Nutrition education to improve dietary intake and micronutrient nutriture among children in less-resourced areas: a randomised controlled intervention in Kabarole district, western Uganda

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Abstract

Objective: To determine whether nutrition education targeting the child-feeding practices of low-income rural caregivers will reduce anaemia and improve vitamin A nutriture of the young children in their care.

Design: A controlled intervention trial, based on experiential learning theory. Forty-six women completed a nine-session nutrition education programme, while controls (n = 43) concurrently engaged in sewing classes.

Setting: Two rural farming communities in the Kabarole district, western Uganda.

Subjects: Less literate, low-income rural female caregivers and the children in their care (6-48 months).

Outcome measures: Caregivers' child-feeding practices and the children's nutritional status were assessed at baseline, one month after intervention (Follow-up 1) and one year from baseline (Follow-up 2).

Results: Caregivers in the intervention group reported improved child snacking patterns, food-selection practices, meal adequacy, and food variety. Children in the intervention group recorded lower haemoglobin levels at baseline (9.86 vs. 10.70 g/dl) and caught up with controls at Follow-up 1 (10.06 vs. 10.78 g/dl). However, changes were not sustained. Mean retinol-binding protein improved from 0.68 µmol/l (95% CI: 0.57-0.78) to 0.91 µmol/l (95% CI: 0.78-1.03) among intervention children, but remained approximately the same in controls. Vitamin A nutriture was influenced by infections.

Conclusion: Nutrition education significantly improved feeding practices and children's nutritional status. The effectiveness and sustainability of this programme can be enhanced if nutrition education is integrated into other food-production and public health programmes.

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Introduction

Vitamin A deficiency disorders and iron-deficiency anaemia remain a public health concern in developing countries,[1] and inadequate diets are a major risk factor for micronutrient malnutrition. As a key strategy to improve feeding practices, the World Health Organization (WHO) advocates improved access for caregivers to objective, consistent and complete information on appropriate feeding practices.[2] Hence, culturally appropriate nutrition education is needed to empower caregivers with the information and skills needed to optimise the utilisation of available food resources. Nutrition education is especially important in less-resourced communities, where diets often centre on bulky, plant-source foods, that do not contribute significant amounts of micronutrients in bioavailable forms.

The purpose of this study was to determine whether a nutrition education programme, targeting the food selection and preparation skills of low-income, less literate caregivers, would improve the feeding practices of rural caregivers, and consequently improve the dietary intake and nutritional status of the young children in their care, aged 6-48 months. The study was conducted in western Uganda, a region that was reported to have a 37.6% and a 15% prevalence of stunting and underweight among children aged 6-59 months, respectively.[3,4] It was hypothesised that caregivers who attended nutrition classes would have improved nutrition knowledge, and change their attitudes about feeding children aged 6-48 months. It was hoped that this would consequently lead to improvements in the young children's dietary intake (food variety, diet adequacy and meal patterns) and their micronutrient nutriture.

Subjects and method

Participants were female primary caregivers (mostly mothers) and the children in their care, aged 6-48 months, from the Kabarole district, western Uganda. Based on the results from the pilot study, this intervention was expected to have a medium effect on feeding behaviour.[5] Using a hypothesised effect size of 0.55, power of 0.82 and 95% level of significance, a sample of 35 child-caregiver pairs were needed to detect a medium effect on overall feeding behaviour using analysis of covariance (ANCOVA). Due to the high drop-out rate experienced during the pilot study,[5] the sample was increased to 42 child-caregiver pairs per site. However, due to the great need for the programme, all caregivers of children from whom blood was drawn (approximately 50 from each site) were invited to participate in the study.

Two rural areas with similar socio-demographic characteristics were selected to serve as study sites. The intervention site was randomly selected by tossing a coin. One side of the coin represented the intervention site, and the other, the control site. Local council leaders of the two selected sites provided lists of households with children under the age of five years. Investigators screened and recruited potential participants through household interviews that were carried out with the primary caregivers. Because there were more eligible women and children, study participants were randomly selected from the 246 child-caregiver pairs or triads (118 from the intervention and 128 from the control site) who participated in health fairs conducted at a central location in each site.

The randomisation process involved lining up participants as they came in for the baseline assessment, and selecting the first woman in line, and every other woman after that. If the selected caregiver did not consent to participate in the study activities (cooking or sewing classes) and to bring the child for monthly growth-monitoring assessments, the next woman in line was selected.

Ethics

The study protocol was approved by the University of Georgia's institutional review board and an ethics committee constituted by the Uganda National Council for Science and Technology. Participants were not coerced to engage in the study activities, and informed consent was also sought from participants during the recruitment process, and whenever data were collected.

Study design

This study was a controlled intervention that lasted for one year. Data on the caregivers' feeding practices (food selection and meal-planning patterns) and the children's nutritional status [haemoglobin (Hb) and retinol-binding protein (RBP)] were collected before intervention (baseline), one month after the intervention (Follow-up 1), and nine months later (one year from baseline, or Follow-up 2) to assess the effectiveness of nutrition education on improving the children's dietary intake and nutritional status.

The intervention

In a nine-session nutrition education programme, participants learnt how to prepare and serve nutritionally adequate meals and snacks to young children aged 6-48 months. Each session had a didactic component that lasted 45-60 minutes, and a cooking session that lasted 3-5 hours. The didactic sessions provided the caregivers with basic knowledge of the contribution of individual foods and food groups to nutrient intake. The cooking sessions provided hands-on skills about incorporating a variety of foods in traditional dishes, as a way to improve the nutrient density of children's meals. Emphasis was placed on improving consumption of underutilised indigenous foods and low-cost animal source foods. The cost of food was also considered in modifying traditional recipes. For example, the traditional staple of *katogo* (green banana and bean casserole) was improved by incorporating a variety of locally available vegetables, offal and ghee. Table I provides a summary of key food-selection and food-preparation practices that were addressed.

Data collection and processing

Caregivers' food beliefs

A structured questionnaire was used to interview the caregivers about their knowledge of good food sources containing iron and vitamin A. The caregivers' responses were dichotomised (0 = wrong response; 1 = correct response) and correlated to measures of the children's nutritional status (Hb and RBP).

Caregivers' food-selection practices

The caregiver's food-selection practices were determined by assessing the variety of foods consumed in the household and how frequently (in a day, week, month or year) individual foods were selected. A food frequency questionnaire that included 76 locally available food items was used to assess both food variety and selection frequency.

Food variety scores were computed by summing up the number of foods selected from each group, namely bananas, tubers and starchy vegetables, legumes, meat, fruit and vegetables. The score for each subgroup was computed by dividing the number of foods consumed in each subcategory with the total number of foods in that group. The same procedure was followed to compute scores for the three major food groups (energy-yielding, body-building and protective foods) and the total variety score.

Selection frequency scores were assigned for each food depending on how often an item was consumed, whereby 5 = daily, 4 = four to six times per week, 3 = one to three times per week, 2 = one to three times per month, 1 = less than once per month, and 0 = never. Scores for each food group were computed by summing up the frequency scores of individual food items in a particular group.

Meal patterns and adequacy of children's diets

Meal patterns were assessed by asking the caregivers to indicate how many times they provided meals and snacks to the young children. A qualitative 24-hour dietary intake recall was used to determine the adequacy of the children's diets. The caregivers were asked to recall all the foods and drinks that the children consumed during the 24 hours preceding the interview, but were not required to quantify the children's dietary intake. This is because a previous investigation conducted in this region revealed that caregivers do not habitually keep track of the amounts of food eaten by children in

Table I: Key food-selection and food-preparation practices addressed in cooking classes

Nutrient targeted	Food-selection and food-preparation practices	
	Encouraged	**Discouraged**
Iron	Incorporating local fresh fruits and vegetables, such as guavas and tomatoes, in children's meals to improve vitamin C intake.	Giving children soup only, and no meat or beans.
	Adding low-cost animal protein. e.g. [a]*mukene,* blood and offal, with [b]beans to improve non-haeme iron absorption.	Providing children with water from unprotected wells and streams.
	Selecting different kinds of non-traditional, or less desirable meats, such as rabbit and pork.	Not boiling drinking water.
	Appropriate food-handling techniques that reduce contamination of meats.	
Iodine	Identifying iodinated salt.	Using unrefined rock salt.
	Whenever possible, using refined white salt, as it is often iodised.	
Vitamin A	Increasing consumption of yellow- and orange-fleshed fruits and vegetables.	Heating cooking oils and fats to very high temperatures.
	Increasing consumption of amaranth leaves, and leaves of local staples, such as bean leaves, cassava leaves and yam leaves.	Bleaching palm oil by overheating the oil.
	Selecting vitamin A-fortified cooking oils and fats.	
	Using appropriate frying methods that conserve vitamin A in fortified cooking oil.	
	Using red palm oil often, especially when cooking green vegetables.	
Protein	Providing young children with milk, eggs and meat.	Consuming excessive amounts of green bean seeds.
	Soaking legumes to improve protein digestibility and reduce cooking time.	Roasting beans before cooking.
	Complementing legumes with grains when preparing children's meals, e.g. fortifying finger millet porridge with groundnut (peanut) paste.	Providing children with soup, and no beans or meat.
	Including a variety of grains and legumes in children's diets to ensure adequate intake	

a = *mukene* (*Rastreneobola argentea*) are dried small pelagic fish, approximately 5 cm long. One heap (~¼ kg) costs approximately US$0.10, and is sufficient for a family of 12. When mixed in beans and a ¼ kg of beef (with bones and fat), it costs approximately US$0.37, but may yield only three servings.
b = beans (*Phaselius vulgaris*) were emphasised because they are the staple protein source, and the most commonly consumed legume.

their care.[5] Hence, diet adequacy scores were computed using the scoring method.[6] Each time a food item appeared on the 24-hour recall, regardless of the amount, a score of one point was assigned to the subgroup in which that food belongs. A few foods, such as porridge and milk in tea, were assigned half a point. The validity of this scoring method was assessed in an earlier study.[5]

Children's nutritional status

Blood was drawn from all the children by a finger prick using safety lancets (1.5 x 1 mm) to assess Hb, RBP and subclinical infection [C-reactive protein (CRP) and α_1-acid glycoprotein].

Hb was used as indicator of iron nutriture, because iron deficiency is believed to be part of, or the only cause of, anaemia when the prevalence of anaemia in a population exceeds 30-40%.[7] Hb was measured with a Hemocue® β-haemoglobin photometer (Lake Forest, California, USA), and after adjusting for race, a cut-off of < 10.0 g/dl was used to indicate anaemia.

RBP and acute-phase proteins [CRP and α_1-acid glycoprotein (AGP)] were determined from dried blood spots (DBS) collected using Schleicher and Schuell (#903) collection cards. RBP, CRP and AGP were measured by the sandwich enzyme-linked immunosorbent assay (ELISA) technique from a piece of filter paper (3 mm in diameter) punched from the edge of the dried blood spot. DBS with known RBP, CRP and AGP were used as controls.[8] RBP values were corrected for the corresponding retinol by high-performance liquid chromatography values, to be able to use the standard cut-off value of 0.70 μmol/l (20 μg/dl). The sensitivity and specificity of cut-off points for CRP and AGP in diagnosing different infections and inflammations have been investigated in various studies,[9-15] but as there were no set values for using these proteins in assessing vitamin A nutriture, the cut-offs of 5 mg/l and 1 g/l were used for CRP and AGP respectively.[16]

Statistical analysis

Data were analysed using SPSS Version 10.0 (Chicago, Illinois, USA). To examine intervention outcomes, ANCOVAs were conducted to assess differences between the two groups one month after the intervention (Follow-up 1) and nine months later (Follow-up 2). Baseline main effects on feeding practices (variety, frequency and adequacy of the children's diets) and nutritional status indicators (RBP and Hb), were used as covariates and an alpha level of 0.05 was used to determine significant differences. Spearman's correlations were also conducted to determine relationships between the caregivers' beliefs and the children's nutritional status.

Results

In general, both the intervention and the control group fully participated in cooking and sewing classes respectively. However, some participants did not complete all assessments. Mixed-effects selection models that quantified associations between missing and observed data determined that the missing data could be ignored without affecting the study results.[17] Hence, the number of subjects for the results presented here varies across the parameters assessed.

Characteristics of study participants

Subsistence farming was the primary livelihood activity of most of the caregivers (94.6%). Most of the caregivers were the mothers of the children recruited for the study, and the mean ages of the caregivers were 30.0 ± 10.6 years and 27.9 ± 9.1 years for the intervention and control groups, respectively. Approximately one-quarter (23.8%) of the caregivers had not attained any formal education. The mean years of formal education were 3.9 and 4.0 for the intervention and control groups, respectively.

Changes in food beliefs and food-selection practices

Food beliefs

There were no statistically significant differences in changes in beliefs of the two groups. In general, the caregivers believed that the foods they were giving the children were the most appropriate.

Food variety

At baseline, there were no significant differences in the variety of foods selected by the caregivers in the two groups. However, one month after the intervention (Follow-up 1), the caregivers in the intervention group selected an increased variety of grains, fats and sweets, legumes, meat, and fruit and vegetables, when compared to the control group (see Figure 1). These results remained consistent, even when children who missed any of the assessments were excluded from the analyses.

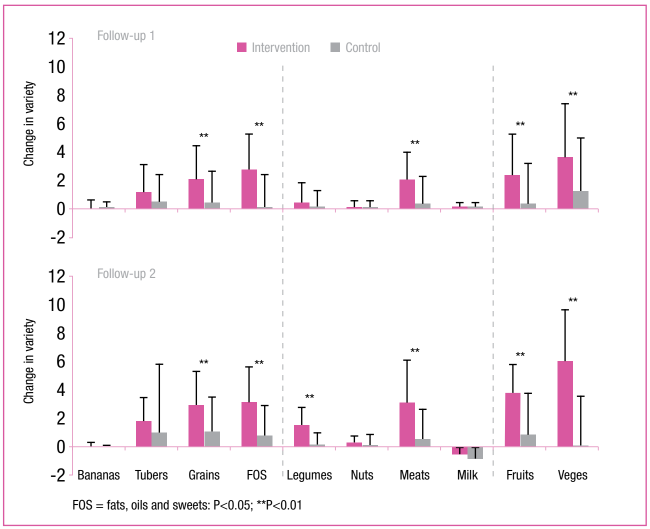

Figure1: Change in variety of foods included in children's diets

Overall, the intervention and control groups did not report significant differences in the variety of bananas, tubers, and starchy vegetables and nuts included in the children's diets (Figure 1).

Selection frequency

Food frequency scores also show that people in the intervention group increased the number of times they selected foods from most food groups (Figure 2), while those in the control group selected foods from all food groups less frequently. Changes between baseline and the end of the intervention (Follow-up 2) indicate that the intervention group maintained the improved frequency in food selection. The only significant difference between Follow-up 1 and Follow-up 2 was that the intervention group selected legumes more frequently than the control group (mean change 1.5 vs. -0.18; p-value = 0.006).

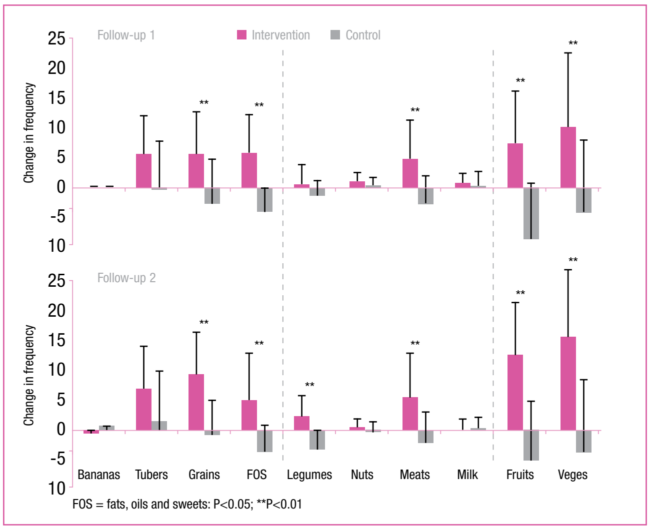

Figure 2: Changes in frequency of food selection

Adequacy of children's meals

The caregivers' recall of the children's dietary intake indicates that the intervention group provided the children with better quality meals, both at Follow-up 1 and Follow-up 2 (see Table II). At Follow-up 1, the intervention group provided more grain servings (mean difference = 0.6; 95% CI = 0.12-1.06), milk (mean difference = 0.7; 95% CI = 0.46-1.01) and vegetables (mean difference = 0.4; 95% CI = 0.12-0.68). At Follow-up 2, the intervention group also provided more grains, milk and vegetables and, in addition, provided significantly more fat, oil and sweets servings (mean difference = 0.5; 95% CI = 0.10-0.90), while the control group provided significantly more banana and legume servings. This consequently improved the quality of children's meals, as is reflected by the total diet scores both at Follow-up 1 and Follow-up 2 (see Table II).

Meal patterns

There were no significant differences in the number of meals provided by the two groups at all three assessment points. On average, both groups provided the children with three meals per day. However, the

Table II: Changes in quality of children's meals and nutritional status

Variable of interest	Baseline			Follow-up 1			Follow-up 2		
	Intervention (n = 36)	Control (n = 37)	[a]p-value	Intervention (n = 33)	Control (n = 23)	p-value	Intervention (n = 31)	Control (n = 29)	p-value
Energy-yielding food	**3.00 ± 0.89**	**2.93 ± 0.97**	**0.75**	**0.45 ± 1.30**	**-0.87 ± 1.29**	0.00	**1.32 ± 2.01**	**0.48 ± 1.43**	**0.02**
Bananas	1.64 ± 1.02	1.68 ± 0.94	0.87	-0.82 ± 1.16	-0.78 ± 1.04	0.86	-0.77 ± 1.54	0.07 ± 1.28	0.02
Tubers and starchy vegetables	0.67± 0.63	0.46 ± 0.6	0.16	0.09 ± 0.84	-0.09 ± 0.79	0.44	0.45 ± 1.12	0.45 ± 1.24	0.99
Grains	0.36 ± 0.54	0.57 ± 0.90	0.24	0.30 ± 0.73	-0.30 ± 1.10	0.02	0.84 ± 1.13	-0.34 ± 1.01	0.00
Fats, oils and sweets	0.14 ± 0.35	0.14 ± 0.35	0.96	0.57 ± 0.50	0.31 ± 0.56	0.07	0.81 ± 0.91	0.31 ± 0.66	0.02
Body-building foods	**2.22 ± 0.67**	**2.23 ± 0.74**	**0.96**	**-0.14 ± 1.07**	**-0.63 ± 1.02**	0.06	**0.63 ± 1.22**	**0.33 ± 1.32**	**0.35**
Legumes	1.78 ± 0.90	1.22 ± 0.79	0.01	-0.92 ± 1.07	-0.47 ± 0.94	0.07	-0.23 ± 1.15	0.55 ± 0.99	0.01
Nuts	0.19 ± 0.47	0.35 ± 0.54	0.19	0.18 ± 0.52	0.04 ± 0.64	0.37	-0.03 ± 0.31	-0.17 ± 0.76	0.35
Milk	0.11 ± 0.38	0.39 ± 0.65	0.03	-0.03 ± 0.53	-0.08 ± 0.67	0.00	0.92 ± 0.90	0.16 ±0.84	0.00
Meats	0.14 ± 0.42	0.27 ± 0.51	0.24	0.62 ± 0.52	-0.1 ± 0.48	0.75	-0.03 ± 0.55	-0.21 ± 0.68	0.27
Protective foods	**0.33 ± 0.59**	**0.41 ± 0.69**	**0.63**	**0.73 ± 0.80**	**0.22 ± 0.60**	0.01	**0.32 ± 1.14**	**-0.10 ± 0.77**	**0.09**
Fruits	0.22 ± 0.54	0.08 ± 0.28	0.16	0.24 ± 0.61	0.13 ± 0.34	0.44	0.16 ± 0.93	0.03 ± 0.33	0.49
Vegetables	0.11 ± 0.32	0.32 ± 0.63	0.07	0.49 ± 0.51	0.09 ± 0.51	0.01	0.16 ± 0.64	-0.14 ± 0.69	0.07
Total diet score	**5.56 ± 1.32**	**5.57 ± 1.35**	**0.97**	**0.74 ± 2.14**	**-1.28 ± 1.85**	**0.00**	**2.27 ± 2.07**	**0.71 ± 2.30**	**0.00**
[b]Hb (g/dl)	**9.72 ± 1.57**	**10.78 ± 1.83**	**0.02**	**9.94 ± 1.66**	**10.65 ± 2.10**	**0.16**	**9.76 ± 1.79**	**10.83 ± 1.75**	**0.032**
			4			**8**			
	0.68 ± 0.30	**0.91 ± 0.39**	**0.01**				**0.91 ± 0.34**	**1.02 ± 0.42**	**0.257**
[b]RBP (µmol/l)			**2**						

Unless indicated, all values are mean changes ± standard deviation.
a = Differences were considered significant when p-value < 0.05.
b = Changes in haemoglobin (Hb) and retinol-binding protein (RBP) are reported for children (32 in the intervention, and 25 in the control) who participated in all three assessments.

intervention group provided more snacks than the controls both at Follow-up 1 (mean: 1.26 vs. 0.35; p-value = 0.000) and at Follow-up 2 (mean: 1.22 vs. 0.58; p-value = 0 .001).

Changes in children's vitamin A and iron nutriture

In this study, iron (Hb) and vitamin A (RBP) were used as proxies for micronutrient nutriture. The results indicate that the children whose caregivers attended nutrition classes experienced improvements in their micronutrient status.

Mean Hb concentrations of the children in the intervention group were significantly lower than for the controls at baseline (mean: 9.72 vs. 10.78 g/dl) and at Follow-up 2 (9.76 vs. 10.83 g/dl), but no significant differences were noted at Follow-up 1 (see Table II). This indicates a slight improvement in the Hb levels of the children in the intervention group one month after the intervention (Follow-up 1). However, this improvement was not sustained. The children whose caregivers believed that the consumption of beans (Spearman's r = -0.259; p-value = 0.020) and passion fruit (r = -0.255; p-value = 0.022) improves iron status were at reduced risk of being anaemic. After controlling for baseline Hb status, the risk for anaemia was also significantly associated with subclinical infections, as indicated by elevated CRP (r = -0.420; p-value = 0.000) and AGP (r = -0.403; p-value = 0.001).

Changes in RBP levels indicate an improvement in vitamin A status. Using the cut-off value of 0.70 µmol/l (20 µg/dl) for RBP, the prevalence of vitamin A deficiency reduced from 47.5% to 25.0% and from 25.6% to 24.2% among children in the intervention and control groups, respectively.[18] Baseline mean RBP was significantly lower in the intervention group (Table II), but improved from 0.68 µmol/L (95% CI: 0.57-0.78) to 0.91 µmol/L (95% CI: 0.78-1.03) in the intervention group.

After controlling for baseline RBP, there were no significant differences in the mean RBP of the two groups at the end of the intervention ($F_{(1,56)}$ = 1.045; p-value = 0.311). ANCOVAs, using the end of the intervention RBP as the dependent variable, and intervention as the between-group factor, indicate that vitamin A supplementation and deworming did not have significant effects on changes in the children's vitamin A nutriture. Baseline vitamin A status explained approximately 18.8% of the changes in RBP levels observed at the end of the intervention ($F_{(1,55)}$ = 12.72; p-value = 0.001), while current infection indicated by elevated levels of CRP accounted for 21.7% ($F_{(1,68)}$ = 18.83; p-value = 0.0001). RBP levels were also low among children who were reported to have been ill during the two weeks preceding Follow-up 2 (p-value = 0.043). The illnesses that were most commonly reported by caregivers were fever or undiagnosed malaria (82.4%) and coughing (16.2%).

Discussion

In general, the caregivers in the intervention group exhibited changes in child-feeding behaviour, as indicated by the increased variety of foods provided to the children, the improved frequency of incorporation of nutrient-dense foods in the children's diets, and the greater number of snacks given to the children. The increased frequency of use and number of servings of nutrient-dense foods, such as grains, milk, fruits and vegetables, were expected to improve the children's nutrition status. However, changes in dietary patterns were not directly correlated to improvements in Hb and RBP levels. On the contrary, both Hb and RBP were associated with subclinical infections indicated by elevated acute-phase proteins (notably CRP), suggesting that children's nutritional status was compromised by infections.

Despite the positive changes in feeding behaviours, there were no significant differences in the food beliefs of the caregivers in the intervention and control groups, because the participants believed that the foods they were giving the children were the most nutrient dense. This can partly be explained by the fact that emphasis was placed on modifying traditional recipes, rather than encouraging new foods. Hence, changes in food-selection practices were determined by food access. For example, the caregivers in the intervention group selected grains, fruits and vegetables more frequently, because these foods are commonly cultivated, or are locally available in the study area. Fewer changes were recorded in the consumption of nuts and meats, because these foods are often purchased. This emphasises the need for interventions to encourage the production and utilisation of locally available foods.

The reduction in the number of servings of bananas and legumes by the intervention group is a positive change that indicates that the caregivers in the intervention group were more informed of the benefits of supplementing the traditional staples (banana and beans) with other foods. On the other hand, there were no significant changes in the variety of banana products consumed by the children in the two groups, because vegetable bananas (*matooke*) are highly valued, and were frequently consumed by both groups, while dried bananas (*emikakaro*) and banana flour (*obuteere*) are likely to have been under-reported because they are considered to be socially undesirable foods. The reduction in the number of servings of bananas (*matooke*), coupled with no change in frequency of the use of banana products, calls for interventions to improve the nutrient density of commonly consumed staple foods.

Another important finding from this study is the need to improve the snacking patterns of young children. Although the caregivers in the intervention group were encouraged to increase the number of meals by preparing special meals for the children, the caregivers from both the intervention and the control group reported providing the young children with an average of three meals a day. This can be attributed to the fact that the caregivers in the study region do not habitually prepare special meals for young children.[5] The caregivers in the intervention group tried to improve the number of times the children were fed (meal frequency) by providing more snacks. An increase in the number of snacks can potentially increase the variety and amount of food consumed by children.

Conclusion

This study supports research that has shown that when income is not a limiting factor, nutrition education is effective in motivating mothers to change their feeding practices.[19] The success of this intervention can be attributed to its total-diet approach. With a total-diet approach, each programme participant was likely to pick out at least one behaviour to modify, or a food item that he/she had access to, and was willing to try out. The total-diet approach was especially important because of the high prevalence of malnutrition in the study area, and limited literature on specific micronutrient deficiencies. Overall, this intervention demonstrated that culturally appropriate nutrition education has the potential to improve caregivers' child-feeding practices and children's nutritional status. Given the high costs involved in implementing the demonstration components of this intervention, the sustainability of this kind of nutrition programme can be improved by integrating nutrition education in other food-production and public health programmes.

Competing interests

The authors declare no competing interests.

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