Title

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"I have remained strong because of that food": Acceptability and use of lipid-based nutrient supplements among pregnant HIV-infected Ugandan women receiving combination antiretroviral therapy

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Abstract

We evaluated the acceptability and use of macronutrient supplementation among HIV-infected pregnant Ugandan women receiving antiretroviral therapy in a clinical study (NCT 00993031). We first conducted formative research among 56 pregnant and lactating women to select a supplement regimen. Acceptability and use of the supplementation regimen [35 sachets of lipid-based nutrient supplements (LNS) and 4 or 6 kg of instant soy porridge for the household provided monthly] were evaluated among 87 pregnant women. Organoleptic assessments of LNS were favorable. Participants reported consuming LNS a mean of 6.1 days per week, and adherence to recommended consumption behaviors (e.g. frequency, quantity, not sharing) was >80%. Few women reported negative social consequences of supplementation. The majority of participants also consumed most of the porridge intended for the household. In sum, LNS was acceptable and used regularly. Larger studies to evaluate physical and psychosocial consequences of LNS during pregnancy among HIV-infected women are warranted.

INTRODUCTION

HIV-infected pregnant women have elevated macro- and micronutrient requirements due to the metabolic demands of both pregnancy and HIV disease [1–3]. Nutrient deficiencies, in turn, have demonstrable deleterious health consequences in both pregnant [4] and HIV-infected populations [5,6].The observed sequelae of poor nutrition during pregnancy among

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HIV-infected populations includes a range of adverse maternal, obstetric and infant health outcomes, including a potential increased risk of vertical transmission [7–11].

Consistent with this, data from our then ongoing trial among HIV-infected pregnant Ugandan women receiving antiretroviral therapy (NCT00993031, http://clinicaltrials.gov) indicated that both net weight loss during pregnancy and grossly inadequate gestational weight gain (GWG) were common. Further, low GWG (< 0.1 kg/week) was associated with increased risk for low birthweight (LBW), preterm delivery, and composite adverse birth outcomes [11]. Because nutritional status is a major modifiable determinant of both maternal and infant health [12–14] and poor nutritional status is common among many HIV-infected many pregnant women [7–11], we sought to offer a supplementation regimen to our pregnant participants that would be appropriate for increasing weight gain.

However, little is known about the implementation or effects of supplementation of HIV-infected pregnant women [15]. First, the majority of nutritional supplementation studies during pregnancy have been conducted among HIV-uninfected populations [16]. Of these, the few studies that have assessed supplement acceptability during pregnancy [17–21] have revealed great variability. Second, the number of supplementation studies conducted among HIV-infected pregnant women is limited, and all have focused on micronutrients [15]. Indeed, the clinical effects and other benefits of macronutrient supplementation for the general population of people living with HIV (PLHIV) remain largely unknown [22–24]. There are even fewer data about the effects of macronutrient supplementation on pregnant and lactating women, with a notable exception of the BAN study, which provides important insights into macronutrient supplementation during lactation [25,26]. Importantly, a recent Cochrane review suggested that there are currently insufficient data to assess the impact of macronutrient interventions on morbidity or mortality among even the general population of PLHIV [27]. Therefore, we set out to determine the perceived needs, acceptability, and use of a macronutrient supplement during pregnancy.

METHODS

Setting

This study was nested within a prospective clinical trial in Tororo, Uganda, evaluating malaria outcomes among HIV-infected pregnant women between 12 and 28 weeks gestation who had been randomized to receive a lopinavir/ritonavir or efavirenz-based combination antiretroviral regimen (NCT00993031, http://clinicaltrials.gov). Women were followed monthly until one year postpartum. Briefly, women with HIV-1 infection and a documented pregnancy between 12 and 28 weeks of gestation were eligible for enrollment in the parent clinical trial. All participants received multivitamins containing iron and folic acid, as well as iron supplements, prophylactic mebendazole, an insecticide-treated bed net, and were started on either zidovudine/lamivudine/efavirenz or zidovudine/lamivudine/lopinavir/ritonavir. Women were also started on daily trimethoprim/sulfamethoxazole (TS) if they were not already receiving TS prophylaxis prior to study enrollment. Women were encouraged to breastfeed for one year postpartum.

Study procedures

Formative study—To understand the perceived nutritional challenges and needs in the community, semi-structured interviews lasting approximately 90 minutes were conducted with a convenience sample of pregnant (n=24) and lactating (n=32) study participants, from June until August 2011. The interview guide was informed by the ecological model of nutrition, in which the individual's biological and psychological needs are understood to both influence and be influenced by multiple social and environmental factors [28,29]. The last 23 of these participants to be enrolled were asked about the appropriateness and appeal of 8 potential food supplements: millet flour, sesame paste, groundnut paste (peanut butter), roasted termites, *mukene* (small dried silver cyprinid fish), instant soy porridge both with and without micronutrient Sprinkles added, and Plumpy'Sup. Because Plumpy'Sup, instant soy porridge and micronutrient Sprinkles were unfamiliar to most participants, they were asked to taste them during the interview.

At the end of the interview, participants were asked to assess how much they liked the 3 supplements they tasted, from 1 (strongly like) to 5 (strongly dislike), and to rank the eight candidate supplements from most (1) to least (8) acceptable. Lastly, participants were asked to explain their rankings, and to describe stigma that they thought could be associated with receiving supplements as well as what the expectations of other household members might be about sharing any supplements received as part of the study. Interviews were conducted in private in the participants' language of choice, primarily Japadhola and Luganda.

Acceptability and use study—All pregnant participants who were actively enrolled in the parent study between February and October 2012 were invited to participate in the acceptability and use study, regardless of gestational age. At enrollment into the sub-study, participants were asked to consume and rate the organoleptic properties of the lipid-based nutrient supplement (LNS) created for the study. Data were also collected on covariates that were posited to affect or be affected by supplementation, including food insecurity, social support, depression, attitudes towards GWG, stigma, and typical physical activity and diet. All of these interviews were conducted by a locally resident Ugandan woman fluent in Jahadhola and Luganda, who had not previously been involved with the sub-study or parent trial.

Participants then met with a nutritionist individually, for nutritional counseling about appropriate supplement use. Participants were instructed to eat exactly one package of LNS per day, that it should be eaten between meals; i.e. not as a meal replacement; and that it should be eaten only by her, "taken like any other drug you receive from the clinic or pharmacy". Instructions were also given on the preparation of soy porridge. Participants were asked to use it to prepare family meals, and to not sell or share it with neighbors or relatives. They were then given a month's supply of both supplements: 35 sachets of LNS, and 4 kg of soy porridge if < 7 household members were reported (adults and children were not differentiated) and 6 kg of soy porridge if there were 7 or more in the household.

Participants were asked to return to the clinic every month as part of the parent study activities. At these follow-up visits, they were surveyed about their experiences with the supplements, including consumption patterns, as well as about the above covariates. They

then received further nutritional counseling from the study nutritionist and another month's supply of supplement. The nutritionist logged any challenges participants faced.

Food insecurity was assessed using the Household Food Insecurity Access Scale (HFIAS) [30] and Household Hunger Scale (HHS) [31]. Social support was assessed using the Perceived Social Support scale [32], which is a modified version of the Duke-UNC Functional Social Support questionnaire [33]. Depression was assessed using the 11 cognitive and affective symptom items on Center for Epidemiologic Studies Depression Scale (CES-D) [34]. In order to limit confounding depression with HIV disease-related symptoms, we did not administer somatic depression items because they overlap with HIV-related symptoms [35]. Stigma was measured using the Internalized AIDS-Related Stigma Scale [36]. Reported possession of six household assets were used as a proxy for wealth. Anthropometric data, including maternal height and weight, gestational age, obstetric outcomes and infant birthweight were collected in the parent study, as described elsewhere [11].

Supplementation stopped after maternal delivery. Within two weeks after delivery, participants who had had at least four weeks of exposure to the LNS supplement were invited to take part in a semi-structured exit interview about their experiences with supplementation in the study, in which individual-, interpersonal-, and community-level experiences with supplements were explored.

Data analysis

*Q*ualitative analysis followed the principles and procedures of Grounded Theory [37,38]. For the semi-structured formative interviews, notes were typed up and then read by 3 of the authors. Each independently identified themes, and the first author then developed a coding structure based on the list of themes. The transcripts were subsequently reread by two authors, quotes were manually extracted, and frequencies of responses pertinent to each of the themes were tallied. For the exit interviews, conducted among women exposed to at least one month of supplement, a similar procedure was followed for developing a coding structure. The transcripts were then coded by two independent coders (CM, AZ) using the qualitative software dedoose (www.dedoose.com).

Quantitative data from the acceptability and use study were analyzed to examine the relationship between LNS supplementation and both psychosocial (depression, food insecurity, social support, stigma) and physiological [anthropometric and obstetric outcomes] constructs. Participants were dichotomized according to their reported supplement consumption: Those who reported consuming one or more LNS packages 6 or 7 days per week on average throughout the study period were considered "high consumers"; the rest were "low consumers". As a proxy for wealth, we used the first two components of a principle component analysis of six household assets which accounted for 55.7% of the information contained in the asset holding variables. Women were then categorized as either having "high" household assets if they scored above the median for both components, or "low" if not.

Continuous variables were compared between “high” and “low” supplement consumer groups using the Wilcoxon rank sum test, and categorical variables were compared using Fisher’s exact test. Baseline comparisons were performed using all women who returned for at least one follow-up visit during the supplement period and whose data were available. Post-supplementation comparisons were restricted to women who had at least two follow-up visits during the supplementation period. For some outcomes, missing data values resulted in slightly smaller sample sizes. Additionally, all anthropometric comparisons were restricted to participants whose first and last follow-up visits were at least 28 days apart. Changes in outcomes during the supplementation period were calculated as the difference between each participant’s last and first measurements. Change in GWG and BMI were calculated by taking the difference between the last and first measurements and dividing it by the number of weeks between the measurements. All analyses were performed using Stata 12.0 (StataCorp).

Ethics

All women gave written informed consent. The study protocol was approved by Cornell University, the Faculty of Medicine’s Research and Ethics Committee at Makerere University, the Uganda National Council of Science and Technology, and the Committee on Human Research at the University of California San Francisco.

RESULTS

Formative study

Formative research revealed that adequate food and good nutritional status during pregnancy and lactation were of major concern to participants. For example, 59% (33/56) of participants reported difficulties in accessing sufficient food, and 45% typically ate only 1 or 2 meals per day. This was triangulated by later findings among participants in the parent study that the prevalence of moderate to severe household hunger and moderate to severe household food insecurity access were 47.8% and 76.7%, respectively [39].

Further, 73% (41/56) of participants thought that their current diet had negative consequences for their health: "I sometimes get stressed when I wake up in the morning and begin thinking where I am going to get food for the family [and] sometimes you may get food that is not enough for the family so you may not even get some to spare for yourself for swallowing your medicine". Other perceived negative consequences of insufficient diets were exacerbated side effects of ARTs: “[Eating] helps me to avoid getting dizzy like when I swallow them [ARVs] before eating food." "When I am taking medicine minus eating, I feel like I have no energy."

Given the difficulties many participants had in acquiring sufficient food, the possibility of receiving supplements during pregnancy was appealing. One-third of the 24 pregnant participants thought that it could help with “maternal energy” during pregnancy, and 20.8% thought that it could help the mother and/or baby. Although 62.5% of the pregnant participants said they would not share their supplements, 20.8% said they would not be able to refuse sharing with their children, and 29.1% said they would like to share at least with

their younger children. Ideas suggested for reducing sharing included eating the supplement away from the family (25%), having other food for the family (16.6%), and educating the family on the importance of the supplement (12.5%). Only one pregnant women thought that receiving supplements might cause stigma.

Of the three items that participants would have been unfamiliar with, such that they were offered tastes before actually evaluating their overall likeability (PlumpySup, and instant soy porridge with and without micronutrient Sprinkles), Plumpysup had the highest median likeability score, 1, higher than soy porridge alone (3) or with Sprinkles (3). When ranking the overall acceptability of all 8 supplements, however, instant soy porridge with Sprinkles was ranked as the most acceptable (median rank 2), together with millet flour (median rank 2) (Online supplementary Table 1). Roasted termites were the least acceptable.

Acceptability and use study

We chose to supplement pregnant participants with non-fortified LNS in individual sachets. (Nutritional content described in online supplementary Table 2). This decision was informed by participants' ranking of likeability (median rank 1) and overall acceptability (median rank 5, Online supplementary Table 1), as well as the study needs to 1) standardize quality and quantity of supplement consumed, 2) minimize sharing, 3) deliver a macronutrient-dense food low in micronutrients such that the parent study protocol of provision of micronutrient tablets would not need to be altered, and 4) reduce substitution of family foods with the study supplement. Supplements were manufactured by Nutriset (Malaunay, France) and flown to Uganda. The cost to purchase one month's supply of LNS was $24.62, ($12.45 for the product, $12.17 for shipping).

We also provided a supplement for other household members, to minimize sharing of LNS sachets. We selected instant soy porridge based on its acceptability (median rank 2.5), short preparation time, the variety of ways of consuming it, and ease of sharing amongst many. Instant soy porridge cost $1.50/kg, such that the cost of supplement per month was either $6 or $9 USD.

Study population—Eighty-eight women were actively enrolled in the parent study during the period of eligibility and were thus invited to participate in the acceptability and use study. Eighty-seven women agreed (one woman was allergic to peanuts) and participated in the enrollment visit during which organoleptic properties of LNS were evaluated. Of these, 87.5% (76/87) returned for at least one follow-up visit during which supplement use was reported on and data were collected on a number of physiological and psychosocial aspects; data were lost from one individual (P2-0534). Ninety-six percent of those eligible (73/76) participated in the qualitative "exit interview". All study attrition was due to delivery; no woman withdrew consent for the nutrition sub-study.

Acceptability of LNS—Participants (n=87) had a very favorable opinion of the study LNS at their initial encounter. The median score for taste, smell, texture, packaging, and "overall liking" of the LNS supplement was 1 (out of 5, "strongly like"). Further, a rating of 1 or 2 ("strongly like or like") was given by the majority of participants for taste (87.5%), smell (94.3%), texture (96.9%), packaging (100%), and "overall evaluation" (96.9%). In

terms of women's assessment of the quantity of LNS in one sachet, 63.6% felt it was an appropriate amount, while 21.6% felt it was too much and 14.8% thought it was too little.

Women reiterated the acceptability of the LNS during the postpartum "exit interviews". The majority of participants (92%) reported that they enjoyed eating LNS. Of those 67 women, (69%) spontaneously mentioned that they liked the taste, which many compared to groundnuts; 47.8% mentioned the smell, frequently described as "sweet" (which can mean both sugary and pleasant); 18% appreciated its nutritional value; and 9% liked that it required no preparation.

The biggest objection to LNS was that it caused nausea and vomiting. This was reported by 14.5% (11/76) of participants at the first follow-up visit, 7.6% (5/66) at subsequent follow-up visits, and 13.7% (10/73) of participants at exit interviews. This was primarily attributed to the supplements being overly sweet. However, eight women who initially disliked the supplement (primarily because it caused nausea and vomiting) grew to like it after receiving counseling on strategies for diminishing nausea associated with its consumption, including eating small amount of LNS throughout the day and drinking warm water with it. Five women who initially liked the supplement reported growing to dislike it, primarily because they found it grew too sweet over time. These data are corroborated by counseling logs that indicate that the most common counseling issues included LNS causing gastrointestinal distress and dislike of its taste or smell (Table 1).

At the completion of participation in the supplementation sub-study, the majority of participants thought the purpose of LNS was to improve maternal health (41.1%), infant health (31.5%), the health of people with HIV (21.9%), or the health of pregnant women (10.9%). Four women (5.5%) initially thought it could be harmful, because it contained HIV medicine (which could hurt others if they consumed it) (n=2), because it would cause her to vomit her HIV medicine (n=1), or because it was meant to hurt her directly (n=1). "At first I thought that the food was meant to kill me because I have HIV/AIDS, but later on I had a second thought that I am mature, I have done nothing bad, I am innocent, and I have not hurt anybody. I think this is love and care."

Use of LNS—We assessed adherence to LNS consumption messages by inquiring about frequency and quantity of supplement consumed, if timing coincided with meals (meal replacement), and if supplement was shared (Table 2). By most measures, reported adherence to counseling messages was high, and improved at subsequent visits. In terms of frequency, LNS was consumed approximately 6 days per week. At the first follow-up visit, 70.1% reported consuming it the prior day. The most common reasons for not consuming LNS during the prior day was that there was none left (26.0%) and that it caused nausea or vomiting (14.3%). At subsequent follow-up visits, 79.9% of women reported using it the prior day, and the proportion not taking it because they had none left or were experiencing nausea and vomiting dropped to (7.6%) for both reasons.

In terms of quantity of LNS consumed, the majority of participants typically consumed the entire sachet (83.1% at initial follow-up, 93.1% at subsequent visits) and tended to do so right after opening (81.8%, 93.6%, Table 2). Some of the lowest adherence was reported for

consumption of exactly one sachet in the prior two days; this was likely due to low supplies of LNS by the end of the month. Some of the best adherence to supplement use messaging was seen with respect to replacement of other meals with LNS. Women did not report eating LNS with meals (96.1% at initial follow-up, 96.6% at subsequent follow-up visits) or mixing it with other household foods (84.4%, 96.0%).

Reported sharing was minimal; only 15.6% and 4.0% of women reported actively sharing LNS on first and subsequent clinic visits respectively (Table 2). At exit interviews, the majority of participants (84.9%) also reported not feeling compelled to share their LNS with household members. Women attributed their ability to not share by explaining that they were following instructions from the clinic (58.9%), or that the supplement was meant only for pregnant (15.1%) or HIV-infected people (12.3%), or because soy porridge was available for others (12.3%). Although most women did not feel they needed to share the supplement, 26.0% reported experiencing theft of LNS. Counseling logs provided triangulation that LNS was sometimes stolen or lost, contributing to low supplies by the end of the month (Table 2).

Difficulties caused by LNS within the household were reported by 41.1% of participants at the exit interviews. This was most commonly due to their children wanting to eat the LNS (30.1%), theft of supplement (26.0%), envy of supplement (4.1%), and household members "saying bad things" (4.1%).

Approximately half of the participants (n=40) reported that people outside their household knew they were using LNS. Of these, women experienced community responses that included curiosity (62.5%), association with HIV-disease (35.0%), and a desire to obtain it for themselves (32.5%). Three women mentioned stigma associated with LNS. For example, one woman's husband did not want LNS in the house for fear that people would know they were both HIV-positive.

Overall, 80% of women were "high consumers", i.e. they reported consuming a mean of at least 1 package per day, 6 or more days per week, throughout the entire supplementation period. At baseline, high consumers had approximately two more residents in their households, were more likely to have disclosed their HIV status, and scored approximately 6 points higher on the HFIAS scale, i.e. lived in households with greater food insecurity (Table 3).

Impact of LNS—There were no statistically significant differences in maternal or infant outcomes by reported supplement consumption, including for changes in maternal depression, exertion, household food insecurity, or maternal or infant anthropometry (Table 4); the study was not powered to detect these differences. However, trends were in the anticipated direction. For example, women who were high consumers gained 100g/week more weight than low consumers. Further, infants born to mothers who were high supplement consumers were 1.0 cm longer and a smaller proportion were LBW (9.1% vs 21.4%). Infants born to nulliparous and multiparous high consumers weighed 176g and 102g more at birth, respectively. Lastly, high consumers became less depressed over the course of pregnancy than low consumers (−2.0 change vs. −1.8 change in CESD score), and high consumers scored 0.7 points higher on the HFIAS scale.

Acceptability and use of household food ration—In exit interviews, 98.6% of women found the soy porridge to be enjoyable, spontaneously attributing their enjoyment to the taste (75.3%) which many described “like fried soya”; the smell, “like soya flour” (41.1%); the nutritional value (21.9%); and the texture when mixed with other foods (8.2%). Of note, some of the participants who found the soy porridge to be enjoyable disliked the smell (8.2%) or thought it caused gastrointestinal distress (2.7%). One woman initially liked it, but later came to dislike it, while three who initially disliked it (all because of the smell) came to like it. The quantity of soy porridge seemed sufficient; the majority (79% at initial follow-up, 87.5% subsequently) reported that “a little” or “none” remained at the end of the month. Of those whom had finished all of the porridge, they had done so a mean(SD) of 5(3) days before the clinic visit.

In monthly interviews, participants reported that the household food ration was consumed by both children (94% at first follow-up, 97% subsequently) and adults (96%, 98%) that lived in their household. Surprisingly, study participants seemed to consume the bulk of the soy porridge meant for household members. The majority of women (75%, at first follow up, 88% subsequently) reported that they ate “most” of the soy porridge and that the majority (67.5%) of family members ate only “some”.

As for use outside the household, women reported it being consumed by children (52% at first follow-up, 66% subsequently) and adults (40%, 62% subsequently) that lived elsewhere. The amounts shared were small; of those who shared, the majority (91% at first follow-up, 99% subsequently) described the quantity as “a little”. The non-household members with whom the soy porridge was most commonly shared were neighbors (49.3%) (n=36 of 73), in-laws (16.4%), neighbor’s children (12.3%), and others (9.6%).

Some women spontaneously offered what they thought the purpose of soy porridge was during the exit interviews. Twelve thought it was to help with HIV or ART consumption, 4 thought the soy porridge was for the health of their baby, and 2 thought it was HIV medicine. Women reported that community members thought that the soy porridge was for maternal health (reported by 9 participants), to help with pregnancy (n= 8), for providing energy (n= 6), and for the baby’s health (n= 2).

In exit interviews, ten women reported that the consequences of receiving the soy porridge were that they felt “special” or “good”, e.g. “I was thinking about how [they] love me to give this good food to help me during pregnancy,” and “I became happy because I had what [sic] to eat”.

As for intra-household consequences, at exit interviews, 82.2% of participants said the receipt of soy porridge caused no problems. Of those 13 whom experienced problems, seven reported household tension (including envy, name calling, strained relations) and 2 reported theft. Four women spontaneously mentioned positive household impact: improved relationships with their husbands (n=3), and “peacefulness” (n=1) because the children no longer cried from hunger: “Before there was no peace because of starvation”.

As for consequences of soy outside the home, 74.0% (54/72) of participants reported that people outside of their household knew that they had received soy porridge. Women

reported that community members were curious 48.1% (26/54), wanted some porridge (33.3%), or thought it was associated with HIV (27.8%). For 13 participants, soy porridge caused social problems including strained relationships (n=7), anger and name calling (n=7), and “too much inquisitiveness” (n=2). Three women feared that receiving soy porridge supplement would flag them as HIV-infected. Only two women mentioned how relationships with people outside the home changed for the better, namely because they could share with neighbors or visitors.

Discussion

In this first study of macronutrient supplementation of pregnant, HIV-infected women, both LNS and instant soy porridge were regarded favorably and used regularly. Overall, the vast majority of participants enjoyed consuming LNS both at their initial encounter and at the end of the study, citing its positive taste, sweet smell, and ease of preparation. Participants also reported adhering to guidelines for supplement use: the majority (80%) of participants consumed the entire sachet and ate it at least 6 days a week. Surprisingly, a large proportion of instant soy porridge, which was provided with the intention to reduce household use of the LNS, was consumed by pregnant study participants.

The acceptability of LNS among adult populations has been studied in 4 other countries, all in sub-Saharan Africa [17,40–45] OR (Table 5). The approaches to developing a supplementation regimen, the regimen itself, period of follow-up and assessment of acceptability and use have varied widely, making comparisons difficult. In broad strokes, however, it is possible to say that both the acceptability and use of LNS in our study compares favorably to other studies. For example, in Ghana, 96% of the 23 pregnant and lactating participants reported that they either liked the peanut-based LNS “a little” or “a lot” after a 14 day trial [17]. In our study, 100% of participants rated all organoleptic characteristics as “liked” or “strongly liked” at the first assessment, and 92% reported liking LNS at the exit interview.

Reported use of the supplement in our study (93% typically consumed entire sachet daily) was similar to or greater than in other LNS studies, even with our longer study follow-up (Table 5). In Malawi, 92.4% of participants reported consuming the recommended amount (140 g) the day prior to clinical visit [26], while in Ethiopia, 74% reported eating the recommended portion (200g LNS+30g whey or soy protein) in the prior three days [46]. In Kenya, participants in a cross-over randomized control trial ate more than 75% of the daily dosage of peanut-based LNS (250g) on 87.7% of days under direct observation (compared to 86.1% of days for a soy maize blend) [42]. In Ghana, 96% of participants reported consuming the recommended 20g “every time” [17].

Many of the issues with LNS observed in this study are also similar to those of other LNS studies. For example, pregnant and lactating women of unknown HIV status in Ghana [17] and HIV-infected adults in Ethiopia [46] initially reported the sweetness of LNS to cause nausea and vomiting. A less sweet-tasting formulation should likely be considered for future uses. LNS was experienced as stigmatizing by only 3 of our study participants; the stigmatizing connotations of LNS were also observed, but not quantified, in Kenya [41] and

Ethiopia [46]. Our participants' (mis)perceptions of LNS as a drug or medicine occurred less frequently than in the Kenyan and Ethiopian studies [41,46].

Reported sharing of LNS was low (15.6% on first follow-up visit, 4.0% subsequently), but approximately half of women reported that soy porridge had been shared with both adults and children living outside of the household. Sharing of LNS has also been reported in studies in Ethiopia [46] and Malawi [43]. Wherever food sharing is a common practice and even a cultural expectation, as it is in much of sub-Saharan Africa, it is often difficult for participants to not share their supplement, especially with their children. It was for this reason that we provided soy porridge for the household. Only one other LNS study implemented a means of reducing sharing, and its consumption by the target patient was not measured [26]. It was surprising in our study that participants consumed "the majority" of the soy porridge that had been intended for the household, and that only a small proportion of women (12.3%) attributed not sharing their LNS to the provision of soy porridge. This suggests that the importance of a household supplement may need to be reconsidered.

Although the study was not powered to detect differences in physiological or psychosocial outcomes of interest, we measured a number of characteristics that could possibly be influenced by supplementation for future study planning (Table 5). Although most differences were not significant, the values were trending in the expected direction, suggesting a positive impact would emerge in a larger study sample. They also resembled impacts of LNS supplementation observed in a much larger study of LNS use among 491 Ghanaian pregnant women of unknown HIV status [40]. There, the receipt of 20g/d of LNS during pregnancy was associated with an increase of 0.4cm in birth length compared to non-LNS intervention groups (vs. 1.0 cm in our study) and among primiparous women, infants weighed 200g more at birth (vs. 176.4g more in our study). The greater length and weight at birth of infants whose mothers were "high" consumers of LNS is biologically significant, and, if replicable at a larger scale, such that statistical significance could be shown, is a finding that could motivate policymakers to see the value of supplementation during pregnancy.

Strengths of this study include a formative phase for determining perceived nutritional needs and an appropriate supplementation regimen; a mixed-methods approach to assessing acceptability and use that included survey data complemented by data from in-depth interviews and counseling logs; inquiry into both the physiological and psychosocial consequences of supplementation for the individual and within the household and community; and the inclusion of a supplement for household members to reduce sharing. The study would have been strengthened by a larger study sample size, but logistics (e.g. LNS delayed in Ugandan customs, new quality control procedures for LNS at Nutriset) precluded this. The measurement of women's intake of soy porridge would have been beneficial for understanding the impact of the intervention, as would better elucidation of why women consumed the majority of the household supplement. Lastly, more intense exploration of reasons for low and high consumption of LNS would help to understand the differential exposure to LNS, especially probing about the role of household size and disclosure (cf. Table 4). However, at the time of the exit interview, data about amount of LNS consumed were not available.

In sum, this study contributes to the discussion about appropriate nutritional support for PLHIV because it is the first to present acceptability and use data on macronutrient supplementation of HIV-infected pregnant women. Such information is important because although LNS and other supplements are currently provided to pregnant women as part of a number of programs, including Food by Prescription [22,47], their actual use and impact are almost entirely unknown. Our findings here suggest that the plausibility of positive health impacts of supplementation during pregnancy is high and negative psychosocial or physical health consequences seems low, but that further larger studies are needed to determine the health and behavioral impacts, cost-effectiveness, scalability, and sustainability of various supplementation regimens.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

1. Papathakis PC, Rollins N. HIV and nutrition: pregnant and lactating women. World Health Organization: Consultation on Nutrition and HIV/AIDS in Africa: Evidence, lessons, and recommendations for action Durban, South Africa. 2005:1–42.
2. Kosmiski L. Energy expenditure in HIV infection. Am J Clin Nutr. 2011; 94:1677S–1682S. [PubMed: 22089443]
3. Food and Agricultural Organization. Human Energy Requirements: Report of a Joint FAO/WHO/UNU Expert Consultation, Rome. 2001 Oct 17–24. 2004.
4. Nutrition During Pregnancy. National Academies Press; 1990. Committee on Nutritional Status During Pregnancy and Lactation, Institute of Medicine, (null).
5. Raiten DJ, Mulligan K, Papathakis P, Wanke C. Executive summary--Nutritional Care of HIV-Infected Adolescents and Adults, including Pregnant and Lactating Women: What Do We Know, What Can We Do, and Where Do We Go from Here? Am J Clin Nutr. 2011; 94:1667S–1676S. [PubMed: 22089438]
6. Baum MK, Campa A, Lai S, Sales Martinez S, Tsalaile L, Burns P, et al. Effect of micronutrient supplementation on disease progression in asymptomatic, antiretroviral-naive, HIV-infected adults in Botswana: a randomized clinical trial. JAMA. 2013; 310:2154–2163. [PubMed: 24281460]
7. Banda Y, Chapman V, Goldenberg RL, Chi BH, Vermund SH, Stringer JSA. Influence of body mass index on pregnancy outcomes among HIV-infected and HIV-uninfected Zambian women. Trop Med Int Health. 2007; 12:856–861. [PubMed: 17596253]

8. Ekouevi DK, Coffie PA, Becquet R, Tonwe-Gold B, Horo A, Thiebaut R, et al. Antiretroviral therapy in pregnant women with advanced HIV disease and pregnancy outcomes in Abidjan, Côte d'Ivoire. AIDS. 2008; 22:1815–1820. [PubMed: 18753864]
9. Villamor E, Dreyfuss ML, Baylín A, Msamanga G, Fawzi WW. Weight loss during pregnancy is associated with adverse pregnancy outcomes among HIV-1 infected women. J Nutr. 2004; 134:1424–1431. [PubMed: 15173407]
10. Castetbon K, Ladner J, Leroy V, Chauliac M, Karita E, De Clercq A, et al. Low birthweight in infants born to African HIV-infected women: relationship with maternal body weight during pregnancy: Pregnancy and HIV Study Group (EGE). J Trop Pediatr. 1999; 45:152–157. [PubMed: 10401193]
11. Young, S.; Murray, K.; Mwesigwa, J.; Natureeba, P.; Osterbauer, B.; Achan, J., et al. Maternal Nutritional Status Predicts Adverse Birth Outcomes among HIV-Infected Rural Ugandan Women Receiving Combination Antiretroviral Therapy. In: Thorne, C., editor. PLoS ONE. Vol. 7. 2012. p. e41934
12. Kramer MS. Determinants of low birth weight: methodological assessment and meta-analysis. Bulletin of the World Health Organization. 1987; 65:663–737. [PubMed: 3322602]
13. Kelly A, Kevany J, de Onis M, Shah PM. A WHO Collaborative Study of Maternal Anthropometry and Pregnancy Outcomes. Int J Gynaecol Obstet. 1996; 53:219–233. [PubMed: 8793624]
14. Viswanathan, M.; Siega-Riz, AM.; Moos, MK.; Deierlein, A.; Mumford, S.; Knaack, J., et al. Outcomes of maternal weight gain. Rockville, MD: Evidence report/technology assessment; 2008. p. 1-223.
15. Siegfried N, Irlam JH, Visser ME, Rollins NN. Micronutrient supplementation in pregnant women with HIV infection. Cochrane Database Syst Rev. 2012; 3:CD009755. [PubMed: 22419344]
16. Bhutta ZA, Das JK, Rizvi A, Gaffey MF, Walker N, Horton S, et al. Evidence-based interventions for improvement of maternal and child nutrition: what can be done and at what cost? Lancet. 2013; 382:452–477. [PubMed: 23746776]
17. Adu-Afarwuah S, Lartey A, Zeilani M, Dewey KG. Acceptability of lipid-based nutrient supplements (LNS) among Ghanaian infants and pregnant or lactating women. Matern Child Nutr. 2011; 7:344–356. [PubMed: 21496207]
18. Young SL, Blanco I, Pelto GH, Neufeld LM. Organoleptic properties, ease of use, and perceived health effects are determinants of acceptability of micronutrient supplements among poor Mexican women. J Nutr. 2010; 140:605–611. [PubMed: 20107141]
19. Aguayo V, Kone D, Bamba S, Diallo B, Sidibe Y, Traore D, et al. Acceptability of multiple micronutrient supplements by pregnant and lactating women in Mali. Public Health Nutr. 2005; 8:33–37. [PubMed: 15705243]
20. Seck B, Jackson R. Determinants of compliance with iron supplementation among pregnant women in Senegal. Public Health Nutr. 2007:1–10.
21. Galloway R, Dusch E, Elder L, Achadi E, Grajeda R, Hurtado E, et al. Women's perceptions of iron deficiency and anemia prevention and control in eight developing countries. Soc Sci Med. 2002; 55:529–544. [PubMed: 12188461]
22. Nagata, JM.; Cohen, CR.; Young, S.; Wamuyu, C.; Armes, MN.; Otieno, BO., et al. Descriptive Characteristics and Health Outcomes of the Food by Prescription Nutrition Supplementation Program for Adults Living with HIV in Nyanza Province, Kenya. In: Lama, JR., editor. PLoS ONE. Vol. 9. 2014. p. e91403
23. Rawat R, Kadiyala S, McNamara PE. The impact of food assistance on weight gain and disease progression among HIV-infected individuals accessing AIDS care and treatment services in Uganda. BMC Public Health. 2010; 10:316. [PubMed: 20529283]
24. Tirivayi N, Groot W. Health and welfare effects of integrating AIDS treatment with food assistance in resource constrained settings: a systematic review of theory and evidence. Soc Sci Med. 2011; 73:685–692. [PubMed: 21824702]
25. Flax VL, Bentley ME, Chasela CS, Kayira D, Hudgens MG, Knight RJ, et al. Use of lipid-based nutrient supplements by HIV-infected Malawian women during lactation has no effect on infant growth from 0 to 24 weeks. J Nutr. 2012; 142:1350–1356. [PubMed: 22649265]

26. Kayira D, Bentley ME, Wiener J, Mkhomawanthu C, King CC, Chitsulo P, et al. A lipid-based nutrient supplement mitigates weight loss among HIV-infected women in a factorial randomized trial to prevent mother-to-child transmission during exclusive breastfeeding. Am J Clin Nutr. 2012; 95:759–765. [PubMed: 22258269]
27. Grobler L, Siegfried N, Visser ME, Mahlungulu SSN, Volmink J. Nutritional interventions for reducing morbidity and mortality in people with HIV. Cochrane Database Syst Rev. 2013; 2:CD004536. [PubMed: 23450554]
28. Jerome, N.; Kandel, R.; Pelto, G. An Ecological Approach to Nutritional Anthropology. In: Jerome, N.; Kangel, R.; Pelto, GH., editors. Nutritional Anthropology: Contemporary Approaches to Diet and Culture. Redgrave Publishing Company; 1980. p. 13-45.
29. Young, SL.; Pelto, GH. Core Concepts in Nutritional Anthropology. Temple, N., et al., editors. Totowa, NJ: Humana Press; 2012. p. 523-537.
30. Coates, J.; Swindale, A.; Bilinsky, P. Household food insecurity access scale (HFIAS) for measurement of food access: Indicator guide. Washington DC: Food and Nutrition Technical Assistance Project; 2007.
31. Deitchler M, Ballard T, Swindale A, Coates J. Introducing a Simple Measure of Household Hunger for Cross-Cultural Use. Food and Nutrition Technical Assistance II Project (FANTA-2) AED. 2011:1–16.
32. Antelman G, Smith Fawzi MC, Kaaya S, Mbwambo J, Msamanga GI, Hunter DJ, et al. Predictors of HIV-1 serostatus disclosure: a prospective study among HIV-infected pregnant women in Dar es Salaam, Tanzania. AIDS. 2001; 15:1865–1874. [PubMed: 11579250]
33. Broadhead WE, Gehlbach SH, de Gruy FV, Kaplan BH. The Duke-UNC Functional Social Support Questionnaire. Measurement of social support in family medicine patients. Med Care. 1988; 26:709–723. [PubMed: 3393031]
34. Radloff, LS. Applied Psychological Measurement. Vol. 1. Sage Publications; 1977. The CES-D scale a self-report depression scale for research in the general population; p. 385-401.
35. Kalichman SC, Rompa D, Cage M. Distinguishing between overlapping somatic symptoms of depression and HIV disease in people living with HIV-AIDS. J Nerv Ment Dis. 2000; 188:662–670. [PubMed: 11048815]
36. Kalichman SC, Simbayi LC, Cloete A, Mthembu PP, Mkhonta RN, Ginindza T. Measuring AIDS stigmas in people living with HIV/AIDS: the Internalized AIDS-Related Stigma Scale. AIDS Care. 2009; 21:87–93. [PubMed: 19085224]
37. Charmaz, K. Constructing grounded theory. Sage Publications Ltd; 2006.
38. Glaser B, Strauss A. The discovery of grounded theory strategies for qualitative research. Aldine Transaction. 1967
39. Young S, Plenty AHJ, Luwedde FA, Natamba BK, Natureeba P, Achan J, et al. Household Food Insecurity, Maternal Nutritional Status, and Infant Feeding Practices Among HIV-infected Ugandan Women Receiving Combination Antiretroviral Therapy. Matern Child Health J. 2014
40. Adu-Afarwuah S, Lartey A, Okronipa H, Peerson J, Vosti S, Ashorn P, et al. Lipid-based nutrient supplement for pregnant women improve birth outcomes among primiparous but not multiparous women in Ghana (256.7). FASEB J [Internet]. 2014 Available from: http://www.fasebj.org/content/28/1_Supplement/256.7.short.
41. Dibari F, Bahwere P, Le Gall I, Guerrero S, Mwaniki D, Seal A. A qualitative investigation of adherence to nutritional therapy in malnourished adult AIDS patients in Kenya. Public Health Nutr. 2011; 15:316–323. [PubMed: 21294939]
42. Dibari F, Bahwere P, Huerga H, Irena AH, Owino V, Collins S, et al. Development of a cross-over randomized trial method to determine the acceptability and safety of novel ready-to-use therapeutic foods. Nutrition. 2013; 29:107–112. [PubMed: 22981306]
43. Corneli A, Piwoz E, Bentley M, Moses A, Nkhoma J, Tohill B, et al. Involving communities in the design of clinical trial protocols: the BAN Study in Lilongwe, Malawi. Contemp Clin Trials. 2007; 28:59–67. [PubMed: 17000137]
44. Ndekha MJ, van Oosterhout JJG, Zijlstra EE, Manary M, Saloojee H, Manary MJ. Supplementary feeding with either ready-to-use fortified spread or corn-soy blend in wasted adults starting

antiretroviral therapy in Malawi: randomised, investigator blinded, controlled trial. BMJ. 2009; 338:b1867. [PubMed: 19465470]

45. Bahwere P, Sadler K, Collins S. Acceptability and effectiveness of chickpea sesame-based ready-to-use therapeutic food in malnourished HIV-positive adults. Patient preference and adherence. 2009; 3:67–75. [PubMed: 19936147]
46. Olsen MF, Tesfaye M, Kaestel P, Friis H, Holm L. Use, perceptions, and acceptability of a ready-to-use supplementary food among adult HIV patients initiating antiretroviral treatment: a qualitative study in Ethiopia. Patient preference and adherence. 2013; 7:481–488. [PubMed: 23766634]
47. Gerberg, L.; Stansbury, JP. Food by prescription in Kenya: An assessment conducted in 2009. Arlington, VA: AIDSTAR-ONE Project; 2010.

Table 1

Issues with LNS and soy porridge supplements reported during counseling sessions, by number of participants reporting them

	LNS	Soy porridge
Caused nausea, vomiting, gas, stomachache, diarrhea	10	2
Disliked the smell or taste	9	1
No supplement with her while traveling	8	0
Overconsumed (>1 sachet/day) because of hunger	6	0
Loss of appetite made it undesirable	5	1
None to eat because children stole them	4	0
Forgot to take it	4	0
Shared “for public relations”	4	0
Difficulty eating because of hiding them, fear of stigma	2	0
Afraid it will make baby too big	1	1
None to eat because she left them in taxi	1	1
Overconsumed (>1/day) because she had forgotten the previous day	1	0
Husband sold for $ for alcohol	0	1

Table 2

LNS consumption patterns among 77 pregnant, HIV-infected Ugandan women on cART

Consumption behavior	characteristic assessed	At initial follow-up visit n=77	At subsequent follow-up visits* n=66
Mean days per week typically consumed	frequency	6.1	6.4
% reporting consumption the prior day	frequency	70.1%	79.9%
% reporting typically consuming entire sachet	quantity	83.1%	93.1%
% reporting consuming entire sachet immediately after opening	quantity	81.8%	93.6%
% reporting consuming exactly 1 sachet the prior day	quantity	62.3%	78.0%
% reporting consuming exactly 1 sachet two days ago	quantity	71.4%	86.6%
% reporting not sharing LNS since last visit	sharing	84.4%	96.0%
% reporting consumption in between meals	replacement	92.2%	97.1%
% reporting consuming supplement by itself, i.e. not mixed with other foods	replacement	96.1%	96.6%

* Mean across 2nd-6th visits

Table 3

Sociodemographic, anthropometric, nutrition and psychosocial characteristics of supplementation study participants at baseline, by high and low supplement consumption

	Low supplement consumers (N=15)	High supplement consumers (N=60)	
	Mean(SD) or %	Mean(SD) or %	p-value
Sociodemographics			
Maternal age (years)	26.7 (3.6)	29.6 (5.8)	0.059
Number of people in household	4.3 (1.7)	6.4 (2.1)	0.001
Disclosed HIV status to anyone in household	73.3%	93.3%	0.046
Number of adults with HIV in household	1.2 (0.4)	1.2 (0.6)	0.621
Number of children with HIV in household Marital status:	0	0.2 (0.4)	0.198
Single	13.3%	1.7%	
Married or cohabiting	86.7%	83.3%	
Other	0.0%	10.0%	0.305
Experienced physical or sexual violence in the last year from household member	20.0%	21.7%	1.000
Experienced physical or sexual violence in the last year from non-household member	20.0%	11.7%	0.408
High asset score	20.0%	5.8%	0.134
Anthropometry			
Gestational age at enrollment into parent study (weeks)	21.8 (3.8)	20.1 (4.3)	0.162
Height (cm)	161.1 (7.8)	162.1 (5.0)	0.525
Weight (kg)	57.8 (7.9)	58.8 (7.1)	0.386
BMI at enrollment	22.5 (4.0)	22.4 (2.5)	0.497
Food security and intake			
HFIAS score	5.8 (3.9)	11.8 (6.4)	0.002
Household hunger score	0.6 (1.0)	1.6 (1.8)	0.069
For the remainder of this pregnancy, would you like to:			
Gain no more weight	6.7%	18.3%	
Gain weight at a slower pace	26.7%	51.7%	
Gain weight at the same pace	26.7%	15.0%	
Gain weight at a faster pace	26.7%	13.3%	
Don't know	13.3%	1.7%	0.051
Number of meals eaten yesterday	2.0 (0.8)	1.7 (0.6)	0.172
Number of meals eaten two days ago	2.0 (0.7)	2.0 (0.6)	0.862
Number of snacks eaten yesterday	0.5 (0.7)	0.8 (0.8)	0.281
Number of snacks eaten two days ago	1.3 (0.9)	0.8 (0.8)	0.076
Engaged in geophagy during this pregnancy	50.0%	50.0%	1.000
Exertion			
Hours spent digging/weeding/harvesting during last two days	1.1 (1.9)	1.5 (1.6)	0.277
Hours spent walking with a heavy load during last two days	0.5 (0.7)	0.8 (1.6)	0.721

	Low supplement consumers (N=15)	High supplement consumers (N=60)	
	Mean(SD) or %	**Mean(SD) or %**	**p-value**
Hours spent pounding during last two days	0.1 (0.3)	0.3 (0.9)	0.376
Total exertion over last two days (hours)	1.7 (2.1)	2.6 (2.3)	0.143
Psychosocial Indicators*			
Social support score Low social support	30.6 (4.3) 13.3%	31.4 (3.6) 13.3%	0.499 1.000
Depression score	14.1 (5.3)	12.6 (5.2)	0.341
Stigma score	2.9 (1.6)	2.2 (2.1)	0.117

* See Methods section for explanation of assessment.

Table 4

Differences in anthropometry, depression, exertion, and infant outcomes, by high and low supplement consumption

	Low Supplement Consumers (N=15)	High Supplement Consumers (N=56)	p-value
	Mean(SD) or %	Mean(SD) or %	
Days on study (range: 27 – 169)*	61.9 (29.9)	92.3 (38.3)	0.008
Maternal Outcomes			
Depression score (change oversupplementation period)[1,2]	−2.0 (10.0)	−1.8 (4.3)	0.811
Change in hours of exertion in prior twodays over supplementation period[1,2]	−0.1 (1.9)	0.1 (0.4)	0.719
HFIAS score (change oversupplementation period)	−0.1 (1.9)	0.6 (2.8)	0.719
HFIAS score at last assessment	5.7	12.6	0.002
GWG per week (over supplementation period)[3]	0.17 (0.21)	0.18 (0.23)	0.844
BMI per week (over supplementation period)[3]	0.06 (0.08)	0.07 (0.09)	0.922
Infant Outcomes			
Birthweight (g)	3016.8 (609.2)	3040.5 (561,6)	0.607
Birthweight (g), Parity = 0 (n=7)	3271.3 (812.1)	3446.7 (470.1)	1.000
Birthweight (g), Parity > 0 (n=62)	2915.0 (525.4)	3017.4 (561.2)	0.405
Low birthweight (<2500g)[6]	21.4%	9.1%	0.345
Low birthweight, Parity = 0 (n=7)	25.0%	0.0%	1.0 00
Low birthweight, Parity > 0 (n=62)	20.0%	9.6%	0.3 14
Length (cm)	47.3 (2.7)	48.3 (2.1)	0.257
Head circumference (cm)	34.1 (1.7)	34.3 (1.1)	0.276

[1] Restricted to women with at least two measurements (n=64)

[2] Change in depression and exertion are computed as last measurement minus first measurement.

[3] Restricted to women whose first (after starting supplementation) and last measurements were at least 28 days apart (N = 70)

Table 5

Overview of all LNS acceptability and use studies conducted among adults

Study country, Year	Sample size	HIV status	Formative work ?	Quantity of LNS (daily)	Supplement for HH	Duration of Follow-Up	Acceptability	Reported use	Ref
Ethiopia, 2001	74 HIV-infected adults	Infected, on ART	Yes	200g of peanut-based LNS + 30g of whey or soy protein	None	Up to 3 months	Acceptable based on qualitative data	Median intake of 176g/day; 74% reported to have consumed consumed “everything” or “almost everything” over the past 3 days	[39]
Ghana, 2009	24 pregnant or lactating women	Uninfected	Yes	20g of peanut-based LNS	None	2 weeks	Acceptable based on quantitative (hedonic) and qualitative data	96% reported eating the entire supplement “every time.”	[17]
Ghana, unknown	930 pregnant women	Not reported	Yes	1 treatment group received 20g of peanut-based LNS	not reported	Not reported	Not reported	not reported	[43]
Kenya, 2008	41 HIV/TB-infected adults	Infected, some on ART	No	250g of soy/maize blend, then 250g of peanut-based LNS	None	2 weeks each with 1 week washout	Both supplements were acceptable, though soy/ maize blend slightly more so based on qualitative and quantitative (hedonic scale and safety) data	Soy/maize blend: Participants ate more than 75% of the provided dose 86.1% of time LNS: Participants ate more than 75% of the provided dose 87.7% of the time	[40]
Kenya, 2008	46 HIV-infected adults	Infected, on ART	No	400g of peanut-based LNS	None	1 month	High acceptability based on qualitative data	63% complied with prescribed amount of supplement	[41]
Malawi, 2004	35 mothers of undisclosed status	Unknown	Yes	Fortified maize–soy blend; fortified sweet biscuit; fortified unsweetened biscuit; and vitamin–mineral sprinkles.	None	2 days for each supplement	Maize soy blend, sweet biscuit, and peanut butter paste were found to be acceptable	88% of the 17 mothers interviewed said they would consume the peanut butter paste daily	[42]

Study country, Year	Sample size	HIV status	Formative work ?	Quantity of LNS (daily)	Supplement for HH	Duration of Follow-Up	Acceptability	Reported use	Ref
				Quantities not reported. Quantities not reported.			based on qualitative data.		
Malawi, 2005	60 HIV-infected adults	Infected, some on ART	No	500g of chickpea-sesame based LNS	None	3 months	Acceptable based on qualitative data	Mean daily intake was 300 g	[45]
Malawi, 2006–7	491 HIV- infected adults with BMI <18.5	Initiating ART	No	245g of peanut-based LNS vs 376g of corn-soy blend	None	14 weeks	“Universally highly appreciated” based on focus group discussions.	95.2% in LNS arm reported not missing a dose in the prior week	[46]
Uganda, 2012	56 HIV-infected pregnant or lactating women for formative phase; 89 HIV-infected pregnant women for acceptability and use study	Infected, all on ART	Yes	92g of peanut-based LNS and 4–6kg of soy porridge for household (for month)	Monthly supply of 4–7 kg of instant soy porridge	Pregnancy	Acceptable based on qualitative and quantitative (hedonic scale) data	93% reported typically consuming the entire 92g sachet daily.	this study