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Nutritional Counseling Improves Dietary Diversity and Feeding Habits of Zambian Malnourished Children Admitted in Rainbow Nutritional Programs

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Introduction

The causes of childhood malnutrition are many and complex. As widely explained in the UNICEF Conceptual Framework of Malnutrition inadequate food intake (mostly poor quality diets low in calories and essential nutrients) and infections are listed as major reasons attributed to childhood malnutrition, worsened by factors such as economic status, hygiene, living conditions, medical care, parental education, and feeding practices.[1] The most critical period is the first 1000 days of life, with growth faltering having proximal effects on child morbidity and mortality, and work productivity in adulthood.[2] Poor feeding practices can adversely impact the health and nutritional status of children, which in turn have direct consequences for their mental and physical development. Furthermore, in malaria and HIV endemic countries, those infections impaired child immune system with a negative impact on nutritional status.[3,4]

Nutrients, essential for child growth and development, come from a diet composed of different food items. Dietary diversity (DD), defined as the sum of food groups consumed over a period of 24 hours, is an easy-to-measure key indicators used by the World Health Organization (WHO) to assess child feeding practices.[5] DD has been long documented as a valid and reliable indicator of dietary adequacy[6] and an useful predictor of dietary quality among infants and young children.[7,8] Higher DD has been positively associated with nutrient intake,[9] micronutrient intake and adequacy[10] and child nutritional status.[11] Contrary, poor DD, that is a hallmark of poverty, has been associated with growth faltering and all form of child malnutrition,[12] more especially in rural contexts.[13] Lower DD is particularly critical during the complementary feeding period, when essential nutrients for normal physical and mental development are most needed.[14]

In sub-Saharan Africa, many children cannot achieve healthy dietary diversity, particularly among vulnerable households. Lack of mother's knowledge in adequate feeding practices has been also described as one of the causes of inadequate children diets, reflecting in to poor food quality and frequency. The monotony of diet is not just dreary, it results in poor nutrition and health.[15]

Supplementary feeding programs (SFPs) are effective in the community-based management of child malnutrition since incorporate nutrition-specific goals and actions to address the immediate determinants of child nutrition and development: adequate food and nutrient intake, caregiving and parenting practices in complementary feeding, dietary supplementation and diversification, access to health services and safe/hygienic environment for lowing the burden of infectious diseases.[16,17] SFPs are more successful when integrating cooking demonstrations, food handouts and nutritional counseling with tailored messages on child complementary feeding.[18] Scaling-up community-based programs for malnutrition and integrating nutritional activities aimed at improving infant and young child feeding (IYCF) practices would reduce the overall burden of childhood mortality and substantially reduces existing disparities.[19]

The Case of Zambia

Although the proportion of Zambian people living in extreme poverty has declined in the past decade, the country has not achieved the Millennium Development Goal 1 (MDG1) of eradicate extreme poverty and hunger by 2015,[20] with lack of progress or deterioration reflecting in more than 45% of the population being undernourished.[21] Climate changes and weather variability have increased the occurrence of droughts and flooding, threatening the mainly rain-fed agricultural production and consumption.[22] In Zambia staple food typically consists in a plant-based meal: maize accompanied with seasonal vegetables, and few animal-sources food. It is not only insufficient in food quantity but also poor in dietary quality. [23]

Under-five children are most vulnerable to this conditions, especially during complementary feeding period. The most recent Zambian Demographic Survey reports that only 11% of children (6-23 months old) are fed in accordance with IYCF practices, with 42% consuming a minimum of 3 meals/day and 22% having a minimum dietary diversity of 4 food groups. Children of mothers with a secondary education or higher, and children in the richest households, are most likely to be fed according to the recommended IYCF practices.[24]

The basic determinants of health are still in a critical state in Zambia. Limited access to water and sanitation facilities accompanied by poor hygiene is associated with skin diseases, acute respiratory infections (ARIs), and diarrhoeal diseases, the leading of preventable diseases. In 2012 the mortality rate attributed to exposure to unsafe water, sanitation and hygiene (WASH) services was 24.5 per 100 000 population.[25]

In 2015 only 65% of the Zambian population was using improved drinking-water source,[26] with greater access for households in urban areas than households in rural areas (86% vs 51%).[27] The most common improved source of drinking water was piped water (41%), especially in urban areas; while especially in rural area, the most common unimproved source of drinking water was unprotected dug well (21%). Adding chlorine was the most common treatment method (24%), followed by boiling water prior to drinking (15%). Households that do not treat drinking water accounted for 66%, with rural households more likely not to treat water before drinking compared with urban areas (78% vs 50%).[24]

Materials and Methods

The current study presents data of a cohort of Zambian under-five malnourished children assisted from 2015 to 2016 in the Rainbow Project SFPs (under Association Pope John 23rd) in Ndola area. On a weekly basis, Rainbow Project SFPs included routinely nutrition-specific activities (anthropometric assessment, on-site feeding, cooking demonstrations, food handouts: local food – maize flour, beans, groundnuts, sugar, oil and fortified blended foods – high energy protein supplement/HEPS), coupled by nutrition-sensitive interventions (nutritional counseling and health education, home visits). Details of SFPs activities have been previously described.[28]

For this study only information of children meeting the following criteria were considered: older than 12 months of age, not breastfed, HIV uninfected, nutritionally rehabilitated (outcome cured). All those children needed to have nutritional questionnaires filled both at baseline (T1) and follow up (T2). T1 coincided with admission to SFP and T2 coincided with discharge from SFP. The impact of the nutritional intervention was assessed by evaluating anthropometric data and dietary characteristic and feeding habits both at admission and discharge.

Anthropometric Assessment and Follow Up

Pediatric information (socio-demographic and anthropometric data) was routinely collected and entered in a database, with removal of personal identifiers.

Anthropometric assessment of malnutrition included measurement of weight and mid-upper arm circumference (MUAC), and presence of bilateral pitting edema.

According to the most updated WHO guidelines[29] and the Integrating Management of Acute Malnutrition (IMAM) guidelines of the Zambian Ministry of Health for children aged 6 to 59 months,[30] severe acute malnutrition (SAM) was defined when MUAC ≤ 11.5 cm (marasmus), and/or presence of bilateral pitting edema (kwashiorkor); moderate acute malnutrition (MAM) was defined when MUAC between 11.5 and 12.5 cm; underweight was defined as weight-for-age z-score (WAZ) <-2.[31] More details on Rainbow SFPs anthropometric assessment and discharge criteria have been described elsewhere.[32]

Nutritional Assessment and Counseling

Information on children's diet was collected both at T1 and T2, during a structured interview administered by a local nutritionist in face-to-face with the mothers/guardians. The questionnaire included dietary habits (appetite, number of daily meals), as well as access to drinking-water and hygiene practices. A semi-quantitative 24-hours food recall reported the food consumed the previous day by the child. Portion sizes were assessed by asking the respondents to describe in greater detail using standardized household measures (spoonfuls, cupfuls, etc). These amounts were later transformed into food weights and quantities of ingredients used to prepare mixed recipes, to estimate dietary intakes. Total energy and macronutrient intakes (carbohydrates, fats, protein) were calculated using NutVal (Version 4.1).[33] Consumption of specific products for nutritional rehabilitation (ready-to-use therapeutic food - RUTF, fortified blended food/HEPS) was also taken in count.

According to national Zambian guidelines, nutritional counseling included principles for feeding young children at home with family food,[34] complemented with dietary recommendation for the rehabilitation of malnutrition.[30] Dietary recommendation focused on locally available foods was performed by using tools for community nutrition workers: a booklet[35] in conjunction with growth-promotion infant and young child feeding (IYCF) counseling card.[36]

Nutritional counseling included:

- drinking-water source and treatment
- food hygiene
- hands hygiene
- food groups and dietary diversity
- food frequency (at least 5 meals a day)
- healthy and balanced meal containing three main ingredients: energy (*staple* food –maize), body-building (protein-source foods: beans, groundnuts, meat, eggs, small dried fish - *kapenta*) and protective food (vegetables, fruits)
- daily fruit and vegetables consumption (at least three portions).

Specific nutrition recommendation included the explanation of HEPS recipe and portions to be daily consumed, prescribed according to child's age. Children with SAM were also sent to collect RUTF from the out-patient therapeutic program (OTP), when programs were integrated in the local clinic and RUTF was available.

In addition, generally health talks on the importance of balanced diet, hygiene, prevention of infections and diseases were performed.

Assessment of Dietary Diversity

The dietary diversity was defined based on 24-hour food recall. Since there is still no international consensus on which food groups to include in the calculation of the dietary diversity at the individual level and it could be adapted to the local context, for our analysis we considered 12 different food groups: cereals; tubers and roots; beans/pulses; nuts/seeds; milk/dairy products; meat/poultry; fish; eggs; fruits; vegetables; oils/fats; sugar.[37] A score of 1 was assigned if a child ate 1 or more foods from a given food group, and a score of 0 if not. A minimum of 10 grams consumption for food was required to be counted in the group. The score values were then summed up for all food groups to create dietary diversity scores (DDS), which ranged from 0-12. Dietary adequacy was given to a goal of 7 scoring points, considering that at T2 at least 4 groups (cereals, oil, sugar, soya beans) could be provided within the supplementary food (HEPS) prescribed as part of the nutritional rehabilitation. Children with scores below 7 were classified to have poor dietary diversity; those with scores equal or above 7 to have good dietary diversity.

The daily dietary intakes were compared to age- and gender-specific Required Daily Amount (RDA) of WHO/FAO/ONU for energy[38] and protein.[39]

Average children energy requirements and safe levels of intake for protein were also compared with FAO recommendation of *Human Nutrition in developing World*, considering a diet containing a great deal of cereals and pulses (therefore high in fiber), and little complete animal-origin protein.[40] A consumption of less than 75% of the recommended intake for energy and protein was considered inadequate.

Micronutrients intake was not considered in this analysis since all the children were consuming fortified food as part of the nutritional rehabilitation, so micronutrient adequacy could be not accurate.[41]

Statistical Analysis and Ethical Considerations

Data were analyzed using SPSS software system 21.0 (IBM, Somers, NY, USA). Weight-for-age z-scores (WAZ) and MUAC-for-age z-scores (ZMUAC) were calculated using the WHO Anthro Software (Version 3.2.2, January 2011, WHO, Geneva, Switzerland),[42] and ENA (Emergency Nutrition Assessment) Software (Version 2011, July 31st, 2012).[43]

Descriptive data and variables measured were presented as means with standard deviations (SD). Non-parametric tests for related samples (Wilcoxon Signed-Rank Test) were used to evaluate differences on feeding habits and dietary characteristics from baseline to follow up, and McNemar's test was performed to examine the effect of nutritional counseling on food groups consumption. Mann-Whitney U Test for independent samples was used to investigate the association between dietary diversity scores at follow up (DDS_T2) and response in nutritional rehabilitation. The significance level was set at $p<0.05$.

This analysis is part of the study approved by the Tropical Diseases Research Centre (TDRC) Ethics Committee of Ndola, Zambia (IRB registration number 00002911).

Results

Data of a cohort of 37 malnourished children (62.2% male) were analyzed. All the children recovered from malnutrition, with a mean length of stay in the nutrition program of 11.3 ± 6.2 weeks. Socio-demographic, health and anthropometric characteristics of the sample at baseline are shown in Table 1.

The mean age in months of children was 23.2 ±8.6 SD. The majority of children came from urban areas (97.3%) and were referred to the Rainbow SFPs from the community (75.7%).

More than half of the sample did not have any health problems at admission (64.9 %), while among the others diarrhea was the most represented health complain (16.2%).

Figure n.1 illustrates the distribution of different type of malnutrition, by age and sex at baseline. Almost half of the children were admitted in Rainbow SFPs because of SAM. Youngest children were in most critical nutrition condition, with nearly 38% being affected by kwashiorkor. Nearly 35% of the sample was admitted because of MAM, and about 16% of children were underweight.

Table 1. Socio-demographic, health and anthropometric characteristics at baseline.

Variables (n.37)	Value
Male, n. (%)	23 (62.2)
Age in months, mean ± SD	23.2 ± 8.6
[min-max]	[12 - 53.9]
Orphans, n. (%)	5 (13.5)
Guardians, mothers, n. (%)	28 (75.7)
Age of the guardian, mean ± SD	31.4 ± 12.5
Referred from, n. (%)	
Hospital	2 (5.4)
Local health facility	7 (18.9)
Community	28 (75.7)
Urban area, n. (%)	36 (97.3)
Relapse of malnutrition event, n. (%)	5 (13.5)
Weight (kg), mean ± SD	7.8 ± 1.2
WAZ, mean ± SD	-3.4 ± 0.9
MUAC (cm), mean ± SD	12.2 ± 1
ZMUAC, mean ± SD	-2.7 ± 0.9
Health problem, n. (%)	
None	24 (64.9)
Diarrhea	6 (16.2)
Cough	4 (10.8)
Lack of appetite	2 (5.4)
Fever	1 (2.7)
Drinking-water source, n (%)	
Public tap or borehole	25 (67.6)
Protected dug well	12 (32.4)

Table n. 2 shows the dietary characteristics of children at admission and discharge. Analysis of 24-hour food recalls underlies significant changes in terms of dietary diversity and number of daily meal from baseline to follow-up, respectively before and after nutritional counseling was performed.

The dietary interview conducted prior to nutritional counselling, revealed a DD on admission quite low (5 ± 1SD), while it increased at follow-up (7± 1SD), representing a statistically significant difference ($p<0.001$). It is interesting to note also the significant increase in the mean number of meals, which rose from 3 to 5 meals per day on average.

The percentage of children having ≤ 3 meals/day, that can be defined a critical but very common practice,[44] declined from

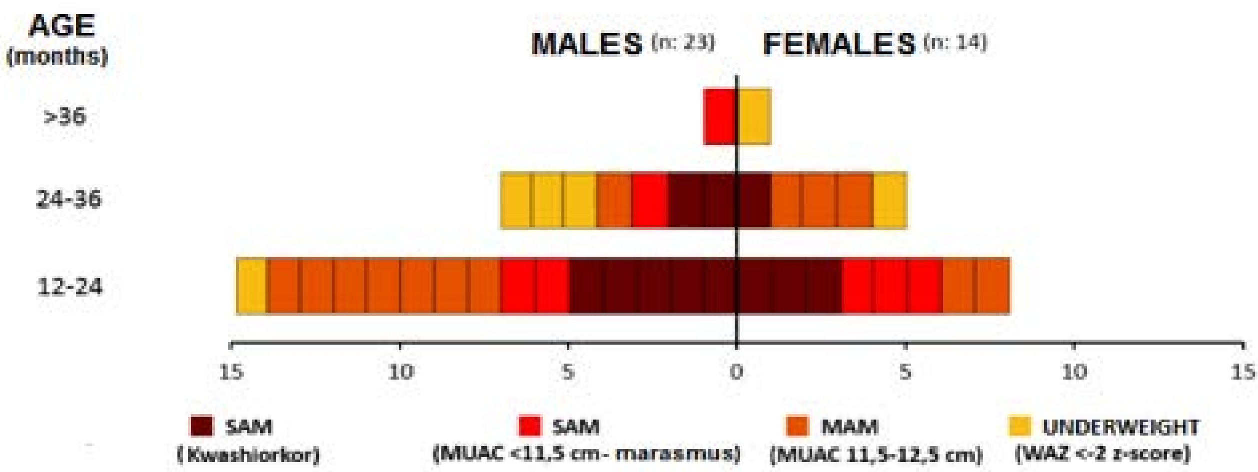

Figure 1. Classification of malnutrition by age and sex at baseline.

Table 2. Dietary characteristics of children at baseline (T1) and follow-up (T2).

	BASELINE_T1	FOLLOW UP_T2	GAIN VALUE	*p-value*
Dietary diversity, mean ± SD [min-max]	5 ± 1 [3-7]	7 ± 1 [4-9]	2 ± 1	< 0.001
Meal frequency	3 ± 0.8	5 ± 0.6	2 ± 0.7	< 0.001
Children having ≤ 3 meal/d, n. (%)	29 (78.4)	1 (2.7)		
Energy (kcal/d), mean ± SD	654 ± 295	1204 ± 446	550 ±534	< 0.001
Proteins (g/d), mean ± SD	17.6 ± 9.1	37.4 ± 11.7	19.8 ±15.2	< 0.001
Fats (g/d), mean ± SD	31 ± 15.5	50.5 ± 24.2	19.5 ±29	< 0.001
Carbohydrates, mean ± SD	76.4 ± 34.3	150.3 ± 49.9	73.9 ±57.9	< 0.001
Children with energy intake <75% of RDA (FAO 1997), n. (%)	32 (86.5)	12 (32.4)		
Children with energy intake <75% of RDA (WHO/FAO/ONU 2004), n. (%)	24 (64.9)	6 (12.2)		
Children with protein intake <75% of RDA (FAO 1997), n. (%)	19 (51.4)	0		
Children with protein intake <75% of RDA (WHO/FAO/ONU 2007), n. (%)	7 (18.9)	0		

nearly 79% to less than 3%. We underlie that 5 meals a day is the gold standard for children recommended in national and international guidelines.[33]

The average intake of energy and most nutrients was much lower than International recommendation, especially at baseline. For comparative analysis of the dietary composition, a statistically significant rise in the intake of energy and all macronutrients was observable from T1 to T2. At follow-up, 32.4% of children were still receiving less than 75% of the daily recommended energy per WHO/FAO/ONU guidelines,[37] while the percentage decreased to 12.2% per FAO guidelines.[39] All children received at least 75% of the protein allowance at that time point.[38]

Figure n.2 shows food groups eaten from children at T1 and at T2. One of the major evident nutritional problems at baseline was that children had a monotonous diet, with energy food (cereals, oil and sugar) mainly represented, and poor protein-source food (mostly plant origin such as nuts). Statistically significant changes in food groups consumption were noted at T2, after nutritional counseling. The number of children consuming animal-sources food (fish, eggs, meat/poultry) increased generally by 35% (*p*=0.004), and respectively by 27% (p=0.031), 8% (NS; p=0.607) and 16% (NS; p=0.180). A consistent improvement in consumption of food plant origin was noted: +35% for vegetables and +50% for fruit (p<0.001). The important achievement

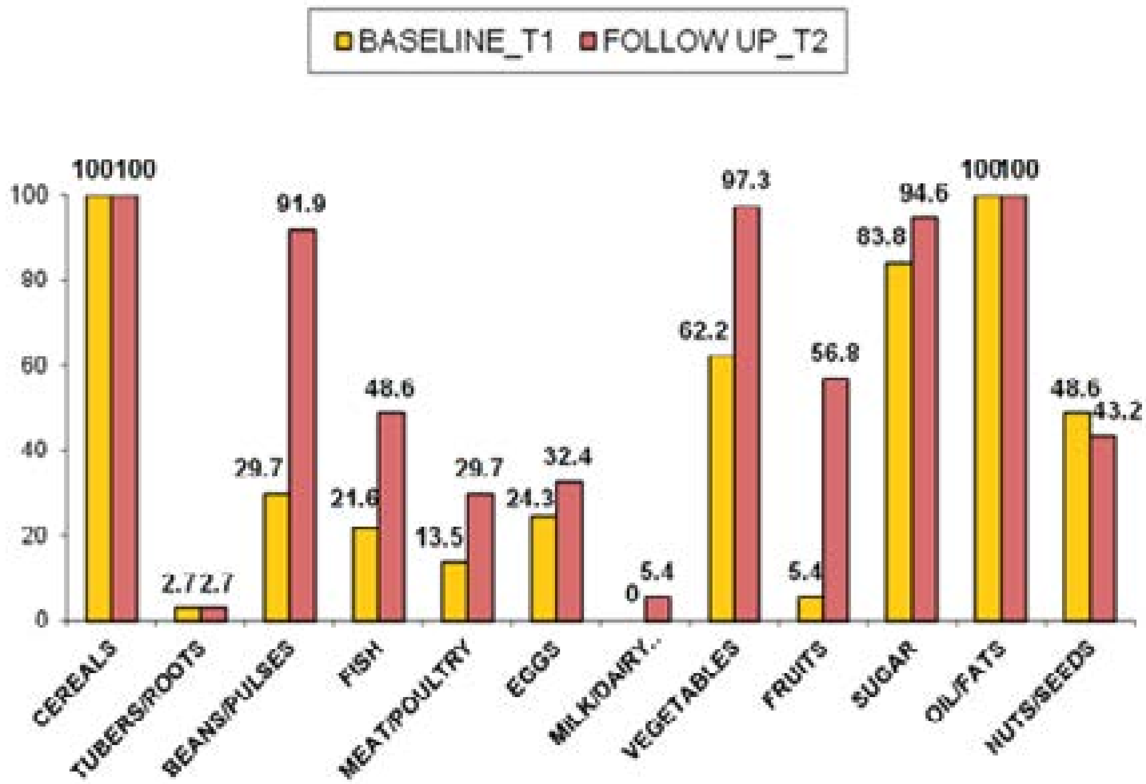

Figure 2. Changes in food groups consumption from T1 to T2.

in animal-source foods and vitamin-rich foods consumption can be considered a direct result of nutritional counseling and education, since Rainbow SFPs did not include this food type in food handouts. Furthermore, supplementary foods were not observed to be substituted for typical local food offered in the home. These results are in line with those of recent studies that also detected no negative impact of supplementary food on the consumption of typical complementary foods.[45]

In Table n.3 we investigated the association between DDS and type food group consumed at baseline and follow up. DDS_T1 underlined that children were fed only a limited number of food groups, with a range of score from 3 to 7. Cereals, oil and sugar were the mainly represented food source, independently from the dietary diversity score. Fruit group consumption was very poor in central DD score. More than half of children ate vegetables, since at the basis of local diet to accompany the staple food.

Low DDS_T1 showed general lack of protein, starting at diversity scores of 4. Animal-sources food were few consumed in low DDS_T1, while rose with increasing of the score (50% of children with score=5). None of the children had milk or dairy products.

In DDS_T2 cereals, oil and sugar remained the main food groups consumed, for all the DD scores. Fruit group started to be considerably eaten by more than half of the sample with DDS≥7. A relevant increase in food protein consumption (both animal and plant protein) was found in DDS_T2, even starting at low

Table 3. Changes in trends of food group consumption, numbers of daily meals and animal-source protein by DDS from T1 to T2.

DDS_T1

	DDS	3	4	5	6	7	8	9
	Children, n. (%)	n.1 (2.7)	n.11 (29.7)	n.18 (48.7)	n.4 (10.8)	n.3 (8.1)	-	-
Food groups consumed (%)	Cereals	100	100	100	100	100	-	-
	Oil/fats	100	100	100	100	100	-	-
	Sugar	-	72.7	88.9	100	100	-	-
	Nuts/seeds	-	9.1	55.6	100	100	-	-
	Fish	-	18.2	16.7	-	100	-	-
	Vegetable	100	54.5	61.1	75	66.7	-	-
	Eggs	-	9.1	22.2	50	66.7	-	-
	Beans/pulses	-	27.3	33.6	25	33.3	-	-
	Meat/poultry	-	9.1	11.1	25	33.3	-	-
	Fruit	-	-	5.6	25	-	-	-
	Tubers/roots	-	-	5.6	-	-	-	-
	Milk/dairy products	-	-	-	-	-	-	-
	Number of meals %							
	<3	100	18.3	33.3	-	-	-	-
	=3	-	72.7	50	50	-	-	-
	>3	-	-	16.7	50	100	-	-
	Animal-origin protein (%)	-	36.4	50	75	100	-	-

DDS_T2

	DDS	3	4	5	6	7	8	9
	Children, n. (%)	-	1 (2.7)	2 (5.4)	8 (21.6)	12 (32.4)	12 (32.4)	2 (5.4)
Food groups consumed (%)	Cereals	-	100	100	100	100	100	100
	Oil/fats	-	100	100	100	100	100	100
	Sugar	-	-	50	100	100	100	100
	Nuts/seeds	-	-	50	37.5	50	33.3	100
	Fish	-	100	-	37.5	25	75	100
	Vegetable	-	100	100	100	91.7	100	100
	Eggs	-	-	50	-	41.7	33.3	100
	Beans/pulses	-	-	50	87.5	100	100	100
	Meat/poultry	-	-	-	12.5	41.7	41.7	-
	Fruit	-	-	-	25	50	91.7	100
	Tubers/roots	-	-	-	-	-	8.3	-
	Milk/dairy products	-	-	-	-	-	16.7	-
	Number of meals %							
	<3	-	-	-	-	-	-	-
	=3	-	100	-	-	-	-	-
	>3	-	-	100	100	100	100	100
	Animal-origin protein (%)	-	100	50	62.5	91.7	100	100

scores. Only few children had milk/dairy products when DDS_T2 = 8, reflecting that milk is not locally considered as an aliment for children. Vegetable group was mostly represented for all the DDS_T2.

As an important part of the nutritional counseling, good emphasis was also given to water source and treatment. Significant improvements in treating drinking-water by boiling it ($p< 0.001$) were noticed from baseline to follow up (18.9% vs 72.9%).

Finally, Mann-Whitney U Test for independent samples was performed in order to test the hypothesis that changes in DDS after nutritional counseling could be associated with response in nutritional rehabilitation. The variable of DDS_T2 was dichotomized (0=DDS_T2 ≤7; 1= DDS_T2 >7) and correlated with changes in anthropometric measurements and gain in z-scores. High dietary diversity scores (DDS_T2 >7) were positively correlated with gain in MUAC-for-age z-scores, expressed as gain in standard deviations ($p=0.046$). No other statistically significant associations were found.

Discussion

Feeding practices play a pivotal role in determining the optimal physical growth, development and health of infants and young children. Unfortunately, Zambian diet is often monotonous, highly insufficient and inadequate, exposing vulnerable children to growth faltering and malnutrition. At admission in Rainbow SFPs children's diet resulted to be very poor, with a lack in dietary diversity, energy and macronutrient deficits, and inappropriate feeding practices that could have been contributed to child malnutrition. Our study findings imply that efforts to promote optimal child feeding practices with behavior change communication should not be underestimated in resource-limited settings. Dietary consumption and feeding practices have been significantly improved after nutritional counselling was integrated as a routinely activity of nutritional rehabilitation. Our results are consistent with those of other studies highlight the complexity of nutritional rehabilitation efforts in community-based programs for management of malnutrition, when food insecurity and infectious diseases such as HIV and malaria coexist in a vicious circle.[46,47,48]

Nutritional assessment, monitoring and evaluation is therefore one of the key to improve children diet, not only in terms of energy and nutrients, but also in terms of dietary diversity. Our results point to the effectiveness of nutritional counseling when integrated within community-based programs against malnutrition, suggesting the need of enhancing nutritional education with an emphasis on a culturally appropriate balanced diet.

Limitations of the Study

The first limitations of the present study included the small convenience-based sample and the use of semi-quantitative questionnaire to estimate amounts of foods consumed and nutrient composition data. Being derived from single 24-hours recalls, our estimates of dietary intakes are subject to random error as a consequence of within-subject variation. Being more specific on types of food consumed and integrating a food frequency assessment questionnaire could improve dietary estimations. Food recall of mothers/guardian could be also facilitated using an atlas with pictures of specific quantities of local food. Since all the children were consuming fortified foods during nutritional rehabilitation, micronutrients intake and adequacy could not be evaluated. Further study can be done with large sample size, longer intervention period and more strong design to confirm consistency of result.

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