl(s)	290.52	Estimated.	Using the estimated weight of a small bowl of steamed omugombe, assumption #6 was then applied.
Omugombe	Steamed	Tablespoon(s)	15.13	Estimated.	Using the estimated weight of a small bowl of steamed omugombe, assumption #3 was then applied.
Omugombe	Boiled	Small Bowl(s)	121.05	Estimated.	Using the estimated weight of a small bowl of steamed omugombe, assumption #3 was then applied.
Omugombe	Steamed	Small Bowl(s)	121.05	Estimated.	The steamed weights of a small bowl of ebisunsa, enswiga, enyamusiri, omubwiga, nakati and eyobyo were collected; the steamed weight for a small bowl of omugombe was estimated using the average weight of the aforementioned leafy greens.
Omukondwa (Omurondwa)	Fresh	Medium Size, Whole Food(s)	0		
Orange	Fresh	Medium Size, Whole Food(s)	70	Estimated.	Using the weight of a medium size, fresh mandarin orange.
Passion Fruit	Fresh	Medium Size, Whole Food(s)	44	Calculated.	Calculated based on heap of 7.
Passion Fruit	Fresh	Big Size, Whole Food(s)	66	Estimated.	Assumption #7
Passion Fruit	Fresh	Heap(s)	305	2	
Passion Fruit	Fresh	Little Size, Whole Food(s)	22	Estimated.	Assumption #1
Paw paw	Fresh	Tablespoon(s)	0		
Paw paw	Fresh	Big Size, Whole Food(s)	1800	Estimated.	Assumption #7
Paw paw	Fresh	Small Bowl(s)	0		
Paw paw	*Fresh*	*Little Size, Whole Food(s)*	600	*Estimated.*	*Assumption #1*
Paw paw	Fresh	Medium Size, Whole Food(s)	1200	25	
Pork	Cooked	Bite Size(s) of Meat	12.5	Mettle PC 180 Electronic Balance.	
Posho	Mingled	Large Bowl(s)	648	Estimated.	Using the estimated weight of a small bowl of posho, assumption #6 was then applied.
Posho	Mingled	Tablespoon(s)	33.75	Estimated.	Using the estimated weight of a small bowl of posho, assumption #2 was then applied.

Primary Name	Food Preparation Method	Unit of Measurement	Weight (g)	Scale Used	Notes (Assumptions are explained in Appendix 11)
Posho	Mingled	Small Bowl(s)	270	Estimated.	Assumption #9; Estimated based on the weight of a small bowl mingled of: a half glass sorghum, half glass millet, 1 kg of cassava flour.
RABBIT	Cooked	Bite Size(s) of Meat	12.5	Estimated.	Estimated based on the weight of a bite size of cooked pork.
Rice	Boiled	Large Bowl(s)	500	2	
Rice	Boiled	Tablespoon(s)	26	Estimated.	Assumption #2
Rice	Boiled	Small Bowl(s)	208.33	Estimated.	Assumption #6
SHEEP	Cooked	Bite Size(s) of Meat	12.5	Estimated.	Estimated based on the weight of a bite size of cooked pork.
Sim Sim Ball, candied	Mixed in sauce	Small Bowl(s)	0		
Sim Sim Ball, candied	Fresh	Medium Size, Whole Food(s)	39.1	Mettle PC 180 Electronic Balance.	
Sombe	Steamed	Tablespoon(s)	30	Estimated.	Assumption #'s 3 & 2
Sombe	Fresh	Bundle(s)	500	25	This is the weight of fresh sombe less the part of the leaf that is not consumed.
Sombe	Boiled	Small Bowl(s)	240	2	
Sombe	Mixed in sauce	Small Bowl(s)	240	Estimated.	Assumption #5
Sombe	Mixed in sauce	Tablespoon(s)	30	Calculated.	Assumption #'s 2 & 5
Sorghum	Mingled	Tablespoon(s)	33.75	Estimated.	Using the estimated weight of a small bowl of sorghum, assumption #2 was applied.
Sorghum	Mingled	Small Bowl(s)	270	Estimated.	Assumption #9; Estimated based on the weight of a small bowl mingled of: a half glass sorghum, half glass millet, 1 kg of cassava flour.
Sorghum	Fresh	Glass(es)	190		
Sorghum	Mingled	Nice Cup(s)	30.72	Estimated.	Estimated using the weight of the maize meal added to a tumpeco cup of maize porridge.
Soy Beans	Mingled	Tablespoon(s)	34.4	Estimated.	Using the estimated weight for a small bowl of mingled soy beans, assumption #2 was then applied.
Soy Beans	Roasted	Tablespoon(s)	25	Estimated.	Assumption #'s 3 & 2
Soy Beans	Mingled	Small Bowl(s)	275	Estimated.	Given that a small bowl containing a mixture of sorghum, millet, and cassava flour (1:1:21) mingled together weighs 270 g and a small bowl of mingled fresh ground nuts (ground down) weighs 280 g, an estimate of 275 may be assumed for the weight of a small bowl of mingled (floured) soy beans.
Soy Beans	Roasted	Glass(es)	0		
Soy Beans	Fried	Small Bowl(s)	199.4	Mettle PC 180 Electronic Balance.	Based on the weight of a small bowl of fried ebhimba.
Soy Beans	Mingled	Nice Cup(s)	0		
Soya Porridge	Mingled	Nice Cup(s)	30.72	Estimated.	Estimated using the weight of the maize meal added to a tumpeco cup of maize porridge.
Soya Porridge	Mingled	Cup(s), Tumpeco	38.4	Estimated.	Estimated using the weight of the maize meal added to a tumpeco cup of maize porridge.
Squash	Boiled	Medium Size, Whole Food(s)	438.8	Estimated.	Estimated using measured weight of a medium size boiled green squash.
Squash	Boiled	Tablespoon(s)	31.05	Estimated.	Using the estimated weight for a small bowl of boiled green squash, assumption #2 was applied.
Squash, white	Boiled	Medium Size, Whole Food(s)	438.8	Estimated.	Estimated using measured weight of a medium size boiled green squash.
Squash, white	Boiled	Tablespoon(s)	31.05	Estimated.	Using the estimated weight for a small bowl of boiled green squash, assumption #2 was applied.
Sugar Cane	Fresh	Segment(s)	178	2	

Primary Name	Food Preparation Method	Unit of Measurement	Weight (g)	Scale Used	Notes (Assumptions are explained in Appendix 11)
Sugar Cane	Fresh	Small Bowl(s)	178	Estimated.	Based on primary researcher's conception that a small bowl should be able to hold approximately one segment of sugar cane.
Sweet Potatoes	Boiled	Big Size, Whole Food(s)	450	Estimated.	Assumption #7
Sweet Potatoes	Fresh	Heap(s)	1000	25	
Sweet Potatoes	Boiled	Little Size, Whole Food(s)	150	2	
Sweet Potatoes	Fresh	Basket(s)	10000	100	
Sweet Potatoes	Boiled	Small Bowl(s)	220		Assumption #12; estimated based on the boiled weight of a small bowl mingled of Irish Potatoes.
Sweet Potatoes	Steamed	Small Bowl(s)	220		Using the estimated weight of a small bowl of boiled sweet potatoes, assumption #3 was then applied.
Sweet Potatoes	Boiled	Tablespoon(s)	27.5		Using the estimated weight of a small bowl of boiled sweet potatoes, assumption #2 was then applied.
Sweet Potatoes	Boiled	Medium Size, Whole Food(s)	300	Estimated.	Assumption #1 and to add strength to the assumption, this was also estimated by Christine at the time of weighing based on a small sized small sweet potatoe.
Tomatoes	Fresh	Heap(s)	880	2	
Tomatoes	Fried	Medium Size, Whole Food(s)	147	Estimated.	Assumption #4
Tomatoes	Fresh	Big Size, Whole Food(s)	220.5	Estimated.	Assumption #7
Tomatoes	Fried	Small Bowl(s)	441	Estimated.	First, assumption #4 was applied and secondly, the primary investigator made the assumption that a small bowl can hold 3 medium size whole tomatoes.
Tomatoes	Mixed in sauce	Medium Size, Whole Food(s)	147	Estimated.	Assumption #'s 4 & 5.
Tomatoes	Fresh	Medium Size, Whole Food(s)	147	Calculated.	Calculated based on heap of 6; 5 average size tomatoes are 200 UGX in the village.
Tomatoes	Mixed in sauce	Small Bowl(s)	441	Estimated.	Using the estimated weight of a small bowl of medium size tomatoes, assumption #5 was then applied.
Tomatoes	Fresh	Small Bowl(s)	441	Estimated.	Using the estimated weight of a small bowl of medium size tomatoes, assumption #4 was then applied.
Tomatoes 2	Fresh	Medium Size, Whole Food(s)	147	Calculated.	Calculated based on heap of 6; 5 average size tomatoes are 200 UGX in the village.
Turkey	Cooked	Bite Size(s) of Meat	12.5	Estimated.	Estimated based on the weight of a bite size of cooked pork.
VACADO	Fresh	Tablespoon(s)	51.9	Estimated.	Using the estimated weight of a small bowl of avocado, assumption #2 was then applied.
VACADO	Fresh	Medium Size, Whole Food(s)	415	Calculated.	Calculated based on heap of 4.
VACADO	Fresh	Small Bowl(s)	415	Estimated.	Estimated based on primary researchers assumption that a small bowl can hold 1 medium sized whole avocado.
VACADO	Fresh	Heap(s)	1660	2	
VACADO	Fresh	Little Size, Whole Food(s)	207.5	Estimated.	Assumption #1
Vocado - Seasonal	Fresh	Medium Size, Whole Food(s)	415	Calculated.	Calculated based on heap of 4.
WATERMELLON	Fresh	Medium Size, Whole Food(s)	4600	25	
Wheat (Bread, cakes, muffins, chapatti, tea biscuit)	Fresh	Big Size, Whole Food(s)	80	Estimated.	Assumption #7
Wheat (Bread, cakes, muffins, chapatti, tea biscuit)	Fresh	Little Size, Whole Food(s)	20	Estimated.	Assumption #1
Wheat (Bread, cakes, muffins, chapatti, tea biscuit)	Fresh	Medium Size, Whole Food(s)	40.6	Mettle PC 180 Electronic Balance.	
Wheat (Bread, cakes,	Fresh	Small Bowl(s)	40.6	Estimated.	Estimated based on the assumption that one medium size whole food fits in

Primary Name	Food Preparation Method	Unit of Measurement	Weight (g)	Scale Used	Notes (Assumptions are explained in Appendix 11)
muffins, chapatti, tea biscuit)					a small bowl.
Wheat (Bread, cakes, muffins, chapatti, tea biscuit)	Fresh	Package(s)	243.6	Calculated.	Calculated based on the assumption that there are 6 medium size whole buns in a package.
YAM	Boiled	Little Size, Whole Food(s)	85	2	
YAM	Boiled	Medium Size, Whole Food(s)	140	2	
YAM	Mixed in sauce	Little Size, Whole Food(s)	85	Estimated.	Assumption #5
YAM	Fresh	Heap(s)	2400	25	
YAM	Mixed in sauce	Big Size, Whole Food(s)	255	Estimated.	Assumption #'s 7 & 5
YAM	Boiled	Large Bowl(s)		Estimated.	Using the estimated weight of a small bowl of boiled yams, assumption #6 was applied.
YAM	Boiled	Tablespoon(s)	15.75	Estimated.	Using the estimated weight of a small bowl of boiled yams, assumption #2 was applied.
YAM	Boiled	Small Bowl(s)	126	Estimated.	A basket of Irish potatoes weighs 16 Kg. A basket of yams of the same size weighs 9200 Kg. Therefore, the density of Irish Potatoes is 1.74 times that of yams. Thus, dividing the weight of a small bowl of boiled Irish Potatoes by 1.74 provides an estimate for the weight of a small bowl of boiled yams, assuming they both absorb the same amount of water.
YAM	Fresh	Basket(s)	9200	25	

Appendix 11: *Explanation Of Assumptions Used To Estimate Food Weights That Were Not Specifically Measured*

1) *The little size whole food weight is half that of the medium size whole food weight assumption*;
2) *Tablespoon assumption:* calculated based on Christine's understanding of the size of a tablespoon being that there are approximately 8 tablespoons in a small bowl;
3) *Small bowl - steamed, boiled, fresh, fried, roasted or mixed assumption:* estimated based on the assumption that the weight of a small bowl of steamed food weighs the same as a small bowl of fried and/or boiled food or any combination of the above;
4) *Medium sized whole food - steamed, boiled, fresh or fried assumption:* estimated based on the assumption that the fresh, fried, boiled and steamed weights of a given medium sized whole food are all the same;
5) *The mixed food assumption:* unless otherwise noted, Christine recorded the intake rate of the specific ingredient of interest consumed in the mix, despite the additional volume of the rest of the mix;
6) *Small bowl to large bowl and vise versa conversion:* calculated based on the fact that the large bowl is 2.4 times the volume of the small bowl;
7) *The big size whole food weight is one and a half times that of the medium size whole food weight assumption*;
8) *Small bowl to tumpeco cup and vise versa conversion:* calculated based on the fact that the tumpeco cup is 1.9 times the volume of the small bowl;
9) *All flours (cassava, maize meal, millet, sorghum) have similar density.*
10) *Large Bowl – steamed, boiled or fried assumption:* estimated based on the assumption that the weight of a large bowl of steamed food weighs the same as a large bowl of fried and/or boiled food or any combination of the above;
11) *Small bowl to nice cup and vise versa conversion:* calculated based on the fact that the tumpeco cup is 1.54 times the volume of the small bowl;
12) *All tubers (sweet potatoes, cassava, yams (& Bwaise) and Irish potatoes have similar density;*
13) *All porridges are made with 38.4 g of flour/meal per 500mL*

Appendix 12: *The Food Nutrient Values Used to Calculate The Food Nutrient Contribution to the Diet Per Gram of Edible Portion*

When reviewing this table, please consider:

a) Food nutrients that are blank are so because no composition data was available; that is not to say that said food does not contain any of that nutrient,
b) A food presented below with no nutrient data is so because while it certainly does contain various nutrients, no children were found to be consuming it and therefore, no effort was made to assess its composition, and,
c) FAO refers to the 1968 Food Composition Table for Use in Africa[99]

* In calculation of vitamin A (retinol) nutrient intake, B-carotene values were converted to vitamin A as 1 ug of beta-carotene was equal to 0.5 ug of vitamin A

** In calculation of niacin nutrient intake, tryptophan values were converted to niacin equivalents as 60 milligrams of tryptophan was equal to one milligram of niacin

Conversions follow those used in the 1968 Food Composition Table for Use in Africa[99]

Name	Scientific Name	Degree Of Nutrient Value Match	Preparation Nutrient Value Based On	Eng-ergy (Cal)	Pro-tein (g)	Cal-cium (mg)	Iron (mg)	VitA (ug)	B-car-otene (ug)*	Thia-mine (mg)	Ribo-flavin (mg)	Niacin (mg)	Tryp-tophan (mg) **	VitC (mg)	FAO Food Group[99]	Food Nutrient Value Reference Database
Amakerre	Rubus sp.	Blackberry; raspberry; youngberry (Rubus spp.), berries --> In inventory but no data	Same fruit as that I have referred to as Blackberry; This fruit does not appear to make any great macronutrient contributions but it may contribute to vitamin A consumption, although I don't have a reference for this	0.43	0.01	0.29	0.01	0.642				0.01		0.21	Fruits	Australia/New Zealand Food Standards Website (http://www.foodstandards.govt.nz/monitoringandsurveillance/nuttab2006/onlineversionintroduction/onlineversion.cfm?&action=getFood&foodID=15A10365)and also used www.nutritionanalyser.com

Name	Scientific Name	Degree Of Nutrient Value Match	Preparation Nutrient Value Based On	Energy (Cal)	Protein (g)	Calcium (mg)	Iron (mg)	VitA (ug)	B-carotene (ug)*	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	Tryptophan (mg) **	VitC (mg)	FAO Food Group[99]	Food Nutrient Value Reference Database
Amatehe	Aframomum sanguinem	Exact	Fruit, raw	0.4	0.009	0.15	0.01							0.02	Fruits	FAO
Amoozi	Cucurbita maxima	cucurbita pepo	cooked, fat added	0.58	0.012	0.16	0.006								Starchy Root, Tubers and Fruits	FAO
Ants		Not in inventory													Meats, Poultry and Insects	
Bamia		Not sure what this is													Starchy Root, Tubers and Fruits	
Banana juice		--> no way to standardize concentration; no nutrient data in tables													Beverages	
Beef		Table simply *stated* "Beef"	No information *mentioned*.	1.09	0.168	0.09	0.048					0.027			Meats, Poultry and Insects	FAO
Biringanya		Eggplant, garden; eggfruit; brinjal; aubergine (Solanum melongena)	Cooked.	0.73	0.01	0.13	0.004								Vegetables and Veg Products	FAO
Blackberry		Blackberry; *raspberry*; youngberry (Rubus spp.), berries --> In inventory but no data	Is this the *same* thing as Amakere?												Fruits	
Blue band															Oils and Fats	

Name	Scientific Name	Degree Of Nutrient Value Match	Preparation Nutrient Value Based On	Energy (Cal)	Protein (g)	Calcium (mg)	Iron (mg)	VitA (ug)	B-carotene (ug)*	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	Tryptophan (mg)**	VitC (mg)	FAO Food Group[99]	Food Nutrient Value Reference Database
Bogaya		Banana, common (Musa sapientum):	Ripe	0.88	0.015	0.09	0.014		1.2	0.0003	0.0003	0.06		0.09	Starchy Root, Tubers and Fruits	FAO
Broccoli		Not consumed so not important													Vegetables and Veg Products	
Brussels sprouts															Vegetables and Veg Products	
Butter, Margarine or Ghee															Milk Products	
Bwaise		The type of yams observed in Uganda is not certain; therefore, the nutrient values are an average of the nutrient composition of the 10 type of yams whose nutrient values are published in the FAO *table "Food Nutrition Table for Use in Africa"*: 1) [Taro; d	tuber, raw	1.13	0.0247	0.548	0.022		0.1	0.00087	0.00027	0.0053	0.26	0.0867	Starchy Root, Tubers and Fruits	FAO

Name	Scientific Name	Degree Of Nutrient Value Match	Preparation Nutrient Value Based On	Eng-ergy (Cal)	Pro-tein (g)	Cal-cium (mg)	Iron (mg)	VitA (ug)	B-car-otene (ug)*	Thia-mine (mg)	Ribo-flavin (mg)	Niacin (mg)	Tryp-tophan (mg) **	VitC (mg)	FAO Food Group[98]	Food Nutrient Value Reference Database
Cabbage, green		Cabbage common (Brassia oleracea var. capitata)	raw	0.26	0.017	0.47	0.007		1	0.0004	0.0004	0.003		0.54	Vegetables and Veg Products	FAO
Cabbage, red		Cabbage common (Brassia oleracea var. capitata) --> estimated using a variety that is not red; therefore, the extra vitamin A that would be of benefit from Red Cabbage is not accounted for	raw	0.26	0.017	0.47	0.007		1	0.0004	0.0004	0.003		0.54	Vegetables and Veg Products	FAO
Cakati/obujorra		Not sure what this is														
Carrots		Carrot (Daucus carota), root	raw	0.4	0.009	0.35	0.007		54.8	0.0004	0.0004	0.006		0.08	Vegetables and Veg Products	FAO
Cassava		(Canna bidentata), tuber, edible Cassava, common, bitter	Cooked	1.24	0.009									0.26	Starchy Root, Tubers and Fruits	FAO
Cassava flour		(Canna bidentata), tuber, edible Cassava, common, bitter	Dried. (konkonte; kokonte)	3.55	0.021	1.02	0.007			0.0012	0.0002	0.015	0.15	0.01	Starchy Root, Tubers and Fruits	FAO

Name	Scientific Name	Degree Of Nutrient Value Match	Preparation Nutrient Value Based On	Eng-ergy (Cal)	Pro-tein (g)	Cal-cium (mg)	Iron (mg)	VitA (ug)	B-car-otene (ug)*	Thia-mine (mg)	Ribo-flavin (mg)	Niacin (mg)	Tryp-tophan (mg)**	VitC (mg)	FAO Food Group[99]	Food Nutrient Value Reference Database
Cauliflower		Cauliflower (Brassica oleracea var. botrytis);	Cooked, fat added	0.82	0.015	0.18	0.008								Vegetables and Veg Products	FAO
Chick peas		Not sure exactly what type of peas these are	mature seeds, cooked, boiled, without salt	1.64	0.09	0.49	0.03	0.081				0.01		0.01	Grain Legumes and Leg Products	http://www.nutritionanalyser.com/food_composition/?fid=16057&amount=1&measures=0, www.nutritionanalyser.com
Chicken		Chicken (Gallus gallus)	Young bird	1.46	0.205	0.1	0.011								Meats, Poultry and Insects	FAO
Cooking spread (cowboy)															Oils and Fats	
Cow peas		Cowpeas, catjang (Vigna unguiclata, subs. catjang)	Immature seeds	0.49	0.048	1.51			1.5						Grain Legumes and Leg Products	FAO
Cucumber		Trace amounts of B-carotene; Cucumber (Cucumis sati- vus)	whole, raw	0.15	0.008	0.13	0.005			0.0002	0.0001	0.003		0.14	Vegetables and Veg Products	FAO
Doodo	Amaranthus Dubius	Exact (spp)	Cooked	0.43	0.04	5.06	0.017								Leafy Green Vegetable	FAO
Duck		Duck (Anatidae), domesticated, total edible		2.87	0.186										Meats, Poultry and Insects	FAO
Ebhimba	Phaseolus vulgaris	Correct phaseolus vulgaris but "snap or wax"	Raw	0.36	0.025	0.43	0.014		7.5	0.0008	0.0012	0.005		0.27	Grain Legumes and Leg Products	FAO

Name	Scientific Name	Degree Of Nutrient Value Match	Preparation Nutrient Value Based On	Energy (Cal)	Protein (g)	Calcium (mg)	Iron (mg)	VitA (ug)	B-carotene (ug)*	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	Tryptophan (mg)**	VitC (mg)	FAO Food Group[99]	Food Nutrient Value Reference Database
Ebidodoima		Tree tomato (Cyphomandra betacea)	fruit, raw	0.57	0.015	0.71	0.007								Fruits	FAO
Ebikeke		Not sure what this is													Vegetables and Veg Products	
Ebisobooza	Phaseolus vulgaris	Not sure what part of the plant Ebisobooza is													Grain Legumes and Leg Products	
Ebisobyo (ebikaga)	Phaseolus Vulgaris															
Ebisokoro	Phaseolus vulgaris	Exact	Raw leaf	0.36	0.036	2.74	0.092		32.4	0.0018	0.0006	0.013		1.1	Leafy Green Vegetable	FAO
Ebisunsa	Cucurbita maxima	Exact	Raw leaf	0.27	0.04	4.77	0.008		36	0.0006	0.0032			0.8	Leafy Green Vegetable	FAO
Eggs		Hen egg	whole, raw	1.4	0.118	0.45	0.026	3.5	3			0.003			Meats, Poultry and Insects	FAO
Ekiryo	Lagenaria siceraria														Starchy Root, Tubers and Fruits	
Ekituruguma		Not sure what this is														

Name	Scientific Name	Degree Of Nutrient Value Match	Preparation Nutrient Value Based On	Eng-ergy (Cal)	Pro-tein (g)	Cal-cium (mg)	Iron (mg)	VitA (ug)	B-car-otene (ug)*	Thia-mine (mg)	Ribo-flavin (mg)	Niacin (mg)	Tryp-tophan (mg)**	VitC (mg)	FAO Food Group[69]	Food Nutrient Value Reference Database
Emitenne	Canna Edulis	Ascorbic Acid reported as reduced; Taro; dasheen; cocoyam; arum lilly (Colacasia esculenta; Arum esculentum)	young leaves, raw	0.31	0.024	0.98	0.02		18	0.0017	0.0035	0.008		0.11	Leafy Green Vegetable	FAO
Emiyembe	Mangifera indica	Exact	Ripe	0.6	0.006	0.24	0.012		32	0.0003	0.0005	0.004		0.42	Fruits	FAO
Empengere																
Emyongo	Cucurbita maxima	--> Not certain of species													Starchy Root, Tubers and Fruits	
Enderema (nderema)	Basella alba	Exact	Raw	0.2	0.018	1.38								0.39	Leafy Green Vegetable	FAO
Enjagi	Solanum gilo	--> genus not specified in tables; Used Solanum macrocarpon, fruit	Fruit, raw	0.4	0.014	0.13									Vegetables and Veg Products	
Enkomanyangwa	Punica granatum	Exact	Raw	0.78	0.016	0.12	0.01		0.4						Fruits	FAO
Enkombe		Not sure what this is														
Ennanansi	ananas comosus	Pineapple (Ananas comosus):	Fruit, raw	0.47	0.004	0.16	0.004		0.9	0.0006	0.0003	0.001		0.34	Fruits	FAO
Ensaali	Garcinia buchananii	Garcinia, sp.; muKute (Garcinia huillensis)	fruit, raw -> probably a poor match											0.08	Fruits	

Name	Scientific Name	Degree Of Nutrient Value Match	Preparation Nutrient Value Based On	Energy (Cal)	Protein (g)	Calcium (mg)	Iron (mg)	VitA (ug)	B-carotene (ug)*	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	Tryptophan (mg)**	VitC (mg)	FAO Food Group[99]	Food Nutrient Value Reference Database
Ensenene		Grasshoppers (Acridium; Zonocerus):	Raw	1.7	0.268	0.4	0.11								Meats, Poultry and Insects	FAO
Enswa		*Not sure what this is*														
Enswiga	Solanum nigrum	Exact	Raw	0.38	0.043	4.42	0.01		36.6					0.2	Leafy Green Vegetable	FAO
Entendigwa	Possibly: Cajanus cajan	--> Not certain of species	Pigeon peas (red gram), mature seeds, cooked, boiled, without salt	1.21	0.07	0.43	0.01	0.009				0.01			Grain Legumes and Leg Products	http://www.nutritionanalyser.com/food_composition/?fid=16102&amount=1&measures=0; home.tiscali.be/lpauwels/Latham2.htm
Entutu	Physalis peruviana	--> *In inventory but no data*								0.0013	0.0004			0.01	Fruits	http://www.foodstandards.govt.nz/monitoringandsurveillance/nuttab2006/onlineversionintroduction/onlineversion.cfm?&action=getFood&foodID=15A10350
Enyamatundu		*Not sure what this is*														
Enyamusiri	Corchorus olitorius	Exact	Cooked	0.34	0.015	0.51	0.034								Leafy Green Vegetable	FAO
Eteke	Hibiscus cannabinus	(*Hibiscus cannabinus*), seed	Dried	4.27	0.202	2.94									Vegetables and Veg Products	FAO

Name	Scientific Name	Degree Of Nutrient Value Match	Preparation Nutrient Value Based On	Eng-ergy (Cal)	Pro-tein (g)	Cal-cium (mg)	Iron (mg)	VitA (ug)	B-car-otene (ug)*	Thia-mine (mg)	Ribo-flavin (mg)	Niacin (mg)	Tryp-tophan (mg)**	VitC (mg)	FAO Food Group[99]	Food Nutrient Value Reference Database
Eyobyo/ejjobyo	Gynandropsis gynadran	Leaves, raw Spider herb, African; cats' whiskers; lerotho; bastard mustard (Gynandropis gynandra; G. pentaphylla)	Leaves and stems, cooked	0.41	0.04 2	1.35	0.03 4								Leafy Green Vegetable	FAO
Fene	Artocarpus heterophyllus/integer	Jackfruit; jackfruit (Artocarpus heterophylla), fruit --> In inventory but no data; used external website	Raw	0.94	0.01	0.34	0.01	0.891						0.07	Fruits	http://www.nutritionanalyser.com/food_composition/?fid=09144&amount=1&measures=0
Fish		Cichlids; St. Peter's fish; "breams" (Tilapia spp.):	Dried, smoked	4.03	0.77										Meats, Poultry and Insects	FAO
Fruit juice, canned		Juice, canned	The type of juice is not specified	0.62	0.00 3	0.02	0.04		2.85	0.00 01	0.00 03	0.002			Beverages	FAO
Fruit juice, fresh		None of the juices in the inventory have nutritional values indicated.													Beverages	
Game		Based on beef; type of game was not specified	Not specified	1.43	0.19	0.08	0.1	8.1	1.8			0.052		0.71	Meats, Poultry and Insects	FAO
Garlic		Garlic (*Allium sativum*), bulbs:	Raw	1.31	0.05 2	0.33	0.01 7							0.11	Vegetables and Veg	FAO

Name	Scientific Name	Degree Of Nutrient Value Match	Preparation Nutrient Value Based On	Energy (Cal)	Protein (g)	Calcium (mg)	Iron (mg)	VitA (ug)	B-carotene (ug)*	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	Tryptophan (mg)**	VitC (mg)	FAO Food Group[99]	Food Nutrient Value Reference Database
															Products	
Ghee		Ghee		8.62	0		0.004								Milk Products	FAO
Ginger	Zingiber officinalis	Ginger (Zingiber officinale), root	dried	3.01	0.076	1.8			1.2	0.0016	0.0027	0.084			Vegetables and Veg Products	FAO
Goat		Based on beef; goat data incomplete	Not specified	1.43	0.19	0.08	0.1	8.1	1.8			0.052		0.71	Meats, Poultry and Insects	FAO
Green onions		Common garden onion --> perhaps poor species to estimate with?	Mature bulbs, raw	0.41	0.012	0.27	0.008			0.0002	0.0004	0.002		0.11	Vegetables and Veg Products	FAO
Green peppers	Used Capsicum abyssinicum	--> not sure what kind of peppers these are; used fruit, raw		1	0.03	0.19	0.056	0	14.1	0	0.003	0.016		1.47	Vegetables and Veg Products	FAO
Green squash		Not sure what species this is referring to													Starchy Root, Tubers and Fruits	
Ground nuts		Fat and Niacin composition questionable; Peanut; groundnut; monkeynut; goober-pea (Arachis hypogaea):	Boiled	2.35	0.168	0.45	0.051			0.0044	0.0016	0.014			Grain Legumes and Leg Products	FAO

Name	Scientific Name	Degree Of Nutrient Value Match	Preparation Nutrient Value Based On	Energy (Cal)	Protein (g)	Calcium (mg)	Iron (mg)	VitA (ug)	B-carotene (ug)*	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	Tryptophan (mg)**	VitC (mg)	FAO Food Group[99]	Food Nutrient Value Reference Database
Ground nuts - seasonal edition		Fat and Niacin composition questionable; Peanut; groundnut; monkeynut; goober-pea (Arachis hypogaea):	Boiled	2.35	0.168	0.45	0.051			0.0044	0.0016	0.014			Grain Legumes and Leg Products	FAO
Guavas	psidium guajava	Exact	Fruit, raw	0.64	0.011	0.24	0.013		2.9	0.0006	0.0004	0.013		3.26	Fruits	FAO
Irish potatoes		Protein composition questionable; Potatoes(Solanum tuberosum), tubers	Cooked	0.84	0.02	0.11	0.007							0.12	Starchy Root, Tubers and Fruits	FAO
Kamulali	Capsicum frutescens/ C. annuum	Exact	Raw	0.94	0.041	0.58	0.029		71.4	0.0025	0.002	0.024		1.21	Vegetables and Veg Products	FAO
Kamulali leaves		Peppers (Pipers umbellatum), leaves													Leafy Green Vegetable	
Kisibi		Not sure what this is														
Kyangwe	luffa cylindrica															
Lard (kimbo)															Oils and Fats	
Leeks		Leek (Allium porrum)	raw	0.46	0.015	0.55	0.017							0.11	Vegetables and Veg Products	FAO
Lemon	citrus limon	Lemon (Citrus limon):	Fruit	0.29	0.007	0.25	0.005				0.0002				Fruits	FAO

Name	Scientific Name	Degree Of Nutrient Value Match	Preparation Nutrient Value Based On	Energy (Cal)	Protein (g)	Calcium (mg)	Iron (mg)	VitA (ug)	B-carotene (ug)*	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	Tryptophan (mg)**	VitC (mg)	FAO Food Group[99]	Food Nutrient Value Reference Database
Lentils															Grain Legumes and Leg Products	
Lime	citrus aurantiifolia														Fruits	
acrons		Macaroni	Cooked	1.54	0.047	0.08	0.006								Cereals and Grain Products	FAO
Maize		Maize; corn (Zea mays):	Yellow variety	3.64	0.1	0.13	0.049		1	0.0032	0.0012	0.017		0.04	Cereals and Grain Products	USDA
Maize porridge		Fresh maize meal		0.76	0.018	0.04	0.006			0.0006	0.0001	0.005			Cereals and Grain Products	FAO
Mandarin oranges		Orange, mandarin; tangerine (Citrus reticulata; C. nobilis):	Fruit, raw	0.49	0.008	0.38	0.011		2.3	0.0008	0.0005	0.002		0.28	Fruits	FAO
Matooke		Plantain (Musa paradisiaca): Ripe	Green, unripe, cooked.	0.77	0.013										Starchy Root, Tubers and Fruits	FAO
Milk		Fat composition questionable; Milk, cow:	Whole	0.79	0.038	1.43		0.95	0.8					0.01	Milk	FAO

Name	Scientific Name	Degree Of Nutrient Value Match	Preparation Nutrient Value Based On	Energy (Cal)	Protein (g)	Calcium (mg)	Iron (mg)	VitA (ug)	B-carotene (ug)*	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	Tryptophan (mg)**	VitC (mg)	FAO Food Group[99]	Food Nutrient Value Reference Database
Millet		Ragimillet; African millet; finger millet; tolabun; dagussa; bula; tamba; bolu; korakan; wimbi (Eleusine coracana):	Whole-grain meal	3.36	0.056	3.16	0.545			0.0022	0.001	0.008			Cereals and Grain Products	FAO
Millet porridge		Ragimillet; African millet; finger millet; tolabun; dagussa; bula; tamba; bolu; korakan; wimbi (Eleusine coracana):	Whole-grain meal	3.36	0.056	3.16	0.545			0.0022	0.001	0.008			Cereals and Grain Products	FAO
Mistaferi		Not sure what this is														
Mukwano															Oils and Fats	
Mushrooms		Mushrooms (Agaricus spp.):	raw	3.22	0.0152	0.2	0.015								Vegetables and Veg Products	FAO
Nakati (obogorra)	Solanum aethiopicum	Exact	Raw	0.51	0.048	0.523	0.08		64	0.0023	0.0044	0.018		0.67	Leafy Green Vegetable	FAO
Nyabutongo (*enyabutongo*)	Amaranthus *graecizans*	Exact (spp)	Cooked	0.43	0.04	5.06	0.017								Leafy Green Vegetable	FAO
Obuhindihindi	Phaseolus lunatus	Exact	Whole seeds, dried	3.35	0.214	1.16	0.049			0.0033	0.0016	0.021		0.01		FAO

Name	Scientific Name	Degree Of Nutrient Value Match	Preparation Nutrient Value Based On	Energy (Cal)	Protein (g)	Calcium (mg)	Iron (mg)	VitA (ug)	B-carotene (ug)*	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	Tryptophan (mg)**	VitC (mg)	FAO Food Group[99]	Food Nutrient Value Reference Database
Obuhoro	Tristemma incompletum														Fruits	
Obujabara/ entura	Solanum indicum/ subsp. Distichum	--> genus not specified in tables; Used Solanum macrocarpon, fruit	Fruit, raw	0.4	0.014	0.13									Vegetables and Veg Products	
Obukeje		Not sure what this is														
Obushera		Soured maize meal and sorghum								0.0003	0.0003	0.004			Beverages	
Obusukaali		Banana, dwarf (Musa nana; M. cavendishii; M. sinensis):	Ripe	1.11	0.012	0.1	0.008		2.85					0.01	Starchy Root, Tubers and Fruits	FAO
Obutere		Banana, common (Musa sapientum):	Flour	3.42	0.035	0.45									Starchy Root, Tubers and Fruits	FAO
Obutunguru		Common garden onion	Mature bulbs, raw	0.41	0.012	0.27	0.008			0.0002	0.0004	0.002		0.11	Vegetables and Veg Products	FAO
Omubwiga	Amaranthus hybridus/ subsp. Incurvatus	Exact (spp)	Cooked	0.43	0.04	5.06	0.017								Leafy Green Vegetable	FAO
Omugombe	Vigna unguiculata	Exact	Common, mature seed	3.38	0.225	1.04				0.0008	0.0009	0.04		0.02	Leafy Green Vegetable	FAO
Omukondwa (omurondwa)		Not sure what this is													Fruits	

Name	Scientific Name	Degree Of Nutrient Value Match	Preparation Nutrient Value Based On	Eng-ergy (Cal)	Pro-tein (g)	Cal-cium (mg)	Iron (mg)	VitA (ug)	B-car-otene (ug)*	Thia-mine (mg)	Ribo-flavin (mg)	Niacin (mg)	Tryp-tophan (mg)**	VitC (mg)	FAO Food Group[99]	Food Nutrient Value Reference Database
Omuyonza	Carissa edulis	--> Name in table but no nutrient data	In table but no info!												Fruits	
Omweronde															Fruits	
Orange	citrus sinensis	B-carotene composition questionable; Orange, sweet (Citrus sinensis)	fruit	0.43	0.006	0.28	0.001		0.75	0.0002	0.0003	0.002		0.46	Fruits	FAO
Palm nuts		Palm, African oil (Elaeis guineensis)	kernel, shelled	5.87	0.066	0.78									Nuts and Seeds	FAO
Palm oil															Oils and Fats	
Parsley	petroselinum crispum														Vegetables and Veg Products	
Passion fruit	passiflora edulis	Granadilla, purple; passion fruit (Passiflora edulis), fruit	raw			0.25				0.0003	0.001				Fruits	
Paw paw		Papaya; (Carica papaya)	fruit raw	0.32	0.004	0.21	0.006		9.5	0.0003	0.0003	0.004		0.52	Fruits	FAO
Pork		Pork (Sus scrofa): Medium fat	Not specified	4.18	0.124	0.11	0.018								Meats, Poultry and Insects	FAO
Pork fat		Not important because can not be contributing overly to child's diet														

Name	Scientific Name	Degree Of Nutrient Value Match	Preparation Nutrient Value Based On	Eng-ergy (Cal)	Pro-tein (g)	Cal-cium (mg)	Iron (mg)	VitA (ug)	B-car-otene (ug)*	Thia-mine (mg)	Ribo-flavin (mg)	Niacin (mg)	Tryp-tophan (mg)**	VitC (mg)	FAO Food Group[99]	Food Nutrient Value Reference Database
Posho		Porridge, made from fresh maize meal	Viscosity of porridge not specified	0.76	0.018	0.04	0.006			0.0006	0.0001	0.005			Cereals and Grain Products	FAO
Rabbit		Based on beef; rabbit listed but data not available	Not specified	1.43	0.19	0.08	0.1	8.1	1.8			0.052		0.71	Meats, Poultry and Insects	FAO
Red skinned sweet potatoes		Sweet potato(Ipomoea batatas), roots --> This does not account for the vitamin A in the "Red Skin" that is so valuable	Cooked	1.02	0.019		0.003								Starchy Root, Tubers and Fruits	FAO
Rice		Rice (Oryza sativa):	Cooked, fat added?	1.4	0.023	0.08	0.002								Cereals and Grain Products	FAO
Sheep		Based on beef; sheep data incomplete	Not specified	1.43	0.19	0.08	0.1	8.1	1.8			0.052		0.71	Meats, Poultry and Insects	FAO
Sim Sim Ball, candied		Sesame, sp. (Sesamum alatum), seed	Sesame seeds, whole, roasted and toasted; dried --> I cannot account for the groundnut included in this treat nor the sugar that holds it together	5.65	0.17	9.89	0.15	0.027		0.01	0	0.05			Nuts and Seeds	http://www.nutritionanalyser.com/food_composition/?fid=12024&amount=1&measures=0

Name	Scientific Name	Degree Of Nutrient Value Match	Preparation Nutrient Value Based On	Eng-ergy (Cal)	Pro-tein (g)	Cal-cium (mg)	Iron (mg)	VitA (ug)	B-car-otene (ug)*	Thia-mine (mg)	Ribo-flavin (mg)	Niacin (mg)	Tryp-tophan (mg)**	VitC (mg)	FAO Food Group[99]	Food Nutrient Value Reference Database
Sombe	Manihot esculenta	(Manihot esculenta; M. utilissima), leaves:	Cooked		0.082	1.42	0.03							2.48	Leafy Green Vegetable	
Sorghum		Sorghum, spp.; guineacorn; kaffir-corn (Sorghum spp.):	Whole-grain, meal, unsifted or home-pounded	3.43	0.095	0.28	0.1			0.0028	0.0009	0.034			Cereals and Grain Products	FAO
Sorghum porridge																
Soy beans		Soybean (Glycine max; G. hispida; G. soja):	Whole mature seeds, dried	4.05	0.337	1.83	0.061		0.55	0.0071	0.0025	0.02			Grain Legumes and Leg Products	FAO
Soya porridge		Calcium composition questionable; Soybean (Glycine max; G. hispida; G. soja):	Meal or ground whole dried seeds	3.98	0.337	2.49	0.06			0.0055					Grain Legumes and Leg Products	FAO
Squash		Not sure what squash this refers to													Starchy Root, Tubers and Fruits	
Squash, white	Cucurbita pepo		Squash, summer, zucchini, includes skin, cooked, boiled, drained, without salt	0.16	0.01	0.13		3.351						0.05	Starchy Root, Tubers and Fruits	http://www.nutritionanalyser.com/food_composition/?fid=11478&amount=1&measures=0
Strawberries															Fruits	

Name	Scientific Name	Degree Of Nutrient Value Match	Preparation Nutrient Value Based On	Energy (Cal)	Protein (g)	Calcium (mg)	Iron (mg)	VitA (ug)	B-carotene (ug)*	Thiamine (mg)	Ribo-flavin (mg)	Niacin (mg)	Tryp-tophan (mg)**	VitC (mg)	FAO Food Group[99]	Food Nutrient Value Reference Database
Sugar cane	saccharum officinarum	Preserves, average of all kinds of fruits Sugar cane, stems and juice. See Fruits.	Sugar, native brown	3.44											Sugars and Syrups	FAO
Sukumawiki																FAO
Sweet potatoes		Sweet potato(Ipomoea batatas), roots:	Cooked	1.02	0.019		0.003								Starchy Root, Tubers and Fruits	FAO
wiss chard															Vegetables and Veg Products	
Tamu															Oils and Fats	
Tangerine	citrus reticulata														Fruits	
Tomatoes		Tomato (Solanum lycopersicum; Lycopersicon esculentum):	Ripe, whole	0.21	0.01	0.1	0.006		4.5	0.0006	0.0004	0.006		0.26	Vegetables and Veg Products	FAO
Tomatoes 2		Tomato (Solanum lycopersicum; Lycopersicon esculentum):	Ripe, whole	0.21	0.01	0.1	0.006		4.5	0.0006	0.0004	0.006		0.26	Vegetables and Veg Products	FAO
Tree berries		Blackberry; raspberry; youngberry (Rubus spp.), berries --> In inventory but no data	Is this the same thing as Amakere?												Fruits	

Name	Scientific Name	Degree Of Nutrient Value Match	Preparation Nutrient Value Based On	Energy (Cal)	Protein (g)	Calcium (mg)	Iron (mg)	VitA (ug)	B-carotene (ug)*	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	Tryptophan (mg)**	VitC (mg)	FAO Food Group[99]	Food Nutrient Value Reference Database
Turkey	-	Chicken (Gallus gallus) --> This is the only fowl with data in the nutrient composition table	Young bird	1.46	0.205	0.1	0.011								Meats, Poultry and Insects	FAO
USA vegetable oil															Oils and Fats	
Avocado		Avocado, American: alligator pear (Persea americana; P.gratissima),	raw.	1.21	0.014	0.19	0.014		5.3	0.0005	0.0015	0.02		0.18	Fruits	FAO
Avocado - seasonal		Avocado, American: alligator pear (Persea *americana*; P.gratissima),	Raw.	1.21	0.014	0.19	0.014		5.3	0.0005	0.0015	0.02		0.18	Fruits	FAO
Watermelon	citrullus lanatus	Watermelon (Citrullus lanatus), fruit	raw	0.22	0.005	0.08	0.003		2.5	0.0004	0.0005	0.001		0.08	Fruits	FAO
Wheat (Bread, cakes, muffins, chapati, tea biscui)		Wheat breads:	White bread	2.61	0.077	0.37	0.017			0.0016	0.0006	0.01		0	Cereals and Grain Products	FAO

Name	Scientific Name	Degree Of Nutrient Value Match	Preparation Nutrient Value Based On	Eng-ergy (Cal)	Pro-tein (g)	Cal-cium (mg)	Iron (mg)	VitA (ug)	B-car-otene (ug)*	Thia-mine (mg)	Ribo-flavin (mg)	Niacin (mg)	Tryp-tophan (mg) **	VitC (mg)	FAO Food Group[99]	Food Nutrient Value Reference Database
Yam		The type of yams observed in Uganda is not certain; therefore, the nutrient values are an average of the nutrient composition of the 10 type of yams whose nutrient values are published in the FAO table "Food Nutrition Table for Use in Africa": 1) [Taro; d	tuber, raw	1.13	0.0247	0.548	0.022		0.1	0.00087	0.00027	0.0053	0.26	0.0867	Starchy Root, Tubers and Fruits	FAO

Appendix 13: Grouping Households by Socioeconomic Status (SES)

It is widely accepted that SES is associated with health outcomes, nutritional status included, so many studies stratify their results by SES (see **Figure 1**). Consumption expenditures are one methods of appraising SES. Consumption expenditures assess food expenditures on market purchases and inputs into home production as well as nonfood expenditures including weekly and annual expenses, the depreciation of consumer durables, utilities, house renting or retail value, education expenses and in-kind wages[102]. Houweling et al. describe that measuring household data on wealth is problematic because data on frequently used indicators, mainly household income and expenditure levels, are often unavailable or unreliable[103,104]; moreover, in a country or study where the majority of the participants are involved in subsistence agriculture or the informal sector, expressing income or expenditure levels in monetary values can be extremely time-consuming and suffer important reliability problems[103]. It has been suggested that the assets a household has acquired is a good indicator of the 'long-run' economic status of the family[103]. Referencing data from numerous national studies, Sahn and Stifle have suggested that an index based on the assets a household has as opposed to a household's expenditures is a better predictor of child nutritional status because the latter is more prone to measurement error [102]. Assuming that long-run wealth is what causes the most common variation in asset variables[105], the asset index is a suitable predictor of child nutrition outcomes[102].

Indices aside, a valid question is: why use the SES/household variables to create an index when they could be put directly into the model? Some SES/household variables are also direct determinants of child nutritional status; the problem, explained by Filmer and Pritchett, is that putting these variables directly into the model does not isolate the "wealth effect" from the direct effect the variable has upon the outcome of interest. For example, home latrine status may be an indicator of wealth but it is also an indicator of home hygiene, something that has direct impact on child nutritional status. They caution that placing an SES/household variable directly into the model does not allow one to infer from the unconstrained regression coefficients the impact of an increase in wealth. Therefore, while in some sense the regression coefficients produce a linear 'index' of the asset variables (that which best predicts the dependent variable), the index cannot be interpreted as the effect of an increase in wealth; therefore, outcomes cannot be stratified by SES. While Filmer and Pritchett do not propose that asset indices be used for poverty analysis or as a proxy for living standards, they suggest it is effective for sample stratification[105].

When constructing an index, the basic decisions concern the variables include in the index and the weights to assign to them. Houweling et al. criticized an asset index used in a series of World Bank studies[106] because it contained variables that were both directly and indirectly related to the outcome of interest, child mortality. They stated that in explanatory research, it is important to make a conceptual distinction between factors that work directly on health, such as exposure to infection (for instance, through unhygienic sanitary practices) and the indirect, distal determinants of health such as household wealth. They suggested that it is preferable that an asset index not contain direct determinants of health. However, Vyas et al. pointed out that exclusion of variables may make it more difficult to divide households, particularly when considering smaller groups, into SES strata[107]. The present study took steps to minimize the number of durable assets directly related to stunting status that went into the asset index. However, assets significantly correlated with child stunting status were not systematically excluded from the asset index.

The second question of concern when constructing an asset index is the weights to assign to each variable. Houweling et al. point out cynically that "Equal weights have the appeal of simplicity and apparent objectivity but these qualities only mask the fact that the imposition of numeric equality is completely arbitrary."[103]. One may chose to assign weights to index items using reason but this could be equally arbitrary. Principle Component Analysis (PCA) it a third option and permits variables to self-weight based on the way they correlate with one another. The World Bank used scores derived from PCA as the weights of the items in its asset index[106]. It is explained that factor scores are a measure of the strength of the association of an item with the first principle component and assumed that this first factor represents household economic status[103]. PCA produces an unbiased index but it may produce odd results if applied to a short index item list[103]. The minimum number of index items necessary was not discussed; therefore, this limitation must be kept in mind during data analysis.

Appendix 14: The Mean, Linearized Standard Error, and Count of Stunting, Wasting and Underweight as well as HAZ, WHZ, WAZ and Breastfeeding Status by Traditional Age Grouping for children of 0 to 59 months

Age Group	0 to 59 months			0 to 5 months			6 to 11 months			12 to 23 months			24 to 35 months			36 to 47 months		
Variable	$\bar{\mu}$ / %	**Std err.**	**n**	$\bar{\mu}$ / %	**Std err.**	**n**	$\bar{\mu}$ / %	**Std err.**	**n**	$\bar{\mu}$ / %	**Std err.**	**n**	$\bar{\mu}$ / %	**Std err.**	**n**	$\bar{\mu}$ / %	**Std err.**	**n**
Stunting	0.428	0.035	322	0.196	0.075	23	0.347	0.113	31	0.498	0.061	85	0.360	0.086	68	0.438	0.077	56
Wasting	0.035	0.013	321	0.115	0.078	22	0.000	0.000	31	0.046	0.025	85	0.025	0.016	68	0.024	0.017	56
Under-weight	0.175	0.046	322	0.000	0.000	23	0.088	0.045	31	0.176	0.052	85	0.163	0.092	68	0.280	0.073	56
HAZ	-0.9722	0.2892	23	-1.492	0.5519	31	-1.7707	0.2438	85	-1.3639	0.2944	68	-2.222	0.2678	56	-1.9864	0.2114	59
WHZ	0.323	0.116	321	1.501	0.481	22	1.136	0.273	31	0.690	0.239	85	-0.332	0.138	68	0.127	0.142	56
WAZ	-0.893	0.130	322	0.338	0.244	23	-0.433	0.336	31	-0.678	0.237	85	-1.141	0.221	68	-1.227	0.183	56
Breast feeding	0.218	0.026	322	0.919	0.076	23	0.738	0.091	31	0.306	0.076	85	0.030	0.020	68	0.035	0.032	56

Age Group	48 to 59 months		
Variable	$\bar{\mu}$ / %	**Std err.**	**n**
Stunting	0.523	0.102	59
Wasting	0.026	0.024	59
Under-weight	0.176	0.056	59
HAZ	-1.7313	0.1307	322
WHZ	-0.044	0.199	59
WAZ	-1.245	0.141	59
Breast feeding	0.000	0.000	59

Appendix 15: *The Mean, 95% Confidence Intervals and Count for Stunting, Wasting and Underweight as well as HAZ, WHZ and WAZ by Purposeful Age Grouping for Children of 6 to 59 months*

Age Group	Overall: 6 to 59 months				6 to 11 months				12 to 23 months				24 to 41 months			
Anthropometric Indicator	**Mean**	**95% CI**		**Count**	**Mean**	**95% CI**		**Count**	**Mean**	**95% CI**		**Count**	**Mean**	**95% CI**		**Count**
Stunted	0.45	0.37	0.52	299	0.35	0.11	0.59	31	0.50	0.37	0.63	85	0.35	0.24	0.46	101
Wasted	0.03	0.01	0.05	299	0.00	-	-	31	0.05	-0.01	0.10	85	0.02	0.00	0.05	101
Underweight	0.19	0.09	0.29	299	0.09	-0.01	0.18	31	0.18	0.07	0.28	85	0.18	0.01	0.36	101
HAZ	-1.79	-2.07	-1.51	299	-1.49	-2.65	-0.33	31	-1.77	-2.28	-1.26	85	-1.51	-1.96	-1.07	101
WHZ	0.24	0.01	0.47	299	1.14	0.56	1.71	31	0.69	0.19	1.19	85	-0.18	-0.47	0.10	101
WAZ	-0.98	-1.26	-0.71	299	-0.43	-1.14	0.27	31	-0.68	-1.18	-0.18	85	-1.10	-1.46	-0.75	101

Age Group	42 to 59			
Anthropometric Indicator	**Mean**	**95% CI**		**Count**
Stunted	0.55	0.39	0.71	82
Wasted	0.03	-0.01	0.07	82
Underweight	0.24	0.12	0.35	82
HAZ	-2.27	-2.73	-1.81	82
WHZ	0.03	-0.33	0.39	82
WAZ	-1.33	-1.63	-1.03	82

Appendix 16: Recommended Daily Intake Values for Study Nutrients, by Age Group

Age Group (months)	Protein (g/day)	Calcium (mg/day)	Iron (mg/day)	Vitamin A (ug/day)	Thiamine (mg/day)	Riboflavin (mg/day)	Niacin (mg NE/day)	Vitamin C (mg/day)
0-5	9.3	210	0.27	400	0.2	0.3	2	40
6-11	11	270	11	500	0.3	0.4	4	50
12-35	13.7	500	7	300	0.5	0.5	6	15
36-60	21	800	10	400	0.6	0.6	8	25

Source: Shils et al.[93]; energy requirement was calculated based on a formula from Shils et al., 2006.

Appendix 17: The Nutrient Intake Adequacy (NAR), Mean Adequacy Ratio (MAR) and Food Variety Score (FVS) For All Study Nutrients By Age Group

Age Group	Overall: 6 to 59 months of age				6 to 11 months of age				12 to 23 months of age				24 to 41 months of age			
Adequacy of Nutrient Intake	**Mean**	**95 % CI**		**Count**	**Mean**	**95 % CI**		**Count**	**Mean**	**95 % CI**		**Count**	**Mean**	**95 % CI**		**Count**
MAR	9.29	9.10	9.48	297	7.24	5.98	8.50	29	9.05	8.74	9.36	85	9.72	9.56	9.87	101
FVS	24.76	22.99	26.52	296	17.85	14.48	21.22	29	24.19	22.26	26.12	85	25.99	23.56	28.42	100
Protein	3.62	3.30	3.94	296	2.59	1.62	3.55	29	3.54	2.98	4.10	85	4.27	3.71	4.83	100
Energy	1.96	1.78	2.15	296	1.29	0.88	1.71	29	1.90	1.59	2.21	85	2.24	1.96	2.51	100
Iron	2.83	2.52	3.14	294	0.86	0.46	1.26	27	2.75	2.23	3.27	85	3.44	2.89	3.99	100
Calcium	1.94	1.67	2.20	296	2.19	1.30	3.07	29	2.19	1.51	2.86	85	2.04	1.78	2.31	100
Vitamin A	12.53	10.43	14.63	296	3.80	1.90	5.70	29	11.83	8.19	15.46	85	14.89	12.39	17.40	100
Vitamin C	21.33	17.63	25.03	296	2.83	1.39	4.26	29	20.11	13.55	26.67	85	25.80	19.85	31.74	100
Thiamine	1.64	1.46	1.83	293	1.24	0.62	1.86	26	1.33	1.11	1.54	85	1.97	1.63	2.32	100
Riboflavin	1.67	1.46	1.88	293	0.94	0.39	1.48	26	1.30	1.06	1.53	85	2.09	1.69	2.49	100
Niacin	1.99	1.70	2.28	296	1.35	0.83	1.87	29	1.60	1.22	1.98	85	2.50	1.87	3.13	100

Age Group	42 to 59 months of age			
Adequacy of Nutrient Intake	**Mean**	**95 % CI**		**Count**
MAR	9.60	9.40	9.80	82
FVS	25.82	23.78	27.85	82
Protein	3.15	2.88	3.43	82
Energy	1.87	1.62	2.12	82
Iron	2.67	2.30	3.04	82
Calcium	1.46	1.28	1.64	82
Vitamin A	12.81	9.56	16.06	82
Vitamin C	22.32	17.50	27.14	82
Thiamine	1.66	1.46	1.85	82
Riboflavin	1.72	1.48	1.96	82
Niacin	1.92	1.54	2.30	82