Dietary Intakes and Nutritional Status of Rural Ghanaian Children: Are Season and Attending Daycare Important Determinants?

Kimberly B. Harding

School of Dietetics and Human Nutrition

Centre for Indigenous Peoples' Nutrition and Environment (CINE)

McGill University, Montreal

Submitted August, 2008

A thesis submitted to McGill University in partial fulfilment of the requirements of the

degree of Master of Science

© Kimberly B. Harding 2008

Abstract

High rates of malnutrition among Ghanaian children indicate the need to examine determinants of diet and nutritional status in this population. This study examined differences in the diets of children 2-5 y of age associated with: 1) pre- to post-harvest season changes in rural northern Ghana (n=190) and 2) attendance at daycare centres (DCC) with informal school feeding programs in rural mid-country Ghana (n=193). Interviewer-administered questionnaires were used to collect dietary (24-hour recall), morbidity and demographic information. Although diets improved with the post-harvest season, illness increased and acute nutritional status deteriorated which were likely due to unexpected severe flooding prior to post-harvest data collection. Children who attended DCC had higher daily intakes of energy, protein, calcium, iron and zinc than their non-DCC counterparts. These findings provide important insights into determinants of diet and nutritional status among Ghanaian children as well as a potential mechanism for improving diets in this population.

Résumé

Des taux élevés de malnutrition parmi enfants ghanéens indiquent le besoin d'examiner les déterminants d'alimentation et de nutrition dans cette population. Cette étude a examiné les différences d'alimentation des enfants âgés 2 à 5 ans associées avec : 1) les changements avant et âpres-saison moisson dans le canton nord du Ghana (n=190) et 2) la présence aux garderies (DCC) qui se comprennent des programs non-officiels d'alimentation au milieu du pays (n=193). Des questionnaires administrés par des interviewers étaient utilisés pour collecter information diététique (rappel 24-heur), de morbidité et démographique. Bien que l'alimentation s'est améliorée lors de l'âpres-saison moisson, les maladies se sont augmentées et le statu aigu nutritionnel s'est détérioré, lesquels il est probable étaient en raison des inondations sévères inattendues avant que l'information d'âpres-moisson aie été collecté. La consommation d'énergie, protéine, calcium, fer et zinc parmi les enfants qui se présentaient aux garderies était plus élevée que celle des ses homologues. Ces découvertes apportent des aperçus importants à propos des déterminants du statu nutritionnel et d'alimentation des enfants ghanéens, et aussi des mécanismes potentiels pour améliorer l'alimentation de cette population.

Acknowledgements

I would like to acknowledge those people who made it possible for me to complete this thesis. Thank you to my supervisor, Dr. Grace Marquis, for allowing me the unique opportunity to travel to Ghana and conduct a research study, and for her support, guidance and encouragement throughout the process. Thank you to my advisory committee members Dr. Katherine Gray-Donald and Dr. Francis Aboud, for always providing important insights and suggestions. I also thank my friends and colleagues at CINE and in the School of Dietetics and Human Nutrition.

Thank you to the communities of Gia, Wuru, Bonia, Biu, Fiaso and Nkwaeso in Ghana, for welcoming me. I would especially like to thank the caregivers who agreed to participate for their acceptance and patience. And of course their children, who usually showed remarkable acceptance and patience when being measured. The data collectors also deserve gratitude for all their hard work, often under trying conditions.

I am thankful to the Enhancing Child Nutrition Through Animal Source Food Management (ENAM) project team, including Dr. Esi Colecraft, Dr. Anna Lartey, Dr. Owuraku Sakyi-Dawson and the field supervisors and students. Thank you to the Nutrition and Food Science Department and the Department of Agricultural Extension at the University of Ghana, Legon. Also to the Research to Improve Infant Growth in Ghana (RIING) project. And thank you to Dr. Esi Colecraft, the Lartey family, the Kobati family and Dinah Amoah for sharing your homes with me.

I am also grateful to Global Livestock Collaborative Research and Support Program (GL-CRSP) and the United States Agency for International Development (USAID) for project financial support and to the Canadian Institutes of Health Research (CIHR) and Dr. Grace Marquis for personal financial support.

Lastly and most importantly to my dearly loved family and friends, thank you for putting up with me and for always being optimistic.

Contribution of authors

       The manuscripts included in this thesis were accomplished through collaborative efforts from the co-authors. Both manuscripts were authored by K. Harding, G. S. Marquis, E. K. Colecraft, A. Lartey and O. Sakyi-Dawson. K. Harding developed the research questions, wrote the project proposal, obtained independent funding for the fieldwork and traveled to Ghana (May through December, 2007) where she independently managed and supervised her data collection in six communities in two regions of Ghana. This involved developing the field instruments, training local staff to collect data, conducting quality control to ensure the completeness and accuracy of data as well as collecting some of the data herself, with the help of local interpreters. She also entered and analysed the data and wrote the manuscripts. All of this was accomplished with guidance and support from the co-authors. G. S. Marquis, E. K. Colecraft, A. Lartey and O. Sakyi-Dawson edited the manuscripts. All of the data were collected solely as part of her thesis.

Table of contents

List of tables

List of figures

List of abbreviations

AMDR	Acceptable Macronutrient Distribution Range
ASF	Animal source food
BMI	Body mass index
CINE	Centre for Indigenous Peoples' Nutrition and Environment
DCC	Daycare centre
dL	Decilitre
ENAM	Enhancing Child Nutrition through Animal Source Food Management in Africa
FAO	Food and Agriculture Organization
g	Grams
GHS	Ghana Health Service
HAZ	Height-for-age Z-score
Hb	Haemoglobin
IGA	Income generation activities
kcal	Kilocalories
kg	Kilograms
mo	Months
mg	Milligrams
RE	Retinol equivalents
SD	Standard deviation
SFP	School feeding program
WAZ	Weight-for-age Z-score
WHO	World Health Organization
WHZ	Weight-for-height Z-score
WPPSI-III	Wechsler Preschool and Primary Scale of Intelligence - Third Edition
y	Years
µg	Micrograms

1.   Introduction

1.1   Brief overview

Malnutrition is widespread among young children in Ghana and is rooted in a variety of different causes, including illness and inadequate diet (Figure 1.1) [1]. Research on the environmental and social determinants of children's diets will provide important information that may help enhance nutrition and health in this population. This study examined the effects of seasonal food shortages on children's diets and nutritional status in northern Ghana. Very little information exists about the effects of seasonality on Ghanaian children, although there is evidence to suggest that food shortages do occur and that they may have negative effects on children's diets and health. Findings about seasonal effects can be used to plan and implement timely and locally appropriate interventions to enhance child health as well as to inform policy in the areas of agriculture and healthcare. This study also examined informal daycare centre (DCC) feeding programs, where children bring ingredients from home which are cooked at school and shared amongst everyone, and the role they play in participating children's diets. There is a lack of information on programs such as these but they have the potential to enhance children's diets year-round as well as during times of transient food insecurity, such as seasonal food shortages. Information on the structure and effectiveness of existing DCC feeding programs has potential policy implications in the areas of education and also agriculture. Findings from this study may provide important insights into determinants of diet and nutritional status among Ghanaian children and may guide future efforts to promote health and wellbeing in this population in an effective and sustainable manner.

1.2   Rationale

There is considerable evidence indicating seasonal food shortages occur in Ghana. However, not a lot of information exists on the seasonal effects on children's diets. Given the potential negative effects of seasonal food scarcity on young children's nutrition and health, it is

important to assess if and when food stress occurs. Information can then be used to develop appropriate and timely interventions to improve the diets of young Ghanaian children. In addition, little information exists on informal SFP, such as those seen in some rural Ghanaian DCC, where children bring ingredients from home to contribute to a communal meal. These feeding programs may improve children's diets year-round as well as during times of decreased food availability. It is therefore of interest to know what role these feeding programs play in children's diets. Investigations into the impact of existing informal programs will provide important information that may lead to introduction of similar programs in other DCC. Pre-school child nutrition plays an important role in future health and education outcomes. A study in Ghana showed that at the age of six years when children would normally start primary school, children with poorer nutritional status (as indicated by low height-for-age) delayed enrolment into primary school for longer and completed fewer years of school than their better nourished peers [2]. Economic factors were found to have inconsistent, insignificant or indirect impacts on age of enrolment so it was concluded that malnutrition was the primary cause of delayed enrolment. Findings from this study will provide important insight into potential mechanisms to enhance child nutrition in Ghana, which has important implications for the children's and country's future.

1.3 Purpose

The overall purpose of this thesis is to examine the variation in Ghanaian children's diets and nutritional status that is associated with season and participation in DCC feeding programs.

1.4 Specific objectives and hypotheses

Primary objectives:

1. To determine whether there is change within the diets of children, from the pre- to post-harvest season, in rural northern Ghana.

    i)   It is hypothesized that there will be an increase in energy, iron and zinc intake and dietary diversity from the pre- to post-harvest season.

2. To determine whether there is change within indicators of child nutritional status, from the pre- to post-harvest season, in rural northern Ghana.

     i)   It is hypothesized that there will be an increase in weight-for-height and weight-for-age Z-scores from the pre- to post-harvest season.

Primary objectives 1 and 2 are addressed in Manuscript 1

3. To determine whether there is a difference in the diets of children who do and do not attend DCC with informal feeding programs in rural mid-country Ghana.

     i)   It is hypothesized that children who attend DCC will have higher energy intake and dietary diversity than non-DCC children.

Primary objective 3 is addressed in Manuscript 2

Secondary objectives:

1) To examine whether dietary diversity is associated with iron status (haemoglobin) in rural Ghanaian children.

     i)   It is hypothesized that there will be a positive association between dietary diversity and iron status.

2) To examine whether iron status is associated with language development (verbal comprehension) in rural Ghanaian children.

     i)   It is hypothesized that there will be a positive association between iron status and language development.

Figure 1.1 Conceptual framework of the factors affecting child diet, nutritional status and cognitive development

Legend

→ Known/accepted relationships　　- - →Unknown/conditional relationships　　☐ Measured factors　　⬚ Unmeasured factors

▭ Main outcomes of interest　　(Indicators: Total diet: energy and selected micronutrient intake and dietary diversity
Nutritional status: weight-for-age, height-for-age and weight-for-height Z-scores
Cognitive development: verbal comprehension)
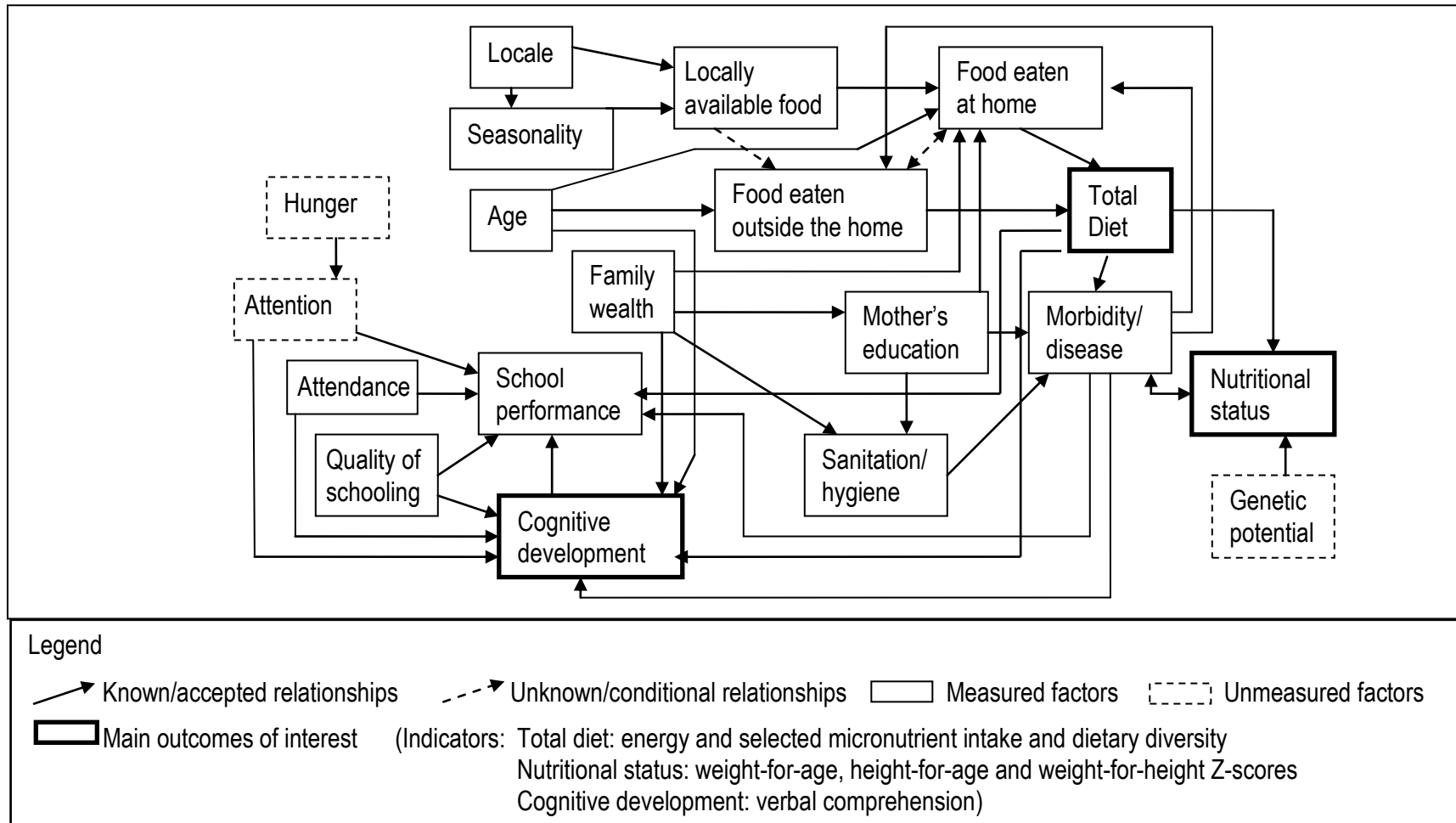
## 2.	Literature review

### 2.1	Seasonal food shortages

Many rural communities in low-income tropical countries experience seasonal variation in the availability of food, resulting in periodic food scarcity [3]. Most tropical climates have little variation in temperature throughout the year so seasons are differentiated by rainfall and are divided into distinct wet and dry seasons. The rainy season is the growing season, and crop harvesting begins a few months into the rains and lasts into the first few months of the dry season. It is during the months leading to the harvesting of food, or the pre-harvest season, that seasonal food stress occurs [4]. Food becomes less available, more expensive and less varied [5]. Food acquired during the harvest season must last until the next harvest. However, even if enough food is produced, inadequate storage facilities may prevent it from lasting [6].

It has been estimated that over one billion people live in such environments that are prone to seasonal food shortages [7]. Young children are thought to be particularly vulnerable during these times as they need a constant supply of adequate food for growth and development and because limited resources may be preferentially allocated away from them to more economically productive members of the household [3, 5]. However, some evidence exists to suggest that children are actually protected from food stress during these times [8] and in some communities the greatest dietary stress in children occurs during the plenty, harvest season, when mothers are busy with agricultural activities [9]. These findings demonstrate the complexity of the problem and the need to examine children's diets at different times of the year in order to determine if and when they experience food stress.

West Africa is vulnerable to seasonal variation in food availability because it lies in a tropical region [4]. Seasonal food shortages in this area have been tied to deleterious effects on several health status indicators related to children including birth weight and early infant growth [10], child linear growth and rates of wasting, underweight and stunting [11] and weight change during pregnancy and lactation [10].

2.1.1   Nutrition and growth faltering

The nutritional cause(s) of growth faltering in children, including seasonal growth faltering, are not entirely known. In young children (13 months to eight years of age), it is estimated that 20 kcal per day are needed for energy deposition, in addition to that required for energy expenditure [12]. Although it is difficult to interpret the association between energy intake and linear growth because generally when energy intake is low, the intake of other nutrients is low as well [13]. Some studies have compared the growth of infants, manipulating energy content of diets while maintaining similar content of other nutrients [14-16]. It was found that weight, but not linear growth was affected. Studies involving supplementation of energy alone to stunted children have shown mixed results regarding improved linear growth. Some studies showed no increase in linear growth rate in stunted (but not wasted) children with additional energy added to the diet (although weight and fat were gained) [17, 18]. On the other hand, undernourished Indian children (neither height, weight, stunting not wasting status were disclosed) whose diets were supplemented with high-energy (low-protein) showed increases in height (and weight) gain across 14 months [19].

It is also difficult to assess the relationship between protein intake and linear growth. Dietary protein sources contain several essential micronutrients, such as iron, zinc, calcium, copper and vitamin A, and so when protein intake is low, micronutrient intakes are likely to be low too, in addition to energy intake [13]. Linear growth faltering has been widely reported, even with adequate protein and essential amino acid intakes [20, 21]. Also, in Guatemala there was no additional growth benefit for children provided with high quality protein supplements, over an energy-only supplement [21]. Therefore, it appears that linear growth faltering can occur even with adequate energy and protein intake.

Studies on zinc supplementation to improve linear growth have shown mixed results, though some demonstrated positive effects in short American and Canadian children and in marasmic Chilean infants [22-24]. Studies on the effect of iron supplementation on linear growth have also shown mixed results. Iron supplementation increased the height of anaemic children, but not non-anaemic children in Indonesia [25]. Whereas in Kenya there was increased weight but not height after iron supplementation in anaemic and non-anaemic children [26].

The effect of vitamin A on growth faltering is also unclear. In Indonesian preschool children, growth was slower in vitamin A deficient children who showed clinical symptoms compared to children with normal vitamin A status [27]. Results of vitamin A supplementation trials on linear growth are also inconsistent [13]. An Indian study found no effect on linear growth [28]. Whereas a study in Indonesia showed a significant impact on linear growth (through food fortification, as opposed to supplementation) [29].

Although differences in population and methodology may explain differences in findings from the above studies, the amount of supplement provided by these interventions should have affected linear growth if the studied nutrient was growth-limiting [13]. Interventions involving single nutrients have not been able to show exactly what is lacking in the diet that results in growth faltering. It is more likely that multiple nutrient deficiencies co-occur, instead of one growth-limiting nutrient.

2.1.2   Seasonal morbidity

In discussing seasonality, diet and growth, it is also important to consider the 'seasonal ecology of disease', which generally occurs during the wet season and can compound dietary stress during the rains until harvest begins [30]. In the tropics, such as West Africa, where rainfall differentiates seasons, morbidity and illness-related mortality often peak during the wet season [7]. Common infections including malaria and diarrhoeal diseases show seasonal patterns, generally peaking during the rains, because of climatic effects on breeding grounds for vectors and survival and proliferation of microbes [30].

2.1.3   Seasonality in Ghana

Fluctuation in the availability of staple foods is cause for concern for many rural Ghanaian children. The majority of Ghanaians (63%) live in rural areas which depend on subsistence agriculture [31]. The extent to which children are affected by seasonal changes in food availability,

quality and intakes may depend on several factors including local food preservation and storing practices, as well as where in the country they live [6, 32, 33].

Ghana can be divided into two regions based on rainfall. The northern region experiences one rainy season, lasting approximately from June or July to August or September, giving rise to one growing season [34, 35]. Crop harvesting in this region generally occurs from July through September [36]. The rest of the country has two wet seasons, one from April to June and another from September to November, resulting in major and minor growing seasons [34, 35]. Harvesting generally occurs from July to September then again in November and December [36]. Because the north experiences a unimodal wet season, and therefore only one harvest, the area is more severely affected by seasonal food shortages than the rest of the country, which experiences bimodal rainfall and two harvesting periods [32]. Pre-harvest season adult weight loss and reduced body mass index (BMI) have been documented in northern Ghana [37, 38]. In addition, a recent survey showed that throughout most of the year, around a third of households in several northern communities reported severe food shortages. This proportion rose in March through July, peaking at almost two-thirds of households from April through June, the pre-harvest season [39]. The length of the period with increased reports of 'severe' food shortage spanned half the year. In addition, a reduced number of foods consumed per day by children has been documented in the pre-harvest season [40]. Figure 2.1 illustrates the rainfall, harvest and food shortage report patterns in northern Ghana.

Monthly changes in staple food prices also suggest reduced food availability at certain times of the year. The price of maize, a major staple crop in Ghana, shows seasonal fluctuation, rising in the pre-harvest months when food is less available and falling once harvest begins [6]. Nationally aggregated price data on several major staples, including maize, sorghum, millet, rice, cassava and yam also show strong seasonal patterns corresponding with harvesting times [41]. Figures 2.2 and 2.3 show regression coefficients for the monthly prices of these crops. National data however, are likely to hide regional differences with a country [42, 43]. Therefore it is important, particularly in a country with regional differences in rainfall patterns such as Ghana, to examine seasonal variations in diets where they are likely to be most severe. It is also important to

examine indicators of nutritional status to determine if the variation in dietary intakes is severe enough to translate into seasonal changes in nutritional status.

2.2 Nutritional status and diet of Ghanaian children

Anthropometric indicators of nutritional status show that malnutrition is prevalent among young Ghanaian children. Twenty-two percent of children under five years of age are underweight (weight-for-age < -2 standard deviations (SD)), 33% are stunted (height-for-age < -2 SD) and 7% are wasted (weight-for-height < -2 SD) [44, 45]. The proportion of stunting is on the rise [45], indicating an urgent need for examination of children's diets, and ways in which the diets can be enhanced. The trend in the prevalence of stunting may be indicative of chronic dietary inadequacies, which is consistent with documented high levels of childhood anaemia and poor zinc status. Over three-quarters of Ghanaian children under five years of age have some degree of anaemia [45]. Low iron intake is one of the most common causes of anaemia, along with malaria and intestinal worm infestation. In one sample of young Ghanaian children, over half of anaemia cases were unrelated to recent infection or inflammation, as indicated by normal C-reactive protein levels [46]. This information indicates that low iron intake is a major concern regarding anaemia. Low intakes of zinc in pre-school children are also a concern [47]. Children living in rural areas appear to be more malnourished than urban children as indicated by higher prevalence of anaemia (80% rural vs. 68% urban) stunting (34.5% rural vs. 20.5% urban) and underweight (25.4% rural vs. 15.4% urban) [45]. The trends in anthropometric and biochemical indicators of child malnutrition, particularly in rural areas, demonstrate the need for examination of periods of dietary risk as well as mechanisms for improving diets in this population.

As the indicators of nutritional status suggest, diets of Ghanaian children are often inadequate. Cereal and root staples such as maize and cassava are the major sources of energy and of several micronutrients including iron and zinc [40]. These core foods are bulky and tend to have low micronutrient density, or if the density is reasonable they contain other factors which can inhibit nutrient absorption [48, 49]. For example, roots and tubers have low zinc content and although cereals may have reasonable levels, they are also high in phytates and fibre which lower zinc bioavailability. The micronutrient density of young Ghanaian children's diets has been shown

to be low for several nutrients including iron and zinc [50]. As a result, it is difficult for children to consume the recommended levels of micronutrients essential for healthy growth and development. A further cause for concern is the low consumption of animal source foods (ASF) [40, 51], which are energy-dense, provide high quality protein, and are rich in bioavailable micronutrients essential for healthy growth and development [52]. ASF are rarely included in the diets of young Ghanaian children, and when they are, it is often in very small quantities [51]. Also, ASF may be preferentially allocated away from young children to older family members. Fish is the most available and inexpensive form of ASF but is low in iron and zinc compared to other ASF, especially beef [51], [53].

2.3 Dietary diversity

Low-diversity, monotonous diets, such as those common in rural Africa, are linked with poverty and are a barrier to adequate consumption of essential nutrients [54]. In areas subject to seasonality, dietary diversity is likely to change throughout the year, particularly between the pre- and the post-harvest season when food availability increases. The dietary diversity of young Ghanaian children living in a coastal community was lower in the pre-harvest compared to the post-harvest season [40]. Such reductions in food variety could have deleterious effects on health, as diversity is an important aspect of children's diets [55]. There is a generally accepted belief that nutritional adequacy is improved by consuming a wider variety of foods [56, 57]. Accordingly, dietary diversity is a predictor of dietary quality. Two reviews of the literature on \ diets of children living in low-income countries found that dietary diversity was positively associated with overall dietary adequacy [55, 58]. This association has been found regardless of child age, illness, or nutritional status [59]. Dietary diversity can be used as an indicator of the quality of children's diets particularly when there is a possibility of nutrient deficiency [56]. In addition, dietary diversity has been shown to be associated with children's intake of several individual micronutrients including vitamin A, vitamin C, riboflavin, niacin, iron, zinc and calcium [58]. Although it has not been investigated, it has been proposed that an additional benefit of increased food variety might be enhanced bioavailability of micronutrients, such as iron and zinc [58].

Because of the high rates of malnutrition among young Ghanaian children, and the potential threat of seasonal food shortages on dietary quality, research is needed into potential mechanisms, such as school feeding programs (SFP), for protecting children during periods of dietary risk. These programs may enhance diets and buffer fluctuations in food availability throughout the year.

2.4 School feeding programs

Existing research on SFP focuses on those sponsored by a government or institution which follow structured feeding guidelines to meet a set proportion of children's nutrient requirements [60-63]. However, not all SFP are highly formalized and structured. In rural Ghana, some DCC have feeding programs which are informal and provide a meal based on the local diet. Typically, this meal is made with ingredients that children bring from home which are cooked at school and shared amongst everyone. In addition to a small quantity of food, children may also be required to contribute fuel wood for cooking and money to buy additional ingredients or for the milling of grains. There is no information in the literature about how these types of informal SFP operate or how they affect participating children's diets or nutritional status. In a study of Kenyan pre-school children's dietary patterns, several participating pre-schools used this type of informal feeding program, but no data were reported on the composition of the meals or their contribution to the children's total diet [64]. Information on these feeding programs and their impact on children has important policy implications. Ghana is currently piloting a SFP in selected elementary schools and kindergartens. Research on currently operating programs can be used to provide recommendations to the government regarding 'best practices' for SFP or to encourage inclusion of preschools in the current efforts.

2.4.1 Benefits of school feeding programs

Research on SFP has been limited to formal programs, however it is possible that the benefits apply to informal programs as well. The goals of school feeding are to improve children's nutritional status, school enrolment and attendance, and cognitive or academic performance [65].

In addition, SFP have the potential to enhance food security, provide an opportunity to introduce other health and nutrition interventions [66] and support the local community [67].

Dietary quality and nutritional status

The nutritional benefits of SFP have been examined in terms of dietary quality and indicators of nutritional status. A Kenyan school snack program involving ASF significantly increased children's intake of essential micronutrients including vitamin B_{12}, iron and zinc [62]. In Peruvian schools, a fortified breakfast resulted in increased iron intake and a reduced incidence of anaemia [61], [68]. In Jamaica, children receiving school breakfast gained more weight and increased in height and BMI more than the controls [69]. In India, the number of days in which children ate at school was highly correlated with height-for-age and weight-for-age [63]. These findings demonstrate the potential for formal feeding programs to enhance children's nutritional status. Because informal programs incorporate food from sources other than the child's home, including other households and the school itself, they may enhance the dietary diversity and hence the quality of children's diets.

In low-income countries, better nourished children, as indicated by height-for-age, enter school earlier than their malnourished peers. This is said to be because at the minimum age of enrolment parents deem their malnourished, or physically small children not yet ready for school [70]. Age at enrolment is also highly related to duration of travel time to the closest school, which adds support to the idea that physical maturity factors into parental decisions to delay school enrolment. Delayed enrolment is not however related to school fees, and family income has an inconsistent impact on age at enrolment, which suggests that family wealth or socioeconomic status may not play a predominant, direct role in determining when children start school [2]. Earlier entry into school has been shown to predict higher grade attainment, even after controlling for preschool cognitive abilities and household socioeconomic status [71]. Therefore if preschool programs such as DCC feeding can enhance child nutrition so children reach full physical maturity, in addition to helping parents understand normal child development, prior to the minimum age at which children normally enter school, such programs may potentially reduce delayed enrolment and enhance success in school.

School enrolment and attendance

SFP can also serve as an incentive and motivation for parents to enrol and send their children to school [67]. The Jamaican and Peruvian breakfast programs were both successful in increasing attendance rates [61, 69, 72]. Increased attendance and duration of schooling gives the child more opportunity to learn, which can improve educational outcomes [67]. If caregivers see informal SFP as positive and beneficial to their children's diets, then they may be likely to send their children to DCC with informal feeding programs. However it is also possible that, particularly in food insecure homes or during seasonal food shortages, caregivers would be uncomfortable with the requirement of sending food or money away from the home. In such situations, they may be less likely to send their child to school if an informal feeding program existed.

Cognitive or academic performance

Another way in which SFP can improve education is by enhancing cognitive performance and development [67]. In the Jamaican program, which was a randomized control trial, the breakfast group showed greater improvements in arithmetic test scores than the low-energy control group [69]. In the Kenyan program, meat-based school snacks resulted in greater improvements to problem-solving ability as compared to no snack, a high energy snack or a snack containing milk [73].

Both the alleviation of hunger and micronutrient deficiencies can enhance cognition in children [67]. Long walks to school and eating inadequate breakfast in the morning may exacerbate hunger in schoolchildren living in poor rural areas [67]. Alleviation of this short-term hunger may help increase concentration and attention, which in turn enhances cognitive functioning and learning. The effects of hunger appear to depend on the nutritional status of the child [65]. The cognitive performance of Peruvian children after overnight fasting depended on whether the child was nutritionally at risk (defined for this population as height-for-age $\leq$ -1 SD, weight-for-height $\leq$ -0.5 SD) or not at risk (defined for this population as height-for-age > -1 SD, weight-for-height $\geq$ 0 SD). Omission of breakfast adversely affected memory only in at-risk children. It is unclear why children whose weight-for-height Z scores fall between -0.5 and 0 were not included in this

analysis. Similarly in Jamaica, only undernourished (weight-for-age $\leq$ -1 SD) and not adequately nourished (weight-for-age > -1 SD) schoolchildren's performance improved after provision of breakfast [74]. These findings suggest that poorly nourished children may benefit most from effective SFP.

SFP can also enhance cognition and the ability to learn by the reduction of micronutrient deficiencies [67]. Micronutrient deficiencies can have negative impacts on cognitive development in children [75]. Beliefs that interventions aimed at influencing cognitive development need to take place in the first three years of a child's life are being challenged [76]. Interventions taking place after this time, such as in the preschool and school years, particularly those which involve micronutrients important in cognition, have the potential to enhance cognitive development in children. Deficiencies in iron and more recently zinc and vitamin B_{12} have received the most attention for their role in suboptimal cognitive development in young children [49].

Iron plays an important role in cognitive development and performance because it is a required co-factor for neuron myelin production and it is an essential component of enzymes involved in the synthesis of neurotransmitters [77-79]. In addition to impeding development and function of the central nervous system, poor iron status may also impair cognitive development through functional isolation [80]. Anaemic children tend to be more withdrawn and unreactive, explore their environment less and bring about less stimulating caregiver responses than their non-anaemic counterparts, all of which may hinder the acquisition of new skills and hence cognitive development. A comprehensive review of the relationship between iron status and cognition found that anaemic children over two years of age generally had lower cognitive and school performance compared to non-anaemic children, but were able to catch up to the non-anaemic children after iron supplementation [81]. Even at mild to moderate levels of iron deficiency, cognitive development can be impaired [49].

Zinc is also important in the brain, as it is found in presynaptic vesicles and is likely involved in synaptic transmission [82]. Inadequate dietary intake of zinc may disrupt the brain's zinc homeostasis and result in brain and cognitive dysfunctions and learning impairments [83]. Like with iron, a zinc deficiency may have detrimental effects on cognitive development via decreased

14

attention and activity in children, and subsequent reduced maternal responsiveness [83, 84]. Studies on the effects of zinc supplementation on cognitive function in children have shown poor results, which may be due to an inability of the cognitive measurement scales to pick up improvements or the presence of other nutritional deficiencies [84, 85].

Vitamin B_{12} is essential in the maintenance of myelin [86]. A deficiency leads to accumulation of homocysteine which may have neurotoxic effects, for example by inhibiting methylation reactions in neurotransmitter metabolism pathways [87]. Vitamin B_{12} deficiency has been associated with diminished cognitive performance but no intervention studies have assessed its causal role [88].

It is common for several micronutrient deficiencies to co-occur however little is known about the role of multiple micronutrient deficiencies on child cognitive development [88]. Consumption of foods high in multiple micronutrients, such as ASF, has been linked with improved cognitive performance in children. In African schoolchildren, the consumption of ASF was highly correlated with measures of cognition including verbal comprehension and test performance abilities, even after controlling for family socioeconomic status [89]. Further support for the role of iron, zinc, or vitamin B_{12}, or a combination of them, comes from the previously mentioned Kenyan SFP trial in which the meat supplemented children showed much greater improvement in problem-solving tasks compared to the milk, energy or control groups [73]. SFP, particularly those which involve foods high in essential micronutrients such ASF, may help optimize cognitive development in young children.

There are several methods of assessing cognitive development in young children. One of these is the Wechsler Preschool and Primary Scale of Intelligence - Third Edition (WPPSI-III) [90]. The WPPSI-III is appropriate for children aged 2.5-7.25 years. Although the WPPSI was developed in the United States, it has been used widely in non English-speaking countries including Bangladesh, Brazil, Israel and Peru [91-94]. The entire test has 14 subscales and measures intelligence quotient. Only four of the subscales, including receptive vocabulary, are recommended for use in the lower age range although not all four subtests are always used [90, 95]. The receptive vocabulary subtest measures verbal comprehension, or the child's understanding of

words, and is used as a proxy for language development [90]. The process of language acquisition accelerates at a rapid pace during the preschool years [96]. This phenomenon, known as the 'vocabulary explosion', usually starts in the second year of life and continues through to the fourth year, although this timing can vary. These preschool years are an important period for language development [97]. By the end of this time, most children have formed basic language skills which form the base for subsequent learning of more complex and subtle linguistic skills. The size of a child's vocabulary prior to school entry is a strong predictor of subsequent ease of learning to read as well as reading ability [98]. The vocabulary subtests of the WPPSI in preschool children have been shown to predict reading test scores after entry into school approximately two years later [99, 100]. A similar picture test has been used with schoolchildren elsewhere in Africa and shown to have acceptable construct validity with reference to children's school examination scores, and reflect locally acquired and required skills [89].

Food security, local community support and opportunities for integrating additional health-related interventions

By improving educational outcomes, regardless of the mechanism by which this is accomplished, SFP can have long-term benefits to the community: increased employment, income and productivity, improved natural resource and household management and reduced family size [66]. Through these improvements, SFP have the potential to indirectly enhance the mid to long-term food security of a nation. Such programs can be used by governments as a part of a permanent 'safety net' policy, protecting vulnerable children from chronic or short-term food insecurity [66]. SFP can also support the local community and encourage its involvement in schools, particularly when food is locally produced and prepared [67]. Once in place, they can provide a platform for integrating other health and nutrition interventions, such as de-worming, micronutrient supplementation and HIV/AIDS education [66]. Informal DCC feeding programs are a potential avenue for dietary interventions that target young children, such as those aimed at enhancing ASF consumption. Money brought by children or from an outside source, with information about ASF that is the 'best buy' [101] for micronutrients, could be used to purchase ASF such as small fish to add to the lunches.

Effective feeding programs for preschoolers are one mechanism to reduce the large proportion of young children in Ghana who have growth deficits. However, substitution may occur and children may be offered less at home because of the meal they receive at school. It is important to keep this in mind when assessing the dietary impact of SFP.

2.4.2   Replacement of home diet with school diet

It cannot be assumed that all SFP will result in benefits for the participating children. The process of supplementing a child's normal diet with additional food, such as with a SFP, may or may not result in increased food intake. The intended effect may be mitigated by changes in food allocation in the child's household or changes in the child's feeding behaviours throughout the day. Substitution occurs when either practice results in a decrease in the normal home diet. Depending on the magnitude of this decreased food intake, the supplementary feeding could have a positive, negative or null effect on the child's diet. Figure 2.4 illustrates some possible outcomes of supplementary feeding.

Studies of SFP that have examined the dietary intakes at home in addition to school have shown mixed results on whether there were decreases in the child's home diet. Some findings indicate this does occur, whereas others specifically report no substitution [61, 63, 68, 69, 102, 103]. One study showed that changes in home food consumption depended on whether the food provided was meat, milk or vegetable-based [62]. There seems to be no consensus in the literature as to whether the effects of formal SFP are mitigated as a result of changes in home food allocation or feeding behaviours. However, it is thought to be common enough that recommendations for planning such programs call for the supplementary food to be adequate enough to compensate for potential losses from substitution [66]. Nothing is known about whether or not this substitution occurs in informal programs where food brought from children's homes is pooled and shared. However it is important to know in case there is any detrimental effect on children's diets.

Figure 2.1 General rain, harvest and food shortage patterns in northern Ghana

| Month | J | F | M | A | M | J | J | A | S | O | N | D |
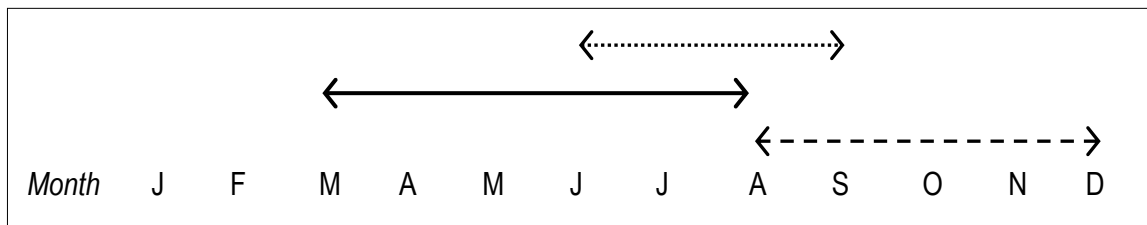
Legend
Rains ········ (reference [34])
Harvest – – – (reference [39])
Increased household reports of severe food shortage —— (reference [39])

Figure 2.2 Monthly national prices of grain crops in Ghana
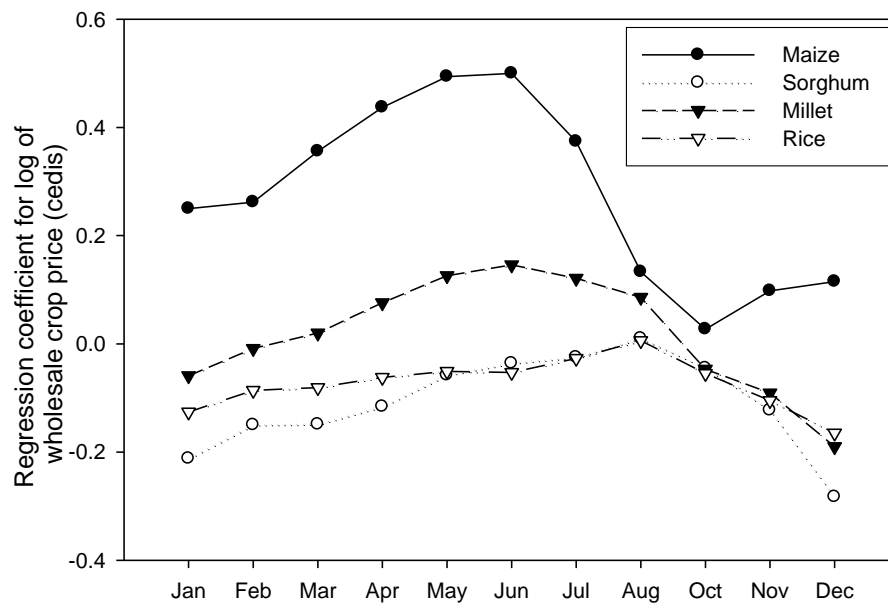
Note: September was left out of original data set (reference [41])

Figure 2.3 Monthly national prices of root and tuber crops in Ghana
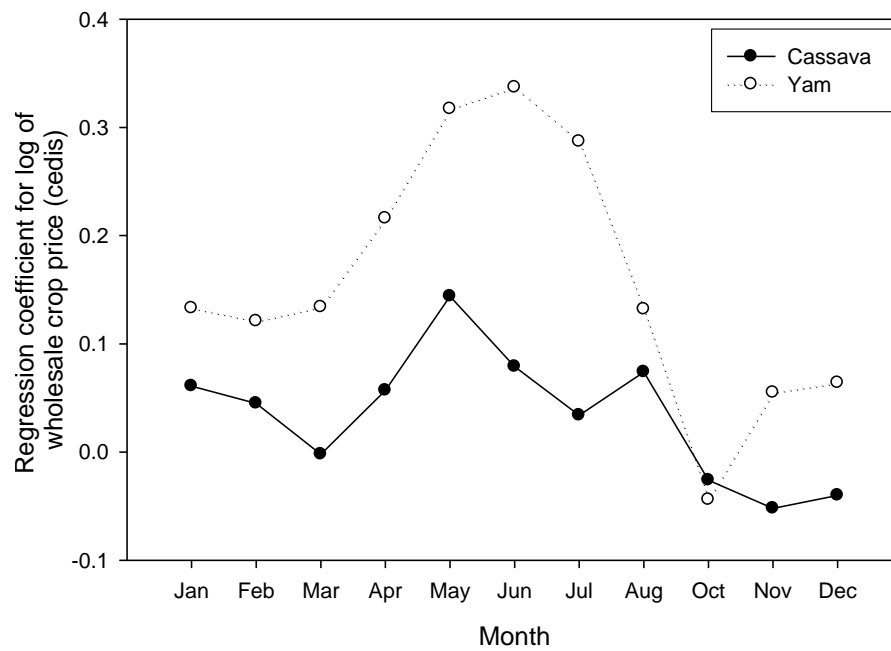
Note: September was left out of original data set (reference [41])

Figure 2.4 An example of possible outcomes after food supplementation
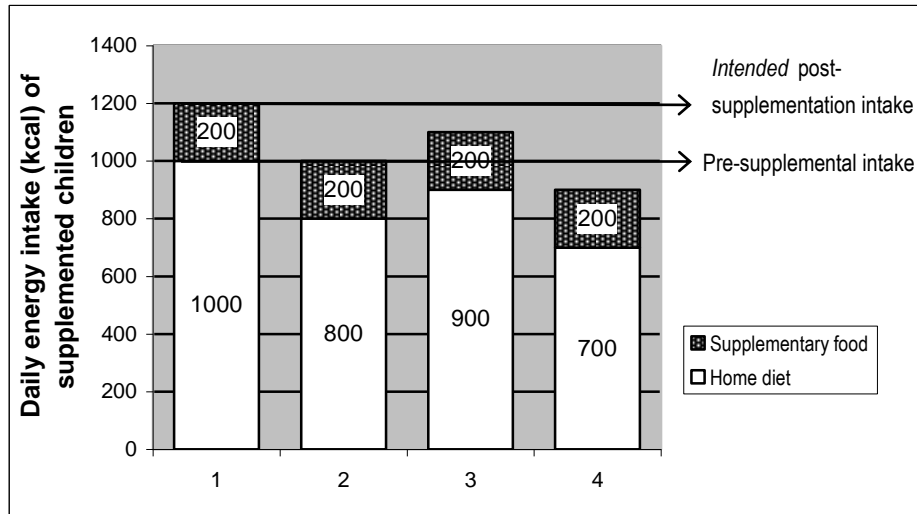
1) Total supplementation, with no replacement or diet change at home
2) Complete replacement of supplementation; no net benefit
3) Partial replacement, but still resulting in a greater energy intake
4) Complete replacement (over that which was supplemented), resulting in a lower energy intake

Adapted from reference [104]

3. General Methodology and Community Characteristics

3.1 Study sites and population

Data were collected as part of a larger intervention study to improve the quality of preschool children's diets entitled Enhancing Child Nutrition through Animal Source Food Management in Africa (ENAM) [51]. The ENAM project used Participatory Rapid Appraisal methods, involving local knowledge to identify perceived constraints to the availability, accessibility and utilization of ASF in children's diets. Study sites were intentionally selected to represent the northern Guinea Savannah, the mid-country Forest-Savannah Transition and the southern Coastal Savannah, three distinct agro-ecological zones of Ghana. Multi-stage sampling was used to select an administrative region within each zone and then one rural and one semi-rural intervention community within each region. Nearby communities were matched for each intervention site. Twelve communities in total, six intervention and six control, were chosen. Figure 3.1 shows the ENAM project site districts and the intervention communities. Control communities are not shown, but are located nearby. Results varied slightly between regions, but showed that ASF was predominantly purchased (although animal-rearing was common), and that low income and lack of access to technology and markets were commonly reported constraints. With this information, an intervention to enhance the inclusion of ASF in young children's diets was designed that included income generation activities (IGA) with assisted entry into markets, along with nutrition and entrepreneurial education for caregivers of young children. Self-selected caregivers from the six intervention communities participated in the IGA. Internal (within the same intervention community) and external (from the matched control community) control caregivers were chosen and received a health education intervention not thought to influence the provision of ASF to their children.

For the present study, data were collected in all four ENAM communities in northern Ghana: Gia, Wuru, Bonia and Biu and two of the four ENAM communities in mid-country Ghana: Fiaso and Nkwaeso. Fiaso and Nkwaeso were chosen because of the existence of DCC with informal feeding programs. Of the other two communities in this region, one had no DCC and the other had a very small DCC with an informal feeding program, but was not included because the

22

sample size was reached with only the first two communities. Gia, Wuru and Fiaso are ENAM intervention communities. Biu, Bonia and Nkwaeso are control communities. No ENAM intervention caregivers or their children were included in this study, because of the exposure to nutrition education. ENAM control caregivers and their children however, were included in this study.

3.1.1   Northern Ghana

The northern Ghana sites are located in the Kassena-Nankana district of the Upper East region, which is situated in the Guinea Savannah agro-ecological zone of northern Ghana. This area of Ghana has one annual rainy season, lasting from June or July through August or September [34], and one yearly crop harvest during and following this rainy period. The main staple foods are locally grown maize, rice, millet and sorghum as well as non-local cassava and yam [105]. Anthropometric and biochemical markers of nutritional status indicate that malnutrition among children under five years of age is common in this region (stunting (31.7%), underweight (32.4%), wasting (12.9%) and anaemia (79.1%)) [45]. In the ENAM communities, approximately one-third (30%) of households with young children reported severe food shortages throughout the year [39]. This rose significantly to two-thirds (65%) of households during the pre-harvest season, indicating both chronic and transient food insecurity. Pre-harvest season reductions in adult body weight and BMI have also been reported in the Upper East region [37, 38]. Study communities are located near the Tono dam, where wet and dry season irrigation farming takes place. The dam is run by the government and has land reserved for communities. Although the land is free to use, individuals pay a seasonal water fee.

Study communities

Each community is presided over by a chief. All communities are farming communities. Farm land generally surrounds households. There are no latrine facilities in any of the study sites.

Gia is a rural farming and fishing community [105]. Fishing is done in nearby canals and at the Tono dam. The main sources of water for domestic use are four community boreholes and several hand-dug wells, which are built and owned by community members. During the wet season, water from nearby canals is used for irrigation farming and domestic purposes. In the dry season, these canals dry up. Roads leading to and within the community, which is about three kilometres from Navrongo, the closest city, are difficult to access during the rainy season. There are no electricity facilities. No formal health facilities exist within the community; however there are two resident community nurses and several surveillance health volunteers who work under the Ghana Health Service (GHS). There are also traditional healers and traditional birth attendants. The community has one primary school, as well as one junior high school. There is a small daily community market, and many travel to Navrongo or other nearby towns for market day, which occurs every three days.

Wuru is a rural farming community with around 400 residents [105]. The community uses boreholes, improved hand-dug wells, individually constructed hand-dug wells and a nearby stream for domestic water purposes. During the rains, canal water is used for irrigation farming and some domestic uses. Outside the rainy season, these canals largely dry up. Electricity was recently acquired, but very few households had access at the time of study. The main road leading to the community, only one kilometre from Navrongo, is good year-round. There are no formal health facilities, but there is one resident community nurse as well as several health surveillance volunteers and traditional birth attendants, all under GHS supervision. There are also many traditional healers. Children attend school in nearby communities, one to two kilometres away. There is a small daily community market, and many residents travel to nearby towns for their market day.

Bonia is a farming and fishing community with approximately 800 residents [105]. Canals are used for fishing. The main water sources for domestic purposes are six boreholes. In the rainy season, water from canals is used for irrigation farming. There are no electricity facilities. No well-established health facilities exist, but there is one resident community nurse and several health surveillance volunteers and traditional birth attendants, who work under the GHS, as well as many traditional healers. Navrongo is about two kilometres away. The road leading to the community is good and accessible year-round, although roads within the community are difficult to use during the rains. There is a DCC and a primary school with a kindergarten. There is a small community market each day, and many travel to other towns for their market day.

Biu is a community of about 180 households [105]. One borehole and five hand dug wells are used for domestic purposes. In the rainy season, some residents use canal water for irrigation farming. Canals are also used for fishing. There are no electricity facilities. The community is approximately 15 kilometres from Navrongo. The major road leading to the community is accessible by vehicle year-round, although roads within are difficult to access during the rainy season. There is a GHS community health centre which is also used by residents of nearby communities. In addition there are several health surveillance volunteers and traditional birth attendants. The community has two DCC, two primary schools and a junior high school, all except one DCC are government-run. There is a small market, which has a market day every three days. Residents also travel to nearby towns for their market days.

3.1.2   Mid-country Ghana

Study sites are located in the Techiman municipality of the Brong-Ahafo region, which is located in the Forest-Savannah Transition agro-ecological zone of mid-country Ghana. This area of the country has two annual rainy seasons, one from April to June and another from September to November [45], resulting in major and minor growing seasons [35]. The main staple foods are locally grown maize, cassava, yam and cocoyam [105]. Anthropometric and biochemical indicators of nutritional status show that malnutrition among under five year-old children is common in this region (stunting (29.4%), underweight (20.4%), wasting (5.7%) and anaemia (74.9%)) [45]. Over

one-third (40%) of households with young children in the ENAM communities reported severe food shortages throughout the year [39], indicating a high prevalence of chronic food insecurity.

Study communities

Fiaso is a rural farming community with a population of approximately 5000 residents which is presided over by a chief. Farm land is located on the periphery of and outside the community. As a settler community, the population is comprised mainly of migrant farmers from northern Ghana. There are two boreholes which are used for drinking, cooking and washing. Two nearby streams are also used for cooking and washing. There is no electricity. Households have their own or shared latrine facilities. There are no paved roads within the community, but a major roadway runs through the community which leads to Techiman, the nearest town, about five kilometres miles away. There is a community health centre with one nurse and an assistant, run by GHS. In addition to a community-run DCC, there is also a government-run kindergarten, elementary school and junior high school. Fiaso is part of the government pilot SFP for elementary schools, which the kindergarten also has access to. There is a small daily market in the community, but shopping and trading is also done in nearby Techiman which has a very large market (one of the largest in Ghana [106]) every Wednesday, Thursday and Friday.

Nkwaeso is a semi-rural farming community with a population of around 3000 residents, which is also presided over by a chief. Farming here also occurs outside the community. The main water sources for domestic purposes are three boreholes and two hand-dug wells. Nearby streams are also used. The community has electricity, although not all households have access. There is one community pit-latrine and some households have their own latrine facilities. A major, paved road passes through the community and leads to Techiman, about five kilometres away. There is a GHS community health centre with three nurses and one assistant. There are two DCC, three kindergartens and elementary schools, and a junior high school, some of which are privately owned and some are government run. Nkwaeso is part of the government pilot SFP for elementary schools, which the kindergartens also have access to. There is a small market which operates daily and trading and buying is also done at the Techiman market.

Daycare centres and feeding programs

The Fiaso Community DCC was started by the community over 15 years ago. Staff consists of one director, her assistant and a cook. A few weeks into the 2007-2008 school year, approximately 80 children were registered, although it is common for children to be registered and then never attend or eventually stop attending prematurely. The DCC is situated under a thatched roof, held in place by wood posts. There is a three-day rotation of lunches: bean stew and *gari* (dried cassava powder), *jollof* rice (rice made with red palm oil, tomatoes, hot pepper, onion and sometimes dried fish) and boiled yam with *kontomire* (cocoyam leaves) stew. Every day, children are required to bring 10 GHp (the equivalent of around 0.10 US$) and a piece of firewood for cooking. On yam and *kontomire* stew days, children are also required to bring a piece of raw yam. No foods from external sources are provided for the meal. To register, the family must pay 0.50 GH¢ (around 0.50 US$) and the child is required to bring a chair and a lunch bowl every day. They must also wear a uniform, which costs around 1.80 GH¢ (around 1.80 US$), although some children do not wear one.

The Nkwaeso Community DCC was started and built by the community over 20 years ago. Currently, it is run by a director and her assistant, both women from the community. The director prepares and cooks the lunch every day. At the beginning of the 2007-2008 school year, 74 children were registered. It is located in a small, one room mud and brick building with a corrugated metal roof. The same meal is served everyday, which consists of boiled yam with *kontomire* stew. Every day, children are required to bring a piece of raw yam and some raw *kontomire* for the lunch as well as a bowl and a piece of firewood for cooking. No foods from external sources are provided for the meal. If a child does not bring food, they are required to bring 10 GHp (the equivalent of around 0.10 US$) instead. Every Monday, children must also bring 10 GHp, to cover the cost of ingredients not brought by the children, such as salt and red palm oil. The one-time registration fee is 1 GH¢ (the equivalent of around 1 US$). According to the director, children must wear a uniform, which would cost around 1.80 GH¢ (around 1.80 US$), but most children do not wear a uniform.

3.2   Participants

3.2.1   Sample size

Sample size calculations were made using the following formula [107]:

$$N = [(1/q_1 + 1/q_2) S^2 (z_\alpha + z_\beta)^2] / E^2$$

Where N = the total number of participants required

q_1 = the proportion of participants in group 1

q_2 = the proportion of participants in group 2

S = the standard deviation of the outcome variable

z_α = the standard normal deviate for α

z_β = the standard normal deviate for β

E = the expected effect size of the outcome variable

Assumptions: 2-sided test, equal proportions of participants, z_α=1.96, z_β=0.84

Primary objective 1:   To determine whether there is change within the diets (energy, iron and zinc intake and dietary diversity) of children, from the pre- to post-harvest season, in rural northern Ghana.

Primary objective 2:   To determine whether there is change within the nutritional status (weight-for-age and weight-for-height Z-scores) of children, from the pre- to post-harvest season, in rural northern Ghana.

Outcome variable: <u>Within-subject change in weight-for-age Z score between seasons</u>
(Chosen because sample size calculations using this variable resulted in a larger required sample size than using dietary outcomes from primary objective 1)

Expected effect size = 0.16 (As seen in other seasonal studies [11, 108])

Standard deviation = 0.57 (Data on changes in Ghanaian children over a two to four month period [109])

N = **200 total** for northern Ghana

Primary objective 3:   To determine whether there is a difference in the diets (energy intake and dietary diversity) of children who do and do not attend DCC with informal feeding programs in rural mid-country Ghana.

Outcome variable: <u>Difference in energy intake between groups</u>

Fixed sample size: **100 per group** (based on prior information on DCC attendance)

This sample size is able to pick up an expected effect size of 120 kcal (which is equivalent to a small amount of red palm oil (1.5 tsp) and groundnuts (3 tsp), foods known to be included in DCC lunches which may not be a part of the mid-day meal at home) with a standard deviation of 300 (which is consistent with data from Ghanaian preschool children [110]), using the above assumptions. This additional amount of energy (120 kcal) is substantial; it is equivalent to approximately 10% of the recommended energy intake of this population [111].

N = **200 total or 100 per group** (DCC and non-DCC) for mid-country Ghana

3.2.2   Selection criteria

The first criterion for participation was the child being between two and five years of age at the time of enrolment. For mid-country Ghana, children in the DCC group also had to be 'attenders' of the community DCC (were on the attendance list and attended according to the caregiver) and children in the non-DCC group had to be 'non-attenders' (not on the attendance list, and never attended according to caregiver). Children were excluded if their caregiver was participating in the ENAM project intervention. Children in mid-country Ghana attending an educational institution other than the participating DCC (including attending a DCC in another community) were also excluded.

3.2.3   Recruitment

In northern Ghana, every household with a child aged two to five years (identified by the ENAM community census lists) was approached for participation. This was done because the number of eligible households (215) was only slightly larger than the required sample size (200). If more than one child in that age range resided in a household, the study child was randomly selected. In mid-country Ghana, DCC children were randomly selected from DCC attendance lists. Non-DCC children were randomly chosen from the community census lists, matching the ages of the DCC children (2, 3, 4 and 5 years). DCC attendance was checked the day prior to enrolling a DCC caregiver, to ensure the 24-hour dietary recall would capture a DCC day. The objectives were explained to the caregiver and they were invited to participate. Written informed consent was attained from all caregivers, for their and their child's participation. See appendix 9.2 for the informed consent form. This study was approved by the institutional review boards at McGill University, Iowa State University, and the University of Ghana, Legon. See appendix 9.1 for the ethics approval certificates.

3.3   Data collection

3.3.1   Demographic and household information

Interviewer-administered questionnaires with the caregiver were used to collect data on the age, marital status, education level, major occupation and relationship to study child of all household members. Whenever possible, child date of birth was verified with a GHS weighing card or birth certificate. Information on religion, ethnicity and secondary occupation of caregiver and household head was also collected. Household was defined as 'a group of people who eat together from the same pot on a regular basis', household head was defined as 'the recognized person in charge of the household, who makes major decisions concerning the household' and caregiver was defined as 'the person who has responsibility (caring and feeding) for the child most of the time and lives with the child'. Definitions, all of which are locally appropriate and understood concepts, were explained to the caregiver prior to relevant questions. Data were also collected on

caregiver income, household assets (including livestock and other belongings), dwelling materials and toilet facilities. Within-community household wealth rankings were available from the ENAM project. For each community, a group of opinion leaders and other residents decided upon criteria for low, medium and high wealth ranking, such as ability to send children to school or lend money to others, and assigned rankings to all households [51]. Disagreements were discussed as a group, until a consensus was reached.

3.3.2   Dietary intakes

Twenty-four hour dietary recalls were administered with the caregiver to estimate the child's food intake on the previous day. A multi-pass method was used, where one first asks what was consumed during the previous day and at what time, then goes over each item to estimate quantity, source and place consumed, and finally asks if anything was forgotten or left out [112]. Local dishes, cooking utensils and other appropriate props were used to help estimate quantity. For all consumed foods, local samples were weighed on a food-weighing scale to the nearest 0.1 grams (Ohaus Corp., Pine Brook, USA) to convert the different dish, utensil and prop sizes to actual food weights. Two 24-hour recalls were collected, on non-consecutive days, and the average of the two days of intake was used for all related variables. Recalls were collected on all days of the week for the study in northern Ghana, and from Tuesday through Saturday in mid-country Ghana, reflecting weekday dietary intakes. In mid-country Ghana, it was verified with the caregiver that the child ate lunch at DCC the previous day, then the lunch was later imputed with the meal served at DCC that day, which was measured separately (see below for explanation).

For mixed dishes prepared by the caregiver, information was also collected on type and quantity of ingredients in the preparation. Dishes, cooking utensils and other appropriate props were used to help estimate quantity of ingredients. The amount of each ingredient in a preparation consumed by the child was calculated using the following steps. First the weight of all ingredients was summed (for cooked soups, the weight of water was multiplied by a water reduction factor prior to summing). Then the proportion of the preparation consumed was calculated by dividing the weight consumed by the child by the total weight of the preparation. Finally the quantity of each ingredient consumed was estimated, by multiplying the total weight of each ingredient by the

proportion the child consumed. Water reduction factors were calculated based on locally prepared soups. For each preparation, the cooking pot and all ingredients, including water, were weighed prior to cooking on a food weighing scale to the nearest 0.1 g up to 2 kg (Ohaus Corp., Pine Brook, USA) or on a digital scale (model BWB-800, Tanita Corp., Tokyo, Japan) to the nearest 0.1 kg for heavier items. After cooking, the final preparation was weighed, taking into account the pot weight. The reduction in weight was assumed to come entirely from water loss. The weight of water loss was divided by the total weight of water added, for a proportion of water loss. This was performed at least three times to estimate an average water reduction factor for each commonly consumed soup. For less commonly consumed soups, an average reduction factor from the known recipes was used.

On the day prior to conducting interviews in mid-country Ghana, the DCC lunch was observed. All ingredients in the preparation were weighed and five servings of each lunch food were weighed for an average serving size. According to the DCC directors in both communities, serving sizes were the same for every child, regardless of sex, age, or bowl size, which was consistent with observations. In both communities, data collection took place at the beginning of the school year so many children were new to the DCC and the staff were often unable to identify them, making observations of individual children's lunch consumption difficult. A month after data collection, the directors were asked about the eating habits of the participating children and asked to observe their eating habits at one lunchtime. According to the Fiaso DCC director, children generally finished the food served to them and never received extra servings, which was consistent with the director's lunchtime observations as well as general observations during data collection. Accordingly, in Fiaso, if the caregiver said the child ate lunch at the DCC on a given day, the child was assumed to have consumed the average lunch serving size. In Nkwaeso however, according to the director and her assistant, some children regularly did not finish their original servings while others often received an extra serving if they were still hungry, which was consistent with the one-day observation as well as general data collection observations. A list was made of children who usually ate what was served to them, those who received an extra serving, and those who did not finish what was served to them. The director and assistant made quantitative estimates of food consumed for the groups who ate more and less than originally served. If there was disagreement

between the director and assistant about the quantity the child normally ate, an average between the two was calculated.

Nutrient intakes were calculated predominantly from local food composition tables and other published composition data for local foods [113, 114]. For missing nutrients or foods, published values from other West African countries were used [53, 115].

Dietary diversity was calculated from the 24-hour recalls using the following food groups: 1) grains, 2) roots and tubers, 3) legumes, pulses and nuts 4) vitamin A-rich fruits and vegetables (defined as those containing greater than 130 retinol equivalents (RE) per 100 g [116]), 5) other fruits and vegetables, 6) dairy, 7) meat and poultry, 8) fish, 9) egg and 10) fats and oils. These groups were adapted from one used for Malian children and one used for children in a multi-country study including five African nations [59, 117]. Because of the importance of ASF in the diets of children living in low income countries, it is common to separate such foods into several categories [58, 59]. ASF was subdivided into these four groups because of the micronutrients they provide as well as to fit with how these foods are commonly consumed in this setting. An 'other' category including sugar and sugary beverages, candies and condiments was not included in the final score because foods in this group do not contribute substantially towards micronutrient intake [118] and the dietary diversity score was intended to reflect micronutrient adequacy, not energy adequacy [116].

Eating events were defined by the caregiver and reported in sequence with an estimated time of consumption in the 24-hour dietary recall. Each eating event was later defined as a meal or snack based on the types of foods consumed. Definitions were determined (from anecdotal evidence) based on those appropriate in a Ghanaian setting in which a meal is considered to consist of a starchy staple accompanied by a sauce such as a soup or stew. An exception was *koko*, a thin porridge usually made from fermented maize or millet dough, which is a common breakfast food. Snacks were defined as any other food consumed apart from meals. Definitions were based on type of food alone, regardless of amount or time consumed. The lunch meal was defined for the mid-country Ghana study only. The definition was based on the time of day. For DCC children, lunch was the DCC meal. For non-DCC children, lunch was considered the first

meal food consumed between 11am and 4pm. If no meal was consumed during this time, the first snack eaten was considered the lunch meal. This timing was based on patterns of food consumption within the population observed from 24-hour dietary recalls. Although not part of the original research objectives, observations during data collection indicated these variables may also be of interest and post-hoc analyses were performed accordingly.

3.3.3   Crops and harvesting

In northern Ghana, questions were asked about crop type and time of harvest for the household in the past harvest season. Information on the months of the year in which 'severe household food shortages' occurred was also collected. In mid-country Ghana, only information on type of crop grown by the household was collected.

3.3.4   Morbidity

A questionnaire regarding symptoms of child illness in the past two weeks was administered with the caregiver. Symptoms included fever, cough (as well as cough with short, fast breaths), diarrhoea and loss of appetite. Information was also collected on vitamin A supplementation and medicinal deworming in the past six months, which was verified with a GHS weighing card wherever possible.

3.3.5   Anthropometric data

Child weight was measured with a digital scale (model BWB-800, Tanita Corp., Tokyo, Japan) to the nearest 0.1 kg. Child height was measured with a Shorr Board vertical stadiometer (Irwin Shorr, Olney, USA) to nearest 1 mm. Both weight and height were measured in duplicate using standard methodology, taken with only light clothing [119]. An average of the two values was used.

3.3.6   Iron status

A haemoglobin (Hb) photometer (HemoCue Inc, Lake Forest, USA) was used to measure the Hb content of a sample of children's capillary blood taken from a finger prick. This was used as a proxy for iron status. The caregiver was given the results of the test and anaemic children (Hb less than 11 g/dL) were referred to the nearest GHS provider for treatment.

3.3.7   Language development

In mid-country Ghana only, language development was evaluated with the receptive vocabulary subtest of the Wechsler Preschool and Primary Scale of Intelligence - Third Edition (WPPSI-III). The test was translated into the local languages and back-translated to ensure accuracy of translation. Thirteen words from the original test were changed, after pre-testing, in order to preserve the intended level of difficulty in the local culture. This is commonly done when adapting the test [92, 95]. During administration of the test, the examiner said a word aloud and showed four pictures, one of which corresponded to the word. The child was asked to point to the matching picture. There were 38 words in total and the child received a score of "1" for a correct answer and "0" for an incorrect or no answer. Efforts were made to minimize distractions during the test, such as conducting it away from other people, or asking other people to leave the area. To enhance test reliability, only one administrator was used. Data on language development were collected for secondary hypotheses. Results were not included in the manuscript for mid-country Ghana because they would have distracted from the main objectives of that paper and because these data were collected for secondary hypotheses. Preliminary results are shown in appendix 9.4.

3.3.8   Daycare centre information

In mid-country Ghana only, caregivers of DCC children were asked about why they chose to send their child to DCC, when they started attending, how often they usually attended, and also about the feeding program, particularly the foods served and their ability to send the required items.

Caregivers of non-DCC children were asked if they knew of the DCC in their community and if they were aware, they were asked why they did not send their child and also about their attitude towards the feeding program.

3.4   Data collection procedures

In northern Ghana, data were collected over two non-consecutive days in each season (the two non-consecutive days were generally one day apart unless the caregiver was busy or could not be located). Data were collected on the same children in each season, so each caregiver was interviewed on a total of four days. Data collection took place in both the pre-harvest (June-July) and post-harvest (November-December) seasons. In the pre-harvest season, demographic information was collected on the first data collection day, morbidity and anthropometric information on the second and dietary recall on both days (two 24-hour recalls in each season). In the post-harvest season, demographic and crop information was collected on the first day, and morbidity, anthropometric and haemoglobin data on the second day.

In mid-country Ghana, data collection took place at one time point only (September-October), which happened to coincide with the post-harvest season. Here also, data were collected over two non-consecutive days. Demographic and crop information and language development was collected on the first day, and morbidity, anthropometric and haemoglobin data on the second day. Dietary recall was collected on both days (two 24-hour recalls in total). DCC lunches were weighed on the day prior to each data collection day so the dietary recall would capture the time period that lunches were weighed in. For both sites, all caregivers were given a token of appreciation for participation in the study (either a bar of soap or a plastic basket) upon bringing their child for anthropometric measurement.

Pre-harvest season			Post-harvest season	
Day 1	*Day 2*		*Day 1*	*Day 2*
Household demographic information			Household demographic information	
	Morbidity			Morbidity
			Crop harvesting	
24-hr recall	24-hr recall		24-hr recall	24-hr recall
	Anthropometric measures			Anthropometric measures
				Haemoglobin

Mid-country Ghana only
Language development
DCC lunch weighing   DCC lunch weighing
(*Day prior to data collection day*)

3.5   Data analysis

Microsoft® Access (Microsoft Corporation, 2002) was used for data entry and SYSTAT version 10 (SPSS Inc., Chicago, 2000) was used for data analysis. Z-scores of anthropometric indicators were computed with WHO Anthro 2005 (WHO, Geneva, 2006) for children up to 60 months of age and Epi Info™ Version 3.4.3 (CDC, Atlanta, 2007) for children over 60 months. Descriptive analyses were used to determine proportions, means, ranges and measures of dispersion on all measured variables. In northern Ghana, the data were collected on the same individuals in both seasons, so Student's paired t-test for continuous data and McNemar's test for dichotomous variables were used to test within-individual differences between seasons. For the mid-country data, Student's t-test was used for normally distributed continuous data, Wilcoxon-Mann Whitney test was used for non-parametric continuous data and chi-squared tests were used for categorical data to test between-group differences. Multiple linear regression analysis was used for the mid-country Ghana data only, to determine the association between participation in DCC feeding programs and diet while controlling for other predictor variables. The *a priori* conceptual framework (Figure 2.1) and observations during data collection drove which variables were tested in the regression models. Bivariate tests between potentially important predictor variables and DCC attendance status as well as the outcomes of interest were performed. Those found to be statistically significant, or approaching significance, were tested in the model. Significant digits were reported as suggested by Truman [120]. Significance was set at $p < 0.05$, unless otherwise indicated.

Figure 3.1 Map of Enhancing Child Nutrition through Animal Source Food Management in Africa (ENAM) project intervention communities in Ghana
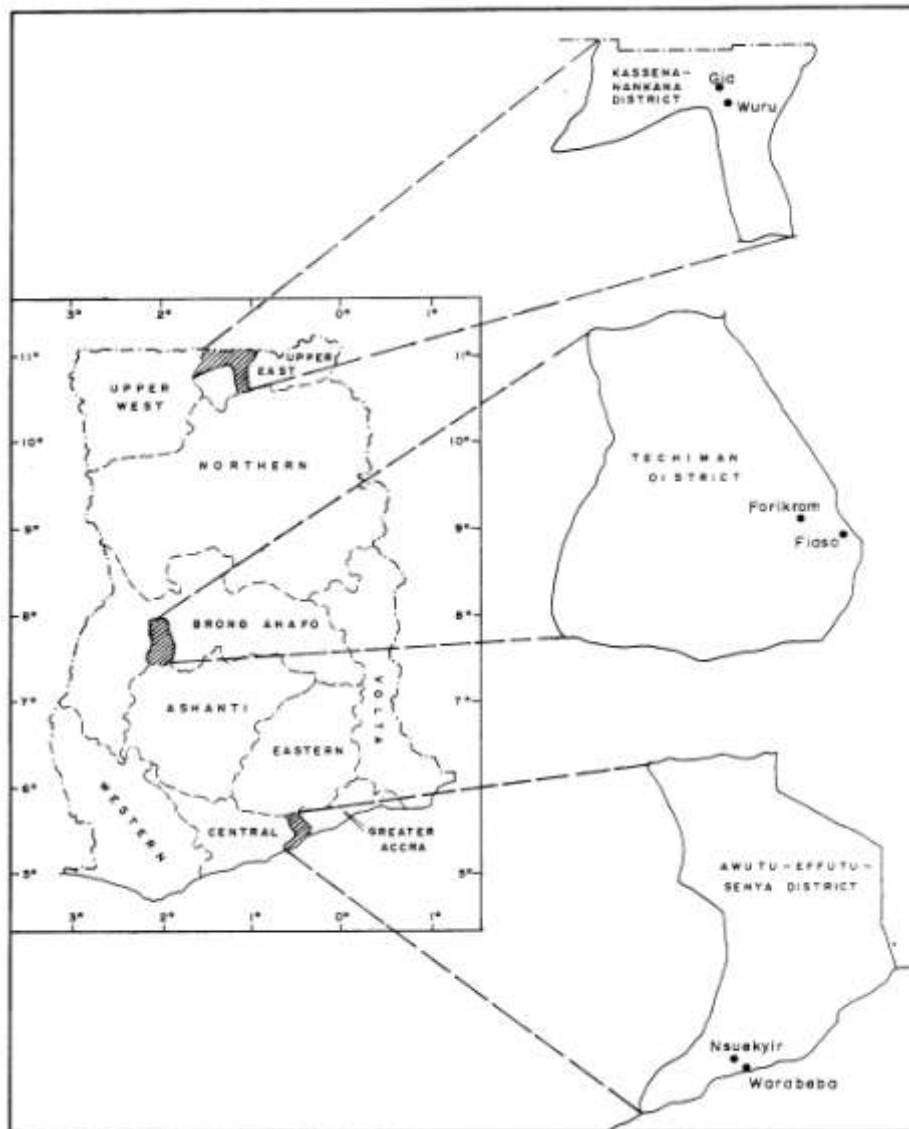
4.   Manuscript I: Pre-harvest to post-harvest season changes are positive for dietary intakes but negative for weight-related indicators of nutritional status of 2 to 5 year old children after severe flooding in rural northern Ghana

Manuscript in preparation

Kimberly Harding[1], Grace S Marquis[1, 2], Esi K Colecraft[2,3], Anna Lartey[3] and Owuraku Sakyi-Dawson[4]

[1]School of Dietetics and Human Nutrition and Centre for Indigenous Peoples' Nutrition and Environment (CINE), McGill University, Ste-Anne-de-Bellevue, Quebec, Canada

[2]Department of Food Science and Human Nutrition, Iowa State University, Ames, IA, USA

[3]Nutrition and Food Science Department, University of Ghana, Legon, Ghana

[4]Department of Agricultural Extension, University of Ghana, Legon, Ghana

Corresponding author:

Grace S. Marquis
Centre for Indigenous Peoples' Nutrition and Environment
School of Dietetics and Human Nutrition
Macdonald Campus, McGill University
21, 111 Lakeshore Rd.
Ste. Anne-de-Bellevue, Quebec
Canada H9X 3V9
Email: grace.marquis@mcgill.ca

4.1 Abstract

Background: Populations in tropical regions are prone to seasonal food shortages due to the limited crop growing time allowed by the rainy seasons. Children's diets and nutritional status may be negatively affected during the 'lean' pre-harvest season.

Methods: Interviewer-administered questionnaires were used to collect dietary (24-hr recall), morbidity and household demographic information in the pre- and post-harvest seasons for 190 children 2-5 y of age living in four communities in northern Ghana. Height and weight were also measured.

Results: From the pre- to post-harvest season, energy intake increased by 134 ± 534 kcal (p=0.001) and weight-for-height Z-score decreased by 0.15 ± 0.47 (p<0.0001). Fever, cough and appetite loss also increased during this time (by 25.8%; p<0.0001, 35.0%; p<0.0001 and 17.9%; p<0.0001, respectively).

Conclusion: Although diets improved slightly from the pre- to post-harvest season, weight-related nutritional status deteriorated. This was likely due to increased illness which may have been exacerbated by unexpected severe flooding that occurred in the region prior to post-harvest data collection. This knowledge may help plan for future natural disasters to improve the effectiveness of response and help protect this vulnerable population.

4.2 Introduction

Many people living in rural communities of low-income tropical countries experience seasonal variation in the availability of food, resulting in periodic seasonal food shortages [3]. It is estimated that over one billion people worldwide live in environments that are prone to seasonal food scarcity [7]. Tropical climates have distinct wet and dry seasons. The rainy season is the growing season, and crop harvesting begins a few months into the rains and lasts into the first few months of the dry season. It is during the months leading to the harvesting of food, or the pre-harvest season, that seasonal food stress occurs [4] as food becomes less available, more expensive and less varied [5]. Food acquired during the harvest season must last until the next harvest, or be supplemented by purchased foods [121]. Areas that experience only one annual rainy season, and hence one crop harvest, are more prone to seasonal food scarcity than areas with two wet seasons and crop harvests [32].

Young children are particularly vulnerable during food shortages as they need a constant supply of adequate food for growth and development and because limited resources may be preferentially allocated towards older, more economically productive members of the household [3, 5]. There is evidence, however, that children in some societies may be protected during food-scarce times [9]. Seasonal food shortages have been tied to deleterious effects on several health status indicators related to children including birth weight and early infant growth, child linear growth and rates of wasting, underweight and stunting as well as weight change during pregnancy and lactation [10, 11].

It is also important to consider the 'seasonal ecology of disease' which generally occurs during the wet season and can compound dietary stress during the rains until harvest begins [30]. Morbidity and mortality often peak during the wet season [7]. Common infections including malaria and diarrhoeal diseases show this seasonal pattern because of climatic effects on breeding grounds for vectors and survival and proliferation of microbes [30].

Information on timing and severity of the effects of seasonal variation and seasonal food scarcity on children's diets and nutritional status is important to inform locally appropriate and timely interventions as well as effective policy development.

The original objective of this study was to examine pre- to post-harvest season changes in diet and anthropometric indicators of nutritional status of preschool-aged children living in rural northern Ghana. However in late August and September of 2007, during the harvest season and in between the two phases of data collection for this study, northern Ghana experienced severe flash flooding due to heavy rains as well as spillage from an upstream dam in Burkina Faso [122]. The floods destroyed crops and food stocks, killed people and livestock, and damaged homes and infrastructure. Over 325,000 people were affected and more than 54,000 homes were destroyed. Crop losses have been estimated at one-fifth of the annual requirements of the affected area, which occupies almost half the nation's land mass. 'Post-harvest' data collection for this study continued as originally planned. This paper reports on changes in dietary and anthropometric indicators of nutritional status in preschool-aged children from the pre-harvest to post-harvest season, with the second data collection period occurring approximately two months post-flooding, in northern Ghana.

4.3   Methods

4.3.1   Study sites

Study sites were located in the Kassena-Nankana district of the Upper East region, which is situated in the Guinea Savannah agro-ecological zone of northern Ghana. Northern Ghana experiences one rainy season, lasting approximately from June or July through August or September, giving rise to one annual growing season and crop harvest [34, 35]. This area of the country is therefore more affected by seasonality than the rest of the country, which experiences two annual rainy seasons and crop harvests [32]. Adult weight loss and reduced body mass index, and doubling of reports of household food shortages have been documented in the pre-harvest season in northern Ghana [37-39]. Monthly variations in staple foods prices including rice, maize,

42

sorghum, millet, cassava and yam, have also been documented in Ghana, rising during the pre-harvest season when food is less available and falling once harvest begins [6].

During the late August and September, 2007 floods, the Upper East region was one of the three affected regions in Ghana. The Kassena-Nankana district was one of the 20 'most affected' districts in the affected regions [123]. There were no flood-related deaths in any of the study communities.

Data were collected in four rural farming communities; Gia, Wuru, Bonia and Biu. Most households practiced subsistence farming on land that surrounds their house. Gia and Bonia were also fishing communities and used nearby canals and dams to fish. Study sites were located near the Tono dam, where families could pay a seasonal water fee for wet and dry season irrigation farming. Fishing also occurred in the dam reservoir. Gia had a much smaller community dam which was used for the same purposes. There were no latrine facilities in any of the study sites. Only Wuru had electricity facilities, which were newly acquired at the time of study and very few household had access. The main sources of water were boreholes and hand-dug wells.

4.3.2   Participants

Every household with a child aged two to five years (from recent community census lists) was approached for participation. This was done because the number of eligible households (215) was only slightly larger than the required sample size (200). Sample size calculations were based on changes in anthropometric nutritional status seen in other seasonal studies [11, 108] using standard deviation of changes in anthropometric nutritional status of Ghanaian children [109]. If more than one child in the age range resided in a household, the study child was randomly selected. Children were excluded from the study if a household member was participating in another concurrent child nutrition intervention program in the community. The objectives were explained to the caregiver and they were invited to participate. Written informed consent was attained from all caregivers, for their and their child's participation. This study was approved by the institutional review boards at McGill University, Iowa State University, and the University of Ghana.

4.3.3   Data collection

Food intake measures

Twenty-four-hour dietary recalls were used to estimate children's food intakes on the previous day (including foods eaten at home and elsewhere). The caregiver was asked to report all foods, except water, consumed by the child on that day. The quantity consumed was estimated with common household units (bowls, cups, spoons). For mixed dishes which were prepared by the caregiver, household units were used to estimate ingredient quantities. For these dishes, the child's portion size as a fraction of the total weight of the preparation was used to calculate the amount of each ingredient consumed by the child. Water reduction factors were determined based on locally prepared recipes. These factors were used to take water loss with cooking into account in the calculations, where appropriate. The household units were used to weigh all consumed ingredients and foods on a food-weighing scale to the nearest 0.1 grams (Ohaus Corp., Pine Brook, USA) to convert the unit estimations to weights.

Nutrient intakes were calculated from local food composition tables for Ghana [113] and other West African nations [53, 115] as well as other published composition data [114]. FAO/WHO reference values were used for energy and all nutrients [111, 124, 125] with the exception of fat, for which the Institute of Medicine reference value was used [126]. Percents of recommended nutrient intakes were calculated on an individual level, taking into account sex, weight and age as appropriate.

Dietary diversity was calculated from the 24-hour dietary recalls using the following food groups: 1) grains, 2) roots and tubers, 3) legumes, pulses and nuts 4) vitamin A-rich fruits and vegetables (greater than 130 retinol equivalents (RE) per 100 grams [116]), 5) other fruits and vegetables, 6) dairy, 7) meat and poultry, 8) fish, 9) egg and 10) fats and oils. This grouping was adapted from ones used for children in several other African nations [59, 117]. It is common to separate animal source foods (ASF) into several categories because of the importance of these foods in the diets of children living in low income countries [58, 59].

Eating events were defined by the caregiver and reported in sequence with an estimated time of consumption in the 24-hour dietary recall. Events were later defined as meals or snacks based on the types of foods consumed. Definitions were determined based on those appropriate in a Ghanaian setting in which a meal is generally considered to consist of a starchy staple accompanied by a sauce such as a soup or stew. An exception was *koko*, a thin porridge usually made from fermented maize or millet dough, which is often eaten for breakfast. Snacks were defined as any other food consumed apart from meals. Definitions were based only on type of food, regardless of time or amount consumed.

Other information

Interview-administered questionnaires with the caregiver were used to collect demographic and household information including age, marital status, education level, occupation, religion, ethnicity and relationship to study child. Where possible, child date of birth was verified with a Ghana Health Service weighing card or birth certificate. Data were also collected on caregiver income, household assets (including livestock and other belongings), dwelling materials, latrine facilities, crop harvests and timing of seasonal food shortages. Within-community household wealth rankings for the participating households had been completed by a concurrent project [51]. For each community, a group of opinion leaders and other community members agreed upon criteria to categorize households as belonging to low, medium or high wealth rank and assigned a level to each household. Criteria included factors such as the ability to lend money to others or send children to school. Interview-administered questionnaires with the caregiver were also used to collect information on child symptoms of illness in the past two weeks, including fever, cough (as well as cough with rapid breathing), diarrhoea and loss of appetite. Child weight was measured with a digital scale (model BWB-800, Tanita Corp., Tokyo, Japan) to the nearest 0.1 kg. Child height was measured with a vertical stadiometer (Shorr Board model, Irwin Shorr, Olney, USA) to nearest 1 mm. Both weight and height were measured in duplicate using standard methodology, taken with only light clothing [119]. An average of the two values was used.

Figure 4.1 shows the timeline of data collection along with the rains, floods and crop harvesting. Pre-harvest season data collection ended about a week before harvesting of the first

crops of the season began, in early August. Flooding began in late August and lasted into September. Post-harvest season data collection began in mid-November. Children were exposed to the harvest season for at least three and a half months, prior to post-harvest season data collection. Data were collected over two non-consecutive days, which were generally one day apart, on the same children in both the pre-harvest season (June – July, 2007) and the post-harvest season (November – December, 2007). Dietary data were collected on both days in each season and for each season an average of the two days of intake was used for all food, energy and nutrient intake variables. Household demographic information was collected mainly in the pre-harvest season. Anthropometric and morbidity data were collected in both seasons.

4.3.4   Statistical analysis

SYSTAT version 10 (SPSS Inc., Chicago, 2000) was used for all data analysis. Z-scores of anthropometric indicators were computed with WHO Anthro 2005 (WHO, Geneva, 2006) for children up to 60 months of age and Epi Info™ Version 3.4.3 (CDC, Atlanta, 2007) for children over 60 months. Paired Student's t-test was used to compare continuous data within individuals between seasons and McNemar's test was used to compare categorical data within individuals between seasons. Significant digits were reported as recommended by Truman [120]. Unless otherwise indicated, significance was set at p<0.05.

4.4   Results

There were 266 households with a child aged two to five years in the four study communities. Fifty-one were excluded because a household member was participating in a concurrent child nutrition intervention program in the community, which left 215 eligible child-caregiver pairs. A total of 194 were invited to participate and all of them were enrolled in the study. The remainder could not be located, mainly because the caregivers were farming, at the market or had traveled temporarily when the enumerators visited the household. Four cases were lost to follow-up during the second round of data collection; two moved to a different community, one traveled temporarily and one caregiver could not be located (although child anthropometry was

collected). One child refused the height measurement. Anthropometric data for five children were discarded because of recording errors (height and weight for three children and height only for five children). Demographic information for 191 children, dietary data for 190 children and anthropometric data for 188 children (height-related for only 185 children) were included in the analysis. The time between data collection in the two seasons ranged from 4.2 to 5.7 months, with a mean of 4.9 ± 0.3 months. Flooding occurred approximately two months prior to the post-harvest season data collection.

4.4.1 Household characteristics

In over 90% of cases, the household head was male (n=175) and the caregiver was the biological mother of the child (n=179). Almost all caregivers were married, and around one-fifth were in a polygamous marriage (Table 4.1). There was an average of approximately six people per household and just over half of households lived with extended family (n=104). Approximately 45% of households were considered low wealth rank and less than 5% high rank within their communities. Around two-thirds of household heads and caregivers had no form of formal education, and approximately 20% had attended, but not necessarily completed elementary school. Farming was the most common occupation for both household heads and caregivers. The second most common occupation for caregivers was trader or food seller at the market. One-third (n=71) of caregivers earned cash from their occupation. Around half of household heads and a third of caregivers (n=59) practiced a local traditional religion, the remainder of whom were Christian.

4.4.2 Seasonal food shortages

During the pre-harvest season, caregivers were asked to report the months of the year they experienced severe food shortages in the past year. There was a sharp increase in reports from February to March, a few months after harvesting ended (Figure 4.1). Reports remained high through July, and then tapered off during the beginning of the harvesting season.

4.4.3   Child morbidity

There were higher proportions of children with fever, cough and appetite loss in the post-compared to the pre-harvest season (Table 4.2). Of children who had a cough, the proportion whose cough was severe, with short or rapid breaths increased from 40.5% (n=17 out of 42) to 60.0% (n=25), although the change only approached statistical significance (p=0.059). In addition, the mean number of symptoms increased by almost one (0.8 ± 1.7, p<0.0001) in the post-compared to the pre-harvest season.

4.4.4   Child anthropometry

In over 90% of cases (n=173 out of 189) date of birth was verified with a weighing card or other government-issued document. From the pre- to post-harvest season, there was a significant drop in weight-related Z-scores (by 0.15 for WHZ and 0.06 for WAZ), although the mean HAZ significantly increased by about 0.08 (Table 4.3). There was no significant change in proportion of children with wasting between the two seasons, but the proportion of underweight increased by almost six percent. The 3% decrease in stunting did not reach statistical significance. Approximately 13% of children lost weight during this five month period. Of these children, the average weight loss was 0.3 kg. All children grew at least 1 cm in height in between the two data collection points. The average time between data collection was 4.9 ± 0.3 months.

Further analyses (Analysis of Variance with Bonferroni post-hoc tests) were performed to determine if weight-related Z-scores deteriorated more for children of a certain age (data not shown). Children were divided into age groups including two years (24.0 - 35.9 months, n=74 for WAZ and 71 for WHZ)), three years (36.0 – 47.9 months, n=62 for both WAZ and WHZ)) and four to five years (48.0 + months, including only five children between 60 and 69 months, n=51 for both WAZ and WHZ). For both WHZ and WAZ, the pre- to post-harvest change was more negative as the age group increased (p=0.014 and p=0.005, respectively), although post-hoc tests showed that the differences were only significant between the two and the four to five years of age groups (p=0.015 and p=0.004, respectively). In addition, Pearson's correlation tests showed small, but

statistically significant (or marginally significant) relationships between months of age and seasonal change in both WAZ and WHZ (r= -0.2, p=0.006 and r= -0.14, p=0.054, respectively). This information indicates that the weight-related indicators of nutritional status deteriorated more for older children from the pre- to post-harvest season.

4.4.5   Dietary intakes

Although total energy, protein and fat intakes increased from the pre- to post-harvest season (by 134 ± 534 kcal, p=0.001; 4.0 ± 17.5 g, p=0.002; and 6.0 ± 25.3 g, p=0.001, respectively), the increases relative to body weight for energy and protein and as a percentage of energy intake for fat did not reach statistical significance (Table 4.4). The percent of recommended intake of energy and fat increased in the post-harvest season, but only approached statistical significance for protein. The change in vitamin A intake was not statistically significant. Thiamine, riboflavin, niacin and calcium intakes increased in the post-harvest season, as did the percent of recommended intake for these nutrients. Conversely, both absolute intake and percent of recommended intake of vitamin C decreased by around 20%. The increase in iron intake only approached statistical significance. Although the absolute intake of zinc increased (by 0.8 ± 4.3 mg; p=0.014), the increase on a body weight basis was not statistically significant and the increase in percent of recommended intake only approached statistical significance.

Over half of energy, iron and zinc intake in the pre- and post-harvest seasons came from grains (Table 4.5). The main contributor in both seasons was *Tuo Zaafi*, which is maize or millet flour dough that is dipped into soups. Another important source of energy, zinc, and to a lesser extent iron, was groundnuts which were commonly consumed out of the shell as a snack or grounded as an ingredient in soups. The same foods or ingredients were contributing to energy, iron and zinc intake in both seasons. Almost all vitamin A intake came from plant sources, mainly green leaves and hot pepper.

There was a very slight increase in the number of times food was consumed per day from the pre- to post-harvest season (3.2 ± 0.7 to 3.4 ± 0.7; p=0.017). There was no nutritionally significant change in the number of meals consumed per day (2.7 ± 0.5 to 2.8 ± 0.6; p=0.035) or

dietary diversity (5.2 ± 0.7 to 5.3 ± 0.8; p=0.049). There was no change in the number of snacks eaten (0.6 in both seasons; p=0.488).

4.5   Discussion

The unique aspect of this study is that it was able to assess diet, illness and anthropometric nutritional status in the pre- and post-harvest seasons, in a year when severe flooding occurred while crops were being harvested. Pre-harvest season data were collected in June and July, 2007, the first two months of the rainy season (Figure 4.1). Harvesting of the first crops of the year began in early August, and continued through December. In late August and September, the study area was heavily flooded. Post-harvest season data collection took place in November and December, which was the dry season.

4.5.1   Energy intakes

The increase in energy intake across seasons was small, around 135 kcal (10 percent), or 5 kcal/kg (five percent) when corrected for body weight (8% of the recommended intake). In Bangladesh, post-harvest season energy intake in children was one-third higher than the pre-harvest intakes [127]. The small change seen in this study is likely due to flood-related loss of household crops in the study communities. Although small, the increases in intakes are somewhat surprising considering the extent of the observed and reported crop losses. However, when asked who priority is given to when food is limited, almost all caregivers responded 'children'. 'They cannot withstand hunger' was a commonly reported reason. It is possible that adults in the households, or just caregivers, sacrificed for their young children. This is further supported by the finding in this study that weight-for-height and weight-for-age decreased more for older children than younger children. A study in Peru showed less seasonal variation in dietary intakes of children compared to adults' dietary intakes, indicating that children were actually protected during times of food stress [128]. Although the flooding damaged crops and food stores, some was able to be salvaged and this natural disaster did not have a large negative effect on the children's diets in the post-harvest season. However, it is likely that due to the flood damage, this year's harvest will not

last as long as usual and the annual pre-harvest or 'lean' season will start earlier and be more severe than normal.

4.5.2   Anthropometric nutritional status

Weight-for-height Z-scores decreased by an average of 0.15. To take the example of a four year-old girl whose height was increasing at the expected trajectory over a period of five months, this means she gained 0.25 kg less weight during this time than she should have if her WHZ stayed on its original path. The average WAZ decreased by 0.06. As WHZ is more of an acute indicator of nutritional status than WAZ, it is not surprising that a greater change was seen in WHZ between the two seasons. An examination of seasonal changes in WHZ has been shown to increase from the pre-harvest to the post-harvest season in rural Ethiopian children (up to five years of age), indicating an improvement in nutritional status [108]. The same pattern was seen in Malian children [11]. The opposite effect was seen in this study. Energy and micronutrient intakes generally increased, therefore the weight-related Z-scores might be expected to increase as well, or at least remain the same. The changes make sense, however, when considering that symptoms of illness also increased, indicating children were sicker during the post-harvest season. There was a small but significant negative correlation (r=-0.152; p=0.038) between number of post-harvest illness symptoms and pre- to post-harvest season change in WHZ. Also, children with one or more post-harvest illness symptoms showed greater drops in WHZ from the pre- to post-harvest season than children with no illness symptoms (-0.20 WHZ, n=155 vs. -0.02 WHZ, n=31; p=0.097), although the difference only approached significance, which may have been due to the small number of children with no illness symptoms. These findings indicate that the more ill children were, the more weight they lost, and that children with reported symptoms of illness lost more weight than children with no reported symptoms of illness.

Illness can affect energy status, and therefore weight, through a variety of mechanisms including: anorexia and cultural/therapeutic practices resulting in decreased energy intake, nutrient malabsorption and intestinal loss, as well as fever and other metabolic effects [129]. With a fever for example, for each one degree Celsius increase in body temperature, there is a 13% increase in basal metabolic rate [130]. In the Gambia, malaria and diarrhoeal disease (by -746 g/mo and -1072

g/mo, respectively), but not respiratory infections, contributed significantly to weight faltering in young children [131].

Children's HAZ increased over the course of the study. As an indicator of long-term nutritional status, it is not surprising that this variable increased while the more acutely sensitive WHZ and WAZ decreased. In Peruvian children, HAZ has been shown to start a gradual increase from the age of two years [132]. Rates of stunting in Ghanaian children nationwide show a general downward trend from two to five years [45]. Also, in a study of seasonal changes in nutritional status of Malian children, HAZ was shown to generally increase from pre- to post-harvest time [11].

4.5.3   Morbidity

This study found that illness generally increased from the pre-harvest to the post-harvest season. These rises were seen specifically in fever and appetite loss, both indicative of malaria in this population, as well as cough and severe cough, which are common symptoms of acute respiratory infection (ARI).

The findings on fever and appetite loss, if indicative of malaria, fit with other research on season and morbidity. Normally, malaria transmission starts around two months after the start of the wet season and then ends around two months after the peak rainfall [133]. This area of Ghana experiences year-round transmission [134], which explains why malaria rates were so high at the beginning of the rains. Research in other communities in this district of Ghana have shown around half of children (aged two to five years) tested positive for malaria parasites in the 'low transmission' season at the end of the dry season (May) and around three-quarters in the 'high transmission' season after the end of the wet season (November) [135]. A much lower proportion had fever at the time of testing.

Sharp increases in malaria incidence are common post-flooding [136]. Flooding can initially wash out mosquito breeding grounds, but once waters recede can result in expansion sites for breeding. The lag-time prior to a post-flooding malaria epidemic is normally around six to eight

weeks [137]. The flooding in the study sites potentially contributed to the rise in, and exacerbated the seasonal influence on malaria-related symptoms.

Reports of cough more than doubled across seasons in this study. ARI often has two seasonal peaks; one at the end of the wet season and one in the cooler, dry season, otherwise known as the *harmattan*, which may be indicative of different responsible pathogens [138]. Post-harvest season data collection for this study occurred around two months after the end of the wet season, and just as the *harmattan* season was beginning. So, the rise in ARI was not expected. Flooding may have contributed to the extended cough season however. Respiratory infections more than tripled in India after flooding [139].

4.6　　Conclusion

It is not possible to separate the effects of season and the floods on children's morbidity, nutritional status and diets in this study. It appears that the flooding may have exacerbated or extended the wet season's effect on illness. Although diets generally improved from the pre- to post-harvest season, acute nutritional status deteriorated, which was likely due to increased illness. The knowledge that past flooding may have led to decreased child nutritional status in the post-harvest season, a time when nutritional status should normally improve, can help plan for future natural disasters to improve the effectiveness of response and help protect this vulnerable population.

Figure 4.1 Proportion of households with children 2 to 5 y of age in northern Ghana reporting monthly food shortages in the past year and timeline of rainfall, data collection, flooding and harvesting
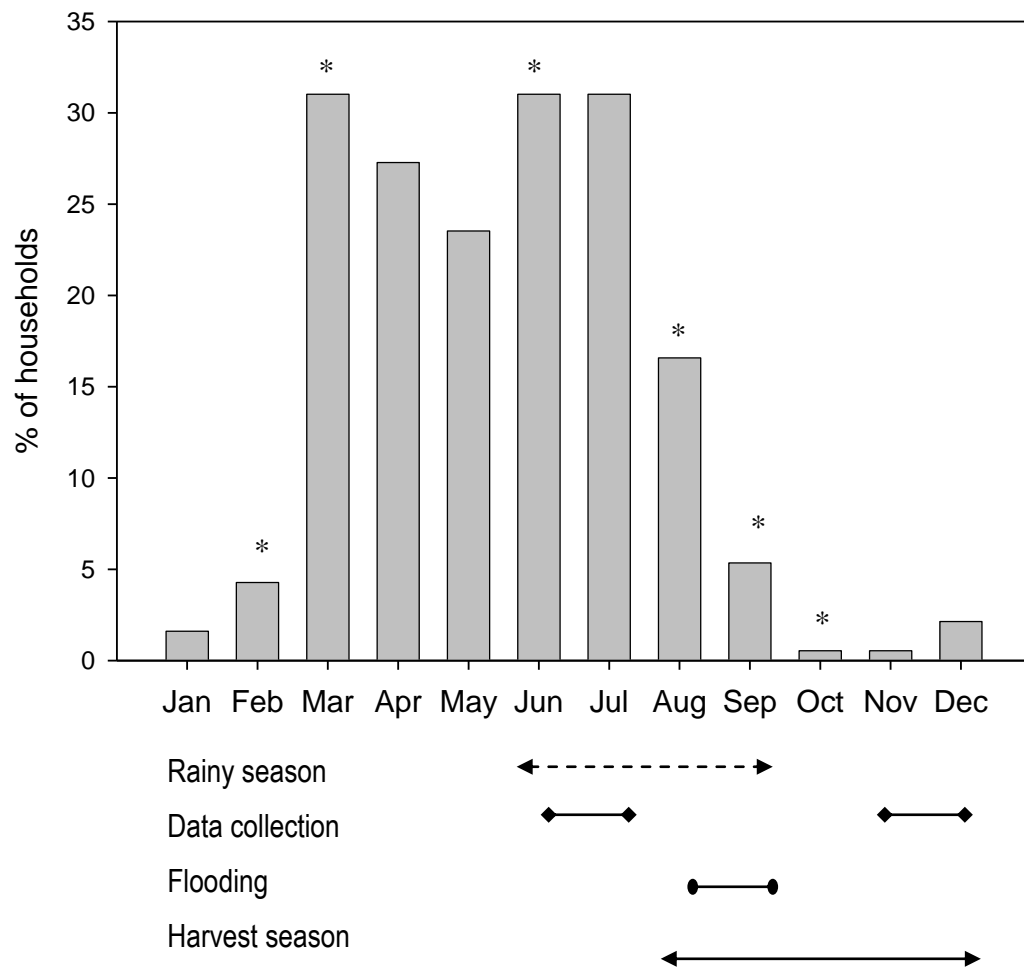
* p<0.05 and refers to comparison with previous months (McNemar's test for within-individual changes between two time points)

Table 4.1 Demographic characteristics for household with children
2 to 5 y of age in northern Ghana (n=191)

	% (n)	
Wealth rank[1]		
Low	44.7	(85)
Medium	51.6	(98)
High	3.7	(7)
Household head		
Education[2]		
None	66.3	(124)
Elementary	18.7	(35)
Junior high	9.1	(17)
Senior high or higher	5.9	(11)
Occupation		
Farming	85.3	(163)
Salaried worker	5.2	(10)
Fishing	3.1	(6)
Other	3.7	(7)
None	2.6	(5)
Ethnicity		
Kassena/ Nankana	69.1	(132)
Bulsa	30.9	(59)
Religion		
Traditional	53.4	(102)
Christian	46.6	(89)
Caregiver		
Marital status		
Married (monogamous)	70.5	(134)
Married (polygamous)	21.6	(41)
Unmarried/separated	7.9	(15)
Education		
None	64.9	(124)
Elementary	20.4	(39)
Junior high	11.5	(22)
Senior high or higher	3.1	(6)
Occupation		
Farming	73.8	(141)
Trader/food seller	14.6	(28)
Fish mongering	4.2	(8)
Other	4.7	(9)
Not working	2.6	(5)

[1]n=190

[2]n=187

Table 4.2 Reported symptoms of illness in the past two weeks of children 2 to 5 y of age in northern Ghana, by season (n=186)

	Pre-harvest		Post-harvest[1]		p-value[2]
	% (n)				
Fever	47.3	(88)	73.1	(136)	<0.0001
Cough	27.4	(51)	62.4	(116)	<0.0001
Diarrhea[3]	18.9	(35)	19.4	(36)	0.884
Appetite loss[3]	35.1	(65)	53.0	(98)	<0.0001

[1]Data collected after September 2007 flood
[2]McNemar's test for paired data
[3]n=185

Table 4.3 Anthropometry of children 2 to 5 y of age in northern Ghana, by season

	n	Pre-harvest			Post-harvest[1]			p-value[2]
		mean ± SD						
Age (mo)	187	40.7	±	10.3	45.7	±	10.2	
Weight (kg)	188	13.12	±	2.26	13.72	±	2.13	<0.0001
Height (cm)	185	92.8	±	7.3	96.0	±	7.1	<0.0001
Weight-for-age Z-score	187	-1.08	±	0.86	-1.14	±	0.81	0.008
Height-for-age Z-score	184	-1.42	±	0.92	-1.34	±	0.88	<0.0001
Weight-for-height Z-score	185	-0.40	±	0.85	-0.55	±	0.79	<0.0001
		% (n)						
Underweight[3]	187	12.3	(23)		18.2	(34)		0.016
Stunted[4]	184	27.2	(50)		24.4	(45)		0.096
Wasted[5]	185	2.7	(5)		2.7	(5)		0.999

[1]Data collected after September 2007 flood

[2]Student's t-tests for paired continuous data and McNemar's tests for paired categorical data

[3]Weight-for-age Z-score < -2 standard deviations

[4]Height-for-age Z-score < -2 standard deviations

[5]Weight-for-height Z-score < -2 standard deviations

Table 4.4 Daily intake and percent of recommended daily intake of energy and selected nutrients for children 2 to 5 y of age in northern Ghana, by season

	Recommended daily intake[1]	Average daily intake (n=190)			% recommended daily intake (n=189)		
		Pre-harvest	Post-harvest[2]	p-value	Pre-harvest	Post-harvest[2]	p-value[3]
		mean ± SD			mean ± SD		
Energy (kcal/kg)	71.5 – 83.6[4]	87.0 ± 33.5	91.9 ± 29.3	0.103	110.4 ± 41.6	118.8 ± 37.4	0.032
Protein (g/kg)	1.06 – 1.17[5]	2.66 ± 1.08	2.80 ± 1.08	0.147	242.6 ± 97.2	259.1 ± 99.0	0.069
Fat (% of energy)	25 – 30[6]	24.6 ± 7.4	26.2 ± 9.2	0.079	86.4 ± 27.0	94.9 ± 34.6	0.008
Vitamin A (RE)	400 – 450[7]	356 ± 281	382 ± 296	0.290	86.6 ± 69.6	90.7 ± 72.0	0.473
Thiamine (mg)	0.5 - 0.6[8]	0.72 ± 0.33	0.81 ± 0.34	0.004	136.0 ± 62.3	149.6 ± 63.3	0.031
Riboflavin (mg)	0.5 - 0.6[8]	0.42 ± 0.18	0.51 ± 0.23	<0.0001	80.2 ± 33.8	95.0 ± 42.7	<0.0001
Niacin (NE)	6 – 8[8]	10.4 ± 5.0	12.5 ± 6.1	<0.0001	160.1 ± 77.4	185.0 ± 94.4	0.003
Vitamin C (mg)	30[8]	32.4 ± 15.7	25.9 ± 24.1	0.001	108.1 ± 52.4	86.4 ± 80.2	0.001
Calcium (mg)	500 – 600[8]	564 ± 226	769 ± 444	<0.0001	107.4 ± 43.2	142.3 ± 81.9	<0.0001
Iron (mg)	11.6 - 12.6[8,9]	20.4 ± 8.3	21.9 ± 8.6	0.061	171.8 ± 70.1	181.8 ± 181.8	0.151
Zinc (mg/kg)	0.38 - 0.46[8,10]	0.64 ± 0.26	0.66 ± 0.25	0.349	147.7 ± 59.0	157.2 ± 58.4	0.091

[1]Ranges reflect requirements of different age groups (by sex and 2 y age groups for energy, by 2 y age groups for protein, 1-3 and 4-18 y for fat and 1-3 and 4-6 y for micronutrients)
[2]Data collected after September 2007 flood
[3]Using paired Student's t-test
[4]Estimated requirement (reference [111])
[5]Mean safe level of intake (reference [125])
[6]Minumum end of Acceptable Macronutrient Distribution Range (reference [126])
[7]Recommended safe intake (reference [124])
[8]Recommended nutrient intake (reference [124])
[9]Based on 5% dietary iron bioavailability (reference [124])
[10]Based on low dietary zinc bioavailability (reference [124])

Table 4.5 Top five foods/ingredients contributing to energy, iron, zinc, and Vitamin A intake in children 2 to 5 y of age in northern Ghana, by season

	Energy		Iron		Zinc		Vitamin A		
	% of intake	kcal/100g[1]	% of intake	mg/100g[1]	% of intake	mg/100g[1]	% of intake	RE/100g[1]	Average daily intake (g)[2]
Pre-harvest									
Tuo Zaafi[3]	29.1	95	50.0	3.0	32.9	0.8	---	---	341.3
Groundnuts	19.7	571-588	7.2	3.2-4.2	15.6	3.4	---	---	38.1
Rice (cooked)	18.5	116	4.3	0.5	12.9	0.6	---	---	178.1
Fats/oils	4.0	873-900	---	---	---	---	---	---	4.9
Fish	3.3	95-403	---	---	---	---	---	---	11.6
Green leaves (fresh)	---	---	13.0	2.9-7.2	13.3	0.4-3.0	20.4	192-519	37.5
Shea fruit	---	---	4.7	5.4	---	---	---	---	17.9
Dawadawa[4]	---	---	---	---	4.2	5	---	---	7.0
Hot pepper (fresh)	---	---	---	---	---	---	46.6	3540	4.7
Red palm oil	---	---	---	---	---	---	16.3	6000	1.0
Vitamin A fortified oil	---	---	---	---	---	---	4.1	750	1.9
Tomato (fresh)	---	---	---	---	---	---	3.8	135	10.0
Post-harvest[5]									
Tuo Zaafi	26.6	95	48.0	3.0	31.0	0.8	---	---	350.2
Groundnuts	22.2	571-588	8.4	3.2-4.2	18.1	3.4	---	---	48.0
Rice (cooked)	15.0	116	---	---	10.7	0.6	---	---	161.8
Fats/oils	4.4	873-900	---	---	---	---	---	---	6.2
Gari[6]	3.9	350	---	---	---	---	---	---	13.8
Green leaves (dry)	---	---	8.7	12.5	11.3	6.7	10.8	274	15.2
Green leaves (fresh)	---	---	5.3	5.3-7.2	5.0	0.5-3.0	9.5	192-429	16.7
Okra (dry)	---	---	5.0	23.0	---	---	---	---	4.8
Hot pepper (fresh)	---	---	---	---	---	---	28.2	3540	3.1
Hot pepper (dry)	---	---	---	---	---	---	22.7	4161	2.1
Red palm oil	---	---	---	---	---	---	14.4	6000	0.9

Table 4.5 continued

[1]Range reflects different foods or ingredients grouped together
[2]Average intake of the group, not only those who consumed the particular food or ingredient
[3]Maize or millet flour dough
[4]Fermented locust bean
[5]Data collected after September 2007 flood
[6]Dried cassava powder

5.   Bridge

        Children's diets and health may suffer during periods of transient food insecurity. One potential mechanism for ameliorating the negative effects of food scarcity on child wellbeing is to supplement children's diets with foods from outside the home. School feeding programs (SFP) are one example that could specifically target young children. In areas with chronic food insecurity, SFP offered throughout the school year may enhance children's diets, thereby promoting healthy growth year-round. Established programmes would supplement children's home diet during seasonal food shortages, thereby helping to protect children from seasonal perturbations in growth. In addition, they would buffer the effects on children's diets of unanticipated food scarcity, such as during and after a severe flood that destroys crops and local food stores. Research on the effects of SFP on young children's diets may provide insights on how to enhance child health and wellbeing in areas that experience transient and/or chronic food security.

6. **Manuscript II: Participation in informal daycare centre feeding programs is associated with higher energy, calcium, iron and zinc intakes in rural Ghanaian children**

Kimberly Harding[1], Grace S Marquis[1, 2], Esi K Colecraft[2,3], Anna Lartey[3] and Owuraku Sakyi-Dawson[4]

[1]School of Dietetics and Human Nutrition, McGill University, Ste-Anne-de-Bellevue, Quebec, Canada

[2]Department of Food Science and Human Nutrition, Iowa State University, Ames, IA, USA

[3]Nutrition and Food Science Department, University of Ghana, Legon, Ghana

[4]Department of Agricultural Extension, University of Ghana, Legon, Ghana

Corresponding author:

Grace S. Marquis
Centre for Indigenous Peoples' Nutrition and Environment
School of Dietetics and Human Nutrition
Macdonald Campus, McGill University
21, 111 Lakeshore Rd.
Ste. Anne-de-Bellevue, Quebec
Canada H9X 3V9
Email: grace.marquis@mcgill.ca

6.1   Abstract

Background: High levels of child malnutrition in sub-Saharan Africa are a major public health concern. School feeding programs (SFP) based on local foods brought by children from home and cooked and shared at school may be a sustainable food-based strategy for improving children's diets in poverty-stricken areas.

Objective: To compare the dietary intakes of children who attend daycare centres (DCC) with informal SFP and children who do not attend DCC in rural Ghana.

Methods: Interviewer-administered questionnaires were used to collect dietary (24-hr recall) and other household information for 104 DCC and 89 non-DCC children 2-5 y of age living in two communities.

Results: The DCC lunch meal was higher in energy (+64 kcal; $p<0.0001$), but lower in calcium (-18 mg; $p=0.002$), iron (-1.3 mg; $p<0.0001$) and zinc (-0.2 mg; $p=0.046$) than the non-DCC lunch. DCC children ate more times in a day (4.2 ± 0.8 vs. 3.4 ± 0.6, $p<0.0001$), had higher dietary diversity (7.2 ± 0.6 vs. 6.7 ± 1.0; $p<0.0001$) and higher daily intakes of energy (1140 ± 320 kcal vs. 878 ± 240 kcal; $p<0.0001$), protein (25.8 ± 8.8 g vs. 22.1 ± 7.0 g; $p=0.002$), calcium (282 ± 139 mg vs. 244 ± 118 mg; $p=0.048$), iron (12.4 ± 6.4 mg vs. 10.7 ± 4.7 mg; $p=0.048$) and zinc (0.40 ± 0.15 mg vs. 0.35 ± 0.11 mg; $p=0.019$) than their non-DCC counterparts. However, after controlling for total energy intake and other important variables, daily intakes of iron and zinc were lower in the DCC group. .

Conclusion: In low-resource communities, informal SFP could be introduced in pre-existing schools, with little to no additional resources available for feeding programs, to enhance children's diets. Informal SFP also provide the opportunity, with minimal additional support and education to improve the meal quality, to address specific population's micronutrient needs.

6.2 Introduction

High levels of child malnutrition are a major public health concern worldwide. Approximately one-third of all child deaths can be attributed, either directly or indirectly, to malnutrition [140]. Sub-Saharan Africa, where almost half of all child deaths occur, is a region of particular concern, especially rural areas that account for the majority of child deaths [141, 142].

To address malnutrition in early life, locally appropriate and food-based solutions are needed [143]. School feeding programs (SFP) based on local foods provide a potential sustainable opportunity to improve children's diets. Existing research on SFP focuses on formal government or institution-supported programs which follow structured feeding guidelines, aimed to meet a set proportion of children's nutrient requirements [60-63]. Improved diet [61, 62] and nutritional status [63, 68, 69] of participating children have been documented in formal SFP. Findings on other potential benefits of these programs include increased attendance [61, 69, 72] and enhanced cognitive or academic performance [65, 67, 69, 73]. However, little research exists on less formal SFP, where the meal is made with ingredients that children bring from home which are cooked at school and shared amongst everyone [64]. Such informal programs may also require children to contribute fuel wood for cooking or money to buy additional ingredients or pay for the milling of grains.

SFP can have important educational implications. Nutritional status is a determinant of time of entry into school in low-income countries, likely because parents deem their malnourished, or physically small children not yet ready for school [70]. Earlier entry into school predicts higher grade attainment, even after controlling for preschool cognitive abilities and household socioeconomic status [71]. If preschool feeding programs can enhance child nutrition, and subsequent parental views of their children's physical maturity, such programs may reduce delayed enrolment and enhance success in school. In addition, increased attendance and duration of schooling gives the child more opportunity to learn which can improve educational outcomes [67]. Hunger can have deleterious effects on cognitive performance [65], and certain micronutrient deficiencies can have negative impacts on cognitive development in children [49, 75], so alleviation of either could also enhance success in school [67].

Although research on the benefits of SFP has been limited to formal programs, it is possible that these benefits could be seen with informal programs as well. Effective feeding programs for preschoolers is one potential mechanism to reduce the large proportion of young children with growth deficits in countries such as Ghana, which have high levels of child malnutrition [45]. Research in this area has important policy implications in low-resource settings where poverty is prevalent. The objective of this study was to determine whether children who attend DCC with informal SFP had different dietary intakes compared to children who did not attend any school. It was hypothesized that DCC children would have higher energy intake and dietary diversity than their non-DCC peers.

6.3   Methods

6.3.1   Study sites

Study sites were located in the Techiman district of the Brong-Ahafo region, which is located in the Forest-Savannah Transition zone of mid-country Ghana. Data were collected in two rural farming communities, Fiaso and Nkwaeso, which had significant populations of migrants from northern Ghana. In Fiaso, there was no electricity. Nkwaeso had electricity, although not all households had access. In both communities, the main water source was boreholes and hand-dug wells and households had their own or shared latrine facilities. Both sites also had one community-run DCC with an informal SFP. In Fiaso, there was a three-day rotation of lunches: bean stew with *gari* (cassava powder), *jollof* rice (rice made with red palm oil , tomatoes, hot pepper, onion and sometimes dried fish) and boiled yam with *kontomire* (cocoyam leaves) stew. Each day, children were required to bring the equivalent of US$ 0.10 for ingredients as well as a piece of firewood for cooking. On days when yam is served, children were also required to bring a piece of uncooked yam. In Nkwaeso, boiled yam with *kontomire* stew was served everyday. There, children were required to bring a piece of uncooked yam, some *kontomire* leaves and a piece of firewood for cooking every day. They were also required to bring the equivalent of US$ 0.10 once a week to cover the cost of other ingredients such as red palm oil and salt. No foods from external sources were provided to either DCC feeding programs.

6.3.2 Participants

All children were between two and five years of age at the time of enrolment. Children were categorized as 'attenders' of the community DCC (were on the attendance list and attended according to the caregiver) or 'non-attenders' (not on the DCC attendance list and never attended according to caregiver). Children were excluded from the study if a household member was participating in another concurrent child nutrition intervention program in the community. Children attending an educational institution other than the participating DCC were also excluded. The intended sample size was 100 DCC 'attenders' and 100 DCC 'non-attenders'.

DCC children were randomly selected from DCC registration lists. Non-DCC children were randomly chosen from the community census lists, matching the age demographics of the DCC children (2, 3, 4 and 5 years). If more than one child in the age range resided in a household, the participating child was randomly selected. This was done by assigning each eligible child in one household a number, writing those numbers on pieces of paper then choosing one piece of paper out of a bag. DCC attendance was checked the day prior to enrolling a DCC caregiver, or previous day's attendance was confirmed with the caregiver on the day of interview to ensure the dietary recall would capture a DCC day. The objectives were explained to the caregiver and they were invited to participate. Written informed consent was attained from all caregivers for their and their child's participation. This study was approved by the institutional review boards at McGill University, Iowa State University, and the University of Ghana.

6.3.3 Data collection

Food intake measures

Children's food intakes on the previous day (at home and elsewhere) were estimated using two 24-hour dietary recalls (on non-consecutive days, generally one day apart). The caregiver was asked to report all foods, except water, consumed by the child on the previous day. Common household units (bowls, cups, spoons) were used to estimate quantity consumed. For mixed dishes prepared by the caregiver, household units were used to estimate ingredient quantity. After

data collection, the household units were used to weigh local samples of all reported ingredients and foods on a food-weighing scale to the nearest 0.1 grams (Ohaus Corp., Pine Brook, USA) to convert the unit estimations to weights. For mixed dishes, the amount of each ingredient the child consumed was calculated from the child's portion size as a fraction of the total weight of the preparation. Water loss with cooking was taken into account in the calculations, and based on locally prepared recipes. Recalls were collected from Tuesday through Saturday, to reflect weekday dietary intakes.

On the day prior to conducting in-home interviews, the DCC lunch was observed. All ingredients in the preparation were weighed and five servings of each lunch food serving were weighed to estimate the average serving size. Data collection took place at the beginning of the school year so many children were new to the DCC and the staff were often unable to identify them, making observations of individual children's lunch consumption difficult. Therefore it could not be determined how much of the DCC lunch servings the participating children consumed. In order to account for this, a month after data collection, the directors were asked about the eating habits of the participating children and asked to observe their eating habits at one lunch-time. This data were collected at this time so as to allow for time for the directors to get to know the children and their eating habits better.

According to DCC director comments and project staff observations, DCC children in Fiaso generally finished the food served to them and never received extra servings. Therefore if a Fiaso caregiver said that their child ate lunch at the DCC on a given day, the child was assumed to have consumed the average lunch serving size. In Nkwaeso however, according to staff, some children regularly did not finish the food served to them while others often received an extra serving if they were still hungry. A list was made of children who usually ate what was served to them, those who received an extra serving, and those who did not finish what was served to them. The DCC staff estimated the serving portion consumed by the groups of children who ate more and the group who ate less than originally served (group, not individual estimates were made). It was assumed these estimates represented that amount of food consumed during data collection, a month prior to this time. If a DCC child consumed the school lunch on the recall day, the DCC foods served were added to those foods that were consumed at home and were reported by the caregiver. Nutrient

intakes were calculated from local food composition tables for Ghana and other West African nations as well as other published composition data [53, 113-115]. Food composition information for vitamin B_{12} was not consistently available, and so was not included in the final analysis. FAO/WHO reference values were used for energy and all nutrients [111, 124, 125] with the exception of fat, for which the Institute of Medicine reference value was used [126]. Percents of recommended nutrient intakes were calculated on an individual level, taking into account sex, age, weight and height, as appropriate.

Dietary diversity was calculated from the 24-hour dietary recalls using the following food groups: 1) grains, 2) roots and tubers, 3) legumes, pulses and nuts 4) vitamin A-rich fruits and vegetables (containing greater than 130 retinol equivalents (RE) per 100 grams [116]), 5) other fruits and vegetables, 6) dairy, 7) meat and poultry, 8) fish, 9) egg and 10) fats and oils. This grouping is adapted from ones used for children in several different African nations [59, 117]. Because of the importance of animal source foods (ASF) in the diets of children living in low income countries, it is common to separate such foods into several categories [58, 59].

Eating events were defined by the caregiver and reported in sequence with an estimated time of consumption in the 24-hour dietary recall. Each eating event was later defined as a meal or snack based on the types of foods consumed. Definitions were determined based on those appropriate in a Ghanaian setting in which a meal is considered to consist of a starchy staple accompanied by a sauce such as a soup or stew. An exception was *koko*, a thin porridge usually made from fermented maize or millet dough, which is a common breakfast food. Snacks were defined as any other food consumed apart from meals. Definitions were based on type of food alone, regardless of amount or time consumed. The lunch meal was defined based on the time of day. For DCC children, lunch was the DCC meal. For non-DCC children, lunch was considered the first meal food consumed between 11am and 4pm. If no meal was consumed during this time, the first snack eaten was considered the lunch meal. This timing was based on patterns of food consumption within the population observed from 24-hour dietary recalls. For all dietary variables (food, energy and nutrient intakes), an average of the two days of intake was used in the analysis.

Other information

Interviewer-administered questionnaires with the caregiver were used to collect demographic and household information including age, marital status, education level, occupation, religion, ethnicity and relationship to child. Whenever possible, child date of birth was verified with a Ghana Health Service (GHS) weighing card or birth certificate. Data were also collected on caregiver income, household assets (including livestock and other belongings), dwelling materials, latrine facilities and crop harvests. Within-community household wealth rankings for the participating households had been completed by a concurrent project [51]. In each community, a group of opinion leaders and other residents agreed upon criteria to categorize households as belonging to low, medium or high wealth rank. Criteria included factors such as the ability to send children to school or lend money to others. The group assigned a rank to each household. Interviewer-administered questionnaires with the caregiver were also used to collect information on child symptoms of illness in the past two weeks, including fever, cough (as well as cough with rapid breathing), diarrhoea and loss of appetite. Interviewer-administered questionnaires were also used to collect information on caregivers' reasons for sending, or not sending, children to DCC, as well as perceptions of and opinions on the DCC feeding program.

Child weight was measured with a digital scale (model BWB-800, Tania Corp., Tokyo, Japan) to the nearest 0.1 kg. Child height was measured with a vertical stadiometre (Shirr Board model, Irwin Shirr, Olney, USA) to the nearest 1 mm. Both weight and height were measured in duplicate using standard methodology, taken with only light clothing [119]. An average of the two values was used. A haemoglobin (Hb) photometer (HemoCue Inc, California, USA) was used to measure Hb with capillary blood from a finger prick. The caregiver was given the results of the test and anaemic children (< 11 g/dL) were referred to the nearest GHS provider for treatment. Data collection took place in late September and October, 2007.

6.3.4   Statistical analysis

SYSTAT version 10 (SPSS Inc., Chicago, 2000) was used for all data analysis. Z-scores of anthropometric indicators were computed with WHO Anthro 2005 (WHO, Geneva, 2006) for children up to 60 months of age and Epi Info™ Version 3.4.3 (CDC, Atlanta, 2007) for children over 60 months. For bivariate analysis between groups, Students t, Wilcoxon-Mann Whitney and chi-squared tests were used where appropriate. Multiple linear regression was used to determine if attending DCC remained an important determinant for the intake of energy, iron, zinc and calcium, after controlling for other determinants. The a priori conceptual framework (Figure 2.1) and observations during data collection drove which variables were tested in the regression models. Bivariate tests between potentially important predictor variables and DCC attendance status as well as the outcomes of interest were performed. Those found to be statistically significant, or approaching significance, were tested in the model. Data were reported to the number of significant figures as suggested by Truman [120]. Unless otherwise indicated, significance was set at p<0.05.

6.4   Results

There were 140 DCC and 226 non-DCC child-caregiver pairs in the two communities who were eligible for the study. A total of 203 child-caregiver pairs were invited to participate and all of them were enrolled in the study. Ten pairs were subsequently excluded, either because it was discovered that the child attended kindergarten or because the child attended DCC but we were unable to collect dietary information for a day on which they attended. Data for 193 child-caregiver pairs (104 DCC and 89 non-DCC) were included in the analysis.

6.4.1   Household characteristics

There were no significant differences in any household, caregiver or household head characteristics between the DCC and non-DCC groups (Table 6.1). Slightly over half of households were considered low wealth rank within their communities. In over 90% of cases, the

caregiver was the child's birth mother (n=178), the caregiver was married and the household head was male (n=177). Around half of caregivers and two-thirds of household heads had some form of formal education and had attended, but not necessarily completed, primary school. The most common primary occupation for both household heads and caregivers was farming. Almost all households (n=174 out of 188) were involved in some type of crop farming. Households produced an average of around seven crops, the most common of which were maize, cassava, cocoyam and yam, followed by plantain, hot pepper and okra. Around two-thirds of household heads had migrated to the area, and belonged to tribes from northern Ghana.

6.4.2   Child characteristics

Although children in the DCC group were on average about three months older than the non-DCC children (p=0.051), the one-half kilogram difference in average body weight between the two groups did not reach statistical significance (p=0.075, Table 6.2). In over 90% of cases (n=175 out of 188), date of birth was verified with a weighing card or other government-issued document. There were no significant between-group differences in anthropometry, whether reported as weight- or height-related Z-scores or proportion of wasted, stunted or underweight. The non-DCC group had almost 20% more children with anaemia, but the between-group difference in Hb levels (0.4 g/dL) did not reach statistical significance (p=0.068).

In both groups, approximately 60% of children had at least one symptom of illness in the past two weeks (Table 6.2). There were no significant differences in the proportion of children with fever, cough or diarrhoea between the two groups. The non-DCC group had over 10 percent higher reports of appetite loss, although the difference did not reach statistical significance (p=0.073).

6.4.3   Dietary intakes

Children who attended DCC had higher intakes of energy and protein, both on an absolute and a relative (to body weight) basis (Table 6.3). Although absolute intake of fat was higher in the DCC group, there was no significant between-group difference when fat intake was expressed as a percent of energy. The DCC group had higher intakes of vitamin A, thiamine, vitamin C, calcium, iron and zinc. Riboflavin and niacin intakes tended to show similar patterns ($p=0.08$ and $p=0.10$ respectively). The DCC children consumed a higher proportion of their recommended intake of energy, protein, vitamin A, thiamine, vitamin C and zinc than the non-DCC children (Table 6.3). The differences for calcium and iron followed the pattern of the other nutrients ($p=0.089$ and $p=0.076$ respectively).

For protein, vitamin A and vitamin C, both groups consumed, on average, at least 150% of the recommended intakes (although in each case the DCC group consumed significantly more than the non-DCC group) (Table 6.3). For energy, thiamine, niacin, iron and zinc, both groups consumed between 80% and 110% of the recommended intake. Both groups had low intakes of fat, thiamine and calcium (all below 75% of the recommended intake). The nutrient of greatest concern was calcium. For the average child, intakes only met approximately 50% of recommended daily intake.

The DCC children ate almost one more time (0.8) in a day compared to their non-DCC peers (Table 6.4). Over 90% of the time, when a child consumed food, it was a meal not a snack. The median number of snacks consumed was zero for both groups. DCC children had, on average, greater dietary diversity but consumed 10 grams (25%) less ASF than the non-DCC children.

The DCC lunch meal was higher in energy (+64 kcal; $p<0.0001$), fat (+2.6 g; $p<0.0001$), vitamin A (+199 RE; $p<0.0001$), thiamine (+0.06 mg; $p<0.0001$) and riboflavin (+0.02 mg; $p=0.024$), but lower in calcium (-18 mg; $p=0.002$), iron (-1.3 mg; $p<0.0001$) and zinc (-0.2 mg; $p=0.046$) than the non-DCC lunch. These between-group differences were likely due to the inclusion of red palm oil in the DCC lunches, contributing to higher energy, fat and vitamin A content, and higher overall

intakes of ASF in the non-DCC group, which are concentrated sources of iron, zinc and calcium. Looking at the average daily intakes, not including the lunch meal, the DCC children consumed higher amounts of energy, protein, fat, vitamin A, thiamine, vitamin C, calcium, iron and zinc. This likely reflects the fact that the DCC children are eating more times in the day, showing quantitative and not necessarily qualitative differences in the non-lunch diets.

Further analyses were performed on energy, as a quantitative indicator of overall diet, and calcium, iron and zinc, as qualitative indicators of diet and because these are potential problem micronutrients in this population. Over 60% of energy and zinc, over 70% of iron, and over 40% of calcium intake came from starchy staples (Table 6.5). Although these foods have low energy and micronutrient density, average daily intakes were considerable.

Attending DCC remained a significant positive predictor of energy intake while controlling for other potentially confounding variables (Table 6.6). However, DCC did not predict calcium intake and became a negative determinant of iron and zinc intakes when other statistically significant variables were included in the model. Along with DCC attendance, other factors, including dietary diversity and ASF intake also showed a similar pattern of enhancing dietary quantity but decreasing quality, once other important factors were included in the model. As expected, child weight, dietary diversity and ASF intake were positive predictors of energy intake, currently being breastfed was a negative predictor of energy intake and energy intake was a positive predictor of iron, zinc and calcium intakes.

6.5   Discussion

6.5.1   Energy intakes

The reasons for the differences in energy intake between the DCC and non-DCC children are likely twofold. Firstly, DCC children ate more times in a day, allowing them more opportunities to consume food, regardless of amount or type. Secondly, the DCC lunch meals on average had higher energy content compared to the non-DCC lunches. These differences in part came from the

73

daily use of red palm oil (the average serving was around 7 g or 63 kcal which is almost equivalent to the difference in energy content of the DCC and non-DCC lunches).

Energy intakes among the DCC group were similar to those intakes (1122 kcal) previously reported for slightly older (59 ± 10 mo), preschool-aged rural Ghanaian children [47]. The differences in overall energy intake could have also been due to the DCC children being slightly older and heavier (although the differences were not significant) than the non-DCC children. However, when weight and other potentially confounding variables were included in the regression model for energy intake (age was not a statistically significant predictor in the model), DCC remained an important predictor of energy intake. After accounting for other factors, attending a DCC with an informal SFP in this setting increased energy intake by around 230 kcal, which is over 20% of the mean requirement of the group and around 25% more than the non-DCC energy intake. This is slightly higher than reported differences in other, formalized, SFP. A school breakfast program consisting of cookies and an instant drink in Peru reported a 15% difference in energy intake between those receiving the breakfast and the no-breakfast controls [61]. In Kenya, a formal school snack program which used four different groups (a no-snack control group, and isocaloric snacks of vegetable stew, stew served with milk, and meat stew) showed around a 20% increase in energy intake from the baseline in the meat group, which was 10% greater than the increase in energy intake of the no-snack control group [62]. The other groups showed decreased home intakes which negated the gains from the school snack.

These dietary differences between the DCC and non-DCC groups would be expected to be reflected in anthropometric indicators of nutritional status. There were no differences, however, which is likely due to the fact that data were collected within the first month of the new school year (comparison of anthropometric outcomes was not a main objective of this study because exposure to treatment, DCC lunches, was too short in duration to reasonably expect differences to be seen). Approximately 45% of the DCC children were returning back to school from a month-long summer break while the rest very recently started attending DCC for the first time. Those who started this year had been attending for an average of between two and three weeks at the time of data collection. More time would be needed before differences in weight, and particularly height, could be seen. In order to investigate this relationship further, Z-scores of last year's returning DCC

children (n=42) were compared to those of the non-DCC children (n=89). No statistically significant differences were found. However, returning DCC children were 4.7 months older than the non-DCC children (p=0.013), so a subgroup of comparable age was chosen for further analysis. Non-DCC children younger than 30 months were excluded, and there was no longer a statistically significant difference in age between the groups (p=0.679). Again, there were no differences in WAZ, HAZ nor HAZ between this age-group of returning DCC children (n=42) and non-DCC children (n=64). Because of the small sample size however, these tests may not be adequately powered.

6.5.2   Calcium, iron and zinc intakes

For both groups, calcium intakes were slightly lower and iron and zinc intakes were similar to those reported in previous studies of other rural preschool Ghanaian children (344 mg, 11.6 mg and 5.1 mg, respectively) [47]. Calcium intakes in both groups were low, the average was around half of the recommended intake. DCC children had slightly higher overall daily intakes but lower lunch intakes of calcium. The DCC lunches contained leafy greens, which are high in calcium, but were not likely to contain other important sources of calcium for this population such as rice, fish or *Tuo Zaafi (*maize or millet flour dough). The higher lunch intakes of calcium in the non-DCC children may have come from greater intakes of fish, which was the most commonly consumed ASF (non-DCC group had higher daily ASF intakes). Attending DCC was not a significant predictor of calcium intake when other important variables were included in the multiple regression equation. This fits with findings from the Kenyan SFP study, which showed increases in calcium intake only for the group that was given milk, a calcium-rich food [62].

Iron intakes were close to the recommended intake for a low (5%) iron-bioavailability diet. The non-DCC group's zinc intakes were approximately 20% below the recommended intakes for a low bioavailability diet, while the DCC group's intakes were only around 5% below. However, over 70% of iron intake and 65% of zinc intake came from starchy staples, mainly grains, which have very low bioavailability for both minerals.

High levels of anaemia may reflect the low iron bioavailability diet and high levels of illness, such as malaria and intestinal worm infestation [45]. It is unclear why the non-DCC group showed higher levels of anaemia than the DCC group given their higher intake of ASF. However, the ASF was mainly fish, which is not an iron-rich ASF. On the other hand, fish does contain haeme-iron which enhances the absorption of non-haeme iron in plant foods. There was a trend toward the non-DCC children having more appetite loss in the past two weeks. This difference may be because the caregivers of children who did not attend DCC were present for more meals so had more chances to notice changes in appetite. It does not appear to reflect higher rates of illness because reports of other symptoms of illness, including fever, did not differ between the groups.

The higher overall daily intake of iron and zinc in the DCC group was due to a greater number of meals consumed in a day. A 'meal' by definition included a starchy staple, which was the primary dietary source of iron and zinc. The overall difference in iron intakes is interesting considering that the non-DCC lunches contained more iron (by around 1.3 mg) than the DCC lunches. DCC lunches did not contain any foods which contributed substantially to the iron intake of this population or any iron-rich foods. *Kontomire* leaves were often served, but have low iron content (1.7 mg/100g) compared to many other leafy greens [113]. Non-DCC lunches were only about 0.2 mg higher in zinc. The DCC lunches often contained yam and sometimes rice, both important sources of zinc in this population (contributing 7.5% and 14.3% to overall intake, respectively), which may explain why the difference in zinc content between the DCC and non-DCC lunches was small compared to the differences in iron content.

The addition of energy intake to the regression model changes the interpretation of the beta coefficients for the other predictors. After accounting for energy intake and other important variables, attending DCC was a negative predictor of both iron and zinc intakes. These results indicate that attending DCC did not result in a qualitative improvement for these components of the diet, even though it did result in greater overall intakes of iron and zinc. Other SFP that have reported considerable increases in iron intakes have included iron-rich foods such as fortified cookies in Peru [61] and meat in Kenya [62]. The Kenyan SFP study also found that available zinc intakes increased for the meat stew group only, and actually decreased for the isocaloric vegetarian stew group, likely reflecting enhancing and inhibiting factors in the diet.

6.5.3   The daycare centre lunch

The average energy content of the DCC lunch was around 290 kcal, which is similar to other formalized SFP for school-aged children in India (grain and oil lunch, around 310 kcal) [63] and Kenya (snack of vegetable stew, stew with milk or meat stew, around 250 kcal) [62]. Although not designed to meet a certain proportion of the children's requirements, the lunches on average delivered almost 30% of the daily energy requirement, which is a reported goal for formalized school feeding programs [61, 144]. The iron, zinc and calcium content of the DCC lunch however fell short of the 30-100% goals of these feeding programs and were lower than the content of the non-DCC lunches, which were generally prepared and consumed at home. Caregivers often commented that foods cooked at DCC were inferior to those at home because the ingredients, such as tomatoes or fish powder, had to be shared among many children and also because the cook could not 'take her time' when preparing the food (data not shown). This somewhat negative evaluation may have been the reason many caregivers felt the need to serve their children a 'home-cooked' lunch again or buy something of their choosing once the child returned home from school in the early to mid-afternoon.

The process of supplementing a child's diet with food will not necessarily result in increased food or nutrient intake. Intended effects of SFP may be mitigated by changes in food allocation in the child's household or changes in the child's feeding behaviours throughout the day. This substitution may result in a decrease in the normal home diet. Given that DCC children ate more times in a day, it appears that no substitution took place in the present study. Children were often served a 'second lunch' upon returning home from school. These findings are consistent with other SFP studies which specifically report no substitution [61, 68, 103]. Other research on SFP however does report reduced home intakes with school food supplementation [63, 69, 102]. A Kenyan study reported that changes in home food consumption depended on whether the food provided was meat, milk or vegetable-based [62]. Substitution may depend on how the caregiver evaluates the school meal; the less adequate it seems, the more concerned the caregiver may be to feed the child upon returning home from school. The phenomenon is thought to be common so that recommendations for planning such programs call for the supplementary food to be adequate enough to compensate for potential home dietary intake losses from substitution [66].

6.5.4   Caregiver perceptions of DCC and feeding program

When asked about sending money, food and firewood to school, two-thirds of caregivers said they had no problem or did not mind, often stating because these goods were to be used for their child (data not shown). One-quarter reported that sending money on a regular basis was difficult and 5% stated that sending food and/or firewood was a challenge. All but two of the non-DCC caregivers were aware of the community DCC. When asked why they had not sent their child, 20% reported financial concerns, a quarter said their child was not ready yet (too young, could not talk yet or was still breastfeeding) and 40% claimed they were planning to send them soon. For DCC children, when asked why the family sent the child to DCC, over 80% of caregivers responded with a reason related to the child's education or future opportunities.

6.5.5   Methodological limitations

One major limitation of the study was the different method of dietary data collection for the lunch meal in both groups. Although similar procedures, using a combination of dietary recall and weighed intake data or the known nutritional content of the school meal for one group, and dietary recall only for another group, have been used in other SFP studies [61, 62]. The different methods of estimating dietary intakes may account for some of the between-group variation both in the lunch and overall daily intakes. The 24-hour recall method has been shown to underestimate intakes when compared to food weighing methods in Ghanaian infants [145]. Another study on preschool children's intakes in rural Kenya however has found no significant differences between the two methods [146]. It is not clear in the present study how accurate caregivers estimations were, or to what direction the bias was. However, even if the recall non-DCC lunches were underestimated compared to the weighed DCC lunches, the different methods could not account for all of the between group differences because the DCC children ate more times in a day than the non-DCC children. Therefore, daily energy and nutrient intakes could be expected to be higher in this group. Regardless, the results must be interpreted with caution.

6.5.6   Informal school feeding programs

Anecdotal evidence shows that some other DCC in Ghana have no feeding program whatsoever. In these cases, the children either do not eat until they return home in the afternoon, or they bring food from home to eat at school, or they bring money to buy food. If money is brought, it is often the same amount that was paid daily in Fiaso and weekly in Nkwaeso, and the children or their siblings decide what to buy with it. Some caregivers in the present study commented that they did not mind sending money to school for food because that money would otherwise be spent by their children on inadequate foods such as candies. The Jamaican SFP study reported that most schoolchildren who do not participate in SFP buy food from street vendors or stores [102]. It seems that informal SFP where children bring food and/or money to school, such as those seen in this study, may be an option in settings where there would otherwise be no school meal, and may a better option than children buying foods or not eating at all. Beyond a person to cook and a space to cook in, these programs require no inputs other than what families provide, so could be initiated in schools with no support available for feeding programs. With additional support however, and information on the 'best buy' [101] for local foods rich in micronutrients of concern in the population, the quality of the meals provided could be greatly improved.

It is possible however that informal SFP which require the sending of food or money would not be desirable for lower income, food insecure families who would then be less likely to send their children to school. Even formalized, government-funded SFP however may require children to pay for the school meal, for example in Jamaica [102]. In the present study, although most DCC caregivers said they had did not mind sending money, food and firewood to school, around one-fifth said this was challenging. For non-DCC caregivers, one-fifth said the reason they did not send their child to DCC was financial. It appears that sending money to school for lunch may pose a problem for some families; but a large majority did not object to the practice.

6.6   Conclusion

      In the present study, children who attended DCC with informal SFP had higher daily intakes of energy and several micronutrients, including calcium, iron and zinc, nutrients of potential concern in this population. These differences were seen despite the fact that the DCC children's lunches were lower in calcium, iron and zinc than the non-DCC children's lunches. Overall, it appears that attending DCC with informal SFP enhanced the quantity but not necessarily the quality of children's diets. Informal SFP show the potential to enhance young children's diets in areas where poverty is prevalent. Research in this area has important implications in low-resource settings where such programs could be introduced in pre-existing schools with little to no additional resources for feeding programs. Also, with minimal support and education, informal SFP provide the opportunity to address micronutrient needs of specific populations.

Table 6.1 Demographic characteristics for households with children 2 to 5 y of age in Ghana, by daycare centre (DCC) attendance status

	DCC (n=104)		Non-DCC (n=89)		p-value[1]
	mean ± SD				
No. people	6.3 ± 2.8		6.5 ± 2.6		0.524
	% (n)				
Low wealth rank[2]	57.7	(60)	56.2	(50)	0.832
Household head					
Education[3,4]					0.461
None	31.7	(33)	42.0	(37)	
Primary	22.1	(23)	15.9	(14)	
Junior high	29.8	(31)	26.1	(23)	
Senior high or higher	16.3	(17)	15.9	(14)	
Occupation					0.340
Farming	73.1	(76)	80.9	(72)	
Salary	6.7	(7)	6.7	(6)	
Other	20.2	(21)	12.4	(11)	
Ethnicity[4]					0.753
Akan	34.0	(35)	36.0	(32)	
Sissala[5]	27.2	(28)	22.5	(20)	
Dagaati[5]	12.6	(13)	10.1	(9)	
Other[5]	26.2	(27)	31.5	(28)	
Religion					0.713
Christian	50.5	(52)	48.3	(43)	
Muslim	41.7	(43)	40.4	(36)	
Traditional / none	7.8	(8)	11.2	(10)	
Migrant[5]	68.0	(70)	70.8	(63)	0.672
Caregiver					
Education[3,6]					0.525
None	42.3	(44)	50.6	(45)	
Primary	17.3	(18)	19.1	(17)	
Junior high	36.5	(38)	28.1	(25)	
Senior high or higher	3.8	(4)	2.2	(2)	
Occupation					0.424
Farming	48.1	(50)	59.6	(53)	
Trading	28.8	(30)	22.5	(20)	
Other	13.5	(14)	9.0	(8)	
None	9.6	(10)	9.0	(8)	
Marital status					0.555
Married (monogamous)	76.9	(80)	76.4	(68)	
Married (polygamous)	15.4	(16)	19.1	(17)	
Unmarried	7.7	(8)	4.5	(4)	

Table 6.1 continued

[1]Student's t-test or chi-squared test for DCC attendance group comparisons
[2]Compared to medium/high wealth rank (only 2 DCC and 3 non-DCC were high rank)
[3]Highest level attended, not necessarily completed
[4]n=192
[5]From northern Ghana
[6]n=193

Table 6.2 Demographic and anthropometric characteristics, iron status and illness symptoms of Ghanaian children 2 to 5 y of age, by daycare centre (DCC) attendance status

	DCC (n=104)		Non-DCC (n=89)		p-value[1]
	mean ± SD				
Age[2] (mo)	41.1	± 10.5	38.2	± 10.3	0.051
Weight (kg)	13.49	± 1.97	12.96	± 2.12	0.075
Weight-for-height Z-score	-0.03	± 1.03	-0.22	± 1.12	0.216
Height-for-age Z-score[2]	-1.44	± 1.14	-1.29	± 1.31	0.411
Weight-for-age Z-score[2]	-0.84	± 0.83	-0.89	± 0.90	0.656
Haemoglobin (g/dL)[3]	10.50	± 1.43	10.11	± 1.28	0.068
	% (n)				
Female	49.0	(51)	57.3	(51)	0.252
Still breastfed	6.7	(7)	12.4	(11)	0.180
Wasted[4]	2.9	(3)	5.6	(5)	0.342
Stunted[5]	32.4	(33)	25.6	(22)	0.309
Underweight[6]	7.8	(8)	10.5	(9)	0.532
Anemic[3,7]	60.2	(53)	78.7	(59)	0.011
Illness symptoms[8]					
Fever	32.4	(33)	35.3	(30)	0.672
Cough	43.1	(44)	32.9	(28)	0.154
Diarrhoea	19.6	(20)	28.6	(24)	0.152
Appetite loss	35.3	(36)	48.2	(41)	0.073

[1]Student's t-test for DCC attendance group comparisons

[2]n=188

[3]n=163 (remainder were excluded from this test because they were controls in concurrent child nutrition intervention)

[4]Weight-for-height Z-score < -2 standard deviations

[5]Height-for-age Z-score < -2 standard deviations

[6]Weight-for-age Z-score < -2 standard deviations

[7]Hemoglobin < 11 g/dL

[8]In past 2 wk, as reported by caregiver

Table 6.3 Daily and percent of recommended daily intake of energy and selected nutrients of Ghanaian children 2 to 5 y of age, by daycare centre (DCC) attendance status

	Recommended daily intake[1]	Daily intake			Percent of daily recommended intake		
		DCC (n=104)	Non-DCC (n=89)	p-value[2]	DCC (n=102)	Non-DCC (n=86)	p-value[2]
		mean ± SD			mean ± SD		
Energy (kcal)[3]	1042[3]	1140 ± 320	878 ± 240	<0.0001	109.1 ± 28.7	87.2 ± 23.4	<0.0001
Protein (g)[3]	14.5[4]	25.8 ± 8.8	22.1 ± 7.0	0.002	176.7 ± 56.4	158.2 ± 49.9	0.019
Fat (% of energy)	25 – 30[5]	20.8 ± 6.2	20.7 ± 8.0	0.866	73.2 ± 22.2	69.6 ± 26.7	0.310
Vitamin A (RE)	400 – 450[6]	950 ± 410	640 ± 440	<0.0001	230.8 ± 102.5	156.6 ± 109.4	<0.0001
Thiamine (mg)	0.5 - 0.6[7]	0.58 ± 0.22	0.45 ± 0.20	<0.0001	110.3 ± 39.6	87.9 ± 40.6	<0.0001
Riboflavin (mg)	0.5 - 0.6[7]	0.38 ± 0.12	0.34 ± 0.15	0.078	73.6 ± 25.1	68.6 ± 31.3	0.226
Niacin (NE)	6 – 8[7]	6.46 ± 2.43	5.87 ± 2.47	0.100	100.4 ± 35.4	94.8 ± 40.4	0.306
Vitamin C (mg)	30[7]	67.7 ± 22.0	58.4 ± 26.3	0.008	225.7 ± 73.4	194.7 ± 87.7	0.008
Calcium (mg)	500 – 600[7]	282 ± 139	244 ± 118	0.048	54.1 ± 25.7	48.0 ± 22.2	0.089
Iron (mg)	11.6 - 12.6[7,8]	12.4 ± 6.4	10.7 ± 4.7	0.048	105.1 ± 52.3	92.8 ± 39.5	0.076
Zinc (mg)	0.38 - 0.46[7,9]	0.40 ± 0.15	0.35 ± 0.11	0.019	93.7 ± 36.0	81.0 ± 25.1	0.007

[1]Ranges reflect requirements of different age groups (1-3 and 4-18 y for fat and 1-3 and 4-6 y for micronutrients)
[2]Student's t-test for DCC attendance group comparisons
[3]Between-group differences in energy (p<0.0001) and protein (p=0.03) intake corrected for body weight were also statistically significant
[3]Mean requirement of group, for given sex and age (by 2 y age groups, reference [111])
[4]Mean safe level of intake of group, for given age (by 2 y age groups, reference [125])
[5]Minumum end of Acceptable Macronutrient Distribution Range (reference [126])
[6]Recommended safe intake (reference [124])
[7]Recommended nutrient intake (RNI) (reference [124])
[8]RNI based on 5% dietary iron bioavailability (reference [124])
[9]RNI based on low dietary zinc bioavailability (reference [124])

Table 6.4 Average dietary diversity, animal source food intake, and number of times eaten in a day by Ghanaian children 2 to 5 y of age, by daycare centre (DCC) attendance status

	DCC (n=104)			Non-DCC (n=89)			p-value[1]
	mean ± SD						
Dietary diversity[2]	7.2	±	0.6	6.7	±	1.0	<0.0001
Animal source food (g)	30.4	±	22.8	40.3	±	23.6	0.004
Times eaten/d (#)	4.2	±	0.8	3.4	±	0.6	<0.0001

[1]Student's t-test for DCC attendance group comparisons
[2]Score out of 10 (grains, roots and tubers, legumes, pulses and nuts, vitamin A-rich fruits and vegetables, other fruits and vegetables, dairy, meat and poultry, fish, egg, oils and fats)

Table 6.5 Top five foods/ingredients contributing to energy, iron, zinc and calcium intake of children 2 to 5 y of age in Ghana

	Energy		Iron		Zinc		Calcium		Average daily intake (g)[1]
	% of intake	kcal/100g	% of intake	mg/100g	% of intake	mg/100g	% of intake	mg/100g	
Boiled yam	14.0	114	---	---	7.5	0.3	---	---	124.6
Rice	13.7	116	5.2	0.5	14.3	0.6	15.7	35	112.9
Fufu[2]	13.1	126	9.1	1.0	8.4	0.4	---	---	104.9
Tuo Zaafi[3]	12.6	95	34.9	3.0	21.4	0.8	15.1	30	134.3
Oils and fats	8.7	900	---	---	---	---	---	---	9.7
Koko[4]	---	---	7.2	0.6 - 1.3[5]	---	---	---	---	121.8
Banku[6]	---	---	5.2	1.5	5.6	0.7	---	---	40.2
Fish (not powder)	---	---	---	---	---	---	15.2	40 – 1023[5]	18.3
Green leaves	---	---	---	---	---	---	9.9	59 – 1130[5]	11.6
Fish powder	---	---	---	---	---	---	7.0	1240	1.5

Note: For each food, percent contributions were calculated for the entire study population
[1]Average intake of the group, not only those who consumed the particular food or ingredient
[2]Pounded cooked cassava and plantain
[3]Maize or millet flour dough
[4]Thin maize or millet porridge
[5]Range reflects different foods or ingredients grouped together
[6]Steamed fermented maize dough

Table 6.6 Regression coefficients for energy, iron, zinc and calcium intakes for daycare centre (DCC) and non-DCC children 2 to 5 y of age in Ghana

Variable	Energy[1]	Iron[2]	Zinc[3]	Calcium[4]
Child				
Attends DCC	226.098**	-1.918**	-0.570**	
Weight (kg)	32.762**			
Dietary diversity[5]	78.082**	-1.050*		
Animal source food intake (g)	3.109**	- 0.032*		
Fever in past 2 wks	75.145*			36.829*
Energy intake (kcal)		0.014**	0.005**	0.214**
Still breastfed	-186.198**			
Household				
Involved in farming		-3.536**		
Caregiver				
Muslim[6]	122.977**	3.144**	0.692*	72.815**

*p<0.05

**p<0.01

[1]Model: n=186, adjusted R^2=0.413, p<0.001

[2]Model: n=187, adjusted R^2=0.601, p<0.001

[3]Model: n=192, adjusted R^2=0.765, p<0.001

[4]Model: n=186, adjusted R^2= 0.417, p<0.001

[5]Score out of 10 (grains, roots and tubers, legumes, pulses and nuts, vitamin A-rich fruits and vegetables, other fruits and vegetables, dairy, meat and poultry, fish, egg, oils and fats)

[6]Compared to Christian, Traditional and no religion

7.   Final conclusions

This project was the first to examine changes in dietary intakes and nutritional status of children from the pre- to post-harvest season in which severe flooding occurred during the harvest season. Results showed that from the pre- to post-harvest season, children in rural northern Ghana had small improvements in the diet, while morbidity increased and weight-related anthropometric nutritional status deteriorated. The increase in illness and decrease in nutritional status are cause for concern given the already-high rates of morbidity and malnutrition in this population. Other studies show increases in weight-related nutritional status during the post-harvest season [11, 108], which suggests that the decreases seen in this study may have been caused or exacerbated by flooding-related increases in morbidity. It is important to note that, although diets did not appear to be greatly affected, data collection occurred soon after most crops were harvested, and even though some crops and food stores were destroyed, some were also salvaged. However, with reduced food stores, it is likely that the coming year's pre-harvest 'lean' season will begin earlier and be more severe than usual. This should be kept in mind when planning and executing response to this and other disasters that affect local food availability.

During the floods, on September 11, 2007, a State of Emergency was called by the government, and an inter-agency assessment mission was formed under the United Nations Disaster Assessment and Coordination system [122]. Food, water, health and shelter/non-food items were identified as the most urgent priorities, and it was stated that the affected populations were at increased risk of malnutrition and illness from water-borne diseases. The government provided $US 5.4 million for emergency response and the United Nations made an appeal for donations of funds from other countries. The World Food Programme (WFP) and the United Nations Children's Fund (UNICEF) conducted assessment surveys of the flood damage in collaboration with GHS [122, 123]. The WFP planned for food assistance to the 'most affected' areas (which did not include this study's area) from December, 2007 through April, 2008, including 'baskets' of grains, pulses and vegetable oil as well as supplementary feeding for pregnant and lactating women and malnourished children under five years of age. It is not clear if any further support will be provided for these or other affected areas from April onwards, until harvesting

begins again in August. Households affected by the floods are likely to experience more severe food shortages that normal during this time.

Understanding how season affects children's diets and nutritional status is important to inform timely and locally appropriate interventions and in addition to prioritize interventions in settings with low-resources for health promotion and care. Also, understanding how past flooding affected young children can help both governmental and non-governmental agencies plan for future natural disasters in order to improve disaster preparedness and response, especially for this vulnerable segment of the population. Future research should assess how flooding affects subsequent 'lean' pre-harvest seasons to determine the magnitude of increased risk of child malnutrition and also examine to what extent catch-up growth occurs in the subsequent post-harvest season. In addition, research on coping mechanisms of caregivers and families during such times would give important insights on how children may be protected from dietary stress at the household level during these times.

Flooding may be unpredictable, but if effective support systems and mechanisms are established year-round, they would already be in place when regularly occurring or unanticipated changes in food availability occur. To be sustainable, these systems could not rely solely on outside inputs to function. One such example is an informal SFP based on local foods and small amounts of money provided by participating families. However, programs which rely on daily or weekly contributions from participants may also be vulnerable to fluctuations in food availability. Families may not be able to send food or money to school at certain times, for example when local food availability and livelihood activities are disrupted during and after a flood. If external inputs from governmental or non-governmental agencies were available, whether during normal or 'lean' times, they could easily be incorporated into the existing program. The feeding program would then have a safety net in place during times of local food stress, such as seasonal food shortages, natural disasters or increased food prices. In fact, knowledge of the success of already-existing programmes may encourage external agencies to support and expand upon the program's efforts.

This project was also the first to examine informal SFP and their impact on children's dietary intakes. Results show that, compared to children who did not attend any DCC, children who attended DCC with informal feeding programs in rural mid-country Ghana ate more times in a day and had higher intakes of energy and several micronutrients, including calcium, iron and zinc, which are nutrients of potential concern in this population. These results are encouraging and show the potential for informal, community-led initiatives based on local foods to benefit children's diets, and potentially health and wellbeing, with little to no external support (provisions would have to be made for cooking utensils and a person to cook, but these could possibly come from the community itself). On the other hand, results of this research lend support to the idea of policy changes that would support DCC such as those seen in this study in order to improve the quality of the lunches. The government of Ghana is currently piloting SFP in some elementary schools and kindergartens. Expanding these efforts to include preschools such as DCC or nursery schools may help improve the diets and health of a younger group of children. Inclusion of ASF for example would add an energy- and nutrient-dense component to the meal. Specific nutrients of concern could be addressed depending on the ASF, for example calcium with fish, or iron or zinc with beef. These findings could also inform agricultural policy in Ghana. With support and training for school gardens and/or livestock rearing, the meals could be improved with the inclusion of local crops, livestock, or products such as eggs. In addition, this would be an educational tool for children allowing hands-on experience to learn important agricultural skills [147]. School gardens in Bangladesh and Rwanda have reported positive impact on participating children's diets, increased attendance and decrease reports of illness. Agricultural education via school gardens have been used in other areas of Ghana [148].

Using SFP as a mechanism for improving the nutritional status of preschool-aged children prior to the age of entry of elementary school may result in earlier and increased enrolment in school [149], thereby enhancing the future potential of these children, their communities and the nation as a whole. Future research should include examinations of informal SFP in other settings in order to gain an understanding of 'best practices'. The present study was observational and cross-sectional. Other studies could introduce and test informal SFP on schools which currently have no feeding programs to see if such programs have efficacy in other settings.

Overall, the results from this study provide new insights into influences on young Ghanaian children's diets and health. These findings can be used to inform future research and encourage policy change to promote health and wellbeing of children in Ghana.

8. Bibliography

1. Scrimshaw NS and SanGiovanni JP, Synergism of nutrition, infection, and immunity: an overview. American Journal of Clinical Nutrition, 1997. 66: 464S-477S.

2. Glewwe P and Jacoby HG, An economic analysis of delayed primary school enrollment in a low income country: The role of early childhood nutrition. The Review of Economics and Statistics, 1995. 77: 156-169.

3. Chambers R, Longhurst R and Pacey A, Climatic Seasonality in the Tropics, in Seasonal Dimensions to Rural Poverty, Chambers R, Longhurst R, and Pacey A, Editors. 1981, Frances Pinter Ltd., London.

4. Walsh RPD, The Nature of Climatic Seasonality, in Seasonal Dimensions to Rural Poverty, Chambers R, Longhurst R, and Pacey A, Editors. 1981, Frances Pinter Ltd., London.

5. Schofield S, Seasonal Factors Affecting Nutrition in Different Age Groups and Especially Preschool Children. Journal of Development Studies, 1974. 11(1): 22-40.

6. Armah PW and Asante F, Ensuring food security in Ghana: The role of maize storage systems. Strategies and analysis for growth and access. 2005. USAID, Washington, DC.

7. Chambers R, Health, Agriculture and Rural Poverty: Why Seasons Matter. The Journal of Development Studies, 1982. 18(2): 217-238.

8. Leonard WR, Age and Sex-Differences in the Impact of Seasonal Energy Stress among Andean Agriculturalists. Human Ecology, 1991a. 19(3): 351-368.

9. Graham MA, Seasonal dietary stress in Peruvian children. Journal of Tropical Pediatrics, 2003. 49(1): 24-27.

10. Prentice AM, Whitehead RG, Roberts SB and Paul AA, Long-term energy balance in child-bearing Gambian Women. American Journal of Clinical Nutrition, 1981(34): 2790-2799.

11. Adams AM, Seasonal-Variations in Nutritional Risk among Children in Central Mali. Ecology of Food and Nutrition, 1994. 33(1-2): 93-106.

12. Energy, in Dietary reference intakes, DRI: the essential guide to nutrient requirements, Otten JJ, Hellwig JP, and Meyers LD, Editors. 2006, National Academies Press Washington, DC.

13.	Allen LH, Nutritional influences on linear growth: A general review, in Causes and Mechanisms of Linear Growth Retardation, Waterlow J and Schürch B, Editors. 1993, United Nations University Press, Tokyo.

14.	Fomon SJ, Filer LJ, Thomas LN, Anderson TA and Nelson SE, Influence of formula concentration on caloric intake and growth of normal infants. Acta Paediatrica Scandinavica, 1975. 64: 172-181.

15.	Fomon SJ, Filer LJ, Ziegler EE, Bergmann KE and Bergmann RL, Skim milk in infant feeding. Acta Paediatrica Scandinavica, 1977. 66: 17-30.

16.	Peipert JM, Stallings VA, Berry GT and Henstenburg JAD, Infant obesity, weight reduction and normal increase in linear growth and fat-free body mass. Pediatrics, 1992. 89: 143-145.

17.	Malcolm LA, Growth retardation in a New Guinea boarding school and its response to supplementary feeding. British Journal of Nutrition, 1970. 24: 297-305.

18.	Lampl M, Johnston FE and Malcolm LA, The effects of protein supplementation on the growth and skeletal maturation of New Guinean school children. Annals of Human Biology, 1978. 5: 219-217.

19.	Gopalan C, Swaminathan MC, Kumari VKK, Rao DH and Vijayaraghavan K, Effect of calorie supplementation on growth of undernourished children. American Journal of Clinical Nutrition, 1973. 26: 563-566.

20.	Beaton GH, Calloway D and Murphy SP, Estimated protein intakes of toddlers: predicted prevalence of inadequate intakes in village populations in Egypt, Kenya, and Mexico. American Journal of Clinical Nutrition, 1992. 55: 902-911.

21.	Martorell R and Klein RE, Food supplementation and growth rates in preschool children. Nutrition Reports International, 1980. 21: 447-454.

22.	Walravens PA, Krebs NF and Hambidge KM, Linear growth of low income preschool children receiving a zinc supplement. American Journal of Clinical Nutrition, 1983. 38: 195-201.

23.	Gibson RS, Smit Vanderkooy PD, MacDonald AC, Goldman A, Ryan BA and Berry M, A growth-limiting, mild zinc-deficiency syndrome in some Southern Ontario boys with low height percentiles. American Journal of Clinical Nutrition, 1989. 49: 1266-1273.

24.   Schlesinger L, Arevalo M, Arredondo S, Diaz M, Lönnerdal B and Stekel A, Effect of a zinc-fortified formula on immunocompetence and growth of malnourished infants. American Journal of Clinical Nutrition, 1992. 56: 491-498.

25.   Chwang LC, Soemantri AG and Pollitt E, Iron supplementation and physical growth of rural Indonesian children. American Journal of Clinical Nutrition, 1988. 47: 496-501.

26.   Latham MC, Stephenson LS, Kinoti SN, Zaman MS and Kurz KM, Improvements in growth following iron supplementation in young Kenyan children. Nutrition, 1990. 6: 159-165.

27.   Tarwotjo I, Katz J, West KP, Tielsch JM and Sommer A, Xerophthalmia and growth in preschool children. American Journal of Clinical Nutrition, 1992. 55: 1142-1146.

28.   Rahmathulla L, Underwood BA, Thulasiraj RD and Milton RC, Diarrhea, respiratory infections, and growth are not affected by a weekly low-dose vitamin A supplement: a masked, controlled field trial in children in southern India. American Journal of Clinical Nutrition, 1991. 54: 568-577.

29.   Muhilal, Permeisih D, Idjradinata YR, Muherdiyantiningsih and Karyadi D, Vitamin A fortified monosodium glutamate and health, growth, and survival of children: a controlled field trial. American Journal of Clinical Nutrition, 1988. 48: 1271-1276.

30.   Chambers R, Longhurst R and Pacey A, The Seasonal Ecology of Disease, in Seasonal Dimentions to Rural Poverty, Chambers R, Longhurst R, and Pacey A, Editors. 1981, Frances Pinter Ltd., London.

31.   United Nations Population Development Fund. Ghana Statistics. Country Profiles for Population and Reproductive Health, Policy Developments and Indicators 2005 [cited 2006 November 29]; Available from: http://www.unfpa.org/profile/ghana.cfm.

32.   Hussain MA, Seasonal variation and nutrition in developing countries. Food and Nutrition, 1985. 11(2): 23-27.

33.   Rankins J, Hopkinson S and Diop M, Palatability and nutritional significance of solar dried mangoes for Senegal Ecology of Food and Nutrition 1989. 23: 131-140.

34.   Ghana Meteorological Services Department. Climatology. Metrological Information 2002 [cited 2007 March 18]; Available from: http://www.meteo.gov.gh/climatology.html.

35.   FAO Aquastat. Ghana: Geography, climate and population. Land and Water Development Division 2004 [cited 2007 February 22]; Available from: http://www.fao.org/ag/agl/aglw/aquastat/countries/ghana/index.stm.

36. FAO. Part 1: Position by subregion. Sub-Saharan Africa's crop calendar. Food supply situation and crop prospects in Sub-Saharan Africa. FAO Global Information and Early Warning System on food and agriculture (GIEWS) 2005 [cited 2006 November 27]; Available from: http://www.fao.org/docrep/008/j6009e/J6009e04.htm.

37. Hunter JM, Seasonal hunger in a part of the West African savanna: A survey of bodyweights in Nangodi, North-East Ghana. Transactions of the Institute of British Geographers, 1967. 41: 167-185.

38. Destombes J, From long-term patterns of seasonal hunger to changing experiences of everyday poverty: Northeastern Ghana. Journal of African History, 2006. 47: 181-205.

39. Marquis GS, Harding K, Colecraft EK, Fox M and Sakyi-Dawson O, Seasonal patterns of severe food shortages vary by region in Ghana. FASEB Journal, 2007 21(Meeting abstract).

40. Ferguson EL, Gibson RS, Opare-Obisaw C, Osei-Opare F, Lamba C and Ounpuu S, Seasonal food consumption patterns and dietary diversity of rural preschool Ghanaian and Malawian children. Ecology of Food and Nutrition, 1993. 29: 219-234.

41. Alderman H and Shivley G, Economic reform and food prices: Evidence from markets in Ghana. World Development, 1996. 24: 521-534.

42. Sahn DE, A Conceptual Framework for Examining the Seasonal Aspects of Household Food Security, in Seasonal Variability in Third World Agriculture: The Consequences for Food Security, Sahn DE, Editor. 1989, Johns Hopkins University Press (IFPRI), Baltimore.

43. Food and Agricultural Organization of the United Nations, Food security: concepts and measurements, in Trade Reforms and Food Security. Conceptualizing the Linkages, FAO, Rome.

44. WHO, Use and interpretation of anthropometric indicators of nutritional status. Bulletin of the World Health Organization, 1986. 64: 924-941.

45. Ghana Statistical Service, Ghana Demographic and Health Survey 2003. 2004, GSS, NMIMR, and ORC Macro. Calverton.

46. Lartey A, Manu A, Brown KH and Dewey KG, Predictors of micronutrient status among six- to twelve-month-old breast-fed Ghanaian infants. Journal of Nutrition, 2000. 130: 199-207.

47.   Ferguson EL, Gibson RS, Opare-Obisaw C, Ounpuu S, Thompson LU and Lehrfeld J, The zinc nutriture of preschool children living in two african countries. Journal of Nutrition, 1993. 123(9): 1487-1496.

48.   Brown KH, The importance of dietary quality versus quantity for weanlings in less developed countries: a framework for discussion. Food and Nutrition Bulletin, 1991. 13: 86-94.

49.   Neumann C, Harris DM and Rogers LM, Contribution of animal source foods in improving diet quality and function in children in the developing world. Nutrition Research, 2002. 22(1-2): 193-220.

50.   Lutter CK and Rivera JA, Nutritional status of infants and young children and charactersitics of their diets. Journal of Nutrition, 2003. 133: 2941S-2949S.

51.   Colecraft E, Marquis GS and Aryeetey R, Constraints on the use of animal source foods for young children in Ghana: A participatory rapid appraisal approach. Ecology of Food and Nutrition, 2006. 45: 351-377.

52.   Bender A, Meat and meat products in human nutrition in developing countries FAO Food and Nutrition Paper # 53. 1992. Food Policy and Nutrition Division of FAO, Rome.

53.   Murphy SP, Beaton GH and Calloway DH, International Minilist, ed. INFOODS. 1993. University of California, Berkley.

54.   Golden MHN, The nature of nutritional deficiency in relation to growth failure and poverty. Acta Paediatrica Scandinavica Supplement, 1991. 374: 95-110.

55.   Onyango AW, Dietary diversity, child nutrition and health in contemporary African communities. Comparative Biochemistry and Physiology. Part A, Molecular & Integrative Physiology, 2003. 136(1): 61-69.

56.   Hodgson JM, Hsuhage BHH and Wahlqvist ML, Food variety as a quantitative descriptor of food intake. Ecology of Food and Nutrition, 1994. 32(3-4): 137-148.

57.   Randall E, Nichaman MZ and Contant CF, Diet diversity and nutrient intake. Journal of the American Dietetic Association, 1985. 85: 830-836.

58.   Ruel MT, Operationalizing dietary diveristy: A review of measurement issues and research priorities. Journal of Nutrition, 2003. 133: 3911S-3926S.

59.   Hatloy A, Torheim LE and 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.

60.   Grantham-McGregor SM, Chang S and Walker SP, Evaluation of school feeding programs: some Jamaican examples. American Journal of Clinical Nutrition, 1998. 67(4): 785S-789S.

61.   Jacoby E, Cueto S and Pollitt E, Benefits of a school breakfast program among Andean children in Huaraz, Peru Food Nutrition Bulletin, 1996. 17(1): 54.

62.   Murphy SP, Gewa C, Liang LJ, Grillenberger M, Bwibo NO and Neumann CG, School snacks containing animal source foods improve dietary quality for children in rural Kenya. Journal of Nutrition, 2003. 133(11): 3950S-3956S.

63.   Rewal S, Results of a School Lunch Programme in India Food and Nutrition Bulletin, 1981. 3(4): 42-47.

64.   Ngatia EM, Ng'ang'a PM, Muita JG and Imungi JK, Dietary patterns and nutritional status of pre-school children in Nairobi. East African Medical Journal, 2005. 82(10): 520-525.

65.   Pollitt E, Jacoby E and Cueto S, School breakfast and cognition among nutritionally at-risk children in the Peruvian Andes. Nutrition Reviews, 1996. 54(4): S22-S26.

66.   Bennett J, Review of School Feeding Projects. 2003, Program of Advisory Support Services for Rural Livelihoods, Department for International Development. London.

67.   Miller Del Rosso J, School Feeding Programs: Improving effectiveness and increasing the benefit to education. A Guide for Program Managers. 1999, Partnership for Child Development. Oxford.

68.   Jacoby ER, Cueto S and Pollitt E, When science and politics listen to each other: good prospects from a new school breakfast program in Peru. American Journal of Clinical Nutrition, 1998. 67(4): 795S-797S.

69.   Powell CA, Walker SP, Chang SM and Grantham-McGregor SM, Nutrition and education: a randomized trial of the effects of breakfast in rural primary school children. American Journal of Clinical Nutrition, 1998. 68(4): 873-879.

70.   Glewwe P, Jacoby HG and King EM, Early childhood nutrition and academic achievement: A longitudinal analysis. Journal of Public Economics, 2001. 81(3): 345-368.

71.	Gorman KS and Pollitt E, Determinants of school performance in Guatemala: Family background characteristics and early abilities. International Journal of Behavioral Development, 1993. 16: 75-91.

72.	Powell C, Grantham-McGregor S and Elston M, An evaluation of giving the Jamaican government school meal to a class of children. Human Nutrition: Clinical Nutrition, 1983. 37C: 381-388.

73.	Whaley SE, Sigman M, Neumann C, Bwibo N, Guthrie D, Weiss RE, Alber S and Murphy SP, The impact of dietary intervention of the cognitive development of Kenyan school children. Journal of Nutrition, 2003. 133: 3965S-3971S.

74.	Chandler AK, Walker S, Connolly K and Grantham-McGregor S, School breakfast improves verbal fluency in undernourished Jamaican children. Journal of Nutrition, 1995. 125: 894-900.

75.	Scrimshaw NS, The consequences of hidden hunger for individuals and societies. Food and Nutrition Bulletin, 1994. 15: 3-23.

76.	Nelson CA, Neural plasticity and human development: Role of early experience in sculpting memory systems. Developmental Sciences, 2002. 3: 115-130.

77.	Connor JR and Menzies SL, Relationship of iron to oligodendrocytes and myelination. Glia, 1996. 17: 83-93.

78.	Beard J, Iron deficiency alters brain development and functioning. Journal of Nutrition, 2003. 133: 1468S-1472S.

79.	Youdim MB and Yehuda S, The neurochemical basis of cognitive deficits induced by brain iron deficiency: involvement of dopamine-opiate system. Cellular and Molecular Biology, 2000. 46: 491-500.

80.	Letitsky DA and Strupp BJ, Malnutrition and the brain: Changing concepts, changing concerns. Journal of Nutrition, 1995. 125: 2212S-2220S.

81.	Grantham-McGregor S and Ani C, A review of studies on the effect of iron deficiency on cognitive development in children. Journal of Nutrition, 2001. 131(2): 649S-666S.

82.	Takeda A, Zinc homeostasis and functions of zinc in the brain. Biometals, 2001. 14: 343-351.

83.	Takeda A, Movement of zinc and its functional significance in the brain. Brain Research Reviews, 2000. 34: 137-148.

84. Black MM, Zinc deficiency and child development. American Journal of Clinical Nutrition, 1998. 68: 464S-469S.

85. Black MM, Sazawal S, Black RE, Khosla S, Kumar J and Menon V, Cognitive and motor development among small-for-gestational-age infants: Impact of zinc supplementation, birth weight, and caregiving practices. Pediatrics, 2004. 113: 1297-1305.

86. Grosvenor MB and Smolin LA, Nutrition: From Sciences to Life. 2002. Harcourt Inc., Fort Worth.

87. Bottiglieri T, Folate, vitamin B12, and neuropsychiatric disorders. Nutrition Reviews, 1996. 54: 382-390.

88. Black MM, Micronutrient deficiencies and cognitive functioning. Journal of Nutrition, 2003. 133: 3927S-3931S.

89. Sigman M, Neumann C, Jansen AAJ and Bwibo N, Cognitive abilities of Kenyan children in relation to nutrition, family characteristics, and education. Child Development, 1989. 60: 1463-1474.

90. Wechsler D, WPPSI-III Wechsler Preschool and Primary Scale of Intelligence - Third Edition. 2002. The Psychological Corporation, San Antonio.

91. Méio MDBB, Lopes CS, Morsch DS, Monteiro APG, Rocha SB, Borges RA and Reis AB, Pre-school cognitive development of very low birth weight preterm children. Jornal de Pediatria, 2004. 80: 495-502.

92. Lieblich A, Ninio A and Kugelmass S, Effects of ethnic origin and parental SES on WPPSI performance of pre-school children in Israel. Journal of Cross-Cultural Psychology, 1972. 3: 159-168.

93. Salinas-Pielago JE, Vega-Dienstmaier JM and Rojas-Oblitas M, Effect of biscuits fortified with haem iron on the intellectual status of pre-school children. Revista de Neurologica, 1998. 27: 400-404.

94. Aboud FE, Evaluation of an early childhood preschool program in rural Bangladesh. Early Childhood Research Quarterly, 2006. 21: 46-60.

95. Aboud FE, Evaluation of the Shishu Bikash Kendra Component of the Early Childhood Program of Plan Bangladesh. 2006, McGill University. Montreal.

96. Cattell R, Children's Language: Consensus and Controversy. 2000. Cassell, London.

97. Bloom L, Language development from two to three. 1991. Cambridge University Press, Cambridge.

98. Preventing reading difficulties in young children, ed. Snow CE, Burns MS, and Griffin P. 1998. National Academy Press, Washington, DC.

99. Lieblich A and Shinar M, The predictive validity of the WPPSI with Israeli children. Educational and Psychological Measurement, 1975. 35: 473-475.

100. Yule W and Rigley LV, Predicting future reading attainment from the WPPSI. Journal of Research in Reading, 1982. 5: 67-74.

101. Creed-Kanashiro H, Respicio G, Cuba C and Benavides B. La Mejor Compra: Una Estrategia de Educacion Nutricional para Obtener Maxima Nutricion a Menor Costo. in XII Congreso Latinoamericano de Nutricion. 2000. Buenos Aires.

102. Walker SP, Powell CA, Hutchinson SE, Chang SM and Grantham-McGregor SM, Schoolchildren's diets and participation in school feeding programmes in Jamaica. Public Health Nutrition, 1998. 1(1): 43-49.

103. Jacoby HG, Is there an intrahousehold 'flypaper effect'? Evidence from a school feeding programme. Economic Journal, 2002. 112(476): 196-221.

104. Overholt C, Sellers SG, Mora JO, de Paredes B and Herrera MG, The effects of nutritional supplementation on the diets of low-income families at risk of malnutrition. American Journal of Clinical Nutrition, 1982. 36: 1153-1161.

105. Marquis GS and Sakyi-Dawson O, GL-CRSP Annual Report 2004-2005. ENAM in Africa: Enhancing child nutrition through animal source food management. 2005. GL-CRSP, Davis.

106. Nezic T and Kerr WA, A market and community development in West Africa. Community Development Journal, 1996. 31(1): 1-12.

107. Hulley SB, Cummings SR, Browner WS, Grady DG and Newman TB, Designing Clinical Research. 2007. Lippincott, Williams and Wilkins, Philadelphia.

108. Branca F, Pastore G, Demissie T and Ferroluzzi A, The Nutritional Impact of Seasonality in Children and Adults of Rural Ethiopia. European Journal of Clinical Nutrition, 1993. 47(12): 840-850.

109.   Colecraft E, Marquis GS, Bartolucci AA, Pulley L, Owusu WB and Maetz HM, A longitudinal assessment of the diet and growth of malnourished children participating in nutrition rehabilitation centres in Accra, Ghana. Public Health Nutrition, 2003. 7: 487-494.

110.   Colecraft E, Adjei GA, Lartey A and Marquis GS, Contribution of Animal Source Foods to Total Dietary Iron Intake of Children in Coastal Ghana. FASEB Journal, 2007 21(Meeting abstract).

111.   Human energy requirements, in FAO Food and Nutrition Technical Report Series. 2001, FAO. Rome.

112.   Forshee RA and Tech V, Methods of surveying diet and physical activity, in The Economics of Obesity. 2004, USDA. Washington, DC.

113.   Eyeson K, Ankrah EK, Sundararajan AR, Karinpaa A and Rudzka JM, Composition of foods commonly used in Ghana. 1975. Food Research Institute, Accra.

114.   Ferguson EL, Gibson RS, Opare-Obisaw C, Osei-Opare F, Stephen AM, Lehrfeld J and Thomson L, The zinc, calcium, copper, manganese, non-starch polysaccharide and phytate content of seventy-eight locally grown and prepared African foods. The Journal of Food Composition Analysis, 1993. 6: 87-99.

115.   Barikmo I, Ouattara F and Oshaug A, Food Composition Table for Mali. 2004. Akershus University College, Oslo.

116.   Kennedy G and Nantel G, Basic guidelines for validation of a simple dietary diversity score as an indicator of dietary nutrient adequacy for non-breastfeeding children 2-6 years. 2006, Nutrition Planning, Assessment and Evaluation Service, Nutrition and Consumer Protection Division. FAO. Rome.

117.   Arimond M and Ruel MT, Dietary diversity is associated with child nutritional status: Evidence from 11 Demographic and Health Surveys. Journal of Nutrition, 2004. 134(10): 2579-2585.

118.   Kennedy GL, Pedro MR, Seghieri C, Nantel G and Brouwer I, Dietary diversity score is a useful indicator of micronutrient intake in non-breast-feeding Filipino children. Journal of Nutrition, 2007. 137: 472-477.

119.   United Nations, How to Weigh and Measure Children. Preliminary Version 1986, United Nations. New York.

120.   Truman LK, How Many Figures Are Significant? Science, 1924. 60(1562): 524-524.

121. Wright J, Vaze P, Russell G, Gundry SW, Ferro-Luzzi A, Mucavele P and Nyatsanza J, Seasonal aspects of weight-for-age in young children in Zimbabwe. Public Health Nutrition, 2001. 4(3): 757-764.

122. World Food Programme. Emergency Operation Ghana - 10710.0 Emergency Food Assistance to flood-affected populations in Northern Ghana. 2007 July 11, 2008; Available from: http://www.wfp.org/operations/current_operations/project_docs/107100.pdf.

123. UNICEF, Emergency Rapid Assessment Surveys of Flood Affected Areas of Northern, Upper East and Upper West Regions. Draft Report. February, 2008.

124. Food and Nutrition Division, Human Vitamin and Mineral Requirements. 2001, FAO/WHO. Rome.

125. Energy and protein requirements, in World Health Organization Technical Report Series 724. 1991, FAO/WHO/UNU. Geneva.

126. Institute of Medicine, Dietary Reference Intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein, and amino acids (macronutrients). 2005, National Academies Press. Washington, D.C.

127. Brown KH, Black RE, Robertson AD and Becker S, Effects of season and illness on the dietary intake of weanlings during longitudinal studies in rural Bangladesh. American Journal of Clinical Nutrition, 1985. 41: 343-355.

128. Leonard WR, Household-Level Strategies for Protecting Children from Seasonal Food Scarcity. Social Science & Medicine, 1991b. 33(10): 1127-1133.

129. Scrimshaw NS, Energy cost of communicable diseases in infancy and childhood, in Activity, energy expenditure and energy requirements of infants and children, Schürch B and Scrimshaw N, Editors. 1989, United Nations University, Tokyo.

130. Du Bois EF, The basal metabolism of fever. Journal of the American Medical Association, 1921. 77: 352-355.

131. Rowland MGM, Cole TJ and Whitehead RG, A quantitative study into the role of infection in determining nutritional status in Gambian village children. British Journal of Nutrition, 1977. 37: 441-450.

132. Lopez De Romana G, Brown KH and Black RE, Health and growth of infants and young children in Huascar, Peru. Ecology of Food and Nutrition, 1987. 19: 213-229.

133. Findley SE, Doumbia S, Medina DC, Guindo B, Toure MB, Sogoba N, Dembele M and Konate D. Season-Smart: How Knowledge of Disease Seasonality and Climate Variability Can Reduce Childhood Illnesses in Mali. in IUSSP XXV International Population Conference. 2005. Tours, France.

134. Binka FN, Morris SS, Ross DA, Arthur P and ME A, Patterns of malaria morbidity and mortality in children in northern Ghana. Transactions of the Royal Society of Tropical Hygiene and Medicine, 1994. 88(4): 381-385.

135. Koram KA, Owusu-Agyei S, Fryauff DJ, Anto F, Atuguba F, Hodgson A, Hoffman SL and Nkrumah FK, Seasonal profiles of malaria infection, anaemia, and bednet use among age groups and communities in northern Ghana. Tropical Medicine and International Health, 2003. 8(9): 793-802.

136. Ahern M, Sari Kovats R, Wilkinson P, Few R and Matthies F, Global Health Impacts of Floods: Epidemiologic Evidence. Epidemiologic Reviews, 2005. 27: 36-46.

137. WHO. Flooding and communicable diseases fact sheet. 2008 [cited 2008 July 14]; Available from: http://www.who.int/hac/techguidance/ems/flood_cds/en/index1.html.

138. Brewster DR and Greenwood BM, Seasonal variation of paediatric diseases in The Gambia, west Africa. Annals of Tropical Paediatrics 1993. 13(2): 133-146.

139. Biswas R, Pal D and Mukhopadhyay SP, A community based study on health impact of flood in a vulnerable district of West Bengal. Indian Journal of Public Health, 1999. 43: 89-90.

140. Black RE, Allen LH, Bhutta ZA, Caulfield LA, de Onis M, Ezzati M, Mathers C and Rivera J, Maternal and child undernutrition: global and regional exposures and health consequences. Lancet, 2008. 371: 243-260.

141. Black RE, Morris SS and Bryce J, Where and why are 10 million children dying every year? Lancet, 2003. 361: 2226-2234.

142. UNICEF. Figure 1.5 Fewer than 10 million children under five died in 2006. The State of the World's Children 2008 Child Survival 2008 [cited 2008 June 11]; Available from: http://www.unicef.org/sowc08/docs/Figure-1.5.pdf

143. Demment MW, Young MM and Sensenig RL, Providing Micronutrients through Food-Based Solutions: A Key to Human and National Development. Journal of Nutrition, 2003. 133: 3879S-3885S.

144.   Final Report for Reform of the Jamaica School Feeding Programme A Pilot Project. 2003. Caribbean Food and Nutrition Institute (CFNI) Kingston.

145.   Lartey A, Manu A, Brown KH, Peerson JM and Dewey KG, A randomized, community-based trial of the effects of improved, centrally processed complementary foods on growth and micronutrient status of Ghanaian infants from 6 to 12 mo of age. American Journal of Clinical Nutrition, 1999. 70: 391-404.

146.   Kigutha HN, Assessment of dietary intake in rural communities in Africa: experiences in Kenya. American Journal of Clinical Nutrition, 1997. 65: 1168S-1172S.

147.   FAO. Setting up and Running a School Garden - A Manual for Teachers, Parents and Communities [cited 2008 July 18]; Available from: http://www.fao.org/schoolgarden/.

148.   Annor-Frempong F, Zinnah M and Adam I, Teaching of Agricultural Science at the Basic Education Level in Developing Countries: A Case Study of the Nature and Constraints at Cape Coast District of Ghana. Association for International Agricultural and Extension Education, Proceedings of the 19th Annual Conference. 2003. Raleigh.

149.   Glewwe P and Jacoby H, Delayed primary school enrollment and child malnutrition in Ghana, in Living Standards Measurement Study Working Paper No. 98. 1994, World Bank. Washington D.C.

9.   Appendices

9.1   Ethics approval certificates

McGill

Faculty of Medicine
3655 Promenade Sir William Osler
Montreal, QC H3G 1Y6

Faculté de médecine
3655, Promenade Sir William Osler
Montréal, QC, H3G 1Y6

Fax/Télécopieur: (514) 398-3595

26 April 2007.

Dr. Grace Marquis
School of Dietetics and Human Nutrition
Faculty of Agricultural and Environmental Sciences
21,111 Lakeshore
Ste-Anne-de-Bellevue QC H9X 3V9

RE: IRB Study Number A04-M34-07A

Dear Dr. Marquis,

Thank you for responding to the IRB correspondence in reference to the April 02, 2007 full Board review of the study entitled, *ENAM in Africa: Enhancing Child Nutrition through Animal Source Food Management.*

The submitted responses and revisions are acceptable. Final ethics approval for this study is provided on April 26, 2007 and includes the following:

- Study Protocol (IRB dated April 2007);
- Revised Informed Consent Document (IRB dated April 2007);
- WPPSI-III: Receptive Vocabulary Subtest;
- ENAM Project: Income-Generation Activity Participant Questionnaire;
- ENAM Project Community Level Baseline Questionnaire.

The ethics approval for this study is valid until **April 2008**. The Certificate of Ethical Acceptability is enclosed.

All research involving human subjects is required to undergo an annual ethics review as stipulated in Federal and Provincial documents guiding and regulating human subjects research. This annual review is scheduled according to the date of initial approval and it is the responsibility of the investigator to submit a completed application form for Continuing Ethics Review to the IRB prior to the stop date of the study's ethics approval. A copy of the Continuing Review form is available on the IRB website at: http://www.medicine.mcgill.ca/research/irb/.

Any modifications or unanticipated developments that may occur to the study prior to the annual review must be reported to the IRB promptly. Study modifications can not be implemented prior to ethics review and approval of the change.

The IRB has assigned this study the following **IRB Study Number: A04-M34-07A**. Please reference this number for all correspondence with our office.

Sincerely,

C. Celeste Johnston, RN., D.Ed
Co-Chair
Institutional Review Board

Cc: A04-M34-07A

1

McGill

Faculty of Medicine
3655 Promenade Sir William Osler
Montreal, QC H3G 1Y6

Faculté de médecine
3655, Promenade Sir William Osler
Montréal, QC, H3G 1Y6

Fax/Télécopieur: (514) 398-3595

CERTIFICATION OF ETHICAL ACCEPTABILITY FOR RESEARCH INVOLVING HUMAN SUBJECTS

The Faculty of Medicine Institutional Review Board (IRB) is a registered University IRB working under the published guidelines of the Tri-Council Policy Statement, in compliance with the Plan d'action ministériel en éthique de la recherche et en intégrité scientifique, (MSSS, 1998) and the Food and Drugs Act (17 June 2001); and acts in accordance with the U.S. Code of Federal Regulations that govern research on human subjects. The IRB working procedures are consistent with internationally accepted principles of good clinical practice.

At a full Board meeting on April 02, 2007, the Faculty of Medicine Institutional Review Board, consisting of:

CATHERINE GARDNER, BSC	LAWRENCE HUTCHISON, MD
NEIL MACDONALD, MD	WILSON MILLER, PHD, MD
ROBERT L. MUNRO, BCL	LAURIE SNIDER, PHD

NELDA SWINTON, BSC

Examined the research project A04-M34-07A entitled *ENAM in Africa: Enhancing Child Nutrition through Animal Source Food Management*

As proposed by: Dr. Grace Marquis   to   _____
                 Applicant   Granting Agency, if any

And consider the experimental procedures to be acceptable on ethical grounds for research involving human subjects.

April 26, 2007   _____, M.D.   _____
Date   Co-Chair, IRB   Dean of Faculty

Institutional Review Board Assurance Number: FWA 00004545

108

NOGUCHI MEMORIAL INSTITUTE FOR MEDICAL RESEARCH
INSTITUTIONAL REVIEW BOARD

(UNIVERSITY OF GHANA)

Phone: +(233) 21 500374 /501178
Fax: +(233) 21 502182
Email: Director@noguchi.mimcom.net
Telex No: 2556 UGL GH

P.O. Box LG581
Legon
Ghana

My Ref. No: DF.22

3rd April 2007

Your Ref. No:

ETHICAL CLEARANCE

FEDERALWIDE ASSURANCE FWA 00001824　　　　　**IRB 0001276**

NMIMR-IRB CPN 021/05-06 *(reviewed 03/04/07)*　　　　**IORG 0000908**

On 3rd April 2007 the Noguchi Memorial Institute for Medical Research (NMIMR) Institutional Review Board (IRB) at an expedited meeting, performed *continuing review* and approved your *amended* protocol titled:

TITLE OF PROTOCOL	:	**ENAM in Africa: Enhancing child nutrition through animal source food management"**
INVESTIGATORS	:	**Grace S. Marquis** **Owuaraku Sakyi-Dawson**

Please note that a final review report must be submitted to the Board at the completion of the study. Your research records may be audited at any time during or after the implementation.

Any modification of this research project must be submitted to the IRB for review and approval prior to implementation.

Please report all serious adverse events related to this study to NMIMR-IRB within seven days verbally and fourteen days in writing.

This certificate is valid till 2nd April 2008. You are to submit annual reports for continuing review.

Signature of Chairman: ....
Rev. Dr. Samuel Ayete-Nyampong
(NMIMR – IRB, Chairman)

cc:　　Professor David Ofori-Adjei
　　　(MB CHB, FRCP, FWACP)
　　　Director, Noguchi Memorial Institute
　　　for Medical Research, University of Ghana, Legon.

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

DATE: March 6, 2007

TO: Grace Marquis
1127 HNSB

FROM: Jan Canny, IRB Administrator
Office of Research Assurances

SUBJECT: IRB ID Number: 05-310

Approval Date of Modification: 22 February 2007
Date for Continuing Review: 8 June 2007

The Chair of the Institutional Review Board Chair has reviewed and approved the modification of your protocol entitled, "ENAM: Enhancing child Nutrition through Animal source food Management."

As a reminder, the **continuing review date** for this study is no later than 8 June 2007. Please allow a minimum of three to four weeks for IRB review and approval.

Please remember, any further **changes in the protocol or consent form** may not be implemented without prior IRB review and approval, using the "Continuing Review and/or Modification" form. Research investigators are expected to comply with the principles of the Belmont Report, and state and federal regulations regarding the involvement of humans in research. These documents are located on the Office of Research Assurances website www.compliance.iastate.edu or available by calling (515) 294-4566.

You must promptly report any of the following to the IRB: (1) **all serious and/or unexpected adverse experiences** involving risks to subjects or others; and (2) **any other unanticipated problems involving risks** to subjects or others.

Upon completion of the project, please submit a Project Closure Form to the Office of Research Assurances, 1138 Pearson Hall, to officially close the project.

110

9.2   Informed consent form

INFORMED CONSENT DOCUMENT

ENAM: Enhancing child nutrition through animal source food management

Investigators: Esi Colecraft, DrPH, and Owuraku Sakyi-Dawson, PhD

This is a research study. Please take your time in deciding if you would like to participate. Please feel free to ask questions at any time.

INTRODUCTION
Animal-based foods (such as meats, fish, milk, eggs) provide important nutrition to help children grow well. Many Ghanaian children, however, eat very little of these foods. We are interested in learning about ways to improve access to these health-promoting foods in your community. The purpose of this study is to understand what food is available now. Your household has been selected for this study because there is a child under 5 years of age. We are asking you to take time out of your busy schedule to answer questions about your family and the foods you eat.

DESCRIPTION OF PROCEDURES
If you agree to participate in this study, one of the study staff will ask you questions about who lives in the household, income-related activities, food production, food expenditures, food-related beliefs, and dietary intakes of the child. At the end, your child will be weighed and his/her height measured. We will repeat this process about every 4 months. Your participation will last approximately 40 minutes each time. We are also interested in looking at children's iron status. For this, we will take a small amount of blood (about 2 drops) through a finger prick from some of the children chosen at random. We will select some caregivers at random (that is, by chance) to visit in their homes. If you are selected, a study staff will visit your home from 6am to 6pm for two days; one market day and one non-market day. During each visit, we will record and weigh the foods that your child (under 5 years) eats. We will repeat the visits after 6 months. We ask that you carry on your activities as normal during these visits; the staff member doing the visit will follow the child wherever he/she is taken or goes to. We will select another group of caregivers at random, half of whom have children in daycare and half of whom do not. The child's language will be measured with a simple questionnaire and dietary intakes on four days will be weighed in the home twice over six months. For children in daycare, daily school activities and food preparation will be observed and dietary intakes at lunch will be measured.

RISKS
Participation in this study poses no risk to you or your child. There may be slight local discomfort to those children who have their finger pricked.

BENEFITS
If you decide to participate in this study there will be no immediate benefit to you. However, the information from this project will help us find ways to help individuals or communities like yours to improve the nutritional quality of children's diets for better growth and health. If your child is selected to be tested for iron status, the blood results will be given to you and explained.

COSTS AND COMPENSATION

There are no costs to you for being in this study. You will receive a small token of our appreciation for participating.

PARTICIPANT RIGHTS

Your participation in this study is completely voluntary and you may refuse to participate or leave the study at any time with no negative consequences.

CONFIDENTIALITY

All the information you provide will be kept confidential, to the extent permitted by applicable laws and regulations and will not be made publicly available. However, federal government regulatory agencies [United States Department of Agriculture] and the Institutional Review Board (a committee that reviews and approves human subject research studies) may inspect and/or copy your records for quality assurance and data analysis. These records may contain private information. To ensure confidentiality to the extent permitted by law, the following measures will be taken: data will be stored only with a study identifier and will be kept in a locked cabinet and be made available only to study staff. No individual reference will be made in oral or written reports that could be linked to your study information.

QUESTIONS OR PROBLEMS

You are encouraged to ask questions at any time during this study. If you have any questions at any time about the study or the procedures used in this study, you may contact any of the following individuals

Owuraku Sakyi-Dawson, PhD	Esi Colecraft, DrPH
University of Ghana, Legon	University of Ghana, Legon
Dept. of Agriculture Extension	Dept of Animal Science (ENAM project)
021-500629	021-310972

If you have any questions about the rights of research subjects, please contact the Iowa State University (USA) Human Subjects Research Office, 1138 Pearson Hall, (515) 294-4566; jcs1959@iastate.edu or the Director, Office of Research Compliance, 1138 Pearson, (515) 294-3115; dament@iastate.edu

****

SUBJECT SIGNATURE

Your signature indicates that you voluntarily agree to participate in this study, that the study has been explained to you, that you have been given the time to read the document and that your questions have been satisfactorily answered. You will receive a copy of the signed and dated written informed consent prior to your participation in the study.

Subject's Name (printed) _____

_____   _____

(Subject's Signature)   (Date)

Child's Name (printed) _____

_____   _____

(Signature of Parent/Guardian or   (Date)
Legally Authorized Representative)

INVESTIGATOR STATEMENT

I certify that the participant has been given adequate time to read and learn about the study and all of their questions have been answered. It is my opinion that the participant understands the purpose, risks, benefits and the procedures that will be followed in this study and has voluntarily agreed to participate.

_____   _____

(Signature of Person Obtaining Informed Consent)   (Date)

9.3   Data collection instruments

	Community:				HHID:	
Date (dd/mm/yy): __/__ /__	Caregiver:		Child:		Interviewer:	

"I am going to ask you about the people in your __household__, which is a __group of people who eat together from the same pot on a regular basis__. We will start with the __household head__, which is the recognized '__person in charge__' of the household, who __makes major decisions__ concerning the household."

NOTE: Double check that the listed caregiver is actually "*The person who has __responsibility__ (caring and feeding) for the child __most of the time and lives with the child__*"

Name	Sex	Age (yrs)	Marital status	*Highest* level of education	*Major* occupation	Relation -ship to *index child*
(*household head*)						
(*caregiver*)						
(*index child*)						
	1=Male 2=Female		1=Single 2=Married (one wife) 3=Married (multiple wives) 4=Widowed 5=Divorced 6=Separated	0=None 1=Primary 2=Middle/JSS 3=Secondry/SSS 4=Higher than SSS 5=Islamic school 6=Other (specify)	1=Farming 2=Gathering 3=Fishing 4=Fish mongering 5=Farm laborer 6=Skilled artisan 7=Trading/ food seller 8=Salaried worker 9=Student 10=Not employed 12=other	1=Parent 2=Sibling 3=Grand parent 4=Aunt/ Uncle 5=Cousin 6=Other relative (specify) 7=Not related

HHID:		Date of interview (dd/mm/yy): ___ / ___ / ___	
Caregiver:	Child:		Interviewer:

1. Index child date of birth (dd/mm/yy) *Ask to see <u>weighing card</u> or <u>birth certificate</u>*   ___ / ___ / ___

2. Source of date of birth ……………………………………………….   [ ]
  1=Caregiver recall; 2=Weighing card; 3=Birth certificate 4=Other (specify_____)

3. Dewormed in the past ___6 months___? 1=Yes; 2=No………………………………....   [ ]

4. [IF YES] Confirmed with weighing card? 1=Yes; 2=No………………………..   [ ]

5. Received vitamin A supplementation in the past ___6 months___? 1=Yes; 2=No………   [ ]

6. [IF YES] Confirmed with weighing card? 1=Yes; 2=No………………………….   [ ]

7. Relationship of the *caregiver* to the index child ……………………………   [ ]
  1=Mother; 2=Grandmother; 3=Aunt; 4=Sibling; 5=Other relative (specify); 6=Non relative (specify)

8. Ethnicity of **household head** ………………………………………………...   [ ]
  1= Akan ; 2= Ewe; 3= Kasena/ Nankana; 4= Bulsa; 5=Effutu; 6= Other (specify _____)

9. Ethnicity of *caregiver*……………………………………………   [ ]
  1= Akan ; 2= Ewe; 3= Kasena/ Nankana; 4= Bulsa; 5=Effutu; 6= Other (specify _____)

10. Religion of **household head**…………………………………………..   [ ]
  1 = Traditional; 2 = Christianity; 3 = Islamic; 4 = Other (specify _____)

11. Religion of *caregiver* …………………………………………………...   [ ]
  1 = Traditional; 2 = Christianity; 3 = Islamic; 4 = Other (specify _____)

12. Residential status of **household head** ……………………………………..   [ ]
  1 = Indigene/Native; 2 = Migrant

13. Residential status of *caregiver* ……………………………………………….   [ ]
  1 = Indigene/Native; 2 = Migrant

14. Another work for **household head** on the side, other than major occupation ……………..   [ ]
  0=no; 1=Farming; 2=Gathering/Hunting; 3=Fishing; 4=Fish mongering; 5= Farm labourer;
  6= Skilled artisan; 7 =Trading/ food seller; 8=Salaried worker; 12=Other (specify)

15. Another work for *caregiver* on the side, other than major occupation……………   [ ]
  0=no; 1=Farming; 2=Gathering/Hunting; 3=Fishing; 4=Fish mongering; 5= Farm labourer;
  6= Skilled artisan; 7 =Trading/ food seller; 8=Salaried worker; 12=Other (specify)

16. Is *caregiver* paid in cash for any work? 1=Yes; 2=No ……………………….   [ ]
  [IF 'NO', SKIP TO NEXT PAGE]

During this time of year, how much money does *caregiver* earn in total per week?

17. Maximum ……………………………………………………...   ¢_____

18. Minimum ………………………………………………………   ¢_____

19. On average (in a normal week) ………………............................   ¢_____

NORTHERN GHANA ONLY

"*Now I am going to ask you about severe food shortages in different months of the year*"

1. In what months does your household experience <u>severe food shortages</u> (food is difficult to come by)?

1=Severe food shortage month

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC

[IF EXPERIENCES SEVERE FOOD SHORTAGE IN ANY MONTH, ASK]

2. Your household experiences severe food shortages in [NAME MONTHS FROM Q1]. Why doesn't your household have enough food during (this time/these times)? WHYNOFD (7=DK; 8=Refused; 9=N/A)

_____

3. Does the household diet change during this time? 1=Yes; 2=No.......................... ☐

  [IF 'YES' ABOVE, ASK]
  4. How does the household diet change? _____

  _____

  5. Does the children's (<5yrs) diet change like the household diet? 1=Yes; 2=No ……… ☐

  6. [ASK FOR EXPLANATION] _____

  _____

  _____

7. [IF CHILD DIET CHANGES] Do you think this/these change(s) …   1=Yes; 2=No ☐

   have a negative impact on the child/children in anyway?
8. [ASK FOR EXPLANATION]
_____

_____

HHID:	Date of interview (dd/mm/yy): ___ / ___ / ___		
Child:	Caregiver:		Interviewer:

In this **past harvest season** on the **household farm**… 1. Did the household **sow**?		If YES:		
		When was crop **harvested**? (early/mid/late…)	**Loss** to flood? (None, little, some, most, all)	**Poor yield** for other reason? (Y/N, describe)
Maize	*1=Yes; 2=No*			
Early millet	*1=Yes; 2=No*			
Late millet	*1=Yes; 2=No*			
Sorghum	*1=Yes; 2=No*			
Guinea corn	*1=Yes; 2=No*			
Groundnuts	*1=Yes; 2=No*			
Cowpea	*1=Yes; 2=No*			
Local bean	*1=Yes; 2=No*			
Bambara beans	*1=Yes; 2=No*			
Tomato	*1=Yes; 2=No*			
Garden egg	*1=Yes; 2=No*			
Pepper	*1=Yes; 2=No*			
Okro	*1=Yes; 2=No*			
Onion	*1=Yes; 2=No*			
Vegetables	*1=Yes; 2=No*			
Other 1	*1=Yes; 2=No*			
Other 2	*1=Yes; 2=No*			
Other 3	*1=Yes; 2=No*			

2. In this past season did the household farm at the Tono **Dam**?   1=Yes; 2=No ………………

[If YES]	Crop	Dry season?	When harvested?	Wet season?	When harvested?
	1.				
	2.				
	3.				
	4.				

6. During this time of year, does any household member **gather** any food? 1=Yes; 2=No

      [IF 'YES'] Which foods? _____

7. Describe any other **damage/loss** due to the floods (housing, livestock…)

_____

8. Describe any **aid** received (food or other) because of the floods (when, what, from whom?…)

_____

MID-COUNTRY GHANA ONLY

1. Household involved in crop farming? 1=Yes 2=No *(If answered "No", skip to Q 4)*…… ☐

2. [IF YES ABOVE, ASK] How did you obtain the land used for farming?………………… ☐
   1. Purchased; 2. Part of family land/inherited; 3. Communal land/ allocated by chief;
   4. Rent/ Leasing; 5. Sharecropping; 7. Gift; 8. Other (specify)

3.	Household produces?
Maize 1=Yes; 2=No	
Millet 1=Yes; 2=No	
Sorghum 1=Yes; 2=No	
Rice 1=Yes; 2=No	
Cassava 1=Yes; 2=No	
Cocoyam 1=Yes; 2=No	
Yam 1=Yes; 2=No	
Plantain 1=Yes; 2=No	
Tomato 1=Yes; 2=No	
Pepper 1=Yes; 2=No	
Garden egg 1=Yes; 2=No	
Okro 1=Yes; 2=No	
Onion 1=Yes; 2=No	
Cowpea 1=Yes; 2=No	
Groundnut 1=Yes; 2=No	
Cabbage 1=Yes; 2=No	
Other 1 (specify _____) 1=Yes; 2=No	
Other 2 (specify _____) 1=Yes; 2=No	

4. During this time of year, does any household member *gather* any type of food? 1=Y; 2=N ☐
   [IF 'YES', ASK]
      5. Which foods? HARVFD _____

      6. For household consumption or for selling? 1=consumption; 2=selling; 3=both ☐

HHID:	Date (dd/mm/yy): ___ / ___ / ___		Data collection day ___
Caregiver:	Child:		Interviewer:

"*I am going to ask you to tell me about everything that (INDEX CHILD NAME) ate and drunk <u>yesterday</u> from the time s/he woke up to the time s/he went to bed. Do not leave anything out. I want to know everything s/he ate and drunk, besides water, no matter what it was or how small it was. I will also ask you to estimate the amount s/he ate or drunk (have household measures available for estimates) I will start with when s/he woke up <u>yesterday</u>*"

Time of day ____:____am/pm	Food consumed	Estimated quantity	Source	Place consumed
			1=bought 2=homemade 3=gift	1=Home 2=Other home 4=School 5=Other (specify)

Was this a normal intake day for [NAME OF INDEX CHILD] ? 1=Yes; 2=No; …………

Was this a market day for this community? 1=Yes; 2=No ………..……………………

HHID:	Date (dd/mm/yy) ____ / ____ / ____		Data collection day: _____
Caregiver:	Child:		Interviewer:

"Now I am going to ask you what some of the foods (INDEX CHILD NAME) ate yesterday were made of"

Food name	**Ingredient**	*Total* **estimated quantity of ingredient in prepared dish**

HHID:		Date of interview (dd/mm/yy): ___ / ___ / ___		
Names:	Child:	Caregiver:		Interviewer:

"Now I am going to ask you some questions about (NAME OF CHILD)'s health in the past 2 wks"

1. Has (NAME) been ill with a fever at any time in the last 2 weeks? 1=Yes; 2=No……………. ☐

2. Does (NAME) have a fever now? …1=Yes; 2=No ………………………………………… ☐

3. Has (NAME) had an illness with a cough at any time in the last 2 weeks? 1=Yes; 2=No …… ☐

4. [IF HAD A COUGH] When (NAME) had an illness with a cough, ……1=Yes; 2=No …… ☐

   did he/she breathe faster than usual with short, fast breaths?

5. Has (NAME) had diarrhea in the last 2 weeks? …1=Yes; 2=No ………………………….. … ☐

6. In the past 2 weeks, has (NAME) lost his appetite or eaten less than normal?. 1=Yes; 2=No ☐

MID-COUNTRY GHANA ONLY

HHID:		**Date of interview** (dd/mm/yy): ___ / ___ / ___	
Names:	**Child:**	**Caregiver:**	**Interviewer:**
DCC child: 1=Yes; 2=No _____			

*For caregivers whose child **attends** DCC*

During this time of year, on average, how many days per week does (CHILD) attend DCC

How long age did they start attending? *(write response in underline months)*

Who made the decision to send them?

   1=Family decision; 2=Caregiver; 3=Mother *(if different from caregiver); 4=Father; 5=Grandparent; 6=Other (specify _)

Why was it decided they should go to DCC?

_____

_____

On a daily basis, are there any challenges or barriers to sending them?

_____

_____

What do you think about the DCC feeding program?

_____

_____

How does the food served at DCC compare to what the child would eat at home? (Better? Worse?)

_____

_____

How do you feel about having to send food, money and firewood to the DCC for lunch?

_____

_____

*For caregivers whose child **does not attend** DCC*

Do you know that your community has a daycare centre where you can send your young children during the day to be taken care of before they start school?
        1=Yes; 2=No …………………………………………………………………….

[IF ANSWERED YES, ASK] Why haven't you sent them?

_____
_____

124

Community:						Anthropometrician:				
IDENTIFICATION						**HEIGHT**		**WEIGHT**		**Hb LEVEL**
HHID	Date (dd/mm/yy)	Caregiver's name	Child's name	Child DOB (dd/mm/yy)	Child sex 1=M; 2=F	1	2	1	2	*88=Refused*
	_ _/_ _/_ _			_ _/_ _/_ _						
	_ _/_ _/_ _			_ _/_ _/_ _						
	_ _/_ _/_ _			_ _/_ _/_ _						
	_ _/_ _/_ _			_ _/_ _/_ _						
	_ _/_ _/_ _			_ _/_ _/_ _						
	_ _/_ _/_ _			_ _/_ _/_ _						
	_ _/_ _/_ _			_ _/_ _/_ _						
	_ _/_ _/_ _			_ _/_ _/_ _						
	_ _/_ _/_ _			_ _/_ _/_ _						
	_ _/_ _/_ _			_ _/_ _/_ _						
	_ _/_ _/_ _			_ _/_ _/_ _						

MID-COUNTRY GHANA ONLY

Community:		HHID:	
Date (dd/mm/yy):___ /___/___		Interviewer:	
Caregiver:		Child:	
"Show me…"	Actual response	Correct	Points
1. the **foot**	1 2 3 4 DK	2	
2. the **cup**	1 2 3 4 DK	3	
3. the **book**	1 2 3 4 DK	4	
4. the **butterfly**	1 2 3 4 DK	2	
5. the **elephant**	1 2 3 4 DK	2	
6. **painting**	1 2 3 4 DK	4	
7. the **axe**	1 2 3 4 DK	3	
8. the **spider**	1 2 3 4 DK	3	
9. **raining**	1 2 3 4 DK	2	
10. the **broom**	1 2 3 4 DK	4	
11. the **car**	1 2 3 4 DK	2	
12. the **matches**	1 2 3 4 DK	3	
13. **kicking**	1 2 3 4 DK	3	
14. the **triangle**	1 2 3 4 DK	1	
15. **stirring**	1 2 3 4 DK	3	
16. **lying** down	1 2 3 4 DK	1	
17. **carrying**	1 2 3 4 DK	1	
18. the **forest**	1 2 3 4 DK	2	
19. **paying**	1 2 3 4 DK	3	
20. the **curly** tail	1 2 3 4 DK	3	
21. the **watch**	1 2 3 4 DK	2	
22. the **calculator**	1 2 3 4 DK	4	
23. the bird **beneath** the tree	1 2 3 4 DK	4	
24. the **drums**	1 2 3 4 DK	1	
25. **fancy**	1 2 3 4 DK	3	
26. **shaggy**	1 2 3 4 DK	2	
27. **balancing**	1 2 3 4 DK	4	
28. the **bulldozer**	1 2 3 4 DK	2	
29. the **blackboard**	1 2 3 4 DK	1	
30. **gnawing**	1 2 3 4 DK	4	
31. the **mountains**	1 2 3 4 DK	2	
32. **crouching**	1 2 3 4 DK	3	
33. **prancing**	1 2 3 4 DK	4	
34. **clenching**	1 2 3 4 DK	2	
35. **parallel**	1 2 3 4 DK	2	
36. the **cylinder**	1 2 3 4 DK	3	
37. **equivalent**	1 2 3 4 DK	2	
38. **horizontal**	1 2 3 4 DK	3	
		Total _____	

9.4 **Receptive vocabulary test results**

Receptive vocabulary test results

A secondary objective of this study was to examine whether iron status is associated with language development (verbal comprehension) in rural Ghanaian children. The receptive vocabulary subtest of the Wechsler Preschool and Primary Scale of Intelligence - Third Edition (WPPSI-III) was used for this purpose [90]. The receptive vocabulary subtest measures verbal comprehension, or the child's understanding of words and is used as a proxy for language development [90]. For this study, the test was translated into the local languages and back-translated to ensure accuracy of translation. Thirteen words from the original test were changed, after pre-testing, in order to preserve the intended level of difficulty in the local culture. This is commonly done when adapting the test [92, 95]. During administration of the test, the examiner said a word aloud and showed four pictures, one of which corresponded to the word. The child was asked to point to the matching picture. There were 38 words in total and the child received a score of "1" for a correct answer and "0" for an incorrect or no answer.

In addition to testing the relationship between the test score and iron status, other variables of interest were also tested for their relationship with the test score (Table 9.1). Pearson's correlation was used to test the linear relationship between the test score and other continuous variables. Chi-squared test was used to determine if the test score depended on certain dichotomous variables of interest. The grouping variable was the dichotomous variable itself and the test score was the outcome.

The receptive vocabulary test was attempted on 194 children. Seventeen children refused to do the test and 20 clearly did not understand what was being asked of them, even after it was explained and demonstrated several times, so could not perform the test. In many of the latter cases, caregivers commented that the child 'can't speak well because she/he is small', even though the test did not require the child to speak. One child was hearing-impaired and so could not perform the test. Data for 156 children were included in the final analysis. For 15 children whose parents were migrants from northern Ghana, the tests had to be translated into another language (by the caregiver or other family member). Haemoglobin was collected on 137 of the children, the

remaining 19 were excluded from this portion of data collection because they had caregivers which were participating in a concurrent nutrition education intervention study [51].

The mean test score was 18.1 out of 38 (Table 9.1). Contrary to the hypothesis, iron status (haemoglobin level) did not predict the receptive vocabulary test score. Similarly, anaemic and non-anaemic children's test scores did not differ. There was a statistically significant, but weak, linear relationship between age and the test score, indicating that older children performed better. There were no linear relationships between the test score and any anthropometric indicator of nutritional status (Z-scores). The test score did not differ according to child sex, household wealth rank, or caregiver or household head education. Children who attended DCC did not have higher test scores than those who did not attend DCC. About half of the DCC children had only recently started attending, within the last few weeks. So further analysis was performed to test whether last year's returning DCC students' test score differed from non-DCC children's. Because non-DCC children were, on average, four months younger than the returning students (p=0.048), an older sub-group (≥ 30 months of age) was selected for this analysis. These groups no longer differed in age (p=0.655). Similarly, there was no difference in the test score between these 'old' DCC and non-DCC children.

Although some children responded well to the test and appeared to enjoy it, many others did not understand what was being asked of them, even after repeated explanations and demonstrations, or refused to participate. In this setting, many children of this age do not attend school, and those who do would have never been tested in this way. Understandably, this may have been an intimidating experience for some. The test instructions state not to respond to the child's answer, but in practice in this setting, many children needed and responded well to positive encouragement. In the future, if this test is to be used in this population again, children may need to be sensitized to the test first. This could possibly be done by having another child demonstrate several examples, using words and pictures not included in the actual test.

Table 9.1 Receptive vocabulary test score and child and household characteristics for rural Ghanaian children aged 2 to 5 y (n=156)

			mean	± SD		
Receptive vocabulary test score[1]			18.1	± 4.7		
					r^2	p-value[2]
Age[3] (mo)			42.0	± 10.2	0.191	0.018
Haemoglobin (g/dL)[4]			10.37	± 1.38	-0.072	0.406
Weight-for-age Z-score[3]			-0.86	± 0.86	-0.011	0.896
Height-for-age Z-score[3]			-1.40	± 1.11	0.041	0.616
Weight-for-height Z-score			-0.09	± 1.01	-0.064	0.426
	%	(n)	mean	± SD[5]		p-value[6]
Child sex						0.307
Female	54.5	(85)	18.5	± 5.1		
Male	45.5	(71)	17.7	± 4.5		
Anaemia status[4]						0.800
Anaemic	68.6	(94)	18.1	± 4.5		
Non-anaemic	31.4	(43)	17.9	± 5.0		
Household wealth rank						0.668
Low	58.3	(91)	18.3	± 5.4		
Medium or high	41.7	(65)	18.0	± 4.0		
Caregiver education						0.739
≥ primary school[7]	57.7	(90)	18.3	± 4.7		
None	42.3	(66)	18.0	± 5.0		
Household head education						0.703
≥ primary school[7]	62.6	(97)	18.2	± 5.0		
None	37.4	(58)	17.9	± 4.6		
Daycare centre (DCC) attendance status						0.594
Attends	57.7	(90)	18.3	± 4.8		
Does not attend	42.3	(66)	17.9	± 4.9		
DCC status[8]						0.787
Returning student from last year	48.8	(42)	18.7	± 4.4		
Does not attend	51.2	(44)	18.4	± 4.5		

[1]Out of 38 (Wechsler Intelligence Scale for Children – Revised (Reference [90])
[2]Pearson correlation with receptive vocabulary test score. Only age was significant.
[3]n=153
[4]n=137 (19 children excluded due to being participants in a concurrent intervention study)
[5]Mean and SD refer to test score for these classifications
[6]Student's t-test, by group listed
[7]Attended but not necessarily completed
[8]Sub-group selected (≥ 30 months of age)to ensure similar ages of groups (because non-DCC children were younger than returning DCC students)

9.5 **Co-author waiver forms**

August 9, 2008

To Whom It May Concern:

The purpose of this letter is to confirm that the co-authors (Drs. Grace Marquis, Esi Colecraft, Anna Lartey and Owuraku Sakyi-Dawson) agree that the candidate (Kimberly Harding) includes the manuscript entitled *Pre-harvest to post-harvest season changes are positive for dietary intakes but negative for weight-related indicators of nutritional status of 2 to 5 year old children after severe flooding in rural northern Ghana* in her thesis.

For this study, the candidate developed the research questions, wrote the project proposal, developed the field instruments, obtained independent funding for the field work, traveled to Ghana and independently managed and supervised data collection, and entered and analysed the data. All of the data were collected solely as part of her thesis. The co-authors provided guidance and support throughout. The candidate wrote the manuscript under guidance of the co-authors and made modifications to it in response to their comments.
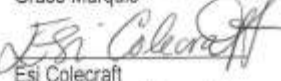
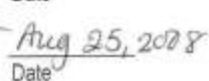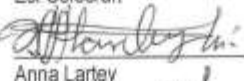_K. Harding_   _Aug 25, 2008_
Kimberly Harding   Date

I, the co-author, agree that the candidate, Kimberly Harding, include the above-listed manuscript in her thesis.

Grace Marquis   _Aug 25, 2008_
Grace Marquis   Date

See attached
Esi Colecraft   Date

See attached
Anna Lartey   Date

See attached
Owuraku Sakyi-Dawson   Date

August 9, 2008

To Whom It May Concern:

The purpose of this letter is to confirm that the co-authors (Drs. Grace Marquis, Esi Colecraft, Anna Lartey and Owuraku Sakyi-Dawson) agree that the candidate (Kimberly Harding) includes the manuscript entitled *Pre-harvest to post-harvest season changes are positive for dietary intakes but negative for weight-related indicators of nutritional status of 2 to 5 year old children after severe flooding in rural northern Ghana* in her thesis.

For both studies, the candidate developed the research questions, wrote the project proposal, developed the field instruments, obtained independent funding for the field work, traveled to Ghana and independently managed and supervised data collection, and entered and analysed the data. All of the data were collected solely as part of her thesis. The co-authors provided guidance and support throughout. The candidate wrote the manuscripts under guidance of the co-authors and made modifications to it in response to their comments.

_____   _____

Kimberly Harding   Date

I, the co-author, agree that the candidate, Kimberly Harding, include the above-listed manuscript in her thesis.
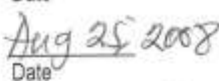
_____   _____
Grace Marquis   Date

Esi Colecraft   Aug 25, 2008
                                       Date

Anna Lartey   Aug 25 2008
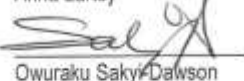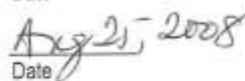   Date

Owuraku Sakyi-Dawson   Aug 25, 2008
                                       Date

July 22, 2008

August 9, 2008

To Whom It May Concern:

The purpose of this letter is to confirm that the co-authors (Drs. Grace Marquis, Esi Colecraft, Anna Lartey and Owuraku Sakyi-Dawson) agree that the candidate (Kimberly Harding) includes the manuscript entitled *Participation in informal daycare centre feeding programs is associated with higher energy, calcium, iron and zinc intakes in rural Ghanaian children* in her thesis.

For this study, the candidate developed the research questions, wrote the project proposal, developed the field instruments, obtained independent funding for the field work, traveled to Ghana and independently managed and supervised data collection, and entered and analysed the data. All of the data were collected solely as part of her thesis. The co-authors provided guidance and support throughout. The candidate wrote the manuscript under guidance of the co-authors and made modifications to it in response to their comments.

Kimberly Harding   Aug 25, 2008
_____   _____
Kimberly Harding   Date

I, the co-author, agree that the candidate, Kimberly Harding, include the above-listed manuscript in her thesis.

Grace S. Marquis   Aug 25, 2008
_____   _____
Grace Marquis   Date

                     see attached
_____   _____
Esi Colecraft   Date

                     see attached
_____   _____
Anna Lartey   Date

                     see attached
_____   _____
Owuraku Sakyi-Dawson   Date

August 9, 2008

To Whom It May Concern:

The purpose of this letter is to confirm that the co-authors (Drs. Grace Marquis, Esi Colecraft, Anna Lartey and Owuraku Sakyi-Dawson) agree that the candidate (Kimberly Harding) includes the manuscript entitled *Participation in informal daycare center feeding programs is associated with higher energy, calcium, iron and zinc intakes in rural Ghanaian children* in her thesis.

For both studies, the candidate developed the research questions, wrote the project proposal, developed the field instruments, obtained independent funding for the field work, traveled to Ghana and independently managed and supervised data collection, and entered and analysed the data. All of the data were collected solely as part of her thesis. The co-authors provided guidance and support throughout. The candidate wrote the manuscripts under guidance of the co-authors and made modifications to it in response to their comments.
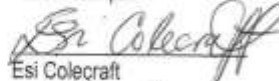
_____   _____
Kimberly Harding   Date

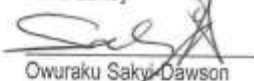I, the co-author, agree that the candidate, Kimberly Harding, include the above-listed manuscript in her thesis.

_____   _____
Grace Marquis   Date

_____   Aug 25, 2008
Esi Colecraft   Date

_____   Aug 25, 2008
Anna Lartey   Date

_____   Aug 25, 2008
Owuraku Sakyi-Dawson   Date