

Dietary Patterns, Nutritional Status, Prevalence and Risk Factors for Anemia among  
School Children in Naama Community, Uganda

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Thesis submitted in partial fulfillment of  
the requirements for the degree of  
Master of Science in the Duke Global Health Institute  
in the Graduate School of Duke University

2015

ABSTRACT

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## Abstract

Background: The disease burden of malnutrition, anemia, malaria and helminth infections among school-aged children is rarely studied in low- and middle-income countries (LMICs) although these children are still at a high risk for these diseases compared with other more studied populations, such as pregnant women and children under 5 years old. Even in countries where the prevalence and trend of anemia and malnutrition are relatively well documented, few studies relate this to dietary factors, which are considered major contributors to anemia and malnutrition in most age groups. Aims: The aims of the study are (1) To determine the prevalence of anemia, malaria, helminth infections and malnutrition in a sample of 95 children, ages 6 to 14, attending primary schools in Naama Community, Uganda, and to observe and quantify school children's dietary patterns and daily nutrient intakes. (2) To find out the association between dietary factors and the risk of anemia and malnutrition. Methods: Measures included school-based, cross-sectional surveys, dietary assessments, anthropometric measurements and biological tests among school children. Photo-assisted 24-hour recall was used to collect daily nutrient intakes, combined with a Food Frequency Questionnaire (FFQ) to capture the dietary patterns. Anthropometrical and biochemical data was collected using standardized protocols. Socioeconomic data was obtained from parent surveys. Results: Ninety-five children in total were enrolled in all or some components of the study. The prevalence of anemia was low (3.2%), and all were mildly anemic. However, the prevalence of malaria and hookworm infections was relatively high, representing 12.9% and 24.4% of the studied population, respectively. In the studied children, 2.8% were underweight, 15.6% stunted and 1.3% thin, using criteria based on the

WHO Growth reference. According to the WHO recommendations for nutrient intake, 80% of participants consumed inadequate energy from their daily diet, especially boys. Dietary fat intake was insufficient in 78% of the children. About 25% of the children had a low protein intake and 93% had low intakes of vitamin A. Calcium intake was low in school children's diet- 97.6% of children lacked of calcium. Inadequate vitamin C intake was less common, appearing in one out of three participants (29.1%). Matooke and posho, the most common local staple food, were the major sources for children's energy. Avocado, beans and matooke contributed to the highest fat, protein and vitamin A intake, respectively. Every participant reported consuming cereal/cereal products, roots/tubers/plantain, pulses/nuts, oil/oil-rich foods and fruits during the previous month, while almost one-fifth never consumed milk/dairy products. Vegetables were consumed by most of the respondents. Few (1.6%) of the respondents reported no animal source food in their diet. In general, children ate 3.81(SD: 0.99) out of all five meals in the area. Dinner was consumed by most of the participants (93.7%) while afternoon tea was the least consumed meal and was skipped by half of the children. No significant association between dietary factors and anemia were found, mainly due to the small sample size and low prevalence of disease. None of the dietary factors of primary interest were found to be associated with children's Hb concentration, but secondary analysis found the frequency of eating oranges was a protective factor for higher Hb concentration (P=0.015). The association between diet and stunting was not significant, except children who had low dietary fat intakes had a lower risk of being stunted compared with those had adequate fat consumption (OR=0.27, P=0.046). Conclusions: Malaria and helminth infections, but not anemia, in this cohort of school children is relatively high.

Stunting was the most prevalent type of malnutrition. Most of the nutrients studied were not adequate in children's diets. The dietary pattern in this sample of children was primarily high in carbohydrates from staple foods and a minimal intake of fat and protein from animal sources. Children generally ate four meals per day. Dietary factors do not explain anemia and stunting in this population.

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## **Acknowledgements**

Using this opportunity, I would like to express my gratitude to everyone who has supported my project, without whom it would never have been possible. I am extremely grateful to Dr. Ariely for her consistent guidance and invaluable advice as well as her patience. I cannot express enough thanks to my other committee members, Dr. Story and Dr. Puffer, who provided timely feedback and support.

Furthermore, I would like to express my great appreciation to Dr. Kigongo for his valuable and constructive suggestions during the planning and development of this research work. In addition, all DGHI faculty and staff should be thanked for their efforts to make this project successful and meaningful. I would especially like to express my appreciation to Dr. Egger, Sarah Martin and Michael Russell. Their willingness to give their time so generously has been very much appreciated.

Finally, many thanks to all our team members and local partners: Nakafeero Robinah, Ntale Kenneth, Muwanguzi Victoria. The time we spent together will always be an invaluable experience and unforgettable memory for me.

Thank you,

Yi

# 1. Introduction

## 1.1 *Malaria in school-aged children*

As a consequence of the increasing and intensified malaria control efforts targeting pre-school children in Sub-Saharan Africa (SSA), some children that once naturally acquired immunity to malaria at younger ages (and were then less likely to acquire severe malaria later) are now more vulnerable to the disease, and clinical attacks are threatening school-aged children more frequently (Nankabirwa et al., 2014). However, the epidemiology of malaria in this age group, until recently, received little attention (Lalloo, Olukoya, & Olliaro, 2006). In 2010, the number of school-aged children who were at risk of malaria reached 500 million; 40% were from SSA (Gething et al., 2011). The number of deaths the disease caused is unknown in these regions, but Snow (2003) and colleagues estimated that in 2003, malaria contributed to the annual deaths of 214,000 African school children, and accounted for almost half of all deaths in this age group (Snow, Craig, Newton, & Steketee, 2003). Approximately one out of three Ugandan children aged 2 to 10 were affected by malaria in 2013, which ranks Uganda in the top nine of all SSA regions in terms of the proportion of children infected (WHO., 2014). However, neither national nor regional data on the disease burden for this specific age group is available.

## **1.2 Helminth Infection in school-aged children**

School-aged children are the most vulnerable to helminth infections compared with other populations (Lwanga, Kirunda, & Orach, 2012). In SSA, approximately 85% of the neglected tropical disease burden results from helminth infections, in which almost half (89 million) of school-aged children are infected with hookworm, ascariasis, trichuriasis, or some combination of these infections (Hotez & Kamath, 2009). Uganda is the first country to have implemented a nationwide helminth infection control program since 2003. Strong evidence suggested that after two rounds of annual mass treatment interventions, the overall prevalence of major helminth infections dropped significantly. The prevalence of *S.mansoni* infection and hookworm infections decreased from 42.4% to 17.9%, and from 50.9% to 10.7%, respectively (Kabatereine et al., 2007). However, years after the initiation of the program, the prevalence of helminth infections in Ugandan school children consistently remained high. A countrywide study investigated 20,185 school children from 271 schools in Uganda in 2005, two years after the initiation, and found the overall prevalence of *Ascaris lumbricoides*, *Trichuris trichiura* and hookworm was 6.3%, 5.0% and 43.5%, respectively (Kabatereine et al., 2005). A later regional study in Central Uganda also indicated the prevalence of helminth infections was 10.9%, 3.1%, 1.9% for hookworm, *Trichuris trichiura* and *Schistosoma mansoni*, respectively (Lwanga et al., 2012).

Considering the adverse consequences of helminth infections, such as increases in school absenteeism and reduced school performance (Hotez & Kamath, 2009) and the huge variation of prevalence by areas, sustainable and regional surveillances targeting school children are urgently in need.

### ***1.3 Anemia in school-aged children***

Anemia is not only a worldwide public health problem but also an obstruction to social and economic development, especially in LMICs (Benoist, McLean, Egll, & Cogswell, 2008). Its multifactorial etiology results in the varied prevalence across regions, age and gender. Iron deficiency contributed to approximately half of the global burden of anemia incidence (Benoist et al., 2008; UBOS, 2011). The prevalence of iron deficiency anemia (IDA) is highest in Southeast Asia (57%), followed by Africa (46%) (WHO, 2001). It is widely recognized that children under 5 years old and pregnant women are most vulnerable to IDA (Benoist et al., 2008). Accordingly, the majority of the studies and interventions on IDA have been done targeting these two groups. However, in areas with a high prevalence of hookworm infestation, school-aged children as well as adults are also likely to develop severe iron deficiency and anemia. It is estimated that the prevalence of anemia in non-industrialized countries has reached 48% in children between five and 14 years old (WHO, 2001). In Uganda, about half of young children (6 to 59 months) are anemic, mostly in rural areas (UBOS, 2011). Unfortunately, existing studies failed to give us an overview of the burden of anemia

among school children in the country. According to a limited number of regional studies, the burden of anemia in this age group is considered to be moderate to severe, ranging from 24% to 46% (H Acham, Kikafunda, Tylleskar, & Malde, 2012; Barugahara, Kikafunda, & Gakenia, 2013).

Gender, as a risk factor for anemia in school children, especially in older children, has also been studied, but there is a lack of consensus. The majority of the studies suggested females are at a higher risk of anemia due to menstrual blood loss, which imposes additional demand for iron (Abalkhail & Shawky, 2002; Gupta et al., 2012; WHO, 2001). This conclusion is supported by the result of a study in Nepal that found menstruating girls encounter double the risk of anemia than non-menstruating girls (Baral & Onta, 2009). However, a cross-sectional study in Tanzania, including 6,801 school children, showed boys are more anemic than girls. (Lwambo, Brooker, Siza, Bundy, & Guyatt, 2000). This trend was also observed in a study comprising 14,000 school children in eight countries in Africa and Asia (Hall et al., 2001) as well as in a recent study in Kenya (Halliday et al., 2012). But the reason behind this phenomenon has not yet been explained.

Functional consequences of IDA and iron deficiency have been well documented. IDA adversely affects school children by impairing cognitive performance, behavior, and physical growth, which undermine their immune system, physical strength and work performance (WHO, 2011).

## **1.4 Malnutrition**

Though rarely listed as direct cause, malnutrition is estimated to contribute to one-third of children's deaths worldwide and affects their well-being and development. Common anthropometric indicators of child malnutrition include low height-for-age (stunting), low weight-for-height (wasting), and low weight-for-age (underweight) (Blössner et al., 2005). According to the latest Uganda demographic and household survey (UBOS, 2012), 33% of Ugandan children under 5 years old are stunted, 5 % wasted, and 14 % underweight (UBOS, 2012). Despite the relatively comprehensive and scaled data in younger children, limited information is available among school-aged groups, especially in resource-limited regions (H Acham et al., 2012; H Bachou & Demetre Labadarios, 2002). a regional study in 2006/2007 in Eastern Uganda, shows that the prevalence of stunting, underweight and thinness in school children (aged 9 to 15) was 8.7%, 13.0% and 10.1%, respectively, of which males and the older-age group of children were more affected (H Acham et al., 2012). It is of significant importance to track children's growth across their entire childhood, especially those who were malnourished in their younger age, since this is a dynamic period of both physical and mental development for a child.

## ***1.5 Dietary pattern, nutrients intakes in Ugandan school children and their association with anemia***

### **1.5.1 Dietary pattern and nutrient intake in Ugandan school children**

Few studies have recorded the dietary patterns among school children in Uganda. A study in Eastern Uganda identified the major dietary components in the diets of children (aged 9 to 15) and found the diets were primarily carbohydrate staple-based, with high consumption of dark leafy vegetables, and low consumption of animal-origin foods, which are considered to be important sources of iron (Hedwig Acham, Tumuhimbise, & Kikafunda, 2013a).

In terms of nutrients intake, the majority of studies targeting school children focused on a single type of nutrient, such as iron, zinc or Vitamin A (Tidemann-Andersen, Acham, Maage, & Malde, 2011). Studies combining macronutrients and major micronutrients intake are lacking. Better understanding of information on the intake of macro- and micronutrients would not only give us a general overview on the nutritional status in terms of dietary intake in the population, but also provide evidence for future interventions to improve the overall nutritional status of children.

### **1.5.2 The association between dietary factors and anemia**

The inverse association between dietary iron intake and anemia has been widely reported in cross-sectional research (Bagni, Yokoo, & da Veiga, 2014; Barugahara et al., 2013; Hashizume et al., 2004; Kaur, Deshmukh, & Garg, 2006). A study in rural India

indicated that girls who took 14-20 mg of iron from their diet per day were at double the risk of being anemic than those who took >20 mg, while five times the risk for those with <14 mg intake (Kaur et al., 2006). Unfortunately, studies that link dietary iron intake to anemia in Ugandan children have been rarely reported from regional to national levels (H. Bachou & D. Labadarios, 2002; Benoist et al., 2008).

In addition to the quantity of dietary iron, bioavailability of iron is another concern that complicates the situation. Heme iron from meat, fish or poultry is much more bioavailable than non-heme iron from plant-based foods (Neumann et al., 2003). As a result, diverse dietary patterns across the regions and cultures lead to different bioavailability of iron in diets and eventually weaken the existing generalizability of the association between dietary iron intake and anemia. For example, the frequency of meat intake in Japanese school children's diet did not show a positive association with the prevalence of anemia (Kunitsugu et al., 2012), while in Ethiopia it suggested the opposite (Assefa, Mossie, & Hamza, 2014). Thus, region-specific studies on this association between dietary iron intake, iron-rich food intake and anemia are needed to provide evidence for future interventions that are designed appropriately and effectively for local needs and situations.

## ***1.6 Meal patterns and anemia***

Meal patterns are considered to affect both school children's health and academic achievement. Studies have found that academic achievement in primary school students

is associated with missing breakfast and a midday meal, particularly for boys (Hedwig Acham, Kikafunda, Malde, Oldewage-Theron, & Egal, 2012). On the other hand, it still remains controversy on the efficiency of number of meals as a predictor of anemia among Ugandan school-aged children due to the mixed results in recent studies (Barugahara, Kikafunda, & Gakenia, 2013; Turyashemererwa, Kikafunda, Annan, & Tumuhimbise, 2013).

### ***1.7 Study gaps***

The disease burden of malnutrition, anemia, malaria and helminth infections among school-aged children is rarely studied in LMICs though they are also at high risk compared with other well-studied populations, such as pregnant women and children under 5 years old. Even in areas where the prevalence and trend of anemia and malnutrition are relatively well documented, few studies relate them to dietary factors, which are considered major contributors to the two health outcomes of the two studied populations.

### ***1.8 Purpose and Study aims***

The purpose of this study is to help better understand the disease burden of anemia, malaria, helminth infections and malnutrition and the association between children's diet and diseases and nutritional status in the Naama community and provide the basis for developing nutrition and health interventions to improve the health and well being of school-aged children in the community. The aims of the study include:

1. To examine the prevalence of anemia, malaria, helminth infections and malnutrition in a sample of children ages 6-14 years attending school in Naama, Uganda.

Hypothesis: The prevalence of diseases and malnutrition are consistent with previous data on similar population in the region.

2. To observe and quantify school children's dietary patterns and daily food nutrient intake relative to nutrition standards and recommendations.

Hypothesis: School children in Naama community generally have inadequate nutrient intake from their daily diet compared with WHO recommendations.

3. To examine whether children's diet is associated with anemia, using Hb concentration as the criterion.

Hypothesis: Three dietary factors are associated with increased risk for anemia and lower Hb concentration among school-aged children living in Naama, Uganda: (1) lower daily intake of iron, (2) lower frequency of consumption of iron-rich foods such as meat or dark green leafy vegetables, and (3) consuming fewer number of meals per day.

4. To examine the association between dietary factors and children's growth and nutritional status.

Hypothesis: Children's daily energy and macronutrients (protein, fat, carbohydrate) intake, meal patterns (number of meals consumed per day, missing certain meals) are associated with their nutritional status.

In addition to the primary aims, the association between family SES and children dietary intake will also be explored.

## 2. Methods

### 2.1 Setting

Naama community is a rural community in Mityana District, Central Uganda. Mityana District is about 48 miles away from Kampala, the capital of Uganda (Figure 1). In 2008, the Naama community and the Duke Global Health Institute Fieldwork Program partnered to form the Naama Community Health Collaboration. Since then, a number of cross-sectional and longitudinal studies and interventions have been conducted in the community targeting different population and health issues.



Figure 1: Map of Study setting

## **2.2 Participants**

### **2.2.1 School recruitment**

Four primary schools in the community were recruited, including two private schools and two public ones. Selected students in three primary schools (two public and one private) have been participating in a longitudinal study- Child Nutrition and Disease Burden (CNDB)- since 2013, aiming to track children's growth and development in the community. Thus the three schools were automatically considered as the participant schools after the head teacher's consent. The fourth new school was identified based on following criteria: 1) a private school, 2) the majority of the students came from a populous village in the community, which were less representative in the other three schools, 3) the head teachers consented to participate.

### **2.2.2 Participants recruitment**

We conducted school-based cross-sectional surveys, anthropometric measurements and biological tests among a sample of schoolchildren ages 6 to 14 between June and August 2104 in Naama community. After the school's consent, student rosters were obtained from the head teacher, then converted into digital versions (Excel), categorized by school, class and gender. Children were excluded from the digital rosters under the circumstances that 1) they had enrolled in the longitudinal study (CNDB), 2) they were boarding students, 3) they were physically incapable of finishing the surveys, such as being unable to use a camera or talk to the researcher or

translator. For the purpose of the study, we intended to randomly select two boys and two girls per class per school, but more students were selected under the following circumstances: 1) only one to two students were left unselected in the whole class, 2) the class contained an inadequate number of students for selection (e.g. only one boy was eligible), in which case the “compensation” method was applied- if one class in one school did not provide enough eligible students for inclusion, we would select more students from the other school within the same school system, in order to balance the total number of participants between public and private schools. This method was based on the assumption that there was no significant difference in students’ socioeconomic status (SES), dietary patterns, anthropometric status and disease burden across the same school system in the community. Eligible children were then assigned a number using an online random number generator (RANDOM.ORG). Potential participants for each school were listed after random selection. Two or more rounds of parent meetings were held in the schools to obtain consent from parents/guardians. Consenting parents/guardians also finished a family SES survey during the meetings because we assumed parents had more knowledge about their family information than children.

### **2.2.3 Ethical considerations**

Approval was attained from the Duke University Institutional Review Board Office in addition to local approval from the Mityana District Local Government’s District Health Officer. Informed consent was obtained from recruited

parents/guardians before any survey administration and biochemical tests occurred. Assent was obtained from school-aged children following consent from their parents. Oral consent was obtained before survey administration and height-weight measurements.

## 2.4 Methods and Measures

Figure 2 illustrates the entire method and measures used in this study. In general, there are four measures in the study including anthropometric status, disease burdens, family socioeconomic, nutritional assessment. The methods used for each measurement are shown in the following sections in detail.

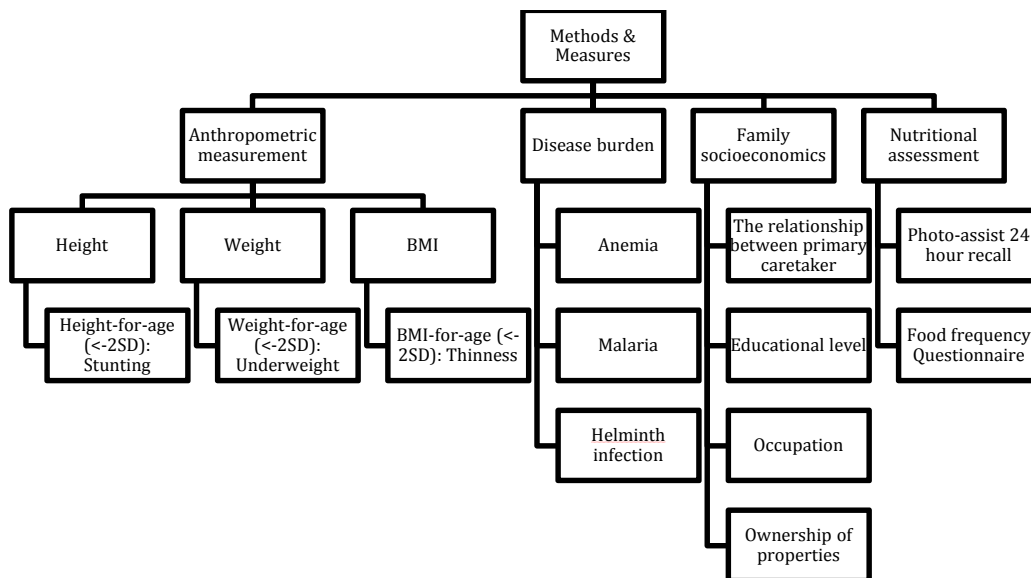


Figure 2: Methods and measures used in the study

### **2.4.1 Family SES and demographic data**

The survey on family SES information and household demographic data was conducted during each parent meeting once we obtained parental consent. Survey questions focused on information about the relationship between children and their primary caregivers (PC) (e.g. the primary caregiver of children in the family), PC's and parents' occupation and education level, and ownership of certain properties, such as land, electronics, mode of transportation etc., which served as a basic proxy for family socioeconomic status.

### **2.4.2 Anthropometric and biochemical data**

To identify children's malnutrition, their anthropometric data was collected, and their nutritional status was calculated and determined based on the WHO Growth reference data for those between 5 and 19 years of age on weight-for-age (W/A), height-for-age (H/A) and BMI-for-age (WHO Multicentre Growth Reference Study Group, 2006). The three indices of participants are expressed as standard deviation units from the median of the reference group. Less than -2 weight-for-age (W/A), height-for-age (H/A) and BMI-for-age (H/W) Z-scores were indicative of being underweight, stunting and thinness, respectively, all of which are considered indicators for malnutrition.

Measurement of height and weight was performed by a trained researcher and a translator in each school, using a mechanical scale (EatSmart) and a tape measure. When measuring weight, participants were required to be lightly dressed and take off their

shoes and take their belongings out of their pockets before measuring. They were instructed to stand on the middle of the scale until the pointer was stable. The researcher read and recorded the number in kilograms, accurate to one decimal point. For height measurement, a scale tape was attached vertically to a flat wall. Participants were required to take off their shoes and stand with their backs against wall and heels in close contact with the wall. A flat board was placed horizontally between the crown of the children's head and the scale tape. The researcher read and recorded the number, accurate to one metric decimal point.

### **2.4.3 Biochemical assessment**

To study the disease burdens of our interest in the area, we tested the prevalence of anemia, malaria and helminth infections in the sample of school children. A registered technician was hired from a local clinic to conduct the biochemical tests and a nurse to dispense treatment for the participants who tested positive for anemia, malaria and hookworm infections. To assess hemoglobin (Hb) level and test malaria status, the technician went to each school and drew 3mL venous blood from the left arm of each participant and tested the samples in the lab the same day. Anemia was diagnosed using WHO recommended cyanmethemoglobin method, which is the reference laboratory method for the quantitative determination of hemoglobin. The grade of anemia was assessed by using the WHO's cut-off values (WHO, 2011), shown in Table 1. The public health significance of anemia prevalence was also identified and the WHO criteria is

shown in Table 2. Malaria in children was detected using the method of microscopy, which is considered to be the “gold standard” that could accurately diagnose malaria cases (Rosenthal, 2012). To test helminth infections, stool sample containers were sent to participants with instructions on how to use them appropriately. Containers were collected by the researcher one or two days after dispensing and sent to the technician within two hours after receiving the samples. The stool samples collected more than 48 hours after dispensing were discarded for the accuracy of the results. We chose these three biochemical testing methods while also considering the local resources and the technician’s capacity.

Table 1: WHO cut-off of anemia for school-aged children

<i>Population</i>	<i>Non-anemia (g/dl)</i>	<i>Anemia (g/dl)</i>		
		Mild	Moderate	Severe
Children 5 - 11 years of age	>115	110-114	80-109	<80
Children 12 - 14 years of age	>120	110-119	80-109	<80

Table 2: WHO cut-off for public health significance of anemia

<i>Category of public health significance</i>	<i>Prevalence of anemia(%)</i>
Severe	>40
Moderate	20.0 – 39.9
Mild	5.0 – 19.9
Normal	<4.9

### **2.4.3 Photo-assisted 24-hour dietary recall**

In order to obtain information on children's nutrient intake, participants were given a photo-assisted 24-hour recall to calculate nutrient intakes from all food/beverage they had consumed on a given day. Similar methods had been adopted in a previous study among Bolivian women and suggested acceptable validity and suitability for dietary assessment among rural population in LMICs (Claudia E Lazarte, Ma Eugenia Encinas, Claudia Alegre, & Yvonne Granfeldt, 2012). We modified the method based on the ability of target population. For example, instead of letting participants estimate portion size of food they consumed, which was done in the Bolivia study, the researcher did this according to photos participants took since we assumed that young children had inadequate cognitive capacity to quantify portion size, which is supported by Livingstone and Robson (M. Livingstone & P. Robson, 2000). Participants' demographic information, food/beverage items, time and place of consumption, supplement intake and level of physical activity were acquired from the interview with the help of the photos taken by the participants. The researcher estimated the amount of food participants actually consumed by comparing food in their photos with those in a food atlas developed by the researcher in the middle of study process based on the preliminary results from the 24-hour recall.

To develop the food atlas, the researcher took photos of food that was commonly consumed by the participants in various portion sizes. Mixed dishes were prepared by

the researcher with the help of a local translator and cook and displayed in the food atlas in different containers that were frequently shown in participants' photos. Raw ingredients (such as tomatoes) and fresh fruits were also shown in the photos with different or average sizes depending on the actual sizes available in local market.

Photo-assisted 24-hour dietary recall consisted of three steps: training, photo taking and interview.

### **2.3.3.1 Training**

We conducted the training during the break time in school by groups of participants. Each participant received a camera kit including a digital camera equipped with flash light, a 15 cm string attached to the camera, a square checked mat and an instruction in Luganda (the instruction in English shown in Appendix A). Participants were trained to put their food/containers in the middle of the checked mat on a flat surface and use the fix-length string to measure the distance from food to camera. They were asked to take photos vertically and at an angle of approximately 45 degree before eating their meals and after, if there were leftovers. If the children were not capable (usually younger than 7 year old) to learn the method, their older siblings in the same school were called to assistant their photo-taking and interview. If the sibling was not found in the same school, the participants were excluded from the study. The training was conducted in English or Luganda with the help of a translator. They were asked to take photos of all the food and beverages he/she ate over 24 hours before the interview.

### **2.3.3.2 Photo taking**

Participants took photos of any food and beverage they consumed over 24 hours period after receiving the camera kit. The researcher and translator were available at school for instruction if the participants had problems taking photos.

### **2.3.3.3 Interview**

The researcher collected the cameras on the day of the interview and downloaded and coded all of the photos to a computer. The photos were coded by participant's survey ID. The interview was conducted among one participant, a researcher and a translator in a quiet, private room. First, the researcher checked the quality of the photos to ensure they were clear enough to measure the quantity of food. If the photos were not clear enough, such as being too dark or too vague, the participant would be re-trained and asked to take photos again over the next 24 hours if he/she chose. Participants who tried twice but failed to successfully finish the method were excluded from the 24-hour recall part of the study. With the qualified photos, the researcher administered a modified multi-pass 24-hour recall interview (Gibson, 2005). The participants were also asked to describe hidden or missing food that was not visible in the photos. If the participant was able to describe the missing/hidden foods in standardized portion size (eg. a half cup of porridge, two teaspoons of sugar in tea), then we included and recorded the food item on our questionnaire. Otherwise, we considered this 24-hour recall invalid and retrained the participant if applicable. Other

photos not related to food were deleted immediately for consideration of individual privacy. All the responses were recorded on a paper-based, 24-hour recall questionnaire (Appendix B). It took approximately 15 minutes for each participant to finishing the interview. Detailed processes of the modified multi-pass 24-hour recall interview are described in Appendix C.

#### **2.4.4 FFQ**

In addition to the 24-hour recall, each participant was also instructed to take a FFQ survey that asked about their frequency of food intake in the previous month on a weekly basis (eg. five times a week); if the frequency was less than once a week, then it was measured on a monthly base (eg. twice a month).

Frequency of food intake in the previous month was estimated using a food frequency questionnaire that was developed for the study. The food items included in the questionnaire were based on the preliminary results from the 24-hour recall and knowledge from local key informants that identified the commonly-consumed foods among school children in the community. Forty-nine food items were identified and divided into nine categories (cereal/cereal product, roots/tubers/plantain, pulses/nuts, meat/poultry/fish/eggs, milk/ dairy product, vegetables, fruits, oil/oil rich food, and drinks). The food categories were summarized and modified based on a previous study conducted in primary school children in rural Uganda (Hedwig Acham, Tumuhimbise,

& Kikafunda, 2013b). The FFQ also included questions on the number and type of meals participants consumed regularly in one month. (Questionnaire in Appendix D)

## **2.5 Analysis**

All analyses were conducted using STATA, Version 11.0 (StataCorp. 2009) and Microsoft Excel 2007. Frequencies, percentages, means (SD) or medians were used to summarize descriptive data. The distribution of all continuous variable outcomes were tested before conducting any analysis. If the variable of interest was not normally distributed, then it was converted into a log and distribution was tested again. If the log variable was still not normally distributed, nonparametric analysis methods were used. Differences among groups were tested using the t-test or Wilcoxon-Mann-Whitney test and chi-square/exact test. To determine the predictors of interested outcomes, a logistic or linear regression was performed depending on the characteristics of the outcomes (binary or continuous). Estimated coefficients and odds ratio (OR) were of primary interest for reporting the association between predictors and outcomes.  $P < 0.05$  was used as the cutoff for statistically significant differences.

Daily nutrient calculation using data from 24-hour recall was elaborated in Microsoft Excel 2007. Standard nutrients for each food item was derived from the food composition table (FCT) appropriate for Ugandan diets developed by HarvestPlus (Hotz, Abdelrahman, Sison, Moursi, & Loechl, 2012). All the ingredients in mixed dishes were separated using receipts in the FCT and their nutrients were calculated

respectively. The FCT data only represented the edible portion of food items thus we referred to USDA Agriculture Handbook No. 102 (Matthews & Garrison, 1975) to present the edible quantity of food participants consumed when the food included refuse, such as skins and seeds. Each participant's nutrient intake was compared with WHO recommendations (when available) and determined the presence of nutrient deficiency in diet.

To identify the major food sources for a certain nutrient of interest, we identified the major food source for that nutrient in individual participants and then calculated the frequencies of each food item identified as a major source of nutrients in all participants. The food items that had the highest frequencies as primary sources of the certain nutrient intake were described as the major sources of that nutrient.

### 3. Results

#### 3.1 Demographic and clinical characteristics of children

Ninety-five children in total were enrolled in all or some components of the study. Table 3 illustrates the number of children participated in each component.

Table 3: Number of children participated in each component of measures

<i>Measures</i>	<i>Number of participants</i>
Total	95
Biochemical tests	93
Anthropometric measures	77
Photo-assisted 24-hour recall	82
Food frequency questionnaire	64

Table 4 The demographic and clinical characteristic of children

<i>Characteristics</i>	<i>Percentage</i>	<i>P-value</i>
<b>Age of child (year)(n=80)</b>		
Mean (SD)	10.6 (2.1)	
<b>Gender of child (n=95)</b>		
Male	51.6%	
Female	48.4%	
<b>School type (n=95)</b>		
Public	44.2%	
Private	55.8%	

<b>Anemic (n=93)</b>	3.2%	
<i>By gender</i>		0.61 <sup>a</sup>
Male	2.1%	
Female	4.4%	
<i>By school type</i>		1.00 <sup>a</sup>
Public	2.4%	
Private	3.9%	
<b>Malaria (n=93)</b>	12.9%	
<i>By gender</i>		0.33 <sup>a</sup>
Male	11.6%	
Female	18.4%	
<i>By school type</i>		0.06 <sup>a</sup>
Public	5.1%	
Private	23.8%	
<b>Helminth infection (n=86)</b>	24.4%	
<i>By gender</i>		0.26
Male	41.9%	
Female	23.5%	
<i>By school type</i>		0.30
Public	25.8%	
Private	38.2%	

<sup>a</sup> Exact test

The demographic and clinical characteristics of children were summarized in Table 3. There was nearly equal number of boys and girls (51.6% and 48.4%,

respectively). Figure 3 shows the gender distribution of participants stratified by school type. The average age was  $10.6 \pm 2.1$  years old. Age distribution did not show differences across gender or school type. There were slightly more children studying in private schools (55.8%) than in public ones (44.2%).

Among the 93 children in the study population who had biochemical results, 3.2% (n=3) were tested positive in anemia, of which all were mildly anemic. However, the prevalence of malaria and hookworm infection was four-fold (12.9%, n=12) and eight-fold (24.4%, n=21) compared with anemia, respectively. There was no significant difference of disease prevalence across gender, and school type. Age of children was considered as a potential predictor for disease burdens and tested associations in the regression models.

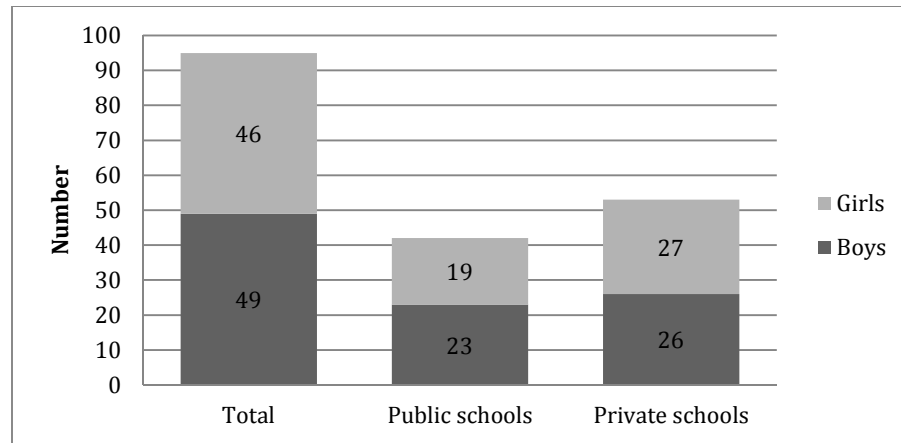


Figure 3 Gender distribution of participants stratified by school type

### 3.2 Nutritional status of the children

According to WHO Growth reference data for 5-19 years, among children in the study, 2.8% were underweight, 15.6% were stunted, 1.5% were thin. In addition, one child (1.3%) was overweight using over  $>2$  H/W Z-scores as indicative. Differences in gender and school type did not affect the results (Table 5).

Table 5: Nutritional status of children

Nutritional status (<2SD)	Underweight <sup>b</sup>	P-value	Stunting	P-value	Thinness	P-value
	(n=36)		(n=77)		(n=74)	
Total	2.8%		15.6%		1.4%	
Male	5%	0.56 <sup>a</sup>	15.8%	0.96	0	0.51 <sup>a</sup>
Female	0		15.4%		2.6%	
Public schools	5.9%	0.47 <sup>a2</sup>	16.7%	0.81	0	0.26 <sup>a</sup>
Private schools	0		14.6%		2.6%	

<sup>b</sup> Weight-for-age reference data for determination of underweight for children over 10 years old is not available because this indicator does not distinguish height and weight. Many children in this age period are experiencing a pubertal growth and have excess weight while they are only tall.

### **3.3 Demographic and socioeconomic status of children’s family**

As shown in Table 6, more than half (57.5%) of the respondent parents reported child’s grandmother primarily took care of the child in the household, followed by their aunt (12.5%). Only 7.5% and 5% of the responses were for the father or mother, respectively. A small percentage of the respondents did not specify the relationship between the primary caregiver (PC) and child (5% answered parent and 7.5% grandparent), thus were excluded from future regression analysis.

Table 6 Relationship between children and primary caregivers

<i>Primary caregiver (PC) (n=40)</i>	<i>Percentage%</i>
Grandmother	57.5%
Aunt	12.5%
Mother	5.0%
Father	7.5%
Grandparent	7.5%
Parent	5.0%
Other	5.0%

Table 7 illustrates the education level of children’s PC in general, specifically grandmother as a PC and parents. Only a small portion of the PC of children and grandmother in specific never received any formal education (20.0% and 23.7%

respectively). Approximately one-fifth of the PCs (23.3%) and grandmother (19.1) left school in the middle of their primary education (Primary1-4), and another one-fifth (23.3%) of PC and one-third of grandmother never continued to secondary schools after graduation from primary school (33.3%). Only 6.7% of the PCs finished secondary school and none went to a university/college, while none of the grandmothers finished secondary school. In terms of parents' education, generally, father 's education was higher than mother's (P=0.042). Specifically, higher percentages of mothers never went to any school than, father (10.06%, 6.06%, respectively). None of the children's mother attended college/universities while 3% fathers did.

Table 7: Educational level of children's caregivers and parents

<i>Educational Level</i>	<i>PC (n=30)</i>	<i>Grandmother (as a PC)(n=23)</i>	<i>Mother (n=66)</i>	<i>Father (n=66)</i>
No schooling	20.0%	23.8%	10.6%	6.1%
Some primary school (P1-P4)	23.3%	19.1%	9.1%	12.1%
Most primary school (P5-P6)	10.0%	9.5%	28.8%	13.6%
Completed primary school (P7)	23.3%	33.3%	19.7%	21.2%
Some secondary school (S1-S3)	13.3%	9.5%	16.7%	22.7%

Most secondary school (S4-S5)	3.3%	4.8%	15.2%	16.7%
Completed secondary school (S6)	6.7%	0	0	4.6%
Colleges/universities	0	0	0	3.0%

The majority of PCs (84.4%), grandmothers (91.3%), mothers (58.7%) and fathers (44.6%) of the children worked as farmers. A small portion of fathers worked as businessman (6.2%), teacher (4.6%), hotelier (3.1%), chairman (3.1%), boda driver (6.2%), car driver (6.2%), builder(7.7%), fisherman(6.2%), and other occupations(12.3%). A small portion of mothers worked as hairdresser(4.0%),businesswoman(10.7%), hotelier(5.3%), housewife(6.7%) and other (21.3%)

Less than half (46.6%) of the families owned their own land. Among those who owned land, the average size was  $1.96 \pm 1.58$  (SD) acres.

### **3.4 Daily nutrient intakes from 24-hour recalls**

#### **3.4.1 Daily nutrient intakes and comparison to WHO recommendations**

Eighty-two participants (86.3%) aged 6-14 years successfully completed the photo-assisted 24-hour recalls. After chi-square tests, no differences were found in terms of gender and school type attended between 24-hour recall participants and non-participants. Mean/median and differences of macronutrients (carbohydrate, protein

and fat) and major micronutrients stratified by gender and school type are shown in Table 8,9.

In general, school children in the community consumed  $1714 \pm 803$  kcal of energy from their daily diet in the 24 hours (Table 8). The average intakes of macronutrients (fat, carbohydrate, protein) were 16.9g, 336.8g and 35.5g, respectively. In terms of major micronutrients intakes, the average quantities were  $9 \pm 4.5$ mg for iron, 145 mg for Vitamin A (Retinol Activity Equivalent), 70mg for Vitamin C and 210mg for calcium (Table 8).

There was no significant difference in both macro- and major micro- nutrients intakes across stratifications (gender and school type) after t-test, except that, on a daily base, girls consumed higher amount of energy, fat, and iron from their diet, compared with boys ( $P=0.03, 0.03, 0.03$ , respectively).

By comparing the energy and nutrient intake (fat, protein, vitamin A, vitamin C, calcium) of our sample with the WHO recommendations adjusted for age groups and gender, we found that the majority (80%) of the participant in the area consumed inadequate energy from their daily diet, particularly for boys than girls (92.6% vs 65.5%, respectively,  $P<0.05$ ). Low dietary fat intake, measured by the percentage of total energy attributes to fat ( $<25\%$  total energy intake), occurred in 78% of the children. On the other hand, 7% of the children exceeded the WHO recommendation for percentage of energy from fat ( $>35\%$  of total energy intake). The WHO recommendation on protein intake was

given out in the form of gram of protein per kg of weight for specific gender and age group, so we calculated the required protein intake for each of our participants based on their gender, age and weight and compared the requirement with their actually intake. The finding shows about a quarter of (26.8%) children did not meet the requirement for protein intake based on their age, gender and weight. In addition, the study population of school aged children in the area had very low intakes of vitamin A—almost all participants were deficient (93.33%), especially students in private schools (97.4%). Calcium was low in local school children’s diet, even more than Vitamin A— only 7% met the WHO recommendations for calcium. Inadequate Vitamin C intake was less common (29.1%). Generally, no significant differences were found across gender and school type, but more male students lacked dietary fat in their diet compared to female students ( $P=0.03$ ).

Table 8: Energy and macronutrients intake and deficiency

	<i>Energy, kcal</i> (mean, SD)	<i>P-</i> <i>Value</i>	<i>Deficiency</i>	<i>P-</i> <i>Value</i>	<i>Fat, g</i> (median) <sup>a</sup>	<i>P-</i> <i>value</i>	<i>Deficiency</i>	<i>P-value</i>	<i>Carbohydrate, g</i> (mean,SD)	<i>P-</i> <i>value</i>	<i>Protein,g</i> (median) <sup>a</sup>	<i>P-</i> <i>Value</i>	<i>Deficiency</i>
<b>Total</b>	1714.8(803.4)		79.3%		16.9		Deficiency: 78.1%		336.9(146.0)		35.6		26.8%
							Exceed: 7.3%						
<b>Gender</b>		<b>0.03*</b>		<b>0.00*</b>		<b>0.03*</b>				0.08		0.23	
<b>Male (41)</b>	1525.5(670.4)		92.7%		7.8		85.4%	0.16	308.5(130.9)		34.4		29.3%
<b>Female (41)</b>	1904.2(885.4)		65.9%		24.0		70.7%		365.2(156.2)		37.9		24.4%
<b>School type</b>		0.55		0.63		0.64		0.57		0.44		0.53	
<b>Public</b>	1657.5(850.1)		81.6%		21.6		73.7%		323.4(156.8)		35.1		23.7%
<b>Private</b>	1764.4(767.2)		77.3%		13.1		81.8%		348.5(136.8)		35.6		29.6%

Table 9: Major micronutrients intake and deficiency

	<i>Iron, mg</i> <i>(mean, SD)</i>	<i>P-Value</i>	<i>Vitamin A,mg</i> <i>, (median)<sup>c</sup></i>	<i>P-Value</i>	<i>Deficiency</i>	<i>Vitamin C,</i> <i>mg(median)</i>	<i>P-Value</i>	<i>Deficiency</i>	<i>Calcium,mg</i> <i>(median)<sup>a</sup></i>	<i>P-Value</i>	<i>Deficiency</i>
Total	9.0 (4.5)		144.9		93.3%	69.7		29.1%	210.4		97.6%
Gender of child (n=82)		<b>0.03*</b>		0.73			1.00			0.92	
Male (41)	7.9(3.9)		135.4		91.9%	67.6		30.8%	220.7		97.6%
Female (41)	10.1(4.8)		144.9		94.7%	70.9		27.5%	190.5		97.6%
School type child attended (n=82)		0.55		0.90			0.74			0.38	
Public	8.7(4.4)		130.0		89.2%	69.6		21.6%	186.8		100.0%
Private	9.3(4.5)		151.6		97.4%	76.0		35.7%	241.7		95.5%

<sup>c</sup> Retinol Activity Equivalent

### 3.4.2 Major food sources of nutrients intake

Based on the results from 24-hour recalls, the most frequently consumed food items and categories that contributed to children's major energy and nutrient intake were identified in Table 10. Matooke (a green cooking banana) and posho (a solid dish of maize flour) were reported most frequently in about 20% of the respondents as the major sources of energy, followed by sweet potato (17.0%). Avocado contributed to the highest fat intake for one-third (30.5%) of the participants, much higher than the following food items: posho (9.8%) and matooke (9.8%). Beans were a vital source of protein for one-third (28.1%) of the participants, followed by posho (17.1%) and sweet potato (14.6%). Matooke provided the majority of vitamin A in almost half (43.2%) of the participants' diet, while avocado (14.8%) and cassava (7.4%) followed.

When considering food categories instead of individual food items, "Roots/tubers/plantain" (68.3%) and "Cereal/cereal product" (30.5%), contributed to nearly all participants' energy intake.

Table 10: Major food/food category sources of energy, protein, fat, iron and Vitamin A

<i>Food item</i>	<i>Energy%</i>	<i>Food item</i>	<i>Protein%</i>	<i>Food item</i>	<i>Fat%</i>	<i>Food item</i>	<i>Iron%</i>	<i>Food item</i>	<i>Vitamin A%</i>
Matooke	19.5	Beans	28.1	Avocado	30.5	Beans	26.8	Matooke	43.2
Posho	19.5	Posho	17.1	Posho	9.8	Matooke	20.7	Avocado	14.8
Sweet potato	17.0	Sweet potato	14.6	Matooke	9.8	Sweet potato	20.7	Cassava	7.4
<i>Food categories</i>	<i>Energy%</i>	<i>Food categories</i>	<i>Protein%</i>	<i>Food categories</i>	<i>Fat%</i>	<i>Food categories</i>	<i>Iron%</i>	<i>Food categories</i>	<i>Vitamin A%</i>
36 Roots/tubers/pla ntain	68.3	Roots/tubers/pl antain	37.8	Fruits	30.5	Roots/tubers/plant ain	44.9	Roots/tubers/plan tain	58.5
Cereal/cereal product	30.5	Cereal/cereal product	29.3	Roots/tubers/plantain	26.8	Cereal/cereal product	27.5	Fruits	18.3
Fruits	1.2	Pulses/nuts	22.0	Cereal/cereal product	22.0	Pulses/nuts	4.4	Dairy	6.1
								Vegetables	6.1

### **3.5 Frequency of food consumption from FFQ**

Two-thirds of enrolled children participated in FFQ component of the study and yielded 64 valid FFQ questionnaires. Table 11 lists commonly consumed food items and categories in the area and their frequencies of consumption (in times per week) in the previous month before the study was conducted. Food items (millet, coffee) were consumed by less than 20% respondents. Mean and median of frequencies were reported in Table 11. Every individual respondent consumed cereal/cereal product, roots/tubers/plantain, pulses/nuts, oil/oil rich food and fruits in the previous month, while almost one-fifth (17.74%) never consumed milk/dairy products. Vegetables were consumed in most of the respondents. Only a small portion (1.6%) of the respondents reported no consumption of animal-source food (meat/poultry/fish/eggs) or drinks listed in the questionnaire.

For specific food items, groundnut and cassava were both consumed by almost every respondent in the frequency of 4 times a week. Posho and rice were two top cereal foods consumed by 95% of the respondents. Following cassava, sweet potato was the second popular roots/tubers/plantain food for 97% respondents. Fish and eggs were choices of 90% respondents, respectively, for animal-source food. Milk, as the major type of dairy in local market and household, was consumed by 80% children in the previous month. Only one out of ten children never ate dark green vegetables in a month.

Jackfruits and sugarcane were top 2 popular local fruits.

Table 11: Frequently consumed food items and categories in a month

<i>Food item</i>	<i>Never eat in a month</i>	<i>Frequency (times per week)</i>	
	%	Mean (SD)	Median
<b>Food category:</b>	<b>0</b>	<b>19.78(7.0)</b>	<b>19</b>
<b>cereal/cereal product</b>			
Posho	4.7	3.7 (2.9)	5
Porridge	9.4	5.8(3.7)	5
Maize	9.4	3.4(2.2)	3
Rice	4.7	3.5(2.4)	3
Bread	7.8	3.4(3.4)	2
<b>Food category:</b>	<b>0</b>	<b>20.6(12.0)</b>	<b>18</b>
<b>roots/tubers/plantain</b>			
Matooke	17.2	6.1(5.8)	5
Cassava	1.6	4.4(2.8)	4
Sweet potato	3.1	5.3(7.1)	3
Irish potato	20.3	3.1(2.7)	2
Pumpkin	32.8	3.2(3.3)	2
Plantain	46.9	2.7(2.0)	2
<b>Food category:</b>	<b>0</b>	<b>12.9(6.5)</b>	<b>12</b>
<b>Pulses/nuts</b>			
Groundnuts	1.2	4.4(3.4)	4
Beans	6.3	5.6(3.9)	5
Peas	57.1	1.9(1.5)	2
Soya	48.4	2.0(1.4)	2
Simsim	47.6	2.7(1.7)	2
<b>Food category:</b>	<b>1.6 (n=61)</b>	<b>13.0(9.5)</b>	<b>11</b>
<b>meat/Poultry/Fish/Eggs</b>			

Beef	30.2	4.4(6.9)	3
Chicken	15.6	2.9(2.8)	2
Eggs	12.5	3.4(2.7)	3
Fish	11.1	3.5(3.0)	3
Other meat	63.5	3.1(1.6)	3
<b>Food category: milk/ dairy product</b>	<b>17.7</b>	<b>4.6(4.6)</b>	<b>3.5</b>
Milk	20.6	4.7(4.0)	4
Other dairy	71.4	3.1(1.9)	2.5
<b>Food category: vegetables</b>	<b>4.8</b>	<b>8.7(9.0)</b>	<b>6</b>
Dark green vegetables	9.4	3.9(4.9)	2.5
Other veggies	16.1	6.1(6.2)	4
<b>Food category: fruits</b>	<b>0</b>	<b>40.3(18.4)</b>	<b>36.5</b>
Mango	28.1	4.4(3.3)	4
Pawpaw	19.1	3.8(3.4)	2
Orange	20.6	4.5(4.0)	3
Avocado	12.5	6.8(4.7)	6
Pineapple	25.0	3.6(3.8)	2
Banana	14.3	4.0(4.0)	2
Jackfruit	6.3	5.7(4.3)	4.5
Watermelon	50.8	3.5(2.9)	3
Sugarcane	3.1	5.6(4.5)	4
Passionfruit	17.5	4.0(5.2)	3
Guavas	29.7	3.2(2.4)	2
<b>Food category: oil/oil rich food</b>	<b>0</b>	<b>26.2(12.1)</b>	<b>28</b>

Oil	25.4	13.9(10.3)	14
Ghee	37.5	2.8(2.0)	2
Margarine	33.9	2.2(1.7)	2
Chapatti	6.4	3.3(2.8)	2
Rolex	46.9	2.7(2.0)	2
Popcorn	25.0	2.6(1.8)	2
Doughnut	18.0	3.1(2.32)	2
Pancake	7.9	4.4(3.6)	3
<b>Food category: drinks</b>	<b>1.6</b>	<b>13.8(6.9)</b>	<b>13.5</b>
Tea	4.8	8.3(5.0)	7
Soda	12.7	2.7(3.5)	2
Fruit juice	12.5	3.3(2.5)	3

### **3.6 Meal Patterns**

The most commonly consumed meals by the children in the Naama area were breakfast, snack for break, lunch, afternoon tea and dinner. Breakfast was usually consumed at home between 7:00-8:00 AM. The snack break was a simple meal occurring during the only recess between classes in the morning (10-10:30am) in four schools we investigated. Lunch (1:00-2:00pm) was mostly school-based with some children, as we observed, eating food prepared by the school if they paid for it, while others brought their own food. In the study, afternoon tea represented all food consumed after school and before dinner, usually between 5:00-7:00pm. Dinner was the last meal for some of the participants occurring around 8-9 pm. Table 12 represents the average number of meals participants consumed stratified by gender or school type and the percentage of

people who consumed each meal. In general, children ate 3.81(SD: 0.99) out of all five meals in the area. No difference was shown across gender and school type. We found dinner was consumed by the majority of the participants (93.7%), followed by lunch (92.4%), which was consumed by more girls (100%) than boys (86.36%)(P=0.023). Approximately four-fifths (77.6%) of the children consumed snacks for break regularly during our investigation period, followed by breakfast (69.6%). Afternoon tea was the least common meal and was skipped by half of the children.

Table 12: Number of meals and the percentage of participants consumed each meal

	<i>Mean</i> <i>(SD)</i>	<i>P-</i> <i>value</i>	<i>Breakfast%</i>	<i>P-</i> <i>value</i>	<i>Break%</i>	<i>P-</i> <i>value</i>	<i>Lunch%</i>	<i>P-</i> <i>value</i>	<i>Afternoon</i> <i>tea%</i>	<i>P-</i> <i>value</i>	<i>Dinner%</i>	<i>P-</i> <i>value</i>
Total (n=79)	3.8(1.0)		69.6		77.2		92.4		48.1		93.7	
Gender of children		0.58		0.42		0.60		0.02		0.20		0.84
Male (n=44)	3.8(1.0)		65.9		75.0		86.4		54.6		93.2	
Female (n=35)	3.9(1.0)		74.3		80.0		100.0		40.0		94.3	
School type		0.11		0.37		0.31		0.10		0.58		0.66
Public (n=40)	3.6(1.1)		65.0		72.5		87.5		45.0		92.5	
Private	4.0(0.9)		74.4		82.1		97.4		51.3		94.9	

### ***3.7 Dietary Factors and their association with anemia***

We aimed to examine whether or not children's diets were associated with anemia. We hypothesized that three dietary factors would increase the risk for anemia and lower Hb concentration in the studied sample: (1) lower daily intake of iron, (2) lower frequency of consumption of iron-rich foods such as meat or dark green leafy vegetables, and (3) consuming fewer number of meals per day.

To build a regression model, we first ran univariate regression between each independent variable and dependent variable and identified independent variables that significantly associated with the outcome ( $P < 0.05$ ). Then, we combined the identified independent variables together to build a new model and ran the regression again to identify those that were still significantly associated with the outcome ( $P < 0.05$ ) and combined them into a new model. We repeatedly ran the process until we found the model with the highest R-square which represented the fitness of the model and considered the model identified as our final regression model.

Based on existing evidence and our experience, we considered family socioeconomic status and children's disease status could be confounders between the dietary factors and anemia, so we first tested correlations between each potential confounder and each independent variable, and dependent variable, respectively. If the potential confounder variable was correlated to both independent and dependent

variables ( $P < 0.05$ ) and excluded the possibility of being a mediator, then we consider this variable a confounder, and adjusted the regression model by identified confounders.

### **3.7.1 Dietary factors and anemia**

No confounder was found to affect the association between dietary intake and anemia, thus we conducted univariate regression for each dietary factor of interest (Table 13). Though the association was not significant for iron intake and meal patterns with anemia, the frequency of chicken consumption was negatively associated with anemia ( $OR=1.4, P=0.04$ ), that is consuming chicken one more time per week is associated 1.39-time increase in odds of being anemic.

### **3.7.2 Dietary factors and Hb level**

The univariate regressions only found a significant association between the frequency of egg consumption and child's Hb level. In addition, father's occupation was related to both exposure and outcome variables, thus we considered it a confounder between this association. When controlled for father's occupation, the association between egg consumption and Hb level was no longer significant ( $P=0.189$ ) (Table 12).

In addition, we conducted a secondary analysis to explore other factors that may affect children's anemia/Hb level (Table 13). We found the frequency of orange consumption as well as mother's occupation and father's occupation was significant. We ran a poisson regression and found mother's occupation and father's occupation were

associated with orange consumption ( $p < 0.05$ ). We controlled for mother's and father's occupation as confounders, and ran the regression model. The result showed the frequency of orange intake continued to be positively associated with children's Hb level ( $P = 0.015$ ), that is, the higher frequency of consuming oranges per week, the higher a child's Hb level was. No association was found between Hb level or anemia and vitamin C intake ( $P = 0.717, 0.318$ , respectively).

Table 13: Dietary factors and their association with anemia and Hb level

<i>Factors</i>	<i>Anemia</i>			<i>Hb level</i>		
	Adjusted OR	95% CI	P-value	Adjusted coefficient	95%CI	P-value
Dietary iron intake	0.9	(0.7,1.2)	0.55	0	(0,0)	0.79
<b>Frequency of food consumption</b>						
Beef consumption	1.0	(0.9,1.2)	0.53	0	(0.0,0.0)	0.87
Chicken consumption	1.4	(1.0,1.9)	<b>0.04*</b>	0	(-0.1,0.1)	0.56
Egg consumption	0.5	(0.1,1.8)	0.30	0.1	(0,0.2)	0.19
Fish consumption	0.5	(0,3.7)	0.18	0	(0-0.1)	0.09
Meat category consumption	1.0	(0.9,1.2)	0.76	-1.3	(-2.4,0.2)	0.09
Dark leafy vegetable consumption	1.1	(0.9,1.3)	0.57	0	(0,0.1)	0.96
<b>Meal patterns</b>						
Number of meals	0.9	(0.3,2.8)	0.84	0.2	(0,0.4)	0.12
Missing breakfast	0.9	(0.1,10.5)	0.93	0.1	(-0.3-0.6))	0.58
Missing break snack	0.6	(0.1,7.0)	0.68	0.4	(-0.2,0.9)	0.16
Missing lunch	/	/	1.0	0.4	(-0.5,1.2)	0.40
Missing afternoon tea	2.4	(0.2,27.1)	0.49	0.21	(-0.2,0.7)	0.35
Missing dinner	0.1	(0.0,1.5)	0.10	-0.1	(-1.0,0.8)	0.88

<b>Secondary analysis</b>						
Frequency of orange consumption	0.4	(0.1,2.0)	0.25	0.1	(0,0.2)	<b>0.02*</b>
Vitamin C intake	1.0	(1.0,1.0)	0.32	0	(0,0)	0.72

### 3.8 Dietary factors and their association with nutritional status

Since the prevalence of being underweight and thinness was relatively low in the area (2.7% and 1.3%, respectively), we lacked sufficient power to detect any association between dietary factors and underweight/thinness. Thus we conducted logit regressions focusing on stunting with dietary factors. We found that number of meals ( $p=0.049$ ) and eating breakfast ( $p=0.009$ ) were both associated with stunting. In addition, eating breakfast was associated with the number of daily meals eaten ( $p<0.05$ ). Thus, we included the two variables into one model. However, the associations were no longer significant. In addition, we also found that children who consumed less total dietary fat were less likely to be stunted than those who consumed enough ( $OR=0.327$ ,  $P=0.046$ ).

Table 14: Dietary factors and their association with stunting

<i>Factors</i>	<i>Stunting</i>		
	Adjusted OR	95% CI	P-value
Energy intake	1.0	(1.0,1.0)	0.11
Carbohydrate intake	1.0	(1.0,1.0)	0.09
Fat intake	1.0	(1.0,1.0)	0.37
Protein intake	1.0	(0.9,1.0)	0.23
Energy deficiency	3.3	(0.4,27.7)	0.27
Fat deficiency	0.3	(0.1,1.0)	<b>0.049*</b>
Number of meals	1.0	(0.3,2.8)	0.96

Missing breakfast	0.2	(0,1.5)	0.11
Missing snack for break	0.4	(0,1,1.7)	0.24
Missing lunch	/	/	0.99
Missing afternoon tea	0.3	(0.1,1.4)	0.12
Missing dinner	/	/	0.99

### ***3.9 Family socioeconomic status and their association with dietary pattern and nutrients intake***

Through regression analysis, we found father's education was the only socioeconomic factor associated with children's daily energy intake. Children whose father received Primary 4 and Primary 7 education were consumed more energy from their daily diet compared with those whose father never received any formal schooling (P=0.019 and 0,046, respectively). However, though age of the participants ranged from 6 to 14 years, no association was found between children's age and their total daily energy intake (P=0.08). In terms of the factors that affect children's daily iron intake, we found father's occupation was associated with iron intake. Children whose father worked as a businessman/trader had lower dietary iron intakes compared with those whose father worked as a farmer (p=0.03). No factors were found associated with other daily nutrient intake and meal patterns.

## **4. Discussion**

To the best of our knowledge, this study was the first one to specifically reveal dietary patterns and nutrient intake among school-aged children in Naama community and one of few studies using photo-assisted 24-hour recall among school-aged children in LMICs. Analyses were conducted to find out what factors affected children's health, growth, food quantity and diversity, which would help to fill the gap of the existing literature and establish knowledge for future interventions targeting this population.

### ***4.1 Malnutrition and anemia in the community***

#### **4.1.1 Malnutrition**

In the population investigated, malnutrition in the form of being underweight and thinness was less common and problematic compared with the data from the same region in the same age group (Turyashemererwa et al., 2013). The percentage of children stunted was relatively higher (15%), but still lower than the regional average (22.5%) (Turyashemererwa et al., 2013). We did not find differences across age and gender which were reported in other studies (H Acham et al., 2012; Wolde, Berhan, & Chala, 2015) (Lwanga et al., 2012). In our primary analysis, we failed to identify any risk/protective dietary factors to stunting, including those reported in some studies, such as energy intake, protein intake and carbohydrate intake (Esfarjani, Roustae, Mohammadi-Nasrabadi, & Esmailzadeh, 2013; Mittal & Srivastava, 2006). However, we found that children who consumed inadequate fat (compared with WHO

recommendation) from their diet were less likely to be stunted than those who consumed adequate (OR=0.3, P=0.046). Only one study in Iran found that lower fat intake was associated with children's undernutrition status. (Ahmadi, Moazen, Mosallaei, Mohammadbeigi, & Amin-Iari, 2014), but this cannot explain our finding. We explain this disparity could be due to the fact that WHO recommendation on fat intake is based on the percentage of fat contributes to total energy intake. Given the result on the general dietary pattern in school children in Naama, it is possible that carbohydrates in staple food (cereal, roots and etc.) was the major source of energy and contribute to a higher percentage of total energy intake, which led to a lower percentage of energy comes from fat while the total energy was adequate for child growth. Future studies are needed to investigate the association between fat intake and stunting.

On the other hand, some other factors related to children's being stunting were not measured in our study, such as family income, nutritional education/knowledge of parents (Mittal & Srivastava, 2006; Motadi, Mbhenyane, Mbhatsani, Mabapa, & Mamabolo, 2015). Future studies in the area should also include these factors to establish a more comprehensive model for investigating what factors affect child under-optimal growth and address the issue by targeting specific risk factors.

#### **4.1.2 Anemia**

The prevalence of anemia in the area was 3.7%, significantly lower than the regional average in the same age groups, estimated in 2013 (37.7%) and in Eastern

Uganda (24.1%) (H Acham et al., 2012; Turyashemererwa et al., 2013). According to the WHO cutoff for public health significance of anemia prevalence, the local situation of anemia was not considered a public health problem among school children. Gender difference was not significant in terms of the prevalence compared with other studies targeting school children (Abalkhail & Shawky, 2002; Gupta et al., 2012; WHO, 2001).

Previous research in Central Uganda showed that school children who never consumed fish had a 9-fold increase in the odds of being anemic (Turyashemererwa et al., 2013), which is consistent with results from other low-income countries (Djokic et al., 2010). However, we found fish consumption was not a predictor of anemia in our participants. On the other hand, higher frequency of chicken consumption was a risk factor for anemia, which went against the results from previous study (Wolmarans, Dhansay, Mansvelt, Laubscher, & Benade, 2003). We explain that this disparity was mainly due to the small sample size and low prevalence of anemia in the research area.

We did not find significant associations between the dietary factors of our primary interest and children's Hb level. However, secondary analysis indicated the frequency of orange intake was highly related. Thus we assumed frequent orange intake could be a potential protective factor for anemia. Few studies have investigated this association; one in the U.S. found the intake of 125 ml of orange juice in pre-school children was negatively associated with iron deficiency anemia (Schneider et al., 2008). It might be due to the large amount of ascorbic acid in oranges that increased the

absorption of dietary iron (Fairweather-Tait, Fox, Wharf, & Eagles, 1995), especially considering the predominant carbohydrate-based diet in the community which contained a large amount of inhibitors against iron absorption. However, in our study, we also estimated the quantity of ascorbic acid (vitamin C) intake from children's daily diet and found no association between intake and their Hb level. We considered the discrepancy was partly due to the different sources of data on children's dietary intake, that is, we used 24-hour recall to collect nutrients intake for one weekday while using FFQ to collect the frequency of food consumption in one month. It is possible that a child may have missed vitamin C-rich food on the day he/she took photographs of the food, while he/she may have eaten such food at other times of the month (before and/or after the day of the photograph). Future dietary assessment research that captures food intake in a comparable period to find an association between orange/vitamin c-rich food and anemia/Hb level would be meaningful since there are a variety of vitamin c –rich foods such as papaya, guavas, pineapple, available and commonly consumed by children in Naama community. Promoting such foods could help the absorption of children's dietary iron, particularly when they have limited iron intake due to the lack of animal-source food, and potentially protect a portion of children from becoming anemic.

#### ***4.2 Strengths and limitations of the methods***

In rural areas, a weighed food record administered by a researcher is considered to be a “gold standard” for dietary assessment since it avoids the imprecision of paper-

based methods due to the high illiteracy rate in the local population. However, this method is time consuming and expensive, and not feasible for a larger sample size (C. E. Lazarte, M. E. Encinas, C. Alegre, & Y. Granfeldt, 2012). In contrast, 24-hour dietary recall is considered cost effective and has a lower burden for participants. However, the accuracy of traditional 24-hour dietary recall is compromised by recall bias, deliberate over- or under- reporting, and difficulty in estimating portion size (Bingham, 1991). Furthermore, younger children's capacity to answer the 24-hour recall interview is also questioned considering their cognitive ability to memorize, describe and quantify their food intake, especially in children under 8 years (M. B. Livingstone & P. J. Robson, 2000). As a result, we chose a modified photo-assisted 24-hour recall as our assessment method to capture one-day dietary information among the children. To our knowledge, this method was rarely used before in school-aged children in LMIC settings, so there is no previous literature on how it worked and its validity. One study in rural Bolivia applied this method on women and compared it with the gold standard (Claudia E Lazarte et al., 2012) and concluded that although all nutrients were somewhat underestimated, digital photos could act as a memory aid for the subjects during 24-h recall and as an estimation tool. The method could be appropriate for assessing dietary intake among rural populations in low-income countries.

Through our experience, photo-assisted 24-hour recall was generally suitable for assessing nutrient intake among school children in Naama, the limitations were also

very obvious. First, a single 24-hour recall failed to estimate the population's usual intake distributions (Thompson & Subar). Specifically, our study only collected dietary data on one weekday, which overlooked the potential differences in diet between the week and weekend, thus created bias on the usual nutrients intake in the population. Furthermore, seasonal changes in dietary pattern also needed to be investigated, which we failed to do, considering the food availability and price changes in different agricultural seasons (Nakakeeto, Rudi, & Taylor, 2011). Second, hidden/forgotten food was another issue that emerged during our study. Food at the bottom of the container that was covered by other food or food which children had forgotten to take photos posed potential loss or over- or under- estimation of the quantity of food intakes. Finally, the logistic issues, such as the lack of power in the field also generated obstructions for conducting the method. In response to these limitations, we suggested that for future study using photo-assisted 24-hour recall, 1) multiple-administrations and longitudinal 24-hour recalls studies are needed to capture the population's usual diet and account for seasonal changes, 2) studies on validation of this method are urgently needed by comparing it with the gold standard in a specific population and region, 3) training processes should be improved to insure the quality of photos participants take, 4) local resources and logistics need to be taken into account when designing the method.

Another limitation of the study was the inability to report precise nutritional status in school children. In the field, it was impossible to collect data on exact months or dates of birth of children since their parents or even the children themselves did not know. Instead, we only collected approximate age as an independent variable to determine nutritional status. Thus it may result in an underestimate of the situation of stunting, underweight and thinness in the field.

Furthermore, we did not apply the WHO recommendation on iron due to the lack of data on the bioavailability of iron in children's meals. The bioavailability of iron can vary dramatically in meals with similar contents of iron, energy, protein, and fat (Joint & Organization, 2005). For example, the intake of an additional cup of tea may reduce the bioavailability of the meal by one half or more. Detailed composition of common meals in the region should be identified using statistical methods and then the general bioavailability of iron in the diet should be calculated then compared with the WHO recommendations.

### ***4.3 Implications for policy and future research***

#### **4.3.1 Recommendations for Naama community**

##### **4.3.1.1 Using school structure to prevent communicable diseases in the community**

Based on the results we found, it suggested that school children in Naama community are suffering from a relatively high burden of malaria and helminth infections. We suggested that by taking advantage of the existing school infrastructures

and staff, intensified school-based interventions for malaria and helminth infections control should be delivered to this population in the community.

For malaria control in school children, though there is not yet consensus on the optimal method, but possible options have been identified and implemented in various settings and population groups (Brooker, Clarke, Snow, & Bundy, 2008). The first is the long-lasting insecticidal nets (LLIN), which is recommended by WHO for full coverage of all people at risk of malaria (WHO, 2007). This includes providing/marketing LLINs to school children and their parents and supporting the strategy with skill-based education, which empowers children with knowledge, attitudes and skills that are necessary to reduce their risks from malaria (Brooker et al., 2008). The second promising option is presumptive treatment of schoolchildren by teachers in schools. A large scale study in Malawi evaluated the effectiveness of teachers dispensing sulfadoxine-pyrimethamine tablets, according to national guidelines in school, and suggested a significant reduction in malaria-specific mortality in schoolchildren (Pasha, Del Rosso, Mukaka, & Marsh, 2003).

Admittedly, large-scale helminth chemotherapy programs rely heavily on financing from external donors. Even with an estimated 10-fold reduction (<US\$ 0.25 per child treated with albendazole) in delivery cost from integrating these programs into school systems compared with dispense by mobile teams, it might still be a huge burden for local government and community (Guyatt, 2003), especially in a resource-limited

area like Naama, which has many other health priorities at the same time. However, by combining the treatment with health and hygiene education into current school curricular and providing adequate sanitation in school settings, it could not only sustain the benefits of the treatment but also protect the uninfected at a relatively low cost (Asaolu & Ofoezie, 2003). Though adding potential extra costs, it is a sustainable way to improve children's attitudes on health and general living conditions that would benefit the whole community longer term and potentially reduce the dependency on treatment.

#### **4.3.1.2 Addressing deficiency of energy and nutrients in school children's diet and raising awareness of good nutrition**

Our results reveal a view of significant deficiency in energy and nutrients in school children's diets during our investigation period, especially in fat, vitamin A and calcium, which are nutrients related to both children's immediate health outcome and long-term development. Thus, it is of vital importance to improve energy and these nutrients in children's diet and raise awareness of the importance of nutrition in the community, especially among school staff and children's primary caregivers who play important roles in children's daily diets and creating a health-promoting family in the community.

From the school perspective, the existing diet schools provide to children when they attend school is merely posho and beans, and porridge, which is high in carbohydrates but low in protein and micronutrients, which are vital to a child's cognitive and physical growth. Admittedly, school feeding programs have been

proposed in a number of settings similar to Naama, and achieved remarkable success in improving the health and development in school children, though at a high cost (Galloway et al., 2009). Thus I propose a school garden project in the community aiming to diversify children's diet in school, limit the costs, improve children's activity and potentially benefit both families and community, and even generate extra income for schools at the same time. This type of projects has been highly recommended by UNICEF and FAO, and achieved great successes in rural LMICs settings (FAO, 2005). However, further studies are needed to investigate the validity of the school garden intervention in the community through RCTs and prices children's parents or guardians are willing to pay for the food provided by school and their attitudes and preferences.

#### 4.3.2 Implication for future study

School, as an essential part of a community, can serve as an important medium in raising health awareness and disease prevention in both children and the community at large. However, studies on both the disease burdens suffered by school-aged children and the evaluations on school-based interventions addressing these problems are rare. Specifically, in designing our study, we found few previous studies have been done to investigate the prevalence of anemia, malaria, helminth infections as well as dietary patterns and nutrients intake in school children. Thus, researchers should be aware of the vulnerability of this population, and future studies are needed to investigate dietary nutrients and their association with disease burdens targeting school-aged children.

## 5. Conclusion

Malaria and helminth infections in this cohort of school children is high, but anemia is low. Stunting is the most prevalent type of malnutrition. The dietary nutrient deficiency is severe in most nutrients we studied especially vitamin A, iron, and calcium, which are of vital importance for child growth and health. The dietary pattern in school children is mainly staple food-based with a high frequency but low quantity of animal source food. Children generally eat four meals per day. Primary dietary factors do not explain anemia and stunting in the population. The consumption of orange in the diet is a potential protective factor for higher Hb concentration, but more research is needed to confirm the association.

## Appendix A

### Instruction for children to take photos of their food

How to take photos of your food

Hi. How are you?

Thank you for participating our study! My name is Yi and Victoria and we are a part of the Naama Community Health Collaboration. In this study, we would like to know what food you eat every day, how much you eat and how it is prepared. We are going to give you a camera and ask you to take photos of all the meals, drinks and snacks you have for the whole day. At the next day, we will collect the camera and ask you some questions about your food with help of the photos you take. If you like, you can also take other photos, and we will print out your favorite one and give it to you. But please make sure that people are willing to be taken in your photos before you do that.

As you know, the batteries of the camera are very limited, so you may only be able to take about 50 photos in total including the photos of your food.

#### Camera Kit:

1. A camera
2. A check mat
3. A 15 cm string

**Process:**

**For food or drink in a plate/bowl/cup (cassava, posho, matooke, rice, water and etc.)**

1. Place the check mat on a flat table/floor
2. Place your plate/bowl/cup of food or drink in the middle of the mat
3. Take photos using the digital camera
  - Use the rope in the bag to estimate the distance (50 cm)
  - Take one photo vertically, and one photo horizontally from 50 cm distance
  - Take 2 photos before eating
  - Take 2 photos after eating only if you have leftover

**For food not in a plate/bowl (plain fruits and etc.)**

1. Place the check mat on a flat table/floor
2. Place your food in the middle of the mat
3. Take 2 photos like process 3 above.

**For prepackaged food/drink (bottle water, soda, snacks)**

1. Take 1 photo of the food/drink before eating and remember their brands
2. Take 1 photo after eating only if you have leftover.

If you have any question about our study or taking photos, please be free to call us at any time. Yi:XXXXXXXX, Victoria:XXXXXXXX. You can also ask your parents or older sisters/brothers to help do that for you. If you meet some problems that cannot or forget to take photos, no worries, just come back and you can do it again if you like.

## Appendix B

### Children Dietary Assessment (24-hour dietary recall)

Date: \_\_\_\_\_  
Investigator: \_\_\_\_\_  
Length of Assessment \_\_\_\_\_  
School: \_\_\_\_\_  
Consent Given: \_\_\_\_\_  
Blood Taken: Y \_\_\_ N \_\_\_  
Stool Sample taken: Y \_\_\_ N \_\_\_  
Bio\_ID# (from health worker) \_\_\_\_\_  
Survey ID# (give to health worker) : \_\_\_\_\_

#### I. Student demographics (to be asked of parents as well, in case child doesn't know answer)

Gender: Male \_\_\_ Female \_\_\_  
Age: \_\_\_\_\_ (Date of Birth \_\_\_/\_\_\_/\_\_\_ or Month \_\_\_ Year \_\_\_)  
Place of Residence: Village \_\_\_\_\_  
Grade: \_\_\_\_\_  
Religion: \_\_\_\_\_  
Height: \_\_\_\_\_  
Weight: \_\_\_\_\_

#### II. Family demographics (to be asked of parents as well, in case child doesn't know answer)

##### Mother:

What is your mother's highest level of education? (If not sure: None, some primary, completed primary, some secondary, completed secondary, more than secondary?)  
What is your mother's job?

##### Father:

What is your father's highest level of education?  
(If not sure: None, some primary, completed primary, some secondary, completed secondary, more than secondary?)  
What is your father's job?

Does your family own \_\_\_\_\_? (gauging socioeconomic status)

Television  Radio  Mobile telephone  Running water  Electricity  Car  Boda-boda  Bicycle  Cement floor  Acres of land: \_\_\_\_\_

4. What kind of house does your family own?  
 a. brick b. thatch c. reeds d. other

**III. 24-hour Dietary Recall:**

Time	Place	Meal	Food/Beverage Item	Details/Ingredients/Preparation	Amount	Note

**Please list all vitamin, mineral, and herbal supplements you took yesterday.**

Type/Brand of Supplement	Reason for taking	Dosage	Frequency of Dose (times/day)

**Please indicate your activity level each day**

- Less than 30 minutes  
 30-60 minutes  
 More than 60 minutes

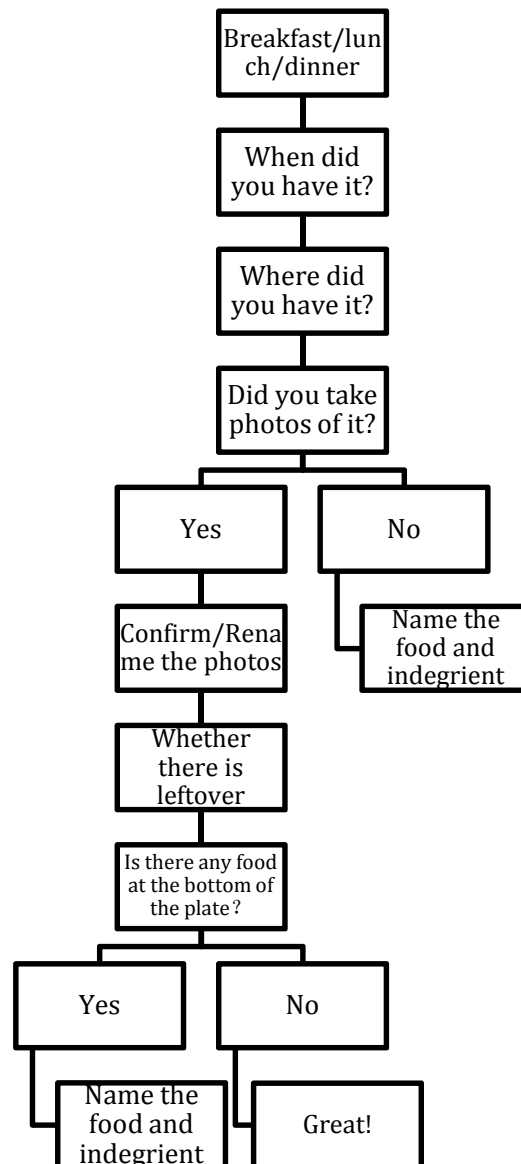
# Appendix C

## Multiple-Pass 24 HR Recall For Naama Primary students

*Modified in reference of USDA Multiple-Pass 24 HR Recall*

### Step One: The Quick List

*\*Repeat the whole Step One by each meal*



### **Step Two: The Forgotten Food**

1. Did you eat anything before breakfast?
2. Between breakfast and lunch?
3. Between lunch and dinner such as afternoon tea?
4. After dinner, before going to bed?
5. Any snacks?
6. Any fruits?
7. Any drinks such as soda, juice, milk and etc.?

*\*Question will be modified by The Forgotten Food List which will be created after identifying common forgotten food by children, so it is important to ask comprehensively at the beginning of the study.*

### **Step Three: Detailed Cycle**

#### **For food showing on photos taken by the respondent**

The interviewer confirms the ingredients and estimates the portion size after surveying by comparing with the standardized photos.

#### **For food not showing on photos taken by the respondent but on the standardized photos (also may include hidden food and missing food)**

The interviewer asks the respondent to choose the standardized photos with the closest portion size as they consumed.

#### **For food neither showing on photos taken by the respondent nor on the standardized photos (also may include the hidden food and missing food)**

Using measurement tool (cups, spoon, handful and etc.) to help the respondent recall the portion size

### **Step Four: Final Probe**

Final probe for anything else consumed such as supplement.

## Appendix D

### Children Dietary Assessment (Food Frequency Questionnaire)

Date: \_\_\_\_\_

School: \_\_\_\_\_

Bio\_ID# (from health worker) \_\_\_\_\_

Survey ID# (give to health worker) : \_\_\_\_\_

#### 1. Which meals do you usually have?

- A. Breakfast B. Break C. Lunch D. Afternoon tea E. Dinner F. Other, please specify \_\_\_\_\_

#### 2. How often did you eat these foods during last 4 weeks?

##### Please match the frequency below to each food.

- A. Never or less than once per month  
B. 1 per month  
C. 2-3 per month  
D. 1 per week  
E. 2 per week  
F. 3-4 per week  
G. 5-6 per week  
H. 1 per day  
I. 2+ per day

##### Cereal/cereal product

1. Posho
2. Porridge
3. Maize
4. Rice
5. Bread
6. Millet

##### Roots/tubers/plantain

7. Matooke
8. Cassava
9. Sweet potato
10. Irish potato
11. Pumpkin
12. Plantain

##### Pulses/nuts

13. Groundnuts
14. Beans
15. Peas
16. Soya/soya products

17. Simsim seeds

**Meat/Poultry/Fish/Eggs**

18. Beef

19. Chicken

20. Eggs

21. Fish. If know, please specify the type of fish \_\_\_\_\_

22. Other meat. If yes, please specify \_\_\_\_\_

**Milk/ dairy product**

23. Milk

24. Other dairy product such as powder milk, yogurt. If yes, please specify \_\_\_\_\_

**Vegetables**

25. Dark green leafy vegetable/Green

26. Other vegetables such as cabbage, carrot, eggplant, carrot, onion, green pepper, tomato and etc.

**Fruits**

27. Mangos

28. Paw paws

29. Oranges

30. Avocado

31. Pineapple

32. Banana

33. Jackfruit

34. Watermelon

35. Sugar corn

36. Passion fruit

37. Guavas

**Oil/Oil rich food**

38. Oil (used in cooking)

39. Ghee

40. Margarine

41. Chapatti

42. Rolex

43. Popcorn

44. Doughnut

45. Pancakes

**Drinks**

46. Tea

47. Soda

48. Coffee

49. Fruit juice

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