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ORIGINAL PUBLICATIONS

Feeding patterns of underweight children in rural Malawi given supplementary fortified spread at home

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Abstract

Fortified spread (FS), containing dry food particles embedded in edible fat, offers a convenient means for nutrition rehabilitation. To describe how caregivers feed FS to their undernourished children at home, and how FS use affects other feeding patterns, we conducted a longitudinal observational study in rural Malawi. Sixteen 6- to 17-month-old underweight children (weight-for-age z-score < –2.0; –3.0 < weight-for-height z-score < 0) received FS for 12 weeks. Twelve-hour observations were conducted before supplementation and during weeks 1, 4, 8 and 12 of FS use. FS was fed to children about two times per day; each serving was 15–20 g. The spread was first used mainly alone as a between-meal snack, and then became integrated into the typical complementary feeding pattern by being mixed with porridge. Introduction of FS reduced the number of plain porridge meals, but did not decrease the total number of meals or breastfeeds per day and did not change the daily mean time caregivers spent on feeding. Children accepted the FS well, but more FS was wasted when it was offered mixed with porridge than when given alone (23.6% vs. 1.2%, 95% CI for the difference 13.2% to 31.6%). FS supplementation is feasible for community-based nutrition interventions in Malawi because it easily becomes part of the feeding routine, does not replace other foods and does not take extra caregiver time. To limit wastage, caregivers should be advised to serve FS plain or to mix it with only a small quantity of porridge.

Keywords: child, underweight, supplementary feeding, fortified spread, feeding patterns, sub-Saharan Africa.

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Introduction

Undernutrition affects up to 40% of children aged less than 5 years in low-income countries (UNICEF 2000). It causes morbidity and adverse long-term sequelae and contributes to global childhood mortality. Severely undernourished children have the highest risk of morbidity and death from this condition, but mild and moderate undernutrition create a greater health burden at the population level (Pelletier *et al*. 1995). In Malawi, the problem usually develops in children aged 6–17 months, so that by the age of 18 months, 30–50% of all children in rural Malawi are undernourished (Maleta *et al*. 2003).

Supplementary feeding is one possible avenue for improving the feeding and growth of children in poor communities. Efficacy trials of a variety of types of food supplements in different settings and with children of different ages have had variable results, with some studies showing that supplements have a positive impact on growth while others show no change (WHO 1998; Allen & Gillespie 2001). Age, initial nutritional status, food availability and feeding practices may all have an effect on the success of supplementation (WHO 1998). Despite these possible constraints, in locations, such as Malawi, where other interventions, like dietary diversification and fortified complementary foods, are too expensive to reach the poor, supplementary feeding may be a feasible and appropriate option.

Fortified spread (FS), containing dry food particles embedded in edible fat, is food supplement that has proven to be effective in research settings and that offers some clear benefits over milk- or cereal-based supplements. FS is five times more energy dense than cereals, needs no cooking before use, is hygienic because it does not support bacterial growth, and contains adequate quantities of micronutrients (Briend *et al*. 1999; Briend 2001). A therapeutic version of spread, called ready-to-use therapeutic food, has been used successfully for rehabilitating severely undernourished children either in hospital or as outpatients (Collins & Sadler 2002; Diop *et al*. 2003; Manary *et al*. 2004; Sandige *et al*. 2004). Increases in weight and length gain have also been reported among moderately undernourished children supplemented with FS at home (Patel *et al*. 2005; Kuusipalo *et al*. 2006). These studies suggest that different types of spreads may spread a potential avenue for community-level management of undernutrition. To date, there is no published information available on the practical aspects of home spread use, which would be needed to plan larger-scale interventions.

In order to provide data on how FS is used at home, we carried out a longitudinal observational study of feeding patterns among underweight 6- to 17-month-old children in rural Malawi. The aim of this descriptive study was to look at issues such as the size of a typical FS feed, time spent feeding FS, waste of FS, impact of FS on complementary feeds, and changes in FS use over time.

Methods

Setting, design and overview

The study was conducted around Lungwena and Malindi in a rural area in southern Malawi. Participants were provided with FS for a period of 12 weeks. Ten 12-h observations were conducted for each child; observations were carried out on two consecutive days. The first pair of observations was completed before the children received FS (week 0). Children and their caregivers were then observed during weeks 1, 4, 8 and 12 of FS use. A background questionnaire to obtain socio-economic information was completed on the first day of observation. Children's weight and length were measured at enrolment and at the end of the study. Ethical approval for the study was obtained from the College of Medicine Research and Ethics Committee at the University of Malawi, and from the Ethical Committee of the Pirkanmaa Hospital District in Finland.

Participants

Participants were a sample of 16 6- to 17-month-old children selected from six villages. Villages were chosen so as to include possible differences in health-seeking and availability of food (especially fish) based on their distance from health facilities and the lake. Research assistants and village health workers visited the villages to prepare initial lists of children in the age group. The research team then went to each village to measure the children, test for peanut allergy, and verify eligibility [weight-for-age z-score(WAZ) < -2.0; $-3.0 <$ weight-for-height z-score (WHZ) < 0; not participating in another study; looked after by biological mother; no peanut allergy; no chronic illness; and guardian-signed informed consent]. The weight-for-age and weight-for-height criteria for this study were selected to obtain children who were underweight but not wasted and not short and fat. At the time the study was conducted, low weight-for-height (WHZ < -3.0) was the Malawian Ministry of Health's criteria for a child to enter inpatient nutrition rehabilitation. Weight was measured using a UNICEF Salter scale (reading increment 0.10 kg), and length was measured using a length board (Shorr Productions, Olney, MD, USA; reading increment 0.10 cm). Weights and heights were converted into z-scores using the Center for Disease Control and Prevention tables (Kuczmarski *et al*. 2002).

Procedures

Each trained female research assistant was responsible for carrying out all study activities for four children in one or two villages. Research assistants were assigned to observe and visit the same four participants so that they could develop rapport with the families, thereby minimizing their effect on the observations.

The FS used in this study contained peanut butter, milk powder, sugar, oil and vitamin/mineral mix, and a daily dose provided approximately 250 kcal of energy, 7 g protein, 14 g carbohydrates, 17 g fat, and one recommended daily allowance of 17 micronutrients. It was obtained from a local producer in the capital (Project Peanut Butter, Blantyre, Malawi). Research assistants delivered three plastic jars of FS to participants' homes every 2 weeks; each jar contained enough FS for 5 days. At the beginning of the FS feeding period, caregivers were informed that they should feed the study child 7 teaspoons (approximately 50 g) of FS per day, and that the FS was specifically for the study child. No advice about how or when to give FS was offered because the aim of the study was to see how families chose to use FS in practice.

Background questionnaire

A background questionnaire was administered to each caregiver on the first day of observation. The questionnaire contained demographic and economic questions, including the age, education and occupation of the parents, number of family members, and food availability.

Observations of feeding

On each day of observation, a research assistant visited the family from approximately 6 AM to 6 PM. First, the research assistant asked the caregiver if either she or the child was ill. If so, the research assistant inquired about the kind of illness. Then the research assistant sat near the child and recorded the type of food and duration of all feeding episodes (including breast milk). Research assistants also used a semi-structured form to collect information about caregiver–child interactions during meals, including who fed the child, what utensil was used, and how many bites were offered and eaten.

The study's principal investigator conducted 25% of observation visits with research assistants and independently recorded the data. This allowed us to estimate interobserver reliability for individual variables using Pearson's correlation coefficient and Cohen's κ statistic. On feeding logs, κ was 0.99 for type of food and r was 0.86 for length of episode. On feeding interaction forms, r ranged from 0.84 to 0.98 for variables counting teaspoons of food offered and eaten, and κ was 0.98 for primary feeders and 0.97 for primary utensils. Because interobserver reliability was high, all analyses presented below use data collected by research assistants.

Method of analysis

Data were entered into a self-designed Microsoft Access database, extracted to Microsoft Excel tables and analysed with SPSS (version 11.5) and STATA (version 9.2). Linear regression analysis was used to calculate means and to test for differences between some subgroups. The analysis was adjusted for within-subject correlation by the Huber-White robust standard error (Binder 1983). Binomial regression was used to analyse proportions (Spiegelman & Hertzmark 2005), with statistical inference based on the robust standard error to allow for correlated data.

In the analysis, foods listed in feeding logs and interaction forms were divided into seven types defined as follows: porridge (made from maize, rice or maize/soy; approximately 10% dry matter); FS alone (spread given straight from the jar); FS mixed (spread mixed with porridge); nsima (dough made from maize; approximately 28% dry matter) and relish (most often green vegetables, fish or beans); other meals (rice or boiled pumpkin); snacks (such as bananas, bread or roasted maize); and breast milk. When breast milk and food were recorded on the same line on feeding logs, only the type of food was used in the analysis. This procedure led to a slight underestimation of the number of breast milk episodes.

Table 1. Background characteristics of children and their families

Mean (SD) age of child at enrolment	13 (3) months
Proportion female	63%
Mean (SD) anthropometric measurements	
Weight	7.5 (0.8) kg
Length	69.8 (3.9) cm
Weight-for-age *z*-score	–2.6 (0.3)
Height-for-age *z*-score	–1.8 (0.7)
Weight-for-height *z*-score	–1.2 (0.9)
Mean (SD) age of mother	26 (7) years
Mother's occupation (%)	
Housewife/farmer	75
Small business owner	19
Other	6
Mother's education (%)	
None	6
1–3 years	44
4–6 years	19
7–9 years	12
10 or more years	19
Father lives with family (%)	50
Mean (SD) number of household members	5 (2)
Mean (SD) number of children < 5 years	2 (1)
Mean (SD) birth order of study children	4 (2)

Results

A total of 228 children were identified in initial screening; 200 (87.7%) of them were measured by the research team. Of those measured, 177 were not eligible for the following reasons: 119 not underweight, 38 not correct age, 18 in another study, 1 chronically ill, and 1 whose mother was deceased. Out of 23 eligible children, 16 were selected. In four villages, all eligible children ($n = 8$) were enrolled. In the other two villages, four children were selected randomly (8 children in total). At enrolment, all caregivers were mothers. The background characteristics of the children and their families are shown in Table 1.

Of the planned 160 days of observation, 155 days were completed. The length of most observations was approximately 12 h; however, 11 observation days (7%) were shorter (usually 4–8 h) due to visits away from home (to health centre, traditional healer, fields, funeral or maize mill) by participants.

Table 2 describes the number and duration of different meal types before FS was provided (week 0) and during FS use (weeks 1–12). All children, except one, were breastfed. In the absence of FS, the typical daily feeding pattern was: breast milk 11 times, porridge one to two times, nsima one time, and snacks three times. When FS was introduced, the mean times per day children ate plain porridge decreased (from 1.5 to 0.3, 95% CI for the difference 0.8 to 1.6, $P < 0.001$), while the mean times they had all other food types, including breast milk, remained the same. The duration of breastfeeding episodes did not change when children received the spread.

FS was generally well accepted by children in this study. It was fed to children two times per day on average, and it comprised or was included in 31% of meals and snacks. There was a large difference in the mean time it took to feed FS alone and FS mixed with porridge (5.4 vs. 14.5 min, 95% CI for the difference 5.6 to 12.5, $P < 0.001$). Fifteen per cent (19/124) of observation days during weeks 1–12 included no FS feedings; approximately half of these were because the child's FS supply was already finished. The recommended dose of 7 teaspoons of FS per day was

Table 2. Number and duration of feeding episodes before and during FS supplementation

	Porridge	FS mixed	FS alone	Nsima and relish	Other meals	Snacks	Breast milk
Mean (95% CI) times per day							
Before FS	1.5 (1.1, 1.9)	–	–	1.0 (0.7, 1.4)	0.3 (0.1, 0.5)	2.7 (1.2, 2.8)	11.1 (8.2, 14.1)
During FS	0.3 (0.2, 0.4)	0.9 (0.5, 1.2)	0.7 (0.4, 0.9)	1.0 (0.8, 1.3)	0.2 (0.1, 0.3)	2.0 (1.3, 4.1)	10.1 (6.8, 13.5)
Mean (95% CI) minutes per episode							
Before FS	14.5 (11.6, 17.3)	–	–	17.2 (13.2, 21.3)	22.0 (14.1, 29.9)	6.6 (5.6, 7.5)	6.0 (4.9, 7.2)
During FS	11.8 (7.0, 16.6)	14.5 (11.7, 17.2)	5.4 (3.5, 7.2)	14.3 (12.2, 16.4)	16.8 (8.5, 24.9)	4.9 (4.1, 5.7)	6.6 (5.0, 8.1)

This table is based on data from feeding logs. Means and confidence intervals were adjusted for within-subject correlation. Before FS (fortified spread) = week 0. During FS = weeks 1, 4, 8 and 12. Porridge = maize, rice or maize/soy, approximately 10% dry matter; FS mixed = spread mixed with porridge; FS alone = spread given straight from the jar; nsima = dough made from maize, approximately 28% dry matter, and relish = side dish made of green vegetables, fish or beans; other meals = rice or boiled pumpkin; snacks = small quantities of food eaten between meals (such as banana, bread, roasted maize).

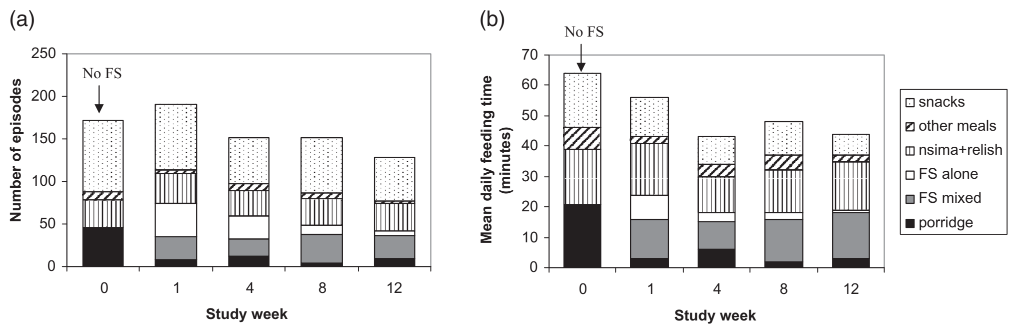

Fig. 1. Number of food episodes and mean daily feeding time by study week.
Figure 1a,b is based on data from feeding logs. In Fig. 1a, the sum of the number of feeding episodes during each study week is presented. In Fig. 1b, the mean daily feeding time for each type of food during each study week was adjusted for within-subject correlation. During week 0, no FS (fortified spread) was provided to participants. FS was available to participants during weeks 1, 4, 8 and 12. Porridge = maize, rice or maize/soy, approximately 10% dry matter; FS mixed = spread mixed with porridge; FS alone = spread given straight from the jar; nsima = dough made from maize, approximately 28% dry matter, and relish = side dish made of green vegetables, fish or beans; other meals = rice or boiled pumpkin; snacks = small quantities of food eaten between meals (such as banana, bread, roasted maize).

offered to children during 27% of visits (34/124); at least 5 teaspoons of FS were offered during 47% of visits (58/124).

The way in which the feeding patterns changed during the course of the study is shown in detail in Fig. 1a. The number of porridge meals was greatest during week 0 (no FS). Most porridge episodes were replaced by FS episodes (alone and mixed) when the children started receiving FS. Both the total number of FS episodes and the number of FS alone episodes were greatest during week 1 and decreased until the end of the study, while the number of FS mixed episodes remained fairly stable throughout the study. During weeks 8 and 12, the combined number of episodes of FS alone, FS mixed and porridge were approximately equal to the number of porridge episodes during week 0 visits.

The daily mean time spent feeding the children decreased when FS was introduced (week 1) and continued to decrease during the rest of the study (Fig. 1b). The mean time spent feeding breast milk, nsima and FS mixed remained fairly constant throughout the study, while the mean time spent feeding porridge and FS alone decreased greatly. Starting from week 4, the combined mean times for feeding porridge, FS alone and FS mixed were less than the mean time spent feeding porridge only during week 0.

Table 3. Teaspoons of FS offered and eaten per episode by study week

	Week 1	Week 4	Week 8	Week 12	Total
Mean (95% CI) teaspoons of FS offered					
FS alone	2.7 (1.7, 3.6)	2.3 (1.4, 3.1)	3.9 (1.8, 6.0)	2.6 (– 1.5, 6.7)	2.7 (2.0, 3.4)
FS mixed	2.8 (2.2, 3.5)	2.8 (2.3, 3.4)	3.2 (2.4, 4.0)	3.0 (2.3, 3.7)	3.0 (2.6, 3.4)
Mean (95% CI) teaspoons of FS eaten					
FS alone	2.7 (1.7, 3.6)	2.2 (1.2, 3.2)	3.9 (1.8, 6.0)	2.6 (– 1.5, 6.7)	2.7 (2.0, 3.4)
FS mixed	2.1 (1.4, 2.8)	2.2 (1.6, 2.7)	2.4 (1.6, 3.2)	2.4 (1.6, 3.3)	2.3 (1.7, 2.8)
Proportion lost (95% CI) during feeding					
FS alone	0.0% (–)	3.9% (–3.1, 9.9)	0.0% (–)	0.0% (–)	1.2% (–1.3, 3.8)
FS mixed	27.0% (11.8, 42.3)	22.6% (15.1, 30.1)	24.8% (8.3, 41.2)	20.0% (8.1, 31.9)	23.6% (14.0, 33.3)

This table is based on data from observations of feeding episodes. Means were calculated using linear regression and proportions were calculated using binomial regression. All calculations were adjusted for within-subject correlation. FS (fortified spread) alone = spread given straight from the jar; FS mixed = spread mixed with porridge. (–) = same value for upper and lower confidence limits.

Data about the amount of FS offered and eaten, as well as the proportion lost or wasted, are presented in Table 3. One teaspoon equals approximately 7 g of FS; so on average, children ate 15–20 g of FS per episode. More of the FS was wasted when it was offered mixed with porridge than when it was given alone (23.6% vs. 1.2%, 95% CI for the difference 13.2% to 31.6%, $P < 0.001$).

To describe who fed the children and what type of utensil was used, proportions were calculated using a feeding episode as the unit of analysis. Caregivers were the primary feeders during 95% (57/60) of FS alone, 88% (66/75) of porridge, 78% (85/109) of FS mixed, and 59% (89/151) of nsima episodes. Children fed themselves 92% (22/24) of snacks and 63% (20/32) of other meals. A spoon was used to feed children during 91% (68/75) of porridge, 88% (53/60) of FS alone, and 83% (91/109) of FS mixed episodes. Children's and caregivers' hands were used during 88% (21/24) of snacks and 64% (96/151) of nsima meals, respectively. For those types of food that were fed to children throughout the study (i.e. porridge, nsima, other meals and snacks), there was little change in the proportions of feeders and utensils before and during FS use.

During the 12-week follow-up, the mean (SD) gain in weight was 1.0 (0.5) kg and in length was 3.8 (1.3) cm. Mean (SD) gains in anthropometric indices were 0.3 (0.6), 0.0 (0.4), and 0.3 (0.5) z-score units for WAZ, height-for-age z-score and WHZ, respectively. At the end of the study, 81% of the participants still had WAZ < -2.0.

Discussion

This study was conducted to learn about patterns of home FS use for underweight young children and how its use modified other complementary feeding patterns. On average, children in this study had breast milk 11 times, nsima one time, porridge one or two times, and snacks three times per day. When FS was added to the diet, it was fed to the children about two times per day; each serving was 15–20 g (1 teaspoon = 7 g). FS was first used mainly alone as a between-meal snack, but was then integrated into the usual feeding pattern by being mixed with porridge. The use of FS did not affect the number of times the child was fed per day, the number or duration of breastfeeds, or the amount of caregiver time spent feeding.

Among the Yao people and in other cultures in the region, porridge is a food that caregivers cook specifically for young children until they are old enough to participate in family meals (Cosminsky *et al*. 1993; Mabilia 1996; Hotz & Gibson 2001). The importance of porridge as a 'baby food' may explain why caregivers rarely used FS to replace meals, and why the number of meals and breastfeeds a child had per day did not decrease when FS was introduced. Because caregivers did not see FS as a replacement for porridge, mixing FS with porridge during regular meals, rather than serving FS alone as a snack, minimized the time they spent feeding the child FS. This strategy meant that the use of supplementary FS did not add to the mean time per day caregivers spent feeding the children.

Observations and discussions with caregivers indicated that the difference in the amount of FS wasted when mixed with porridge vs. plain was related to caregivers' divergent approaches to FS used in these two ways. Caregivers typically offered plain porridge or porridge mixed with FS until the child rejected it or appeared full, and some porridge often remained in the bowl at the end of a feeding session. In contrast, when FS was fed alone, caregivers usually fed it to the children until the supplement they offered was finished. They rarely returned leftover plain FS to the jar or fed it to another family member.

A number of other studies have investigated child feeding with a similar observational methodology to that used here; however, all of these focused only on complementary feeding (Bentley *et al*. 1991; Brown *et al*. 1992; Guldan *et al*. 1993; Izurieta & Larson-Brown 1995; Engle & Zeitlin 1996; Gittelsohn *et al*. 1997). Supplementary feeding studies either collect no data on breastfeeding and food intake, or obtain such information through 24-h recalls. Single or widely spaced recalls are not likely to be as reliable as multiple observations in providing information on what was actually eaten during the entire supplementation period. In addition, such studies have seldom looked at wastage of supplement, or have measured it only when the supplement is supplied at a central location or by a field assistant. We could not identify any published data on time spent feeding supplement.

Our study results agree with findings from Colombia (Mora *et al*. 1981) that breastfeeding frequency remains the same during supplementation, but contrast with data from India (Bhandari *et al*. 2001) showing a decrease. Both of these studies, as well as a study in Jamaica (Walker *et al*. 1991), found that energy intake from regular foods was less during supplementation, whereas data collected from 3- to 4-year-old Malawian children supplemented with FS showed that energy intake from regular foods was unchanged on average (Maleta *et al*. 2004). Our study did not attempt to calculate energy intake, but showed that the number of regular food episodes remained the same before and during supplementation.

The differences between existing studies and ours regarding breastfeeding frequency and regular food consumption during supplementation are probably due to the way in which people from different cultures adopt a supplementary food into child feeding patterns and the type of supplementary food that was provided. If the supplement is similar to foods children are typically fed (e.g. cereal-based food), it is more likely that it will be used in place of regular meals, whereas a supplement like FS may be added to cereals to make an 'improved' food or may be given as a snack. This theory is supported by data from our research group and from a study in Gambia that compared supplementation with FS to maize-soy porridge and high-fat to high-carbohydrate supplements, respectively (Krahenbuhl *et al*. 1998; Maleta *et al*. 2004).

Because FS easily becomes part of the feeding routine, does not replace other foods and does not take extra caregiver time, we believe it could be integrated into community-based nutrition interventions in rural Malawi. The amount of FS wasted when it is mixed with porridge might, however, reduce the population impact of any intervention. To limit wastage, caregivers should be advised to offer FS plain or to mix it with a small quantity of porridge that the child can finish. Other issues, such as the means of identifying appropriate children to receive FS, mode of delivery of FS, and cost of the supplement, should be investigated before undertaking large-scale interventions using this product.

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LETTER-TO-THE-EDITOR

Intake of Lipid-based Nutrient Supplements during Illness and Convalescence among Moderately-underweight Malawian Children

Sir,

The effect of infections and other illnesses on the nutritional status of a child depends on the type and severity of the illness, initial nutritional status of the individual, and food intake during illness and convalescence (1). In practice, illnesses in children are often associated with reduced appetite and decreased food intake (2,3). Although short-term nutritional losses can be overcome (4), illnesses predispose children in resource-poor settings to weight loss and development of malnutrition (2).

Lipid-based nutrient supplements (LNS) are ready-to-use foods that have been used for treating children with severe acute malnutrition and for preventing malnutrition and linear growth failure (5,6). Because of their high energy and nutrient content, LNS could be used for supplementation during and soon after illness to mitigate the impact of illness-associated anorexia on the nutritional status of children. To date, little is known about the acceptability of LNS during and after common childhood illnesses. This longitudinal study provides preliminary comparative information on LNS intake by children on ill, convalescent and healthy days.

The study was conducted around Lungwena and Malindi, a rural area in southern Malawi.

Subjects were 16 moderately-underweight (weight-for-age *z*-score <-2) children aged 6-17 months participating in a study on the incorporation of LNS into home diets. Details of the selection criteria are published elsewhere (7).

During the 12 weeks of supplementation, research assistants delivered three 250-g plastic jars of LNS to homes of the participants fortnightly. They visited the study families five evenings per week to weigh LNS jars and used a semi-structured questionnaire to obtain information on child morbidity. Caregivers were advised to feed the child seven teaspoons (≈50 g) of LNS per day. The LNS, produced in Blantyre, Malawi, was made of peanut butter, milk powder, sugar, oil, and vitamin/mineral mix.

The analysis initially compared LNS intake on days when children were reported to be ill versus not ill. The categories 'ill' and 'not ill' were then further subdivided. Mutually-exclusive groups were developed to categorize illnesses: fever was given the first priority in forming the groups, followed by diarrhoea, as these have the largest effect on food intake of children (2,3). Fever was defined as fever only or in combination with any other symptom; diarrhoea was defined as diarrhoea only or in combination with any symptom other than fever; cough was defined as cough only or cough together with 'other' illnesses; and 'other' illnesses contained only symptoms in the 'other' category, including sores, pus from ears, vomiting, and prolonged crying.

Days when children were reported 'not ill' were coded into three categories: early convalescence (day 1-7 following illness), late convalescence (day 8-14 following illness), and healthy (other days). Convalescent days were coded starting from the first day the child was not reported to be ill and continuing until the next reported illness (if any). The first days of data collection were omitted for children who were reported to be 'not ill' either until they were reported to be ill or until the eighth day, at which point they were counted as healthy. When no information was available, the health status of the child was assumed to be identical to the first day when data were available again.

Linear regression analysis was used for calculating the mean LNS intake and to test for the difference in LNS intake on 'ill' versus 'not ill' days. Means and confidence intervals for LNS intake were adjusted for within-subject correlation by the Huber-White robust standard error.

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At enrollment, the mean (standard deviation [SD]) age of the participants was 13 (3) months, the mean (SD) weight-for-age *z*-score was -2.6 (0.3), the height-for-age *z*-score was -1.8 (0.7), and the weight-for-height *z*-score was -1.2 (0.9). The children lived in households with a mean (SD) of 5 (2) members, and their median birth-order was 3.

Data were collected from all the 16 participants during the first eight weeks that LNS was provided. One child moved away after the eighth week, and the remaining children provided information during the final four weeks of follow-up. In total, 845 days of data were collected (63% of the days when LNS was available). Thirteen (1.5%) of these days were excluded from the analysis because the daily measurements were suggestive of food-sharing (LNS use >150 g/day).

Illness was reported on 142 (17%) days. Of these days, 57 (40%) were classified as fever, 30 (21%) as diarrhoea, 44 (31%) as cough, and 11 (8%) as other illness days. Fifteen children were ill on at least one day; the child who moved away during the study had no reported illness.

The mean LNS intake was 43.4 g (≈230 kcal) on 'ill' and 50.6 g (≈268 kcal) on 'not ill' days (difference=7.2 g, 95% CI 0.6-13.8 g, p<0.034). The mean consumption of LNS for different types of illness is shown in the table. Compared to days when children were not reported ill, the mean daily LNS intake was 14% (≈38 kcal) lower on ill days, ranging from <1% (≈2 kcal) on 'other' illness days to 25% (≈65 kcal) on fever days. On an individual level, 12 of 15 participants had a higher mean LNS intake on days when they were not reported to be ill than on those when they were.

Of the 690 days when children were reported to be 'not ill', 32 days were omitted from the analysis of convalescent and healthy days because the timing of the last illness before the study began was unknown. During a two-week period of convalescence from illness, consumption of LNS was similar to the mean for healthy days (Table).

Findings of this preliminary study suggest that young children readily eat LNS during illness and convalescence. The accuracy of measuring child illness and the use of supplementary food are two possible limitations of the study, but these are unlikely to affect the internal validity of or the general picture obtained from these data. Maternal reports of child illness in low-income countries have been validated, even for two-week periods (8). This study minimized caregiver's recall bias by asking about a 24-hour period. Some food-sharing may have occurred within households. However, the pattern of lower LNS intake during illness, with a larger reduction in intake during fever, is similar to the pattern of food intake found in other studies of sick children (2,3) and suggests that most of supplement was consumed by the intended beneficiaries.

The World Health Organization recommends that caregivers continue to feed children during illness and increase intake thereafter (9). Identifying foods or supplements, such as LNS, that underweight children accept when they are ill or recovering and that are easy to use, may help caregivers follow feeding recommendations and prevent a worsening of the nutritional status of children (1,2). The results of this small pilot study suggest that LNS is well-accepted by ill and convalescing children and, as such, might offer the possibility for short-term feeding interven-

Table. Quantity of LNS consumed daily by health status

Health status	Mean (g)	95% CI	1st quartile	3rd quartile
Days when reported ill				
Fever (n=10)	38.2	26.8, 49.6	20.0	52.5
Diarrhoea (n=9)	45.6	33.6, 57.6	29.8	64.0
Cough (n=11)	47.0	37.8, 56.2	27.5	58.8
Other (n=6)	50.5	35.1, 65.8	36.0	76.0
Days when reported not ill				
Early convalescence (n=15) (1-7 day(s) after illness)	50.4	46.8, 54.1	29.0	65.0
Late convalescence (n=150 (8-14 days after illness)	52.3	49.1, 55.5	34.0	69.3
Healthy (n=16) (>14 days after illness)	49.6	47.1, 52.0	31.0	64.5

CI=Confidence Interval; LNS=Lipid-based nutrient supplement tions. This hypothesis could be tested in a randomized trial where young children are allocated to receive supplementary LNS regularly over a defined age-range or as 2-3-week auxiliary treatment during and after acute illnesses.

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Research report

Malawian mothers' attitudes towards the use of two supplementary foods for moderately malnourished children

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ABSTRACT

The efficacy of lipid-based nutrient supplements (LNS) versus corn–soy blend (CSB) in promoting the growth of moderately malnourished children is currently being tested, but information about maternal attitudes towards the two supplements is lacking. This research studied 504 Malawian mothers' attitudes about LNS and CSB through exit interviews completed at the end of three 12-week clinical trials and compared differences between the groups. Exploratory analyses of factors associated with withholding of supplements during fever, diarrhea, and cough were performed using logistic regression. Mothers generally had similar, positive attitudes towards LNS and CSB. Both supplements were said to be highly acceptable, children learned to eat them within two weeks, and mothers were willing to use them again. Mothers in the LNS group were reportedly more likely to withhold supplements from their children during cough, due to its sweetness, and were willing to pay more for a one-week supply of supplement than mothers in the CSB group. Maternal literacy was negatively and child's weight-for-height *z*-score was positively associated with withholding of supplements during illness. Our results indicate that the sweetness in LNS should be reduced, and programs using supplements in Malawi could include advice on appropriate feeding of supplements during illness.

Introduction

Moderate malnutrition affects a large number of children younger than five years in low-income countries (United Nations Children's Fund, 2008), and contributes to child mortality and disease burden (Black et al., 2008). It is also associated with increased morbidity (Mata, Kromal, Urrutia, & Garcia, 1977; Scrimshaw & SanGiovanni, 1997), and if left untreated may progress to severe acute malnutrition. Supplementary feeding programs to treat moderately malnourished children have existed for decades, and have typically used micronutrient-fortified corn–soy blend (CSB) (Dijkhuizen, 2000; Hoppe et al., 2008). Similar types of fortified cereal or cereal/legume mixtures tested in Africa and Asia have had inconsistent effects on child growth (Bhandari et al., 2001; Dewey & Adu-Afarwuah, 2008; Lartey, Manu, Brown, Peerson, & Dewey, 1999; Oelofse et al., 2003; Owino et al., 2007).

Lipid-based nutrient supplements (LNS) are ready-to-use foods that are attractive food supplements for malnourished children because they can supply adequate nutrients in a hygienic form that requires no cooking (Briend, 2002). LNS are effective for treating severe acute malnutrition in children at home (Manary, Ndekha, Ashorn, Maleta, & Briend, 2004; World Health Organization/World Food Programme/United Nations System Standing Committee on Nutrition/The United Nations Children's Fund, 2007), and some evidence that LNS improves the growth of moderately malnourished children is now available (Adu-Afarwuah et al., 2007; Matilsky, Maleta, Castleman, & Manary, 2009; Phuka et al., 2008). There is strong interest in the international community in the possibility of using LNS for the prevention and treatment of moderate malnutrition in children (The PLoS Medicine Editors, 2008). Large trials comparing different versions of LNS to CSB or other supplements in this target group are underway, but information about similarities or differences in maternal attitudes towards the two foods is lacking.

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Because mothers often have the main responsibility for feeding young children, data on maternal attitudes towards a new food for children are essential for designing interventions to incorporate it into a particular social and cultural setting (Bentley et al., 1991; Kanashiro et al., 1991). No published data on maternal attitudes towards CSB are available. Maternal attitudes towards LNS have been reported in only one study, which found that mothers had similar and generally positive attitudes towards LNS and two non-food micronutrient supplements (Adu-Afarwuah et al., 2008). Additional information on maternal attitudes towards LNS is needed from different locations and as compared to another food-based supplement, like CSB. An understanding of the reasons or factors underlying maternal attitudes towards supplements may also be helpful to programs.

The main aim of this study was to determine if maternal attitudes towards a new supplementary food (LNS) were similar to those of a well-known and widely available supplement (CSB). As a secondary focus, this research identified predictors of particular maternal attitudes, especially use of supplements during illness.

Methods

Study area and timing

The data used in this paper were taken from three community-based clinical trials conducted in the rural areas around seven health centers in Mangochi district, southern Malawi. The total population of the catchment areas covered by the health centers was approximately 215,000. The people living in the area are subsistence farmers and fisherman, mainly from the Yao ethnic group. The studies took place during the following periods: Study 1 (March–July 2005); Study 2 (January–May 2007); and Study 3 (November 2007–April 2008). The primary results of Study 1 have been published (Phuka et al., 2009) and those of Studies 2 and 3 are currently being analyzed.

Eligibility, enrollment, and randomization of participants

The eligibility criteria for the three studies were the same. Inclusion criteria were as follows: 6–14 months of age; weight-for-age *z*-score (WAZ) <-2.0; guardian-signed informed consent; and residence in the area throughout the study period. Because the age of greatest growth faltering in the target population is 6–18 months of age, participants were selected so that they completed the study before they reached the upper limit of this age range. Children were excluded if they had weight-for-height *z*-score (WHZ) <-3.0, presence of edema, severe illness warranting hospital referral on the day of enrollment, peanut allergy, or if they were already participating in another clinical trial. Details of the processes for enrolling and randomizing participants in Study 1 have been reported elsewhere (Phuka et al., 2009), and similar processes were used in Studies 2 and 3.

Interventions and follow-up

In all three studies, the follow-up period was 12 weeks and participants received one of the two food supplements – CSB or LNS – or they received no supplements (controls). Because the present paper is focused on maternal attitudes towards supplement use, controls were not included.

CSB was packed in 500 g bags (supplied by Rab Processors, Blantyre, Malawi) and contained corn and soy flours, sugar, and micronutrients. LNS was packed in 50 g foil packets (produced by Nutriset, Malaunay, France) in Study 1 and in 300 g plastic jars (produced by Project Peanut Butter, Blantyre, Malawi) in Studies 2 and 3. LNS contained peanut butter, milk powder, cooking oil, sugar, and micronutrients. The nutrient composition of the CSB and LNS used in these studies can be found in Phuka et al. (2009).

In Study 1, participants received either 71 g/day (282 kcal) of CSB or 50 g/day (256 kcal) of LNS. In Studies 2 and 3, there were three intervention groups: no supplement (controls), 71 g/day CSB, and 43 g/day (220 kcal) LNS. The quantities of supplements participants received were selected so that the caloric value of the two supplements was roughly comparable and the logistics of supplying supplements was simple (e.g., 1 bag of CSB or 1 jar of LNS per week). Supplements were delivered to participants' homes weekly in Studies 1 and 2, whereas participants in Study 3 obtained their supplements from the health center monthly. During weekly home visits in Study 1, mothers in both study groups reported that supplements were shared <1% of the time and 4.9% of CSB and 6.5% of LNS had not been consumed (Phuka et al., 2009).

CSB must be cooked as porridge, but mothers could choose whether to feed the child LNS plain or mixed with porridge. Mothers were provided with spoons. In Study 1, they were advised to give their child either porridge containing 12 spoons of CSB or 1 packet of LNS per day. In Studies 2 and 3, they were told to give their child porridge containing 4–5 spoons of CSB or 2–3 spoons of LNS 2–3 times per day. All mothers were encouraged to continue breastfeeding on demand.

Sample size

Sample sizes for the individual studies were calculated based on comparison of weight gain between intervention groups. Pooling exit interviews from three trials ($n = 250$ per supplementation group), the present study has a precision level (width of 95% confidence interval) of $\pm 6\%$ for estimation of proportions in each supplementation group for binary variables, such as those used in the main analysis, that have maximum variability. Precision is higher for less evenly distributed binary variables.

Data collection and processing

The exit interview used in these three studies was originally developed for a pilot study in which caregivers of 16 children who had received LNS for 12 weeks were asked open-ended questions during tape-recorded interviews. These questions were then modified into a semi-structured questionnaire that was administered by research assistants to caregivers at their homes at the end of Study 1. Following the completion of Study 1, a few questions were slightly modified and some questions were dropped to produce the questionnaire that was used in Studies 2 and 3. In this paper, only those questions that were the same or similar in all studies were analyzed.

The exit interview questionnaire contained both open- and closed-ended questions. Closed-ended questions were asked about whether supplements were food or medicine; whether supplements should be given during fever, diarrhea, or cough; how easy or difficult it was for the child to eat the supplement; willingness to use supplements again; and willingness to buy supplements. Responses to these questions were dichotomized either by dropping the 'don't know' category or by dividing a 5-point scale so that the two highest categories (e.g., very and somewhat willing) were placed in one group and the other three categories (e.g., neutral, somewhat and very unwilling) were combined in a second group. Open-ended questions were used to assess: positive aspects of supplements; aspects of supplements mothers disliked; changes noticed in the child; how long it took the child to adapt to eating the supplement; the most convenient place to obtain supplements; possible frequency of travel to health center to obtain supplements; reasons why supplements are food or medicine; and reasons why mothers would or would not give supplements during illness. One author (VF), who was blinded to the type of supplement assigned to participants, coded responses to open-ended questions using content analysis to identify themes. Each theme for a given attitude was reviewed to determine whether the content or intensity differed between the CSB and LNS groups, and proportions of all themes for each open-ended question were calculated by study group. Due to the similar content and proportions of themes in both groups, for the main analysis, responses were then dichotomized so that the largest response category or a cluster of related responses represented the mothers' main attitude regarding a particular issue and other responses were combined to form a second category. For example, on the question about changes noticed in the child, responses describing positive changes formed the main category and neutral or negative responses were combined into a second category.

A description of the methods used to obtain anthropometric data for Study 1 is provided in Phuka et al. (2009); similar methods were used in the other two studies. Briefly, weight, height, and mid-upper arm circumference were measured by a researcher (JP) blinded to the participants' study allocation. Anthropometric indices (weight-for-age z-score, height-for-age z-score, and weight-for-height z-score) were calculated using the CDC 2000 growth reference. In all studies, background information on the participants' families, including family assets and maternal literacy, was obtained through questionnaires administered by research assistants during the first visit to the health center.

Data analysis

The data were entered to a Microsoft Access database and analyzed using Stata (version 9.2). For the primary analysis, responses to all questions were placed in two categories and proportions for each food group were obtained. The difference between the proportions and its 95% confidence limit and p-value were then calculated. p-values were obtained with Fisher's exact test. After excluding 'don't know' replies, numerical responses (from about 91% of participants) to an open-ended question about how much mothers are willing to pay for a one-week supply of supplement were used to calculate the mean price per study group and the difference was tested using t-test.

Secondary, exploratory analyses were conducted to gain an understanding of possible factors underlying specific maternal attitudes. Multiple logistic regression models were constructed to detect associations between health and socioeconomic factors selected *a priori* and mothers' perception of the supplement as food not medicine as well as maternal reports of withholding the supplement during fever, diarrhea, and cough. The type of supplement was included in the models to control for differences between study groups. An asset index was created based on a set of assets by using principal components analysis to assess long-term economic welfare in households of participating children (Filmer & Pritchet, 2001). The asset index, child's age at the start of the study, and child's weight-for-height z-score (WHZ) at the start of the study were included in the models as continuous explanatory variables. WHZ was chosen because it indicates the level of the child's thinness or wasting, which mothers can easily identify. Maternal literacy represented whether or not mothers could write their names and was entered in the models as a binary variable. In a sub-sample with known maternal age ($n = 234$), maternal age had no association with belief that the supplement was food ($p = 0.159$) or with withholding the supplement during fever ($p = 0.820$), diarrhea ($p = 0.405$), or cough ($p = 0.809$), and was excluded in the models so that the full sample could be used. The correlations between the regression coefficients for each of the final models were examined and none of the predictors were found to be strongly correlated with one another.

Ethics

Ethical approval for these studies was obtained from the College of Medicine Research and Ethics Committee at the University of Malawi and from the Ethical Committee of the Pirkanmaa Hospital District in Finland. Details of the protocols were provided to the clinical trials registry of the National Library of Medicine, Bethesda, MD, USA (http://www.clinicaltrials.gov, trial identification numbers NCT00131222, NCT00420368, NCT00420758).

Results

Background characteristics

In total, 1278 children were invited to the enrollment session, 667 individuals met the inclusion criteria, and 522 of these were randomized to the CSB and LNS groups (Fig. 1). Of the 506 participants who completed the follow-up, exit interviews were obtained from 504 (CSB 255, LNS 249). There were no significant differences in the socioeconomic and demographic characteristics of the two study groups (Table 1).

Maternal attitudes towards supplements

To check for errors in recording open-ended responses given in the local language onto data collection forms in English, we compared the open-ended responses in this large sample to those from tape-recorded exit interviews in our pilot study. We found no differences in the main themes and types of responses.

Overall, most maternal attitudes about CSB and LNS were quite similar (Table 2), as were the tone and content of their replies to open-ended questions. Consequently, quotes from open-ended questions are used here only to illustrate differences between the groups or clarify possible programmatic issues. Key themes from open-ended questions and the proportion of participants who provided these responses in each study group are reported in the text below.

The majority of mothers in both groups described positive aspects of the supplement, said there was nothing they disliked about the supplement, and noticed positive changes in the child at the end of the study (Table 2). When mothers in both groups were asked about the positive aspects of supplements, they most frequently mentioned that the child liked the sweetness of the food (CSB 32%, LNS 34%), that the supplement improved the child's health or growth (CSB 17%, LNS 19%), or that the child liked eating the supplement (CSB 16%, LNS 15%). A small proportion of mothers in each group (12%) named something they disliked about the supplements. They most frequently said there were problems with the contents or preparation of supplements. The types of problems

Table 1
Selected demographic and socioeconomic characteristics of participants who completed the exit interviews, by group.

Characteristics	Study group	
	CSB	LNS
Number (%) of participants	255 (51%)	249 (49%)
Number (%) of males	134 (53%)	120 (48%)
Mean (SD) age at start of study (months)	11.3 (2.7)	11.0 (2.6)
Mean (SD) number of family members	4.8 (1.8)	4.6 (1.8)
Number (%) of mothers who are literate	72 (28%)	87 (35%)
Housing materials		
Burned brick	43 (17%)	42 (17%)
Unburned brick	177 (69%)	173 (69%)
Other (less expensive than bricks)	35 (14%)	34 (14%)
Mean (SD) weight-for-height z-score at start of study	−1.1 (0.9)	−1.2 (0.9)

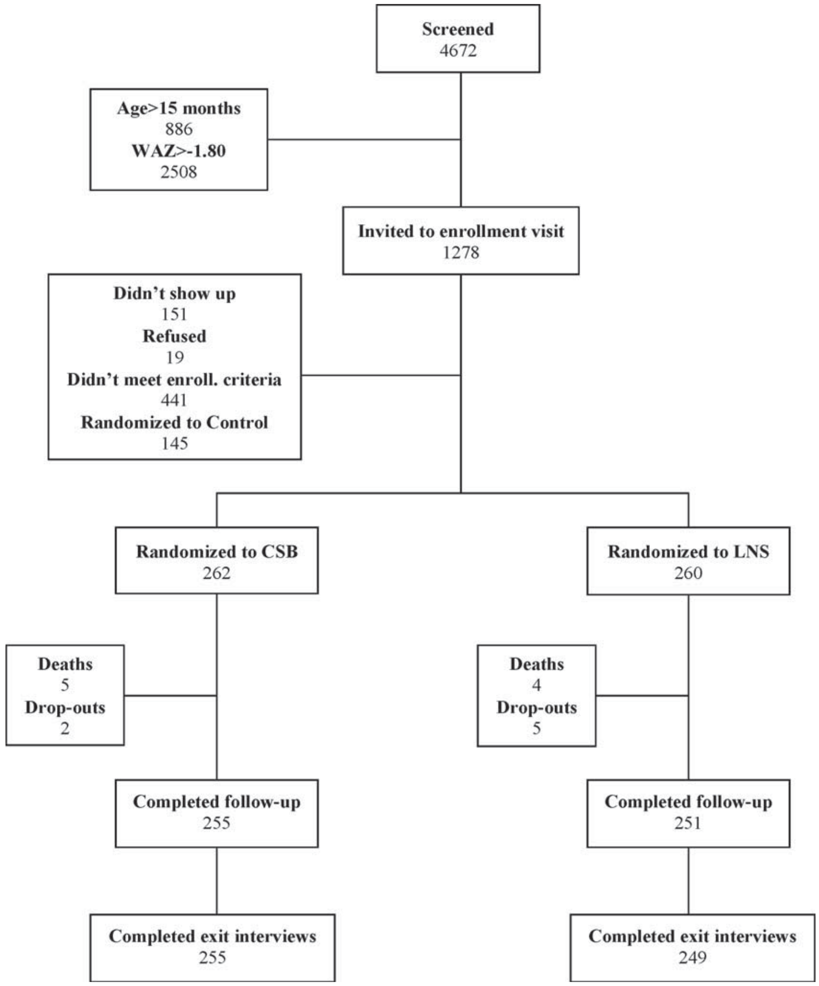

Fig. 1. Profile of the three studies. CSB, corn–soy blend; LNS, lipid-based nutrient supplements.

described differed between the groups. Mothers in the CSB group who disliked something about the supplement raised issues such as CSB does not have enough sugar or it is difficult to cook, whereas mothers in the LNS group most often said that LNS contained too much sugar or they disliked the taste of the cooking oil in it. Changes mothers noticed in their child at the end of the intervention included: the child looked healthier (CSB 51%, LNS 59%), had gained weight (CSB 29%, LNS 22%), or got sick less often (CSB 10%, LNS 8%).

Table 2
Maternal attitudes towards supplements, by study group[a].

Maternal attitudes	CSB	LNS	Difference between groups (95% CI)	*p*-value
Percentage of mothers who reported[b]				
Supplement had positive aspects	97%	97%	0% (−3%, 3%)	0.800
Supplement did not have negative aspects	87%	88%	1% (−5%, 6%)	0.783
There were positive changes in child after feeding supplement for 12 weeks	92%	93%	1% (−4%, 5%)	0.863
It was easy for child to eat supplement compared to usual foods (acceptability)	95%	93%	−2% (−6%, 3%)	0.469
Child learned to eat supplement within the first two weeks	86%	85%	−1% (−8%, 5%)	0.690
Supplement is food rather than medicine	70%	69%	−1% (−9%, 7%)	0.845
Supplement should NOT be given to child during				
Fever	23%	22%	−1% (−9%, 6%)	0.828
Diarrhea	19%	25%	6% (−1%, 14%)	0.101
Cough	25%	38%	13% (5%, 21%)	0.002
They are willing to use supplement again if provided for free	96%	94%	−2% (−6%, 2%)	0.310
They are willing to travel to health center for free supplement	99%	98%	−1% (−3%, 1%)	0.278
They are willing to buy supplement if for sale	96%	94%	−2% (−6%, 2%)	0.292
Health center is the most convenient place to buy supplement	56%	52%	−4% (−13%, 5%)	0.402
Price evaluation[c]				
Mean (SD) amount willing to pay (in Malawian kwacha) for one week of supplement	42 (35)	53 (48)	11 (3, 19)	0.011

[a] CSB, micronutrient-fortified corn–soy blend; LNS, lipid-based nutrient supplements.
[b] Responses to all questions were dichotomized and 'don't know' responses were excluded from the analysis. *p*-value for difference in proportions by Fisher's exact test.
[c] *p*-value for difference between means obtained by *t*-test, non-numeric responses were excluded from the analysis. The average exchange rate during the studies was 136 Malawian kwacha = 1 US$. 2007 GDP per capita = 36,800 Malawian kwacha (IMF World Economic Outlook Database, http://www.imf.org).

Most mothers in both food groups said that it was easy for the child to eat the supplement as compared to usual food. The majority also reported that the child learned to eat the supplement during the first two weeks of the study (Table 2), including those who found it easy to eat the supplement from the beginning of the study period (CSB 62%, LNS 59%) and children for whom it became easier during the first or second week of the study (CSB 24%, LNS 26%). Among those who had difficulty adapting to eating the supplement, different reasons emerged. Some children took longer to learn the new taste and a few never learned, others got used to eating the study food only when they recovered from initial illnesses, while still others were described as being poor eaters. The following quotes highlight these issues:

> "During the first three weeks, he refused to eat it and I was forcing him. After that, he ate it well until the end of the study." (CSB)

> "She started eating it well during the second month of the study, when she was not suffering from cough, fever, and diarrhea anymore." (CSB)

> "Since she was born, she was reluctant to eat any kind of food. It was the same with LNS." (LNS)

The majority of mothers in both groups said that the supplement is food, not medicine (Table 2). Among mothers who considered the supplement to be food, the main reasons were that it was edible and satisfied the child's hunger (CSB 47%, LNS 49%), it looked like food or contained ingredients that are food (CSB 33%, LNS 26%), or it improved the child's health (CSB 11%, LNS 9%). Like the latter group of mothers who said that the supplement is food, mothers who said that the supplement is medicine also believed it was so because it improved the child's health, either by helping the child's nutritional status or by curing or preventing illness (CSB 68%, LNS 79%). Most mothers did not name a specific illness that could be prevented or cured by the supplement, but a few mentioned that their child's diarrhea stopped after starting to eat the supplement. Mothers who said that the supplement is medicine appeared to recognize that it is food but think that it contains medicine or to believe that it has aspects of both food and medicine. Excerpts from mothers' responses illustrate these opinions:

> "In this food there are substances that I believe are medicine." (LNS)

> "[It is medicine] because there is a mixture of vitamins in the porridge." (CSB)

> "At first my child was sick, but now she is fine. That is why it is medicine. It is also food because it gives my child energy." (LNS)

When asked about feeding the supplement to the child during illness, a significantly greater proportion of mothers whose child received LNS than CSB stated that they would withhold the supplement when the child had a cough (Table 2). Although the difference was not significant, a larger proportion of mothers in the LNS than CSB group also said they would not give the supplement during diarrhea, while similar proportions of mothers in both groups reported withholding of supplements during fever. Among mothers who would withhold supplements during illness, the reasons were similar in the two study groups. Loss of appetite was named as a reason for withholding of supplements during fever (CSB 81%, LNS 80%), diarrhea (CSB 56%, LNS 51%), and cough (CSB 27%, LNS 28%). In both groups, mothers who said they would withhold the supplement during cough stated that the sugar in the supplement made the cough worse and/or caused vomiting (CSB 73%, LNS 72%). A mother whose child received LNS explained, "It is not good because this food has a lot of sugar, which can cause high cough that results in the child vomiting." Some mothers stated that they would not give the supplement during diarrhea because it makes diarrhea worse or causes vomiting (CSB 23%, LNS 24%). Mothers in the LNS group mentioned more serious effects of the supplement when used during diarrhea than those in the CSB group, and there was a larger proportion of mothers in the LNS group who said they would not give the supplement during diarrhea because they believed or suspected it caused the diarrhea (CSB 3%, LNS 16%). A mother whose child received LNS gave a typical explanation for this group, "It is not good because it makes the child have fast diarrhea that doesn't stop." In contrast, mothers whose children had CSB generally said that the child vomits if given CSB during diarrhea or that "the diarrhea might continue."

Nearly all mothers in both groups stated that if supplements were provided for free they would be willing to use supplements again and to travel to the health center to get them (Table 2). Approximately three-quarters of the mothers reported they could go to the health center to pick up supplements at least once per month (CSB 74%, LNS 72%). When asked who or what would facilitate their going to the health center for free supplements, most mothers mentioned transportation issues: either they could go to the health center by foot because it was nearby (CSB 40%, LNS 31%) or they would need a bicycle or money for transport because the distance was too far (CSB 20%, LNS 27%). About half of the mothers in both groups stated that the most convenient place to buy supplements was the health center (Table 2), other commonly mentioned locations were markets or groceries (CSB 16%, LNS 21%) or in the village (CSB 10%, LNS 11%).

Of the mothers who gave numerical replies (405/446 = 91%) when asked how much they were willing to pay for a one-week supply of the supplement, the mean price mothers in the LNS group were willing to pay was higher than that of the CSB group (Table 2). The prices suggested by mothers ranged from 5 to 200 kwacha in both study groups. The median prices were 40 and 50 kwacha in the CSB and LNS groups, respectively, and the interquartile range was the same in both groups (20, 50 kwacha). Proportions of different types of non-numeric responses to the price question were similar between the groups (willing to pay (CSB 8%, LNS 8%), cannot buy it (CSB 1%, LNS 2%)).

The majority of mothers in both groups (CSB 88%, LNS 85%) said that they controlled the use of the supplement in their family (not shown in table). When mothers discussed the supplement with someone else, they most frequently talked about it with their husbands (CSB 49%, LNS 56%) or their own mothers (CSB 25%, LNS 17%).

Factors associated with specific maternal attitudes

Exploratory analyses were carried out to determine if selected maternal, child, and socioeconomic factors were associated with the maternal belief that the supplement is food, not medicine and with mothers' reports that they would withhold the supplement if the child has fever, diarrhea, or cough. Several factors were entered at one time into separate logistic regressions models for each of these maternal attitudes. Child's age at the start of the study, child's WHZ score at the start of the study, maternal literacy, and socioeconomic status (using an asset index) were not associated with mother's belief that the supplement is food (Table 3). In models for mothers' reports that they would withhold the supplement during illness, use of LNS was positively associated with withholding during cough and less strongly associated with diarrhea (Table 3). Maternal literacy was negatively associated while the child's WHZ at the start of the study was positively associated with withholding during fever, diarrhea, and cough.

Table 3
Multivariable logistic regression analyses of factors associated with mothers' beliefs about supplements and their practices related to supplement use during child illness.

Predictor variables	Odds ratio (95% CI)			
	Mothers believe supplement is food not medicine	Mothers report they would withhold supplement if child has fever	Mothers report they would withhold supplement if child has diarrhea	Mothers report they would withhold supplement if child has cough
Participation in LNS group	0.94 (0.64, 1.38)	1.01 (0.66, 1.57)	1.53 (0.97, 2.38)*	2.03 (1.36, 3.05)‡
Child's age at start of study	1.01 (0.93, 1.08)	1.00 (0.92, 1.08)	0.94 (0.86, 1.02)	1.02 (0.95, 1.11)
Child's WHZ at start of study	0.89 (0.71, 1.11)	1.31 (1.02, 1.68)†	1.39 (1.08, 1.79)†	1.39 (1.10, 1.74)‡
Maternal literacy	1.18 (0.77, 1.80)	0.46 (0.28, 0.78)‡	0.55 (0.33, 0.92)†	0.54 (0.34, 0.85)‡
Asset index	1.07 (0.92, 1.24)	0.98 (0.83, 1.16)	1.07 (0.90, 1.27)	0.99 (0.85, 1.16)

WHZ, weight-for-height *z*-score; Asset index is a proxy for socioeconomic status and was calculated using principal components analysis.
* $p < 0.10$.
† $p < 0.05$.
‡ $p < 0.01$.

Discussion

The main aim of this research was to compare Malawian mothers' attitudes towards two types of food supplements for moderately malnourished children. We found that mothers' attitudes towards LNS and CSB were positive and quite similar. Most mothers in both study groups reported that supplements were highly acceptable, the child learned to eat the supplement within two weeks, and they would be willing to buy supplements and use them again. Mothers in the LNS group were reportedly more likely to withhold supplements from their children during cough and were willing to pay more for a one-week supply of the supplement than mothers in the CSB group. The variability in responses from both study groups regarding belief in supplements as food versus medicine and withholding during illness was greater than for other questions studied here. As such issues might be of programmatic importance, we explored possible predictors of these particular beliefs and practices. We were not able to identify any significant predictors of mothers' belief that supplements were food, but we found that use of LNS was associated with the attitude that the supplement should not be given during cough and less strongly associated with diarrhea. In addition, child's WHZ at the start of the study was positively associated while maternal literacy was negatively associated with withholding during fever, cough, and diarrhea.

The main strengths of this study were a large total sample size taken from randomized clinical trials with few drop-outs and the use of CSB, a common supplement, as the comparison group. Although we chose to present a summary of themes, illustrated with quotes, rather than a detailed qualitative analysis, collecting qualitative data on maternal attitudes towards supplements was beneficial because we obtained culturally appropriate information that helped explain responses to some of the closed-ended questions.

This study had some limitations. Because our data were collected at the end of intervention trials comparing the effects of supplements on child growth, mothers used only one supplement—either CSB or LNS. We cannot be certain that mothers' attitudes towards the supplements would be similar if they had had the opportunity to try them both before responding to the questions (see Paul, Dickin, Ali, Monterrosa, & Stoltzfus, 2008). Another possible limitation was the lack of data on other predictors that might be important in the regression models, such as maternal age and food security. Information on maternal age was available for a sub-sample within our data set, but was not significantly associated with the any of the outcomes and was excluded in the final models to allow the use of the full sample. Although seasonal differences in levels of food security are marked in Malawi (Maleta, Virtanen, Espo, Kulmala, & Ashorn, 2003), data on food security were not collected during these studies as each took place within a short time period when the general level of food security would have been similar for the participants. Given these possible limitations and the exploratory nature of the regression analyses, the models presented here should be interpreted cautiously, but could provide preliminary evidence to guide future research.

The positive quality and similarity in attitudes found in this study of LNS and CSB mirror results for LNS and two non-food micronutrient supplements in Ghana (Adu-Afarwuah et al., 2008). There were, however, a few important differences between the study groups, and some issues that may be of programmatic importance were identified. We found that the majority of mothers believed that LNS and CSB were food, not medicine. In fact, some mothers who said that the supplement was medicine explained that it had aspects of both food and medicine or that it was food that contained medicine, indicating that our closed-ended question (*Is the supplement food or medicine?*) did not capture the nuances of mothers' perceptions. Similar types of problems have been noted in other surveys in Malawi (Launiala, 2009), and this may explain, in part, why we were not able to identify any predictors of this belief in a regression model. The issue of whether supplements are seen as food or medicine is important because it may affect how they are used within households and could influence whether they are shared. Supplementary feeding studies have frequently dealt with food sharing either by controlling the distribution and consumption of supplements or by providing supplementary food to the whole family (Durnin, Aitchison, Beckett, Husaini, & Pollitt, 2000; Krahenbuhl, Schutz, & Jequier, 1998; Manary et al., 2004; Owino et al., 2007; Rivera & Habicht, 2002; Simondon et al., 1996), but these methods are not feasible on a population level. An alternative approach was taken in one study in Malawi where mothers were told at enrollment that LNS and CSB were medical treatments for their moderately wasted children (Matilsky et al., 2009). While focusing on the "medicinal" qualities of supplements might prevent sharing in a short trial, during longer periods of supplementation it could have the unintended consequence of making mothers think they can discontinue use when their child no longer has symptoms or looks better, as has occurred when other health-related products were marketed as medicine (Bentley, 1988). Further research on Malawian mothers' conceptions of the terms "food" and "medicine" is needed before selecting the most appropriate approach for promoting supplements, and other possible avenues for preventing supplement sharing should be explored.

We have focused part of this research on the use of supplements during illness because children in low-income countries are frequently ill and illness is associated with child nutritional status (Mata et al., 1977; Scrimshaw & SanGiovanni, 1997). The design of our questionnaire did not allow us to determine whether use of supplements during illness was a major concern for mothers. However, the continued consumption of supplements could well be important for maintaining children's nutrient intake during illness (Brown, 2001), and, consequently, for programs promoting supplements. In this study, mothers whose children received LNS were about 1.5 and 2 times more likely than those who received CSB to say that they would withhold the supplement during diarrhea and cough. The differences between the study groups in relation to diarrhea are probably explained by mothers' opinions about the stronger effect of LNS on diarrhea symptoms. The greater likelihood of withholding LNS than CSB during cough was related to its sweeter taste and to the belief that sweet food makes a cough worse, suggesting that this version of LNS may be too sweet. This conclusion should be considered in light of the finding that sweetness was the most frequently mentioned positive aspect of both supplements. Having some sugar in supplements is supported by research showing that children have a preference for sweet food from early in life (Kare & Beauchamp, 1985) and that mothers liked the sweetness of a processed complementary food for their children (Paul et al., 2008). Our results regarding sweetness of supplements highlight the importance of listening to mothers' opinions related to new foods for their children and balancing positive and negative aspects to get a product that is acceptable and likely to be used appropriately (Bentley et al., 1991; Kanashiro et al., 1991).

We identified several factors that are associated with mothers' reports of withholding of supplements during illness, particularly maternal literacy and child's WHZ at the start of the study. Maternal education is known to be associated with child feeding and caring practices (Engle, Menon, & Haddad, 1997), such as more frequent initiation of child feeding (Guldan et al., 1993) and a more nurturing style of feeding (LeVine et al., 1991), which supports our finding that literate mothers are less likely to withhold supplements during illness. Our detection of an association between child's nutritional status and maternal feeding practices is consistent with reports of preferential feeding of thin or poorly growing children (Piwoz, Black, Lopez de Romana, de Kanashiro, & Brown, 1994; Simondon & Simondon, 1995). Mothers' feeding behaviors, in general and during illness, might also be influenced by the undesirability in Malawian cultures of having a child who is too thin because it indicates that parents are not following culturally prescribed rules of abstinence (Bezner Kerr, Dakishoni, Shumba, Msachi, & Chirwa, 2008; Munthali, 2002).

In conclusion, this study found that mothers' attitudes towards a new type of supplementary food, LNS, are comparable to those towards a widely used supplement, CSB, suggesting that mothers of target children in this setting would likely be able to adopt LNS and adapt to using it, if it replaced CSB in supplementary feeding programs. Our results indicate that the sweetness in LNS should be reduced to make it more acceptable for use during cough, and future research and programs using supplements in Malawi could include advice on appropriate feeding of supplements during illness. Additional information on how the labeling of supplements as food or medicine affects their long-term use is needed.

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Research report

Feeding patterns and behaviors during home supplementation of underweight Malawian children with lipid-based nutrient supplements or corn-soy blend

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ABSTRACT

The way caregivers use supplementary food for undernourished children and integrate it into feeding patterns may influence the benefits achieved by supplementation. We studied feeding patterns and behaviors in 170 underweight 6–17-month-olds who received either lipid-based nutrient supplements (LNS) ($n = 85$) or corn-soy blend (CSB) ($n = 85$) during a 12-week intervention trial in southern Malawi. Observational data were collected during one 11 h home visit per participant. Differences were assessed by study group and by mode of serving LNS. Associations between selected caregiver behaviors and child growth were also tested. We found no difference between the CSB and LNS groups in mean number of feeding episodes per day or mean daily feeding time. Caregivers fed the child with a spoon, washed their hands before feeding, and there were leftovers significantly more often in the CSB than LNS group and when LNS mixed with porridge and plain LNS were compared. This suggests that differences between the groups were linked to the mode of serving LNS. Presence of leftovers was negatively associated with change in child's WAZ. Programs promoting LNS in Malawi should consider behaviors related to mode of serving and provide advice to caregivers in order to minimize leftovers during supplement use.

1. Introduction

Supplementary feeding programs for undernourished young children in low-income countries have typically used micronutrient-fortified cereal-legume mixtures, such as corn-soy blend (CSB) (Hoppe et al., 2008). There is little or no evidence that CSB promotes child growth, and results with other types of cereal or cereal-legume blends have been inconsistent (Bhandari et al., 2001; Lartey, Manu, Brown, Peerson, & Dewey, 1999; Dewey & Adu-Afarwuah, 2008; Oelofse et al., 2003; Owino et al., 2007). A new class of supplements for children, lipid-based nutrient supplements (LNS), which contain dry food particles embedded in edible fats, has been available for several years (Briend, 2002). LNS are ready-to-use and have generally proven to be beneficial for the home treatment of severely and moderately wasted children (Ciliberto et al., 2005; Diop el, Dossou, Ndour, Briend, & Wade, 2003; Manary, Ndekha, Ashorn, Maleta, & Briend, 2004; Matilsky et al., 2009; Patel et al., 2005; Sandige, Ndekha, Briend, Ashorn, & Manary, 2004). There is some evidence that LNS may be useful for the prevention of childhood undernutrition (Adu-Afarwuah et al., 2007; Phuka et al., 2008). Large trials studying the effects of LNS compared to CSB or other supplements on child growth are ongoing, but little is known about how the two supplements affect child feeding patterns or caregiver feeding behaviors. This type of information is important because caring behaviors during feeding can have an impact on the benefits that might be achieved by supplementation.

Although several studies have described caring practices during complementary feeding (Bentley, Stallings, Fukumoto, & Elder, 1991b; Dearden et al., 2009; Engle & Zeitlin, 1996; Gittelsohn et al., 1998; Guldan et al., 1993; Moore, Akhter, & Aboud, 2006), published research on behaviors related to use of supplements is sparse. We previously conducted a study in Malawi to learn about typical feeding patterns of 6–17-month-old children, the integration of LNS into the pattern, and changes in supplement use during a 12-week period (Flax et al., 2008). The study provided descriptive information about home use of LNS, but its small sample and lack of control group limited generalizations that could

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be made from the data. The present study took place within the context of a supplementary food trial comparing the effects of LNS and CSB on the growth of moderately to severely underweight children. It used the same observational methods as the earlier study, but had a larger sample and included corn-soy blend for comparison.

The main aim of this study was to compare child food consumption patterns and caregiver and child feeding behaviors in the two study groups. We also examined behaviors related to the use of plain LNS versus LNS mixed with porridge. The aspects of feeding that we observed were based on the behavioral dimensions of complementary feeding outlined in Pelto, Levitt, and Thairu (2003), including *how*, *when*, and *where* food is fed and *who* is feeding the child, and on specific issues, such as leakage, that might influence the impact of supplementary feeding on growth. Our secondary purpose was to test whether selected behaviors, such as feeding frequency, hand washing before feeding episodes, and presence of leftover supplements, were associated with the growth of study participants.

2. Methods

2.1. Study area and timing

The present study was part of a trial testing the effects of supplementation with either LNS or CSB on the growth of underweight children. The trial took place from April to July 2005 in Mangochi district, southern Malawi, an area populated mainly by subsistence farmers and fishermen from the Yao ethnic group. The trial documented no statistically significant difference in the mean weight and length gain between the two intervention groups (Phuka et al., 2009).

2.2. Ethics

Ethical approval for the study was obtained from the College of Medicine Research and Ethics Committee at the University of Malawi and from the Ethical Committee of the Pirkanmaa Hospital District in Finland. The trial protocol was registered with the National Library of Medicine, Bethesda, MD, USA (http://www.clinicaltrials.gov, trial identification number NCT00131222).

2.3. Eligibility, enrollment and randomization of participants

Children could be included in the study if they were 6–14 months of age; had weight-for-age *z*-score (WAZ) <-2.0; had guardian-signed informed consent; and were resident in the area throughout the study period. They were excluded if they had weight-for-length *z*-score (WLZ) <-3.0, edema, severe illness warranting hospital referral on the day of enrollment, peanut allergy, or they were participating in another clinical trial. Details of the processes for enrolling and randomizing participants have been reported elsewhere (Phuka et al., 2009).

2.4. Interventions and follow-up

The follow-up period for the clinical trial was 12 weeks, during which participants received either 71 g/day (282 kcal) of CSB or 50 g/day (256 kcal) of LNS delivered to their homes weekly. CSB was packed in 500 g bags (supplied by Rab Processors, Blantyre, Malawi) and contained corn and soy flours and micronutrients. It was supplied as dry flour that had to be cooked as porridge. LNS were packed in 50 g foil packets (produced by Nutriset, Malaunay, France) and contained peanut butter, milk powder, cooking oil, sugar, and micronutrients. LNS were ready-to-use and could be given either plain or mixed with regular porridge. Caregivers were provided with spoons and advised to feed their child either porridge containing 12 spoons of CSB or 1 packet of LNS per day. Neither study group was given instructions about how many times per day to feed the child the supplement, nor, in the case of LNS, in what form it should be served (plain or mixed with porridge). Caregivers were encouraged to continue breastfeeding on demand.

2.5. Sample size

The sample size was calculated based on expected values for the primary outcome (weight gain) of the clinical trial. A sample size of 84 children per group was required to achieve 80% power and 95% confidence, assuming a standard deviation of 0.39 kg per group during 12 weeks and a mean gain difference of 0.17 kg between groups (CSB and LNS). The target enrollment was 88 children per group to allow for 5% attrition. This gives a power of about 80% for detecting a difference of 0.4 SD in quantitative variables, which is considered a small-to-moderate effect size by Cohen (1988).

2.6. Data collection and measurement of outcome variables

Six trained research assistants collected the data. They were required to achieve at least 80% agreement with the trainer (VF) on five consecutive practice observations before the study began. Agreement between observers was >85% for length of feeding episode and caregiver hand washing and >95% for all other variables studied.

Research assistants made a 1-day visit (6:30 a.m. to 5:30 p.m.) to each participant's home between the 5th and 11th study week. They recorded the date and exact start and end times of the observation visit. This was used together with the enrollment date and dates of supplement delivery to determine the following for each participant: timing of the observation visit within the trial follow-up period, number of days after supplement delivery when the observation took place, and length of observation. The day when supplement was received was counted as zero and the days were numbered consecutively until the next supplement delivery.

At the beginning of each observation, the research assistant introduced herself then sat near the child and recorded on a log form the start and end times and the type of food given during all feeding episodes, including breastmilk. Feeding episodes were counted as separate if there were at least 15 min between the end of one episode and the beginning of another. Food recorded on logs was divided into six categories: plain porridge, nsima and relish, CSB, LNS plain, LNS mixed, and snacks. Plain porridge was made of corn or rice and contained approximately 10% dry matter. Nsima was stiff corn porridge, approximately 28% dry matter, and relish was a sauce, usually made of beans, green vegetables, or fish. CSB was porridge made from corn-soy blend. LNS plain were LNS served as such. LNS mixed were LNS combined with corn porridge. Snacks were small quantities of food served between meals. During the season when the study was conducted, snacks were usually fruit, sugar cane, sweet potato, cassava, banana, or bread.

The number of episodes of each type of food was calculated and these were added to get the total number of episodes per day for each participant. The total number of breastfeeding episodes was slightly underestimated because breastfeeding during a meal or snack was not counted as a separate episode. The length of a feeding episode in minutes was determined by subtracting the start from the end time. The daily time for each type of food was calculated for each participant and the total time was obtained by adding the length of all feeding episodes per child.

Research assistants used a semi-structured form to collect information about child and caregiver behavior during supplement feeding episodes. They recorded the child's main position during the feeding episode and the number of bites of food offered to and eaten by the child, which were used to calculate the proportion accepted. The position of the child was marked as sitting on the caregiver's lap, sitting on the floor, standing, or walking/crawling. Because they occurred infrequently, standing and walking/crawling were combined in the analysis.

Caregivers' behaviors measured included: hand washing before the feeding episode, person feeding the child, utensil used, whether supplement was shared, whether there was any leftover at the end of the feeding episode, and the proportion shared and leftover. Caregivers were counted as washing their own hands and/or their child's hands if they were rinsed with water before the feeding episode. The person feeding the child was noted as the mother, the child him or herself, or another person (usually a grandmother, aunt, or father). Mother and other person were used if they fed the child during the whole meal. If the child fed him or herself at least part of the time, this was recorded as self-feeding. Self-feeding was counted even when it was partial to detect possible differences in child autonomy depending on the type of supplement. The main utensil used during the meal was recorded as: spoon, LNS packet, or hand (caregiver's or child's). The LNS packet was considered as the utensil if the supplement was fed by squeezing it from the packet directly into the child's mouth. Sharing supplement was defined as consumption of the supplement by a person other than the participant during the meal. The proportion of the supplement meal shared was estimated based on the quantity of food presented to the participant that was eaten by someone else. CSB and LNS mixed with porridge were considered to be leftover if the feeding episode had ended but some food remained in the bowl, whether it was eaten by someone else or discarded. Plain LNS were leftover if the remaining part of the packet was given to someone else to eat after the study child had already finished eating. The proportion leftover was recorded as the amount of the original portion that remained in the bowl or was eaten by someone else from the packet after the feeding episode.

Whether supplement feeding episodes were offered as a meal or snack was determined from feeding logs. A supplement episode was considered to be a meal if no other meal of the same type (e.g., breakfast) was offered during that period of the day, and it was counted as a snack if it was offered between meals. Use of the supplement as a meal or snack was included with other caregiver behaviors.

Measurements of weight, height, and mid-upper arm circumference were obtained from unclothed children at the beginning and end of the study by a researcher (JP) blinded to the participants' study allocation. Weight was measured using an electronic child scale (SECA 834, Chasmors Ltd., London, UK) with a 0.1 g increment. Anthropometric indices, including WAZ, were calculated using the CDC 2000 growth reference, which was the latest reference available at the time of enrollment. Background information on the participants' families was obtained through a questionnaire administered by research assistants during a home visit.

2.7. Data analysis

The data were entered to a Microsoft Access database and analyzed using Stata (version 9.2). All comparisons between the CSB and LNS groups were by intention to treat. Means were calculated for each study group for the following variables: study week when observation was conducted, day after supplement delivery when observation was conducted, hours of observation, number of feeding episodes (total and by type of food), daily feeding time (total and by type of food), proportion of offered supplement accepted by the child, proportion of supplement shared, and proportion leftover. The means were compared and the hypothesis that there was no difference between the study groups was tested using *t*-test.

Proportions for each study group were determined for participants who did not eat supplements during observations, participants who were reported to have no supplements left, whether the supplement was offered as a meal or snack, where supplement feeding episodes took place (veranda/yard and earth surface/mat), caregiver and child hand washing, child's main position, feeder, utensil used, supplement sharing, and presence of leftovers. For the analysis of caregiver behavior, only the first supplement feeding episode of the day was included for each participant. The majority of participants had one or fewer supplement feeding episodes (CSB 82%, LNS 87%), and limiting the analysis to the first one allowed us to compare proportions between the study groups without adjusting for intra-individual correlation. The hypothesis that there was no difference between the proportions of behaviors in the two study groups was tested using Fisher's exact test. There were two variables that could have had an influence on behaviors during supplement use–age of the child at observation and whether the supplement was given as a meal or snack. We used logistic regression to determine if controlling for these variables had an effect on our results.

As there was no difference in the growth of the children in the two study groups, we used the full sample to detect whether selected caregiver behaviors were associated with child growth. Using multivariable linear regression analysis with change in child's WAZ during the study as the outcome, we entered the following explanatory variables into a single model: number of feedings, caregiver hand washing, supplement sharing, and presence of leftovers. The child's initial WAZ and age at observation were also included as covariates. Number of feedings was defined as the total number of complementary and supplementary feeding episodes observed. It was entered in the model because a higher number of feeds have been linked with higher total energy intake (Islam et al., 2008), which would be expected to influence growth. Caregiver hand washing was selected because better hygiene decreases incidence of diarrhea in children (Ejemot, Ehiri, Meremikwu, & Critchley, 2008), and diarrhea may have a negative impact on child growth (Black, Brown, & Becker, 1984; Checkley et al., 2008). Supplement sharing and presence of leftover supplement were included to determine the effect of limited supplement consumption on weight gain. Correlations between the regression coefficients were examined, and none of the variables were strongly correlated with one another.

3. Results

In total, 280 children were invited to the enrollment session and 88 were randomized to each study group (Fig. 1). Of these, 85 who received CSB and 86 who received LNS had observation visits. One child in the LNS group with indeterminate information about the type of supplement consumed was excluded. Two children in the CSB group ate LNS and one child in the LNS group ate CSB, but these children did not consume their assigned supplement on the day of observation. There were no statistically significant differences between the study groups in background characteristics (Table 1) or proportions of children reported to be ill on the day of observation (CSB 19/85 = 22%, LNS 14/85 = 16%, difference (95% CI) 6% (−6%, 18%), $p = 0.438$).

Timing of observations and failure to consume supplements on the day of observation did not differ between the study groups (Table 2). Nearly all children were observed during the second half of the follow-up period and most were visited between the first and fifth day after supplement delivery. Seven observation days (CSB 3, LNS 4) were cut short by two or more hours, usually because the child was sick and the mother took him or her to the health center. The main reason for not eating supplements during observation was that the participant had no supplement left

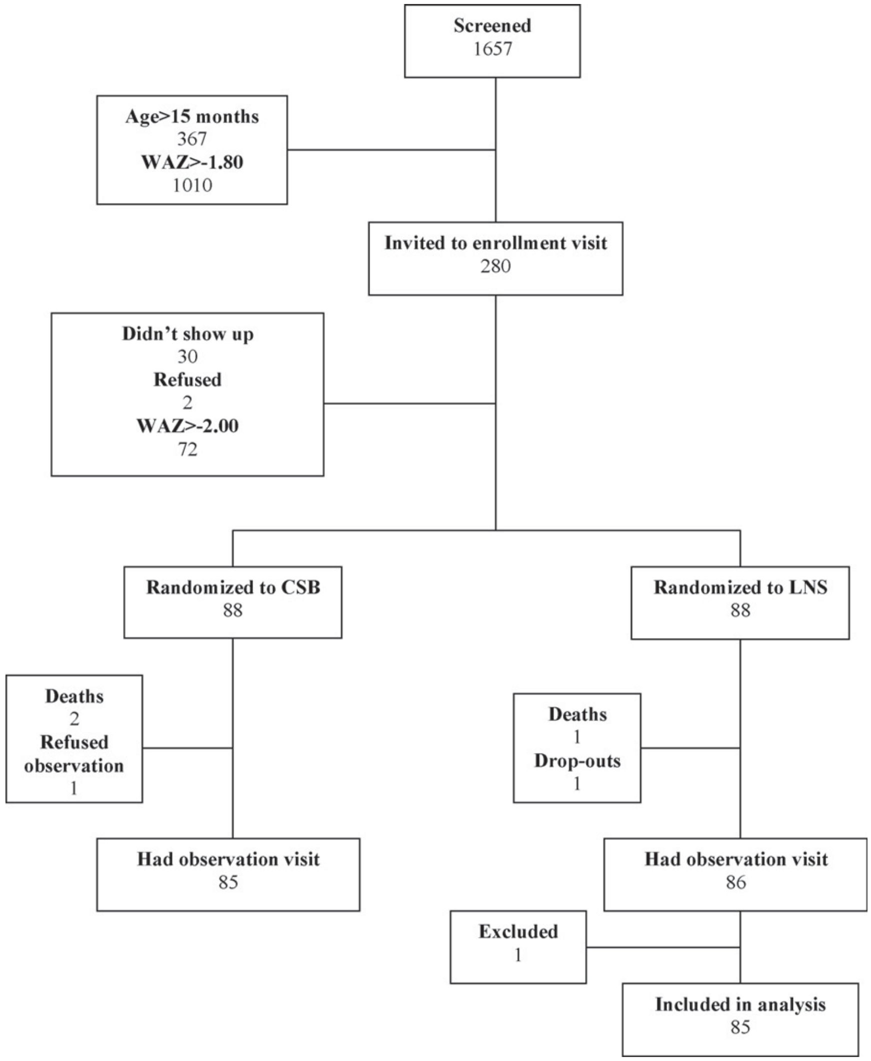

Fig. 1. Study profile. CSB, corn-soy blend; LNS, lipid-based nutrient supplement. WAZ, weight-for age *z*-score.

(Table 2). Among those reporting no supplement remaining, there was no difference between the study groups in the number of days after supplement delivery when the observation took place (CSB 3.5 ± 0.7 days, LNS 2.7 ± 0.9 days, difference (95% CI) 0.8 (−1.6, 3.2), $p = 0.479$). Other reasons for not eating the supplement during observation included: child refuses to eat the supplement in general or due to illness (CSB 4, LNS 2) and mother was away so no supplement was cooked or offered to the child (CSB 2, LNS 1).

Table 1
Selected demographic and socioeconomic characteristics of participants at enrollment.

Characteristics	Study group	
	CSB ($n = 85$)	LNS ($n = 85$)
Number (%) of males	48 (56%)	42 (49%)
Mean (SD) child age at observation (months)	13.6 (2.7)	13.7 (2.4)
Mean (SD) weight-for-age *z*-score at start of study	−3.1 (0.8)	−2.9 (0.7)
Mean (SD) birth order of study child	3.5 (2.1)	3.3 (2.3)
Mean (SD) maternal age (years)	28 (7)	26 (7)
Maternal education		
None	48 (57%)	41 (48%)
1–3 years	13 (15%)	18 (21%)
4–6 years	13 (15%)	16 (19%)
7 or more years	11 (13%)	10 (12%)
Housing materials		
Brick	60 (71%)	58 (68%)
Mud and poles	24 (28%)	23 (27%)
Other	1 (1%)	4 (5%)

CSB, corn-soy blend; LNS, lipid-based nutrient supplements.

There was no difference between the study groups in the total mean number of feeding episodes per day and total mean daily feeding time (Table 3). When specific types of food were examined, the mean number of supplement meals was significantly higher in the LNS group, while the mean daily time spent feeding nsima and relish was significantly higher in the CSB group. Nearly all participating children were still breastfed (CSB 85/85 = 100%, LNS 83/85 = 98%), and the breastfeeding frequency and time spent breastfeeding were similar in both groups. Among those participants who were served LNS during observation, most were offered the supplement plain (47/74 = 64%) rather than mixed with porridge (20/74 = 27%), while a small proportion (7/74 = 9%) were given LNS both plain and mixed. The mean minutes per episode for children who ate each type of food were: CSB (12.4 ± 5.5), LNS mixed with porridge (13.1 ± 7.4), and plain LNS (8.9 ± 4.9).

We detected some similarities and several differences in child and caregiver behaviors in the CSB and LNS groups (Table 4). Children accepted both of the supplements well. Similar numbers of bites of the two supplements were offered to the children, but the mean proportion of the offered supplement that was eaten by participants was slightly higher in the LNS group (CSB 94%, LNS 98%, difference (95% CI) 4% (1%, 7%), $p = 0.003$). There was no

Table 2
Timing of observations and failure to consume supplements during observations.

Characteristics	Study group		Difference between study groups (95% CI)	*p*-value
	CSB (*n* = 85)	LNS (*n* = 85)		
Mean (SD) study week when observation conducted	8.8 (1.8)	8.7 (1.9)	0.1 (−0.4, 0.7)	0.618
Mean (SD) day after supplement delivery when observation conducted	3.0 (2.4)	2.9 (2.3)	0.1 (−0.6, 0.8)	0.720
Mean (SD) hours of observation	10.6 (0.8)	10.3 (1.4)	0.3 (0, 0.6)	0.082
Proportion of participants who did not eat supplement during observation	22%	12%	10% (1, 22)	0.102
Proportion of participants who did not have supplement left during observation	15%	8%	7% (−3, 17)	0.233

CSB, corn-soy blend; LNS, lipid-based nutrient supplements. Difference in means by *t*-test. Difference in proportions by Fisher's exact test.

Table 3
Mean number of feeding episodes and mean daily feeding time by study group and type of food.

Type of food	Mean (SD) number of episodes per day		Mean difference (95% CI)	*p*-Value	Mean (SD) daily feeding time (min)		Mean difference (95% CI)	*p*-value
	CSB (*n* = 85)	LNS (*n* = 85)			CSB (*n* = 85)	LNS (*n* = 85)		
All feeding episodes	16.4 (4.0)	15.9 (4.1)	0.6 (−0.6, 1.8)	0.394	102 (62)	90 (52)	12 (−5, 30)	0.157
Breastmilk	12.4 (4.2)	11.5 (4.2)	0.9 (−0.3, 2.2)	0.121	63 (57)	54 (47)	9 (−7, 25)	0.251
Plain porridge	0.3 (0.5)	0.4 (0.6)	−0.1 (−0.3, 0)	0.130	3 (6)	4 (8)	−1 (−4, 1)	0.180
Nsima & relish	1.0 (0.4)	0.9 (0.4)	0.1 (0, 0.2)	0.107	14 (9)	11 (6)	3 (1, 6)	0.004
Supplement	0.8 (0.5)	1.0 (0.5)	−0.2 (−0.3, 0)	0.035	11 (8)	11 (8)	0 (−2, 2)	0.961
Snacks	1.8 (1.4)	1.9 (1.5)	−0.1 (−0.6, 0.3)	0.599	12 (14)	10 (10)	2 (−2, 5)	0.403

Porridge, corn or rice porridge; Nsima & relish, stiff corn porridge & sauce; Supplement, corn-soy blend or lipid-based nutrient supplements; snacks, small quantities of food (most frequently fruit, sugar cane, sweet potato or cassava, banana, and wheat or corn bread) served between meals. Difference in mean number of episodes and mean daily feeding time by *t*-test.

difference between the groups in the location of the feeding episodes or the child's position during them. Although children in both groups were usually fed supplements by their mothers, those in the LNS group were more likely to have other people feed them the supplement than those in the CSB group. Caregivers in the CSB group were significantly more likely than those in the LNS group to serve the supplement as meal, wash their hands before feeding, and feed the child with a spoon. Outright sharing of supplements was observed relatively infrequently and there was no difference between the groups in the occurrence of sharing or the mean proportion shared (CSB 4%, LNS 1%, difference (95% CI) 3% (−1%, 6%), $p = 0.128$). There were significantly more instances of leftovers and the mean proportion leftover was higher in the CSB than the LNS group (CSB 19%, LNS 6%, difference (95% CI) 12% (9%, 15%), $p < 0.001$). We observed approximately one-quarter of the leftovers being eaten by someone else. Shared supplements and those leftovers that were observed being eaten were most often consumed by the child's siblings or cousins (CSB 76%, LNS 73%). Statistical adjustment for age and use of the supplement as a meal versus snack did not make a difference in the comparison of behaviors in the two study groups (details not shown).

Our sub-group comparisons of behaviors related to the use of LNS mixed and plain generally mirrored the results of CSB compared to LNS (Table 5). Children ate similar proportions of

Table 4
Child and caregiver behavior during supplement feeding episodes.

Child and caregiver behavior	CSB (*n* = 66)		LNS (*n* = 75)		Difference in proportions (95% CI)	*p*-value
	n	%	*n*	%		
Offered as meal not snack	64	97%	54	72%	25% (14, 36)	<0.001
Location						
On veranda not yard	36	55%	40	54%	1% (−15, 17)	1.00
On earth surface not mat	38	58%	53	70%	−12% (−28, 4)	0.157
Hand washing before feeding						
Caregiver washed own hands	42	64%	27	37%	27% (11, 43)	0.002
Caregiver washed child's hands	17	26%	10	13%	13% (−1, 25)	0.085
Sitting on lap	42	65%	52	69%	−4% (−20, 11)	0.592
Sitting on floor	21	32%	18	24%	8% (−7, 23)	0.345
Standing, walking or crawling	2	3%	5	7%	−4% (−11, 3)	0.450
Person feeding						
Mother all of the time	57	86%	59	79%	7% (−5, 20)	0.274
Self part or all of the time	8	11%	8	12%	−1% (−12, 9)	0.797
Other person all of the time	1	2%	8	11%	−9% (−17, −2)	0.037
Utensil						
Spoon	61	92%	36	48%	44% (31, 57)	<0.001
LNS packet	1	1%	34	45%	−44% (−55, −32)	<0.001
Caregiver's or child's hand	4	6%	5	7%	−1% (−9, 7)	1.00
Supplement sharing	10	15%	4	5%	10% (0, 19)	0.088
Part of food was leftover	33	50%	16	21%	29% (13, 44)	<0.001

CSB, corn-soy blend; LNS, lipid-based nutrient supplements. Difference in proportions by Fisher's exact test. Analysis based on the first supplement meal of the day per child. Types of supplement meals within the LNS group were: plain LNS (*n* = 50), LNS mixed with porridge (*n* = 24), and CSB (*n* = 1).

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Table 5
Child and caregiver behavior during LNS feeding episodes.

Child and caregiver behavior	LNS mixed with porridge (n = 24)		LNS plain (n = 50)		Difference in proportions (95% CI)	p-value
	n	%	n	%		
Offered as meal not snack	24	100%	28	57%	43% (29, 57)	<0.001
Location						
On veranda not yard	15	62%	25	51%	11% (−12, 35)	0.455
On earth surface not mat	14	56%	38	77%	−21% (−44, 11)	0.065
Hand washing before feeding						
Caregiver washed own hands	16	69%	11	22%	47% (25, 69)	<0.001
Caregiver washed child's hands	6	25%	4	8%	17% (−2, 35)	0.068
Child's main position						
Sitting on lap	19	76%	32	65%	11% (−11, 32)	0.431
Sitting on floor	6	24%	12	24%	0% (−2, 2)	1.00
Standing, walking or crawling	0	0%	5	10%	−10% (−19, 17)	0.160
Person feeding						
Mother all of the time	21	87%	37	74%	13% (−4, 31)	0.238
Self part or all of the time	1	4%	7	14%	−10% (−22, 3)	0.262
Other person all of the time	2	8%	6	12%	−4% (−18, 10)	1.00
Utensil						
Spoon	24	96%	13	26%	70% (55, 84)	<0.001
LNS packet	0	0%	34	68%	−68% (−81, −57)	<0.001
Caregiver's or child's hand	1	4%	3	6%	−2% (−12, 8)	1.00
Supplement sharing	1	4%	3	6%	−6% (−12, 1)	1.00
Part of food was leftover	14	56%	2	4%	52% (32, 72)	<0.001

Difference in proportions by Fisher's exact test. Analysis based on the first supplement meal of the day per child. The child in the LNS group who was observed eating CSB was excluded.

the offered LNS whether it was served mixed with porridge or plain (LNS mixed 97%, LNS plain 99%, difference (95% CI) 2% (−1%, 4%), p = 0.225). The location of feeding and the child's position did not differ between the sub-groups. Caregivers were significantly more likely to serve LNS mixed with porridge than plain LNS as a meal and wash their own hands before feeding. LNS mixed with porridge was usually fed with a spoon, while plain LNS was frequently fed directly from the packet. There was no difference in supplement sharing or the mean proportion shared (LNS mixed 1%, LNS plain 1%, difference (95% CI) 0% (−2%, 2%), p = 0.567) based on the way LNS were served. There were more frequently leftovers and the mean proportion leftover was larger for LNS mixed with porridge than for plain LNS (LNS mixed 15%, LNS plain 1%, difference (95% CI) 14% (8%, 21%), $p < 0.001$). Statistical adjustment for age and use of the supplement as a meal or snack did not have an impact on comparisons between LNS plain and mixed (details not shown).

Presence of leftovers after supplement feeding episodes was negatively associated with change in child's WAZ (Table 6). The other explanatory variables entered to the model (number of feedings, caregiver hand washing, and supplement sharing) did not predict change in child's WAZ.

Table 6
Multivariable linear regression analysis of caregiver feeding behaviors during supplementary feeding associated with change in child's WAZ.

Explanatory variables	Change in child's WAZ	
	Regression coefficient (95% CI)	p-value
Constant	−0.82 (−1.41, −0.23)	0.007
Age at observation	0.66 (0.03, 0.10)	0.001
Child's WAZ at enrollment	−0.08 (−0.20, 0.04)	0.196
Number of feedings[a]	0.02 (−0.04, 0.08)	0.466
Caregiver hand washing	−0.03 (−0.21, 0.15)	0.760
Supplement sharing	−0.02 (−0.30, 0.28)	0.885
Presence of leftovers	−0.19 (−0.37, −0.01)	0.036

WAZ, weight-for-age z-score.
[a] Number of feedings includes complementary and supplementary feeding episodes, but excludes breastmilk.

4. Discussion

The main aim of this study was to compare feeding patterns and behaviors of undernourished children who received either CSB or LNS as food supplements. We found no difference between the groups in total mean number of feeding episodes per day or total mean daily time spent feeding. The mean number of supplement episodes was higher in the LNS group while the mean daily time spent feeding nsima was higher in the CSB group. Caregivers were more likely to serve the supplement as a meal, wash their hands before feeding, and use a spoon in the CSB than the LNS group. There were more frequently leftovers and the proportion leftover was larger among those who had CSB than LNS. The same patterns of caregiver behavior found in comparisons of CSB with LNS were also detected when LNS mixed with porridge was compared to plain LNS. Presence of leftovers was the only predictor associated with change in child's WAZ.

The strengths of this research were a study population taken from a randomized clinical trial with few drop-outs and the use of structured observations to detect feeding patterns and behaviors. Observational methods have frequently been used to study behaviors related to complementary feeding in children (Bentley et al., 1991b; Engle & Zeitlin, 1996; Gittelsohn et al., 1998; Guldan et al., 1993; Moore et al., 2006) and are more accurate than recall or survey methods for obtaining information about food consumption and other household behaviors (Basch et al., 1990; Curtis et al., 1993; Stanton, Clemens, Aziz, & Rahman, 1987).

This study had some limitations, including the possible influence of observers on feeding behavior and the use by three participants of the supplement that was not assigned. Although caregivers could have modified their behaviors in the presence of observers, we believe that reactivity in the present study was reasonably low. Research has shown that reactivity decreases with two or more observations (Cousens, Kanki, Toure, Diallo, & Curtis, 1996; Gorter et al., 1998), and several aspects of feeding studied here were similar to findings from our earlier study, where there were 10 observations per participant (Flax et al., 2008). In addition, the overall feeding pattern in this study was comparable to the number of complementary feeds per day reported elsewhere in southern Malawi (Hotz & Gibson, 2001). In terms of the participants who were observed eating the other supplement, they made up a very small proportion of the study sample (<2%), so their impact on the analysis was minimal.

The overall feeding patterns detected in this research were quite similar in the two study groups, with the majority of participants being fed one supplement meal, one nsima and relish meal, and one to three snacks. Although the frequency of LNS episodes was significantly higher than CSB episodes, the difference between the groups was small and was probably linked to the variation in proportions of children in each group who did not eat the supplement during observation. Since children usually consumed their supplements in the morning and nsima sometime thereafter, differences between the study groups in the amount of time spent feeding nsima could be related to the large disparity in the volume of the supplements consumed due to their different energy densities (Briend, 2002; Phuka et al., 2009). There is evidence that high volume, low density foods (like CSB) can enhance satiety and influence subsequent meals (Rolls, 2009). The other notable aspect of the feeding pattern was the low frequency of plain porridge use in the LNS and CSB groups, which was similar to findings during LNS supplementation in our earlier study (Flax et al., 2008).

In our previous work, we theorized that LNS was integrated into feeding patterns by mixing it with porridge because porridge was an important element of child feeding (Cosminsky, Mhloyi, & Ewbank, 1993; Mabilia, 1996) and because offering it together with porridge, rather than as an additional snack, saved time. In the present study, LNS was more frequently served plain. The differences in LNS use between the two studies suggest that Malawian caregivers can be flexible and adaptive in their child feeding regimes, as has been shown in feeding interventions and trials of improved practices in other settings (Bentley et al., 1991a; Paul, Dickin, Ali, Monterossa, & Stoltzfus, 2008; The Manoff Group, 2007). We suspect that differences in patterns of LNS use in these two studies may be at least partly related to LNS packaging. In our earlier study, LNS were provided in jars containing a one-week supply, while in the present study they were given to participants in foil packets for daily use. The ease of using foil packets and feeding the child directly from them may have encouraged mothers to give children plain LNS more often than when it was provided in a jar and also influenced the type of utensil used to feed it.

Although there is evidence from Nicaragua that some caregiver and child behaviors, such as self-feeding, are different during meals and snacks (Engle & Zeitlin, 1996), feeding the supplement as a meal or snack did not influence self-feeding or other behaviors in this study.

Differences between the study groups in certain behaviors, such as hand washing and leftovers, were associated with specific patterns of behavior related to plain LNS. Our findings with regard to the proportions of caregivers washing their hands before CSB and LNS mixed with porridge feeding episodes are similar to reports of maternal hand washing before child feeding in other developing countries, while those for plain LNS are somewhat lower (Manun'Ebo et al., 1997; Sakisaka et al., 2002).

Non-compliance in feeding the recommended amount of supplement to children may limit the impact on growth. Other studies comparing CSB and LNS in Malawi have reported minimal levels of supplement sharing based on focus group discussions and maternal reports (Matilsky, Maleta, Castleman, & Manary, 2009; Phuka et al., 2008, 2009). In the same sample from which the present study was drawn, mothers indicated during weekly interviews at the time of supplement distribution that <1% of the supplements were diverted to other family members (Phuka et al., 2009). These figures contrast with our direct observations, which documented larger proportions of outright sharing, frequent leftovers, and some children whose weekly supply of supplement was finished early. Similar discrepancies between reported and observed behaviors have been found in research on household hygiene (Manun'Ebo et al., 1997) and indicate that caregivers tend to under-report undesirable behaviors (Curtis et al., 1993). There is very little research on leftover supplements. Results from our earlier study, where we reported the proportion of LNS plain and mixed that was "lost", are comparable and consistent with the proportion leftover in the present research (Flax et al., 2008).

Our finding that leftovers are associated with child growth concurs with some supplementary feeding research showing that when the intake of supplements was inadequate due to sharing or replacement the effect on growth was constrained (Beaton & Ghassemi, 1982; Owino et al., 2007; Santos et al., 2005). The lack of association between sharing and growth in the present study is probably related to the infrequent occurrence of sharing and to the small quantities shared. The mean feeding frequency in this study is in the range recommended by international agencies for children of this age (PAHO/WHO, 2003). This together with the low variability in the number of daily feeding episodes in our sample may explain why we did not detect an association between feeding frequency and growth. Our finding with regard to hand washing and child growth is consistent with research showing that hygiene behaviors cluster (Arimond & Ruel, 2002). It is likely that we detected no association between hygiene before supplement feeding and growth because hand washing alone does not adequately represent the totality of household hygiene practices.

In conclusion, this study found that most differences between the study groups were linked to the way LNS were served (plain vs. mixed with porridge). Programs promoting LNS in Malawi should consider behaviors related to mode of serving and provide appropriate advice to caregivers in order to minimize leftovers. As several types of packaging for LNS are currently in wide use, further research on behaviors associated with specific types of packaging may be warranted.

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