SUMMARY REPORT

Findings of an Analysis of Infant and Young Child Feeding in Ghana using Optifood and Focused Ethnographic Studies

October 2017

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Summary Report

Findings of an analysis of Infant and Young Child Feeding using Optifood analysis and Focused Ethnographic Studies in Ghana

Global Alliance for Improved Nutrition (GAIN)

In collaboration with

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ABBREVIATIONS AND ACRONYMS

BCC	Behaviour change communications
BF	Breastfed
BM	Breastmilk
EAR	Estimated Average Requirement
FANTA	Food and Nutrition Technical Assistance
FAO	Food and Agriculture Organization
FBR	Food-based recommendation
FES	Focused Ethnographic Study
g/d	Grams per day
GAIN	Global Alliance for Improved Nutrition
GDHS	Ghana Demographic Health Survey
GH¢	Ghana Cedis
GHS	Ghana Health Services
GSS	Ghana Statistical Service
HAZ	Height-for-age Z-score
IYC	Infant and young Child
IYCF	Infant and young child feeding
IZiNCG	International Zinc Nutrition Consultative Group
Kcal	Kilocalories
NBF	Non-breastfed
MUAC	Mid Upper Arm Circumference
NMIMR	Noguchi Memorial Institute for Medical Research, Ghana
PAHO	Pan America Health Organization
RNI	Recommended Nutrient Intake
SD	Standard Deviation
SPSS	Statistical Package for Social Sciences
TZ	Tuo Zaafi
UNICEF	United Nations International Children's Fund
USAID	United States Agency for International Development
WAZ	Weight-for-age Z-score
WHO	World Health Organization
WHZ	Weight-for-length Z-score

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1. INTRODUCTION

The period from conception to 23 months of age is a critical window for the promotion of optimal growth, health and behavioral development (Black et al, 2013). Child malnutrition, particularly stunting and micronutrient deficiencies, primarily result from diets which do not meet energy and nutrient requirements to support the rapid growth of infants and young children. Over the past two decades, the prevalence of childhood stunting in Ghana has hovered around 30%, leading to the country's inclusion in the list of 36 high-burden countries for malnutrition (Black et al., 2008). Recent estimates, however, show some reduction in malnutrition rates but anemia (often used as proxy indicator for micronutrient deficiencies) still affects 70% of children under five years (GSS et al, 2015). Using the minimum acceptable diet as an indicator, optimal feeding (IYCF) appears to be worsening; whereas 64% of infants 6-23 months were inappropriately fed in 2008 (GSS et al, 2009), the 2014 estimate puts it at 87%. This further heightens the need for improvement in optimal IYCF practices. Continued efforts are needed to develop promising and sustainable interventions to achieve optimal IYCF in Ghana.

Following the re-echo (by the 2013 Lancet Series on Maternal and Child Nutrition) of collaboration across different development sectors as a key requirement to fight malnutrition globally, there is growing interest and investment in understanding how programmatic linkages between agriculture and nutrition can contribute to improved nutritional status, especially in agrarian communities. In line with the above, USAID-Ghana aims to improve IYCF through strengthening linkages between agriculture and nutrition and one of the first steps is to identify strategies to improve the nutritional quality of the diet of infants and young children based on locally available and affordable foods. USAID therefore commissioned GAIN (Global Alliance for Improved Nutrition) to conduct a Focused Ethnographic Study (FES) and dietary analysis using the Optifood system. The ultimate aim was to identify a set of *evidence-based, population-specific, food-based recommendations* (FBRs) that can be promoted to improve the nutritional status of infants and young children in farming communities of Ghana. We also endeavoured to suggest context-appropriate nutrition-specific and nutrition-sensitive interventions that would help facilitate implementation of identified FBRs and further support the nutrition and health of infants and young children in these locations.

2. THE STUDY DISTRICTS

Karaga and Gomoa East Districts are situated in two distinctly different ecological zones. Karaga District is in the Guinea Savannah vegetation zone and has a typical unimodal rainy season (May – October), with annual rainfall averaging 60 cm, considered sufficient for a single farming season. Agriculture is the main economic activity employing 95% of the workforce. The major traditional crops cultivated include maize, sorghum (guinea corn), millet, groundnuts, cowpeas, cassava, rice and yam. About 17.8% of households in the district are food insecure with 11% severely or moderately food insecure (WFP, 2012). According to the WFP, 34.7% of households in the district live in the poorest wealth quintiles with an annual income below GHS370 as defined by the Ghana Living Standards Survey (GSS, 2008).

Gomoa East District spans two ecological zones: the dry coastal savannah and the moist semi-deciduous forest zones. The district experiences two rainfall seasons: the major rainy season between March/April to June/July and the minor season, between September and November. The mean annual rainfall ranges between 70cm and 90cm in the southern coastal plains and between 90 cm and 110 cm to the north-western semi-deciduous forest cover. Agriculture is the main economic activity employing about 63% of the active population. Major crops cultivated include maize, cassava, yam, plantain, vegetables (tomatoes, pepper, garden eggs, okra) and fruits (citrus, pineapple, pawpaw, banana).

Despite the agrarian nature of both Karaga and Gomoa East Districts, they are distinctly different, being situated in two completely different agro-ecological zones. Such differences may influence agriculture, food availability and food intake, including IYCF practices.

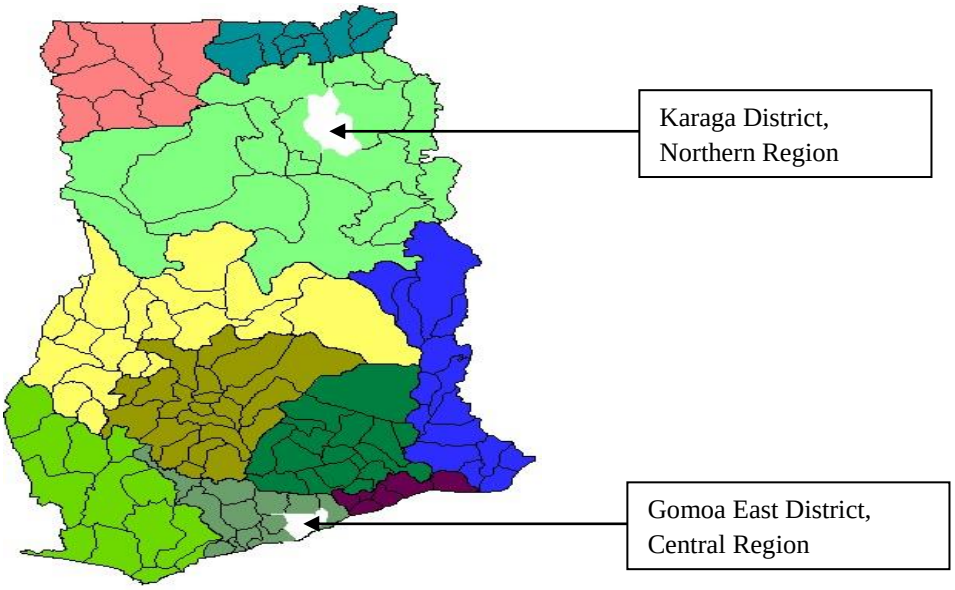

Figure 2.1 Map of Ghana showing study districts indicated as white areas

Karaga is the more disadvantaged of the two districts in terms of infrastructure development and access to amenities. The health status of the people in Karaga is described as among the worse in the Northern region and nearly 30% of children were described as underweight compared to 14% in Gomoa East. Karaga also has very low literacy rates with only 22% of persons 11 years and older are literate compared to 82% in Gomoa East (GSS, 2013).

3. DESCRIPTION OF METHODS

The FES and dietary/Optifood analyses were carried out in two farming districts, one in northern Ghana (Karaga District) and one in southern Ghana (Gomoa East District). Infants and young children between 6-23 months are the primary target of this study, divided into four groups: 6-8 months, 9-11 months, 12-23 months (breast fed), and 12-23 months (non-breast fed). Primary caregivers and key informants were interviewed. In all, 80 women (16 caregiver key informants and 64 caregiver respondents) across all age groups in both districts were interviewed for the FES. Similarly, a total of 705 caregivers of infants and young children were interviewed for the dietary/Optifood analysis.

The FES and dietary/Optifoods analysis are two related, but separate activities. The FES is the formative/landscape analysis aimed at understanding the cultural, social and economic contexts of IYCF behaviours from the household and marketing perspectives. Optifood is a linear programming software that applies mathematical optimization to dietary intake data to identify the lowest-cost combination of local foods that meets, or comes as close as possible to meeting, nutrient needs of specific target groups.

A FES survey was implemented in households with children 6-23 months in selected communities of Karaga District and Gomoa East District to establish household food consumption behaviours and feeding profile of infants. The holistic and modular nature of the FES methodology made it suitable for the landscape/formative research as it provides in-depth insights into all aspects of IYCF behaviours and related factors. The FES integrated survey type and classic ethnographic methods which were used to generate both quantitative and qualitative data from the sampled population. There were two phases involved. In Phase 1, a set of 7 modules was used to interview caregiver key informants. In Phase 2, another 7 modules were employed in interviews with caregiver respondents. Data collected included demographic and SES characteristics; a qualitative 24-hour dietary recall for the index child; food acquisition and preparation; estimated weekly food expenditure; perceptions about value dimensions related to health and food; perceptions about factors that influence IYCF; food and feeding-related problems, challenges and solutions; and effects of seasonality on infant and young child (IYC) and family food management.

For the dietary/Optifood analysis, a quantitative 24-hour recall method was used as the main tool for dietary intake assessment. Dietary data analysis had two components. The first component involved the estimation of energy and nutrient intakes using the Compl-Eat dietary analysis software. This allowed for a detailed description of energy and nutrient intakes of target

children. Breastmilk intake was not measured, and the energy and nutrient contribution was approximated using the assumption of low breastmilk intakes (mean -2 standard deviations (SD)) and average (mean) breast milk intakes, derived from global estimates (WHO/UNICEF, 1998). The prevalence of low nutrient intakes was approximated using intakes below the Recommended Nutrient Intake[1] (RNI; FAO/WHO, 2004) for 11 nutrients for infants 6-8 and 9-11 months of age and the Estimated Average Requirements[2] (EAR) for children 12-23 months of age, derived by adjustment of the RNIs (WHO/FAO, 2006).

The second component involved the use of the Optifood linear programming software to model a series of diets, based on the prevailing local diet of the children, to define problem nutrients, formulate food-based recommendations to fill nutrient intake gaps, and compare alternative sets of food-based recommendations. The parameters for this analysis were derived from the dietary intake data and included: a list of non-condiment foods consumed by ≥5% of the children per age group; the median serving size of each food for all children who consumed the food; and the minimum and maximum (5th and 95th percentiles, respectively) number of servings per week, for each food group and sub-food group. The maximum number of servings per individual food within a subgroup was estimated based on the percentage of children consuming that food. An energy constraint was used to ensure all modeled diets provided the average energy requirement for the target group, estimated using the childrens' mean body weight and the FAO/WHO/UNU algorithm for estimating energy requirements (UNU/WHO/FAO, 2004). For the Optifood analyses, the RNIs (FAO/WHO, 2004) were used as the reference for intake adequacy for all age groups, except for zinc, for which the IZiNCG (2004) EARs were used.

The recumbent length, weight and mid-upper arm circumference (MUAC) of the children were measured in duplicate following standard procedures (WHO 2006; Cogill 2003). Recumbent length was measured with an infantometer to the nearest 0.1 cm and body weight was measured with an electronic scale (UNIscale; Seca GmbH, Hamburg, Germany) to the nearest 0.1 kg. Anthropometric Z-scores were calculated using WHO Anthro (version 3.2.2) for weight-for-age (WAZ), height-for-age (HAZ) and weight-for-height (WHZ). A cut-off value of <-2 SD reflecting underweight, stunting and wasting respectively. Z-scores falling outside the WHO flags (WHZ –5 and +5; HAZ –6 and +6; WAZ – 6 and +5) were excluded from analysis (WHO 2006).

Approval to carry out the research was granted by the Noguchi Memorial Institute for Medical Research Institutional Review Board (Ethical Clearance Certificate No. NMIMR-IRB CPN 087/13-14). Written consent was obtained from all study participants and thumb prints used for those who were not literate.

[1] The RNI is the age/gender/life-stage-specific daily nutrient intake amount at which 97.5% of individuals in an apparently healthy population meet their requirement (FAO/WHO 2004).

[2] The Estimated Average Requirement for a nutrient is the age/gender/life-stage-specific mean dietary requirement or dietary intake level at which 50% of individuals would meet their physiological requirement (IOM 2000). It was obtained from the RNIs by by subtracting the equivalent of 2 SDs of the mean nutrient requirement (EAR). The SDs were obtained from the United States Food and Nutrition Board and Institute of Medicine (IOM, 2000) as summarized by WHO/FAO 2006.

4. CHARACTERISTICS OF THE STUDY POPULATION

Demographic and socio-economic characteristics of the caregivers who participated in the dietary assessment survey are shown in **Table 4.1.** Apart from the average age and physiological status of caregivers, all other characteristics differ widely between the two districts. Whereas more than 90 percent of caregivers from Karaga have not had any formal education, 80 percent of caregivers from Gomoa East have had at least primary education. Caregivers in Karaga are more likely to be farmers than those in Gomoa East. Whereas caregivers from Karaga are predominantly Muslims, those from Gomoa East are predominantly Christians. In Gomoa East, a quarter (26.1%) of caregivers did not report a specific occupation, while the proportion was lower in Karaga (12.8%). Given the high prevalence of caregivers who are farmers in Karaga, the earnings of caregivers from this district were also more often derived from farm related sources than off-farm, compared to caregivers in Gomoa East. The earnings of caregivers in Karaga were lower, however, as less than a third of caregivers in Karaga reported earning GH¢ 10 or more in a week, compared to two-thirds of caregivers in Gomoa East.

Household assets (in working condition) of caregivers also show striking differences between Karaga and Gomoa East with the exception of household ownership of commercial vehicle. About 20% more households in Karaga own a radio compared to Gomoa East. The reverse is true for ownership of a television set. Whereas in Karaga the ownership of a bicycle is almost universal and half of households own motorbike, in Gomoa East only about 10% and 2% of households own bicycle and motorbike respectively.

Household hunger was assessed using the FANTA Household Hunger Score (Deitchler et al., 2010). The results show that more than 80% of households in both districts had little or no hunger. However, the proportion of households in Gomoa East with moderate hunger is two times that of Karaga, despite the generally less advantaged conditions of Karaga.

Table 4.1 Demographic and socio-economic characteristics of caregivers of children 6-23 months from Karaga and Gomoa East participating in the dietary assessment survey

Characteristics	**District**	
	Karaga	**Gomoa East**
n	351	386
Age of caregiver, years	27 ± 6	28 ± 8
Household size, mean ± SD	13 ± 6	6 ± 3
Physiological status, n (%)		
Lactating and Pregnant	13 (3.7)	17 (4.4)
Lactating	338 (96.3)	369 (95.6)
Education, n (%)		
Not literate	325 (92.7)	78 (20.2)
Primary	10 (2.8)	89 (23.0)
Junior high or higher	16 (4.3)	219 (56.8)
Occupation, n (%)		
Housewife/None	45 (12.8)	101 (26.1)
Farmer	216 (61.5)	62 (16.1)
Trader	57 (16.2)	141 (36.5)
Other	33 (9.5)	82 (20.4)
Religion, n (%)		

Muslim	311 (88.6)	26 (6.7)
Christian	32 (9.1)	354 (91.7)
Other	8 (2.3)	6 (1.6)
Earn money, n (%)		
Yes, on farm	200 (57.0)	54 (14.0)
Yes, off farm	79 (22.5)	202 (52.4)
No	72 (20.5)	130 (33.6)
Weekly earnings, n (%) *		
<10 GH¢	225 (82.4)	84 (33.5)
≥10 GH¢	54 (17.6)	164 (66.5)
Household Assets, n (%)		
Radio	242 (71.6)	195 (50.5)
Television	112 (33.1)	215 (55.7)
Bicycle	290 (85.8)	44 (11.4)
Motorbike	166 (49.1)	9 (2.3)
Milling machine	17 (5.0)	4 (1.0)
Vehicle (Private)	3 (0.9)	13 (3.4)
Vehicle (Commercial)	26 (7.7)	28 (7.3)
Household Hunger, n (%)		
Moderate	23 (6.8)	47 (12.8)
Severe	3 (0.9)	7 (1.3)

* USD1 = 3.5 GH¢ (Ghana Cedis)

5. NUTRITIONAL STATUS OF CHILDREN 6-23 MONTHS

The prevalence of wasting in both these regions was very high and considered to be of serious public health concern when compared to the WHO population prevalence cut-offs (i.e., 10-14%, 'serious'), and was somewhat higher overall in Karaga District compared to Gomoa East (**Table 5.1**). In both districts, the prevalence of stunting generally increased with age and doubled in the second year of life. Infants and young children in Karaga were two times more likely to be stunted than those in Gomoa East. In Karaga District, the very high stunting levels (39.7%) indicated a very high chronic malnutrition problem that increased with age, whereas in Gomoa East, stunting prevalence (18.7%) was indicative of a medium chronic malnutrition problem. A similar trend was observed for underweight whereby the prevalence in Karaga was very high, and nearly double the medium prevalence observed in Gomoa East. It is noteworthy that the average age of the non-breastfed children 12-23 months was approximately 4 months greater than their breastfed counterparts. Considering this, and the smaller sample size for the latter, the results for the breastfed and non-breastfed children 12-23 months are not directly comparable.

Table 5.1. Nutritional status of children 6-23 months participating in the dietary assessment survey in Karaga and Gomoa East Districts.

	Karaga District					Gomoa East District				
	n	Age, months	WHZ	HAZ	WAZ	n	Age, months	WHZ	HAZ	WAZ
Age group		Mean ± SD	% <-2SD				Mean ± SD	% <-2SD		

All	*337*	12.4 ± 5.0	13.7	39.7	36.2	384	13.9 ± 5.2	11.0	18.7	17.4
6-8, BF	*96*	7.4 ± 0.9	14.6	27.1	27.1	*80*	7.7 ± 1.2	12.6	8.8	15.0
9-11, BF	*97*	10.2 ± 0.9	13.4	31.9	34.1	*98*	10.2 ± 1.1	9.1	12.2	15.3
12-23, BF	*109*	16.4 ± 3.2	13.7	53.3	44.9	*119*	16.4 ± 2.7	10.9	24.4	20.2
12-23, NBF	*35*	20.2 ± 3.3	11.5	54.3	40	*87*	20.4 ± 2.6	11.5	27.6	18.3

WHZ, weight-for-length Z-score; HAZ, length-for-age Z-score; WAZ, weight-for-age Z-score; BF, breastfed; NBF, non-breastfed;

6. DIETARY INTAKE ANALYSIS

6.1. Foods Consumed: Number, Type and Portion Sizes

Across both districts, the total number of different food types consumed per age group and breastfeeding status in both districts ranged from 50-80 across all age groups. However, the number of commonly consumed foods (i.e., those consumed by >5% of the children) ranged only from 20-40 (**Figure 6.1**).

The 6-8 month old children consume cereals like maize and millet more in the form of liquid or semi-solid porridges. From 12 months onwards the children are increasingly introduced to family foods, such as *Tuo Zaafi* (TZ) and *Fufu*[3], especially among those that are no longer breastfed. All foods consumed by 6-8 month old children are also consumed by older infants and children (with the exception of biscuits and fortified chocolate beverage mix in Karaga District).

[3] *Tuo Zaafi* is a hot thick porridge made from whole grain maize flour and consumed with vegetable soups (eg, green leafy vegetables with dried okro or groundnut paste); *Fufu* is pounded boiled yam served with light soup/groundnut soup with fish or meat

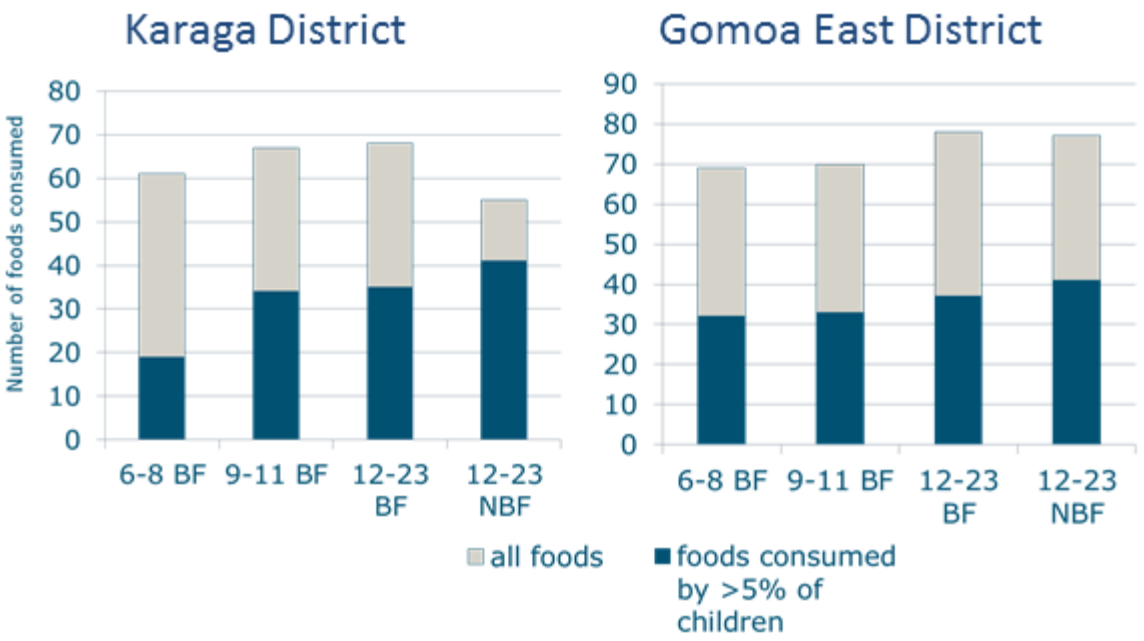

Figure 6.1 Number of different foods consumed per age group and breastfeeding status in Karaga and Gomoa Districts, Ghana

Legend: BF=breastfed; NBF=non-breastfed

The main food items consumed from each food group by the infants and young children are summarized in **Table 6.1**. The main cereal grains consumed in both districts were maize, millet and rice, and cassava was the main starchy root. From bakery and breakfast cereals, mainly bread and biscuits were consumed. Meat was not reported to be consumed in the survey by children in either district, while in Gomoa East District, eggs were also consumed and the variety of fish types was greater than in Karaga District. Dairy was consumed in the form of powdered milk (both districts) or evaporated milk (Gomoa East District). Groundnuts and cowpea were consumed in both districts, and was complemented with pigeon peas and soybean in Karaga District and with melon seeds in Gomoa East District. A larger variety of green leafy vegetables was consumed in Karaga District compared to Gomoa East District. In Karaga District refined vegetable oil was used for cooking, while in Gomoa East District red palm oil was used. In both districts white sugar was often added to tea or porridge.

Table 6.1 Main foods per food group consumed by children in Karaga and Gomoa East Districts, Ghana

Food groups	Karaga District	Gomoa East District
Grains	Maize, sorghum, millet, rice	Maize, millet, rice
Bakery and breakfast cereals	Bread, biscuits	Bread, biscuits, instant fortified infant porridge
Starchy roots and other starchy plant foods	Cassava	Cassava, plantain
Meat, fish & eggs	Dried pounded anchovies, canned mackerel	Smoked herrings, dried lean fish, smoked mackerel, eggs
Dairy	Cow milk powder	Cow milk evaporated and powder
Legumes, seeds & nuts	Groundnut, cowpea, pigeon peas, soybean	Groundnut, cowpea, melon seeds
Vegetables	Green leafy vegetables (ayoyo, bra, baobab, cowpea leaves), tomato, okro	Vitamin A rich vegetables (cocoyam leaves, tomato paste, palm nuts pulp), onion, eggplant, turkey berries
Fruits	Water melon	
Added fats	Vegetable oil (vitamin A fortified and non-fortified)	Red palm oil
Added sugar	White sugar	White sugar

Table 6.2 Percentage of children consuming food groups and mean daily portion sizes*, per age group and breastfeeding state in Karaga and Gomoa East Districts

Food groups	Karaga District				Gomoa East District			
	6-8 BF	9-11 BF	12-23 BF	12-23 NBF	6-8 BF	9-11 BF	12-23 BF	12-23 NBF
	Children consuming food on day of recall (%)							
Grains	92	96	97	100	87	86	95	93
Bakery and breakfast cereals	8	10	9	28	24	22	22	35
Starchy roots and other starchy plant foods	9	17	18	17	32	46	54	65
Meat, fish & eggs	27	60	86	93	48	63	70	90
Dairy	12	11	17	21	37	36	33	26
Legumes, seeds & nuts	28	54	85	100	16	18	23	35
Vegetables	27	62	88	97	48	68	78	89
Fruits	6	9	11	17	1	6	5	2
Added fats	17	37	63	62	29	44	44	45
Added sugar	52	52	59	66	60	43	34	29
	Mean daily portion size (g/day)							
Grains	33	23	40	65	35	56	56	93
Bakery and breakfast cereals	9	0	50	73	46	46	14	72
Starchy roots and other starchy plant foods	3	6	9	34	57	62	36	70
Meat, fish & eggs	1	1	2	12	5	8	5	10
Dairy	3	2	5	274	4	5	3	4
Legumes, seeds & nuts	3	5	9	17	4	4	6	11
Vegetables	5	4	9	11	6	7	10	16
Fruits	0	0	126	118	-	-	-	-
Added fats	14	9	8	12	4	7	5	6
Added sugar	6	9	14	16	7	9	15	19

Legend: BF=breastfed; NBF=non-breastfed

*Data are presented only for food groups included in the Optifood analysis, which were those where at least one individual food item in that food group was consumed by >5% of children.

The percentage of children consuming nutrient-dense foods such as meat, fish and egg, legumes, and vegetables was moderate to high, while fewer children consumed dairy and very few consumed fruits (**Table 6.2**). However, these foods were consumed in only small quantities. For example, among breastfed children the mean portion sizes for meat, fish & egg, legumes, and vegetables, as well as dairy, was ≤10 g, and was as little as 1-2 g for meat, fish & egg among 6-11 month old infants in Karaga District. Portion sizes did not increase consistently with age among breastfed children, but were noticeably larger among non-breastfed compared to breastfed children at 12-23 months of age. Portion sizes of starchy staples such as cereal grains, bakery and breakfast cereals, and other starchy plant foods were somewhat larger in Gomoa East District compared to Karaga District.

5.1 Energy Intake and Food Sources of Energy

The daily median energy intake for the children by age and breastfeeding status is shown in **Figure 6.2** and compared to estimated energy requirements (FAO, 2004). When breastmilk intakes were assumed to be low (i.e., representing the mean -2 SD; WHO/UNICEF, 1998), the energy intakes were below the requirements (hatched line in Figure 6.2) for nearly all breastfed sub-groups, though to a lesser extent among infants in Gomoa East District. When the average breastmilk intake was assumed, median energy intakes were higher than the mean energy requirement for all breastfed groups. Among children who were fully weaned, energy intakes in both districts were higher than the energy intakes of the breast-fed children. This is at least in part attributed to the fact that the non-BF 12-23 month old children were 4 months older than their BF counterparts.

The assumption of low breast milk intakes was considered realistic for this population given the relatively high rates of WHZ <-2 SD. It is possible that the true breastmilk intakes for the group lie somewhere between the low and average assumed amounts. To understand the implications of using different assumptions, energy and nutrient intake adequacy, and identification of problem nutrients are compared for both levels of breast milk intake, as addressed in the following sections.

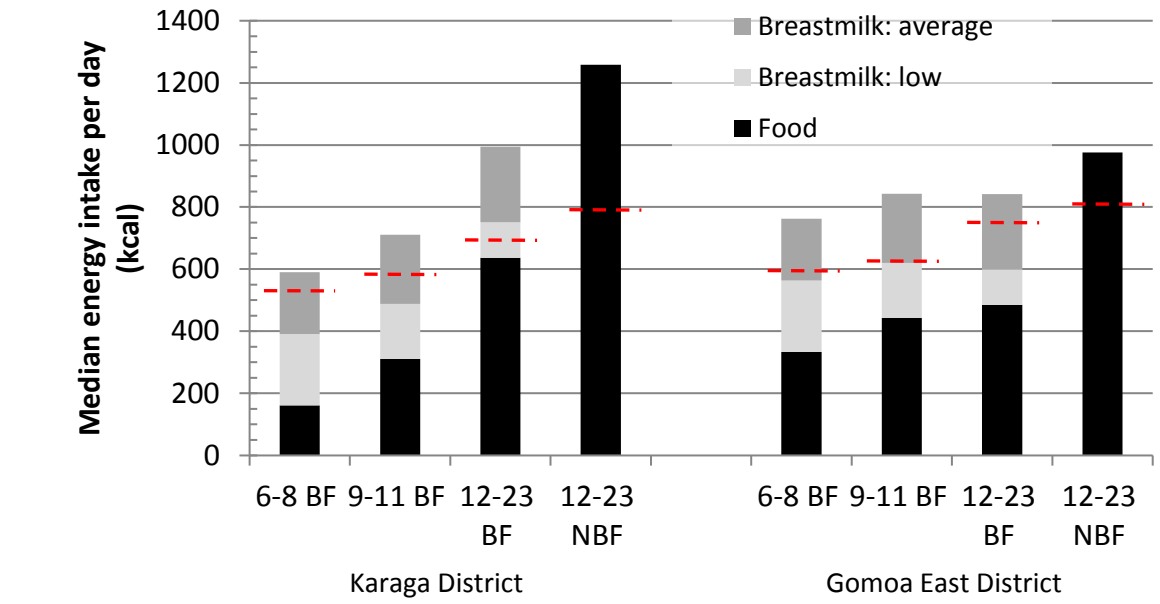

Figure 6.2. Median daily energy intake from food and breastmilk, using the assumptions of 'average' (mean) and 'low' (mean -2 SD) breastmilk intakes (WHO/UNICEF, 1998), and compared to mean daily energy requirements calculated based on body weights (FAO, 2004; shown as red hatched line), per age group and breastfeeding status in Karaga and Gomoa East Districts, Ghana.

Legend: BF=breastfed; NBF=non-breastfed

When considering only the contribution of the diet, grains provide the largest proportion of energy intake of all children, ranging from 60-68% in Karaga District and from 38-49% in Gomoa East District across age groups (**Table 6.3**). The second largest contributors to energy intake from non-breastmilk sources are added fat and legumes in Karaga District and added fat and starchy roots in Gomoa East District, although the contribution is modest compared to that of grains.

Table 6.3 Contribution of food groups to energy intake of children by age group and breastfeeding status in Karaga and Gomoa East Districts

Food groups	**Karaga District**				**Gomoa East District**			
	6-8 BF	**9-11 BF**	**12-23 BF**	**12-23 NBF**	**6-8 BF**	**9-11 BF**	**12-23 BF**	**12-23 NBF**
	Percentage contribution to energy intake							
Grains	68	62	61	60	49	41	47	38
Bakery and breakfast cereals	2	2	2	3	13	6	8	11
Starchy roots and other starchy plant foods	1	2	2	1	13	22	15	17
Dairy	1	3	2	2	3	1	1	1
Legumes, seeds & nuts	7	7	10	13	3	1	3	4
Vegetables	2	2	1	2	3	5	4	6
Added fat	8	13	15	10	7	12	12	10

Added sugars	7	6	5	4	6	6	4	4
Others	4	3	2	5	3	6	6	9

Legend: BF=breastfed; NBF=non-breastfed

6.2. Micronutrient intake through the diet and inadequacy of intake

Results for the estimated prevalence of nutrient intakes below the RNI/EAR, with assumed low breast milk intakes, show that a large percentage of children across all age groups do not meet the Recommended Nutrient Intake (RNI/EAR) of most of the 11 key micronutrients considered (**Table 6.4**). These very high percentages of children whose intakes are below the RNI/EAR values are consistent with the low intake of nutrient-dense foods.

Table 6.4 Percentage of children by age group and breastfeeding status whose intake is below the RNI/EAR* for 11 micronutrients, in Karaga and Gomoa Districts, assuming low breastmilk intake

Micro-nutrients	Karaga District				Gomoa East District			
	6-8 BF	9-11 BF	12-23 BF	12-23 NBF	6-8 BF	9-11 BF	12-23 BF	12-23 NBF
	Percentage below RNI/EAR							
Calcium	99	92	94	76	94	94	98	96
Iron	100	99	83	45	100	100	95	85
Zinc	89	91	28	0	89	89	54	27
Vitamin A	95	95	91	83	78	66	61	57
Niacin	85	79	54	14	82	78	78	50
Riboflavin	90	85	60	35	83	79	78	63
Thiamin	65	55	32	0	54	59	74	56
Vitamin B6	74	55	27	3	54	45	57	21
Folate	88	85	82	62	85	78	86	77
Vitamin B12	95	91	92	83	63	53	46	30
Vitamin C	93	92	84	76	69	59	61	45

Legend: BF=breastfed; NBF=non-breastfed

*Based on RNIs from FAO/WHO (2004); for infants 6-8 and 9-11 months, the prevalence of intakes below the RNI was used, while for children 12-23 months of age, the RNI was converted to the EAR equivalent using conversion factors (WHO/FAO, 2006). Exceptions are for iron, for which no conversion factors are available, and for zinc, the EARs for low bioavailability diets from IZiNCG (2004) were used for all age groups.

When assuming average breast milk intake, the percentage of breastfed children with intakes below the RNI for respective micronutrients in general was reduced, as expected (**Table 6.5**). For nutrients such as vitamins A, B12, and C, which breastmilk supplies in relatively higher amounts in relation to the daily requirement (WHO/UNICEF, 1998), larger reductions in the estimated prevalence of intakes below the RNI were observed when the average breast milk intake was assumed. However, for nutrients such as iron, zinc, and vitamin B6, in particular, for which breastmilk provides only a small portion of daily requirements (WHO/UNICEF, 1998), the assumption of average breast milk intake, compared to low breastmilk intake, did not result in meaningful reductions in the estimated prevalence of intakes below the RNI. For nutrients such as calcium, niacin, riboflavin, folate, some reductions in adequate intakes were observed. The contribution of breastmilk to nutrient requirements for the low and average breastmilk intake assumptions are shown in **Appendix 3**.

Table 6.5 Percentage of children by age group and breastfeeding status whose intake is below the RNI/EAR* for 11 micronutrients, in Karaga and Gomoa East Districts, assuming average breastmilk intake

Micro-nutrients	Karaga District				Gomoa East District			
	6-8 BF	9-11 BF	12-23 BF	12-23 NBF	6-8 BF	9-11 BF	12-23 BF	12-23 NBF
	Percentage below RNI/EAR							
Calcium	96	90	89	76	81	86	94	96
Iron	100	98	83	45	100	100	94	85
Zinc	89	87	18	0	83	83	42	27
Vitamin A	88	81	23	83	54	47	20	57
Niacin	84	75	45	14	78	67	72	50
Riboflavin	79	70	39	35	67	58	56	63
Thiamin	53	38	23	0	38	41	66	56
Vitamin B6	68	52	24	3	53	43	50	21
Folate	76	59	70	62	60	50	83	79
Vitamin B12	81	81	83	83	43	36	31	30
Vitamin C	77	62	29	76	36	28	18	45

Legend: BF=breastfed; NBF=non-breastfed

*Based on RNIs from FAO/WHO (2004); for infants 6-8 and 9-11 months, the prevalence of intakes below the RNI was used, while for children 12-23 months of age, the RNI was converted to the EAR equivalent using conversion factors (WHO/FAO, 2006). Exceptions are for iron, for which no conversion factors are available, and for zinc, the EARs for low bioavailability diets from IZiNCG (2004) were used for all age groups.

6. OPTIFOOD ANALYSIS

6.1 Problem Nutrients

Problem nutrients refer to nutrients for which requirements are difficult to meet with the available local foods and dietary patterns among the target groups. Some of these are 'absolute' problem nutrients, meaning that there is no combination of locally consumed foods that could fill the gaps between modelled intakes and requirements, within the upper boundaries of the foods and amounts currently consumed. A summary of problem nutrients by target group, when assuming low breastmilk intake, is given in **Table 7.1**.

In Karaga District, requirements for all 11 micronutrients considered for non-breastfed children 12 to 23 months of age could be met with changes in the diet using local foods. For the breastfed children 6-8 and 9-11 months of age, requirements for calcium, iron, zinc, vitamin A, riboflavin, vitamin B12, and vitamin C could not be met with any combination of local foods consumed within the boundaries of current dietary patterns, when assuming low breastmilk intake. In this scenario, either existing nutrient-dense foods would need to be consumed with serving sizes or frequencies well above that observed in these populations, or additional nutrient-dense foods would need to be introduced to these children's diets. For the breastfed children 12-23 months of age, requirements of calcium, iron, riboflavin, folate, vitamin B12, and vitamin C could not be met by any combination of local foods, under the low breastmilk intake assumption. Only requirements for vitamin B6, niacin and thiamine can be met within the local diet for all four groups.

In Gomoa East District there is a range of realistic modifications to current diets that would improve nutrient intake adequacy using local foods that are already part of the IYC diet. Among breastfed children 6-23 months of age, calcium (12-23 months), iron and zinc (all children), and niacin (6-8 months) are problem nutrients and requirements could not be met with any combination of locally consumed foods. Also, among the non-breastfed children 12-23 months of age, only the requirement for calcium could not be met. For all other micronutrients considered, requirements could be met with local IYC foods when consumed within the boundaries of the current dietary intake patterns, although increases to the number of servings per week for many individuals would be necessary.

In both districts, the intake of total fat and protein are adequate, but we did not assess adequacy of the quality and composition of fat and protein consumed due to lack of complete food composition data on the content of the subcomponents of these macronutrients.

Table 7.1 Summary of problem nutrients in the diet of children by age group and breastfeeding status in Karaga and Gomoa East Districts, assuming low breast milk intake.

Micro-nutrients	Karaga District				Gomoa East District			
	6-8 BF	9-11 BF	12-23 BF	12-23 NBF	6-8 BF	9-11 BF	12-23 BF	12-23 NBF
Calcium								
Iron								
Zinc								
Vitamin A								
Niacin								
Riboflavin								
Thiamin								
Vitamin B6								
Folate								
Vitamin B12								
Vitamin C								

Legend: BF=breastfed, NBF=non-breastfed

Nutrient requirements cannot be met by any combination of local foods

Nutrient requirements could be met but may require changes in the diet

When assuming average breast milk intake, the number of problem nutrients are reduced. The nutrients that would no longer be identified as problem nutrients are: vitamin A (especially in Gomoa East District and to a lesser extent in Karaga District), vitamin B12 (in the younger age groups in both districts), and vitamin C (in all age groups in both districts). These are nutrients for which breastmilk provides a relatively high proportion of the requirements. Details of the changes in problem nutrients with the average breastmilk intake assumption are summarized in Appendix 3.

6.2 Food-based Modifications

To address the identified shortcomings of local diets and intake patterns, the Optifood analysis proposes modifications that establish the quantity and frequency of consumption of available foods, expressed as recommended number of servings per week. It also indicates when such modifications are insufficient to meet the requirements for all 11 nutrients considered and, hence, where more significant changes to the foods or their frequency of consumption would be required to optimize nutrient intake adequacy. In each age and breastfeeding status group, we examined the optimization of nutrient intake adequacy only using the foods reported to be consumed by these infants and young children; we did not attempt to model the potential impact of any other nutrient-dense foods, including fortified foods, micronutrient powders, or other micronutrient supplements that were not reported to be consumed. These food-based recommendations use the assumption of low breastmilk intakes.

Table 7.2 shows the foods that contribute >5% RNI for at least one of the 11 micronutrients considered. These foods were incorporated individually, and in combination, to meet, or come as close as possible to meeting, nutrient needs of the target groups.

Table 7.2 Foods providing > 5% RNI of at least one of the 11 micronutrients considered by district, age-group and breastfeeding status

6-8 BF	9-11 BF	12-23 BF	12-23 NBF
Karaga District			
Ayoyo leaves	Ayoyo leaves	Ayoyo leaves	Ayoyo leaves
Chocolate drink powder	Bra leaves	Bra leaves	Bra leaves
Cowpea, white, dried	Cowpea, white, dried	Cowpea, white, dried	Chocolate drink powder
Groundnut paste	Fish, anchovies	Fish, anchovies	Cowpea, white, dried
Guinea corn flour	Fish, herring	Groundnut flour	Egg, guinea fowl
Maize flour	Groundnut flour	Groundnut paste	Fish, anchovies
Cow milk powder	Groundnut paste	Guinea corn flour	Maize flour
	Guinea corn flour	Mackerel, canned	Watermelon
	Mackerel, canned	Maize flour	Cow milk
	Maize flour	Watermelon	Millet dough
	Watermelon	Cow milk powder	Vegetable oil (vitamin A fortified)
	Cow milk powder	Vegetable oil (vitamin A fortified)	Okro fruit
	Vegetable oil (vitamin A fortified)	Red palm oil	Okro fruit powder
	Okro fruit	Okro fruit	Rice, brown, local
	Rice, brown, local	Pigeon peas dried	
		Rice, brown, local	
Gomoa East District			
Cassava tuber	Fortified infant cereal	Biscuit, sweet	Biscuit, sweet
Fortified infant cereal	Cocoyam leaves	Cassava tuber	Cassava tuber
Cocoyam leaves	Fish (anchovies,	Chocolate drink powder	Chocolate drink powder
Cowpea, white, flour	herrings, salmon)	Cocoyam leaves	Cocoyam leaves
Fish (herrings, general	Melon seeds	Cowpea, white, dried	Cowpea, white, dried
lean, salmon)	Cow milk powder	Fish (anchovies,	Fish (herrings, general
Groundnut flour with fat	Millet flour	herrings, general lean)	lean, tuna)
Groundnut paste	Okro fruit	Groundnut paste	Groundnut paste
Cow milk powder	Tomatoes	Maize dough, whole	Meat, beef
Millet flour	Tomato paste	grain	Millet flour
Tomato paste		Melon seeds	Red palm oil
		Millet flour	Vegetable oil (vitamin A fortified)
		Red palm oil	Palm nuts pulp
		Okro fruit	Tomatoes
		Palm nuts pulp	Tomato paste
		Tomatoes	

Legend: BF=breastfed; NBF=non-breastfed

The food-based recommendations initially derived from this analysis are presented in **Table 7.3** for both districts. To improve the practical incorporation of the recommendations into complementary feeding guidelines, adjustments were made to the original, target group-specific FBRs to make them more consistent across groups where possible, and avoid having completely distinct sets of FBRs for each. These adapted FBRs are given in **Table 7.4** and were arrived at by: (1) leaving out recommendations that were only applicable to one age group; (2) adding a recommendation to an age group if it occurred in the other groups (3) in 12-23 NBF in Karaga District, changing whole cow milk to milk powder to harmonize between groups (4) increasing servings for meat-fish-egg (Karaga) or fish and legumes (Gomoa East) to compensate for nutrient losses in the previous steps, as needed. While the increase of meat-fish-egg servings in Karaga appears substantial, the portion sizes are very small. Any recommendation for increasing servings of milk powder should specify that this is intended to be added as ingredient

to complementary foods, such as porridges, and not as a separate beverage as this could lead to displacement of breastmilk.

In combination with other foods, consuming at least the foods included in the harmonized recommendations will improve the nutrient adequacy of micronutrients. Portion sizes for the different foods included in the recommendations, especially the nutrient-dense foods, should increase with increasing age. Nonetheless, even if all of the food-based recommendations were adopted, there would still be large gaps in nutrient intake adequacy, particularly in Karaga District. In Gomoa East District, requirements would be met for 5 to 8 of 11 nutrients, while in Karaga requirements for 3 to 8 nutrients would be met, depending on the target group (**Tables 7.5 a and b**).

The percentage of the RNI that would be achieved if the recommendations were incorporated into the IYC diets, and the number of nutrients for which >70% of the RNIs would be met[4], are reported in **Table 7.5a** (Karaga District) and **Table 7.5b** (Gomoa East District). Solutions for achieving greater nutrient intake adequacy must extend beyond food items already consumed by IYC in these populations.

[4] When 70% of the RNI is met, it is likely that most children in the group would meet their requirements.

Table 7.3 Initial food based dietary modifications for young children per age group and breastfeeding status, assuming low breastmilk intake, in Karaga and Gomoa East Districts

Foods	**6-8 BF**	**9-11 BF**	**12-23 BF**	**12-23 NBF**
Karaga District				
Breast milk*	Every day	Every day	Every day	
Fortified chocolate beverage powder	1 serve			
Vegetables	3 serves	2 serves of dark green leafy vegetables		7 serves (of which 2 serves of dark green leafy vegetables
Dairy (milk added to porridges**	1 serve			1 serve
Grains (preferably whole grains)		4 serves	2serves	1 serve
Fruits		1 serve	1 serve	
Meat, fish or eggs		1serves		
Nuts and/or seeds			3 serves	
Red palm oil			1 serve	
Beans				1 serve
Gomoa East District				
Breast milk*	Every day	Every day	Every day	
Starchy roots and other starchy plant foods	1 serve of cassava		2 serves	2 serves
Dark green leafy vegetables	1 serve	1 serve	1 serve	1 serve
Fish	1 serve (small whole fish)	2 serves (small whole fish)	1 serve (small whole fish)	3 serves (fish without bones)
Grains (preferably whole grains)	1 serve	3 serves	2 serves	2 serves
Fats			1 serve (red palm oil)	3 serves (of which 1 red palm oil)
Legumes			2 serves	
Fortified chocolate beverage powder			1 serve	

Legend: BF=breastfed; NBF=non-breastfed

*Breast milk is an important source of additional nutrients, and achieving adequate breastfeeding would improve nutrient intake adequacy (Table 6.5). As the food-based recommendations are derived with the assumption of low breastmilk intake, they may be altered and possibly reduced if breastmilk intake was greater.

**Cow milk (fresh or powdered) was the only source of dairy consumed in this population; to avoid any displacement of breastmilk, additional milk should be added to IYC foods, such as porridges.

Table 7.4 Food based dietary recommendations for infants and young children per age group and breastfeeding state, revised to improve consistency across age groups, assuming low breast milk intake, in Karaga and Gomoa East Districts

Foods	**6-8 BF**	**9-11 BF**	**12-23 BF**	**12-23 NBF**
	servings per day			
Karaga District				
Breast milk*	Every day	Every day	Every day	
Fortified chocolate beverage powder	1 serve			
Vegetables	2 serves of vitamin A rich vegetables	2 serves of green leafy vegetables	2 serves of green leafy vegetables	5 serves (of which 2 serves of green leafy vegetables)
Dairy (milk added to porridges**	1 serve	1 serve	1 serve	1 serve
Grains (preferably whole grains) and not including rice)		3 serves	3 serves	3 serves
Fruits		1 serve	1 serve	1 serve
Meat, fish or eggs		2 serves (of which 1 serve anchovies)	2 serves	2 serves
Beans, nuts and seeds)		3 serves	3 serves of nuts and/or seeds	3 serves (of which 1 serve of beans)
Gomoa East District				
Breast milk	Every day	Every day	Every day	
Starchy roots (preferably vitamin C-rich)	1 serve of cassava	1 serve	2 serves	2 serves
Green leafy vegetables	1 serve	1 serve	1 serve	1 serve
Fish	1 serve (small whole fish)	2 serves (small whole fish)	3 serves (1 small whole fish and 2 fish with bones)	3 serves (fish without bones)
Grains (preferably whole grains and not including rice)	1 serve	2 serves	2 serves	2 serves
Legumes		1 serve	1 serve (beans and peas)	1 serve
Red palm oil			1 serve	1 serve

Legend: BF=breastfed; NBF=non-breastfed

Legend: BF=breastfed; NBF=non-breastfed

*Breast milk is an important source of additional nutrients, and achieving adequate breastfeeding would improve nutrient intake adequacy (Table 6.5). As the food-based recommendations are derived with the assumption of low breastmilk intake, they may be altered and possibly reduced if breastmilk intake was greater.

**Cow milk (fresh or powdered) was the only source of dairy consumed in this population; to avoid any displacement of breastmilk, additional milk should be added to IYC foods, such as porridges.

Table 7.5a Nutrient composition and diet costs in the worst case scenario of the harmonized food based recommendations by age group and breastfeeding status, assuming low breastmilk intakes in Karaga District, Ghana

	Percentage of RNI*												
Target group	**Ca**	**Vit. C**	**Thiamine**	**Riboflavin**	**Niacin**	**Vit. B_6**	**Folate**	**Vit. B_{12}**	**Vit. A (RAE)**	**Fe**	**Zn**	**GH₵/day**	**Number of nutrients ≥70% RNI**
6-8 month BF	47.8	69.8	73.6	72.6	47.6	75.0	51.7	74.6	47.7	11.0	20.3	0.4	5
9-11 month BF	37.1	62.0	142.1	74.0	69.8	131.6	68.8	56.2	45.4	21.7	42.8	0.4	3
12-23 month BF	39.7	74.4	116.9	79.7	85.2	130.4	47.9	52.1	44.6	47.9	105.3	0.7	6
12-23 month NBF	63.6	72.8	151.8	117.1	96.3	163.0	93.5	64.2	31.5	84.3	163.1	1.2	8

Legend: BF=breastfed; NBF=non-breastfed; RNI=recommend nutrient intake

*The shaded cells are those for which the percentage of RNI is <70% and is considered 'inadequate' in this analysis.

Table 7.5b Nutrient composition and diet costs in the worst case scenario of the harmonized food based recommendations by age group and breastfeeding status, assuming low breastmilk intakes in Gomoa East District, Ghana

	Percentage of RNI*												
Target group	**Ca**	**Vit. C**	**Thiamine**	**Riboflavin**	**Niacin**	**Vit. B_6**	**Folate**	**Vit. B_{12}**	**Vit. A (RAE)**	**Fe**	**Zn**	**GH₵/day**	**Number of nutrients ≥70% RNI**
6-8 month BF	44.0	161.2	67.6	76.2	54.3	88.4	97.9	193.1	62.1	12.0	28.2	0.2	5
9-11 month BF	31.4	62.4	125.2	79.0	100.6	156.8	77.8	240.5	51.9	30.1	44.1	0.6	6
12-23 month BF	26.9	113.4	71.0	68.4	54.0	107.6	55.8	195.3	150.0	54.1	70.5	0.8	6
12-23 month NBF	28.5	184.4	82.6	73.3	74.7	149.0	64.9	116.7	124.3	68.8	87.0	1.0	8

Legend: BF=breastfed; NBF=non-breastfed; RNI=recommend nutrient intake

*The shaded cells are those for which the percentage of RNI is <70% and is considered 'inadequate' in this analysis.

6.3 Summary and discussion of dietary intake and Optifood analysis

The results of these analyses show that chronic malnutrition is a problem of high public health concern with higher prevalence of stunting in Karaga District compared to Gomoa District. The current micronutrient adequacy of the diet is poor for all age groups, especially in Karaga District. The modelling of the diets indicates that dietary diversity and nutrient adequacy can be improved significantly in both districts using foods that are currently consumed.

However, modifying diets in ways that are considered to be realistic for at least some of the population (i.e., to increasing frequency of intake of key foods within the upper boundaries of current practices) the requirements would still not be met for all nutrients - even if the resulting FBRs were fully adopted, there would still be large gaps in intake adequacy for some nutrients. In Karaga District among the breastfed target groups, inadequate intakes of iron, calcium, and folate (all 3 breastfed target groups) and zinc, vitamin A, riboflavin and vitamin C (for at least 2 breastfed target groups) would remain, assuming low breastmilk intake. In Gomoa East District, intakes of iron and calcium in particular will remain inadequate (all 3 breastfed target groups) and zinc, vitamin A, and niacin (for at least 2 breastfed target groups). For the non-breastfed 12-23 month old children, nutrient requirements that could not be met even if the FBRs were fully adopted are iron, vitamin A, and possibly niacin (Karaga District) and iron, folate and calcium (Gomoa East District) but may require significant changes in the diet. As a result, additional interventions and solutions are required to enable consumption of nutrient-dense foods beyond those that are already consumed by infants and young children in the districts, especially in the rural northern Ghanaian District of Karaga.

The inability to cover requirements for all 11 nutrients reflects the limited number, frequency, and amounts of foods consumed by the infant and young children in the local diet, that are good sources of nutrients. Nutrient dense foods like meat, legumes, red palm oil, vegetables and dairy were consumed in low quantities with average daily portion sizes between 1-10 g. Cow milk in the form of powder (in both districts) and small dried fish (in Karaga District), which are good sources of iron and zinc, were the only animal source foods consumed, although in Gomoa East District a wider variety of animal source foods are consumed including eggs and different fish varieties. Whereas dark green leafy vegetables are consumed daily by infants and young children, consumption of fruits is far less common. As the linear modelling approach used in Optifood for the present analysis was intentionally limited to the selected foods and the frequencies and portion sizes that are currently being consumed by the target groups, the inclusion of these foods was limited in the food-based recommendations. Before modelling these infrequently consumed nutrient-dense foods, it is recommended to consider whether adopting the more frequent use of animal source foods and fruits for infants and young children is feasible, culturally acceptable, and realistic in these districts.

The results indicate that, within the constraints of the local dietary pattern, it is more difficult to meet nutrient requirements in the 12-23 month old breastfed child age group compared to their non-breastfed counterparts and this may have several explanations. First, the estimated level of energy intake from the IYC diet is one of the main constraints for the food based recommendations and their ability to fill nutrient intake gaps in the Optifood analysis, and thus a greater energy requirement from non-breastmilk foods increases the food options the programme has to select from to fill nutrient intake gaps, as is the case for the non-breastfed children. This points to the importance of consumption of nutrient-dense foods especially in this age group. Concurrently, the diversity of the diet, and the frequency and average portion sizes of foods consumed by the non-breastfed children tended to be higher in the non-breastfed groups (in part attributed to the older age of non-breastfed children), and thus the options for food-based recommendations were less constrained. As consumption of nutrient-dense foods is low in these districts, it confirms the above recommendation to strengthen promotion of nutrient-dense foods for young children. The promotion of increased breastmilk through breastfeeding on demand should always be a priority.

Limitations of the study results

The dietary and Optifood analysis has some limitations that need to be acknowledged and are important for the interpretation of results:

- The analysis is dependent on the quality of the dietary recall data, the food composition table used, the assumed bioavailability of nutrients and the proposed RNIs. However, the analysis and results are based on the best available information at this time.
- Data collection took place during the rainy season before the harvest, and results cannot necessarily be extrapolated to other seasons. Given that food is more abundant in the post-harvest season, it is possible that nutrient intake gaps in that season would be smaller and that those gaps could be filled with a smaller number of modifications. It is also possible that since food is more abundant and tends to be more accessible in the post-harvest season, the food-based recommendations derived in the pre-harvest season would be more feasible to implement by more households. Comparative analyses using dietary intake data from different seasons would be required to understand how food-based recommendations might change.
- Foods reported by <5% of the children in the 24hR were not included in the analysis and may have limited the options the Optifood analysis had for selection of foods. On the other hand, including these foods may decrease the feasibility of implementing recommendations that might include those foods.
- Differences in the modeled and actual breastmilk intakes will modify our findings, and the selection of different breastmilk intake assumptions will affect identification of problem nutrients and the resultant FBRs. Our assumption of low breastmilk intake may underestimate the total energy and nutrient intakes by these children, and overestimate the nutrient intakes gaps that need to be filled. Our analysis shows that nutrients that may be affected by this are vitamins A, B12, and C as breastmilk provides a relatively high proportion of the nutrient requirements. Nonetheless, even with the assumption of average breast milk intake, the prevalence of inadequate intakes of the latter nutrients is still elevated, indicating only very small amounts are derived from the complementary diet. Further, given that the FBRs presented do not fully cover the nutrient requirements, their adoption would still leave gaps to be filled. Therefore, even with some underestimation of actual intakes, it is unlikely that the FBRs as presented would pose an unnecessary burden for improving the adequacy of infant and young child diets or lead to unnecessary interventions.
- The data used to set the model parameters in Optifood originated from limited areas in the northern and the southern part of Ghana, and the agro-ecological zones of these two study areas are not representative of the whole of Ghana. Results from this study may not apply to areas that are not similar to our study areas.

7. FINDINGS FROM THE FOCUSED ETHNOGRAPHI STUDIES

The FES was intended to address the following questions:

- What are infants and young children 6 – 23 months old consuming?
- How are caregivers preparing these foods
- How and where are caregivers acquiring these foods?
- Why have caregivers selected these particular foods? i.e. what are the facilitators and constraints for IYC food acquisition and consumption?

The cultural-ecological framework which is the basis for the FES is reproduced in **Appendix 1.** The FES for IYC is designed to obtain information on all of the sectors in the cultural-ecological framework, as all of them are important for understanding and interpreting IYCF practices and behaviours in any given setting. Information pertaining to the various components of the model are integrated into the data presentation and discussion in all of the chapters of the individual detailed reports for Karaga[5] and Gomoa East Districts[6]. Here we highlight key findings of the study that are of primary interest for the specific landscape questions. The key findings are also organized around the major themes underpinning the overall objective of the study, which is to identify opportunities for improving the diets of infants and young children in rural farming communities.

8.1 Diets and feeding behaviours of infants and young children in Karaga and Gomoa East

8.1.1. Cereals and especially maize-based foods are the predominant core foods in the IYC diet in Karaga and Gomoa East. Except in porridges, cereals are normally paired with vegetable soups and stews in which fish is the only animal source ingredient. Milk is less common, and fruits are rarely consumed.

The concept of "cultural core foods" has been used to describe the differences from one society to another in the foods that are the basis of preferred local diets, allowing these cultural ideals to be taken into consideration when designing nutrition-specific and nutrition-sensitive interventions. These "cultural core foods" for infants and young children were identified by asking key informants about foods that are generally considered as part of the IYC diet. We then supplemented this ideal picture with information about what individual children were actually being fed based on 24 hour dietary recall (details in ***Appendix 2***). Notwithstanding the cultural ideals, actual consumption is determined by constraints including financial and seasonal limitations, competing social or cultural values, and individual preferences. It may not always be possible for a child, a household, or a community to consume the cultural core diet.

In Karaga foods most frequently mentioned were porridges from maize and millet, *Tuo zaafi (*TZ, a maize-based dumpling), rice, beans, pigeon peas (*aduwa*), and *ayoyo* (leaf) soup. These cultural core foods correspond closely with the foods reportedly consumed (**Table 8.1**), but caregivers also reported feeding their infants and young children additional foods not mentioned by key informants, such as tea with powdered milk, and food infrequently mentioned, such as other types of soups and stews (i.e. *Bra* [leaf] soup, tomato stew). In practice then, the IYC diet is broader than the culturally defined IYC diet. In Karaga, *TZ* is eaten with *ayoyo* or *bra* soup (both green leafy vegetables) and rice is eaten with tomato stew. Fish is eaten (in soups and stews) as powdered dried anchovies or powdered herrings and is virtually the sole animal source ingredient. Consumption of other

[5] Armar-Klemesu et al. Feeding infants and young children in Karaga District, Northern Region: A focused ethnographic study, September 2015. GAIN report. Available from GAIN upon request (e-mail: info@gainhealth.org).
[6]Armar-Klemesu et al. Feeding infants and young children in Gomoa East District, Central Region: A focused ethnographic study, September 2015. GAIN report. Available from GAIN upon request (e-mail: info@gainhealth.org).

animal source foods was rare, even at the household level: meat was not reported and eggs were consumed by only 3 children. Thus, from a behavioural perspective, core IYC foods identified for Karaga are porridges (mainly prepared from maize and millet) and *TZ*, with a secondary core consisting of rice, beans, tea with powdered milk, and vegetable-based soups and stews containing small amounts of dried, powdered fish. Fruits were absent from the cultural core IYC diet, and in practice.

In Gomoa East, foods comprising the cultural core diet were porridges (millet and maize), rice, *banku* (a maize-based dumpling), *fufu* (pounded boiled cassava and plantain mixture) *ampesi* (sliced boiled yam, plantain, cocoyam, or cassava), palm nut soup, tomato stew, light soup and kontomire [leaf] stew. The foods that were actually commonly consumed by IYC from the 24-hour dietary recalls included the same foods, with the exception of *ampesi*, whereas biscuits, fish, milk and okro soup/stew were. From a behavioural perspective, the core foods identified for Gomoa East are porridges (mainly prepared from millet and maize), *banku*, rice, and fish, with secondary core foods including *fufu*, milk, and several vegetable-based soups and stews. Meat, chicken and eggs were mentioned by a few households as consumed 1 - 2 days in the past week.

Compared to Karaga, there is more variety in both the staple dishes and the accompanying soups and stews in the IYC diet in Gomoa East. The variety and forms of fish consumed in Gomoa East are greater, including smoked mackerel, herrings and tuna, frozen fish, and dried fish powder used in soup and stew recipes specially prepared for infants and young children. When consumed, milk was added to porridge, and fruits were seldom reported to be consumed nor were they considered as part of the cultural core IYC diet. These findings are consistent with those from the larger dietary survey.

Porridges are consumed on a daily basis by nearly all children in both districts whereas most other core foods enter the IYC diet at about one year of age, suggesting that diversification of diets is delayed. The core cereal staples are paired with soups and stews. Despite the ubiquity of fish in the diet of older infants and young children, the amounts used in typical vegetable soup and stew recipes are small, particularly in Karaga. These results suggest there is scope for expanding what caregivers perceive to be the cultural core foods, and extending the perception of secondary core foods as primary core foods.

Table 7.1 Consumption of core foods by infants and young children

Foods consumed	**No. of children consuming food/age category**				
	Total N=32	6 – 8 N=8	9 – 11 N=8	12 – 23 N=8	12 – 23NBF N=8
KaragaN(%)					
Porridges	29(91)	7	7	7	8
TZ	23(72)	2	5	8	8
Rice	10(31)	4	-	4	2
Beans	8(25)	2	3	2	1
Tea + milk + sugar	10(31)	2	2	4	2
Ayoyo soup	11(34)	-	2	4	6
Bra soup	10(31)	1	1	4	5
Tomato stew	10(31)	4	-	5	1
Fish*	24(75)	4	5	7	8
Gomoa East					
Porridges	24(75)	7	4	7	6
Banku	14(44)	1	4	5	4
Rice	13(41)	1	4	3	5
Fufu	7(22)	1	4	-	4
Kontomire stew	10(31)	2	1	3	4
Okro stew/soup	10(31)	-	4	4	2
Tomato stew	13(41)	-	4	2	7
Palm nut soup	8(25)	1	-	4	3
Fish	23(72)	3	6	7	7
Milk	10(31)	3	1	3	3

Legend: NBF: Non-breastfed

* Fish is an ingredient in soups and stews and not served separately. It is however being included to show the number of children who consumed fish in their soups/stews.

8.1.2. Foods fed to infants and young children include specially prepared foods that are not shared with other family members, suggesting a cultural recognition of particular IYC dietary needs. Cultural recognition of the concept of special foods for infants is thought to be a prerequisite for IYC nutrition interventions. In Karaga and Gomoa East the foods fed to infants and young children included porridges and other foods that are specially prepared and not shared with other family members. In Karaga some specially prepared foods include *moli koko* (smooth textured unspiced porridge), rice and stew and beans with palm oil, and in Gomoa East these are mashed kenkey porridge and rice or *banku* and stew (with powdered fish or eggs). This cultural commitment to special foods for infants and young children may serve as an entry point from which to build targeted nutrition education to increase the nutritional quality of the IYC diet. It is however noteworthy that judging by the 24-hour recall, long-standing national efforts to promote the use of specific blended IYC multi-grain flour mixes appear to have made little headway in either location.

8.2 Acquisition and preparation of foods fed to infants and young children

8.2.1. Special processing methods — some of them requiring considerable investment of time and effort – are employed by caregivers to modify standard food ingredients into safe, palatable foods for their infants and young children. Caregivers' detailed accounts of how foods are prepared for infants and young children show distinct differences from those prepared for the whole family. Of note are "smooth" porridges that require flour (and sometimes the dough) to be passed through a sieve to achieve a higher degree of fineness. In Karaga, *moli koko*, requires initial sieving of the flour, mixing the dough with water, fermenting overnight and drying in the sun to produce a fine, smooth-textured flour. In Gomoa East, caregivers purchase *kenkey* (maize-based ready-prepared dumpling similar to *banku* but processed for a longer shelf-life) which they mash through special muslin cloth to remove the chaff and obtain a smooth-textured mixture used to prepare porridge for younger infants and young children. Cooking techniques for family foods such as *banku* or rice are sometimes adapted for IYCF to produce a softer texture, and standard stews are modified with powdered fish (as advised by health workers). These are positive practices that could be reinforced and possibly extended to increase the diversity of the core IYC diet.

8.2.2. Caregivers in both districts use a variety of implements to feed their infants and young children, including spoons, cups and hands. In Gomoa East this also includes the use of feeding bottles. Caregivers use a variety of methods and utensils to feed their infants and young children. These include bowl and spoon, cup and spoon, cup only and hands (both of caregivers and of the infants and young children themselves). In Gomoa East, some caregivers reported using bottles, contrary to advice given by health workers. Several others reported allowing their infants and young children to suck porridge directly from the polythene bag in which the purchased porridge is carried. These practices are clearly harmful and should be discouraged. The following quotes from caregivers reflect the gravity of the situation:

"I put it (porridge) in a feeding bottle to make feeding easier." I: "Why is it easier?" R: "Because he is used to the feeding bottle. To him it is similar to the breast."

"I give it (millet porridge) to him from the polythene bag it is served in." I: "Why?" R: "Because I am in town and don't have a cup with me."

8.2.3. Prolonged storage resulting from bulk cooking strategies in the management of IYCF may compromise safety of IYC foods. Preparation and storage practices for IYC porridges are similar in Karaga and Gomoa East. Normally prepared or purchased in the morning, porridges are stored in non-insulated plastic or metal containers in ambient temperatures for as long as 10 hours as they are fed to infants and young children over the course of the day, most often without reheating. There are, however, differences in preparation and storage of the stews and soups consumed by older infants and young children. In Karaga, *TZ* soups are prepared on a daily basis and are occasionally stored overnight. In Gomoa East, by contrast, stews and soups including special IYC stews are

cooked in bulk and fed over several days. Daily heating in the mornings and evenings is the common practice. These practices pose potential food safety and health risks for infants and young children, whose resistance to contaminated food may not be as developed as other family members'.

8.2.4. Despite a strong cultural emphasis on self-sufficiency, IYC foods cannot be provided with on-farm produce alone, and markets are indispensable to acquire the foods prepared by caregivers. Several factors force caregivers to rely on a variety of sources to access the ingredients of common IYC foods, including seasonal fluctuations in staple reserves, constraints on access to land or productivity, and the necessity of purchased ingredients. The off-farm sources of IYC food ingredients include markets, vendors, and food borrowed from relatives and neighbours.

Caregivers' expressed preference was to source their food from their farms. However, no household is solely dependent on own production; even for staple cereal grains, there is seasonal reliance on the market, including in Karaga where farming is the main livelihood. Significantly, some key ingredients used in preparing the soups and stews that accompany the staple dishes are solely purchased. These include commercial products and market foods such as fish, palm oil, cooking oil, tomato puree, and bouillon cubes. This is also true to an extent of the porridges that the youngest infants and young children are fed, as the sugar, milk powder and oil, that mothers are frequently advised to add, are only available through markets. Having cash on hand is therefore necessary for IYCF, and when cash is not available, constraints to IYCF are faced. Some of the mitigation strategies are addressed below.

8.2.5. Caregivers describe a number of considerations that together determine where they purchase food ingredients. Caregivers purchase food from various sources including district markets, vendors within their communities or neighbourhoods and, in the case of Karaga, from other nearby communities (as many villages have no local vendor). Caregivers take a number of factors into consideration in their preference for particular sources of purchase. These include i) getting value for money in terms of the quantity and quality of produce, ii) proximity and accessibility, iii) the cost of transportation to point of sale, and iv) opportunity to borrow or to buy on credit. Taking food on credit was a more common practice in Gomoa East, where 47% of mothers reporting having ever taken food on credit, compared to 31% in Karaga. Foods taken on credit are mainly the special foods that infants and young children prefer such as rice and stew (either ready-to-eat or as ingredients), tea, sugar, milk, and biscuits. Significantly, mothers have primary responsibility for deciding on and purchasing food for their infants and young children and as described below make considerable efforts to provide their infants and young children their preferred foods. This suggests a positive environment for interventions that will involve the marketing of special IYC foods.

8.2.6. Caregivers purchase many IYC food ingredients in very small quantities – often just enough for one meal. Sugar, tea bags, and powdered milk are frequently purchased in factory-packed single use portions, or break down the packs available in larger markets

for local resale in smaller, single-use quantities. Mothers described buying one teabag or one serving of powdered milk at a time for infants and young children. Sugar is bought in small, single-use polyethylene-wrapped packets. On a cost-per-unit basis this is not the most economical way to purchase these ingredients, but it is similar to the single-use units of bouillon or tomato paste that are purchased for family foods; it suits households in which there is seldom refrigeration for the preservation of leftovers, and above all it meets the needs of mothers who at any given moment have very little disposable cash.

8.3 Seasonality and its impact on family and IYC diet

8.3.1. Seasonality imposes adjustments to food preparation and consumption both in Gomoa East and the more fully agricultural communities of Karaga. Despite the different degrees of market accessibility in the two districts, many of the coping strategies described by caregivers are similar. In Karaga, where families' own production represents a greater proportion of total consumption needs, the principal challenge is to compensate for shrinking maize reserves and the absence of fresh vegetable ingredients – especially leafy greens – provided from mothers' gardens. Lean season adjustments include substitution of gathered "wild" ingredients. For example, the preferred *bra* leaves produced at home for use in *bra* soup, can be substituted with a 'wild *bra*' found in the lean season. By this means a semblance of these standard dishes is maintained. Caregivers also make alterations to the fundamental structure of common dishes. For example, the common maize dumpling TZ may be eliminated, and use of maize flour limited instead to thickening soup dishes, or other "one-pot meals". Karaga caregivers also reported reductions in meal frequency.

In Gomoa East, the challenge is slightly different. Despite the advantages of a more developed market, Gomoa East caregivers also struggle to access year-round the ingredients for their IYC and family foods, which are typically more elaborate than those consumed in Karaga. Caregivers described reductions both in meal frequency and in portion sizes. Substitutions of more readily available but less preferred ingredients are made (e.g, less preferred dried cassava flour – *kokonte*– is substituted for fresh cassava and plantain in some dishes). The gathering of wild ingredients appears to play less of a role than in Karaga, where households have greater access to bush land; however dandelions which grow freely around the home may be substituted for the preferred *kontomire*. Changes in the fundamental structure of main dishes were also described – principally the "dry" consumption of staples without the normal sauces and stews. This is a radical adjustment that omits some of the most nutritious ingredients – including vegetables, oils, and fish – suggesting that despite the advantages of a more extensive market economy, Gomoa East households are by no means insulated from seasonal price and availability impacts. This is consistent with the greater reported prevalence of household food insecurity (Table 4.1) in this District.

8.3.2. Caregivers seek to buffer infants and young children from the most pronounced effects of seasonality, in some cases with the explicit objective of protecting child

health and growth. Nevertheless there are pronounced differences in IYC diet during annual cycles of scarcity. In both Karaga and Gomoa East, some caregivers described deliberate efforts to minimize alterations to the IYC diet during the period of scarcity that affects farming families during the planting season. Karaga caregivers reasoned that the quantities consumed by infants are already small, and that the disruption to a mother's own work and mental state caused by an unhappy infant was not worth the trouble, especially given the meagre savings realised through altering the diet. In Gomoa East, one respondent described going to bed hungry on consecutive nights in order to ensure that the children had sufficient nourishment. Another reported providing older children with fewer meals so that younger siblings could be adequately fed. Efforts to maintain the normal IYC diet in times of scarcity were more explicitly described in Karaga. Yet this does not necessarily mean that Karaga infants and young children face less hardship. The IYC diet in Gomoa East is founded on a greater variety of core ingredients, so even after reductions in feeding frequency or portion size, infants and young children in Gomoa East may still consume a more nutritious diet than their Karaga counterparts during the lean season.

8.3.3. In addition to alterations and reductions in consumption, caregivers also describe a variety of strategies to maintain food supply during times of seasonal shortage. These include securing food ingredients on credit from local vendors, borrowing food from friends or relatives (a strategy that is unlikely to be very effective against seasonal shortages to which the majority of the community are subject), seeking food aid from charitable organizations, and undertaking casual agricultural labour in the community for income with which to purchase food for the family or infants and young children. Sharing or borrowing strategies that involve a degree of social reciprocity appear less common among the more nuclear households of Gomoa East. Opportunities to access food aid provided by non-governmental organizations or charities appear to be also fewer for Gomoa East families, although like Karaga households they are sometimes able to access free blended foods at the child welfare clinics.

8.4 Caregivers' perceptions, beliefs and knowledge related to nutrition and IYCF

8.4.1. Caregivers' ideas about the attributes of healthy IYC foods and diets share some important commonalities with received wisdom on IYCF. These commonalities include a sense of the importance of balancing dietary components; a notion of the preventive power of certain foods; and the ability of certain foods to supply energy and support growth (in the view of caregivers by "building" or "making blood"). The specific foods mentioned in connection with these attributes vary between Karaga and Gomoa East. But the beliefs are broadly consistent with contemporary nutrition knowledge and recommendations. Leafy vegetables, fish and eggs, for example, are believed to "give" blood which makes children healthy and grow well; without enough blood the child is thought to be prone to sickness and "dull". Similarly, "heavy" foods such as staple dishes with accompaniments (*TZ* and *ayoyo*, rice and stew etc.) are thought to build strength and growth. In designing behaviour change communications (BCC) that aim to improve IYCF, it may be constructive to acknowledge, and build upon, these areas of commonality.

8.4.2. Food safety and cooking conditions feature prominently in caregivers' discussions of healthy IYC foods. Mothers and caregivers in both study locations are aware of the risks of unhygienic food preparation, and the importance of a clean environment or safe IYCF. Many respondents identified a healthy food as one that has been prepared in a hygienic environment, using clean utensils, and cooked for an extended period. At the same time, many mothers seemed unaware of the loss of nutrients that can occur with prolonged boiling of food. This balance between achieving food safety and retaining nutrients during cooking is one gap in knowledge that health care professionals need to address. And, as noted above, prolonged storage and re-use of IYC porridges appears to be common despite awareness of hygiene at the preparation stage.

8.4.3. Some foods are avoided due to a perception that they are not well tolerated by infants and young children; others because they are thought to be prone to adulteration. Young children may not be fed mangoes, because of a perception that they cause diarrhoea. Similarly, the addition of salt peter[7] to hasten the cooking process in *waakye* (beans and rice) is thought by Gomoa East caregivers to cause diarrhoea in infants and young children. In Karaga, by contrast, mothers give beans and use salt peter freely. In both locations certain common cooking ingredients such as oil and salt were also said by some caregivers to be unhealthy for infants and young children if consumed in more than moderate amounts. And in Gomoa East a minority of respondents expressed a belief that infants and young children may be at risk from frozen foods due to chemicals added during the freezing process, or from commercial vegetables due to fertilizers used in cultivation. There thus appears to be a more complex set of perceived hazards and avoidances in Gomoa East – perhaps related to the greater variety of food choices available to caregivers in that district.

8.4.4. IYC food preferences matter to caregivers, who monitor the acceptance by IYC of specific foods, and have a variety of ways to make foods more attractive, often for reasons unrelated to nutritional benefits. Mothers recognise that child acceptance of food is facilitated by appealing to their sense of taste, but also, importantly, their sense of sight and smell. They enhance the characteristics of the food prepared for infants and young children accordingly. The main drivers identified for child acceptance of foods include the key attributes of pleasant or sweet taste, smooth or soft textures, and colourful visual appeal. For most respondents, it is a combination of these qualities that make a food acceptable, and achieving these qualities through food preparation processes and ingredients was considered important. When available, ingredients such as meat, fish and eggs may be added to food to enhance its taste and add visual appeal, and caregivers with sufficient means sometimes use these ingredients as incentives to encourage food acceptance. Condiments, such as flavour enhancers in the form of bouillon stock cubes or powders, are also used to enhance the taste of food. The most common enhancement is the use of sugar (and to a lesser extent, milk) to make beverages and porridges more acceptable. The red colour of palm oil is used to make food attractive, while soft textured food enables

[7] Salt peter is a naturally occurring potassium nitrate, used in food preparation, such as to thicken soups or to aid the softening of beans or meat during cooking.

chewing / swallowing. Where infants and young children have graduated to consumption of family foods, caregivers describe making portions of these foods softer to facilitate their acceptance by infants and young children.

8.4.5. Gomoa East caregivers are more aware than their Karaga counterparts of the importance of the contextual elements of IYCF. Among Karaga caregivers and mothers, the idea that feeding practices might play a role in food acceptance did not emerge spontaneously from discussions. Only one respondent in this study area mentioned the need to devote time and attention during feeding as a route to enabling IYC acceptance of food. Among the Gomoa East respondents on the other hand, child centred feeding practices, such as a congenial feeding environment as well as devoting time and attention during feeding were cited as important to promoting child acceptance of food. Caregivers mentioned the importance of feeding children in a positive, stress-free environment. Those who have to manage dual roles as caregivers and income earners may be "time poor" and struggle to devote the time they would like to IYCF. One respondent asserted that it was as important for her to enjoy a peaceful, stress free feeding time as it was for her child.

8.4.6. Caregivers understand the importance of recommended enhancements to the most common porridges and beverages; however they also consider these enhancements to be costly – often prohibitively so. The cognitive mapping exercise carried out with caregivers where the commonly available IYC foods were rated across selected value dimensions highlighted an important conundrum for those wishing to improve the IYC diet: foods rated by respondents as the most healthy were generally also the ones rated least accessible due to cost. This is not an entirely surprising result, but it does make clear that, with a few notable exceptions, the barriers to sound IYCF appear to be more about material constraints than a fundamental lack of understanding and awareness of what constitutes a nutritious diet.

Across both study locations the addition of protein sources such as milk, beans and groundnuts were recognised to render IYC porridges healthier, however mothers felt these to be costly. In Karaga, even the simple addition of milk was described by many to be an unrealistic enhancement, given the irregular supply of fresh milk and the cost of powdered milk. The problem is succinctly summed up by this caregiver:

"If I had money, I would have prepared the food better for her to eat…….like, I will buy more sugar and buy Nido (powdered milk) and add to the moli koko for her to eat. But because I don't have, I add only sugar and even with that it is not always that I'm able to buy".

8.4.7. While *koko* porridges enriched with milk or other nutritious ingredients were ranked high for healthiness, they were ranked low for affordability, indicating a barrier to their more frequent use. There is greater consensus among caregivers in Karaga than in Gomoa East concerning the best IYC foods. The ratings exercise conducted with caregivers allowed them to assign values on a Likert scale to common IYC foods across 5 important dimensions (healthiness, affordability ease of acquisition, ease of

preparation, and acceptability by the child). In Karaga District, a clear cultural consensus was evident around *moli koko* (plain maize/millet porridge) which emerged as the sole IYC food with high ratings across all five dimensions**.** *Moli koko* is a favourite of many caregivers and, as the first complementary food to which most infants and young children are introduced, respondents described it as easily accepted.. Crucially, plain *moli koko* is also considered affordable. In Gomoa East District, however, while plain *koko* was ranked high with regard to acceptability, it was not deemed as healthy as in Karaga District. On the whole, enriching porridges and beverages with milk and other protein-based products tend to make them more appealing in taste and more acceptable to infants and young children. In both Districts, there was consensus that protein-rich processed foods such as Milo, Cerelac and powdered milk were well accepted by infants and young children. Further, the nutritional value of porridges enriched with nutrient-dense ingredients is not lost on caregivers, as highlighted by the respondent in the following comment:

"Koko with enriched foods has other ingredients that are more nutritious than just the koko alone."

Indeed, caregivers in both Districts gave the same healthiness rating to enriched *koko* (4.7 on a scale of 5) and, more importantly, both rated enriched *koko* higher than Cerelac. Nonetheless, nutrient-dense processed foods such as milk powder, Milo, and Cerelac were ranked unfavourably with regard to cost as they were perceived as being expensive. Not surprisingly, the addition of these foods to *kokos* renders them more expensive compared to the plain versions. The tension between the positive perceptions of child acceptance and healthiness of milk or other enriched products and the perceived high cost is evident in the statements of these Gomoa East respondents:

"Every child likes porridges especially if there's milk in it; but I can't afford the milk."

"*The added ingredients to the corn would cost more for this one (Koko enriched)".*

In Gomoa East, *koko* with enriched ingredients, although home prepared, was perceived as the least affordable IYC food (mean score of 1.3)and even more expensive than powdered milk (1.4) and Cerelac (1.5). In Karaga, *koko* with enriched ingredients was rated relatively low on affordability (2.7) compared to the other home prepared porridges (>4), but not as low as the commercial equivalents such as Cerelac and powdered milk, which both had the lowest score on affordability (1.1).

These findings clearly highlight that cost, more than knowledge or perceptions of healthiness, is the likely barrier to wider use of nutrient-dense foods in the IYC diet. Future product development would do well to focus on providing lower cost options for enriching *kokos* in particular, with equally nutritious ingredients.

8.4.8. Nearly all family foods were perceived as being very healthy for infants and young children among caregivers in Gomoa East District, while perceptions were more variable in Karaga District. *In particular, waaky*e (a combination of boiled beans and rice) +stew was rated the least healthy staple food among Gomoa East respondents,

with an intermediate mean score of 3.0, while in contrast plain rice + stew was rated second highest (4.3). The difference between the health perceptions of *waakye* versus plain rice is attributable to the perceived unhealthiness of salt peter, as noted earlier. The following comment reflects this sentiment and how one single ingredient could alter the perception of the healthiness of a meal:

"Waakye *has saltpetre that causes them (children) to run (diarrhoea), so I don't like it".*

Although among the staple foods, rice with stew was rated lowest on affordability in both locations (mean scores of 2.4 in Karaga and 1.8 in Gomoa), caregivers commented that most of the cost is attributed to the stew. Considering its popularity in the IYCF repertoire rice is another food that could be considered for fortification.

8.4.9. Caregivers believe that it is unwise to feed a child solid or heavy foods before he/she begins to walk; this belief appears to be most strongly held in Karaga, but was also cited in Gomoa East. In both settings the reason offered was that consuming such foods during this period will prevent or retard the ability of the child to walk. The impact of this practice will depend on exactly how the concept of "solid" foods is interpreted by individual mothers. Foods mentioned in connection with this concern include *TZ, fufu, ampesi, kokonte and banku*. It seems plausible that consumption of some nutritious ingredients is being delayed in at least some children due to this proscription. However, whether this represents a significant problem compared to the challenges of affordability and seasonal scarcity in achieving adequate IYCF remains to be established.

8.4.10. Fruits are perceived favourably by caregivers in both locations, particularly Gomoa East. Of the few fruits rated, oranges in both districts as well as pineapples in Gomoa East were perceived as being somewhat healthier than mangoes. Compared to their Gomoa East counterparts, caregivers in Karaga tended to perceive fruits as less easy to acquire, ranking them lower on this dimension than all other foods included except for Cerelac and milk powder, and may be attributed to the fact that fruits are not farmed as much in Karaga. There were also fewer spontaneous mentions of fruits by Karaga caregivers during the discussions on the healthiness of foods. These caregivers appear to perceive fruits more as food for "intervention" to be consumed when the need arises, rather than to be consumed for their nutritional value on a regular basis. Oranges, for instance, are valued for their ability to restore appetite, help digestion and prevent illness. By comparison, there was a higher level of spontaneous mentions of fruits by Gomoa caregivers. This positive orientation is evident in the very high ratings given by Gomoa caregivers across all the values for pineapple, mango and orange, except for child acceptance of mango receiving an average score of 2.7. There is a need to educate Karaga caregivers on the core nutritional value of fruits to enhance their awareness and potentially the inclusion of fruits as part of regular IYCF.

8.4.11. Awareness of vitamins was low in Karaga District but more evident in Gomoa East District. Although Karaga caregivers have absorbed much sound information about the health-giving properties of particular foods, the majority were unfamiliar with the term

"vitamins". Among the small minority who recognized it, vitamins were likened to a medicine that can restore appetite and IYC health, and indeed the children of several respondents had been prescribed vitamin syrups - described by respondents as "blood tonics" – for poor appetite. These caregivers were also aware from their interactions with government health staff that vegetables and fruits contain certain health-giving substances (i.e. vitamins) and that like medicines, consuming these foods could help improve appetite and reduce sickness in infants and young children (although none in Karaga could identify any individual vitamin). By contrast, the term vitamin was familiar to more than two-thirds of caregivers interviewed in Gomoa East. However, here too, vitamins were most immediately associated with treatments prescribed by doctors and nurses. Although beliefs about health-giving foods in these communities were relatively consistent with scientific knowledge of nutrient-dense foods, there may still be value in fostering a more modern understanding of nutrition concepts, particularly in Karaga District. This may help support the uptake of currently available or future nutritional products targeting the improved nutritional adequacy of IYC diets.

8.4.12. The fortification of foods with vitamins is also a more familiar concept to caregivers in Gomoa East District than to those in Karaga District. In Gomoa East about half of caregivers were familiar with the idea that vitamins may be added to foods to improve their nutritional value, whereas in Karaga this was true of far fewer (10%). Those who were knowledgeable were able to identify specific products for children that they believed to be fortified, such as Cerelac (an instant cereal), Lactogen (infant milk powder), Malta Guinness (a malt drink), Don Simon (a fruit drink), and Tom Brown (a wheat-soy flour blend). This suggests that, following from the point above, awareness-raising in Karaga District about the concept of nutrient fortification may be an important precursor to the successful promotion of any new fortified food products that could help fill nutrient intake gaps in the IYC diet.

8.5 Caregivers' challenges and motivations related to IYCF and food management

8.5.1. Challenges. Several challenges related to IYCF and food management have already been identified in the previous sections, including:

- Cost of IYC food ingredients, especially the more nutrient-dense foods, is a constraint for most caregivers. This challenge was further described in the context of 'convenience' among farmer-caregivers, who prize the ability to balance economies of home production and the ability to build recipes from around self-harvested food, with judicious use of purchased ingredients. Only a few caregivers perceived that food prices are affordable and easily within financial reach year-round. Cost or access to money is considered a very important determinant of what can be provided as described in this excerpt:

  "Money is very important because without it I cannot make her food delicious and also I cannot put the things like meat and fish in the food to make it healthy for her".

- Seasonality poses an additional challenge related to food cost whereby, in addition to direct effects on the variety of nutritious foods available for IYCF in the lean season, the cost of seasonal food items is greater due to scarcity, and additional transportation costs and time burden occur if it is necessary to travel further to larger markets to find those foods.

Additional challenges noted by caregivers were centered around problems of food acceptance or fussiness by infants and young children, and problems of appetite related to illness. Poor eating appears to be most common among the 9-11 month cohort.

8.5.2. Caregivers' motivations for making healthy food choices transcend the obvious outcomes of promoting the physical and emotional wellbeing of their children, and include the need for personal contentment and peace of mind for themselves. A few more caregivers in Gomoa East than in Karaga expressed this underlying motivation for making healthy food choices for their children, as reflected in these sentiments:

"If *my child is not healthy, I won't be at peace; I will be worried and restless".*

"*When the child is healthy I am happy and at ease as a mother; if not I'm distressed*".

"If a child eats well enough, and is healthy she will not worry you. All sorts of unnecessary cries will be avoided; hence she will always be healthy because she is satisfied".

These comments suggest a motivation for caregivers that may be appealed to if nutritious IYC foods could be made more accessible.

8.5.3. Embedded within caregiver food choices is an appreciation that good diets can minimize ill-health among infants and young children – an important consideration for mothers who need to work and earn incomes, and who can ill afford the opportunity costs imposed by IYC illness. A few more caregivers in Karaga than in Gomoa East stated that it is imperative their children remain healthy to enable them to engage in their day-to-day chores and economic activities. Any distraction created by the need to attend to their sick infants and young children impedes caregivers' ability to farm or engage in other income-earning work. Respondents sharing this viewpoint tended to rate healthiness very high as a value dimension of IYC foods. The following extracts reflect the peace of mind caregivers crave from being able to work when their children are healthy.

"The health of [my child] is of paramount importance to me. As a result, each time I cook I ensure that it is well prepared so that when she eats she will remain healthy so that I will have peace of mind to do my farm work and household chores".

"I always think about the health of the child because, my child needs to be healthy to be able to eat well. I also think about foods that will make my child healthy. When the child is sick, I'm not happy and cannot do any work".

For a minority of caregivers from both locations, another motivation for preventing ill health was to avoid spending scarce financial resources on hospital fees particularly when

living on very limited budgets. While some caregivers have free access to healthcare through health insurance, others claim they sometimes cannot even afford the National Health Insurance registration fees.

"No mother wants to cook food that your child would eat and fall sick. If I do not cook healthy foods, and he eats and falls sick, then I would still have to spend money to take him to the hospital."

"If I do not cook foods that will make my family healthy, then they will fall sick from eating foods that is not healthy and I would have to spend money that I don't have on medicine or taking them to the hospital."

8.5.4. While mothers and mothers-in-law are generally respected as experts with experience in childcare and husbands influence feeding decisions through their role in providing financial and material support for the household, health workers are respected by caregivers and cited as the most reliable source of information on child health in both Districts. A range of sources of child health advice was identified. When educating caregivers, it is important to consider maternal elders as secondary caregivers within the household. In Karaga, the household living arrangements determine the extent of this influence, where with live-in maternal elders, caregivers are more prone to having to accept both solicited and unsolicited advice. In both locations, a few caregivers reported that their husbands have direct influence in deciding what should be fed; others were of the opinion that such involvement was negligible. But health staff were strongly favoured as the most reliable source of nutrition and health information. Interestingly, this was true not only of Gomoa East but also of Karaga, where the more traditional family structure and the less developed service network might be expected to reduce the influence of health personnel. Mothers frequently echoed standard maternal and child health messages, including specific guidance on exclusive breastfeeding, personal hygiene and food preparation. This suggests that the modern health system has established an influential presence and positive force. Nonetheless, it is important to distinguish between caregivers' ability to recall such messages from their ability to actualise this advice in their own care and feeding routines, as noted below.

8.5.5. Despite the presence established by the modern health system, key recommended IYCF practices remain unimplemented by caregivers. Complementary feeding advice, even when well received and understood, is not always deemed actionable by caregivers – usually due to the costs involved. The best example of this disconnect between knowledge and action is the enrichment of *moli koko*, the commonly-administered infant porridge, made from maize flour, sugar and water. Many caregivers are aware from their interactions with health staff that this formulation alone provides insufficient nourishment to their infant, yet they consider it unaffordable to introduce more nutritious animal proteins from milk or milk powder to the porridge, or to add meat to food, as illustrated by the three mothers who all expressed similar sentiments about health worker advice:

"We are told what to feed our children with by health workers at times when we visit them. But the fact is if you don't have money, what they say will not really count. You will just feed the child on what is affordable and available."

They have knowledge on foods a child is supposed to eat but they don't live with us and they don't give me the foods to feed him."

"Advice from all these people (health workers) is good, but it all depends on what you have available so I cook what I have for the child."

9. IMPLICATIONS FOR PRACTICE

9.1 Implications for Community-level Infant and Young Child Feeding counselling tools

The Ghana Health Service and the Ghana Ministry of Health have produced a package of IYCF counselling tools intended for use at the community level (C-IYCF). Based largely on generic materials for Africa developed by UNICEF, these tools introduce key messages for use by community-level health workers during education and counselling sessions with mothers and caregivers. The adaptation of generic guidelines to specific settings in Ghana relies on the communication of key points in a manner consistent with existing practices and culture. We therefore reviewed the Participant Materials booklet of the C-IYCF package (UNICEF, 2013), with the objective of highlighting areas where the FES and Optifood study results could help to enhance the effectiveness of the Ghana counselling materials. For the most part, we found these materials to be highly appropriate, and their emphasis was consistent with the IYCF landscape of Karaga and Gomoa East revealed in our studies. However, some specific observations were made that may be considered by Ghana Health Services and its partners to further adapt the tools to the local contexts of these Districts:

Animal-source foods: In the existing IYCF counselling tools, the importance of adding animal-source foods to the IYC diet is described using the examples of meat, chicken, fish, liver, eggs, milk, and milk products. However, the dietary intake survey results indicate that currently the only items from this list consumed with any frequency by infants and young children are fish (and this in only very small quantities), and to a lesser extent milk, often in powdered form, mainly as an ingredient in porridges and similar food preparations. Counselling messages and materials adapted for use in Karaga and Gomoa East might gain more immediate traction by putting a specific emphasis on fish. This should include specific reference to the many forms that fish take in the local diet (e.g. tinned, smoked, dry powdered, as well as the fresh whole fish that feature in the counselling booklet visuals). Localizing the generic message in this way need not contradict or displace the message that caregivers should also seek to broaden the range of healthy ingredients in the IYC diet beyond what is already found in the diet, including animal flesh foods. Rather, specific guidance for increased feeding frequency, or portion size, of a culturally acceptable, nutrient dense food that already forms part of the IYC diet, may present a more attainable option for caregivers and achieve results in the short term. It is worth stressing that the absence of meat in the

family food records suggests that it is not a frequent food source for households in general, and is not simply being withheld from young children. Availability therefore needs to be dealt with before BCC will have any impact.

Thicker porridges: C-IYCF materials call for a gradual increase in the "frequency, the amount, the texture (thickness/consistency) and the variety of foods, especially animal source". However, on the matter of consistency this message may run counter to local beliefs. A significant minority of caregivers expressed a concern that "thick" or "heavy" foods can be harmful to a child who is not yet walking. In their view, a child who is introduced too early to heavy foods will fail to walk, or will develop this ability later than they otherwise would. The prevalence of this view needs to be further established, but it is possible that specific assurances about the safety of thicker porridges and family foods will need to be introduced to counselling materials, particularly for those covering children between 7 and 12 months who appear most likely to be adversely affected by this proscription.

Consumption of fruits: C-IYCF messages for the 12-24 month age group include specific emphasis on consuming vitamin A-rich fruits and vegetables. But whereas dark green leafy vegetables are a daily feature of the diet after infants and young children are introduced to family foods, regular consumption of fruit is far less common, particularly in Karaga, despite the fact that caregivers rated fruits to be healthy, convenient and accessible. As noted earlier, fruits appear to be perceived as having more therapeutic properties, administered to solve occasional problems of child appetite or digestion. C-IYCF materials could begin to expand his notion by adding language about the benefits of daily consumption. This can incorporate local ideas about the power of fruits, but link them to preventive properties, in the same way that Western children learned that "an apple a day keeps the doctor away".

Food storage: there is a strong emphasis in the Ghana C-IYCF counselling materials on personal hygiene during the process of breast feeding and complementary feeding to protect infants and young children from sickness. Study respondents also demonstrated a good recall of similar messages typically disseminated in local GHS health education sessions. However, this study revealed that IYC food storage without reheating, remains a potential IYC health risk, and the C-IYCF materials are relatively silent on this topic. Practical suggestions for caregivers who are in the habit of storing IYC porridges while labouring on the farm or travelling to market should be made a priority for new C-IYCF content development. Most infants and young children appear to consume porridges made only with flour, water, and sugar. But the risk of contamination is likely to increase if another C-IYCF recommendation – the addition of milk or other animal proteins to IYC porridges – is adopted. Should caregivers associate the addition of protein-rich ingredients with an increase in IYC morbidity, it would undermine continuation of this practice. In this case, any recommendation to enrich porridges with such ingredients may advise that they be added only at the point of consumption. Alternative, viable solutions, such as greater use of fermented

porridges for their lower microbial content, or more fuel efficient cooking methods, merit further study.

Use of a spoon: C-IYCF materials encourage caregivers to provide older infants and young children with a spoon and encourage the child to feed him/herself. This fosters motor control. In the Western setting, a child's ability to eat using a spoon represents an important benchmark on the road to independence and personhood, and it marks their ability to join the family table where adults feed themselves with utensils. In rural Ghana, however, something opposite may be occurring. Some mothers do use a spoon to feed infants – usually spooning thin porridge from a cup or bowl into the child's mouth. However, the spoon may be retired as soon as the child can grasp the cup and use this to feed directly. In the view of some caregivers, Ghanaian family foods based on TZ and rice do not lend themselves to being eaten with a spoon. These adult foods are eaten with the hands. Thus, whereas Western children graduate from the hands to the spoon, children in settings where meals are consumed around the family pot do the reverse, graduating from the spoon to the hands. In this context, providing a child with a spoon is unlikely to have the same associations with child development. C-IYCF messages may therefore need to spell out for caregivers the particular reasons for this advice (the connection with neural and motor development) and training in the use of C-IYCF materials should empower local health and nutrition educators to determine this particular message is appropriate for the local setting.

9.2 Opportunities for Intervention

The Optifood analysis results suggest that the nutrient intake adequacy from the IYC diet could potentially be improved through modifications to the current local diet. These food-based modifications were derived based on the local dietary patterns, and hence are generally considered to be realistic for the populations as a whole. Nonetheless, some of the modifications may not be feasible for a part of the population because of limited availability or affordability of some of the foods included. In addition, even if the modifications are fully adopted, adequacy of some nutrients (i.e. the problem nutrients) could still not be reached among breastfed children, especially for iron, zinc and calcium (both districts for most age groups).

Promotion of the food-based modifications through nutrition education or BCC activities may lead to some improvements in IYC dietary adequacy and should be pursued in the context of C-IYCF activities and other opportunities. However, the FES results indicate that affordability and poor access to nutrient-dense foods are major barriers to their use. Clearly, additional strategies are required to help overcome these barriers and to improve access to low cost nutrient-dense foods. Agricultural- and market-based strategies, in combination with nutrition specific interventions including fortified foods and, when appropriate, use of micronutrient supplements to be consumed directly or mixed with foods (i.e., home fortification), may offer opportunities to further facilitate adoption of recommendations and provide additional support to improved nutrient adequacy.

9.2.1 Agricultural Approaches

Agriculture-based interventions may support the adoption of the recommendations when focused on increasing the local production and marketing of the nutrient-dense foods identified in the Optifood analysis, such as (green leafy) vegetables, legumes, milk, or other animal-source foods. The following agronomic opportunities appropriate for the context of Karaga and Gomoa East Districts that could be considered to help fill the identified nutrient gaps are suggested:

- Vegetables, and especially green leafy vegetables, are prominently included in the food based recommendations in both districts. Although vegetables are generally available in both districts, the limited amounts and the seasonal absence of fresh vegetables were noted as important limitations to the use of these in IYC diets. Promoting horticulture activities may contribute to increased access to vegetables, and specific messages to increase the frequency of feeding these among the youngest age groups, should be included. Home production of vegetables may also support access but feasibility of this in terms of quantities of foods that need to be produced, the time burden or opportunity cost required to produce them, current levels of production, seasonality, and input requirements for production (e.g., seeds, water, etc.) should be evaluated.
- In Karaga, the use of dried green leaves and dried okro is already practiced; and introducing improved drying and storage practices to reduce post-harvest losses of those vegetables may help to extend their availability outside the main growing season. Ensuring the local availability of quality seed and introduction of water-management practices may also support year-round availability of vegetables. The RING and SPRING programme efforts to interlink dry-season farming with nutrition may also be key in improving the availability of diverse foods, including fresh vegetables, during the lean/dry seasons, especially in Karaga District.
- Maize and millet are the main cereals used for porridge preparation and are among the cultural core foods in the IYC diet. In view of the vitamin A intake identified as inadequate in Karaga District, the introduction of dark orange maize biofortified with pro-vitamin A might be considered. To contribute to iron and zinc intake adequacy, iron and zinc biofortified millet could contribute to the supply of these minerals, especially in Gomoa East District. However, these nutritionally-improved crops have not yet been introduced in Ghana and hence this may represent a longer term strategy. Introduction and local adaptation of biofortified millet and maize varieties may be considered and may provide information on the feasibility and acceptability of these improved crops for infants and young children. In addition, it may be considered to fortify grain and millet based porridges with fortified powder milk. An alternative, although not a direct substitute, is soybean milk, which is nutrient dense and provides several micronutrients. Soy bean milk is sometimes than animal milk, and some nutrients need to be added during the process of production, such as calcium, zinc, riboflavin and vitamin A. However, it contains naturally good amounts of niacin and folate. Although iron is present, soy products contain iron-absorption inhibitors. Small scale processes to produce fortified soy milk are developed, for example by

Malnutrition Matters (Canada), but the longer limitations of small operations also affect this initiative.

- Interventions to reduce post-harvest losses of own-produced maize and millet reserves would help to extend the availability of these into the lean season.
- Finally, despite the emphasis placed on self-sufficiency in food production, IYC foods cannot be provided with on-farm produce alone, and market purchases are indispensable when adopting the food based recommendations. Milk in the form of milk powder (in KaragaDistrict) and small anchovy fish (in Gomoa East) are normally purchased at informal and formal markets. However, costs are constraining the incorporation of sufficient amounts of milk powder and/or fish in the family food and in IYC nutrition in particular. Value chains for milk powder (or fresh milk) and small fish should be strengthened to improve accessibility to these foods.Although meat is absent in the current IYC and therefore does not appear in the developed FBRs, interventions on small ruminants and poultry production and consumption (such as USAID/Ghana RING projects) may offer an opportunity to increase the availability and household consumption of animal source foods as 'external' solutions that reach beyond the currently available foods.

9.2.2 Nutrition-Specific Approaches

Notwithstanding significant barriers to IYC dietary adequacy in the form of poor affordability and access to nutrient-dense foods, the FES findings indicate that there is a positive environment for the adoption of several nutrition-specific interventions, including enrichment of porridges through the incorporation of specific fortified ingredients (e.g. powdered milk, vegetable oil); home fortification; and increased use of existing nutrient-dense foods in the IYC diet coupled with behaviour change communication messages. Features of this positive environment include: i) a cultural commitment to the concept of special foods for IYC which can serve as a basis for modified practices and targeted nutrition education; ii) the considerable efforts of caregivers to address the needs and preferences of their IYC, suggesting incipient demand for special IYC foods, should these be affordably marketed; iii) caregivers' narratives and comments concerning the attributes of common foods, which indicate that "healthiness" is a desired quality in IYC foods, which can be appealed to in their promotion.

The following are specific interventions that can improve IYC dietary adequacy in the immediate term:

Enrichment of porridges with nutrient-dense foods and fortified ingredients: Maize and millet porridges are central in the IYC diet and are consumed on a daily basis by the majority of IYC. The FBRs generated by the Optifood analysis include several nutrient dense foods such as cow milk powder, legumes and legume-based food products such as groundnut paste, cowpea and soy bean flours, and red palm oil or vitamin A fortified vegetable oil. Mothers are aware of the health benefit of adding these nutrient-dense foods to porridges. Their cost and availability however restricts their use by many. Among those for whom cost is not an absolute barrier, there is likely to be value in renewed BCC that addresses other motivations in addition to the health dividend, including improved child

acceptance of foods, which the FES confirmed is valued by caregivers. There is some evidence of success on a limited (i.e one district in the Northern region) scale in increasing micronutrient intakes with enriched porridges using a wider motivation. *Moli koko* enriched with groundnut paste, palm oil and fish powder were promoted to caregivers not solely for their health benefits, but for the variety they offer to IYC, whom caregivers felt were tired of eating plain *moli koko* every day (Armar-Klemesu and Zakariah, 2003).

Modifying family foods consumed by IYC: The FBRs particularly highlight daily servings of green leafy vegetables and fish. Once IYC are old enough to consume family foods, soups and stews, which are the main sources of vegetables, and of fish (currently the main animal source food) become integral parts of the IYC diet. However, the amounts of fish contained in standard stews and soups are negligible. Since separating out the IYC portion during the cooking process is a common practice (e.g., to reduce the amount of spicy ingredients consumed by IYC) there is an opportunity to promote the habit of preparing an IYC portion with additional fish and mashed (rather than chopped) leafy vegetables. BCC will need to address the reasons why IYC particularly need this nourishment, which all family members might naturally wish to receive.

Ensuring timely introduction of solid and semi-solid foods: There is urgent need for targeted BCC messaging to address the belief that feeding IYC "heavy" or "solid" food before they begin to crawl or walk actually delays this developmental milestone. It seems plausible that consumption of some nutritious ingredients is being delayed in at least some children due to this proscription. There is also a need to educate Karaga caregivers on the core nutritional value of fruits to enhance their awareness and potentially the inclusion of fruits as part of their regular feeding repertoire particularly for IYC.

Revisiting blended multigrain flour mixes: Long-standing efforts to promote the use of blended IYC multi-grain flour mixes (popularly called weanimix) have generally not made significant headway in Ghana. Dating back to the mid-1980s, these 4:1 cereal/legume flour mixtures, usually prepared at home or by local women's groups, were promoted widely by the Ghana Health Service and UNICEF. Consistent with other research in Ghana, (Pelto and Armar-Klemesu, 2014) weanimix is virtually absent from the feeding repertoire of caregivers in this study. Reasons offered by respondents include the high cost of constituent ingredients and the time and effort needed to process the mixtures. Various local manufacturers are now producing variants of weanimix under several brand names. However these lower-cost products have had limited success in competing with better known brands such as Cerelac, even among consumers who are unlikely to buy the latter (Masters et al., 2011). Nevertheless, Karaga caregivers, in contrast to their Gomoa East counterparts, rated weanimix more favourably on all dimensions (especially on cost, ease of acquisition and ease of preparation). This suggests a potentially receptive environment for the promotion of weanimix in Northern region, which could be supported with appropriate BCC messaging once the reasons are better understood for the apparent contradiction between low usage and this positive orientation.

Expanding awareness of nutritional concepts: Although existing beliefs about health-giving foods for IYC in Karaga and Gomoa East were reasonably consistent with what we know to be nutrient-dense foods, there may still be value in fostering a more modern understanding of nutrition concepts, particularly in Karaga District. Ultimately, this may be required to support the uptake of interventions to improve nutritional adequacy of IYC diets in the future. In particular, raising awareness in Karaga District about the concept of vitamins and nutrient fortification may be an important precursor to the introduction of any fortified food products introduced to fill nutrient intakes gaps in the IYC diet.

Incorporation of supplements and home fortification when appropriate: in addition to the measures discussed above, which can be implemented in the short term, this study identified both a need and an opportunity for the introduction over the more immediate-to-long term of vehicles to deliver nutrients that cannot be provided by modifications to the existing diet -- including micronutrient powders (MNPs) and other food supplements such as KOKO Plus, a soy-based complementary product, developed under a public-private partnership model. The use of MNPs may contribute to improve the children's diet in Karaga (and indeed the Northern region as a whole) given the insufficiency of several micronutrients. This gives enough justification for at least starting an MNP program in priority areas where options may be limited and ideally this should be done in an operations research environment according to guidelines provided by the Ghana Health Service (GHS, 2014). The national VA supplementation and vaccination days may also offer opportunities to pilot the distribution of MNPs as was done in Benue State, Nigeria through collaboration between the state Ministry of Health and GAIN (Korenromp et al., 2015). KOKO Plus is still in the research and development phase, including efficacy tests and assessment of effective delivery channels for distribution (Ghosh et al., 2014). Such initiatives could also be introduced as part of social programs to enhance usage as income and budgets are limiting in these populations.

Fortified foods/cereal mixes: Fortified chocolate beverage powder came up as one of the FBRs from the Optifood analysis, although it is important to note that it was not so frequently consumed probably due to the cost. Whilst there may be reservations in promoting chocolate beverage for IYC feeding, such fortified products, even in small quantities, can contribute to nutrient intake adequacy. This suggests an opportunity for other types of fortified products that could be produced and marketed at lower cost in the future. KOKO Plus has all the qualities to fill such a gap although it may require reformulation from the original (if not already done) to include problem nutrients. Efforts to scale up production, marketing and distribution need to be expedited.

Food safety: While this research does not confirm the presence or impact of contaminated IYC foods on IYC health, the poor storage practices likely pose undue risk. Research in Ghana (Kimmons et al., 1999) has shown that fermented porridges have lower microbial contamination than non-fermented porridges, especially when they are stored in vacuum flasks, and expanding the use of fermented porridges beyond the ones already in use for

early IYC feeding (eg, *moli koko*) could be beneficial for older IYC that have graduated to the family porridges. Additional research to quantify risks may be required.

9.2.3 Nutrition-sensitive Approaches

WASH: the FES has demonstrated that the most common reason to avoid provision of certain foods is the apprehension that they may cause diarrhoea in infants and young children. This is felt to be particularly true of certain fruits, but was also expressed in connection with other foods (e.g. those cooked with salt-peter). Given the centrality of this concern to care and feeding choices, nutrition interventions to be introduced in Karaga and Gomoa East will need to avoid an association with diarrhoea if they are to be successfully sustained. For caregivers, concurrence of a diarrhoeal episode and the adoption of a new food or practice may be enough to abandon the intervention, whether there is a causal relationship or not. It will be important to ensure that WASH messages stressing the importance of handwashing both for caregivers and infants and young children as well as other hygienic practices have a strong programmatic link to nutrition actions.

Community development/appropriate technology: This study has highlighted the risk presented by the extended room-temperature storage and re-use of cooked IYC foods practiced by almost all households – a risk only likely to increase if as advocated, caregivers begin to integrate more animal-source foods into these foods. Outside the health and nutrition sectors there may exist opportunities to reduce this risk by offering cooking and/or food storage solutions designed to address the constraints of caregivers. These constraints will first need to be better understood. It seems likely that the additional fuel consumption, the inability to reheat foods while caregivers are outside of the home, and the additional time implied by reheating all militate against it; yet the relative importance of these and other factors in the view of Karaga and Gomoa East caregivers needs closer investigation, after which nutrition-sensitive measures such as the propagation of fuel efficient cooking technologies or safer food storage can be identified, along with the sectoral personnel whose involvement will be needed.

Broadening BCC beyond nutrition channels: This study confirms that, in both Karaga and Gomoa East Districts, mothers are usually the ones who decide how, and what, infants and young children are fed. Yet these decisions are made within a context characterised by limits on mothers' action – sometimes by outright scarcity. In Northern Ghana, older females, such as mothers-in-law and grandmothers also wield considerable influence and can be engaged in the BCC process. However, while we have identified some areas where improved access to information can improve IYC care and nutrition, a considerable challenge remains in the form of limited means and material deprivation. To the extent that households do have the resources to purchase other, more expensive ingredients for IYC foods, mothers can only access the full extent of these resources with the cooperation and support of the father, who in farming families usually controls income from the sale of staple cereal crops. To ensure that nutrition BCC is not simply preaching to the converted, it will be important to explore ways to reach men with messages identifying the benefits of improved IYC diet. These efforts are unlikely to be effective if carried out through nutrition and health channels alone, since within the highly gendered context of rural Ghanaian society these are identified mainly with female interests.

Nutrition advocates will need to explore the use of sectors and institutions that have a closer association with men – whether agricultural extension agents, local government staff, religious or traditional bodies – in order to carve out the necessary space for women to act effectively.

10. NEXT STEPS

10.1 Determining the Feasibility of Optifood Recommendations

The Optifood analysis provided technical information regarding problem nutrients, best food sources for nutrients, and food-based modifications that could meet or come as close as possible to meeting, the nutrient needs for infants and young children in the different target groups. However, the extent to which the developed food-based modifications are feasible and affordable to implement by the target population remains to be determined. The modelling was based on the local dietary pattern reflecting the foods that are consumed by at least some (i.e. >5%) of the children in the study areas. The recommended modifications may therefore be considered as realistic and achievable by some but may ask for substantial changes from others.

The feasibility of successfully promoting the modifications should be evaluated by household trials taking into account, amongst others, food availability on-farm and in the market, prices of foods and their fluctuations, time needed for preparation, individual preferences, and caregiver's other time commitments for child care, food production, water and fuel collection. These trials, using program tools like ProPAN (PAHO, 2013) or Trials of Improved Practices (Dickin et al., 1997; Dickin and Seim, 2013), will identify barriers and supporting factors that could encourage the adoption of the modifications. This may lead to adaptation of the suggested food-based modifications to facilitate their adoption, while the information obtained can also assist in formulating appropriate messages to be used in behaviour change strategies to promote using the modifications. There is some experience with these approaches in the Savelu-Nanton District in Northern region of Ghana (Armar-Klemesu and Zakariah, 2003).

10.2 Further Research and Analysis

10.2.1 Optifood Modelling with Additional Foods and Nutritional Supplements

The results presented in this report are based on Optifood analysis using foods that are consumed regularly (defined as those foods consumed by 5% or more of the children studied), their minimum and maximum frequency of consumption, and average portion sizes when consumed, estimated from dietary intake data collected in June-July (Karaga District) and July-August (Gomoa East District), reflecting pre-harvest conditions. The results in this report represent only first-stage, or initial, outcomes of the analysis. However, additional steps should be taken to extend its practical application:

- These initial FBRs were derived separately for each subgroup by age and breastfeeding status, and pertain to the particular feeding patterns represented in the dietary intake survey. As a result, FBRs for certain foods appear for some age groups and not others. However, if these were to be incorporated into C-IYCF materials more directly, it is advised that the FBRs be adapted to be somewhat more

consistent across all age groups. A second stage of modelling can be done to minimize impact on the number of nutrients for which adequacy would be met.

- As breastmilk intake was not measured, an assumption was used regarding the low level of breastmilk intake in this population. However, as breastmilk is an important and preferred source of nutrients for infants and young children, and promotion of adequate breastmilk intakes is an integral part of IYCF recommendations, an increase in breastmilk intake would also lead to a decrease in nutrient requirements from complementary foods. As such, the FBRs may be modified and reduced, although recognizing that gaps will still exist.
- Seasonality affects the type, frequency and amount of foods consumed, for staple foods but especially for nutrient-dense foods. Further research should be carried out to determine the extent to which the developed food-based modifications would also be appropriate for periods outside the studied season (i.e., when food is more plentiful).
- A next step in the modelling process is to optimize diets by including promising nutrient dense foods that address, in particular, the problem nutrients identified. These include foods that are available in the local settings but are not (yet) consumed by >5% of infants and young children (eg, specific animal-source foods), and those that represent new potential product formulations not yet introduced (eg, fortified complementary foods, fortified ingredients, home-fortification products). This step of analysis would also be useful to conduct after determining the feasibility of the food-based recommendations; if some are determined to be infeasible for many caregivers to adopt, these novel food items may need to fill additional nutrient intake gaps. It is important to emphasize that the data used to set the model parameters in Optifood originated from limited areas in the northern and the southern part of Ghana, and the agro-ecological zones in which the two study areas were located, are not representative for the whole of Ghana. Therefore, if similar the extent to which the developed modifications also apply to other areas in Ghana needs to be further assessed. Results from this study may not apply to areas that are not similar to our study areas.

10.3 Value Chain Analysis

The local and regional value chains for small fish, milk powder and fruits and vegetables should be further assessed to understand both the constraints and opportunities to improve the accessibility of these foods to households in these areas. It is also important to understand potential (environmental) trade-offs for expanding fruit and vegetable production. A principal dilemma in development of value chains for nutrient-dense foods is the tension between assuring their affordability for low-income consumers, and ensuring sufficient price incentives for smallholder farmers to produce quality raw materials or produce. The assessment should look into infrastructural and logistical aspects of the specific agri-food value chains, as well as options for increased efficiencies. Results should inform what types of interventions in the specific value chains would lead to more affordable, available, or more preferred (in terms of quality characteristics) small fish, milk, and fruits and vegetables for the target populations.

10.4 Market-based Research for Potential Food or Food Products

Although the households in these Districts are cash-restrained, they do rely on markets to purchase many foods used in IYCF. The feasibility of a low-cost fortified beverage mix or porridge mix targeted for children 6-23 months should be assessed. Public-private partnerships already exist in Ghana to provide low cost fortified products (such as *Maisoy Forte* produced by Yedent[8]) for this age group, but such products are not yet widely available. A scoping study of the infant food market found that even in the major cities of Accra, Kumasi, and Tamale, Maisoy Forte was sold in only one supermarket in Accra catering to higher income brackets. However, the FES indicates that even caregivers with no direct experience of the more common fortified infant cereal *Cerelac* still rate it highly in terms of its health value, suggesting an affordable product could find a receptive market. The barriers and potential opportunities to increased awareness and accessibility of appropriate fortified foods should be determined both for the northern as well as the southern part of Ghana.

Although their acceptance by caregivers was not studied here, micronutrient powders (MNP) may offer another opportunity to complement food-based modifications to achieve nutrient intake adequacy among infants and young children, and could bridge the affordability gap that consistently confronts nutrition interventions in low income settings. The common IYCF practices identified in this study, including the separation of IYC portions, and the addition to these individual portions of certain ingredients (e.g. sugar to porridges) appear to provide a foundation for the successful integration of MNP into existing preparation and feeding routines. Although the correct use of MNP features in the C-IYCF materials currently being circulated, the GHS cautions against the wide use home fortification due to concern over possible hazards related to their use in malaria endemic areas (GHS, 2014). However, guidelines provide for the use of home fortification "under operational research conditions to ensure adequate monitoring of adverse events and also provide information to inform policy for possible scale-up". A similar product about which more information and operational experience is needed is *KOKO Plus* (Ghosh et al., 2014), which is currently being marketed and only available in some areas in the Northern region.

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APPENDICES

Appendix 1: An Ecological Model of Food and Nutrition

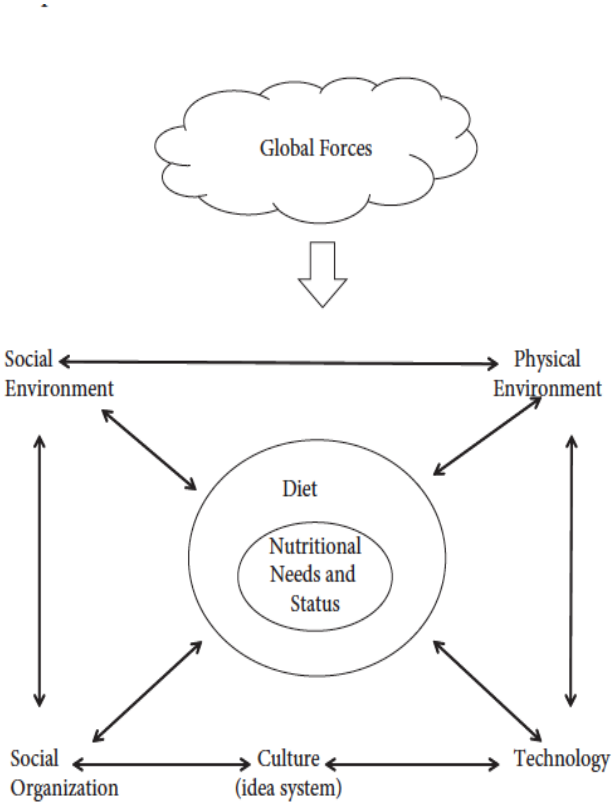

Figure 1 *An ecological model of food and nutrition. Redrawn with modifications from Jerome, Kandel, and Pelto (1980).*

Appendix 2: Description of Core IYC foods

Name of Food item	Description
Karaga	
Moli Koko Koko sali,	**Molikoko** is made from sieved fermented corn/millet dough/flour **Koko salli** is made from sieved corn dough mixed with spices
TZ	Hot thick porridge made from whole grain maize flour and consumed with vegetable soup (ayoyo/bra/okro (dried or fresh)
Rice	Boiled/steamed, consumed with stews with fish/eggs; may also be boiled very soft and made into balls (omotuo) and eaten with groundnut soup with fish/meat
Ayoyo soup	Ayoyo soup is a very slimy soup prepared from onions (chopped), pepper (ground), tomatoes (optional, ground), ayoyo leaves (chopped) and pounded dried fish.
Bra soup	Prepared similar to ayoyo soup but with bra leaves (replacing ayoyo), groundnut paste and/or pounded raw groundnuts and pounded dried fish
Tomato stew	Tomato based stew prepared by cooking chopped onions, ground pepper and chopped or ground tomatoes in oil to a thick texture with added pounded fish/eggs; canned tomato paste sometimes replaces or is additional to fresh tomatoes;
Gomoa East	
Koko (Maize or millet porridge) Mashed kenkey	Made from sieved maize (Koko) or millet (Hausa koko) dough *Kenkey mashed in water and cooked into porridge.(*Kenkey is steamed fermented corn dough wrapped in dried corn husks (Ga variety) or dried plantain leaves (Fante variety) always purchased ready prepared; usually eaten with pepper sauce/stew/fish and fish)
Banku	Fermented corn dough (sometimes plus cassava dough) cooked into dumplings and consumed with stew/soup with fish/meat/eggs; may be served with pepper sauce and fish for older infants and young children
Rice	Boiled rice consumed with stews (tomato/kontomire) and /fish/ meat/eggs.
Fufu	Pounded boiled plantain and cassava; served with soup with fish, meat and occasionally crabs/cow hide (wele).
Palm nut soup	Loose palm fruits are boiled and pounded in wooden mortar; then palm juice is extracted by adding water and sieving off the palm husks. The juice is added to steamed meat or fish (may be fried, smoked, dried or fresh) and cooked with tomatoes, onions and pepper; the cooked vegetables are taken out, ground and returned to the pot till cooked. Preparing this soup could take an average of 2 hours depending on the amount prepared and type of fish/meat used.
Tomato stew	Tomato based stew prepared by cooking chopped onions, ground pepper and blended/chopped/ground tomatoes in oil/palm oil to a thick texture with added fish/meat/eggs; canned pureed tomatoes is sometimes additional to or replaces fresh tomatoes;
Kontomire stew	Prepared as in tomato stew but with chopped, steamed kontomire (cocoyam leaves) or steamed mashed kontomire and cooked in palm oil with smoked fish (powder or whole pieces) or eggs. Other optional ingredients include groundnut paste, "abeduro" (pea eggplant), or "agushi" (ground melon seeds)

Appendix 3: Comparison of data and results using assumptions of low and average breastmilk intakes

Table App 3.1 Nutrient contribution of low and average breastmilk intakes to the RNI/EARs*, by age group

Nutrient composition of human breast milk (amount per 100 grams)			6-8 months			9-11 months			12-23 months		
	Amount	Units	RNI (amount per day)	RNI (%)		RNI (amount per day)	RNI (%)		EAR (amount per day)	EAR (%)	
				Low BM	Average BM		Low BM	Average BM		Low BM	Average BM
Average intake of breast milk		ml/day	660			616			549		
Energy	65	Kcal	678	32	63	764	21	50	935	8	32
Calcium	28	mg	400	25	46	400	19	43	417	12	37
Iron (5% bioavailability)**	0.03	mg		1	1		0	1	13	0	1
Zinc	0.12	mg	4	14	26	4	11	25	2	11	33
Vitamin A	50	µg	400	44	83	400	34	77	286	31	96
Niacin	0.15	mg	4	13	25	4	10	23	5	5	16
Riboflavin	0.035	mg	0.4	31	58	0.4	24	54	0.4	15	48
Thiamin	0.021	mg	0.3	25	46	0.3	19	43	0.4	9	29
Vitamin B6	0.009	mg	0.3	11	20	0.3	8	19	0.4	4	13
Folate	8.5	µg	80	38	70	80	29	65	128	12	36
Vitamin B12	0.097	µg	0.7	49	91	0.7	38	85	0.7	24	76
Vitamin C	4	mg	50	47	88	50	36	82	25	28	88

Legend: BM, breastmilk

*The nutrient composition of breastmilk and energy requirements were derived from WHO/UNICEF, 1998. RNIs derived from FAO/WHO (2004), except for zinc (IZiNCG, 2004). For the 12-23 month age group, the RNI (FAO/WHO, 2004) was converted to the EAR equivalent using conversion factors (WHO/FAO, 2006), except for iron as no conversion factor is available.

**Iron bioavailability in breast milk among infants >7 months has been estimated at 14.8% (Abrams et al., 1997). However, as breast milk provides only a small percentage of the iron requirement after 6 months of age, the assumption of low iron bioavailability pertaining to the diet is used.

Table App 3.2 Summary of problem nutrients in the diet of children by age group and breastfeeding status in Karaga and Gomoa East Districts, assuming average breast milk intake.

Micro-nutrients	Karaga District				Gomoa East District			
	6-8 BF	9-11 BF	12-23 BF	12-23 NBF	6-8 BF	9-11 BF	12-23 BF	12-23 NBF
Calcium								
Zinc								
Iron								
Vitamin A								
Niacin								
Riboflavin								
Thiamin								
Vitamin B6								
Folate								
Vitamin B12								
Vitamin C								

Legend: BF=breastfed, NBF=non-breastfed

Nutrient requirements cannot be met by any combination of local foods

Nutrient requirements could be met but may require changes in the diet

Table App 3.3 Summary of changes in problem nutrients in the diet of children by age group and breastfeeding state, when assuming average breastmilk intake compared to low breastmilk intake.

Age-group	Changes in problem nutrients in Karaga District	Changes in problem nutrients in Gomoa East District
6-8 mo	- vitamin C and vitamin B12 are no problem nutrients anymore - riboflavin is above 100% RNI in best-case scenario (which was not the case for low BM intake) - niacin and vitamin B6 are in best-case scenario not above 100% RNI (which was the case for low BM intake) - vitamin A is in worst-case scenario above 70% RNI (which was not the case for low BM intake) but in best-case also not above 100% RNI	- protein, vitamin C, vitamin B12 and vitamin A are no problem nutrients anymore
9-11 mo	- fat, vitamin C and vitamin B12 are no problem nutrients anymore - niacin is in best-case scenario not above 100% RNI (which was the case for low BM intake) - vitamin A is in worst-case scenario above 70% RNI (which was not the case for low BM intake) but in best-case also not above 100% RNI	- protein, fat, vitamin C, vitamin B12 and vitamin A are no problem nutrients anymore - niacin is in best-case scenario not above 100% RNI (which was the case for low BM intake)
12-23 mo	- fat and vitamin C are no problem nutrients anymore - riboflavin is in best-case scenario above 100% RNI (which is not the case for low BM intake)	- fat and vitamin C are no problem nutrients anymore