EFFECT OF NUTRITION EDUCATION ON NUTRITIONAL STATUS AND GROWTH OF YOUNG CHILDREN IN WESTERN UGANDA

by

MARGARET KIIZA KABAHENDA

(Under the Direction of Rebecca M Mullis)

ABSTRACT

This study has two major components: a baseline cross-section survey conducted to assess feeding behaviors and children's nutritional status and an intervention conducted to ascertain the effectiveness of a nutrition education program on feeding practices of caregivers and nutritional status of their young children.

The baseline cross-sectional survey shows that malnutrition was a problem of public health concern in the study sites. Stunting affected 24.4% of the 204 children assessed, 9.9% were underweight, 39.8% were anemic, while 37.9% were vitamin A deficient. Food selection patterns suggest that bananas were the major staple while beans were the major relish and protein source. Diets of children were limited in variety and possibly inadequate to support normal growth.

The intervention was designed to change the caregivers' food selection patterns to ensure that young children get adequate calories and nutrients. Two groups of caregivers and their children participated in the intervention. One group of caregivers attended nutrition education classes whereas the controls concurrently participated in sewing classes that lasted 5 weeks. Children were weighed and measured each month for one year.

Compared to controls, caregivers in the intervention group reported selecting an increased variety of grains, fats and sweets, legumes, meats, fruits, and vegetables one month after the intervention (Time 2) and nine months later (Time 3). The intervention group also provided young children with more snacks than the controls at Time 2 (Mean: 1.26 versus 0.35, p = 0.000) and at Time 3 (Mean: 1.22 versus 0.58, p = 0 .001), but no changes were observed in number of meals. Children in the intervention group also had improved vitamin A status (Mean change retinol binding protein concentration = 0.24 μmol/L versus 0.04 μmol/L) and growth (Mean weight-for-age: 0.61 ± 0.15 versus -0.99 ± 0.16, p = .038).

Overall, the intervention was effective in improving caregivers' food selection practices and meal planning skills and improved children's nutritional status and growth. However, improvement in nutritional status and growth might have been compromised by the high prevalence of infections, seasonal food shortages, and the heavy workloads of caregivers.

KEY WORDS: Nutrition education, Intervention, Feeding practices, Malnutrition, Vitamin A, Anemia, Growth, Diets, Infections, Uganda.

EFFECT OF NUTRITION EDUCATION ON NUTRITIONAL STATUS AND GROWTH OF YOUNG CHILDREN IN WESTERN UGANDA

by

MARGARET KIIZA KABAHENDA

B.S., Southern Illinois University, Carbondale, 1999

M.S., The University of Georgia, 2002

A Dissertation Submitted to the Graduate Faculty of The University of Georgia in Partial Fulfillment of the Requirements for the Degree

DOCTOR OF PHILOSOPHY

ATHENS, GEORGIA

2006

EFFECT OF NUTRITION EDUCATION ON NUTRITIONAL STATUS AND

GROWTH OF YOUNG CHILDREN IN WESTERN UGANDA

by

MARGARET KIIZA KABAHENDA

Major Professor: Rebecca M Mullis

Committee: Elizabeth L Andress
Patrick Horan
Richard D Lewis
Sharon Y Nickols

Electronic Version Approved:

Maureen Grasso
Dean of the Graduate School
The University of Georgia
August 2006

DEDICATION

To Eynise Tara.

ACKNOWLEDGEMENTS

This research was a collaborative effort and would never have been accomplished without the support of many special organizations and talented individuals. I highly acknowledge the support of Strategies and Analysis for Growth and Access (SAGA)[1], for providing me a research grant that supported the baseline survey and the equipment used for growth monitoring. I also acknowledge the support of the Economic Policy Research Centre (Uganda) which served as my host institution while I was conducting the baseline survey and provided office facilities and technical support. Sight and Life and SEAMEO-TROPMED RCCN[2] are highly appreciated for supporting the processing of dried blood spots for the analyses of vitamin A and acute phase proteins. Hemocue (USA) and High Chem Uganda Ltd are also acknowledged for loaning us the b-Hemoglobin photometers and providing some supplies for assessing hemoglobin. I am also very grateful to the American Association of Family and Consumer Sciences for funding the revisions of the intervention curriculum. Special thanks to the College of Family and Consumer Sciences Foundation and the Department of Foods and Nutrition at the University of Georgia for providing me with financial support to conduct my research and complete my studies.

Of course the support of these organizations would not have benefited my research without the talent and commitment of some special individuals. I am very grateful to Dr. Jeugen Erhardt (SEAMEO-TROPMED RCCN, University of Indonesia),

[1] Cooperative agreement between USAID and Cornell and Clark-Atlanta Universities
[2] South-East Asian Ministers of Education Organization-Tropical Medicine and Public Health Regional Center for Community Nutrition

Dr Christine Northrop-Clewes (IMMPaCt[3] Programme, Centers for Disease Prevention and Control); Dr Mesfin Bezuneh and Andre McKinney of SAGA-Clark-Atlanta University; Dr Okidi of EPRC[4] (Uganda); Jing Xu and Dr Dan Hall from the Statistical Consulting Centre, University of Georgia; and Serina Tabb of Hemocue Inc (USA). I am also very grateful to all the staff and faculty of the College of Family and Consumer Sciences and particularly in the Department of Foods and Nutrition for your support. Special thanks to Veronica Wright, Linnie Martin, Terry Kelly, and Dr Micheal Mouat. And a big salute to my research advisory committee members! Thank you Drs: Elizabeth L Andress, Christine Northrop-Clewes, Patrick Horan, Richard D Lewis, Rebecca M Mullis, and Sharon Y Nickols. I am very grateful for your mentorship.

Fifteen months in the field taught me a great deal about myself and the people I encountered. Overall, I am thankful for being blessed with some special people: Mrs. Mugisa - the educator, Patrick Ruyonga – my longtime assistant, Kyalimpa - our driver and ‘catering officer’, Mr. Basaliza – head of our ‘host family’, and my brother Aberi. You all made my fieldwork fun and endurable. Your good humor and commitment always made the village footpaths feel wider and less thorny. I will always cherish the moments we spent on the road whether it was digging the car out of ditches, repairing tires and oil leaks, stuck in the mud, having a frantic ride to the study sites, or having a pleasant ride home under a cloud of dust after dusk. Keep up the good spirit!

I am also very thankful to my family. You were all awesome on my big nights! I thank you for all the help that you gave me in putting my materials together and stepping in to help whenever needed. You made me very appreciative of the concept of the

---

[3] International Micronutrient Malnutrition Prevention and Control Program
[4] Economic Policy Research Centre

African family. I am equally indebted to my American family and friends. Your love, support, and encouragement pulled me through thick and thin. Mr Rodrick, thanks for the free parking. It made my movements to campus back and forth affordable.   Special thanks to Mrs. Due. You have been a great mentor, cheerleader, mother, and friend.

May God bless you all!

TABLE OF CONTENTS

Page

ACKNOWLEDGEMENTS ... v

TABLE OF CONTENTS ... viii

LIST OF TABLES ... xi

LIST OF FIGURES ... xii

CHAPTER

1 INTRODUCTION ... 1

2 LITERATURE REVIEW ... 4

Prevalence of Undernutrition in Uganda ... 6

Risk Factors for Undernutrition ... 10

Dietary Patterns of Young Children ... 12

Interventions to Improve Nutritional Status ... 15

Preliminary Studies ... 17

Hypotheses Tested ... 19

Rationale ... 19

References ... 22

3 DIETARY INTAKE AND NUTRITIONAL STATUS OF YOUNG CHILDREN IN KABAROLE DISTRICT, WESTERN UGANDA ... 28

Abstract ... 29

Background ... 31

Research Methods 32
Results and Discussion 36
Conclusions 44
References 47
4 EFFECT OF NUTRITION EDUCATION ON CAREGIVERS' FEEDING PRACTICES AND CHILDREN'S NUTRITIONAL STATUS: AN INTERVENTION TRIAL IN WESTERN UGANDA 56
Abstract 57
Introduction 59
Research Methods 60
Results 65
Discussion 68
Conclusions 72
References 73
5 A LONGITUDINAL STUDY OF GROWTH AMONG YOUNG CHILDREN IN A RURAL UGANDAN SUBSISTENCE FARMING COMMUNITY 81
Abstract 82
Introduction 84
Methods 86
Data Analysis 88
Results 89
Discussion 91
Conclusions 94

References: ... 96

6 DISCUSSION AND CONCLUSIONS ... 103

References ... 111

APPENDICES ... 112

A Recruitment Form ... 113

B Informed Consent Script ... 115

C Anthropometric Assessment Questionnaire ... 117

D Clinical Examination Data Sheet ... 119

E Dietary Assessment Questionnaire ... 121

F Phlebotomist Script ... 129

G Growth Monitoring Questionnaire ... 131

H Procedures for Conducting Anthropometrical Assessments ... 134

I Protocol for Collecting and Processing Blood Samples ... 138

LIST OF TABLES

Page

Table 3.1: Organization of Assessment Stations 49

Table 3.2: Characteristics of Study Participants.. 50

Table 3.3: Prevalence of Stunting and Underweight among Young Children 52

Table 3.4: Prevalence of Malnutrition indicated by Clinical Assessments 53

Table 3.5: Variety in Household Diets 54

Table 4.1: Key Food selection and Preparation Practices Targeted by the Intervention..78

Table 4.2: Changes in Food Selection Practices and Quality of Children's Meals 1 Month after the Intervention (Time 2). ……………………..……………………79

Table 4.3: Hemoglobin and Retinol Binding Protein Status at the Three Major Assessment Points ……………………………………………………..……80

Table 5.1: Outline of Intervention Curriculum ………………………………..….100

Table 5.2: Prevalence of Stunting, Underweight, Wasting, and Low MUAC-for-age at Baseline and 9 Months after Intervention………….. ……..……………101

LIST OF FIGURES

Page

Figure 1.1: Study Design 3

Figure 2.1: Effect of Caregiver's Feeding Behavior on Young Children's Nutritional Status 27

Figure 3.1: Frequency of Food Selection by Food Group 55

Figure 5.1: Mean Changes in Height-for-Age, Weight-for-Age, and Weight-fo Height Z-scores……….…………………………………….……..…………….102

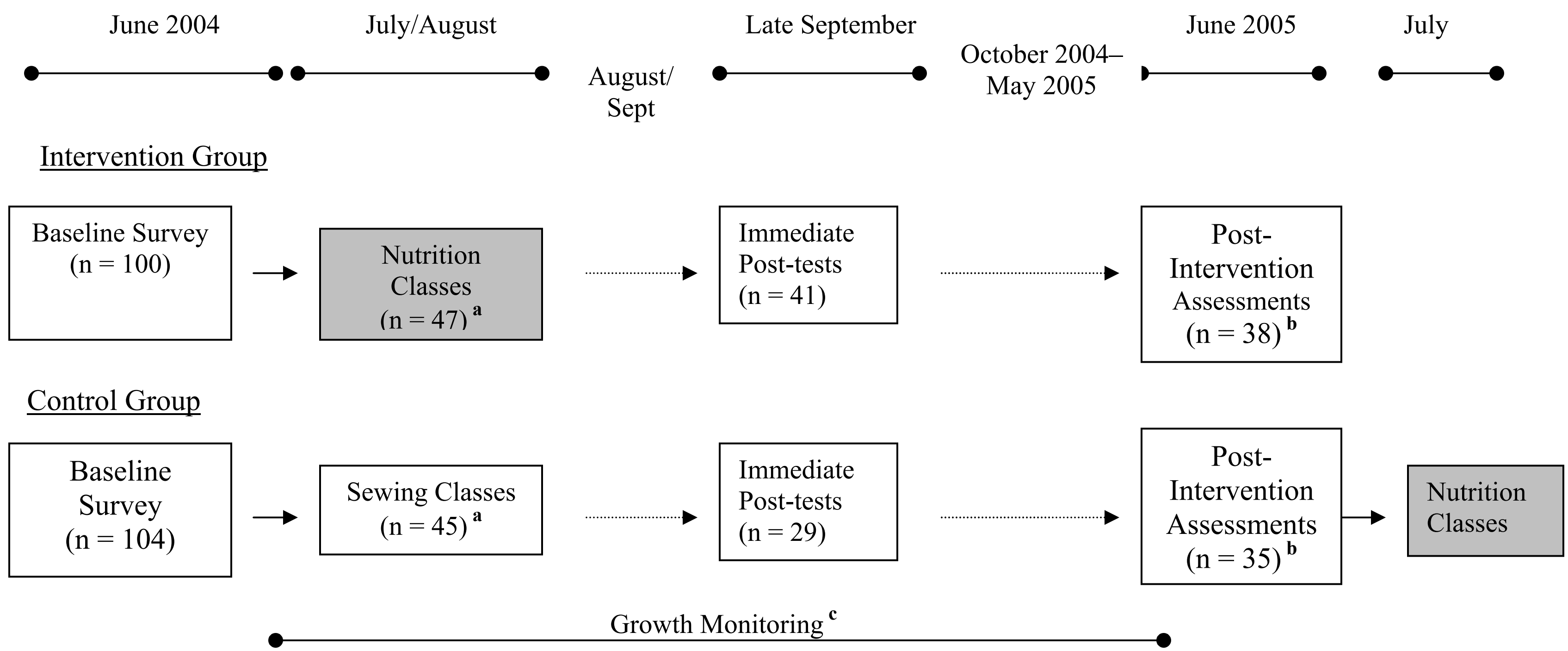
CHAPTER 1

INTRODUCTION

Malnutrition is a serious health concern for children in the developing world. Children under 5 years of age are often at a high risk for malnutrition because this is a period of rapid growth and development characterized by changes in body size and composition and increased physical activity. The consequences of malnutrition are severe and long-lasting when it occurs at an early age (1). In this regard, children need nutritionally adequate diets to provide for the increased nutrient needs. Since most children are developing eating patterns at this stage (2), this is a good time for child-caregivers to encourage appropriate eating habits. The mother, who is in most cases the primary child-caregiver, is usually responsible for ensuring that children are provided with nutritionally adequate diets.

In this study, a nutrition education program was implemented to empower low-income, low literate, rural Ugandan mothers with skills to provide nutritionally adequate diets to their young children. The education program was piloted with a group of low income, rural mothers in western Uganda (3). The results of the pilot study suggest that providing mothers (caregivers) with appropriate nutrition information can lead to improvements in their knowledge, beliefs, and feeding behaviors. However, it was not determined whether the intervention improved the nutritional status of the children whose mothers participated in the intervention. Therefore, there was need to re-assess the effectiveness of the intervention and to determine the efficacy of using this program to improve the nutritional status of young children. Thus, the goal of this study was to determine whether this intervention can improve the feeding behaviors of rural caregivers and consequently lead to improvement in the nutritional status of their young children (6-59 months). **Figure 1.1** depicts the study design. The study protocol was reviewed and approved by the University of Georgia Institutional Review Board and the Uganda National Council for Science and Technology.

As Whitehead (1974) pointed out, intervening to improve nutritional status in developing countries requires more understanding of the nature and possible causes of the malnutrition. It requires a clear understanding of the types of malnutrition in the community, knowing who is affected and level of severity of malnutrition, nature of dietary deficiencies, and environmental factors that increase risk for malnutrition (4). The next chapter is a review of literature on the problem of malnutrition in Uganda, possible causes of undernutrition, and interventions that have been conducted to combat undernutrition in Uganda. Chapter 3 is a cross-sectional study that documents the pre-intervention characteristics of caregivers and the nutritional status of young children in the two sites that were selected for intervention. Chapter 4 discusses the intervention and the effects of the intervention on caregivers' beliefs, food selection patterns, and feeding behavior and effect on children's nutritional status. The effect of the intervention on growth patterns of young children is discussed in Chapter 5. This chapter describes the results from growth monitoring data which was collected over the course of one year. The last chapter is a summary and discussion of key findings from the entire study



n = Number of caregivers. Some caregivers had more than 1 child.
[a] Subjects were randomly selected from the pool of child/caregiver pairs that participated in baseline survey.
[b] All that participated in baseline survey were expected at this assessment. Due to the high drop out rate of non-participants, with the exception of baseline survey, the post intervention n reflect caregivers that participated in sewing and cooking classes only.
[c] Monthly anthropometrical assessments (growth monitoring) were conducted on children whose caregivers participated in cooking and sewing classes.

Figure 1.1: Study Design

CHAPTER 2

LITERATURE REVIEW

Undernutrition threatens the health status, growth, and survival of young children in developing countries. According to a report by the World Health Organization, malnutrition accounted for about 55% of all child deaths that occurred in developing countries in 1995 (5). This is a grim statistic considering that an estimated 150 million children in developing countries are malnourished (6). Reducing hunger and under-five mortality are among the central themes of the United Nations millennium development goals (7), and many nations have set forth strategies for reducing childhood malnutrition. The question that remains unanswered is whether the goal of halving the 1990 level of underweight by 2015 will be attained especially in Sub-Saharan Africa and South East Asia, which are the two regions with staggering levels of child undernutrition.

The 1990 World Summit goal was to reduce the prevalence of severe and moderate malnutrition among under-five children by one half by the year 2000 (6). Overall, between 1990 and 2000, the number of malnourished children declined from 174 million to 150 million (32% to 28%) in developing countries as a whole (6). The small decline in the rate of malnutrition was attributed to the fact that while some regions like East Asia, the Pacific, Latin America and the Caribbean experienced substantial reductions over the decade, the number of malnourished children increased in other regions. Most countries in Sub-Saharan Africa saw little or no decline while others reported an increased prevalence of malnutrition (6). Between 1980 and 2000 the number of stunted children in Africa is estimated to have increased from 34.8 to 47.3 million, which indicates a 5.3% decrease (from 40.5% to 35.2%) in the 20 year period (8). In the eastern African region, prevalence of stunting among preschool-age children is estimated to have increased from 46.5% to 48.1% (a rate of 0.08% per year), and this rate is expected to remain high (8). These trends indicate that the MDG of halving the 1990 level of malnutrition by 2015 may not be attained.

Analyses of trends in growth faltering in Latin America and Africa suggest that children in these regions are usually born within the normal ranges of the reference population for height-for-age and grow well during the first 3-4 months of age; however, many of these children experience growth faltering thereafter (9, 10). Growth faltering usually coincides with the introduction of complementary (or weaning) foods, which are often inadequate in calories and nutrients and most often expose children to gastrointestinal infections. In general, growth continues to decline gradually until around 18 months of life (9), but linear growth may remain depressed up to 3 years of age. For children under 3 years, deficits in linear growth indicate a process of failing to grow whereas for those over 3 years it indicates stunting or failure to grow (11). Thus, interventions designed to improve growth often target children under 3 years of age. The lack of significant differences in height-for-age across age groups indicate that chronic malnutrition is a problem among all age groups. One study conducted in northwestern Uganda showed that both young and older children were at risk for stunting and the odds of recovering from stunting were similar among children <6 months and 54-59 months (12). This emphasizes the need for growth promotion programs that target all children.

PREVALENCE OF UNDERNUTRITION IN UGANDA

Uganda is one of the Sub-Saharan African countries experiencing high levels of childhood undernutrition and a number of studies suggest that malnutrition is a problem across the country (13-17). Results of the 2000-2001 Uganda Demographics and Health Survey (UDHS) show that about one half of Ugandan children suffer chronic malnutrition and a large number of Ugandan children (0 to 59 months) are undernourished or at risk for malnutrition (18). Of the 6,145 children that were assessed, 15.3% were severely stunted, 39.1% were stunted, 4.1% were wasted, and 22.8% were classified as underweight. Based on the World Bank country profiles, it is estimated that the prevalence of malnutrition among under-fives in Uganda increased by 2.5% (23.0% to 25.5%) between 1990 and 1995 and declined from 25.5% in 1995 to 22.9% in 2001 (19). The prevalence of malnutrition in Uganda is expected to decrease to 11.5% by the year 2015; however, the current trends of malnutrition (20) indicate that this goal may not be attained unless very aggressive measures are undertaken to improve health and nutritional status, especially in rural areas.

Overall, it seems that both chronic (stunting) and acute (underweight) malnutrition are more prevalent in rural areas. The 2000-01 UDHS survey documented a 39.9% incidence of stunting in rural areas and 26.5% in urban settings (18). The proportion of children with low weight-for-age was also high in rural areas (23.6%); but was half as frequent in urban settings (12.4%). This could partly be explained by the uneven distribution of resources. When compared to urban dwellers, most rural populations have limited access to health services, clean water, nutrient-dense foods, and health information. Since more than 80% of Uganda's population resides in rural areas, this means that a large proportion of children are at risk for malnutrition. The central region, which has a large urban population, appears to have the lowest incidence of malnutrition. Western Uganda is the region that has a large rural population and the highest rate of malnutrition (18).

The scope of micronutrient deficiencies is not well defined; however, a review of the dietary patterns reported by various investigators (13, 14, 21, 22) suggests a possibility of multiple micronutrient deficiencies. A zinc supplementation intervention conducted in central Uganda did not result in significant changes in growth of supplemented children when compared to controls that did not receive the supplement (23). According to the investigators, this finding indicates that zinc was not the only nutrient that was deficient in diets of young children. The poor quality of diets and high risk of infections are likely to predispose a large proportion of Ugandan children to multiple micronutrient deficiencies. The micronutrients of major concern in Uganda are iodine, iron, and vitamin A; the three nutrients known to pose major threat to the health of young children in the developing world.

Iodine Deficiency

Iodine deficiency, indicated by goiter and low urinary iodine, has been a major problem in Uganda since the late 1960s. Reports from health centers suggest that goiter is prevalent in the country, especially in mountainous regions (24, 25). Iodine deficiency has been tackled through the Universal Salt Iodination program which was initiated in early 1990s. Major progress is attributed to the government's efforts on restricting importation of salt that is not iodized.

A survey of 2880 school age old children in 72 primary schools revealed a goiter prevalence of 60.2%, which indicates a 14.1% decrease in prevalence between 1991 and 1999 (26). According to the 2000-01 UDHS, 94.8% of the households that provided salt samples had adequately iodized salt (15 ppm[5] or higher) and only 1.5% used salt that was not iodized. More efforts are needed to improve awareness on the benefits of iodine to health. The 2000-01 UDHS survey indicated that the proportion of households not using iodized salt was higher than average in the western region (6.2%) and in rural areas (1.7%). The low consumption of iodized salt in the western region could partly be explained by the easy access to unrefined and non-iodized salt from Lake Katwe. Rural populations also prefer the unrefined rock salt to iodized table salt because the former tenderizes beans and other vegetables which are a big component of diets of rural households especially in western Uganda.

Vitamin A Deficiency

According to the WHO, vitamin A deficiency (Xeropthalamia) is considered a public health problem if the prevalence of night blindness is >1%, Bitot's spots >0.5%, corneal xerosis >0.01%, or corneal scars >0.05% (27, 28). High prevalence of sub-clinical vitamin A deficiency (serum retinol <0.70 µmol/L or 20 µg/dl) also indicates a public health problem. Bachou (2000) reported on some findings of a cross-sectional survey[6] of 5074 under 6 year-old children in eastern Uganda. This survey revealed that 2.52% of

---

[5] Parts per million
[6] Kamuli Blindness and Vitamin A Demography Survey conducted by Medi-Kawuma and Louise Sserunjogi

children surveyed had night blindness, 1.04% had Bitot's spots, 0.26% had corneal xerosis, and 1.74% had corneal scars (25). These results indicate that vitamin A is a problem of public health concern in this region. The 2000-01 UDHS shows that about 28% of children under 5 years of age were likely to be deficient in vitamin A (serum retinol <0.7 μmol/L). Vitamin A deficiency was widespread in the country; however, the prevalence was higher in the northern region (36.3%) and among children whose mothers did not attain secondary school education (18). Since the prevalence of infections is not documented in this survey, it is not clear whether vitamin A deficiency is an indicator of low body stores depleted by infection or a result of poor dietary intake.

The government of Uganda is among the countries that have implemented vitamin A capsule supplementation programs as a way to improve vitamin A nutriture and prevent many of the childhood illnesses and decrease related mortality. The 2000-2001 UDHS revealed that 37.6% of children under 5 years of age had received vitamin A supplements in the six months preceding the survey (18). However, children in rural areas and children of less educated mothers were less likely to have received these supplements. This is a dire situation since children in rural areas and children of less educated mothers are often at a higher risk for deficiency. The level of supplementation in rural areas has been improved by incorporating the delivery of supplements into the national immunization days (NIDS), Child Health Days, and other health centre services (29) . In addition, other food-based interventions have also been implemented to boost dietary intake of vitamin A. Such interventions include the implementation of the orange-fleshed sweet potato program (30), fortification of cooking oil , and efforts are underway to fortify sugar.

Iron Deficiency Anemia

Iron deficiency and iron deficiency anemia are common global problems. The scope of iron deficiency among Ugandan children has not been determined; however, the 2000-01 UDHS revealed a 64% prevalence of anemia (hemoglobin <11 g/dl) among young children. It is estimated that about one half of the Ugandan population is likely to have iron deficiency anemia (31). Pregnant women and young children are the two populations with the highest risk for iron deficiency (18, 32, 33). The causes of iron deficiency are varied, but the poor quality of the diets predisposes the majority of the population to iron deficiency anemia. Unless there is a high intake of bioavailable contaminant iron (34), the dietary patterns across the country do not indicate optimal levels of iron intake. Many diets are composed of staples that are high in phytates and tannins, which limit bioavailability of iron and other essential nutrients. In addition, the high incidence of malaria (35), helminthes (36), AIDS/HIV (33), and other infections predispose a large proportion of the Ugandan population to anemia and iron deficiency. Interventions to reduce anemia include de-worming of young children, supplementation of pregnant women, and other public health interventions such as improving sanitation. Novel food-based interventions such as fortification of bean paste with dried bovine blood (37) are also being investigated.

RISK FACTORS FOR UNDERNUTRITION

A cross-sectional assessment of 4320 children in southwestern Uganda revealed a trend whereby nutritional status tends to deteriorate after the first 3 months of life (12, 17). Stunting (which is a good indicator of chronic undernutrition) tends to start at birth and continues during the first 36 months of life, whereas the process of wasting tends to affect children between 3 to 15 months of life (38). The early onset of chronic undernutrition is, in most cases, attributed to the poor nutritional status of the mother during pregnancy and lactation and a large proportion of pregnant and lactating women in Uganda are not getting adequate nutrition (18). Malnutrition is often exacerbated by an early introduction of complementary foods. Data indicate that one in every four Ugandan children start receiving complementary foods around 2-3 months; and during the period of 6-9 months after birth, 83% of Ugandan children have received non-human milk or complementary foods (18). In most cases, these complementary foods and supplemental milks are of poor quality and increase the risk for diarrheal infections; hence the prevalence of malnutrition seems to coincide with the introduction of complementary foods.

A review of literature of nutrition and health surveys conducted in Uganda, suggests that parental education, household resources, duration of breastfeeding, household food patterns, and the high prevalence of infections are the major factors that influence nutritional status (12, 13, 18). Environmental factors such as the quality of water supply and place of residence (rural or urban) also play a major role (12, 15, 16, 39). A survey conducted in Kasese district (western Uganda) indicates that poor diets, early weaning from breastfeeding, not receiving immunizations, and having parents with limited formal education are major risk factors for malnutrition (14). Another study conducted in western Uganda (Hoima district) indicates that mothers' education, household assets, and the gender of the child determine the risk for stunting (40). In the latter study, the mother's education remained an outstanding independent predictor of stunting even after adjusting for socio-economic indicators. This suggests that educating the mother may have profound effects on the nutritional status of young children. This is not surprising since education is well known for promoting health-seeking behavior, which could translate into improvement in child care-giving behavior.

The quality of diets also plays a major role in children's nutritional status. In general, the diets of the majority of Ugandans are monotonous. Diets are usually centered on the staples that are produced in each region; however there are differences in the variety of foods consumed among different households. These differences seem to be related to resources available to an individual household. In Hoima district (western Uganda), the risk for childhood stunting was associated with household ownership of durable assets (such as cupboard, hurricane lamp, radio, telephone etc) and the quality of housing (40). Surprisingly, this study did not find significant associations between risk for stunting and ownership of land, which may suggest that the land ownership is possibly not a good indicator of household food access and/or dietary intake.

DIETARY PATTERNS OF YOUNG CHILDREN

The diets of Ugandan children are mostly vegetarian (18, 21). Bananas, sweet potatoes, cassava, millet and maize are the major staples for the majority of Ugandan families while beans, cowpeas, groundnuts, and green vegetables serve as the main relishes and protein sources (21, 31, 41). In general, the diets of Ugandan children have long been described as limited in animal source foods and low in calories and nutrients. Rutishauser and Whitehead (42) closely followed 20 rural children (18 – 36 months) in effort to characterize caloric intake of young children. Their study revealed that on average Ugandan children consumed about 41 to 96 kcal/kg bodyweight/day (UNICEF/WHO recommendation is 106-124 kcal/kg/day)[7] while children of expatriates (of same age) consumed about 108 to 121 kcal/per kg body weight/day. This study had a limited sample size but confirms what many nutritionists have always suspected. Currently there is limited documentation on dietary patterns in different parts of the country, however the few studies done on this subject indicate that children's diets are too bulky to ensure adequate intake of nutrients and calories. In a study conducted in central Uganda, where the major staples were bananas and maize, the risk for stunting was associated with consumption of foods of low energy density (<350 kcal/100 g dry matter) (13).

A cross-sectional survey of children in Kasese district also documented a pattern of widespread consumption of large amounts of plant source foods (especially vegetables, legumes, and starchy foods) but low amounts of high-calorie and animal source foods (14). A closely related pattern was documented from a survey in Mubende district (central Uganda), the only difference in dietary patterns identified in the two studies is that fish was a big component of the usual diet in central Uganda (13, 22).

Consumption of Animal-Source Foods

The annual per capita consumption of meat, milk, eggs, and fish was estimated at 10.3, 21.5, 0.7, and 17.2 kg respectively in 2000. This is very low when compared to a developed country like the United States of America where annual per capita consumption of the same products is 124, 117.3, 14.5, and 22.4 kg respectively (43).

---

[7]Estimated energy intake of healthy children 0-36 months. Higher value is for young children.

This low consumption of animal source protein has been attributed to poverty. Milk is the most frequently consumed animal protein because it is cheaper and more easily accessible than other animal source foods; hence milk is the main high quality protein available to young children in Uganda (3, 13, 14, 22, 44).

The Uganda National Farmers Federation estimated that per capita milk consumption increased to about 30 liters/year (which equates to about 0.08 liter/day) in 2003; however, consumption is still far below the WHO recommendation of 200 liters/ person/annum (45). Although milk is produced in rural areas, many rural households are less likely to provide milk to their children and when milk is part of a regular diet, it is often mixed in tea. A survey of 271 mothers/caretakers of young children (3- 28 months) in central Uganda revealed that milk was a big component of the usual diet of two thirds (66.3%) of children; however, a recall of children's dietary intake during the 24 hours preceding the survey indicated that only 25.7% of the children had received milk, 17.2% had milk in tea, 10% had milk added to maize-meal porridge, and 2.7% had milk in millet porridge (22). Where milk is mixed in porridge or tea, it is very unlikely for young children to receive the recommended 2 cups (0.5 liter or 16.9 oz) per day. In general, this low consumption of milk indicates deficiencies in consumption of good quality protein, which is needed in greater amounts by rapidly developing children. Limited consumption of animal source foods is associated with increased risk for malnutrition. A survey in central Uganda indicated that children that had never consumed milk had twice the risk of becoming stunted than children who were given milk (13).

Consumption of Plant-Source Foods

Like many less developed countries, plant source foods are the major source of calories in Uganda. There are minor regional differences as a result of cropping patterns. Millet, sorghum, groundnuts, and simsim are the major food crops in the northern region while bananas, potatoes, cassava, and beans predominate in the southern part. Since over 80% of Ugandan families grow their own food (46), the types of foods that are provided to children often depend on what the family can produce. In rural areas, traditional food processing and preservation methods determine the quantity and quality of the household food supply (31). At the household level, these food processing and preparation methods are determined by the child caregivers' (mother or grandmother) beliefs (47). The processing methods are also influenced by the time available to process food in addition to other household chores (48), and time is usually a constraint (49). Therefore, it appears that the dietary intake and nutritional status of young children is, to a large degree, determined by the caregivers' ability to provide nutritious foods.

INTERVENTIONS TO IMPROVE NUTRITIONAL STATUS

There are many interventions that have targeted improving nutritional status especially of young children. Special interventions such as vitamin A supplementation targeted the most vulnerable populations, mainly young children (under 5-year olds) and lactating women. Food-based interventions such as increased production of the orange-fleshed sweet potatoes and iodination of salt target the entire population. Public health interventions such as de-worming and malaria control programs also play a big role on improving nutritional status. These programs are often complemented by social marketing campaigns channeled through mass media (mostly radio) and many have commendable reach.

The government of Uganda recognizes malnutrition as one of the major public health problems and has advocated for nutrition education at the national and local levels to improve the health status of all citizens (31). Nutrition education is still unavailable to the majority of Ugandans since most people cannot read or do not have access to nutrition information. Effective channels through which health messages can be delivered are lacking (31). Health care workers, teachers, and agricultural extension workers are often the people that provide nutritional education (31). The extension workers and teachers are often limited in number and thus do not reach very many people. Nutrition information is also available to parents, mostly mothers, at health centers and hospitals during antenatal clinics and immunization visits (50). Nutrition centers have played a big role in treating malnourished children and providing nutrition education to mothers (21), however these programs only serve people that live near to their catchment areas (50). Efforts are underway to incorporate nutrition into the Integrated Management of Childhood Illness (IMCI) programs (25). This is expected to enable community extension workers to provide more services; and will facilitate early identification of children at risk so they can be referred to appropriate health care facilities.

In reviewing the literature, there were no published studies that document the effectiveness of community-based nutrition education interventions in Uganda. Nutrition education programs have been successful in countries like Malawi and Tanzania that have demographic and socio-economic characteristics comparable to Uganda (51-53).

These studies have demonstrated that nutrition education directly improves the caregivers' feeding practices. There is a need for more research to determine the effectiveness of nutrition education programs on improving the nutrition status of young children in Uganda.

PRELIMINARY STUDIES

In Summer 2001, a pilot nutrition education intervention was conducted in two rural villages of Kabarole district, western Uganda to determine the feasibility of conducting a nutrition education program in a rural setting and to assess the effectiveness of the intervention on improving the child-feeding behaviors of less literate, low-income mothers (3). This was a four-week nutrition education program which consisted of seven lessons on how to select, prepare, and serve nutritious meals to young children. Through cooking classes and classroom-style discussions, rural mothers (mostly subsistence farmers) were taught how to better utilize indigenous foods and ensure that their young children were provided with nutritionally adequate diets. A control group of women from a distant area, but with similar characteristics, was concurrently engaged in sewing classes.

The content and design of the intervention curriculum was developed from findings of focus group discussions with women similar to the mothers that were being targeted for the intervention. The central theme for all intervention activities was improving food variety because published literature indicated a limited variety of foods were provided to Ugandan children (54). Research also shows that diets that include a variety of foods tend to be adequate in most nutrients (55, 56). Cooking classes focused on teaching mothers simple food selection and preparation skills that encourage food variety. Emphasis was placed on improving the traditional food preparation techniques (mostly techniques for preparing meals for young children). Mothers were also motivated to adopt appropriate meal planning skills to ensure that young children were fed frequently and given adequate amounts of food.

Results from the pilot study indicate that the mothers that participated in the cooking classes had improved nutrition knowledge and improved perceptions on what they believed were appropriate foods for children when compared to the controls. The intervention participants also reported improved food selection habits compared to the controls and were more likely to select a large number of foods more frequently. It was concluded that the intervention has the potential to improve the dietary intake and nutritional status of young children.

A follow-up study was conducted in summer 2002. Investigators conducted focus group discussions with the intervention participants, their friends, and spouses. The results also revealed that the intervention was effective in improving awareness about appropriate child-feeding practices among the intervention participants. The intervention participants were also able to share the information with their friends, and most of the friends were interested in participating in such education programs. The spouses were also interested in having their wives learn more about nutrition and indicated that they had noticed many changes in their wives food preparation skills. Many spouses indicated that caregivers provided a wider variety of foods at meals than they used to and one spouse said that his wife no longer roasted beans as she used to.

These positive comments and results of the pilot study indicate that the intervention participants had improved their food selection and meal preparation habits;

however it was not possible to determine if they had also improved their children's nutritional status. The purpose of this study was to determine if changes in caregivers' food selection practices would result in improvement of children's dietary intake and nutritional status.

HYPOTHESES TESTED

It was hypothesized that:

1. Mothers that attend the nutrition classes would have improved knowledge of the food groups, improved beliefs about foods appropriate for children, and will provide their children with nutritionally adequate meals compared to mothers in the control group; and
2. Compared to the controls, children whose mothers attend the nutrition education classes would have improved nutritional status as indicated by anthropometrical indices (weight, height, and mid-upper arm circumference) and micronutrient status (vitamin A and iron).

RATIONALE

Since mothers in rural Uganda always produce food for their families, the most cost-effective method of improving children's nutritional status is to encourage mothers to produce and provide nutritionally adequate meals to their children. The intervention was designed to teach mothers how they can effectively utilize the foods that are available to them to improve their children's diets. The conceptual model (**Figure 2.1**) depicts a combination of factors that are known to influence feeding behavior. According to this model, the caregiver's feeding behavior is influenced by integrated effects of the caregiver's personal characteristics, the dynamics of the caregiver's household, and a multiplicity of environmental factors.

The caregiver's personal attributes that are believed to have major influence on her feeding practices are her knowledge, beliefs, behavior, and skills. Knowledge in this respect refers to her personal experiences, which may or may not have been acquired through formal training. These experiences include, but are not limited to, her knowledge of how children should be fed. The caregiver's beliefs include her perceptions of her role of 'caregiver' and how children should be cared for. Beliefs also refer to the caregiver's views on what constitutes 'food' and which foods are appropriate or inappropriate for young children and how the caregiver perceives young children's dietary needs (57). These beliefs are often influenced by her experiences, cultural norms, household values, and social pressures (especially those pressures that relate to acceptable ways of raising children). Beliefs in turn influence how an individual woman acts in her role as a caregiver (behavior).

The caregiver's behaviors can influence young children's dietary intake and nutritional status through other ways besides her feeding practices. Caregiver's behavior includes her nurturing of young children, hygiene, and health seeking activities (58, 59) . All these factors, independent of feeding practices, affect the dietary intake and nutritional status of young children. This study only focused on care-giving behaviors that are directly related to food and feeding children. Thus, in most cases, the phrase "feeding behaviors" is used to refer to what Arimond and Ruel (58) have called ‘traditional’ feeding practices. By definition, these are “practices that are directly related to nutritional and dietary aspects of feeding” children (58).

In this study, appropriate child-feeding behavior was conceptualized as the caregiver’s ability to provide nutritionally adequate diets to young children. Feeding behaviors encompass appropriate food selection practices, food preparation habits, and meal planning skills. Since the intervention was targeted to subsistence farmers, food selection mostly refers to the types of foods harvested and put aside for household consumption. The intervention participants were coached on ways they can appropriately select indigenous foods accessible to them and how to efficiently use these foods to prepare nutritious meals for young children.

It was therefore hypothesized that if caregivers are educated on appropriate child-feeding behavior, they will improve their food knowledge and attitudes towards food and feeding children. It was further hypothesized that these changes in knowledge and beliefs would translate to improvement in feeding behavior, so that caregivers who attend the intervention would be able to select a variety of nutritious foods; and thus would have improved ability to provide nutritionally adequate meals for young children. This was to be determined by the types of foods that caregivers chose from each group and provided to young children. It was further speculated that if a variety of foods are selected, there would be enough food to serve children an increased amount of food, an increased number of meals, and more snacks. These changes in meal quality and frequency were expected to lead to improvement in children’s nutritional status, which would be indicated by improvements in nutritional status and growth (vitamin A, iron, weight-for-age, height-for-age, weight-for-height, MUAC-for-age).

REFERENCES

1. Schroeder DG. Malnutrition. In: Semba RD, Bloem MW, editors. Nutrition and health in developing countries. Totowa, New Jersey: Humana Press; 2001.

2. Pipes P, Trahms CM. Nutrition in childhood. Boston, Massachusetts: The McGraw-Hill Companies, Inc.; 1996.

3. Kabahenda MK. Developing an intervention to improve the child-feeding behaviors of rural mothers in western Uganda [Master's Thesis]. Athens: University of Georgia; 2002.

4. Whitehead RG. Some quantitative considerations of importance to the improvement of the nutritional status of rural children. Proceedings of the Royal Society of London. 1977 October 19;199:49-60.

5. UNICEF. The state of the world's children 1998: Focus on nutrition. New York: Oxford University Press; 1998.

6. UNICEF. The state of the world's children 2002: Leadership. New York, USA: UNICEF House; 2001.

7. United Nations. The Millennium Development Goals Report 2005. New York: United Nations; 2005.

8. de Onis M, Frongillo EA, Blössner M. Is malnutrition declining? An analysis of changes in levels of childhood malnutrition since 1980. Bulletin of the World Health Organization. 2000;78:1222-33.

9. Ruel MT. The natural history of growth failure: Importance of intrauterine and postnatal periods. In: Martorell R, Haschke F, editors. Nutrition and growth. Philadelphia, USA: Lippncott Williams & Wilkins; 2001. p. 123 - 57.

10. Hop LT, Gross R, Giay T, Schultink W, Thuan BT, Sastroamidjojo S. Longitudinal observation of growth of Vietnamese children in Hanoi, Vietnam from birth to 10 years of age. European Journal of Clinical Nutrition. 1997 1997/03//;51:164-71(abstract).

11. de Onis M. Child growth and development. In: Semba RD, Bloem MW, editors. Nutrition and health in developing countries. Totowa, New Jersey: Humana Press Inc; 2001. p. 71-91.

12. Vella V, Tomkins A, Borghesi A, Migliori BB, Oryem VY. Determinants of stunting and recovery from stunting in northwest Uganda. Journal of Epidemiology. 1994;23:782-6.

13. Kikafunda JK, Walker AF, Collett D, Tumwine JK. Risk factors for early childhood malnutrition in Uganda. Pediatrics. 1998a;102:E45.

14. Tumwine JK, Barugahare W. Nutritional status of children in Kasese district at the Uganda-Congo border. East African Medical Journal. 2002;79:427-34.

15. Vella V, Tomkins A, Borghesi A, Migliori BB, Adriko BC, Crevatin E. Determinants of child nutrition and mortality in northwest Uganda. WHO Bulletin. 1992b;70:637-43.

16. Vella V, Tomkins A, Ndiku J, Marshall T. Determinants of nutritional status in southwestern Uganda. Journal of Tropical Pediatrics. 1995;41:89-98.

17. Cortinovis l, Vella V, Ndiku N, Milani S. Weight, height and arm circumference of children under 5 in the district of Mbarara, southwest Uganda. Annuals of Human Biology. 1997;24:557-68.

18. Uganda Bureau of Statistics, Macro-ORC. Uganda Demographics and Health Survey 2000-2001. Calverton, Maryland, USA: Uganda Bureau of Statistics and Macro International Inc. ORC; 2001.

19. World Bank. Millennium development goals: Uganda country profile. Last updated: April 2004 [cited 2005 December 24]; Available from: *http://devdata.worldbank.org/idg/IDGProfile.asp?CCODE=UGA&CNAME=Uganda&SelectedCountry=UGA*

20. World Bank. Millennium development goals: Uganda. Last updated: April 2005 [cited 2005 December 24]; Available from: *http://devdata.worldbank.org/idg/IDGProfile.asp?CCODE=UGA&CNAME=Uganda&SelectedCountry=UGA*

21. Hoorweg JN, McDowell I. Evaluation of nutrition education in Africa: Community research in Uganda, 1971 - 1972. The Hague, Netherlands: Mouton Publishers; 1979.

22. Kikafunda JK, Walker AF, Tumwine JK. Weaning foods and practices in central Uganda: A cross-sectional study. African Journal of Food, Agriculture, Nutrition and Development. 2003;3:Online.

23. Kikafunda JK, Walker AF, Allan EF, Tumwine JK. Effect of zinc supplementation on growth and body composition of Ugandan preschool children; a randomized, controlled, intervention trial. American Journal of Clinical Nutrition. 1998b;68:1261-6.

24. Kajubi SK, Okel RM. Possible existence of iodine deficiency in Uganda. East African Medical Journal. 1970;47:453-6.

25. Bachou H. The nutrition situation in Uganda. South African Journal of Clinical Nutrition. 2000 Feb 2004;13.

26. Bimenya GS, Olico-Okui, Kaviri D, Mbona N, Byarugaba W. Monitoring the severity of iodine deficiency disorders in Uganda. African Health Sciences. 2002;2:63-8.

27. Sommer A, Davison FR. Assessment and control of vitamin A deficiency: The Annecy Accords. Journal of Nutrition. 2002;132:2845S-50S.

28. Underwood BA. Vitamin A in animal and human nutrition. In: Sporn MB, Roberts AB, Goodman DS, editors. The Retinoids. Orlando, Florida: Academic Press, Inc.; 1984. p. 281-392.

29. Sserunjogi L, Harvey PWJ. Building a multisectoral vitamin A program in Uganda: Establishing sustainable roles for effective implementation. Sight and Life Newsletter. 2005 February 2005:26-9.

30. Odongo B, Mwanga R, Oworr C, Niringiye C, Opio F, Ewell P, Lemaga B, Agwaro G, Serunjogi L, et al. Development and promotion of orange-fleshed sweet potato to reduce vitamin A deficiency in Uganda. 2002.

31. Ugamda Food and Nutrition Council. National Food and Nutrition Policy: Background Document. Final Draft; 2000. p. Pages 52.

32. Kasumba IN, Nalunkuma AJ, Mujuzi G, Kitaka FS, Byaruhanga R, Okong P, Egwang TG. Low birthweight associated with maternal anaemia and Plasmodium falciparum infection during pregnancy, in a peri-urban/urban area of low endemicity in Uganda. Annals of tropical medicine and parasitology. 2000;94:7-13.

33. Totin D, Ndugwa C, Mmiro F, Perry RT, Jackson JB, Semba RD. Iron deficiency anemia is highly prevalent among human immunodeficiency virus–infected and uninfected infants in Uganda. Journal of Nutrition. 2002;132:423-9.

34. Harvey PWJ, Dexter PB, Darnton-Hill I. The impact of consuming iron from non-food sources on iron status in developing countries. Public Health Nutrition. 2000;3:375-83.

35. Ministry of Health. The burden of malaria in Uganda: Why all should join hands in the fight against malaria. [cited 2006 January 2]; Available from: *http://www.health.go.ug/malaria.htm*

36. Kabatereine NB, Tukahebwa EM, Kazibwe F, Twa-Twa JM, Barenzi JFZ, Zaramba S, Stothard JR, Fenwick A, Brooker S. Soil-transmitted helminthiasis in Uganda: Epidemiology and cost of control. Tropical Medicine & International Health. 2005;10:1187-9.

37. Kikafunda JK, P S. Production and use of a shelf-stable bovine blood powder for food fortification as a food-based strategy to combat iron deficiency anemia in Sub-Saharan Africa. African Journal of Food, Agriculture, Nutrition and Development. 2005;5:Online publication.

38. Shrimpton R, Victora CG, de Onis M, Costa-Lima R, Blossner M, Clugston G. Worldwide timing of growth faltering: Implications for nutrition interventions. Pediatrics. 2001;107.

39. Vella V, Tomkins A, Ndiku J, Marshall T. Determinants of child mortality in southwest Uganda. Journal of Biosocial science. 1992a;24:103-12.

40. Wamani H, Tylleskär T, Åstrøm AN, Tumwine JK, Peterson S. Mothers' education but not fathers' education, household assets or land ownership is the best predictor of child health inequalities in rural Uganda. International Journal for Equity in Health. 2004 October 2004;3:(online).

41. Crawford MA. Nutritional control of heart disease and cancer: are different diets necessary. Nutrition and health. 1985;4:7-15.

42. Rutishauser IHE, Whitehead RG. Energy intake and expenditure in 1 - 3-year-old Ugandan children living in a rural environment. British Journal of Nutrition. 1972;28:145-52.

43. Speedy AW. Global production and consumption of animal source foods. Journal of Nutrition. 2003;133:4048S-53S.

44. Wamani H, Åstrøma AN, Peterson S, Tylleskära T, Tumwine JK. Infant and Young Child Feeding in Western Uganda: Knowledge, Practices and Socio-economic Correlates (Abstract). Journal of Tropical Pediatrics. 2005;51:356-61.

45. Uganda National Farmers Federation. Milk consumption increases. IFAP Dairy Quarterly. 2003 December 2003:2.

46. Ministry of Gender and Community Development, Ministry of Planning and Economic Development. Women and men in Uganda: Facts and figures 1998. Kampala, Uganda.

47. Sserunjogi I, Tomkins A. The use of fermented and germinated cereals and tubers for improved feeding and infants in Uganda. Transactions of the Royal Society of Tropical Medicine and Hygiene. 1990;84:443-6.

48. Essers AJ, Ebong C, van der Grift RM, Otim-Nape W, Rosling H. Reducing cassava toxicity by heap-fermentation in Uganda. International Journal of Food Science and Nutrition. 1995;46:125-36.

49. Motarjemi Y, Nout MJ. Food fermentation: a safety and nutritional assessment. Joint FAO/WHO Workshop on Assessment of Fermentation as a Household

Technology for Improving Food Safety. Bulletin of the World Health Organization. 1996;74:553-9.

50. Statistics Department. Uganda Demographic and Health Survey, 1995. Calverton, Maryland: Statistics Department (Uganda) and Macro International Inc.; 1996 August 1996.

51. Kavishe FP. Investing in nutrition at the national level: an African perspective. Proceeding of the Nutrition Society. 1995;54:367-78.

52. World Health Organization/UNICEF. Improving child survival and nutrition. Evaluation Report. Dar-es-Salaam: 1989.

53. Parvanta CF, Gottert P, Anthony R, Parlato M. Nutrition promotion in Mali: Highlights of a rural integrated nutrition communication program. Journal of Nutrition Education. 1997;29:274-80.

54. Rutishauser IHE, Frood JDL. The effect of a traditional low-fat diet on energy and protein intake, serum albumin concentration and body weight in Ugandan preschool children. British Journal of Nutrition. 1973;29:261-8.

55. Heber D, Bowerman S. Applying science to changing dietary patterns. Journal of Nutrition. 2001;131:3078S-81S.

56. Krebs-Smith SM, Smiciklas-Wright H, Guthrie HA, Krebs-Smith J. The effects of variety in food choices on dietary quality. Journal of the American Dietetics Association (JADA). 1987;87:897- 903.

57. Mabilia M. Beliefs and practices in infant feeding among the Wagogo of Chigongwe (Dodoma rural district) Tanzania. Ecology of Food and Nutrition. 1996;35:209-17.

58. Arimond M, Ruel MT. Assessing care: Progress toward the measurement of selected childcare and feeding practices, and implications for programs. Washington, D.C.: International Food Policy Research Institute, Food Consumption and Nutrition Division; 2001 August 2001. Report No.: FCND DP No. 119.

59. Arnold CG, Sobal J. Food practices and nutrition knowledge after graduation from the Expanded Food and Nutrition Education Program (EFNEP). Journal of nutrition education. 2000 2000/05//;32:130-8.

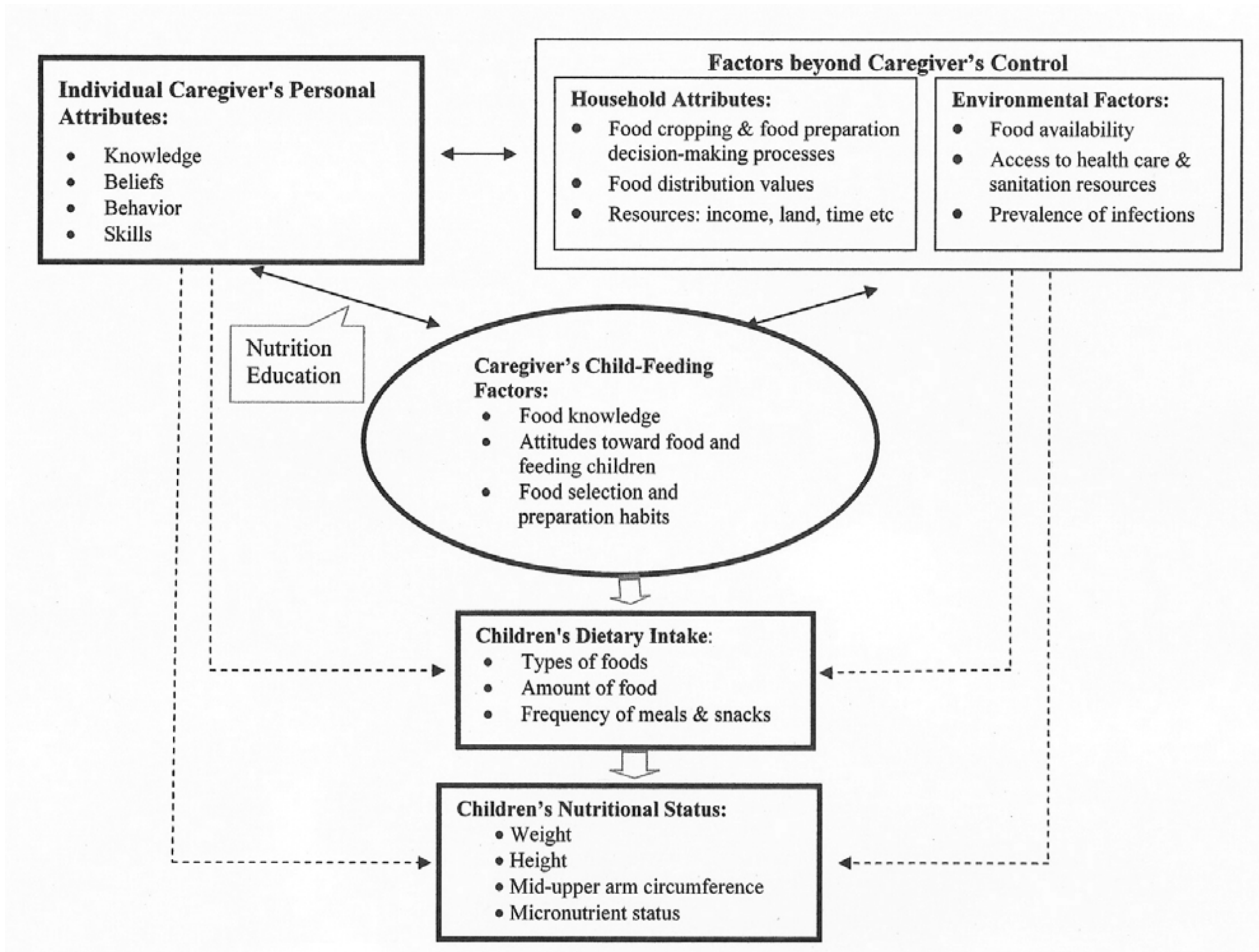


Figure 2.1: Effect of Caregiver's Feeding Behavior on Young Children's Nutritional Status

CHAPTER 3

DIETARY INTAKE AND NUTRITIONAL STATUS OF YOUNG CHILDREN IN KABAROLE DISTRICT, WESTERN UGANDA[1]

[1] Margaret K Kabahenda and Rebecca M Mullis. Submitted to International Journal of Behavioral Nutrition and Physical Activity, 05/04/2006

ABSTRACT

Childhood undernutrition is a global problem, which has been linked to food insecurity, poverty, and illiteracy. It is important to ascertain the level of undernutrition in any population in order to develop, implement, and effectively evaluate interventions for a specific population.

This study was a small but comprehensive cross-sectional survey which was conducted to assess the nutritional status of young children and factors that may explain the high prevalence of malnutrition in Kabarole District, western Uganda. The study participants were 204 less literate and low-income female caregivers and their young children (6-47 months) recruited from two rural areas.

The results indicate that malnutrition is a big problem in this population. Stunting (which is an indicator of chronic undernutrition) affected 24.4% of the children surveyed, 9.9% were underweight, 39.8% were anemic (hemoglobin <10.0 g/dL), while 37.9% were vitamin A deficient (retinol binding protein <0.70 μmol/L or 20 μg/L). The risk for stunting was reduced among children of caregivers with higher income, those that lived in households that spend a large amount of their income on food, and among children that were provided diets comprising a wide variety of foods. Vitamin A deficiency was positively correlated to sub-clinical infections indicated by elevated levels of acute phase proteins.

In general, the diets were limited in variety. The most frequently consumed staple food was bananas (average consumption = daily) followed by sweet potatoes (1-3 times per week) while beans were the major relish and protein source. High levels of food insecurity and poor dietary patterns were documented even though the study participants were predominantly subsistence farmers.

The high prevalence of stunting coupled with no incidence of wasting suggests that undernutrition is chronic. This calls for targeted and sustainable interventions that involve effective participation of the child-caregivers. Since undernutrition was independent of food production but strongly correlated to the caregivers' cash earnings, interventions need to focus on improving caregivers' income, food access and selection practices, and child-feeding practices.

INDEX WORDS: Dietary intake, Nutritional status, Vitamin A status, Anemia, Malnutrition, Stunting, Uganda

BACKGROUND

Childhood undernutrition is a global problem, which has been linked to food insecurity, poverty, and illiteracy. Uganda is one of the countries with high rates of poverty and illiteracy in rural areas [1] and high rates of childhood malnutrition [2-4]. The 2000-01 Uganda Demographics and Health Survey (UDHS) indicates that about one half of Ugandan children suffer from chronic undernutrition [2]. Both chronic (stunting) and acute (underweight) forms of undernutrition were more prevalent in rural areas than urban areas. A 39.9% incidence of stunting was recorded in rural areas versus 26.5% in urban settings; while the prevalence of underweight was 23.6% and 12.4% in rural and urban areas respectively [2]. Since more than 80% of Uganda's population resides in rural areas [1], these results indicate that a large proportion of children are undernourished or at risk for malnutrition.

The purpose of this study was to assess the nutritional status of young children (6-47 months) in order to characterize the types of nutritional deficiencies that are prevalent in rural areas of Kabarole district, western Uganda and to determine caregiver factors that are likely to predispose young children to malnutrition. Western Uganda was selected for this study because this region is largely rural and was among the regions with the highest rates of undernutrition in the 2001 national survey [2]. A pilot nutrition education program had also been conducted in this region; therefore this region was targeted for an intervention. This survey was designed to provide baseline data for assessing the effectiveness of the intervention.

RESEARCH METHODS

Study Location and Participants

In selecting survey sites, investigators needed two areas that were distant from each other to avoid the flow of information from the intervention activities. Two survey sites were identified by visiting villages within a 10-mile radius of Fort Portal township. Many villages were excluded because the investigators could not find areas that matched and yet had enough distance between them. Participants were drawn from villages in Bukuuku and Karambi sub-counties. Villages selected had similar socio-economic status (judging from housing structures), cropping patterns, and had comparable access to the major food market.

Female primary child-caregivers (mostly mothers) and their young children (6 - 47 months) were enlisted by visiting all households with young children within selected villages. Local council members and guides helped in identifying these homes. Participants that met the selection criteria and consented to participate were invited to attend health fairs which were held at local primary schools. At the fairs, the caregivers were interviewed and children's health status was assessed by a team of enumerators who were mainly comprised of certified nurses from local hospitals, health education teachers from local primary schools, and graduate students in an applied human nutrition program. Ten high school students from local schools were also recruited to assist the enumerators. The study protocol was reviewed and approved by the University of Georgia Institutional Review Board and the Uganda National Council for Science and Technology.

Data Collection Procedures

All assessments were conducted at local primary schools. Six classrooms were set up to serve as assessment stations and participants went through the stations in the order of precedence presented in **Table 3.1**. To ease the participants' movement through the stations, flags of different colors were hanged at the entrance of each station to distinguish the assessment stations. Posters and questionnaires were also color-coded to match flags at each station. This helped enumerators identify people that had bypassed some assessment stations and to guide them appropriately. Since some caregivers had more than one child that qualified for assessment, for data quality control purposes, each child was given a number tag which had to be worn by the child throughout the assessment exercise.

Assessment of Children's Nutritional Status. Heights, weights, and mid-upper arm circumferences were assessed from a total of 246 children. Weights were measured using a Salter hanging scale and recorded to the nearest 10 gm. Heights were taken from children 24 months and older with a standiometer while children under 24 months of age were measured recumbent with a Seca 210 measuring mat. Both length and heights were recorded to the nearest 0.1 cm. Measuring tapes [5] were used to measure mid-upper arm circumference (MUAC) and data was also recorded to the nearest 0.1 cm. EpiInfo Version 3.2.2 (CDC, USA) was used to compute height-for-age (HAZ), weight-for-age (WAZ), weight-for-height (WHZ), MUAC-for-age (MUAZ), and MUAC-for-height (MUHZ) z-scores using the median of the NCHS/WHO reference population. After removing data of children whose ages could not be verified and records flagged by Epi Info, 204 children were included in the analysis.

Physical examinations were conducted on all children to determine prevalence of advanced or clinical malnutrition and other health conditions. Certified nurses examined children's hair, nails, skin, mouth, legs, and abdomen for conditions enlisted on data collection sheets.

Vitamin A status (retinol binding protein) and prevalence of anemia (low hemoglobin) were assessed to serve as proxies of micronutrient nutriture. A trained phlebotomist collected capillary blood from all children by finger prick to assess prevalence of anemia and a Hemocue b-hemoglobin photometer (Lake Forest, California) was used to assess hemoglobin. An additional sample was collected randomly from 103 children to prepare dried blood spots for assessing vitamin A status (retinol binding protein) and indicators of sub-clinical infections (C-reactive protein and α_1-glycoprotein). Blood spots were prepared and analyzed using procedures described by Erhardt and colleagues [6].

Assessment of Food selection Practices and Children's Dietary Intake. The purpose of this assessment was to determine household food selection patterns (variety and frequency) and the dietary intake of young children (meal patterns and quality).

Variety in Food Selection. Ninety one (91) locally available indigenous food items were included in the food frequency questionnaire. Caregivers were asked to indicate which foods they consume in their households. Each food consumed was assigned a score of 1 point and those not consumed were assigned a zero. Foods were then grouped into sub-groups (Bananas, Tubers & Starchy vegetables, Legumes, Meats, Fruits, and Vegetables) and a score for each subgroup was computed by dividing the number of foods consumed in each subcategory with the total number of foods in that group. A mean score was computed for each subcategory and then these subcategories were further grouped into the 3 food groups (Energy-yielding, Body-building, and Protective foods), which were then used to compute the total variety score.

Frequency in Food Selection. The adequacy of the diets also depend on how frequently different food items are included in the diet. In this study, caregivers were asked to indicate how often (in a day, week, month, or year) they used each of the foods included in the food frequency questionnaire explained above. Frequency scores were assigned for each food depending on how often a food is consumed (5 = Daily; 4 = 4-6 times per week; 3 = 1-3 times/week; 2 = 1-3 times/month; 1 = <once per month; 0 = Never). Scores for each food group were computed by summing up the frequency scores of individual food items in a particular group.

Meal Patterns and Quality. Meal patterns were assessed by asking caregivers to indicate how many times they provided meals and snacks to young children. A qualitative 24-hour dietary intake recall was used to determine the adequacy of children's diets. Caregivers were asked to recall all the foods and drinks their children consumed during the 24 hours preceding the interview. Participants were not required to quantify their children's dietary intake because a previous investigation [7] conducted in this region had revealed that caregivers do not habitually keep track of the amounts of food eaten by their children. Data obtained through the 24-hour dietary recalls was coded using the scoring method [8]. Each time a food item was consumed, regardless of the amount, a score of 1 point was assigned to the sub-group in which that food belongs. A few foods such as porridge and milk in tea were assigned half a point. The validity of this scoring method has been assessed and the scores obtained using this method were found to be effective in predicting caloric intake, protein, total fat, calcium, iron, and zinc in the diet [7].

Household Socio-economic Status and Access to Food. Caregivers self-reported type of their house structure (floor and roof), occupations of their household heads, monthly income, and other factors such food availability and access. Caregivers were also asked to indicate whether they 'Always have enough food' to feed their families', 'Never have enough food', or 'Sometimes have problems obtaining food'. In addition, caregivers reported on whether or not they bought special food items for young children and to indicate the food items they buy frequently.

The results are presented cross-sectionally across the two study sites. In a few instances, especially in describing the characteristics of study participants, results from each site are presented separately to provide the reader a clear understanding of the study population.

RESULTS AND DISCUSSION

Characteristics of the Study Participants

This study targeted low income, less literate female primary child-caregivers. About a quarter of the caregivers recruited for the study had not received any formal education, 67.5% had received primary education, and only 6.4% attained but did not complete post-primary education. The majority of caregivers (96.8%) described themselves as homemakers and/or subsistence farmers. Only 3.2% engaged in money generating activities such as making and/or selling quick breads, local liquors, and crafts. More than two thirds of caregivers (70.7%) were also married and in monogamous relationships (72.3%); only 16% of the caregivers indicated that they were the heads of their households. The spouses were the primary income earners and heads of the households. Many of the male household heads were also subsistence farmers (41.3%) and a good number (39.1%) were employed full-time outside the home. More information about the characteristics of the children and caregivers is provided in **Table 3.2**.

Level of Undernutrition indicated by Anthropometrical Measures

Table 3.3 provides a summary of children's nutritional status by age group. The rate of chronic undernutrition as indicated by stunting (low height-for-age) was lower than the national rate [2]. Six percent of the children were severely stunted while 18.4% were classified as stunted. Underweight was observed in 9.9% of the children, 19.7% had low MUAC-for-age, while 21.4% had low MUAC-for-height. There were no children that were classified as wasted (weight-for-height below -2 SD).

Even though the study population can accurately be classified as low income, the small differences in income level seem to have had profound effect on children's nutritional and/or health status. In this survey, the risk for stunting was reduced among children of caregivers with higher monthly incomes (Spearman's rho (r_s) = 0.215, $p = 0.010$), children that lived in households that spend more money on food ($r_s = 0.199$, $p = 0.017$), and among children that were provided diets comprising a wide variety of foods ($r_s = .194$, $p = 0.022$). The relationship between the caregiver's income and risk for stunting was determined to be independent of the caregiver's education level, occupation, and total household income. In general, increases in women's incomes have been associated with improved household diets. The positive associations between caregiver's income and children's nutritional status are likely to result from improvement in dietary intake and care. Since the majority of caregivers were subsistence farmers, it can be speculated that food is bought to supplement what the family produces. In this regard, caregivers with more income are likely to buy more food frequently; therefore, a variety of foods is availed to children.

Low mid-upper arm circumference (MUAC) is a strong independent predictor of mortality among young children. Of the 191 children measured, 21.4% had low MUAC-for-age. Household's that spent more of their incomes on food were less likely to have children with low MUAC-for-age and low MUAC-for-height ($r_s = 0.174$, $p = 0.042$ and $r_s = 0.211$, $p = 0.013$ respectively). MUAC-for-age was also positively correlated with the caregiver's age. Possibly older caregivers have more experience in child-rearing and thus have healthier children. However, caregiver's age may also be an indicator of other household factors such as caregiver's involvement in decision making, social support, and accumulated household resources.

Prevalence of Clinical Undernutrition

A total of 205 children were examined by certified nurses. Data from three children were discarded because their body temperature was above 37 ^{o} Centigrade. Almost half of the children (45.5%) were not observed to have any physical signs of malnutrition or poor health. Conditions that were most prevalent (see **Table 3.4**) are dry hair (25.5%), dry skin (21.8%), discolored hair (18.8%), hepatomegaly (12.4%), and tooth carries (10.4%). The lack of association between hepatomegaly and anthropometric measures and indices of dietary intake suggest that the condition could be a result of non-nutritional causes. Strong positive correlations between physical abnormalities in hair and skin and low anthropometric dimensions are a possible indicator of malnutrition; however many of these physical signs could also indicate poor body hygiene. Further analyses revealed that children with dry or discolored hair were likely to consume milk (the most frequently consumed animal source protein) less frequently. This also suggests that physical abnormalities in hair and skin may be diagnostic of malnutrition; however, since most households purchase milk, milk consumption is possibly an indicator of household income. In this regard, a household with more dispensable income would possibly have better access to skin and hair care products.

The incidence of visible tooth carries (10.4%) among young children (6-47 months) was very surprising. This calls for more investigation and immediate intervention. From this survey it cannot be determined whether the tooth caries are a result of poor hygiene, high consumption of simple sugars, or limited intake of nutrients that are essential for the mineralization of teeth. This problem needs more investigation to pinpoint the cause of tooth carries among children this young. In the meantime, simple interventions such as fluoridation of the community water supplies (protected wells) can reduce the problem. Caregivers also need to be informed about appropriate and inexpensive oral hygiene practices.

Caregivers' Food Selection and Dietary Intake of Young Children

Variety in Household Diets. The total variety scores indicate that about half of the foods that are locally available are being consumed (see **Table 3.5**). This finding raises concern since research shows that diets which have a variety of foods tend to be adequate in most nutrients [9-12] Further analyses indicated weak but significant positive associations between consumption of diets limited in variety and risk for stunting ($r_s = 0.187$, $p = 0.028$). Children that lived in households that consumed a variety of meats ($r_s = 0.261$, $p = 0.002$), fruits ($r_s = 0.281$, $p = 0.001$), vegetables ($r_s = 0.214$, $p = 0.010$), and grains ($r_s = 0.203$, $p = 0.015$) were less likely to be stunted. Partial correlations among the food variety scores and stunting controlling for household income indices (caregivers income, income spent on food, and total household income) revealed no relationship between stunting and food variety. This suggests that, even among households that grow their own food, food selection patterns are highly influenced by the household's food purchasing power.

Frequency of Food Selection. The majority of caregivers indicated that they do not regularly select a variety of foods. Green bananas, dried beans, avocado, tomatoes, and tea were the most frequently consumed food items (see **Figure 3.1**). On average, bananas were consumed daily and were the most frequently consumed staple while sweet potatoes ranked second (mean frequency = 1-3 times per week). The mean frequency of consumption of other staples such as grains and dried tubers and starchy vegetables was 1-3 times per month. This finding raises concern since green bananas are nutrient dilute when compared to grains and dried indigenous staples. Beans (mean frequency = daily) were the most frequently consumed relish and food from the body building food group. Milk was the second protein-rich food; however, the frequency scores for milk should be interpreted with caution since the 24-hour recall data show that milk is often mixed in tea. The high frequency score of milk consumption is likely to overrate the diets of most households. The food frequency scores were only related to the amount of income spent on food ($r_s = 0.307$, $p = 0.013$).

Quality of Children's Diets. Overall the diets that were recalled were limited in variety and seem to be inadequate in foods from all groups. ANOVA conducted to assess differences in the mean total scores for the four age groups indicated significant differences in the foods provided to children at the various stages, $F_{(3, 126)} = 4.78$, $p = .003$. Children in the 24-35 age group were provided foods from the energy yielding food group on many occasions while children in the 12-23 age group had slightly more servings from the body-building food group (mostly milk). This difference is related to the development stages whereby milk is a major weaning food provided to children in the second year of life. Spearman's correlations computed to determine the relationship between the diet adequacy scores and children's nutritional status revealed no significant relationships between the diet adequacy scores and the nutritional status indicators. This can partly be explained by the fact that the diets reported by the caregivers were not representative of the usual diets. Almost half of the caregivers (47%) indicated that the 24-hour recall did not reflect their typical meal patterns. Multiple assessments need to be conducted in order to fully characterize the quality of children's diets.

Meal and snacking patterns of young children. About two thirds (62.8%) of the caregivers indicated that they prepared three meals each day, 30.3% provided two meals, and 6.9% provided one meal per day. Caregiver recalls of meals provided to young children 24 hours preceding the survey indicate that caregivers had a tendency of not counting breakfast as a meal especially when they provided food leftover from the previous night's meal. Many caregivers provided children 3 meals in a day. Although 61.3% of the caregivers had indicated that they regularly provide snacks to their young children, only 1/3 of the children were provided snacks in the 24-hour period preceding the survey. The limited number of feeding occasions is likely to increase the risk for malnutrition since young children need to be fed frequently in order to meet their daily nutrient needs [13].

Prevalence of Anemia and Vitamin A Deficiency

Results indicate that more than one third (39.7%) of the 167 children that were assessed were anemic (hemoglobin concentration of <10.0 g/dl). Mean hemoglobin was 10.1 g/dl (range: 5.8 - 13.8). About 5% of the children were classified as severely anemic (<7.0 g/dl) while 34.8% were moderately anemic. More research is needed to determine the cause of anemia in this population, however, a close examination of the quality of children's diets indicate that children may be at risk for deficiency of hematopoetic nutrients such as iron and folate.

Vitamin A deficiency seems to be a problem of public health concern in the population studied. More than one third of the children (37.9%) had low levels of retinol binding protein (RBP), a protein that carries vitamin A in blood. The mean retinol binding protein was 0.81μmol/L (range: 0.08 – 1.78). Although children's diets were generally poor, vitamin A status seem to have been highly influenced by the high prevalence of infections. In general, the levels of circulating markers of vitamin A decrease during infection. In this study, children with clinical signs of illness were excluded from the study. C-reactive protein (CRP) and α1-glycoprotein (AGP) were also assessed to determine the presence of sub-clinical infections. More than a third of the children (35.9%) had higher than normal levels of CRP while 12.6% had elevated levels of AGP; which indicates that these children had some degree of infection. Further analyses showed significant negative associations between elevation of the acute phase proteins and vitamin A nutriture ($r = -0.349$, $p = 0.001$ and $r = -0.217$, $p = 0.052$ for CRP and AGP respectively). This shows that infections are likely to be the underlying cause of vitamin A deficiency among some children; however diet plays a big role too. Since nutrients interact in a synergistic manner [14-16], the high prevalence of anemia and vitamin A deficiency may indicate deficiencies in many nutrients.

Household Access to Food

More than half of the caregivers (58.3%) indicated that they never have enough food or have problems obtaining food (**Table 3.2**). This suggests that a large proportion of the households are likely to experience food insecurity. This finding is disturbing given the fact that the survey participants engage in food crop farming as their primary activity. An analysis of the participants food acquisition patterns indicate that the majority of households buy food on a daily or weekly basis to supplement what they produce. However, judging from the amount of income that is spent on food, the majority of survey participants consume what they produce. Most families produced and could easily access foods such as bananas, potatoes, yams, millet, cassava, maize, amaranth, and beans. Nutrient dense food items such as meat, groundnuts, milk, and eggs were not easily accessible to the majority of households and thus these food items are not consumed regularly. Only a half of the caregivers indicated that they buy special foods for young children; and the food item commonly bought was milk. There is need to improve food purchasing power since the results of this study show that children that live in households that do not buy food regularly are at a high risk for stunting.

CONCLUSIONS

There is no precise measure of nutritional status, however, the volume of literature on nutritional assessments indicate that employment of a combination of assessment parameters provides a good measure of nutritional status [17-19]. In this survey, body dimensions (heights, weights, and MUAC); physical signs of poor health or nutritional deficiencies, dietary intake, and incidence of anemia and vitamin A deficiency were assessed in effort to characterize the nutritional status of young children. The results of the survey indicate a high incidence of malnutrition among young children in the two areas surveyed. The high prevalence of stunting coupled with no incidence of wasting suggests that children in the survey sites are at risk for chronic forms of malnutrition. This is what some investigators have termed as 'silent' malnutrition and tends to have adverse and long lasting consequences such as impaired cognitive ability and reduced productivity later in life. There is need for intervention to combat chronic undernutrition among young children. Since the problem is chronic in nature, sustainable interventions that fully engage caregivers are needed. The assessment of food selection patterns and the quality of children's meals indicate that diets provided to young children were inadequate in calories, protein, and other nutrients essential for achieving optimal growth. This calls for measures to improve food availability, food access, food selection practices, and child-feeding practices.

To develop effective interventions, one needs to fully understand the causes of inadequate dietary intake. Cultural beliefs, limited food availability, limited education, and other social and environmental factors may determine what foods are chosen in a society. Resources such as land for growing food and raising animals for home consumption, income to purchase food, and time allocated to child care also affect children's dietary intake and nutritional status [20]. These factors need to be explored in order to determine what kind of intervention can work for the targeted population [21]. For groups that engage in farming like the survey participants, interventions such as diversification of food production (both crop and small animal production) can improve people's access to a variety of foods. It is important to note that improvement in food production alone may not lead to improvement in nutritional status especially if farming is the primary income generating activity because some families may sell off their produce. This calls for interventions that target both improvement in food production and disposable income.

In this survey nutritional risk was independent of food production and strongly correlated to household income spent on food and the caregivers' income. This suggests that in order to improve nutritional status in this population, interventions need to focus on improving the household income, especially incomes of caregivers. Improving economic growth in rural areas can generate more income, especially for caregivers (homemakers), and lead to improvements in health and nutrition status of young children. Any policies that can lead to reduction in food prices or an increase in households' disposable incomes are likely to improve food purchasing power. In order for us to see such changes, caregivers and household heads need to be encouraged to buy food for their families. Otherwise, the extra income is likely to be spent on non-food items. Nutrition education or communication programs are also needed to target the specific food selection (including purchasing) habits of rural families. Special emphasis needs to be put on increasing access to and consumption of animal source proteins, fruits, vegetables, and whole grains.

COMPETING INTERESTS

The authors did not have any competing interests at any stage in the development, implementation, and reporting of this study.

AUTHORS' CONTRIBUTIONS

All authors contributed to the design and implementation of the study. MKK conducted all the fieldwork under the direction of RMM.

ACKNOWLEDGEMENTS

This assessment exercise was supported by a competitive research grant from Strategies and Analysis for Growth and Access (SAGA), a cooperative agreement between USAID and Cornell and Clark-Atlanta Universities. Economic Policy Research Centre (Uganda) served as our host institution and provided office facilities and technical support. Support of Dr Mesfin Bezuneh and Andre McKinney of SAGA and Dr Okidi of EPRC is highly appreciated. Sight and Life funded analyses of vitamin A and acute phase proteins and analyses were conducted by Dr. Jeugen Erhardt (SEAMEO-TROPMED RCCN, University of Indonesia). Hemocue (USA) loaned us the photometer for assessing hemoglobin. Technical support of Dr Christine Northrop-Clewes (IMMPaCt Programme, Centers for Disease Prevention and Control) is highly appreciated. Many thanks to all enumerators and participants.

REFERENCES

1. Ministry of Gender and Community Development, Ministry of Planning and Economic Development: **Women and men in Uganda: Facts and figures 1998**. Kampala, Uganda: Ministry of Gender and Community Development & Ministry of Planning and Economic Development; 1998.

2. Uganda Bureau of Statistics, Macro-ORC: **Uganda Demographics and Health Survey 2000-2001**. In. Calverton, Maryland, USA: Uganda Bureau of Statistics and Macro International Inc. ORC; 2001.

3. Vella V, Tomkins A, Borghesi A, Migliori BB, Adriko BC, Crevatin E: **Determinants of child nutrition and mortality in northwest Uganda**. *WHO Bulletin* 1992b, **70**:637-643.

4. Vella V, Tomkins A, Ndiku J, Marshall T: **Determinants of nutritional status in southwestern Uganda**. *Journal of Tropical Pediatrics* 1995, **41**:89-98.

5. de Pee S, Bloem MW: **Assessing and communicating impact of nutrition and health programs**. Totowa, New Jersey: Humana Press Inc.; 2001.

6. Erhardt JG, Estes JE, Pfeiffer CM, Biesalski HK, Craft NE: **Combined measurement of ferritin, soluble transferrin receptor, retinol binding protein, and C-reactive protein by an inexpensive, sensitive, and simple sandwich enzyme-linked immunosorbent assay technique.** *Journal of nutrition* 2004, **134**(11):3127-3132.

7. Kabahenda MK: **Developing an intervention to improve the child-feeding behaviors of rural mothers in western Uganda**. *Master's Thesis.* Athens: University of Georgia; 2002.

8. Guthrie HA, Scheer JC: **Validity of a dietary score for assessing nutrient adequacy**. *Journal of The American Dietetic Association* 1981, **78**:240-245.

9. Dixon LB, Cronin FJ, Krebs-Smith SM: **Let the pyramid guide your food choices: capturing the total diet concept**. *Journal of Nutrition* 2001, **131**(2S-1):461S-472S.

10. Freeland-Graves J, Nitzke S: **A Position of the American Dietetic Association: Total diet approach to communicating food and nutrition information**. *J Am Diet Assoc* 2002, **102**(1):100-108.

11. Hatloy A, Torheim LE, Oshaug A: **Food variety - a good indicator of nutritional adequacy of the diet? A case study from an urban area in Mali, West Africa.** *European Journal of Clinical Nutrition* 1998, **52**(12):891-898.

12. Krebs-Smith SM, Smiciklas-Wright H, Guthrie HA, Krebs-Smith J: **The effects of variety in food choices on dietary quality.** *Journal of the American Dietetics Association (JADA)* 1987, **87**:897- 903.

13. Pipes P, Trahms CM: **Nutrition in childhood**, vol. Third Edition. Boston, Massachusetts: The McGraw-Hill Companies, Inc.; 1996.

14. Kolsteren P, Rahman SR, Hilderbrand K, Diniz A: **Treatment for iron deficiency anaemia with a combined supplementation of iron, vitamin A and zinc in women of Dinajpur, Bangladesh**. *European journal of clinical nutrition* 1999, **53**(2):102-106.

15. Muñoz EC, Rosado JL, López P, Furr HC, Allen LH: *American journal of clinical nutrition* 2000, **71**(3):789-794.

16. Wieringa FT, Dijkhuizen MA, West CE, Northrop-Clewes CA, Muhilal: **Estimation of the effect of the acute phase response on indicators of micronutrient status in Indonesian infants**. *Journal of Nutrition* 2002, **132**(7):3061-3066.

17. Brozek J, Schurch B (eds.): **Malnutrition and behavior: Critical assessment of key issues**. Lausanne, Switzerland: Nestle Foundation Publication Series; 1984.

18. Grant A, DeHoog S: **Nutritional assessment and support**, 4th edn. Seattle, Washington; 1991.

19. World Health Organization: **Physical status: The use and interpretation of anthropometry**. In: *WHO Technical Report Series #854.* Geneva: World Health Organization; 1995.

20. Arimond M, Ruel MT: **Assessing care: Progress toward the measurement of selected childcare and feeding practices, and implications for programs**. In. Washington, D.C.: International Food Policy Research Institute, Food Consumption and Nutrition Division; 2001: 115.

21. Crnic LS: **Design of nutritional interventions**. In: *Malnutrition and behavior: Critical assessment of key issues.* Edited by Brozek J, Schurch B. Lausanne, Switzerland: Nestle Foundation; 1982-1983: 499-501.

Table 3.1: Organization of Assessment Stations

Station	Activity
A	Explained study to caregivers, obtained their consent (written or thumbprint), and registered those that consented
B	Measured children's heights or lengths, weights, and mid-upper arm circumferences
C	Conducted physical examinations (children only)
D	Interviewed caregivers on their food selection habits, feeding practices, children's dietary intake, and household dynamics
E	Drew blood from children to assess hemoglobin and vitamin A status
F	Interviewed caregivers on household socio-economic activities and access to food. Disbursed incentives to caregivers.

Table 3.2: Characteristics of Study Participants

Parameter of Interest	†Survey Site		†Total
	Site 1	Site 2	
Mean age of children (months)	23.6 ± 11.6	23.7 ± 10.8	23.6 ± 11.2
*Total number of children	100	104	204
Percentage of children by age group:			
6-11 months	20.0	18.3	19.1
12-23 months	31.0	27.9	29.4
24-35 months	31.0	36.5	33.8
36-48 months	18.0	17.3	17.6
Mean age of caregivers (years)	30.6 ±12.6	27.9 ± 7.7	29.4 ± 10.8
Mean years of formal education	3.9 ± 3.0	4.0 ± 2.9	3.9 ± 2.9
Distribution by years of formal education (%)			
0-2 years	40.0	33.0	36.5
3-5 years	24.0	35.0	29.6
6-8 years	31.0	25.2	28.1
9-11 years	5.0	6.8	5.9
Head of Caregiver's Household (%)			
Self	19.1	12.8	15.8
Husband	63.2	65.4	64.4
Caregiver's parents	13.2	15.4	14.4
Other	4.4	6.4	5.6
Caregiver's occupation (%)			
Homemaker/subsistence farmer	92.9	96.8	94.6
Small scale producer	0.9	0.0	0.5
Small scale trader	5.3	3.2	4.4
Other	0.9	0.0	0.5
Caregiver's spouse or household head's occupation (%)			
Subsistence farmer	43.3	38.7	41.3
Small scale producer	1.8	0.0	1.0
Trader	7.1	5.4	6.4
Other	37.2	41.9	39.3
Do not have spouse or cannot tell	12.1	14.0	12.1
‡**Caregiver's Monthly Income** (%)			
No cash earnings	60.9	58.2	59.5
<Shs.15,000	24.6	20.3	22.3
Shs.15,001 - 30,000	5.8	15.2	10.8
Shs.30,001 - 50,000	2.9	5.1	4.1
>Shs.50,000	5.7	1.3	3.4

‡Total household's monthly income (%)			
No cash earnings	1.4	0.0	0.7
<Shs.15,000	42.0	45.6	43.9
Shs.15,001 – 30,000	24.6	26.6	25.7
Shs.30,001 – 50,000	20.3	8.9	14.2
Shs.50,001-100,000	11.6	19.0	15.5
>Shs.100,000			
‡Total household's income spent on food (%)			
None	4.3	5.1	4.7
<Shs.5000	58.0	51.9	54.7
Shs.5,000 - 10,000	27.5	24.1	25.7
Shs.10,001 - 15,000	5.8	8.9	7.4
>Shs.15,000	4.3	10.1	7.4
Caregiver's perception of food availability(%)			
Did not want to respond	1.5	1.3	1.4
Never have enough	20.6	35.9	28.8
Sometimes have problems obtaining food	29.4	29.5	29.5
Always have enough food	48.5	33.3	40.4
How often food is bought (%)			
Daily	11.8	11.5	11.6
Weekly	41.2	56.4	49.3
Once a month	32.4	23.1	27.4
Occasionally	14.7	8.9	11.6
Buy any special foods for children (%)			
No	41.2	56.4	49.3
Yes	58.8	43.6	50.7
Housing arrangement (%)			
Owns house	80.4	84.9	82.5
Rents	13.4	4.3	9.2
Lives with parents	6.3	9.7	7.8
Other	0.0	1.1	0.5
Housing structure: Floor (%)			
Brick	1.0	0.0	0.5
Concrete	16.7	6.8	15.0
Bare/mud	82.4	93.2	84.5
Housing structure: Roofing (%)			
Iron Sheets	94.7	83.9	89.9
Grass thatched	5.3	16.1	10.2

†Numbers in these columns are percentages unless indicated otherwise.
‡At time of survey, the exchange rate for US$1 = Ug Shs.1,740. This amount could purchase about 1 kg of meat (untrimmed) or 2 (1/2 kg) loaves of bread.

Table 3.3: Prevalence of Stunting and Underweight among Young Children

Age Group (Months)	Height-for-Age (N = 202)			Weight-for-Age (N = 203)			MUAC-for-Height (N = 193)		
	% Children		Mean	% Children		Mean	% Children		Mean
	<-3.0 SD	<-2.0 SD	z-score†	<-3.0 SD	<-2.0 SD	z-core†	<-3.0 SD	<-2.0 SD	z-score†
6-11	5.1	25.6	-.85 ± 1.64	2.6	7.7	-0.45 ± 1.22	3.4	17.2	-1.06 ± 1.03
12-23	3.5	28.1	-1.25 ± 1.59	0.0	6.9	-0.62 ± 1.26	3.5	14.0	-1.07 ± 1.06
24-35	8.7	11.6	-0.88 ± 1.54	1.4	11.6	-0.76 ± 1.03	2.9	23.2	-1.37 ± 0.92
6-47	5.6	8.3	-1.02 ± 1.16	0.0	8.3	-0.92 ± 0.82	0.0	19.4	-1.38 ± 0.75
Total	**6.0**	**18.4**	**-1.01 ± 1.52**	**1.0**	**8.9**	**-0.69 ±1.11**	**2.6**	**18.8**	**-1.23 ± 0.96**

†Mean ± Standard

Table 3.4: Prevalence of Malnutrition indicated by Clinical Assessments

Examination	Parameter of Interest	† Condition Diagnosed (%)		
		YES	NO	Doubtful
HAIR:	a. Dry, staring	25.2	74.8	
	b. Discolored	18.8	81.2	
	c. Easily pluckable	9.9	90.1	
	d. Abnormal texture/ straight	8.9	91.1	
EYES:	a. Conjuctival infection	4.0	93.6	2.5
	b. Bitot's spots	1.0	96.5	2.5
	c. Xeropthalamia	0.0	99.5	0.5
TEETH:	a. Visible carries	10.4	88.6	1.0
	b. Debris/Calculus	5.9	94.1	
	c. Fluorosis	3.5	95.5	1.0
FINGER NAILS:	a. Clubbed	1.5	98.5	
	b. Spooned	0.5	99.0	0.5
	c. Ridged	4.5	95.5	
	d. Combinations	1.5	98.5	0.5
SKIN:	a. Follicular hyperkeratosis, arms	8.4	91.6	
	b. Follicular hyperkeratosis, back	7.4	92.1	0.5
	c. Dry or scaling (Xerosis)	21.8	78.2	
	d. Hyperpigmentation (Face & hands)	5.0	94.1	1.0
	e. Thickened pressure points (not elbow or knees)	3.5	95.5	1.0
	f. Purpura	1.0	98.0	1.0
	g. Cracked skin (mosaic)	2.5	97.5	
	h. Loss of elasticity	5.0	95.0	
	i. Pellagrous dermatitis	0	0	
ABDOMEN:	Hepatomegaly	12.4	87.6	

† Percentage of total children examined (N=202). Some children had more than one condition while others (45.5%) had none.

Table 3. 5: Variety in Household Diets

Food Group	Proportion of Foods Consumed in Each Food Group (Mean ± Std)		
	Site 1 (n = 65)	Site 2 (n = 106)	Total (N=171)
Energy- yielding foods	.51 ± .13	.53 ± .14	.53 ± .14
Bananas	.50 ± .22	.52 ± .16	.51 ±.18
Tubers & starchy vegetables	.68 ± .19	.71 ± .22	.70 ± .21
Grains	.46 ± .21	.47 ± .22	.46 ± .22
Fats, oils, & sweets	.42 ± .16	.44 ± .19	.43 ± .18
Body-building foods	.49 ± .12	.50 ± .16	.49 ± .15
Legumes	.27 ± .16	.31 ± .18	.29 ± .17
Nuts	.46 ± .13	.48 ± .20	.48 ± .17
Meats	.33 ± .19	.37 ± .23	.36 ± .22
Milk[†]	-	-	-
Protective	.42 ± .15	.46 ± .17	.45 ± .16
Fruits	.45 ± .16	.47 ± .18	.46 ± .18
Vegetables	.40 ± .17*	.46 ± .17*	.44 ± .18

*Differences between groups are significant at $P \leq 0.05$ significance level
[†]Milk was not presented in various forms in the food frequency questionnaire

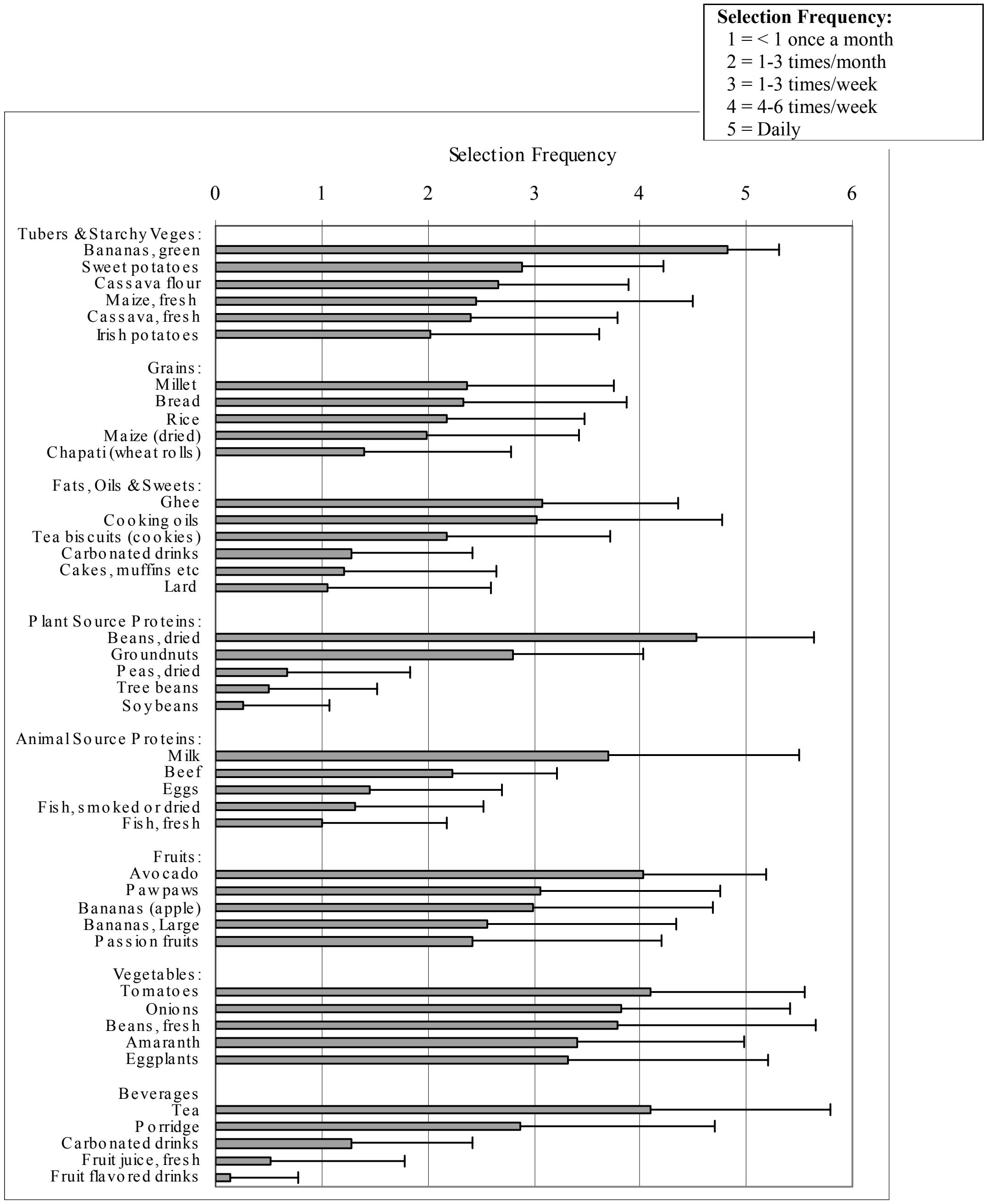


Figure 3.1: Frequency of Food Selection by Food Group

CHAPTER 4

EFFECT OF NUTRITION EDUCATION ON CAREGIVERS' FEEDING PRACTICES AND CHILDREN'S NUTRITIONAL STATUS: AN INTERVENTION TRIAL IN WESTERN UGANDA[1]

---

[1] Margaret Kabahenda, Juergen Erhardt, Christine Northrop-Clewes, and Rebecca Mullis. To be submitted to Nutrition Journal.

ABSTRACT

Undernutrition is a major health problem among children 6-59 months in many developing countries, and this problem is often aggravated by food insecurity, poverty, and illiteracy. Even when food is available, less literate child-caregivers often lack information about appropriate feeding behaviors, which limits their ability to fully utilize the available food resources. The purpose of this intervention was to determine whether a culturally appropriate nutrition education program can improve food selection practices and feeding behaviors of low-income, less literate rural mothers (subsistence farmers).

Forty-six women participated in cooking classes while a control group (n = 43) concurrently engaged in sewing classes that lasted five weeks. Cooking classes were used to provide women with skills on how to prepare nutritionally adequate and appropriate meals for their young children. Caregivers' food selection practices and children's nutritional status were assessed at baseline (Time 1), one month after the intervention (Time 2), and nine months later (Time 3).

Caregivers in the intervention group reported selecting an increased variety of grains, fats and sweets, legumes, meats, fruits, and vegetables. Compared to the controls, the intervention group also provided young children with more snacks both at Time 2 (Mean: 1.26 versus 0.35, $p = 0.000$) and at Time 3 (Mean: 1.22 versus 0.58, $p = 0.001$). Children in the intervention group experienced improvement in vitamin A status at Time 3, but baseline vitamin A status (indicated by retinol binding protein concentrations) and infections (indicated by elevated concentrations of C-reactive protein) accounted for 18.8% and 21.7% of the changes, respectively. Mean hemoglobin concentration of children in the intervention group also improved at Time 2, but returned to baseline levels at Time 3.

Largely, the intervention was effective in improving feeding practices and children's nutritional status, however the effectiveness and sustainability of this program can be improved by piggybacking on other food production and public health programs.

INDEX WORDS: Nutrition education, Intervention, Anemia, Vitamin A deficiency, Feeding practices, Food selection, Infections, Kabarole, Uganda.

INTRODUCTION

Food preparation methods determine the availability of nutrients from a meal and play a key role especially when preparing meals for young children. The risk for malnutrition among young children has been related to the quality, quantity, and timing of introduction of complementary and weaning foods [1-4]. For many children living in developing countries like Uganda, these foods are likely to be the traditional staples which are often bulky [5-7], and high in phytates and tannins. Local processing methods such as roasting are believed to reduce cooking time and improve flavor. However, these methods may reduce protein digestibility and bioavailability of iron [8] and other nutrients. Reduction of these essential nutrients in the diets of young children increases the risk for malnutrition.

Western Uganda has a high prevalence of childhood undernutrition. The 2001 Uganda demographics and health survey [9] showed that about half (47.8%) of children 6–59 months surveyed were stunted, 23.7% were underweight, 39.5% were anemic, and 28.6% were vitamin A deficient. Other studies have also reported high levels of malnutrition [7, 10, 11], and feeding practices have been cited as one of the risk factors for undernutrition among young children [6]. The prevalence of malnutrition in Kabarole district has not been documented but observed child-feeding practices [12, 13] suggest that this region is likely to have high rates of undernutrition. A pilot study conducted in Kabarole district revealed meal patterns that are limited in variety [13]. Bananas are the major staple food, while beans are the major relish and protein source. Consumption of vegetables is very low and fruits (mostly ripe bananas) are consumed as snacks; but in many families older children gather and consume fruits as part of play adventures and thus young children are rarely provided adequate fruit.

Nutrition education has been implemented in many populations to increase awareness about the nutrition problems in the community, to create awareness about the benefits of healthy eating or feeding behaviors, and to improve the knowledge and decision-making abilities of the target population [12-24]. Many of these programs have documented positive changes. A pilot study conducted in western Uganda indicates that nutrition education has potential to improve caregivers' food knowledge, beliefs, and possibly their food selection practices [13]. The purpose of this study was to determine whether nutrition education would improve the child-caregivers' child-feeding behaviors and consequently lead to improvement in the dietary intake and nutritional status of their young children.

RESEARCH METHODS

Study Site and Participants

The study was conducted in Kabarole District, Western Uganda. Participants were mainly recruited from Bukuuku and Karambi sub-counties. These two sites were selected because they are similar in many important ways including food cropping patterns; and yet are distant from each other which was important to control for the possible flow of the intervention messages. The two sites were also good representations of typical rural lifestyle in western Uganda and had similar socio-demographic characteristics. The study participants were pairs of female primary caregivers and their young children (6–43 months of age).

Study Design

At baseline (June 2004 or Time 1), a one-day health fair was organized at each study site and, caregivers were interviewed using a structured questionnaire to obtain baseline data on their beliefs and feeding behaviors. The nutritional status of their children was also assessed. A total of 246 child-caregiver pairs participated in the baseline assessment but only 100 pairs (50 from each site) were selected to participate in the study. Investigators randomly selected study participants by ordering blood samples to be collected from the child of every other caregiver that came through the dietary assessment station, and this selection process was followed at both study sites. One site was assigned to the intervention and the other served as the control. Caregivers in the intervention site participated in a bi-weekly nutrition education program for five weeks whereas the control group concurrently participated in bi-weekly sewing classes. Children were weighed and measured each month to assess their growth patterns (results reported elsewhere). One month after the intervention (September 2004 or Time 2), all caregivers in the intervention and control groups were visited at their homes and interviewed again using the structured questionnaire used for the baseline assessment. These interviews were conducted over a period of 12 consecutive days. Once the caregiver interviews were completed, all children were assembled at a central site and anthropometric measures were taken. A finger-prick sample of blood was also collected to assess their hemoglobin status. A final assessment was conducted one year from baseline (9 months after the intervention or Time 3), and this assessment followed the same format as the baseline assessment.

The Intervention

The intervention was a five-week nutrition education program implemented from mid-July to mid-August 2004. Caregivers were taught skills to prepare nutritionally adequate and appropriate meals for their young children. The curriculum focused on the importance of providing a variety of foods from all food groups. Since this program was targeted to less literate adults, only three food groups were emphasized and these groups were: energy-yielding foods (carbohydrate-rich foods plus fats, oils, and sweets), body-building foods (protein-rich foods), and protective foods (fruits and vegetables). Special emphasis was also placed on iron, iodine, and vitamin A since these are the nutrients of public health concern in Uganda.

Food selection and feeding practices targeted by the intervention were identified from the findings of focus group discussions with caregivers in the region and the pilot study [13]. Inappropriate food selection and preparation practices identified that were possibly affecting iron and vitamin A status included roasting of legumes and grains to shorten cooking time, excessive heating of cooking oils and fats, limited dietary intake of fruits and vegetables, and limited variety of animal source foods. Formative research also revealed food distribution practices that did not favor maximal intake of nutrients from available foods [13]. For example, children were given soup from meat but were not given meat because it was believed that meat causes worm infestations when given to a child whose teeth had not erupted. Beans were not mashed, thus young children were given soup from beans; soup was believed to be higher in protein and iron than beans [13]. The intervention addressed these kinds of practices. **Table 4.1** outlines a sample of specific behaviors targeted by the intervention.

The intervention was also designed to empower caregivers to utilize available resources more efficiently. Some interventions that were already taking place in the study sites included vitamin A capsule supplementation programs of young children (6–59 months), increased availability of vitamin A fortified cooking oil and margarine, and the promotion of the cultivation and consumption of orange-fleshed sweet-potatoes. Caregivers in the intervention group were encouraged to utilize these programs. For example, caregivers learned how to identify fortified cooking oil and were taught food preparation skills that minimized the loss of vitamin A (see **Table 4.1**). To enable the participants to model the learned behavior, the fortified oil was used in all cooking and the educators ensured that caregivers did not overheat the oil and other cooking fats. Taste-testing exercises conducted at the end of each cooking class offered the participants a chance to evaluate food products prepared using non-conventional methods.

Data collection

Assessment of Food Beliefs and Child-feeding Practices. A structured questionnaire was used to interview caregivers about their knowledge of foods that are good sources of iron and vitamin A and the caregiver responses were dichotomized (0 = wrong response, 1 = correct response) and correlated to measures of children’s nutritional status (hemoglobin and retinol binding protein). A food frequency questionnaire that included 76 indigenous food items was employed to characterize food selection patterns (variety and frequency). A 24-hour dietary intake recall with caregivers was used to assess the quality of young children’s diets and meal and snack patterns. Children’s meal and snack patterns together with caregivers’ breastfeeding behaviors and household socio-demographics were also assessed with a structured pre-coded questionnaire.

Children's Nutritional Status. Blood was drawn from all children by finger prick using safety lancets (1.5 x 1 mm) to assess hemoglobin (anemia), retinol binding protein (vitamin A status), and C-reactive protein and α_1-acid glycoprotein (sub-clinical infection).

Hemoglobin was measured with a Hemocue b-hemoglobin photometer (Lake Forest, California) and, after adjusting for race, a cut-off of hemoglobin concentration <10.0 g/dL was used to indicate presence of anemia.

Concentrations of retinol binding protein (RBP) and of acute phase proteins (C-reactive protein and α_1-acid glycoprotein) were assessed only at baseline and at the end of the intervention (one year from baseline). Blood was drawn directly onto dried blood-spot (DBS) collection cards (Schleicher & Schuell #903) and the cards were dried overnight in an opaque plastic basin covered with a light-weight dark sheet. DBS were then sealed in Ziploc bags with desiccant, put in a black plastic bag, and then stored in an air-tight plastic container in a household freezer.

Retinol binding protein (RBP), C-reactive protein (CRP), and α_1-acid glycoprotein (AGP) were measured by a sandwich enzyme-linked immunosorbent assay (ELISA) technique at the SEAMEO-TROPMED Laboratory, Indonesia. A piece of filter paper (3 mm in diameter) was punched from the edge of the dried blood spot and the proteins were extracted overnight in the fridge using 1.5 mL phosphate buffered saline. The extract was then put directly on 96 well plates precoated with antibodies against RBP, CRP or AGP. For detection, antibodies coupled with a peroxidase were used and the resulting color change used to quantify the proteins. The details of the method are described by Erhardt et al [25]. DBS with known RBP, CRP, and AGP were used as controls. RBP values were corrected for the corresponding retinol by HPLC values to be able to use the standard cut off value of 0.70 µmol/L (20 µg/dL). The sensitivity and specificity of different cut-off points for CRP and AGP in diagnosing different infections and inflammations has been investigated, but as there are no set values yet [26-32] cut-offs of 5 mg/L and 1 g/L were used for CRP and AGP respectively [33].

RESULTS

Characteristics of Study Participants

Most of the caregivers (about 90%) were the mothers of children recruited for the study. Subsistence farming was the primary activity of most of the caregivers (94.6%). Mean age of caregivers in the intervention group was 30.0 ± 10.6 years and 27.9 ± 9.1 years for controls. About one quarter (23.8%) of the caregivers did not attain any formal education. Mean years of formal education were 3.9 and 4.0 for the intervention and control group respectively.

Changes in Food beliefs and Food Selection Practices

At baseline (Time 1), there were no significant differences in the variety of foods selected by caregivers in the two groups; however one month after the intervention (Time 2) caregivers in the intervention group selected an increased variety of grains, fats and sweets, legumes, meats, fruits, and vegetables when compared to the control group (**Table 4.2**). The only foods where the two groups did not differ significantly were bananas, tubers and starchy vegetables, and nuts. Similar trends were also observed at Time 3.

Food selection frequency scores (**Table 4.2**) also show that the control group chose fruits ($F_{(1, 40)} = 5.900$, $p = 0.020$) and vegetables ($F_{(1,40)} = 4.077$, $p = 0.050$) more frequently at baseline than the intervention group. At Time 2, the intervention group increased the number of times they selected foods from all food groups (with the exception of nuts and milk groups) while the control group selected foods from all food groups less frequently. Changes between baseline (Time 1) and the end of the intervention (Time 3) indicate that the intervention group maintained the improved frequency of food selection. The only significant difference between Time 2 and Time 3 was that the intervention group selected legumes more frequently than the controls (Mean change 1.5 versus - 0.18, p = 0.006).

On average, both groups provided their children with three meals per day and there were no significant differences in the number of meals provided at all three assessment points. Meal adequacy scores (**Table 4.2**) show changes in the quality of children's meals. The intervention group provided grains, milk, and vegetables on significantly more occasions compared to the controls at both Time 2 and Time 3. Correlations between changes in meal quality indices and markers of nutritional status indicate that children that were provided more servings of fruits were less likely to be anemic (Spearman's r = 0.338, p = 0.004).

Significant changes were also documented in the number of snacks provided by the intervention group. At baseline, there was no significant differences in the number of snacks provided to young children in the two groups, however following the intervention the intervention group provided more snacks than the controls both at Time 2 and at Time 3 (Mean: 1.52 versus 0.53 and 1.29 versus 0 .68, respectively).

Changes in Children's Nutritional Status

At baseline, more children in the intervention group (48.1%) were anemic than in the control group (24.4%). Analyses of variance revealed that mean hemoglobin concentrations of children in the intervention group were significantly lower than for the controls at baseline (Mean: 9.9 versus 10.6 g/dL respectively; $F_{((1,95)} = 5.71$, $p = 0.019$) and one year from baseline (9.7 versus 10.7 g/dl respectively; $F_{(1,82)} = 5.99$, $p = 0 .016$), however there were no significant differences between the two groups one month after the intervention (see Error! Reference source not found.). This trend was observed even when children that missed any of the three assessments were excluded from the analyses and after controlling for infections. At baseline, children whose caregiver's believed that consumption of beans (Spearman's $r = -0.259$, $p = 0.020$) and passion fruits ($r = - 0.255$, $p = 0.022$) improves iron status were less likely to be anemic. There were no correlations between caregiver beliefs and children's hemoglobin concentrations at Time 2 and Time 3. At Time 2, children whose caregivers indicated that they provided a variety of tubers and starchy vegetables ($r = -0.243$, $p = 0.045$) and variety of meats ($r = -0.244$, $p = 0.045$) were more likely to be anemic.

Using the cut off value of 0.70 μmol/L (20 μg/dl) for RBP [34], the prevalence of VAD was higher in the intervention site than among the controls at baseline (47.6% versus 25.6%). Baseline mean whole blood RBP levels were 0.68 μmol/L and 0.92 μmol/L in the intervention and control sites respectively (**Table 4.3**), and the difference was statistically significant ($F_{(1,79)} = 12.37$, $p = 0.001$). There were no significant differences in RBP concentrations of children in the two sites at the end of the intervention (12 months from baseline). Analysis of covariance using end of intervention RBP concentration as the dependent variable and intervention as the between-group factor indicate that vitamin A supplementation, de-worming, breast feeding, baseline age of children, changes in caregiver beliefs, changes in food variety and frequency of consumption patterns did not have significant effects on RBP levels. Baseline vitamin A status explained about 18.8% of the changes in RBP concentration observed at the end of intervention ($F_{(1,55)} = 12.72$, $p = .001$) while current infection indicated by elevated levels of CRP accounted for 21.7% ($F_{(1,68)} = 18.83$, $p = .0001$). The relationship between RBP concentration and AGP was not statistically significant. RBP concentrations were also low among children that were reported to have been ill during the two weeks preceding the end of intervention assessment ($p = .043$) and the illnesses that were most commonly reported by caregivers were fever or undiagnosed malaria (82.4%) and cough (16.2%).

DISCUSSION

Food choices are often influenced by many factors. Social factors [35, 36] such as cultural practices determine which foods are consumed in a population and the pressure of peers and family members often make it harder for individuals to change their food selection practices and eating habits. Caregivers tend to feed their children foods that are culturally acceptable and believed to be appropriate for children [37-39]. In this study, emphasis was placed on improving the awareness of the nutritional value of indigenous foods such that caregivers could select a variety of foods more frequently. Caregivers were also empowered to select even culturally undesirable foods in order to increase food variety. Since messages targeted common beliefs and practices, caregivers were challenged to change their feeding behaviors. For example, many intervention participants reported supplementing bananas (the traditional staple) with sorghum, yams, and pumpkins which are traditionally considered famine foods and are rarely part of the usual diet. Caregivers were also made aware of the value of food items that are not often considered as foods, hence this may have resulted in increased consumed of fruits such as *Entutu* (wild berries), blackberries, and guavas. It is not surprising that caregivers in the intervention group reported providing their children with a variety of foods and better quality meals even at Time 2, which was a period of food shortage.

When income is not the limiting factor, nutrition education is effective in motivating mothers to change their feeding practices [40]. But it has been suggested that to improve nutrition status in the poorest communities, there is need to improve access to food [41]. This was observed in our previous study [13] where caregivers were only able to include foods that were available to the household and these were foods that they always cultivate. A similar trend was observed in this study as there were significant changes in variety and frequency of consumption of grains, tubers and starchy vegetables, legumes, fruits, and vegetables. Fats, oils, and sweets were selected more frequently by the intervention group because of better accessibility to these foods due to customized packaging that allows consumers to purchase very small quantities cheaply. Little or no changes were observed in selection of nuts, meats, and milk products because food items in these groups are more expensive compared to other sub-groups. There is need to improve access to nutrient dense foods such as fish, beef, poultry, liver, and eggs as these foods are the major sources of iron and vitamin A, which are important nutrients for growth, immunity and cognitive development of children [19, 42-44]. The intervention challenged caregivers to try and incorporate low-cost, less desirable animal food sources like organ meats and fish in their children's diets. However since most caregivers do not prepare special meals for children [13], caregivers in the intervention group might have experienced problems incorporating these less desirable foods into the family meals as they may not have been acceptable to other family members. Small scale intensive farming interventions such as increased production of small animals (that are culturally acceptable) at the household level may help rectify this problem.

The use of hemoglobin as a marker of improvement in iron status remains questionable. Hemoglobin is used in most surveys to assess the prevalence of anemia, however hemoglobin concentration is affected by hemoglobinopathies and deficiencies in other nutrients such as vitamin A, folate, and zinc and by protein losing enteropathy [45]. When the prevalence of anemia in a population exceeds 30–40%, iron-deficiency is believed to be part of or the only cause of anemia [46]. In this study, all children assessed were healthy by clinical examination at baseline but 48.1 % of the children in the intervention group and 24.4% in the control group were anemic (Mean: 37.1%). This shows that iron deficiency is likely to be the major cause of anemia. Data on food variety, frequency of food item consumption, and the quality of the children's diets indicate a limited dietary intake of iron. Other investigators [10, 13, 47] have documented low dietary intakes of meats and high intake of phytate-rich foods that increase risk for iron deficiency. It can be concluded that iron deficiency is a problem in this population; therefore the reduced prevalence of anemia observed among children in the intervention group at Time 2 can partly be attributed to improved dietary intake of iron containing foods or improved bioavailability. The positive relationship between children being anemic and consuming variety of tubers and starchy vegetables at Time 2 could be attributed to food shortages which are common in September-November. It is possible that families with limited food choices could have consumed more culturally undesirable foods such as yams, thus had a variety of tubers and starchy vegetables in their diets. The positive association between anemia and consumption of a variety of meats is difficult to explain, however this could be a random effect resulting from over-reporting types of meats consumed.

Retinol binding protein (RBP) is an acceptable indicator of circulating retinol and vitamin A status [48], however both retinol and RBP are affected by infections [33]. Concentrations of RBP fall in response to infections because RBP is a negative acute phase reactant, thus it is important to assess presence of infection when assessing vitamin A status especially in populations with high rates of infection. In this study, C-reactive protein (CRP) and α_1-acid glycoprotein (AGP) were measured to assess presence of asymptomic infections. At baseline, all children did not show symptoms of infection however low RBP and elevated concentrations of CRP and AGP were reported in 47.6%, 31.0%, and 7.1% of children in the intervention group and among 25.6%, 33.3% and 15.4% of the controls. Since sick children were not excluded from the analyses at the end of the intervention, both the intervention and control groups had elevated levels of CRP (57.5% and 59.4% respectively) and AGP (31.3% and 25.0% respectively) and the differences were not statistically significant. However, the prevalence of vitamin A deficiency indicated by RBP decreased in the intervention group but increased in the controls. The significant improvement in RBP concentrations of children in the intervention group at Time 3 suggests that the intervention was effective in improving nutritional status.

Since nutrients tend to interact in a synergetic manner, improvement in status of one nutrient resulting from improvement in dietary intake or supplementation often leads to improved levels of other nutrients [45, 49, 50]. In this study, hemoglobin and retinol were proxies for overall improvement in micronutrient nutriture. Based on this premise, it seems that children in the intervention group had improved nutritional status. Since both groups were at similar risk for infection, it can be concluded that improving the intake of both iron and vitamin A by dietary means is likely to improve nutritional status even in the face of highly prevalent infections such as malaria and cough as the children will be better able to fight infection.

CONCLUSIONS

Most food-based behavioral interventions tend to target increasing consumption of single foods or single nutrients. This intervention took a total diet approach and this may have helped caregivers to provide a variety of foods. Consumption of a variety of foods is associated with high consumption of micronutrients. The benefits of the synergistic effects among nutrients and foods could account for the significant changes observed. This calls for more interventions focusing on improving whole diets rather than single foods or single food groups. This is especially important when dealing with populations with high prevalence of malnutrition and where there is limited literature on specific nutrient deficiencies. With a whole diet approach, each program participant is likely to come out with one behavior they can adopt or a food item they have access to and are willing to try.

COMPETING INTERESTS

The authors declare that there did not have any competing interests.

AUTHORS' CONTRIBUTIONS

CL, RMM, and MK contributed to the design and implementation of the study. JE provided technical support and analyzed dried blood spots. All authors were involved in the writing process.

ACKNOWLEDGEMENTS

Curriculum development (modification) was funded by the American Association of Family and Consumer Sciences. Intervention was funded by Department of Foods and Nutrition and College of Family and Consumer Sciences, University of Georgia. Sight and Life funded analyses of vitamin A and acute phase proteins. Hemocue (USA) loaned us the photometer and provided some cuvettes for assessing hemoglobin. Local council leaders in Uganda were very instrumental in the recruitment of participants.

REFERENCES

1. Motarjemi Y, K Kaferstein F, Moy G, Quevedo F: **Contaminated weaning food: a major risk factor for diarrhoea and associated malnutrition.** *Bulletin of the World Health Organization* 1993, **71**(1):79-92.
2. Brown LV, Zeitlin MF, Peterson KE, Chowdhury AMR, Rogers BL, Weld LH, Gershoff SN: **Evaluation of the impact of weaning food messages on infant feeding practices and child growth in rural Bangladesh.** *American Journal of Clinical Nutrition* 1992, **56**(6):994-1003.

3. Whitworth JA, Cross IB, Morgan D: **Childhood feeding practices and their effects on nutrition in a rural area of The Gambia**. *Journal of Tropical Medicine and Hygiene* 1987, **90**(5):227-231.

4. Mamiro PS, Kolsteren P, Roberfroid D, Tatala S, Opsomer AS, Van Camp JH: **Feeding practices and factors contributing to wasting, stunting, and iron-deficiency anaemia among 3-23-month old children in Kilosa district, rural Tanzania.** *Journal of Health Population and Nutrition* 2005, **23**(3):222-230.

5. Kikafunda JK, Walker AF, Tumwine JK: **Weaning foods and practices in central Uganda: A cross-sectional study**. *African Journal of Food, Agriculture, Nutrition and Development* 2003, **3**(2):Online.

6. Kikafunda JK, Walker AF, Collett D, Tumwine JK: **Risk factors for early childhood malnutrition in Uganda**. *Pediatrics* 1998a, **102**(4):E45.

7. Wamania H, Åstrøma AN, Peterson S, Tylleskära T, Tumwine JK: **Infant and Young Child Feeding in Western Uganda: Knowledge, Practices and Socio-economic Correlates (Abstract)**. *Journal of Tropical Pediatrics* 2005, **51**(6):356-361.

8. Cisse D, Guiro AT, Diaham B, Souane M, Doumbouya NT, Wade S: **Effect of food processing on iron availability of African pearl millet weaning foods.** *International Journal of Food Sciences and Nutrition* 1998, **49**(5):375-381.

9. UBOS, Macro-ORC: **Uganda Demographics and Health Survey 2000-2001**. In. Calverton, Maryland, USA: Uganda Bureau of Statistics and Macro International Inc. ORC; 2001.

10. Tumwine JK, Barugahare W: **Nutritional status of children in Kasese district at the Uganda-Congo border**. *East African Medical Journal* 2002, **79**(8):427-434.

11. Vella V, Tomkins A, Ndiku J, Marshall T: **Determinants of nutritional status in southwestern Uganda**. *Journal of Tropical Pediatrics* 1995, **41**:89-98.

12. Rutishauser IHE, Frood JDL: **The effect of a traditional low-fat diet on energy and protein intake, serum albumin concentration and body weight in Ugandan preschool children**. *British Journal of Nutrition* 1973, **29**(2):261-268.

13. Kabahenda MK: **Developing an intervention to improve the child-feeding behaviors of rural mothers in western Uganda**. *Master's Thesis.* Athens: University of Georgia; 2002.

14. Himes JH, Jacobs DR, Jr: **Food-based nutrition education and hygiene can improve the growth of stunted children.** *The British Journal of Nutrition* 2004, **91**(5):657-659.

15. Hoorweg JN, McDowell I: **Evaluation of nutrition education in Africa: Community research in Uganda, 1971 - 1972**. The Hague, Netherlands: Mouton Publishers; 1979.

16. Hotz C, Gibson RS: **Participatory nutrition education and adoption of new feeding practices are associated with improved adequacy of complementary**

diets among rural Malawian children: a pilot study. *European Journal of Clinical Nutrition* 2005, **59**:226-237.

17. Iannotti L, Gillespie S: **Successful Community Nutrition Programming: Lessons from Kenya, Tanzania, and Uganda**. Washington DC; 2002.
18. Pant CR, Pokharel GP, Curtale F, Pokharel RP, Gross RN, Lepkowski J, Muhilal, Bannister M, Gorstein J, Pak-Gorstein S *et al*: **Impact of nutrition education and mega-dose vitamin A supplementation on the health of children in Nepal**. *WHO Bulletin* 1996, **74**(5):533-545.
19. Salehi M, Kimiagar SM, Shahbazi M, Mehrabi Y, Kolahi AA: **Assessing the impact of nutrition education on growth indices of Iranian nomadic children: an application of a modified beliefs, attitudes, subjective-norms and enabling-factors model.** *The British Journal of Nutrition* 2004, **91**(5):779-787.
20. Schurch B (ed.): **Evaluation of nutrition education in third world communities**. Bern, Switzerland: Hans Huber; 1983.
21. Sur D, Mukhopadhyay SP, Diswas R: **Impact of nutrition education on health of the mother and newborn belonging to the poor urban slum community**. *Journal of the Indian Medical Association* 1997, **95**(7):424-425.
22. Walsh CM, Dannhauser A, Joubert G: **The impact of a nutrition education programme on the anthropometric nutritional status of low-income children in South Africa.** *Public Health Nutrition* 2002, **5**(1):3-9.
23. Guldan GS, Fan HC, Ma X, Ni ZZ, Xiang X, Tang MZ: **Culturally appropriate nutrition education improves infant feeding and growth in rural Sichuan, China.** *Journal of Nutrition* 2000, **130**(5):1204-1211.
24. Ghosh S, Kilaru A, Ganapathy S: **Nutrition education and infant growth in rural Indian infants: narrowing the gender gap?** *Journal of the Indian Medical Association* 2002, **100**(8):483.
25. Erhardt JG, Estes JE, Pfeiffer CM, Biesalski HK, Craft NE: **Combined measurement of ferritin, soluble transferrin receptor, retinol binding protein, and C-reactive protein by an inexpensive, sensitive, and simple sandwich enzyme-linked immunosorbent assay technique.** *Journal of Nutrition* 2004, **134**(11):3127-3132.
26. Palmer A, Carlin JB, Freihorst J, Gatchalian S, Muhe L, Mulholland K, Weber MW: **The use of CRP for diagnosing infections in young infants < 3 months of age in developing countries.** *Annuals of Tropical Paediatrics* 2004, **24**(3):205-212.
27. Garcia Vazquez E, Martinez JA, Mensa J, Sanchez F, Marcos MA, de Roux A, Torres A: **C-reactive protein levels in community-acquired pneumonia.** *The European Respiratory Journal* 2003, **21**(4):702-705.
28. Isaacman DJ, Burke BL: **Utility of the serum C-reactive protein for detection of occult bacterial infection in children.** *Archives of Pediatrics and Adolescent Medicine* 2002, **156**(9):905-909.

29. Korppi M, Kroger L: **C-reactive protein in viral and bacterial respiratory infection in children.** *Scandinavian Journal of Infectious Diseases* 1993, **25**(2):207-213.

30. Semba RD, Yuniar Y, Gamble MV, Natadisastra G, Muhilal: **Assessment of vitamin A status of preschool children in Indonesia using plasma retinol-binding protein.** *Journal of Tropical Pediatrics* 2002, **48**(2):84-87.

31. Paracha PI, Jamil A, Northrop-Clewes CA, Thurnham DI: **Interpretation of vitamin A status in apparently healthy Pakistani children by using markers of subclinical infection.** *American Journal Clinical Nutrition* 2000, **72**(5):1164-1169.

32. Filteau SM, Willumsen JF, Sullivan K, Simmank K, Gamble M: **Use of the retinol-binding protein: transthyretin ratio for assessment of vitamin A status during the acute-phase response.** *British Journal of Nutrition* 2000, **83**(5):513-520.

33. Thurnham DI, McCabe GP, Northrop-Clewes CA, Nestel P: **Effects of subclinical infection on plasma retinol concentrations and assessment of prevalence of vitamin A deficiency: meta-analysis.** *Lancet* 2003, **362**(9401):2052-2058.

34. Sommer A, Davison FR: **Assessment and control of vitamin A deficiency: The Annecy Accords**. *Journal of Nutrition* 2002, **132**(9):2845S-2850S.

35. Shepherd R: **Resistance to changes in diet.** *Proceedings of the Nutrition Society* 2002, **61**(2):267-272.

36. Nestle M, Wing R, Birch L, Disogra L, Drewnowski A, Middleton S, Sigman-Grant M, Sobal J, Winston M, Economos C: **Behavioral and social influences on food choice: Discussion**. *Nutrition Reviews* 1998, **56**(5).

37. Shell-Duncan B, McDade T: **Cultural and environmental barriers to adequate iron intake among northern Kenyan schoolchildren**. *Food and Nutrition Bulletin* 2005, **26**(1):39-48.

38. Kruger R, Gericke GJ: **A qualitative exploration of rural feeding and weaning practices, knowledge and attitudes on nutrition**. *Public Health Nutrition* 2003, **6**(2):217-223.

39. Izurieta LM, Larson-Brown LB: **Child feeding practices in Guatemala.** *Ecology of Food and Nutrition* 1995, **33**(4):249-262.

40. Mcnaughton J: **Nutrition intervention programmes: pitfalls and potential**. *Ceres* 1983, **16**(2):28-33 (abstract).

41. Rosegrant MW, Meijer S: **Appropriate food policies and investments could reduce child malnutrition by 43% in 2020.** *Journal of Nutrition* 2002, **132**(11):3437S-3440S.

42. Thurnham DI, Northrop-Clewes CA, McCullough FS, Das BS, Lunn PG: **Innate immunity, gut integrity, and vitamin A in Gambian and Indian infants.** *Journal of Infectious Diseases* 2000, **182**(Suppl 1):S23-28.

43. Stephensen CB: **Vitamin A, infection, and immune function**. *Annual Review of Nutrition* 2001, **21**:167-192.

44. Pipes P, Trahms CM: **Nutrition in childhood**, vol. Third Edition. Boston, Massachusetts: The McGraw-Hill Companies, Inc.; 1996.

45. Kolsteren P, Rahman SR, Hilderbrand K, Diniz A: **Treatment for iron deficiency anaemia with a combined supplementation of iron, vitamin A and zinc in women of Dinajpur, Bangladesh**. *European Journal of Clinical Nutrition* 1999, **53**(2):102-106.

46. WHO: **Iron deficiency anemia assessment, prevention, and control: A guide for programme managers**. Geneva: World Health Organization; 2001: 132.

47. Kikafunda JK, Walker AF, K TJ: **Weaning foods and practices in central Uganda: A cross-sectional study**. *African Journal of Food, Agriculture, Nutrition and Development* 2003, **3**(2):Online

48. de Pee S, Dary O: **Biochemical indicators of vitamin A deficiency: Serum retinol and serum retinol binding protein.** *Journal of Nutrition* 2002, **132** (Suppl 9):2895S-2901S.

49. Muñoz EC, Rosado JL, López P, Furr HC, Allen LH: *American Journal of Clinical Nutrition* 2000, **71**(3):789-794.

50. Wieringa FT, Dijkhuizen MA, West CE, Thurnham DI, Muhilal, van-der-Meer JW: **Redistribution of vitamin A after iron supplementation in Indonesian infants**. *American Journal of Clinical Nutrition* 2003, **77**(3):651-657.

Table 4.1: Key Food Selection and Preparation Practices Targeted by the Intervention

Nutrient	Targeted Behaviors	
	Encouraged	**Discouraged**
Iron	- Include local fresh fruits and vegetables (such as guavas and tomatoes) in children's meals to improve vitamin C intake. - Adding low cost animal protein (e.g. *Mukene*†, blood, offals) with beansᵼ to improve non-heme iron absorption - Trying different kinds of non-traditional or less desirable meats such as rabbit and pork - Appropriate food handling techniques that reduce contamination of meats.	- Giving children soup only and no meats or beans - Providing children with water from unprotected wells and streams - Not boiling drinking water
Iodine	- Identifying iodinated salt - Whenever possible, using refined white salt since it is often iodized	- Using unrefined local salt
Vitamin A	- Increasing consumption of yellow and orange fleshed fruits and vegetables - Increasing consumption of amaranth leaves and leaves of local staples such as bean leaves, cassava leaves, and yam leaves - Selecting vitamin A fortified cooking oils and fats - Appropriate frying methods that conserve vitamin A in fortified cooking oil - Using red palm oil often, especially in cooking green vegetables	- Heating cooking oils and fats to very high temperatures - Bleaching of palm oil by overheating the oil
Protein	- Providing young children with milk, eggs, and meats - Always soak legumes to improve protein digestibility and reduce cooking time - Complementing legumes with grains when preparing children meals for example fortifying finger millet porridge with groundnut (peanut) paste - Including a variety of grains and legumes in children's diets to ensure adequate intake - Fermenting finger millet for making porridge	- Excessive consumption of green bean seeds - Roasting beans before cooking - Roasting finger millet when preparing flour for porridge - Providing children soup and no beans or meats

†*Mukene* is dried bony fish (sardine type). One heap (~¼ kg) costs about US$ 0.10 and is sufficient for an average family when mixed in beans - ¼ kg of beef (with bones and fat) costs about US$0.37.

ᵼBeans (*Phaselius vulgaris*) were emphasized because they are the staple protein source and the most commonly consumed legume.

Table 4.2: Changes in Food Selection Practices and Quality of Children's Meals 1 Month after the Intervention (Time 2)

Food Group	Food Variety†		Frequency of Use†		Adequacy of Children's Meals†	
	Intervention (n =35)	Control (n=27)	Intervention (n = 20)	Control (n = 15)	Intervention (n = 33)	Control (n = 23)
Energy-yielding	**5.91 ± 5.08*****	**0.81 ± 4.96*****	**10.36 ± 25.96*****	**-18.80 ± 25.12*****	**0.45 ± 1.30***	**-0.87 ± 1.29***
Bananas	0	0	0	0	-0.82 ± 1.16	-0.78 ± 1.04
Tubers & starchy vegetables	1.17 ± 1.84	0.48 ± 2.05	5.55 ± 6.27*	-0.47 ± 8.13*	0.09 ± 0.84	-0.09 ± 0.79
Grains	2.20 ± 2.18**	0.33 ± 2.13**	5.35 ± 7.19**	-2.80 ± 7.53**	0.30 ± 0.73	-0.30 ± 1.10*
Fats, oils and sweets	2.54 ± 2.30***	0.00 ± 2.00***	5.60 ± 6.45***	-4.13 ± 4.34***	0.58 ± 0.50	0.30 ± 0.56
Body-building	**2.03 ± 3.14***	**-0.19 3 ± 0.46***	**7.25 ± 9.03*****	**-2.73 ± 5.75*****	**-0.14 ± 1.07**	**-0.63 ± 1.02**
Legumes	0.49 ± 1.34*	-0.15 ± 0.95*	0.45 ± 3.25	-1.40 ± 2.29	-0.91 ± 1.07	-0.48 ± 0.94
Nuts	0.14 ± 0.49	0.18 ± 0.48	1.00 ± 1.34	0.27 ± 1.39	0.18 ± 0.52	0.04 ± 0.64
Meats	2.17 ± 1.85**	0.11 ± 3.15**	5.00 ± 6.30***	-2.73 ± 4.99***	-0.03 ± 0.53	-0.09 ± 0.67
Milk	0.11 ± 0.32	0.18 ± .39	0.80 ± 1.73	0.13 ± 2.47	0.62 ± 0.52	-0.11 ± 0.48***
Protective	**6.23 ± 5.99****	**1.44 ± 6.04****	**17.60 ± 19.87*****	**-12.80 ± 17.01*****	**0.73 ± 0.80***	**0.22 ± 0.60***
Fruits	2.43 ± 2.76**	0.37 ± 3.05**	7.40 ± 8.74***	-8.60 ± 9.45***	0.24 ± 0.61	0.13 ± 0.34
Vegetables	3.80 ± 3.81**	1.07 ± 4.06**	10.20 ± 12.35**	-4.20 ± 12.18**	0.49 ± 0.51	0.09 ± 0.51**
Total Score	**14.24 ± 13.93****	**2.5 ± 13.00****	**41.35 ± 41.54*****	**- 23.93 ± 33.58*****	**0.74 ± 2.14***	**-1.28 ±1.85***

†All values are Means ± Standard Deviation
*Differences between the two groups statistically significant at .05 level
**Differences between the two groups statistically significant at .01 level
***Differences between the two groups statistically significant at .001 level

Table 4.3: Hemoglobin and Retinol Binding Protein Status at the Three Major Assessment Points

	Baseline		One (1) Month after Intervention		12 Months from Baseline (9 months after intervention)	
	Intervention	Control	Intervention	Control	Intervention	Control
Hemoglobin (g/dL)						
Sample size (n)	52	45	48	33	46	38
Mean ± SD	9.91 ± 1.59*	10.67 ± 1.51*	10.05 ± 1.78	10.40 ± 2.12	9.71 ± 1.82*	10.74 ± 2.03*
95%CI	9.47 ± 10.35	10.21 ±11.12	9.54 ± 10.57	9.65 ± 11.15	9.17 ± 10.25	10.07 ± 11.41
Retinol Binding Protein (µmol/L)						
Sample size (n)$^{\phi}$	42	39	-	-	40	32
Mean ± SD	0.68 ± 0.29**	0.94 ± 0.36**	-	-	0.92 ± 0.35	0.98 ± 0.44
95%CI	0.59 ± 0.77	0.82 ± 1.06	-	-	0.81 ± 1.03	0.82 ± 1.14
C-reactive Protein (mg/L)						
Mean ± SD	6.22 ± 8.56	4.43 ± 7.46	-	-	8.24 ± 9.17	11.14 ± 11.31
95%CI	3.55 ± 8.89	2.01 ± 6.85	-	-	5.31 ± 11.17	7.06 ±15.23
α_1- Glycoprotein (g/L)						
Mean ± SD	0.66 ± 0.23	0.67 ± 0.27	-	-	0.82 ± 0.35	0.91 ± 0.39
95%CI	0.59 ± 0.73	0.58 ± 0.75	-	-	0.71 ± 0.93	0.77 ± 1.06

* Difference in means is statistically significant at p = .05
** Difference in means statistically significant at p = .01
$^{\phi}$ Sample size is same for RBP, CRP, and AGP

CHAPTER 5

A LONGITUDINAL STUDY OF GROWTH AMONG YOUNG CHILDREN IN A RURAL UGANDAN SUBSISTENCE FARMING COMMUNITY[1]

[1] Margaret Kabahenda and Rebecca M Mullis. To be submitted to Nutrition Journal.

ABSTRACT

Background: Reducing hunger and under-five mortality are among the central themes of the United Nations millennium development goals (MDGs); however Uganda is one of Sub-Saharan African countries that have staggering levels of childhood undernutrition and limited food and nutrition interventions and thus may not attain the MDG goal of halving the 1990 number of children of underweight by 2015. Interventions are needed to ensure adequate caloric and micronutrient intake among young children since they are more vulnerable to the consequences of inadequate nutrition.

Methods: This study was a controlled longitudinal study conducted to assess the effectiveness of nutrition education on improving growth patterns of young children in two rural areas of Kabarole district, western Uganda. Participants were caregivers and their young children (6-43 months) recruited from two rural areas in western Uganda. Caregivers attended a 9-session nutrition education program that lasted 5 weeks and their children were measured each month for a period of one year to assess changes in growth patterns. A control group of caregivers participated in sewing classes and their children's growth was also monitored for 1 year. The main outcome measure was change in growth indicated by changes in height-for-age, weight-for-age, weight-for-height, and mid-upper arm circumference-for-age. Repeated measures ANCOVA was used to access differences between the two groups over time and across age groups. Variability in the growth patterns of individual children and clustering of caregiver effects were controlled for.

Results: Children in the intervention group had significant changes in weight-for-age when compared to the controls (Mean: 0.61 ± 0.15 versus -0.99 ± 0.16, $p = 0.038$) and mean WAZ was high among children of younger caregivers (p= 0.012). Changes in height-for-age, weight-for-height, and MUAC-for-age were in a positive trend for children in the intervention group but not statistically different from the controls. Changes in weight-for-height were statistically significant across age groups (p = 0.018) and negatively related to caregiver's age (p = 0.048).

Conclusions: This intervention demonstrates that nutrition education can improve nutritional status and growth of young children.

Index Words: Nutrition education, Intervention, Growth, Weight-for-age, Nutritional status, Uganda, Sub-Saharan Africa

INTRODUCTION

Reducing hunger and under-five mortality are among the central themes of the United Nations millennium development goals [1], and many nations have laid down strategies for reducing childhood malnutrition. The question that remains unanswered is whether the goal of halving the 1990 level of underweight by 2015 will be attained in Sub-Saharan African and South East Asia, which are the two regions with staggering levels of childhood undernutrition.

Uganda is one of the Sub-Saharan African countries experiencing high levels of childhood undernutrition and a number of studies suggest that malnutrition is a problem across the country [2-6]. Results of the 2000-2001 Uganda Demographics and Health Survey (UDHS) show that about one half of Ugandan children suffer chronic malnutrition [7] and it seems that both chronic (stunting) and acute (underweight) malnutrition are more prevalent in rural than in urban areas. The prevalence of stunting and underweight in rural areas are estimated at 39.9% and 23.6%, respectively [7]. In a country like Uganda, where more than 80% of the population resides in rural areas [8], this means that a large proportion of children are at risk for malnutrition.

Western Uganda is predominantly rural and one of the regions with a high prevalence of undernutrition [7]. Factors attributed to undernutrition in the western region include poor diets, early weaning from breastfeeding, not receiving immunizations, having parents with limited formal education, limited household assets, and the gender of the child [3, 9, 10]. The diets of young children are often monotonous, limited in animal source foods, and low in calories and nutrients but few studies have documented actual intakes. An investigation by Rutishauser and Whitehead [11] revealed that on average Ugandan children consumed about 41 to 96 kcal/kg bodyweight/day which is lower than the UNICEF/WHO recommendation of 106-124 kcal/kg/day).

Several interventions have been implemented to improve growth and nutritional status of young children in Uganda. Interventions focused on improving dietary intake and body stores of vitamin A include the increased production and consumption of the orange-fleshed sweet potatoes, fortification of cooking oil, and biannual vitamin A capsule supplementation of preschool children [12]. Biannual de-worming of preschool children is also now part of routine preventative care and this is targeted at improving iron nutriture. Universal Iodinization of salt has led to reductions in iodine deficiency disorders [13]. The Nutrition and Early Childhood Development project was a comprehensive communication program that among other things documented changes in caregiver knowledge and behavior in regard to complementary feeding and de-worming [14]. There are no documented studies that have documented effects of these interventions on child growth.

The purpose of this study was to determine whether nutrition education targeting the food selection practices of caregivers in rural areas (subsistence farmers) would improve the nutritional status and growth patterns of their young children. It was hypothesized that children of caregivers that attend nutrition classes would have improved dietary intake, nutritional status, and growth patterns when compared to children of caregivers living in a similar setting that do not attend nutrition classes. The effects of nutrition education on dietary intake and nutritional status are presented elsewhere (Chapter 4). This paper discusses the effects of nutrition education on children's growth patterns.

METHODS

Study Participants

Pairs or trios of caregivers and their young children were recruited from two rural communities in Kabarole district, western Uganda. A pool of 206 caregivers participated in a health fair and investigators randomly selected intervention participants by selecting the first participant that was in line and skipping the next person. Every selected caregiver was asked if they could attend classes and bring children for measurement every month and those that declined were not included in this study. The next person in line was selected.

Study Design

This study was a controlled longitudinal study that lasted one year. A baseline assessment was conducted to assess caregivers' feeding practices and children's nutritional status. This was followed by an intervention whereby caregivers in the intervention group attended a 9-session nutrition education program that lasted 5 weeks and their children were measured each month for a period of one year to assess changes in growth patterns. A control group of caregivers participated in sewing classes and their children's growth was also monitored for 1 year.

The Intervention. This was a five-week educational program. **Table 5.1** provides an outline of the curriculum used for this intervention. Cooking classes were comprised of a lecture session that lasted 45 to 60 minutes and cooking sessions that lasted three to five hours. Caregivers were divided into groups of 5-6 people. Each group was assigned a meal and caregivers decided on the types and amounts of ingredients they used to prepare the meal. All food items, fuel (charcoal and firewood), cooking utensils, and dinnerware were provided to the caregivers. The educator ensured that all groups had material and ingredients to prepare the assigned meals and where there were shortages the educator gave suggestions on how to improvise and took note of the shortages. At the end of each cooking session, each group was required to serve a meal for a 3-year old child. Each group's meal was evaluated by peers, the educator, and the principal investigator. The meals served helped the educator evaluate whether the lesson objectives had been met and also provided an opportunity to emphasize other important concepts that were not deeply explored in the lectures.

Since classes often lasted 4 to 5 hours, lunch was always prepared for all caregivers. Meals served for lunch were always to emphasize the messages in that day's lesson. For example, during the lesson on Plant Protein Sources, caregivers were provided a variety of indigenous legumes and grains and meals assigned to groups included bean-rice pilaf, maizemeal-groundnut paste porridge, and refried bean sauce thickened with wheat flour. Since caregivers had never tasted cooked soybeans, a common pot of maize meal complemented with soybean-groundnut sauce was prepared for lunch. Meals provided for lunch did not only help to introduce unfamiliar foods to caregivers but also helped put the program concepts in perspective of an average caregiver that is accustomed to preparing meals for large families.

Growth Monitoring. Children's weights and heights or lengths were assessed at baseline and during the second week of each month for a period of 1 year. In addition, mid-upper circumference was assessed at baseline and one year from baseline. These assessments were always conducted on two consecutive days. Weights were assessed using a Salter hanging scale and recorded to the nearest 10 gm. Heights were taken from children 24 months and older with a standiometer while children under 24 months of age were measured recumbent with a Seca 210 measuring mat. Both length and heights were recorded to the nearest 0.1 cm. Seca measuring tapes [15]were used to assess MUAC and data was recorded to the nearest 0.1 cm.

DATA ANALYSIS

Epi Info Version 3.2.2 (CDC, USA) was used to compute height-for-age (HAZ), weight-for-age (WAZ), weight-for-height (WHZ), and MUAC-for-age (MUAZ) z-scores using the median of the NCHS/WHO reference population. After removing data of children whose ages could not be verified and records flagged by Epi Info, 102 children were included in the analysis. Data were analyzed using SAS PROC MIXED (Version 9.1) Ignorability of missing data was examined using mixed effects selection models that quantified association between missingness and observed data [16, 17]; however it was determined that the missing data could be ignored without affecting results. Baseline age was used to classify children into four groups: <12 months, 12 -23.9 months, 24 -35.9 months, and 36- 47 months. Available data were analyzed using repeated measures analysis of covariance (ANCOVA) using baseline age group as the covariate and WAZ, HAZ, WHZ, and MUACZ as the response variables. Since some caregivers had multiple children, a linear mixed-effect model (version of repeated measures ANCOVA) was employed to account for caregiver-specific random effects. The model also controlled for child-specific random effects likely to result from the variability in the growth patterns of individual children. Partial correlations were conducted to assess relationships among changes in dietary factors and growth indicators controlling for baseline nutritional status. For all analyses, an alpha level of ≤0.05 was used to determine statistical significance.

RESULTS

Characteristics of Study Participants

A total of 89 caregivers participated in the study and almost all caregivers had one child, 8 (9.0%) had two children, and only one woman (1.1%) had three children. Children (N = 102) were all healthy (determined by clinical examination and mother's reports) and between 6 to 43 months of age at baseline (Mean = 22.4); 47% of the children were females and 53% were males. The mean age of caregivers was 29.6 years (Range: 17-60) and the majority of caregivers were subsistence farmers (94.6%), had limited literacy (average grade completed was primary two), and about 85% lived in households with a total gross income less than US$28 per month. The two sites did not have statistically significant differences in children's ages and gender and in caregivers' ages, occupations, and attained formal education.

Height-for-Age. Low height-for-age indicates impairment in linear growth or stunting and is often caused by chronic undernutrition or poor health. Baseline prevalence of stunting (-2 SD below NCHS median) was 25.5% and 38.3% in the intervention and control group respectively while the proportions of children at risk for stunting (-2 to -1.01 SD) were 40.0% and 27.7% respectively. Mean baseline HAZ was slightly higher in the intervention group when compared to the controls (-1.43 ± 0.17 versus -1.56 ± 0.17), however the difference was not statistically significant (See **Table 5.2**). There were no significant differences in changes in height-for-age between the intervention and control groups over time ($p = 0.401$) and across age groups ($p = 0.973$); however, the intervention group maintained their height-for-age while the controls experienced some growth faltering beginning April-May (see **Figure 5.1**). Changes in HAZ were related to gender whereby girls were likely to experienced an average increase in HAZ of 0.588 over boys ($p = 0.009$).

Weight-for-Age. Both sites had a high prevalence of underweight and large proportions of children at risk for underweight (see **Table 5.2**). Baseline prevalence of underweight was 14.5% and 19.1% in the intervention and control groups respectively. Children in the intervention group significantly improved in weight-for-age over time when compared to the controls ($F_{(1,85)} = 2.15$, $p = 0.038$). Mean WAZ from baseline to end of intervention improved among children in the intervention group (-0.84 ± 0.15 to -0.61 ± 0.15) but declined among the controls (-0.77 ± 0.16 to -0.99 ± 0.16). Changes in WAZ over time were negatively related to caregivers' age. For every unit increase in caregiver's age, WAZ declined by 0.025 ($p = 0.012$). **Figure 5.1** shows mean changes in WAZ over time.

Weight-for-Height. Low weight-for-height indicates wasting. The prevalence of wasting was low (<5%) in both groups (see **Table 5.1**). Mean baseline and end of intervention weight-for-height z-scores were 0.04 ± 0.14 and 0.22 ± 0.15 for the intervention and 0.37 ± 0.15 and 0.06 ± 0.15 for the control group. There were no significant differences in WHZ for the two treatment groups overtime (p = 0.135); however, the changes in WHZ were statistically significant across age groups ($F_{(3,92)}$ = 3.60, p = 0.018). Children in the youngest age group (6-12 months) had the greatest improvement in weight-for-height. WHZ was also negatively related to caregiver's age. For every unit increase in caregiver's age, children's WHZ decreased by 0.017 (p = 0.048). **Figure 5.1** shows mean WHZ for the two groups over time.

MUAC-for-Age (MUAZ). MUAZ is also a good indicator of nutrition and health status; and low MUAC is also an independent predictor of risk for mortality. At baseline, more children in the intervention had very low MUAC-for-age compared to the control group (23.6% and 15.2% respectively). Change in MUAC-for-age over time was not significantly different between the two treatment groups (p = 0.378) and across age groups (p = 0.286). However, both the intervention and control group had slightly improved mean MUAZ (-1.27 to -0.91 versus -1.22 to -0.99, respectively)

DISCUSSION

When the prevalence of low weight-for-height is low (<5%), as was the case in this study, weight-for-age reflects long-term health and nutritional status [18]. The significant change in WAZ observed in the intervention group indicates that the intervention was effective in improving children's nutritional status and growth. However, improvement in growth seems to have been compromised by infections, food shortages, and the workloads of caregivers. WAZ and WHZ dropped off in both groups from September to around February. This period covers the major rainfall season which tends to coincide with peak of malaria infections [19, 20]. September-December is also a period of food shortage in western Uganda while August-September and February-March are major planting seasons. These difficult periods are followed by the millet harvest season which falls from late December through January and this is also a labor intensive activity. Since caregivers in this study were predominantly subsistence farmers, their child care activities were limited during the planting and harvesting seasons.

Low height-for-age (stunting) is known to decline around 3 years of age [18]. In this study the prevalence of stunting was high but baseline age group did not predict risk for stunting. This suggests that all children were at risk for stunting. HAZ changes were related to gender of the child whereby girls had significant improvement in height-for-age compared to boys. The available data are not adequate to explain the gender-based differences in height-for-age, nevertheless gender differences in growth have been reported in other studies [9, 10, 21, 22]. A longitudinal study of children in a deprived environment in Zimbabwe examined children up to 30 months and documented greater deficits in weight among boys (2.3 kg versus 2 kg) but higher deficits in height among girls (8 cm versus 9 cm) [21]. In this study, girls had significantly more improvement in height-for-age than boys but there were no differences in measures of weight (WAZ and WHZ). In general, boys are heavily affected by both malnutrition and infections which accounts to low anthropometrical values. A review of demographic surveys conducted in Sub-Saharan Africa indicates that the high prevalence of malnutrition among boys could be a biological factor rather than an effect of gender-based preferences in seeking care and feeding practices [23].

Caregiver's age was a strong predictor of improvement in weight-for-age and weight-for-height. Children of older caregivers were more likely to have low WAZ and low WHZ. Kikafunda et al (1998) also documented a similar pattern in central Uganda and it was observed that the high risk of malnutrition among children of older caregivers could be a result of prolonged breastfeeding [2]. In this study, breastfeeding did not have an effect on growth. The lack of improvement in nutritional status among children of older caregivers could be a result of high parity and lack of improvement in feeding practices. The relationship of the caregiver to the child was not documented at the beginning of this study, but from looking at the caregiver ages, 91.8% of the caregivers were of child-bearing age (17-44 years) and most likely the mothers. Many of these women (20.6%) were 35-44 years which is a stage associated with poor birth outcomes and low birth-weights. Thus, it can be speculated that the effect of caregiver's age on changes in weight-for-age and weight-for-height could be attributed to poor birth outcomes (especially low birth-weight) which are common among older and multiparous women [24-26]. Older multiparous women are also more likely to have well established feeding patterns and child care practices and thus less likely to adopt new feeding practices.

Overall, the effects of the intervention could have been confounded by growth monitoring and other programs that were going on during the study period. Growth monitoring by itself is an intervention that is valued by mothers and has been shown to improve growth [27, 28]. It is possible that the control group benefited from growth monitoring since they were told that the monthly assessments were necessary to monitor their children's health status. Caregivers also received advice whenever they sought it and were referred to the government hospital when the child's health was a concern to the investigators. In addition, there was a program called Parents' Concern in the control site during the intervention and this program covered topics such as emotional and physical needs of children, preventing common infections among children, teenage pregnancy, creating a happy and friendly home, and topics on AIDS/HIV. Such a program could have affected the knowledge and childcare behaviors of the control group. Future interventions need to take into consideration on-going programs.

The only limitation of this intervention is that it is expensive to implement. Since the program emphasizes food variety and improving food preparation techniques, it requires availability of a variety of food items and adequate cooking utensils for cooking classes. It also requires a committed educator to organize participants, give lessons, guide discussions, and to oversee the activities in cooking classes. This can be resolved by implementing the intervention through existing local structures such as women's self-help groups and mothers' unions; however, this will still require the training of club leaders. The sustainability of this intervention can be improved by integrating the lessons in other child health and childcare programs.

CONCLUSIONS

This study demonstrates that a culturally appropriate nutrition education program can improve feeding practices of rural caregivers and lead to positive changes in child growth. Future research should consider piggybacking on other programs to improve effectiveness of nutrition education. Many successful interventions to improve feeding practices [29] have implemented multiple communication strategies. Individualized counseling would have been beneficial especially for caregivers with malnourished children. Communicating key messages to intervention participants through local congregations such as churches and local council meetings would also have reinforced messages especially during the 9-month period when children's growth was being monitored.

Most research on growth faltering indicates that interventions can have profound effect when targeted to children up to 2 or 3 years of age. Trends of changes in all anthropometric indices show that children in all age groups benefited from the intervention even though the age range of children was wide (6 to 43 months at baseline). It is not disputed that this intervention could have had greater impacts if it had targeted only younger age groups, notably children under 2 or 3 years of age. This would also have facilitated the delivery of more targeted messages especially in regard to feeding infants and complementary foods. However, the results of this study show that even older children can benefit. This calls for more nutrition education interventions that target caregivers of both younger and older children.

As the number of malnourished children in Africa is expected to increase, especially with the increasing number of orphaned infants of HIV/AIDS victims, there is need for more interventions to encourage caregivers to provide appropriate meals using available indigenous foods. Encouraging the consumption of indigenous foods is particularly appropriate when dealing with rural communities where caregivers are also the food producers. This kind of intervention has potential to improve children's nutritional status and growth since it does not require a family that may already be financially constrained to significantly alter their eating patterns in order to accommodate the needs of young children.

COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

All authors contributed to the design and implementation of the study. MKK conducted the fieldwork.

ACKNOWLEDGEMENTS

Curriculum design adapted from Eating Right is Basic and Wellness First programs. Curriculum modification was funded by the American Association of Family and Consumer Sciences. Measuring equipment was loaned from Economic Policy Research Institute, Uganda. We acknowledge the input of Jing Xu and Dr Dan Hall, Statistical Consulting Centre, University of Georgia for their technical support.

REFERENCES:

1. United Nations: **The Millennium Development Goals Report 2005**. New York; 2005.

2. Kikafunda JK, Walker AF, Collett D, Tumwine JK: **Risk factors for early childhood malnutrition in Uganda**. *Pediatrics* 1998a, **102**(4):E45.

3. Tumwine JK, Barugahare W: **Nutritional status of children in Kasese district at the Uganda-Congo border**. *East African Medical Journal* 2002, **79**(8):427-434.

4. Vella V, Tomkins A, Borghesi A, Migliori BB, Adriko BC, Crevatin E: **Determinants of child nutrition and mortality in northwest Uganda**. *WHO Bulletin* 1992b, **70**:637-643.

5. Vella V, Tomkins A, Ndiku J, Marshall T: **Determinants of nutritional status in southwestern Uganda**. *Journal of Tropical Pediatrics* 1995, **41**:89-98.

6. Cortinovis l, Vella V, Ndiku N, Milani S: **Weight, height and arm circumference of children under 5 in the district of Mbarara, southwest Uganda**. *Annuals of Human Biology* 1997, **24**:557-568.

7. UBOS, Macro-ORC: **Uganda Demographics and Health Survey 2000-2001**. In. Calverton, Maryland, USA: Uganda Bureau of Statistics and Macro International Inc. ORC; 2001.

8. MGCD, MPED: **Women and men in Uganda: Facts and figures 1998**. Kampala, Uganda: Ministry of Gender and Community Development & Ministry of Planning and Economic Development; 1998.

9. Wamani H, Tylleskär T, Åstrøm AN, Tumwine JK, Peterson S: **Mothers' education but not fathers' education, household assets or land ownership is the best predictor of child health inequalities in rural Uganda**. *International Journal for Equity in Health* 2004, **3**(9):online.

10. Wamani H, Åstrøma AN, Peterson S, Tylleskära T, Tumwine JK: **Infant and Young Child Feeding in Western Uganda: Knowledge, Practices and Socio-economic Correlates (Abstract)**. *Journal of Tropical Pediatrics* 2005, **51**(6):356-361.

11. Rutishauser IHE, Whitehead RG: **Energy intake and expenditure in 1 - 3-year-old Ugandan children living in a rural environment**. *British Journal of Nutrition* 1972, **28**(1):145-152.

12. Sserunjogi L, Harvey PWJ: **Building a multisectoral vitamin A program in Uganda: Establishing sustainable roles for effective implementation**. In: *Sight and Life Newsletter.* 2005: 26-29.

13. Bachou H: **The nutrition situation in Uganda**. *South African Journal of Clinical Nutrition* 2000, **13**(3).

14. World Bank: **Uganda's Nutrition and Early Child Development Project: Counting on communication**. In. Findings: Volume 111; 2005.

15. de Pee S, Bloem MW: **Assessing and communicating impact of nutrition and health programs**. Totowa, New Jersey: Humana Press Inc.; 2001.

16. Fitzmaurice GM, Laird NM, Ware JH: **Applied longitudinal analysis**. In. Hoboken, N.J.: Wiley-Interscience; 2004: Chapter 8.

17. Hedeker D, Gibbons RD: **Missing data in longitudinal studies**. In: *Longitudinal Data Analysis.* Hoboken, NJ: John Wiley and Sons, Inc; 2005.

18. de Onis M: **Child growth and development**. In: *Nutrition and health in developing countries.* Edited by Semba RD, Bloem MW. Totowa, New Jersey: Humana Press Inc; 2001: 71-91.

19. Odongo-Aginya E, Ssegwanyi G, Kategere P, Vuzi PC: **Relationship between malaria infection intensity and rainfall pattern in Entebbe peninsula, Uganda.** *African Health Sciences* 2005, **5**(3):238-245 (abstract).

20. Zhou G, Minakawa N, Githeko AK, Yan G: **Climate variability and malaria epidemics in the highlands of East Africa.** *Trends in Parasitology* 2005, **21**(2):54-56.

21. Leonard WR, DeWalt KM, Stansbury JP, McCaston MK: **Growth differences between children of highland and coastal Ecuador.** *American Journal of Physical Anthropology* 1995, **98**(1):47-57(abstract).

22. Hop LT, Gross R, Giay T, Schultink W, Thuan BT, Sastroamidjojo S: **Longitudinal observation of growth of Vietnamese children in Hanoi, Vietnam from birth to 10 years of age.** *European Journal of Clinical Nutrition* 1997, **51**(3):164-171(abstract).

23. Garenne M: **Sex differences in health indicators among children in African DHS surveys.** *Journal of Biosocial Science* 2003, **35**(4):601-614.

24. Chhabra P, Sharma AK, Grover VL, Aggarwal OP: **Prevalence of low birth weight and its determinants in an urban resettlement area of Delhi.** *Asia-Pacific Journal of Public Health* 2004, **16**(2):95-98 (abstract).

25. Cleary-Goldman J, Malone FD, Vidaver J, Ball RH, Nyberg DA, Comstock CH, Saade GR, Eddleman KA, Klugman S, Dugoff L *et al*: **Impact of maternal age on obstetric outcome.** *Obstetrics and Gynecology* 2005, **105**(5):983-990 (abstract).

26. Collins JW, Jr, Simon DM, Jackson TA, Drolet A: **Advancing maternal age and infant birth weight among urban African Americans: the effect of neighborhood poverty.** *Ethnicity and Disease* 2006, **16**(1):180-186.

27. Coulibaly F, Delisle H, Haddad S: **Mothers' perception of quality of growth monitoring and promotion programs: a qualitative study in Cote d'Ivoire.** *Ecology of Food and Nutrition* 2002, **41**(6):475-500.

28. Qazi SA, Khan MA, Rizvi T, Khatoon Z, Peterson KE: **Longitudinal growth patterns of Pakistani infants in a clinic based growth promotion program.** *Indian Pediatrics* 2003, **40**(11):1043-1053 (abstract).

29. Caulfield LE, Huffman SL, Piwoz EG: **Interventions to improve intake of complementary foods by infants 6 to 12 months of age in developing countries: Impact on growth and on the prevalence of malnutrition and potentials contribution to child survival**. *Food and Nutrition Bulletin* 1999, **20**(2):183-200.

Table 5.1: Outline of Intervention Curriculum

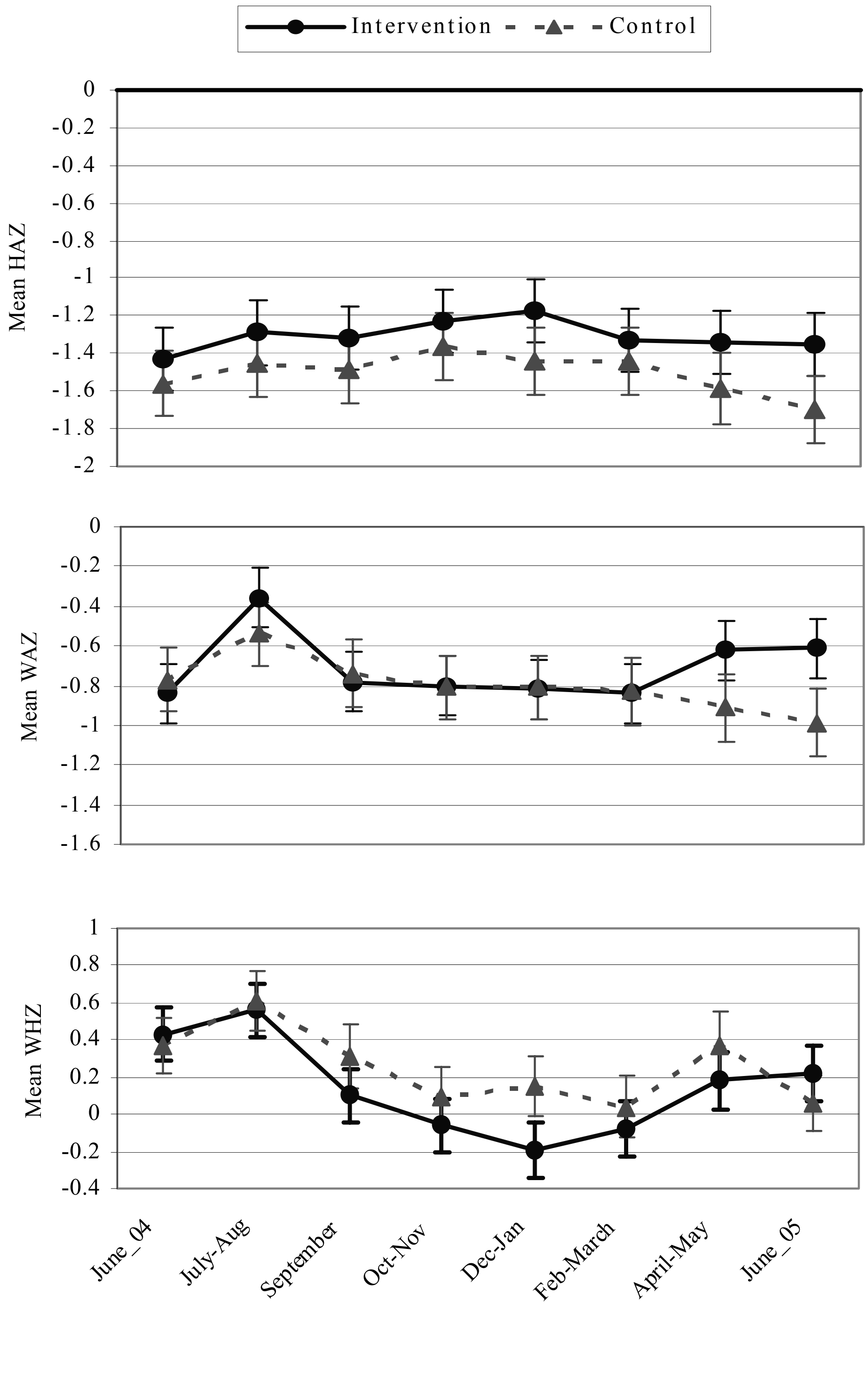
Lesson	Learner Objectives
Lesson 1: ***Selecting and preparing a variety of foods from the three food groups***	▪ Acknowledge diversity of local foods ▪ Correctly classify foods to appropriate food groups ▪ Identify foods lacking/abundant in their children's diets ▪ Prepare a meal that incorporates foods from all food groups
Lesson 2: ***Choosing and preparing body-building foods - Plant sources***	▪ Identify which foods are rich in protein and which of these are appropriate for children ▪ Demonstrate creative ways to make nuts, beans, and other legumes enjoyable for children ▪ Plan meals that incorporate at least 2 servings of protein rich foods each day ▪ Complement legumes with cereals to improve plant protein quality
Lesson 3: ***Choosing and preparing body-building foods - Animal protein sources***	▪ Identify animal source foods rich in protein ▪ Identify which foods are appropriate for children ▪ Identify and prepare low-cost meats ▪ Be familiar with recommended serving sizes for young children
Lesson IV: ***Choosing and preparing energy-yielding foods***	▪ Identify starchy foods appropriate for children ▪ Substitute or complement bananas with other nutrient dense starchy foods on regular basis ▪ Provide children with at least 5 servings of energy yielding foods daily
Lesson V: ***Choosing and preparing energy-yielding foods - Fats, Oils, and Sweets***	▪ Identify which FOS are appropriate for children ▪ Understand importance of providing moderate amounts of FOS to growing children ▪ Recognize fruits as best source of sugars ▪ Appropriately incorporate fats, oils, and sugars in children's diets
Lesson VI: ***Choosing and preparing protective foods - Vegetables***	▪ Understand that vegetables are an important component of a balanced diet ▪ Identify which vegetables are appropriate for children ▪ Know recommended amounts and number of servings needed by children ▪ Prepare meals that incorporate a variety of vegetables
Lesson VII: ***Choosing and Preparing protective Foods - Fruits***	▪ Understand that fruits are an essential component of children's diets ▪ Identify which fruits are appropriate for your children ▪ State recommended servings for children and amounts ▪ Prepare and serve a variety of fruits
Lesson VIII: ***Planning meals for young children: Food variety and meal quality***	▪ Understand that young children have higher needs for nutrients than adults ▪ Improve meal planning skills ▪ Prepare meals that incorporate foods from all 3 food groups ▪ Plan and prepare snacks for children
Lesson IX: ***Planning meals for young children: Meal Frequency and food portions***	▪ Improve the quality of meals prepared for children ▪ Make meals visually attractive to young children ▪ Prepare and serve adequate amounts of food from all food groups to young children

Incorporate = select, cook or prepare, and serve

Table 5.2: Prevalence of Stunting, Underweight, Wasting, and Low MUAC-for-Age at Baseline and 9 Months after Intervention

	Baseline		End	
	Intervention	Control	Intervention	Control
Sample size (n)	55	47	45	38
Height-for-Age				
Stunted[a]	25.5 (14)	28.3 (18)	24.4 (11)	34.2 (13)
At risk for stunting[b]	40.0 (22)	27.7 (13)	35.6 (16)	34.2 (13)
Weight-for-Age				
Underweight[a]	14.5 (8)	19.1 (9)	8.7 (4)	7.9 (3)
At risk for underweight[b]	36.4 (20)	23.4 (11)	34.8 (16)	36.8 (14)
Weight-for-Height				
Wasted[a]	0	0	2.2 (1)	0
At risk for wasting[b]	14.5 (8)	10.6 (5)	11.1(5)	10.5 (4)
MUAC-for-Age				
Low MUAC[a]	23.6 (13)	15.2 (7)	10.9 (5)	11.1 (4)
At risk for low MUAC[b]	40.0 (22)	41.3 (19)	39.1 (18)	41.7 (15)

Unless indicated, all numbers are Percentage (Number).
[a]Less than 2 SD below NCHS median
[b]-2 to -1.01 SD below NCHS median



-

Figure 5.1: Mean Changes in Height-for-Age, Weight-for-Age, and Weight-fo-Height Z-scores

CHAPTER 6

DISCUSSION AND CONCLUSIONS

The UNICEF conceptual framework of malnutrition (1) serves as a guide in assessing and analyzing the causes of poor nutrition especially among children in developing countries. This framework also helps in developing programs because by identifying the causes, interventions can be developed at different levels to address malnutrition. According to this framework the causes of malnutrition are many and involve many sectors of a given economy. Dietary intake and infections are the immediate causes of malnutrition while food insecurity, inadequate maternal and child caring practices, and insufficient health care and unhealthful environmental services are the major underlying causes(1). This complex nature of the causes of malnutrition makes it difficult to come up with simple solutions to the problem. To improve nutritional status measures should be undertaken to improve access to food, health status of mothers, and health services, as well as improve environmental services such as access to clean water and sanitation. This intervention only focused on improving the child-feeding practices which are a key component of child caring practices; however, access to food, health care services and environmental conditions were controlled for by selecting two sites that had comparable farming activities and resources. This improved the study design and helped in quantifying the effects of the intervention. Thus, it can be concluded that the changes in food selection patterns (variety and frequency), hemoglobin and vitamin A status, and weight-for-age reported in Chapters 4 and 5 indicate improvement in children's dietary intake, nutritional status, and growth.

The baseline cross-sectional survey (Chapter 3) shows that malnutrition was a problem of public health concern in the study sites. Stunting affected 24.4% of the 204 children assessed, 9.9% were underweight, 39.8% were anemic, while 62.1% were at risk for vitamin A deficiency. Clinical examinations did not reveal severe cases of malnutrition. The common physical problems that suggested possibility of undernutrition were dry hair and dry skin; however, these signs cannot be completely attributed to malnutrition as these conditions could also result from poor body hygiene and changes in weather. The high prevalence of stunting coupled with a high prevalence of micronutrient deficiency (indicated by anemia and vitamin A deficiency) but no wasting indicates that invisible malnutrition is a chronic problem in this population.

Literature indicates that diets that are comprised of a variety of foods are generally adequate in nutrients (2-4). Thus the intervention used in this study was designed to improve the caregivers food selection habits such that they can select and provide their children with a variety of foods frequently. A look at the food selection patterns of caregivers (Chapter 3) suggest that only 50% of the foods available in the region were consumed on a regular basis. Foods that were consumed frequently (at least once per week) were bananas, beans, avocado, tomatoes, onions, amaranth leaves, egg plants, and milk. The consumption of milk, tomatoes, and onions does not indicate adequate intake of these foods because the 24 hour recalls showed that limited quantities of milk are added in tea while amaranth leaves, eggplants, tomatoes, and onions are used in preparing soups and sauces thus the amounts consumed by an individual are negligible. This means that bananas, beans, and avocados (which are seasonal) are the main sources of calories and nutrients. These food selection patterns indicate inadequate nutrient and caloric intake and this was revealed in the results of the baseline survey (Chapter 3). At baseline, stunting (an indicator of chronic malnutrition) was more prevalent among children that lived in households that consumed a limited variety of meats, fruits, vegetables, and grains. However, there was lack of association between food variety and stunting when income was controlled for, which suggests that food purchasing power determines the variety of foods consumed at the household level.

According to Bandura (5), new behavioral patterns are easily acquired when they are simple, and are clearly observable. The cooking classes provided an arena for transforming acquired knowledge to appropriate food selection and feeding practices. In addition, the classes utilized traditional cooking practices and easily accessible indigenous foods and utensils; hence classes mimicked the participants' home environment. Through this learning experience, intervention participants were able to model the learned behavior. Consequently, caregivers in the intervention group selected an increased variety of grains, fats and sweets, legumes, meats, fruits, and vegetables one month after the intervention and a similar trend was observed at the end of the intervention (one year from baseline). This indicates that the intervention improved food selection practices. The two groups did not differ in selection of bananas, tubers and starchy vegetables, and nuts because bananas are the staple and the only type of nuts consumed are groundnuts (peanuts) while tubers and starch vegetables are typical famine foods that are often consumed in large amounts in September.

The frequency scores also indicate improvement in food selection practices. The control group selected fruits and vegetables more frequently at baseline; however, the scores of the intervention group improved significantly for all food groups with the exception of milk and nuts immediately after the intervention and a similar pattern was documented at the end of the intervention. The lack of significant changes in milk and nuts could be attributed to the fact that both groups were consuming these foods frequently. Milk or milk tea is part of the usual diet while the consumption of nuts often increases when beans are not available and in the rainy season (September-November) because access to firewood is limited.

Meal patterns determine the amount of food that is consumed. In effort to combat malnutrition, UNICEF/WHO guidelines specify that young children on mixed feeding (breastfeeding plus other foods) should be fed 3 times in a day while children that are not breastfeeding or 2 years and older should be fed 5 times a day (6). In general, caregivers in less developed countries tend to feed children less frequently; therefore, improving meal and snack patterns was one of the objectives of this study. On average many caregivers provided children three meals in a day (Mean: 2.8) and there were no significant changes in both groups throughout the intervention. The intervention did not result in significant changes in number of meals because caregivers were already providing three meals, which are a typical pattern even in affluent societies. Significant improvements were observed in snacking patterns. There were no significant differences in the number of snacks provided by caregivers in the two groups at baseline, however the intervention group provided significantly more snacks than the controls at Time 2 (Mean: 1.26 versus 0.35, $p = 0.000$) and at Time 3 (Mean: 1.22 versus 0.58, $p = 0.001$).

This positive change in number of snacks has significant implications on the amount of foods and nutrients that are provided to children daily. Children have small stomachs and need to be fed frequently in order to meet their daily nutrient needs. The change in number of snacks may explain the improvement in the quality of meals indicated by the meal adequacy scores (Table 4.2). Future interventions should pay closer attention to improving the quality of snacks. Caregivers need to be informed about the importance of snacks in children's diets and also be provided with skills on preparation of safe and nutrient dense snacks for young children.

Vitamin A deficiency (VAD) seems to be a public health problem in this population. VAD tends to cluster among people with similar characteristics. In general, people with limited financial resources to do not consume adequate amounts of animal source foods which are rich sources of vitamin A. The limited consumption of fat in the diet also limits the bioavailability of beta carotene from plant sources. The prevalence of VAD was 37% at baseline and declined to 29.2% at the end which suggests a slight decline given the fact that the prevalence of infections indicated by acute phase proteins CRP and AGP increased from 32.1% to 58.3% and from 11.1% to 27.8%, respectively. Some of this improvement can be attributed to vitamin A supplementation, de-worming and other services that could have affected nutritional status. However, the lack of significant differences in prevalence of infections coupled with a significant reduction of vitamin A deficiency among children in the intervention group suggests that the intervention was effective in improving the nutritional status of children in the intervention group. The high prevalence of infections remains a major threat to children's health and nutritional status. At the time of the survey, vitamin A supplementation and de-worming were the major interventions that had been implemented to control infections and insecticide-treated nets were available to pregnant women. Breastfeeding was also being highly promoted and health centers were being set up at sub-county levels to improve access to health care. Other measures are needed to reduce the severity of infections or improve recovery from infections. Improving the nutritional status of children during sickness should be a priority area. Caregivers need to be educated or informed about caring for sick children. This requires interventions that target common practices that are know to compromise dietary intake during illnesses.

The results on growth patterns of children in the intervention group also suggest that this intervention was effective. Generally, height-for-age, weight-for-age, and weight-for-height are the three commonly used and acceptable measures to assess growth among young children (7). Height-for-age is the best indicator of linear growth but its use is often limited by the inaccurate reporting of children's ages. Weight-for-age reflects both weight and height, nevertheless its use in assessing growth has been criticized because it does not distinguish short heavy children from tall thin children (8). Weight-for-height is a good indicator of growth especially when assessing nutritional status among less-literate groups where the ages of children are not well known; however, this index reflects wasting which often result from recent weight loss caused by severe malnutrition and/or wasting diseases such as diarrhea and malaria (9). Thus, it is a poor indicator of growth. Mid-upper arm circumference (MUAC) is also often used to assess nutritional status and risk for mortality; however, MUAC is also influenced by current changes in weight. In this regard, no single anthropometric index is a good indicator of growth especially when monitoring or evaluating interventions in populations where children's ages are not well documented. In this study, multiple indices were used to assess growth and all indices, with the exception of WHZ, showed positive changes among children in the intervention group.

A study conducted in Fiji indicates that WAZ is likely to overestimate prevalence of malnutrition in children born with low birth-weight but of normal growth patterns (8). In this study, more than half of the children were not delivered at the hospital and had no information on their birth weight; hence birth weight was not included in the model. In general, children in the control group had high WAZ and low HAZ at baseline (Mean: -0.61 ± 0.15 and -1.56 ± 0.17, respectively) while children in the intervention had low mean WAZ and high HAZ (Mean: -0.84 ± 0.15 and -1.43 ± 0.16, respectively). The observed significant improvement in weight-for-age among children in the intervention group is likely to have resulted in sustained linear growth. When the prevalence of wasting is low (<5%), weight-for-age is a good indicator of long-term health and nutritional status(9). In this study, the prevalence of wasting (low weight-for-height) was only 2% in the intervention group, which suggests that the significant change in WAZ reflect improvement in health and nutritional status.

Young children experience more rapid growth than older children (10) and young children are also most vulnerable to growth constraints during this time of rapid growth. Growth faltering is common between 6 to 12 months of age and is likely to continue until 18 months or even longer depending on the index used to measure growth (9-11). In this study, children in the youngest age group (6-12 months) gained significantly more weight-for-height. Children in the 12-24 months and 24-36 months age groups did not differ significantly but had significantly higher WHZ than the oldest children (36-47 months). Weight-for height is greatly influenced by current changes in weight which often results from severe malnutrition and/or infections (9). Younger children are at a high risk for infections, however breastfeeding confers protection and reduces the severity of infections. In this study, breastfeeding was not related to indicators of growth and there was no incidence of severe food shortages that would result in acute malnutrition. The associations between changes in weight-for-height and age group can be attributed to the high growth velocity that normally occurs in young children.

Overall, it can be concluded that this intervention had significant positive changes on the caregivers' food beliefs, food selection practices, and feeding behaviors. Significant changes in food variety and frequency of selection but limited changes in quality of children's meals. The 24-hour recalls may not have captured the actual changes in meal quality. More objective measures of dietary intake are needed to measure changes in dietary intake. However, the positive changes in vitamin A status at Time 3 and changes in weight-for-age patterns corroborate the positive changes reported in food selection patterns. This suggests that the intervention was effective. Growth monitoring may have effected the positive changes observed among children in the control group and thus minimized the observed effects of the intervention on growth. The high prevalence of infections and seasonal food shortages is likely to have compromised nutritional status and growth. The effects of vitamin A supplementation and de-worming cannot be down-played, however children in both the intervention and control groups were benefiting from these programs. The effects of the intervention seem to go beyond vitamin A supplementation and de-worming, which are major interventions for improving growth and reducing mortality in developing countries. This emphasizes the need for comprehensive programs that include nutrition education or communication initiatives.

REFERENCES

1. UNICEF. The state of the world's children 1998: Focus on nutrition. New York: Oxford University Press; 1998.

2. Freeland-Graves J, Nitzke S. A Position of the American Dietetic Association: Total diet approach to communicating food and nutrition information. Journal of the American Dietetics Association. 2002;102:100-8.

3. Hatloy A, Torheim LE, Oshaug A. Food variety - a good indicator of nutritional adequacy of the diet? A case study from an urban area in Mali, West Africa. European Journal of Clinical Nutrition. 1998;52:891-8.

4. Krebs-Smith SM, Smiciklas-Wright H, Guthrie HA, Krebs-Smith J. The effects of variety in food choices on dietary quality. Journal of the American Dietetics Association. 1987;87:897- 903.

5. Bandura A. Principles of behavior modification: an integrative approach,1969. New York: Plenum Press; 1977.

6. WHO/UNICEF. Integrated management of childhood illnesses: IMCI adaptation guide. Manuscript. Geneva: Department of Child and Adolescent Health and Development, World Health Organization; 2002.

7. WHO. Physical status: The use and interpretation of anthropometry. Geneva: World Health Organization; 1995.

8. Saito S, Marks GC. Is one nutritional benchmark appropriate? Dilemma in nutritional assessment and growth monitoring of children under five years of age in Fiji. Food and Nutrition Bulletin. 1999;20:401-8.

9. de Onis M. Child growth and development. In: Semba RD, Bloem MW, editors. Nutrition and health in developing countries. Totowa, New Jersey: Humana Press Inc; 2001. p. 71-91.

10. Mei Z, Grummer-Strawn LM, Thompson D, Dietz WH. Shifts in percentiles of growth during early childhood: Analysis of longitudinal data from the California Child Health and Development Study. Pediatrics. 2004;113:e617-e27.

11. Pelto GH, Levitt E, Thairu L. Improving feeding practices: Current patterns, common constraints, and the design of interventions. Food and Nutrition Bulletin. 2003;24:45-82.

APPENDICES

APPENDIX A

Recruitment Form

Nutrition Education Intervention for Caregivers

Department of Foods and Nutrition, University of Georgia

RECRUITMENT FORM

1. Primary caregiver's name: ____________________________ Age: _____________

2. Child's Name: ______________________________________ Age _____________

3. Have you been breastfeeding in the last ______________?

   (1) Week (2) 2 months (3) 4 months (4) 1 year (5) Still breastfeeding

3. Education level attained by primary caregiver:
   (1) No formal education
   (2) Kindergarten
   (2) Primary: 1 2 3 4 5 6 7 8
   (3) Senior: 1 2 3 4 5 6
   (4) Post-secondary

4. Caregiver's Occupation:
   (1) Homemaker
   (2) Subsistence farmer
   (3) Homemaker/subsistence farmer
   (4) Produces other products (beer, clothes, quick breads, crafts)
   (5) Small scale trader (sells beer, clothes, quick breads, crafts)
   (6) Large scale trader – owns shop, regularly attends markets
   (7) Other ____

4. Do you own or rent your house?
   (1) Own (2) Rent(3) Live with parents (4) Other _______________

5. Type of housing
   (a) **Roofing**
      (1) Tile
      (2) Iron sheets
      (3) Grass thatched

   (b) **Floor**
      (1) Tile, hardwood, asphalt, Brick
      (2) Concrete
      (3) Bare/mud

6. Husband/Head of household's occupation
   (1) Subsistence farmer
   (2) Produces products (beer, clothes, quick breads, crafts)
   (3) Small scale trader (sells beer, clothes, quick breads, crafts)
   (4) Large scale trader – owns shop, regularly attends markets
   (5) Other ____

7. How much money do you earn in a week? _________ _____ Month? _______________

8. How much money does your husband earn in week? __________ Month? ___________

###

APPENDIX B

Informed Consent Script

RESEARCH QUESTIONNAIRES

FORM A

Case Number: _____________

Informed Consent Script:

Hello Ms/Mrs _______________ My name is _______ (*Describe* self).

What is your child's name? ___________________

When was (child's name) born? Day______ Month ______ Year ________
(Discontinue interview if child is <6 months or > 4 years of age)

We are conducting a study on how we can improve the health status of young children in our region. So, I would like to ask you some questions concerning your child's health.

First, I would like to inform you Ms/Mrs. __________ that you are not required to take part in this study. And if you decide to participate, you can stop at any time you want to and you will not be penalized.

This interview will take about 1 hour of your time. Our staff will direct you to different stations where you will be asked questions. We also have some medical personnel that will weigh and measure your child. We might also need to draw small amounts of blood from your child's finger or heel to find out if your child has adequate amounts of some nutrients. Feel free to take a break in-between interviews.

Any information about you or your child Ms/Mrs _______ will not be released to anyone else without your permission. We will not write your name or child's name on the forms we use to write the information we get from you and your child. *(Give Case Number card to caregiver)* Please, show this number tag at all the stations you go to.

Would you like to participate in this survey Ms./Mrs ___________?
(If **YES**) Thank you Ms./Mrs____________ for accepting to participate in this study. Please sign or put your thumbprint here:

________________________________ ____________________________
Participant's Full Name Signature or Thumbprint of Participant

_________________________________ ______________________________
Interviewer's Name Interviewer's Signature

Date _____________________ Time _____________________

June 2004 Confidential

APPENDIX C

Anthropometric Assessment Questionnaire

FORM B

Case Number _____________

Anthropometry

1) My name is ______________. I will be assessing your child's growth. *(Verify eligibility)*
When was (Name of child) born? Day ______ Month _____ Year ______
Does that mean that (Child's name) is now _________ months/years?
(Discontinue interview if child is <6 months or > 4 years of age)

2) Do you have a health card for (Child's Name)?
(1) No (*go to #3*) (2) Yes (*Use information on card where applicable*)

3) Where was he/she born?
(1) Home (2) Traditional birth attendant (3) Hospital (4) Other________.

4) Was (name of child):
(1)Very small (2) Small (3) Average size (4) Large (5) Very large

5) Was (Name of child) weighed at birth?
(1) No (2) Yes
If yes, How much did (Name) weigh _________________

Now we are going to measure your child's height and arm to see how he/she is growing. We will also weigh him/her. Do you want to continue with this assessment?
(Discontinue if caregiver refuses)

	Measurement 1	Measurement 2	Average
6. Child's mid-upper arm circumference	______._____ cm	______._____ cm	_____._____cm
7. Child's height	______._____ cm	______._____ cm	_____._____ cm
8. Child's weight	______ kg _____g	______ kg ____g	_____kg_____g
Name of assessor	_ _ _ _ _ _ _ _ _ _ _ _ _ _	_ _ _ _ _ _ _ _ _ _ _ _ _ _ _	

Date _____________________ Time _____________

APPENDIX D

Clinical Examination Data Sheet

FORM C

Date ____________________ Case Number _____________
Day/month/year

Clinical Examination

Examination		**YES**	**NO**	**Doubtful**
Hair	a. Dry staring			
	b. Discoloured			
	c. Easily pluckable			
	d. Abnormal texture/ straight			
EYES	a. Conjuctival infection			
	b. Bitot's spots			
	c. Xeropthalamia			
TEETH	a. Visible carries			
	b. Debris/Calculus			
	c. Fluorosis			
FINGERS AND NAILS	1. ______ Clubbed 2. ______ Spooned 3. ______ Ridged 4. ______ Combinations			
SKIN	a. Follicular hyperkeratosis, arms			
	b. Follicular hyperkeratosis, back			
	c. Dry or scaling (Xerosis)			
	d. Hyperpigmentation (Face & hands)			
	e. Thickened pressure points (not elbow or knees)			
	f. Purpura			
	g. Cracked skin (mosaic)			
	h. Loss of elasticity			
	i. Pellagrous dermatitis			
ABDOMEN	Hepatomegaly			

Source: Nutritional assessments by Walter Willet

Body temperature _______ ^{o}C

Examined by ____________________ Time _____________________

APPENDIX E

Dietary Assessment Questionnaire

FORM D

Case Number ______________

Feeding Practices, Children's Dietary Intake, and Caregiver's Beliefs:

1) How long after birth did you first put (NAME) to the breast?
   (1) Immediately (less than 1 hour)
   (2) After __________ hours
   (3) After __________ days
   (4) Never breastfed ________

2) During the first day after birth, was (NAME) given any of the following?
   (1) Plain water
   (2) Sugar water
   (3) Juice
   (4) Baby formula
   (5) Fresh milk
   (6) Tinned or powdered milk
   (7) Any other liquids

3) Are you still breastfeeding (NAME)?
   (1) No (2) Yes *(Skip to # 8)*

4) For how many months did you breastfeed? ________________ months.

5) When did you stop breastfeeding? Month _________________ Year __________

6) How many times did you breastfeed last night between sunset and sunrise? ________

7) How many times did you breastfeed yesterday during the daylight hours? _________

8) At any time yesterday or last night, was (Name) given any other food?
   (1) Yes (2) No

9) Does (child's name) eat foods that the family eats?
   (1) Yes (2) No

10) How many meals do you prepare in a typical day Ms/Mrs _____________?
   (1) 1 (2) 2 (3) 3 (4) 4 or more

11) Do you prepare special meals for this child?
   (1) Yes (2) No (Skip to 13)

12) (If **YES**) How many times in a day do you prepare special meals for this child?
   (1) 3 or more (2) 1-2 (3) 0

13) Do you provide snacks to this child?
   (1) Yes (2) No *(Go to 15)*

14) (If YES) What do you usually provide as snacks.

1) Leftover food from previous meal
2) Ripe bananas
3) Other fruit
4) Cakes, doughnuts, *Mandazi*, *Kabaragara*
5) Roasted potatoes, plantains, cassava, or maize
6) Juice
7) Milk
8) Porridge

15) **24-hour Dietary Recall** *(Use Table below to record information)*

Use the following questions to get information from participant:

- When was the last time you provided (Child's Name) food Ms/Mrs ___________
- Can you describe the food that your child ate?

- Did she/he eat all his/her food? If **not**, about how much food did she/he eat?
- What did your child eat before this meal/snack?

***Repeat the questions till the preceding 24 hours are all accounted for.*

Time	**Food/Drink Served**	**Description/ Preparation method**	**Was serving LARGE or SMALL**
Breakfast			
Mid-Morning Snack			
Lunch			
Afternoon snack			
Supper			
Other Meals			

16) Was this a typical day for you Ms/Mrs __________? (1) Yes (2) No

17) I have a deck of food picture cards here. Please, sort out the pictures of foods that you use in your household.

After participant has finished sorting, take pictures sorted out one by one and ask participant to indicate <u>how often she provides each food item to young children</u>

Food Frequency Questionnaire:

Item #	Food item	Number of times provided to children			
		Daily	Weekly	Monthly	Yearly
101	Avocado				
102	Bananas, yellow (large)				
103	Bananas, green				
104	Bananas, yellow (small)				
105	Cakes, muffins etc				
106	Beans, dried				
107	Beans, fresh				
108	Beans, string				
110	Black berries				
111	Bread				
112	Broccoli				
114	Squash-like Vege. (*Ebikeke)*				
115	Cabbage, red and green				
117	Carrots				
118	Cassava, fresh				
119	Cassava, leaves				
120	Cauliflower				
121	Celery				
126	Butter or magarine				
127	Cooking oils				
128	Lard (*Kimbo* etc)				
129	Cooking spread (*Cowboy*)				
130	Palm oil				
131	Ghee				

Item #	Food item	Number of times provided to children			
		Daily	Weekly	Monthly	Yearly
133	*Dodo* or spinach				
134	Eggs				
135	Eggplants, black (*Biringanyi*)				
136	Eggplants, green (*Enjagi*)				
138	Fish, fresh				
139	Fish, smoked or dried				
140	Flour:				
	Bananas (*Obutere*)				
	Cassava				
	Maize (corn)				
	Millet				
	Sorghum				
	Wheat				
	Yam				
	Other _________________				
141	Fruit juice, fresh				
142	Fruit juice, canned				
144	Ginger				
145	Green peppers				
147	Groundnuts				
148	Guavas				
149	Hot beverage:				
A	Soy drink				
B	Tea				
C	Porridge				
	Other				
150	Irish potatoes				
154	Maize, fresh				
155	Mangoes				

Item #	Food item	Number of times provided to children			
		Daily	Weekly	Monthly	Yearly
156	Meats:				
A	Beef				
B	Goat meat				
C	Pork				
D	Mutton				
E	Rabbit meat				
F	Game				
	Other ________________				
160	Milk				
164	Onions				
165	Oranges				
167	Paw paws (papaya)				
168	Passion fruits				
169	Peas, dried				
170	Peas, fresh				
171	Pineapples				
172	Popcorn				
173	Poultry:				
A	Chicken				
B	Duck				
C	Turkey				
174	Pumpkins, mature				
175	Pumpkin leaves				
176	Rice				
177	Sim sim (sesame seeds)				
179	Soy beans				
181	Squash				
182	Strawberries				
183	Sweet potatoes				

Item #	Food item	Number of times provided to children			
		Daily	Weekly	Monthly	Yearly
184	Tree beans *(Entendigwa)*				
186	Yams, common (small)				
191	Insect Protein *(Ensenene, Enswa)*				
193	Greens (*Nakati, Enswiga, Eyobyo*)				
195	Tomatoes				
196	*Omugobe*				
198	Maize, dry				
199	*Entutu* (Berries)				
1100	Mushrooms, dried				
1102	Lentils				
1103	Mushrooms, fresh				
1104	Carbonated drinks - sodas				
1105	Candy				
1106	*Chapati* (Wheat rolls)				
1107	*Ebidodoima* (Tomato-like)				
1108	Tea biscuits				

20) Does this child take any vitamin or mineral supplements?
(1) Yes (2) No

If **Yes**, What kinds of supplements does she/he take?

____

____

21) What kind of salt do you use often?
(1) Rock salt (2) White salt?

22). Can you names any food items that are taboo for you or any members in your family

__________ __________ __________

Food Beliefs

23) When are these foods appropriate for young children (9-36 months)?

	Always appropriate (4)	When child is Healthy (3)	When child is Sick (2)	Never Appropriat e (1)
Breast milk				
Water				
Cow's milk				
Red meats/chicken				
Amaranth				
Tea				
Liver				
Cabbage				
Water				
Pumpkins				
Passion fruit juice				
Paw paws				
Eggs				
Groundnuts				
Bananas				
Beans				
Carrots				
Yams, cassava, potatoes				
Red palm oil				
Fresh fruits				

24. Which of these foods will contribute iron to the diets of growing children?

	Best source – **High** (3)	Not good source -**Low** (2)	**No Iron**. Should never be given to child (1)
Red meats/chicken			
Amaranth			
Tea			
Liver			
Cabbage			
Water			
Passion fruit juice			
Eggs			
Groundnuts			
Bananas			
Beans			
Maizemeal or porridge			
Millet or millet porridge			

APPENDIX F

Phlebotomist Script

FORM E

Case Number ______________

PHLEBOTOMIST SCRIPT:

Hello Ms/Mrs ______________. My name is ___________________

Today I will be drawing a few drops of blood from your child's heel/finger to assess his/her health.

Has this child ever had any bad reactions to needle pricks or injections?

(If YES) Ms/Mrs ________ I will not draw blood from your child today because I will not want him/her to get a similar reaction *(Direct participant to next assessment station.)*

(If NO) Would like to continue with this assessment Ms/Mrs __________
(Discontinue if caregiver refuses or child exhibits extreme fear)

We will draw about this much blood *(Show amount fake blood in test tube and explain full procedure to participant)*

Blood collected?
(1) Yes (2) No

Blood spots done?
(1) Yes (2) No

HemoCue reading ______________

General comments on caregiver/child compliance during assessments:

____

____

____

____

Date _____________________ Time _____________________
Day/month/year

Enumerator ____________________________________

APPENDIX G

Growth Monitoring Questionnaire

FORM G

Case Number ______________

GROWTH MONITORING QUESTIONNAIRE

Date _____________________________ Time ______________

Month/Day/Year

1. What is this child's name?____

Q2. How are you related to this child?
(1) Mother
(2) Primary Caregiver
(3) Other ____

Q3. Did _____ (child's name) fall ill any time since we last weighed him/her?
(1) Yes (2) No [*If* **No**, *skip to 6*]

Q4. If **Yes**, what was she/he suffering from?
(1) Cough, influenza, or headache
(2) Diarrhea
(3) Malaria
(4) Typhoid
(5) Eye, ear, or skin infections
(6) Measles
(7) Chicken pox
(8) Toothache
(9) Other ____

Q5. When ______ (child's name) was sick, did you take him/her to hospital?
(0) Not applicable (1) Yes (2) No

Q6. Has she/he had any form of immunization or prophylactic treatment since we weighed him/her last month? (1) Yes (2) No

Q7. What kind of immunization or treatment did she/he receive? [*Check medical card*]
(0) Not applicable
(1) Vitamin A
(2) De-worming
(3) Measles
(4) DTP
(5) Polio
(6) Antimalarials
(7) Other

Q8. How would you say this child has been eating this month?
(1) Eating less than usual
(2) Eating more than usual
(3) No changes
(4) Don't know

Q9. Are you breast-feeding this child? (0) Not applicable (1) Yes (2) No

Q10. [**Breast-feeding mothers only**] Are you taking any form of contraceptive pills or injections?
(1) Yes ***(2) No***

Q11. Child's height/length ____________.__________ cm

Q12. Child's Weight ___________._________kg

Q13. How has your access to food been since we were here last month ?
(1) Decreased (2) No change (3) Increased

Q14. Has your income situation changed since we were here last month?
(1) Decreased (2) No Changes (3) Increased

Q15. Is this child taking any medication or nutritional supplements right now?
(0) No (1) Yes

General observations:

APPENDIX H

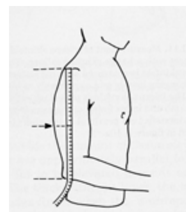
Procedures for Conducting Anthropometrical Assessments

PROCEDURES FOR CONDUCTING ANTHROPOMETRICAL ASSESSMENTS

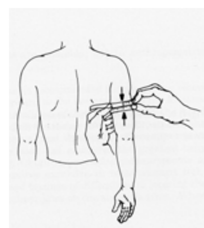
Equipment needed:

- Measuring tape
- Measuring mat
- Height rod
- Hanging scale with several trousers
- Form B (Use Form G for monthly measurements)

Mid-upper Arm Circumference (MUAC)



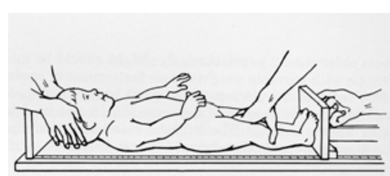
1. Use measuring tapes to measure MUAC.
2. Take all measurements from the children's right arms.
3. Start by bending the child's right arm at the elbow at a 90-degree angle. Hold the upper side of the arm parallel to the body then us the tape to measure the distance between the acrominion (bony pa of the upper shoulder) and the olecranon process (tip of elbow). Mark the midpoint between these two processes with a bright colored marker.



4. Relax child's arm and let arm hang loosely to his/her side.
5. Place tape around the upper arm at the previously marked midpoint. Make sure the tape is snug, but not very tight.
6. Record the arm circumference to nearest 0.1 cm
7. Give the tape to the second assessor and have him/her repeat the measurement.
8. If the two measures differ by > 0.5 cm, repeat measurements and record the average.

Length:

1. Measure the length of all children <36 months with an infantometer or a measuring mat (e.g. Seca 210 measuring mat).
2. Ask caregiver to remove from child shoes, socks, hats, and any heavy or tight clothing that may make it difficult to take measurements.



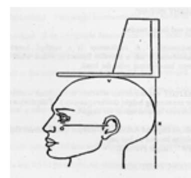
3. Lay child on its back on the measuring mat as demonstrated in diagram.
4. Children have a tendency to pop the legs up or bend their knees when they are laid on their backs. Make sure child's legs are straight before you take measurements.
5. Two people should take measurement to obtain accurate results. One person should stand at the head-board area and hold the child's head so the child looks vertically upward with the crown of the head against the headboard.
6. The second person should straighten the child's legs holding the feet with toes pointed upward. Once the child's legs are well positioned, move the footboard against the child's feet.

7. Take note of the measurement indicated by the footboard. Record child's length to the nearest 0.1 cm.
8. Change positions. The person that was holding the head should now hold the legs and repeat and record the measurement.
9. If the difference between the 2 measurements is greater than 0.5 cm, repeat measurements and record the average.

Height:

1. Measure the heights of all children >36 months using a height rod.
2. Ask caregiver to remove from child shoes, heavy socks, hats, and any heavy clothing and hair accessories located at the top of the head. If the hair accessories cannot be removed or if a hair style which prevents the board from touching the crown of the head, please make note on the questionnaire.

3. Help child to stand straight with heels together. The heels, buttocks, upper back, and head should touch the height rod. The child's arms should hang freely on the sides with palms facing thighs.
4. The child's head should be place in Frankfort horizontal plane. The important feature of this technique is to obtain the maximum distance from the foot rest of the standiometer to the subjects' vertex. The Frankfort Plane is the line from the lower edge of the eye socket (orbitale) to the notch above the flap of the ear (tragus) or the back of the cheekbone. The Frankort Plane is illustrated in the diagram.



5. Ask child to inhale deeply and maintain erect position.
6. Bring down the movable head piece until it touches the head; make sure to put enough pressure to suppress the hair.
7. Adjust your eye level to the level of the measurement before attempting to read the measurement by bending or squatting. Read the measurement indicated at the bottom of the right angle board.
8. Record the measurement to the nearest 0.1 cm.
9. The second person should repeat and record the measurement.
10. If the difference between the two measurements is greater than 0.5 cm, repeat measurements and record the average.

Weight

1. Use hanging scale to weigh all children. Mount the scale on a sturdy beam (such as door way beam or ceiling beams).
2. Before each measurement, make sure the scale is calibrated. Each morning, the scale should be calibrated by weighing standard weigh See section on calibration of scales below.
3. The scale should be put at the 0 kg mark with the empty trousers handing on it.
4. Ask caregiver to undress child and put the trousers on.
5. Assist caregiver to place child on scale. Child should be lifted by th trouser straps. Then the straps are hung on the scale as shown.
6. Read and record weight to the nearest ¼ kg.
7. Repeat measurement and record reading.

Calibration of Scales:

Calibrate each scale with standardized weights (5kg, 10kg, and 20 kg). If the reading on the scale is not within range, the scale should be checked and adjusted accordingly or another scale should be used.

Standard Weight (kg)	Acceptable Range*
5 kg	<4.8 or > 5.2 kg
10 kg	<9.8 or >10.2 kg
20 kg	< 19.8 or > 20.2 kg

*Evaluate scale if weight is less (<) or more (>) than weight indicated above.

References:

Department of Community Health, Department of Human Resources & the Georgia Center for Obesity and Related Disorders (February 2003) Georgia childhood overweight prevalence survey (GCOPS), Athens, Georgia.

Frisancho, A. R. (1990) Anthropometric standards for the assessment of growth and nutritional status. The University of Michigan Press, USA.

Wood, E. (1998) Community health worker's manual. African Medical and Research Foundation (AMREF), Nairobi, Kenya.

APPENDIX I

Protocol for Collecting and Processing Blood Samples

PROTOCOL FOR COLLECTING AND PROCESSING BLOOD SAMPLES

A finger puncture procedure will be used to collect blood samples from children between 13-36 months of age. A heel puncture will be used to collect blood from children < 1 year old. These samples will be used to assess vitamin A and hemoglobin status. About 150µL of blood will be collected into a Hemocue cuvette and a capillary tube for vitamin A, hemoglobin, and C-reactive protein analysis.

In order to obtain enough blood for all of these purposes, it is essential that a **good deep stick is done which will give a good flow of blood.** Remember, each subject can only be punctured once so there will be only one opportunity to collect all the necessary blood.

1) The enumerators will identify the children and guide them to blood collection station.
2) Prepare your collection equipment. You will collect blood from 50 children each day. For each child you will need:
    - Sample of fake blood in Microtainer to show participants how much blood you will collect.
    - 1 pair of latex gloves
    - Safety glasses
    - Safety lancet
    - 2 alcohol (70% isopropyl) pads
    - 2 sterile gauze pads (2x2)
    - Warm wash cloth
    - 1 band-aid
    - 1 Capillary tube
    - I blood spot collection card
    - 1 blue absorbent pad
    - 1 HemoCue cuvette
    - 1 Kim wipe
    - Puncture-resistant sharps container to dispose of used lancets
    - Biohazard bag
3) Introduce yourself to caregiver and identify child.
4) **Wear your gloves and safety glasses before you begin**.
5) With each child, select the skin puncture site.
    a) Children 6-12 months: Puncture on the outside of the heel, on little the toe side. The location of the puncture site should be lateral to a line drawn posteriorly from between the fourth and fifth toes to the heel.
    b) Children 13-36 months: Puncture on the side of the finger (not too close to the nail bed).You may use either hand, but the non-dominant hand is preferred because it is usually not as calloused. Use the middle or ring finger (3^{rd} or 4^{th} finger). Do not use the last finger (5^{th} finger) or the thumb. Do not select a finger that is cold, cyanotic, bruised, cut, swollen, or has a rash.
6) Place a warm wash cloth on the finger or heel for approximately 3 minutes, to increase the blood flow to the puncture site.
7) Gently message the finger or heel five or six times from the base to the tip of the finger. This will also aid blood flow to the puncture site.

8) Thoroughly clean the puncture site with a 70% isopropyl alcohol pad (continue to clean the site until no dirt appears on the alcohol pad). Wipe the site dry with gauze. (Residual alcohol may dilute sample).

9) Puncture the site with a disposable lancet. Hold the child's hand firmly to immobilize the finger. Use moderate pressure and depress the plunger completely, then release the plunger and remove the lancet. Discard the lancet in the sharps container.

10) First collect blood for the Hemocue cuvette and give to assistants to take Hemocue reading. Then use the capillary tube to collect blood for making blood spots (See sections on "Hemoglobin Assessment" and "Blood Spot Preparation" for details).

11) Using gauze, place gentle pressure on the site to stop bleeding. Apply a band-aid.

HEMOGLOBIN ASSESSMENT

1) Fill the Hemocue cuvette by introducing the pointed tip of the cuvette onto the blood drop. The cuvette should be allowed to fill by capillary action in one continuous motion (*do not "top off' the cuvette*). The cuvette must be completely filled (without any large air bubbles) or discarded and the test repeated from another drop of blood.

2) Wipe off any excess blood from the outside of the cuvette by a Kim wipe, being careful not to touch the outer curved edge. This may be done by wiping the edges as you would a butter knife. This will assure that no blood is "sucked out" of the cuvette when wiping it.

3) Place the filled cuvette in the HemoCue instrument holder right away and gently insert slide arm to the "Measuring" position. The results will be displayed in approximately 15-45 seconds and will remain displayed for 4 minutes or until the slide arm is pulled out for removal of the cuvette. Utilize this time to proceed with processing blood collected in the Microtainer.

4) Record your Hemocue results, dispose of the cuvette in the sharps container. Dispose all other materials in the biohazard bag.

BLOOD SPOT PREPARATION

1) Open blood spot collection card and lay flat on protective pad.

2) Label Card with the appropriate child's code number before preparing the blood spots.

3) Fill the capillary tubes by placing the tube on the blood drop.

4) Allow blood to drop from the tube to the collection card and make sure that each circle on the card is filled.

5) Once circles are filled, leave collection card open, and place card on the drying rack.

6) The **blood spots should not be exposed to light**.

7) The blood spots should be allowed to dry overnight.

8) Once the cards are dried, they should be closed and placed in any envelope and the envelope should then be place in a Ziploc bag with dessicant.

Helpful suggestions for the fingerstick:

- If hands are cold it is helpful if the subject rubs hands together, mother can help warm child's hands, prior to testing to stimulate blood flow to the capillaries.
- Avoid squeezing with thumb and forefinger in a V pattern around the puncture site as this will decrease the blood flow.
- When applying pressure to stimulate flow it is helpful to apply pressure and then relax pressure momentarily to allow blood to flow into the capillary bed.
- While performing puncture have the child's hand below his/her heart level. If the arm is above the heart it slows the blood flow to the hand.
- Hold child's hand in a downward fashion to allow gravity to assist with blood droplet formation.
- When doing a finger-stick on young children it usually is easier to grasp all of their fingers together with your entire hand and apply pressure to all four fingers than to work with one small finger.

Important Facts for the Hemocue Hemoglobin Testing:

- Store Hemocue cuvettes at room temperature. Do not allow storage temperature to exceed 86 degrees F.
- Read the cuvette within a maximum of 5 minutes at the most and record the results.
- HemoCue Equipment calibration and Care:
  - The red control cuvette should be used to check the instrument each morning and if it gives a result within the range on the card, go on to check the Hemocue with liquid QC (low and normal). Record results. Repeat this procedure at the beginning of each day and at the end of the day. In addition use red control cuvette at regular intervals during the day to make sure the Hemocue is still giving a result in the correct range. If machine is dropped or anything unusual happens to it please carry out a check with the red cuvette.
  - Tightly reseal round red top container after removing only the number of cuvettes to be used for immediate testing.
  - After filling the cuvette and wipe off excess blood, place the cuvette into the slide arm and **gently** slide the arm into the instrument. Never SLAM the slide arm.
  - Clean the back slide arm daily with alcohol or mild soap solution. Make sure it is dry before returning to the instrument. Check Hemocue for contamination throughout the day and clean if any blood is spilled.

###