IDENTIFYING NUTRIENT GAPS AMONG YOUNG CHILDREN OF THREE ETHNIC GROUPS IN SAPLING AREAS OF BANDARBAN DISTRICT, BANGLADESH

USAID FROM THE AMERICAN PEOPLE

CARITAS BANGLADESH

গণপ্রজাতন্ত্রী বাংলাদেশ সরকার

CRS CATHOLIC RELIEF SERVICES

HELEN KELLER INTL

Sustainable Agriculture and Production Linked to Improved Nutrition Status, Resilience, and Gender Equity (SAPLING)

Identifying Nutrient Gaps Among Young Children of Three Ethnic Groups in SAPLING Areas of Bandarban District, Bangladesh

Helen Keller International

Cooperative Agreement No. AID-FFP-A-15-00010

Submitted to

United States Agency for International Development
Bureau of Democracy, Conflict and Humanitarian Assistance
Office of Food for Peace

August 16, 2018

Chief of Party Contact Information:
Treena Bishop
Chief of Party, SAPLING
Helen Keller International
House 10E, Road 82
Gulshan 2, Dhaka 1212
Tel: (088) 017-7109-1688; (088) 02-882-3055
E-mail: tbishop@hki.org

Country Office Contact Information:
Aminuzzaman Talukder
Country Director, Bangladesh
Helen Keller International
House10E, Road 82
Gulshan 2, Dhaka 1212
Tel:+880-174-660-9064; +880-2-882-3055
E-mail: ztalukder@hki.org

Disclaimer: This report is made possible by the generous support of the American people through the United States Agency for International Development (USAID) under the terms of the Cooperative Agreement AID-FFP-A-15-00010 (SAPLING) managed by Helen Keller International (HKI). The contents are the responsibility of HKI and do not necessarily reflect the view of USAID or the United States Government.

Acknowledgements

We would like to thank the mothers and their children who participated in this study for offering their valuable time and for patiently providing information on their dietary practices. We would also like to thank the data collection team and the local interpreters; whose hard work made this study possible. Special thanks to FFP/USAID for generous support through the SAPLING project. We are very much grateful to Meredith Jackson-deGraffenried, Ame Stormer, Rozena Begum and S.S.B. Hindole for their technical support.

Contributors

Md. Masum Ali
Senior Program & Research Analyst- Quantitative
Research, Learning, and Evaluation Unit
Helen Keller International/Bangladesh

Jillian L. Waid
Director
Research, Learning, and Evaluation Unit
Helen Keller International/Bangladesh

Abu Ahmed Shamim
Research Advisor
Research, Learning, and Evaluation Unit
Helen Keller International/Bangladesh

Table of Contents

Executive Summary 6
Introduction 8
Methods 10
Participants and Sampling 10
Dietary Data Collection Methods 12
Field Work 12
Data Analysis 12
Linear Programming Analysis Using Optifood 12
Setting Model Parameters in Optifood 13
Results 14
Food Intake 14
Problem Nutrients 15
Identifying Food Groups for Promotion in Complementary Feeding Recommendations 15
Testing and Consolidation of Complementary Seeding Recommendations 17
Discussion 20
References 22

Acronyms

CHT	Chittagong Hill Tracts
FANTA	Food and Nutrition Technical Assistance Project
FAO	Food and Agriculture Organization (of the United Nations)
HKI	Helen Keller International
IEHFP	Integrated Enhanced Homestead Food Production
IFPRI	International Food Policy Research Institute
IYCF	Infant and Young Child Feeding
LPA	Linear Programming Analysis
RNI	Recommended Nutrient Intake
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
WHO	World Health Organization

Executive Summary

The Chittagong Hill Tracts (CHT) is an ethnically diverse and historically conflict-ridden area. As of the 2011 census, almost half of the population is Bengali, most of whom migrated from the plain lands of Bangladesh during the early 1980s with support from the Bangladesh government. In response to the unique constraints faced by the citizens of the CHT, in 2015 the United States Agency for International Development (USAID) included this area on a pilot basis into the Food for Peace, Title II process. In response to this call, the "Sustainable Agriculture and Production Linked to Improve Nutrition Status, Resilience, and Gender Equality" (SAPLING) project was funded.

A key aim of the project is to improve child nutritional outcomes through changing behavior around complementary feeding of young children. The first 1,000 days of life, between conception and two years of age, is a unique period of opportunity for the foundation of optimum health, growth, and neurodevelopment (3; 4). This study seeks to develop and test complementary feeding guidelines for children nine to 17 months of age among three major ethnic groups in the SAPLING area – Bengali, Marma, and Mro – using the Optifood software. Optifood was developed by the World Health Organization (WHO) in collaboration with the London School of Hygiene and Tropical Medicine, Food and Nutrition Technical Assistance (FANTA) project, and Blue-Infinity (7). It identifies nutrients that individuals currently obtain from their local diets and formulates and tests food-based recommendations to meet their nutritional needs. The software's optimization analyses can help specify the lowest cost combination of local foods that will meet or come as close as possible to meeting the nutrient needs of specific target groups. Recommendations from the Optifood results will be used to promote specific foods in the SAPLING agriculture and nutrition education components for children in this age group. To obtain dietary data for children of three ethnic groups, SAPLING undertook a cross-sectional dietary 24-hour recall survey and collected anthropometric measurement of length and weight of targeted children. Data was collected from mid-January to mid-February 2017. A large sample size was not required for Optifood analysis, so 40 to 42 children from each ethnic group were surveyed. Due to unrest at the time of data collection, sample attainment was lower in the Mro community (28 households).

Age and anthropometry were similar across groups, but Bengali children had more diverse diets, and fewer nutrients that could not be met with their existing diet. Their more diverse diets enabled higher feeding recommendations to be given to this group compared to the Marma and Mro communities. This is because Optifood only enables feeding recommendations to be made that fit within the "usual" frequency of current consumption for a group – defined here as the 10^{th} to 90^{th} percentile of frequency.

In order to meet nutrient requirements, recommendations for consumption of different foods included Bengali children consuming eggs daily, followed by twice a week for Mro, and once a week for Marma children. At least two servings of vegetables each day were recommended for all ethnic groups. Fish and meat were recommended for consumption every day of the week; three days of the week had fish and another four days had meat. Fruits were also recommended for all groups, but, similar to eggs, due to differences in the frequency of current consumption, the recommendation for fruits was for daily consumption for Bengali children, followed by five days a week for Mro, and three days a week for Marma.

In the end, these recommendations only managed to shift the intake of riboflavin nutrients for Bengali children from below 65% of the recommended nutrient intake (RNI) to above 65% of RNI, while four nutrients were moved from below to above the threshold for Marma children (Riboflavin, Niacin, Folate, and Vitamin A) and four nutrients moved above the threshold for Mro children (Thiamin, Niacin, Vitamin B-6, and Vitamin B12). Niacin requirements were met for Mro but not the other ethnic groups due to pork consumption. Nutrients that could not currently be met at a 65% level for all three ethnic groups included Calcium, Iron and Zinc.

The results of this assessment highlight the differences in young child feeding practices between the three major ethnic groups in the Bandarban district and the limitations current consumption patterns impose on the ability of young children to meet their nutritional needs. The inability of the improved combinations of local foods to ensure population-level dietary adequacy for all twelve micronutrients reflects the limited number, frequency, and amount of foods that are good sources of micronutrients in the current diets and from which the modeling process could draw.

Further analysis will be undertaken to determine if foods promoted by SAPLING for household agricultural production and during nutrition education sessions under SAPLING have the ability to enable households to further meet nutrient demands through greater diversified diets. Greater production through techniques taught by SAPLING could enable the guidelines for foods such as eggs to be equal across all ethnic groups, resulting in a larger proportion of nutrient requirements being met. In addition, pork consumption would not be acceptable for the Bengali communities, but could be promoted among other ethnic groups in order to meet some nutrient requirements such as niacin or thiamin. Consumption of other, less traditional foods, or other dietary interventions such as supplementation or fortification may ultimately be necessary to meet nutrient demands for this age group and SAPLING may need to incorporate these methods into infant and young child feeding (IYCF) guidelines once these results are known.

Introduction

The Chittagong Hill Tracts (CHT) are situated in the southeastern part of Bangladesh and encompass three districts: Bandarban, Khagrachari, and Rangamati. They encompass an ethnically diverse area, with Bandarban district containing twelve ethnic groups including Bengali. As of the 2011 census, almost half of the population of this area was Bengali, most of whom migrated from the plane lands of Bangladesh during the early 1980s with support from the Bangladesh government. In response to the unique constraints faced by the citizens of the CHT, in 2015, the United States Agency for International Development (USAID) included this area on a pilot basis into its Food for Peace, Title II program. In response to this call, the "Sustainable Agriculture and Production Linked to Improve Nutrition Status, Resilience, and Gender Equality" (SAPLING) development food security activity was initiated. SAPLING proposes to improve the gender equitable food security, nutritional status and resilience among communities in five upazilas (Bandarban Sadar, Lama, Rowangchari, Ruma and Thanchi) of Bandarban district in CHT. SAPLING interventions support local structures to improve the social, economic and environmental conditions that contribute to nutritionally inadequate infant and young child diets and a high rate of child stunting (1; 2).

A key aim of the project is to improve child nutritional outcomes through changing behavior around complementary feeding of young children. The first 1,000 days of life, between conception and two years of age, is a unique period of opportunity for the foundation of optimum health, growth, and neurodevelopment (3; 4). As young children of these ages consume only a small amount of food, achieving nutrient adequacy is challenging during this period (5; 6). During the complementary feeding period, breastmilk meets approximately half of an infant's nutrient needs for Iron, Zinc, Calcium, Thiamin, and Riboflavin. However, all too often, the foods fed to young children after weaning are limited to staple starches and not diverse or nutrient-dense enough to provide key nutrients needed for growth (6).

General guidelines for young child feeding exist and have been adapted and approved by the Government of Bangladesh. However, these guidelines lack specificity that can be used to make feeding recommendations using local dishes. This need is even stronger in the CHT where there is a lack of information on the food habits of the population. Developing specific recommendations has been aided in recent years through the development of linear programming software. One such program is Optifood which enables public health professionals to identify nutrients obtained from usual local food habits, then formulate and test population-specific food-based recommendations that will enable individuals to meet their nutritional needs. Optifood was developed by WHO in collaboration with the London School of Hygiene and Tropical Medicine, FANTA, and Blue-Infinity (7).

Using data on foods normally eaten by the target population, as well as frequency, amount and price, a linear programming-based approach can be used to test the efficacy of food-based recommendations. This approach can be used to create complementary feeding recommendations appropriate for the context and which meet approximate nutrient requirements.

Optifood tests food-based recommendations in the context of the actual dietary practices of each community. It identifies gaps between intake and requirements for specific nutrients and locally available foods which are typically defined by agro-ecologies, demographic and cultural

influences. Optifood uses 24-hour recall data to identify complementary feeding patterns. Because feeding practices change as young children grow, Optifood analysis for children often focuses on a targeted age range. The objective of this study was to compare young child diets between children aged nine to fifteen months in the three major ethnic groups in the SAPLING project area – Bengali, Marma and Mro, which together comprise 84.5% of the program area's population. This research focuses on identifying nutrient constraints and currently consumed food that would be promising vehicles to overcome these nutrient inadequacies. This study was the first attempt to use Optifood in the CHT.

Methods

To obtain dietary data for children of all ethnic groups, a cross sectional dietary 24-hour recall survey was undertaken. In addition to dietary recall the survey collected anthropometric measurement of length and weight of targeted children. Data were collected from mid-January to mid-February 2017. This season is a time of comparatively higher food security, due to the availability of jhum cultivation, however, there are usually water shortages around this time.

Participants and Sampling

SAPLING works in five upazilas in the Bandarban District. The population is higher in Bandarban Sadar, Lama and Ruma compared to Rowangchari and Thanchi. SAPLING conducted a household census at project initiation, with data collection beginning in the three more populated upazilas. Using early census results from selected unions in these areas (see Figure 1), a two-level sampling strategy was used to randomly select 40 to 42 households per ethnic group with children estimated to be aged from 9 to 15 months at the time of this survey from each selected ethnic group. This sample size was determined based on a review of the literature and consultation with experts, and though this sample size does not permit traditional statistical testing, it does enable "typical" diets to be identified for modeling.

To select households, all paras and villages which contained at least two households with children from the targeted ages in each ethnic group were listed. From this list, a set of 20 paras with replacement and probability proportionate to size, ranking the selected para in a random order were randomly selected. All children in the para with two or three children and a random sample of three children in paras with more than three children were included until the target of greater than 40 children per ethnic group was reached. To assist in estimating usual intakes, at least one household per para was selected for a second 24-hour recall visit. This process resulted in a total of 41 Bengali households from 14 paras, 40 Marma households from 16 paras, and 42 Mro households from 16 paras.

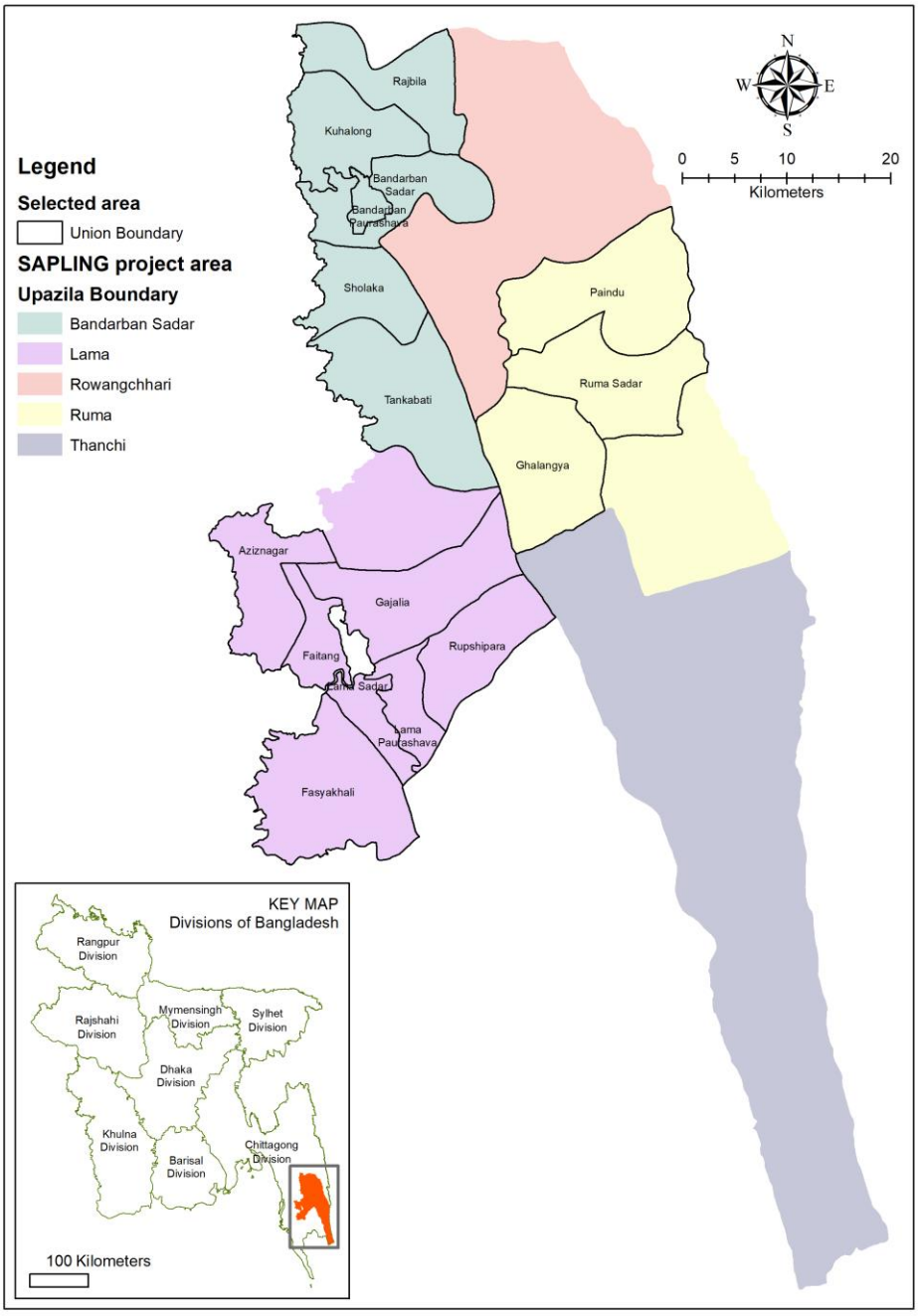
Table 1: Sample Targeted and Attained

	Bengali	**Marma**	**Mro**
Initially Targeted			
Households	41	40	42
Para	14	16	16
Achieved			
Households	41	38	28
Para	15	18	10
Revisit	19	16	8
Attainment Rate	100%	95%	67%
Repeat Visit Rate	46%	42%	29%

Due to errors in age estimation in the sampling frame and constraints during data collection, the sample that was initially selected had to be revised in the field. In addition, due to errors in date of birth estimation, some households had to be changed as the children were older than the targeted age. Among the Bengali sample, one village had only two children in the age range when six were expected, so the next village on the sampling list was added. Among the Marma

children, three villages were replaced due to an inability to reach the selected para at the time of survey due to lack of available transport and/or very high travel times (more than 6 hours of hiking) and two were added from the sampling list due to incorrect date of birth estimation in the census. Among the Mro community, nine villages were inaccessible, due to an emergency situation caused by conflicts between the ethnic group and Bengali settlers. These could largely not be replaced, as there were fewer Mro villages enumerated at the time of this survey.

Figure 1: Map of Selected Area



Dietary Data Collection Methods

Quantitative dietary data was collected for the last 24 hours using a modified version of the methodology used in the International Food Policy Research Institute's (IFPRI) 2011 Bangladesh Integrated Household Survey. For this study dietary intake for food eaten in the home was collected from both the household member who was mainly responsible for cooking and distributing the cooked food as well as the caregiver of the targeted child. During data collection, though all household members were included, focus was given to recording the child's and caregiver's intake. To estimate the amount of food groups and nutrients consumed, the raw weight of the ingredients used in cooking a dish were collected.

The amount of an ingredient was estimated using measurements from an electronic kitchen scale if the ingredient was available in the household. If the ingredient was not available, a photographic book containing the various types and sizes of food ingredients was used to aid recall and household utensils (rice measuring pot, oil, spices measuring utensils and so on) were also measured using standardized equipment to estimate the amount of each ingredient in the dish. The survey also recorded the estimated distribution of the dish to household members and the amount of food wasted and undistributed (leftovers). Additionally, if the child was fed any outside food (for instance, cake, biscuits or chips), information about these snacks were collected by asking the caregiver. These items were converted to their raw ingredients using standard recipes and then to nutrients using food composition tables.

Field Work

Data collection staff consisted of five female data collectors with two years of experience collecting 24-hour recalls. As these staff did not know the local languages and food habits of this area, five local female staff (two Marma, two Mro and one Bengali) were also hired as translators and data collection assistants. Before starting data collection, the SAPLING data collection staff and locally hired assistants were split into teams and provided two days of training on data collection procedures. Each data collection group worked in their own community depending on the ethnicity of the local hire. Data collection took place for one month between January 29th and February 26th.

Data Analysis

Due to the small sample size, significance testing was not undertaken. Dietary intakes for children were extracted from the 24-hour intake data of the household as a whole. As child intakes were raw purchased weight, these were converted to their equivalent edible weight using food specific edible conversion factors. Subsequently, edible weight was converted to their equivalent nutrient using a food composition table prepared for this survey and compiled from the existing food composition tables for Bangladesh as well as the Indian Food Composition Table, United States Department of Agriculture (USDA) database, and other regional databases. Since nutrients are heat sensitive, based on cooking method, a nutrient retention factor was applied. This data management was done using Stata v13.0.

Linear Programming Analysis Using Optifood

Linear Programming Analysis (LPA) was used to generate a series of optimized modelled seven-day diets that identified: (1) Problem nutrients (i.e. nutrients likely to remain low in infant and young child diets based on local food sources as consumed); (2) the best available food sources

to fill nutrient gaps; (3) alternative complementary feeding recommendations for seven-day diets that would improve adequacy for twelve nutrients (Calcium, Iron, Zinc, Riboflavin, Niacin, Thiamin, Folate and Vitamin B6, B12, and C). Optifood version 4.0.9.0 was used for all LPA. Alternative complementary feeding recommendations were generated and then tested in Optifood to select the best set of complementary feeding recommendations emphasizing the anticipated population-level nutrient adequacy and minimum diet cost. The mathematical modeling for developing complementary feeding recommendations has been described in detail elsewhere (7; 8).

Setting Model Parameters in Optifood

Dietary data was used to generate model parameters for Optifood. Realistic modeled diets included: 1) the energy (kilocalorie) content was equal to the average requirement for children of 12 months 2) the minimum and maximum (generally corresponding to the 10^{th} and 90^{th} percentiles respectively) number of servings from food groups and food subgroups per week and 3) the minimum and maximum grams of each individual food items per week. Median serving size for all consumed food items was determined from the data for each ethnic group.

Breastmilk consumed by the children during the dietary survey was not assessed. At 9 to 16 months of age, energy is needed not only for maintaining body functions but also for growth; children's daily intake of milk was assumed at 55% of the median energy requirement for the children. Median energy was calculated using the WHO Optifood energy equation for children. On average, children's reference weight and breastmilk energy content were assumed to be 9.4kg and 0.66 kcal/g. Therefore, daily intake of breastmilk was imputed at 633 g for each child. Nutrient composition of breastmilk for developing countries was utilized (9).

Energy and protein requirements for target children were calculated using the WHO/Food and Agriculture Organization (FAO) algorithms and the WHO growth reference body weight of the target group (10). RNIs from WHO/FAO were also used to calculate adequacy for the target group (7). Dietary bioavailability for Zinc and Iron were assumed to be moderate in line with the moderate consumption of animal source foods among these groups (11).

Results

Anthropometric results are shown below in Table 2. While the mean age of children was similar across the ethnic groups, the age range varied somewhat with a few Marma children who were older. Mean length was similar across groups, but a higher proportion of Bengali children were stunted. Mean weight was greater among Mro children, and rates of wasting and underweight were lower among Mro children compared to the two other ethnic groups.

Table 2: Characteristics of Selected Young Children

	Bengali	Marma	Mro
Number of children	41	38	28
Mean age in months	11.9	12.2	11.8
Age range	9 - 15	9 - 17	9 - 15
% Male	54%	41%	46%
Wasted	12%	16%	4%
Stunted	34%	19%	22%
Underweight	27%	14%	7%

Table 3: Food Intake Information

	Bengali	Marma	Mro
Number of children	41	38	26
Number of observation days	60	54	34
Mean energy intake (kcal, excluding BM)	513	361	544
Number of food items	51	30	33
Mean food groups consumed (out of 7)	3.5	2.3	2.3
Minimum diversity (4+ out of 7)	52%	12%	13%
Eating legumes	34%	5%	0
Eating dairy	5%	9%	0%
Eating flesh foods	59%	17%	33%
Eating eggs	38%	20%	9%
Eating Vitamin A-Rich fruits and vegetables	15%	8%	19%
Eating other fruits and vegetables	99%	68%	67%

Food Intake

Two Mro children had not yet received any complimentary foods, so they were removed from further analysis. Of the children who ate complementary foods, Mro and Bengali children had a greater energy intake compared to the Marma population. The number of food items in the children's diets varied between ethnic groups with Bengali children having a greater higher variety of foods then Marma and Mro (Table 3). Using a 5-gram cut-off for each food group, the dietary diversity of Bengali children was also much greater than that for Marma or Mro. While half of Bengali children attained minimum dietary diversity, only a little over 10% of Marma and Mro children did so. While all children ate starches, and most ate other fruits and vegetables, the other food groups were consumed by a much more limited proportion of the population. Statistical testing was not possible due to the small sample sizes.

Problem Nutrients

Optifood categorizes key nutrients by the ability of a typical diet to provide the amount needed for adequate intake (100% of the RNI). An absolute problem nutrient is defined as a nutrient whose requirement is impossible to meet using local foods within the model constraints for frequency and portion size. A partial problem nutrient is defined as a nutrient whose requirement can be met, but to the detriment of achieving the nutrient requirements of other nutrients.

A number of problem nutrients were identified for each ethnic group (Table 4). Except for Vitamin C and vitamin B-12, all other micronutrients were absolute problem nutrients for Marma children, meaning that children could only obtain nutrient adequacy in these two nutrients. Mro children had fewer absolute problem nutrients, but no nutrient intake was adequate in the diet. Diets of Bengali children could meet the requirements for Vitamin C, Folate, Vitamin B12, and Vitamin A. Calcium was an absolute problem nutrient for all ethnic groups- indicating that no group could meet this requirement with the foods currently consumed. Iron and Zinc were absolute problem nutrients for Bengali and Marma, but only partial problem nutrients for Mro children.

Table 4: Absolute and Partial Problem Nutrients by Ethnic Croup

Nutrient	Bengali	Marma	Mro
Calcium (mg)	Absolute	Absolute	Absolute
Vitamin C (mcg)			Partial
Thiamin(mg)	Partial	Absolute	Partial
Riboflavin(mg)	Partial	Absolute	Partial
Niacin(mg)	Partial	Absolute	Partial
VitaminB-6(mg)	Partial	Absolute	Partial
Folate(mcg)		Absolute	Partial
Vitamin B-12(mcg)			Partial
Vitamin A RAE(mcg)		Absolute	Absolute
Iron(mg)	Absolute	Absolute	Partial
Zinc(mg)	Absolute	Absolute	Partial
No of absolute problem nutrients	3	9	2
No of partial problem nutrients	4	0	9

Identifying Food Groups for Promotion in Complementary Feeding Recommendations

After identifying the dietary constraints of children in the sample, food groups that could help to reduce these gaps between dietary intake and nutrient needs were analyzed. Current food sources that contributed more than 5% of one or more micronutrients in the current diet for each ethnic group are listed in Table 5. Notably breastmilk provided a key source of all included micronutrients for the Bengali and Marma populations, and all but iron among Mro children. Vitamin C-rich fruits were important nutrient sources for Marma and Mro children. Among the vegetable sub-food groups, only dark green leafy vegetables were important nutrient contributors for Bengali children, while no vegetable food groups were currently major nutrient providers for Marma children. In contrast, vegetables were major contributors to the diets of Mro children, with dark green leafy, Vitamin C-rich, and other vegetables contributing to two or more nutrients.

Table 5: Number of Nutrients Contributed to by Listed Food Group

Food sub group	Example of food item	Number of nutrients		
		Bengali	Marma	Mro
Fruits				
Other fruit	Banana, Apple	1	0	0
Vitamin C-rich fruit	Orange, Jujube, Tamarind, Papaya	1	3	2
Vegetables				
Other vegetables	Eggplant, Water gourd, Plantain	0	0	2
Vitamin A-rich leafy vegetables	Indian spinach	5		6
Vitamin A-rich other vegetables	Carrot, pumpkin	0	0	
Vitamin C-rich vegetables	Radish, Tomato, Cauliflower	0	0	4
Condiment vegetables	Onion, Garlic, Green chili	0	0	0
Oil and condiments				
Vegetable oil (unfortified)	Soybean oil, Mustard oil	0	0	0
Savory snacks	Chips	0	0	0
Condiments, herbs, spices	Turmeric, Coriander, Ginger	1	0	2
Starches				
Refined grain, unenriched	Pauruti, Banruti	1	1	0
Sweet bakery products, unenriched	Cake, Biscuit	9	9	0
Other starchy plant foods	Potato, Green banana, Taro	6	1	0
Whole grains, unenriched	Rice, Flour, Puffed rice	4	5	4
Animal Source foods				
Eggs	Chicken egg (Native, Farm)	9	6	0
Fish without bones	Rui, catla	3	0	
Poultry, rabbit	Chicken meat	0	0	0
Processed meat	Large and Small dried fish	2	0	1
Pork	Pork			8
Small, whole fish, with bones	Barb pool, Mola, Mixed fish	3	0	2
Lentils and nuts				
Cooked beans, lentils, peas	Lentil	5		
Nuts, seeds and unsweetened products	Bean, Bean seed	0	0	0
Breastmilk				
Breastmilk	Breastmilk	11	11	11

Note: Boxes with blanks indicate that the ethnic group did not consume the given food group

Due to the limited variety in the diets of these children, many nutrients were supported through consumption of generally nutrient poor starch food groups. Bakery products supported nine nutrients among both the Bengali and Marma populations, while starchy plant foods supported six nutrients among Bengali children. Rice and Wheat supported four to five nutrients in all ethnic groups.

As for protein sources, egg was a good food source for Bengali and Marma children, but not for Mro children where pork was a major contributor to nutrient intake. Large fish had a contribution only for Bengali children, while small fish had contribution for Bengali and Mro. Marma children did not receive a significant amount of nutrients from fish. Lentils contributed to diets of only Bengali children.

Testing and Consolidation of Complementary Seeding Recommendations

Using the observed minimum and maximum servings of these foods among children of the ethnic groups, complementary feeding recommendations were given that conformed to the "usual diet" (Table 6). Eggs were recommended as they were commonly consumed among all ethnic groups and are a comparatively good source for Calcium, Iron and Zinc. However, due to differences in the frequency of consumption the recommendation was greater for Bengali children, followed by Mro, then Marma. At least two servings of vegetables each day was recommended for all ethnic groups. Fish and meat were recommended in such a way that animal source foods are consumed every day of the week; three days of the week had fish and another four days had meat. Fruits were also recommended for all groups; however, as with eggs, due to differences in the frequency of consumption, the recommendation for fruit was able to be greater to achieve nutrient sufficiency for Bengali children, followed by Mro, then Marma.

Table 6: Complementary Feeding Recommendations

	Serving /Week		
Food or food group	**Bengali**	**Marma**	**Mro**
Egg	3	1	2
Vegetable	14	14	14
Fish	3	3	3
Meat	4	4	4
Fruit	7	3	5

The food items and serving sizes that met these recommendations also varied by ethnic group (Table 7). Serving sizes were in line with those consumed in each ethnic group and thus varied across ethnic groups. For home cooked items, Marma children had a serving size closer to one egg per child, while Mro and Bengali children's serving size was closer to half an egg. Bengali children were the only group to eat eggs both inside and outside the home (boiled eggs). Fish consumption was much more varied for Bengali children compared to Marma and Mro. While all groups consumed dried fish in small quantities, Marma and Mro also consumed a fermented fish product "nappi". Mro consumed no other fish items while the only other item in the Marma diet was tilapia, a fish variety with comparatively few nutrients. In contrast, Bengali children also consumed the Vitamin A-rich mola and "panch mishali" small fish varieties. All ethnic groups ate chicken, but other animal source foods were limited. Pork is religiously prohibited for Muslim Bengali children and was not consumed among the Marma households. Vegetable items and servings sizes also varied between ethnic groups. Eggplant was consumed by every ethnic group, but the serving size was much larger among Mro households. The same Vitamin A-rich vegetables were not eaten by the three ethnic groups, while there was limited overlap for Vitamin C-rich vegetables.

Table 7: Food Items and Serving Size in Each Recommended Food Group

	Bengali		Marma		Mro	
	Name	**Weight(g)**	**Name**	**Weight(g)**	**Name**	**Weight(g)**
Egg	Chicken Egg (home)	26.25	Chicken Egg	44.25	Chicken Egg	18.75
	Chicken Egg (boiled, outside)	59.5				
Vegetable	**Other**					
	Eggplant	13	Eggplant	5.25	Eggplant	31.5
	Water gourd	70			Plantain	18
	Vitamin A-Rich					
	Indian Spinach	30.5	Pumpkin	11.5	Radish leaves	53
	Carrot	4.5				
	Vitamin C-Rich					
	Radish	10.25	Ash gourd	6	Ash gourd	33.5
	Tomato	10.25	Cauliflower	3	Radish	26.5
					Tomato	12.5
	Condiment					
	Onion	3	Onion	0.75	Onion	2
	Garlic	0.5			Garlic	1
	Green chili	0.75			Green chili	1
Fish	**Small fish**					
	Barb pool	4.5	Jhatka Fish	0.75		
	Mola/Carplet	4	Nappi (prawn)	0.25	Nappi (Prawn)	1.25
	Panch Mishali	19.75				
	Large fish					
	Rohu	6.25	Tilapia	2		
	Catla	27.75				
	Pangash	10.25				
	Tilapia	9				
Meat	**Poultry Rabbit**					
	Chicken meat	14.25	Chicken meat	10	Chicken meat	20.75
					Pork, meat	68.25
	Dried fish					
	Large	3	Large	1	Large	4
	Small	1.25	Small	0.5	Small	1.25
Fruit	**Other**					
	Banana	54.75	Banana	46	Banana	83
	Apple	37				
	Vitamin C-Rich					
	Orange	32.25	Orange	142.75	Papaya	75
	Jujube	12	Jujube	7.75	Jujube	13.25
			Tamarind	2.5		

These recommendations did improve nutrient adequacy of these nutrients, but could not alone ensure that children met even 65% of the RNI, the Optifood threshold for minimally adequate intake (Table 8). Using Bengali children as an example, the egg recommendation could achieve 45% of the RNI for Calcium, 15% of the RNI for Iron and 33% of the RNI for Zinc. Vegetable recommendations could achieve 47% of the RNI for Niacin and 30% of the RNI for Vitamin E for Bengali children. However, the consolidated recommendations for egg, vegetable, fish and fruits were only able to slightly (5 to 10%) improve the percentage of RNI achieved for Calcium, Niacin, Iron and Zinc.

In the end, these recommendations only managed to shift the intake of one nutrient for Bengali children, riboflavin, from below 65% of RNI to above 65% of RNI, while four nutrients were moved from below to above the threshold for Marma children (Riboflavin, Niacin, Folate, and Vitamin A) and four for Mro children (Thiamin, Niacin, Vitamin B-6, and Vitamin B12). Nutrients that could not be met at a 65% level for all ethnic groups included Calcium, Iron and Zinc.

Table 8: Proportion of the RNI Met After Application of Feeding Recommendations

Nutrient	Bengali	Marma	Mro
Calcium	**50%**	**52%**	**30%**
Vitamin C	104%*	87%*	**43%**
Thiamin	**63%**	**62%**	83%
Riboflavin	74%	67%	**6%**
Niacin	**56%**	67%	107%
Vitamin B-6	**49%**	**34%**	67%
Folate	89%*	79%	**43%**
Vitamin B-12	93%*	95%*	69%
Vitamin A RAE	79%*	82%	**9%**
Iron	**20%**	**20%**	**36%**
Zinc	**37%**	**41%**	**62%**
No of nutrient >65% RNI	5	6	4

*Note: * indicates a nutrient that was not an identified problem nutrient; nutrients where 65% of the RNI are not met are in bold*

.

Discussion

This assessment examined the diets of young children of three major ethnic Bandarban groups to assist in formulating complementary feeding guidelines and to better understand the nutrient constraints among these children. Optifood's assessments do not require robust samples sizes to develop parameters of typical diets, therefore this study provides a qualitative look at diets.

The results of this assessment highlight the differences in young child feeding practices between ethnic groups and the limitations these impose on the ability of young children to meet their nutritional needs. While the level of stunting was somewhat greater for Bengali children, their dietary diversity was one food group greater than the other groups (Table 3). Bengali children were the only group where the majority of observation points had children consuming flesh foods. In addition, the number of food items consumed by Bengali children was nearly double that of the other ethnic groups.

These differences resulted in fewer problem nutrients, nutrients where a typical diet could not meet 65% of the RNI in Optifood, for Bengali children compared to Marma and Mro. This wider variety of foods and greater frequency of consumption also enabled higher intake recommendations for eggs and fruit than could be made for Mro and Marma children as Optifood recommendations can only be made utilizing foods currently consumed. In the end, recommendations were able to fulfill 65% of RNI for six out of the twelve micronutrients examined for Marma children, five for Bengali children, but only four for Mro children. Our inability to obtain adequate intakes of Calcium, Iron, and Zinc for any ethnic group using the foods currently consumed in the children's diets, points to a need to invest in supplementation or to examine additional nutrient-rich food sources that could be introduced, such as dairy.

The inability of the improved combinations of local foods to ensure population-level dietary adequacy for all twelve micronutrients reflects the limited number, frequency, and amounts of foods that are currently good sources of micronutrients in the current diets and from which the modeling process could draw. Cereal grain, starchy roots and tubers and snack foods such as cake and chips were large contributors to the diets of Bengali and Marma children whereas Mro children consumed mainly cereals and pork (Table 5). Among all ethnic groups, micronutrient-rich fruit and vegetable consumption was limited. This situation has been demonstrated to be associated with micronutrient inadequacy in other studies (10). Additional dietary modification is necessary to achieve nutritional adequacy especially for Mro children. Further modification of the diet outside of their current common dietary pattern was not attempted in this study but could assist in achieving nutritional adequacy for children as has been seen in other studies (12; 13).

Production under SAPLING could enable households to diversify diets. Eggs were consumed by all three ethnic groups, but with lower frequency among Marma and Mro children compared to Bengali. Greater production and availability through techniques taught by SAPLING could enable consumption of this food group to be equal across all ethnic groups, resulting in a greater proportion of nutrients being met. In addition, although pork consumption would not be acceptable for the Bengali communities, it could be promoted among other ethnic groups to meet nutrient demands for Niacin and possibly Thiamin. Our recommendations for frequency of fruit and vegetable consumption may be able to be met with household production under SAPLING, enabling the recommendations to balance nutrient needs, acceptability, and accessibility.

Affordability of intake has not yet been included. In the next steps for this analysis, SAPLING will expand the possibilities for child diets by raising the upper level of consumption for the egg food group and by adding in the produce that are grown under the SAPLING Integrated Enhanced Homestead Food Production (IEHFP) program.

References

1. *Contextualising complementary feeding in a broader framework for stunting prevention.* **Christine P. Stewart, Lora Iannotti, Kathryn G. Dewey, Kim F. Michaelsen and Adelheid W. Onyango.** 2013, Maternal and Child Nutrition, pp. 27-45.

2. **UNICEF.** *Strategy for improved nutrition of children and women in developing countries.* New York, USA : UNICEF, 1990.

3. *Evidence Based Interventions for Improving Maternal and Child Nutrition:What Can be Done and at What Cost?* **Zulfiqar A Bhutta, Jai K Das, Arjumand Rizvi, Michelle Gaffey, Neff Walker, Sue Horton, Patrick Webb and Anna Lartey.** 2013, The Lancet, pp. 452-477.

4. *Maternal and child undernutrition: global and regional exposures and health consequences.* **Robert E. Black, Lindsay H. Allen, Zulfiqar A. Bhutta, Laura E. Caulfield, Mercedes de Onis, Majid Ezzati, Colin Mathers, Juan Rivera.** 2008, The Lancet, pp. 243-260.

5. *Nutrient density in complementary feeding of infants and toddlers.* **Vossenaar, N W Solomons and M.** 2013, European Journal of Clinical Nutrition, pp. 501-506.

6. *The Challenge of Meeting Nutrient Needs of Infants and Young Children during the Period of Complementary Feeding: An Evolutionary Perspective.* **Dewey, Kathryn G.** 2013, The Journal of Nutrition , pp. 2050-2054.

7. *Designing appropriate complementary feeding recommendations: tools for programmatic action.* **Bernadette Daelmans, Elaine Ferguson, Chessa K. Lutter, Neha Singh, Helena Pachón, Hilary Creed-Kanashiro, Monica Woldt, Nuné Mangasaryan, Edith Cheung, Roger Mir, Rossina Pareja and André Briend.** 2013, Maternal & Child Nutrition, pp. 116-130.

8. *Zinc, iron and calcium are major limiting nutrients in the complementary diets of rural Kenyan children.* **Elaine Ferguson, Peter Chege, Judith Kimiywe, Doris Wiesmann and Christine Hotz.** 2015, Maternal & Child Nutrition, pp. 6-20.

9. **Kenneth Brown, Kathryn Dewey and Lindsay Allen.** *Complementary feeding of young children in developing countries: a review of current scientific knowledge.* Geneva : WHO, 1988.

10. *Context-specific complementary feeding recommendations developed using Optifood could improve the diets of breast-fed infants and young children from diverse livelihood groups in northern Kenya.* **Marieka Vossenaar, Frances A Knight, Alison Tumilowicz, Christine Hotz, Peter Chege and Elaine L Ferguson.** 2016, Public Health and Nutrition , pp. 971-983.

11. *The use of linear programming to determine whether a formulated complementary food product can ensure adequate nutrients for 6- to 11-month-old Cambodian infants.* **Jutta KH Skau, Touch Bunthang, Chhoun Chamnan, Frank T Wieringa, Marjoleine A Dijkhuizen, Nanna Roos, and Elaine L Ferguson.** 2013, The American Journal of Clinical Nutrition.

12. *Development of Food-Based Complementary Feeding Recommendations for 9- to 11-Month-Old Peri-Urban Indonesian Infants Using Linear Programming.* **Otte Santika, Umi Fahmida, and Elaine L. Ferguson.** 2009, The Journal of Nutrition, pp. 135-141.

13. **HKI.** *Food Security and nutrition assesment in selected unions of the CHT.* Bangladesh : HKI,WFP, 2013.

14. **MOCHTA, FAO.** *Support to preparation of an integrated project for Environment Friendly Agriculture in Chittagong Hill Tracts.* Bangladesh : MOCHTA, FAO, 2013.

15. **HKI.** *Food Security and Nutrition Surveillance Project Bulletin.* Bangladesh : HKI, 2014.

16. **Ahmed, Akhter U., et al.** *The Status of Food Security in the Feed the Future Zone and Other Regions of Bangladesh: Results from the 2011–2012 Bangladesh Integrated Household Survey.* Dhaka, Bangladesh : International Food Policy Research Institute, 2013.

17. **Kobir, Siddika.** *Ranna Kaddo Pusti.* Dhaka : Mowla Brother, 2011.

18. **Nazma Saheen, Abu Torab MA Rahim, Mohiduzzaman.** *Food Composition Table for Bangladesh.* Dhaka : Institute of Nutrition and Food Science (INFS), 2013.