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FOOD BY PRESCRIPTION

Measuring the Impact and Cost-Effectiveness of Prescribed Food on Recovery from Malnutrition and HIV Disease Progression Among HIV+ Adult Clients in Ethiopia

A partnership study between Tufts University and Save the Children US in Ethiopia for USAID/FBP

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The ideas, opinions, and comments below are entirely the responsibility of the author(s) and do not necessarily represent or reflect USAID or Irish AID policy.

Contents

LIST OF ACRONYMS

AIDS	Acquired Immune Deficiency Syndrome
ART	Antiretroviral Treatment
BMI	Body Mass Index
CMAM	Community Management of Acute Malnutrition
CSB	Corn Soy Blend
DALY	Disability-Adjusted Life Year
ETB	Ethiopian Birr
FBP	Food by Prescription
FGD	Focus Group Discussion
GNI	Gross National Income
HAPCO	HIV/AIDS Prevention and Control Office
HFIAS	Household Food Insecurity Access Scale
HIV	Human Immunodeficiency Virus
HMIS	Health Management Information System
IQR	Interquartile Range
LTF	Lost to Follow-Up
MAM	Moderate Acute Malnutrition
MoH	Ministry of Health
MUAC	Mid-Upper Arm Circumference
NACS	Nutrition Assessment, Counseling, and Support
OR	Odds Ratio
OVC	Orphans and Vulnerable Children
PEPFAR	President's Emergency Plan for AIDS Relief
PFSA	Pharmaceutical Fund and Supply Agency
PLHIV	People Living with HIV
RUSF	Ready-to-Use Supplementary Food
RUTF	Ready-to-Use Therapeutic Food
SAM	Severe Acute Malnutrition
SC	Save the Children
SCMS	Supply Chain Management System
TB	Tuberculosis
USAID	United States Agency for International Development
USD	United States Dollar
WFP	World Food Programme
WHO	World Health Organization

EXECUTIVE SUMMARY

Great strides have been made over the last 20 years in the long-term management of HIV infection in developing countries, resulting in improved immune function, reduced mortality, and prolonged survival. However, underlying malnutrition continues to impede positive health outcomes, and HIV infection in turn worsens malnutrition. The Ethiopia Food by Prescription (FBP) program, implemented by Save the Children US (SC US), USAID/Ethiopia, and the Ethiopian Ministry of Health since 2010, provides therapeutic food along with nutritional assessment and counseling to malnourished HIV+ individuals. The Tufts University Friedman School of Nutrition Science and Policy was contracted by SC US to research the effectiveness and cost-effectiveness of this intervention, in order to contribute much needed evidence to guide programming and policy, both in Ethiopia and worldwide.

Specifically, the study aimed to examine the effect on health and nutrition outcomes of food offered "by prescription" to malnourished adults living with HIV/AIDS who were at different stages of treatment. Stages of treatment included: pre-ART, ART for less than six months, and ART for more than six months. The food offered by prescription was "Plumpy'Nut™," a ready-to-use lipid-based therapeutic food. Nutritional status at baseline of participants was classified as either severe or moderate acute malnutrition, defined by BMI <= 16, and BMI > 16 < 18.5, respectively. Cost-effectiveness was assessed by measuring the marginal cost of incorporating the food supplement into the treatment program for HIV+ patients, and then relating it to the marginal benefits (specific health and nutrition outcomes) of this intervention. The study was designed as a quasi-experimental effectiveness evaluation, with a comparison group of clinics selected from a geographic area similar to those in which the intervention was being evaluated.

Key findings are noted below:

- Controlling for other factors, participants receiving the therapeutic food package (Food by Prescription/FBP) were 2.4 times more likely to meet the program criteria for graduation/recovery (i.e., to reach a BMI of 18.5 for two consecutive clinic visits within the defined time period) than similar patients who did not receive the additional food in their ART treatment regimen (comparison group).
- FBP participants were 3.1 times as likely to have ever reached a BMI of 18.5 as those not receiving food (comparison group). Among all participants, 32.6% achieved BMI >= 18.5 at least once during treatment in the FBP group, compared to 18.8% in the comparison group.
- Participants in the FBP group classified as SAM at baseline showed slightly larger increases in BMI than those with MAM (in the same group), though were less likely to recover. Thus for optimal recovery, this result underlines the importance of closely monitoring the nutritional status of HIV patients, treating malnutrition at early stages, and increasing early access to HIV/AIDS care.
- While nutrition outcomes in the intervention area were significantly better than those seen in the comparison area, recovery rates overall, as defined by the program, were low in both groups (11.3% in FBP vs. 7.4% in comparison).
- Recovery rates went up considerably (to 42% in the FBP group) if only those participants who complied with the FBP program protocol (i.e., did not default) were considered. This suggests that there is good potential to improve the impact and effectiveness of this type of nutritional program, if additional efforts are made to improve both patient adherence and health worker understanding of the protocol, program needs, and record-keeping approach.
- In the FBP group, factors associated with increased chance of recovery from malnutrition included being female, recent commencement of ART, being moderately rather than severely malnourished, having a CD4 count higher than 200 cells/microliter, and coming from a food insecure household. These findings could have important implications for the prioritization of resources for nutritional supplementation in ART programs.

- While non-response, as defined by the FBP program, was lower in the FBP participants than in the comparison participants (15.9% vs. 31.9%), overall the rate of non-response among those participants who complied with treatment (i.e., stayed in the program until discharge) in the FBP group was high (58%) and even higher for those who were sickest at baseline.
- Being severely malnourished (SAM), having a low CD4 count, and receiving treatment through a hospital vs. a health center were all associated with increased risk of non-response.
- Qualitative data suggest that poor response rates are, in part, a result of intra-household sharing of the nutritional supplement and limited household access to other food.
- However, weight and BMI gain in the FBP group was still significantly higher in both non-responders and recovered patients than that recorded among both non-responders and recovered participants in the comparison group. Thirty-seven percent of "non-responders" had reached a BMI of 18.5 once during their treatment in the FBP group. This underscores that while recovery may not be achieved according to program definitions, there likely remains considerable benefit to supporting interventions that increase access to nutritional support and thereby weight gain of participants. It also underscores the need to address compliance issues and to re-examine maximum allowable length of stay for the sickest patients admitted with SAM/very low CD4 in order to maximize weight gain and recovery rates
- A key issue identified in the analysis is that a large proportion of the study participants either defaulted or were lost to follow-up before nutritional treatment was completed—70.6% in the intervention group:
  - There were a large number of moderately malnourished who participated in the program for two months (until visit three) and then defaulted (41% of all defaulters who were MAM at admission in the intervention group fall into this category). It is likely that this represents, in part, a misunderstanding of the protocol on the part of the health workers, a hypothesis supported by our qualitative data. The median BMI at the third visit of this group was 18.3, suggesting they were close to reaching the target BMI of 18.5.
  - At baseline, participants who eventually defaulted were more likely to have attended a hospital rather than health center for treatment, have a lower BMI and be categorized initially as SAM, have spent less time on ART, have a high level of food insecurity, and have a greater frequency of other diseases in comparison to those participants who complied with treatment. This study was not able to ascertain the proportion of this group who were either too weak to attend their appointments regularly, or had died at home.
  - Qualitative data also suggests that a not insignificant proportion of recorded defaulters was still participating in the program and had not defaulted at all and also that discomfort or illness resulting from RUTF consumption led some participants to discontinue receipt of the RUTF ration.
  - This study was performed in the early stages of program implementation, as health workers were still being trained on the protocol and before full buy-in by the health system had been achieved. This may have contributed to low recovery rates and high default.
- The provision of a food supplement may help to slow the progression of HIV over time. Controlling for other factors, individuals receiving the RUTF in addition to their ART clinic treatment showed an increase in CD4 count of 75 cells/microliter more than those who did not receive the food supplement. This difference was most significant for those participants who were not on an ART regimen.
- In addition to CD4 count as an indicator for disease progression, participant functional status was also examined using the WHO-defined scale of "working," "ambulatory," and "bedridden." Over time, the treatment group demonstrated greater improvements in functional status than the comparison group, with 21.9% and 3.8% of the treatment and comparison groups, respectively, showing improvement.

- Of those who graduated (recovered according to program protocol), 80.0% maintained or improved their BMI at >= 18.5 at six months after exit, while 20.0% relapsed to become malnourished again. Of those who were discharged from the intervention as a "non-responder," 33.7% maintained or improved their BMI, while the nutritional status of 66.3% remained at BMI < 18.5.
- The largest component of the cost of the FBP program is the cost of the product itself. The RUTF represents about 70% of the total cost per SAM patient, and about 60% of the total cost for MAM.
- SC administration accounts for 30% and 40% of total cost for SAM and MAM, respectively. As the program continues to expand and the number of beneficiaries increases, we expect that the administrative costs will not rise at the same rate, so the cost per patient will drop.
- The FBP program increases the amount of time that clinical staff spend with patients during visits to the ART clinic. This is especially notable among the MAM patients. FBP patients may be benefiting from more intensive interaction with clinical staff during their visits. Clinic staff are aware of the additional burden imposed by the program, citing increased time in record keeping and a higher patient load, but they also report more time spent counseling patients and performing clinical assessments. They also universally mentioned their appreciation of the ability to offer this concrete additional benefit to their patients.
- FBP patients spent more time in a clinical visit, and more time waiting in between interactions with clinic staff of different kinds, than did comparison patients. The time spent in the clinical visit may reflect a positive benefit of the program. Patients in the comparison clinics spend more time traveling to and from the clinic than do patients in FBP clinics, but this is most likely due to the fact that the comparison clinics are in less densely populated areas, and thus patients are more dispersed.
- There was no evidence that transporting the RUTF added to the cost or time burden of traveling to and from the clinic. Among FBP patients, there was no difference in the time or in the cost or need to pay for transportation between traveling to and returning from the clinic, suggesting that carrying the RUTF home did not pose a burden.
- Because "recovery" rate from malnutrition as defined by the program was so low, the marginal cost per patient recovered in the FBP program was high: USD 12,192 for SAM patients and USD 1,980 for MAM patients. This calculation includes those who defaulted. However, the marginal cost of improving nutritional status by at least one BMI point (USD 590 for SAM patients and USD 410 for MAM patients) in the FBP group was much lower and close to Ethiopia's 2011 per capita Gross Domestic Product (GDP) of USD 400 (World Bank 2011).
- Cost per impact indicator is, in almost every case, considerably higher for SAM than for MAM patients, underlining the importance of identifying patients who are wasted and intervening early. The lower cost per patient for SAM patients of adding one BMI point suggests that, starting from a lower BMI to begin with, they had more scope for increasing their BMI.

This study has demonstrated that the addition of therapeutic food to a treatment program for malnourished, HIV+ patients added considerable value. As one of the first studies to examine the effect of the addition of therapeutic food to an HIV treatment regimen using a comparison group, it generated rigorous, useful evidence to inform multiple programmatic recommendations relevant to Ethiopia's Food by Prescription Program, as well as to other similar efforts being scaled up globally.

Patients who received food were significantly more likely to recover from malnutrition than those who did not receive food, and treatment with supplementary food was much more successful, and more cost-effective, when malnourished individuals were identified and treated early. Additionally, patients who recovered through the addition of supplementary food experienced long-lasting positive effects on their health and nutrition status. While the marginal cost per patient recovered in the FBP program was high, the marginal cost of

improving nutritional status by at least one BMI point was much lower—an important finding considering the link between weight loss and increased risk of mortality. In addition, our hypothetical costing models show that a focus on improving supply (health service delivery) and demand (client adherence, participation, compliance) would further strengthen the effectiveness and cost effectiveness of this strategy, and this study makes several recommendations as to how this might be done. In light of these results, we would recommend that nutritional assessment counseling and support remains an integral component of ART programs in Ethiopia. The current (2008) version of the National Nutrition Program in Ethiopia supports the implementation of nutrition support for pre-ART/ART HIV/AIDS patients, and this should remain a priority in the 2012/13 version being developed by the Ministry of Health now. ■

Great strides have been made over the last 20 years in the long-term management of HIV infection in developing countries, resulting in improved immune function, reduced mortality, and prolonged survival (WFP, WHO, UNAIDS 2008; Ivers, Cullen et al. 2009). However, underlying malnutrition continues to impede positive health outcomes, and HIV infection in turn worsens malnutrition (Ivers, Cullen et al. 2009). To address the burden of disease resulting from this vicious cycle, international agencies have called for increased investment in programs that link targeted nutrition interventions to HIV management (SCN 2004; World Bank 2006; WFP, WHO, UNAIDS 2008; WHO 2008). Programs delivering inputs that include nutrition assessment, counseling, therapeutic nutrition rehabilitation, and livelihood support to HIV+ adults and children are being scaled up globally. One study identified 48 different programs (Title II, WFP, and PEPFAR-funded) that combine nutrition support with HIV programming (Webb, Rogers et al. 2011), while another study that surveyed all 336 PEPFAR-funded sites across nine African countries found that 90% of them provided some form of nutrition support (Anema, Zhang et al. 2012)

And yet, there are very few studies of the effectiveness of large-scale nutrition interventions linked to HIV care and no studies, to our knowledge, that have examined the detailed costs and cost-effectiveness of such integrated programs. As Greenaway underscores in her landscape analysis of Food by Prescription interventions, "the need to establish an evidence base is urgent." (Greenaway 2009, p. 29)

The Ethiopia Food by Prescription program, implemented by Save the Children US (SC US), USAID/Ethiopia, and the Ethiopian Ministry of Health since 2010, provides therapeutic food along with nutritional assessment and counseling to malnourished HIV+ individuals. The Tufts University Friedman School of Nutrition Science and Policy was contracted by SC US to research the effectiveness and cost-effectiveness of this intervention, in order to contribute much needed evidence to guide programming and policy, both in Ethiopia and worldwide.

The first section of this report presents the theory of change that underlies the design of food by prescription programs, and describes the rationale for this study in the context of the existing literature. The second section describes the methods used and the results measured as part of the impact study component, and also presents a discussion of the observed results. The third section presents the methods of the cost study, the detailed program costs, and the cost-effectiveness estimates. Finally, the report pulls the results observed in these two overarching approaches together, drawing conclusions from the work and offering recommendations for future programming and policy-making.

Program Theory of Nutrition-HIV Integrated Interventions

The integration of nutrition support into HIV programs aspires to achieve one or more objectives through three potential causal pathways. The first pathway provides nutrition support in order to rehabilitate severely or moderately malnourished individuals. As low BMI has been shown to have an independent effect on HIV-related mortality, improving weight gain, BMI, and lean body mass may be the most direct pathway to achieving greater quality of life and longevity. A second pathway seeks to provide therapeutic nutrition support in order to translate improvements in nutrition status into improved immune function—commonly measured by increased CD4 count and a reduction in opportunistic infections that ultimately lead to mortality. There is a feedback loop in this second pathway back to nutritional status, as suppressed disease activity may also improve metabolism of nutrients as a result of lower levels of inflammation and energy demands from viral load, and may lead to a reduction in catabolism of lean tissue. A third potential pathway harnesses the role of food as an incentive to improve ART adherence, both as a draw to the clinic for ARTs and as a means of improving patient compliance with the ART

regimen through the palliative effects of food on ART side effects and toxicity, leading to better clinical outcomes.

A fourth pathway, operating in some but not all HIV-nutrition programs, seeks to link patients and their households to food security and livelihood support "wraparound" services as a way of sustaining achievements in the first three pathways. Nutrition counseling, when provided as an input, can only be expected to be effective when offered in a food secure context or as part of this fourth sustainability pathway; synergistic effects might be expected from improved food security and effective communication to enable patients to improve the dietary management of their disease. ■

Evidence of Impact

Evidence from developing countries supporting these "theory of change" pathways is still relatively rare and derived primarily from studies with sub-optimal study designs (only two randomized controlled trials were identified that examined macronutrient supplementation and HIV/nutrition outcomes in developing countries. See Cantrell, Sinkala et al. 2008; Ndekha, van Oosterhout et al. 2009.

Evidence of an independent effect of improved weight gain and BMI from supplementary or therapeutic nutrition is inconclusive (Koethe, Chi et al. 2009). Of the studies reviewed here, three found that any detected changes in BMI and weight gain did not differ significantly from those in an unsupplemented group (Cantrell, Sinkala et al. 2008; Swaminathan, Padmapriyadarsini et al. 2010; CRS 2011). In three studies, significant changes in weight gain were observed, but ethical or logistical considerations did not enable comparisons to non-supplemented patients to enable the isolation of the effect of the supplement from other treatment factors (Maina 2005; Ndekha, Manary et al. 2005; Bahwere, Sadler et al. 2009; Food and Nutrition Technical Assistance II Project (FANTA-2) 2009; Ndekha, van Oosterhout et al. 2009; Ahoua, Umutoni et al. 2011). A study by Ivers et al. in Haiti found that BMI *decreased* across both intervention and comparison groups, albeit by significantly less among those receiving a household food ration (Ivers, Chang et al. 2010). And, finally, a study in Uganda of patients receiving assistance from the community-based organization TASO found that weights improved more among those receiving food assistance relative to a statistically derived control group using propensity score matching techniques (Rawat, Kadiyala et al. 2010). The fact that improvements in weight gain and BMI were detected in most studies but that, in those studies with comparison groups, weight gain was not significantly greater in groups receiving food supplements suggests that adherence to the food supplement may have been poor, or that ART initiation alone may also play a significant independent role in improved nutrition outcomes (Cantrell, Sinkala et al. 2008).

Evidence derived from developed country studies suggests a similar picture. A Cochrane systematic review of the effects of macronutrient supplementation on morbidity and mortality of HIV+ individuals examined eight randomized controlled trials in developed countries, and concluded that there was no evidence of an effect on body weight or fat-free mass (Mahlungulu, Grobler et al. 2007). However, in this review, subjects had a mean baseline BMI ranging from 19.9 to 26, and were thus clinically very different from the typical participant in developing country HIV nutrition programs, many of whom are targeted primarily on the basis of malnutrition criteria, with BMI cutoffs of 18.5 or lower. The author determines that the body of evidence, while suggestive, is too scanty to draw any definitive conclusions regarding the overarching question posed by the systematic review.

Many of these same studies also examined outcomes related to the second and third causal pathways described above. While several studies have demonstrated a significant effect of food supplementation on ART adherence (Cantrell, Sinkala et al. 2008; Lamb, El-Sadr et al. 2012), these same studies and others have consistently failed to show a significant effect on disease progression (CD4 counts or WHO stages) and mortality (Mahlungulu, Grobler et al. 2007; Cantrell, Sinkala et al. 2008; Ndekha, van Oosterhout et al. 2009; Ivers, Chang et al. 2010; Rawat, Kadiyala et al. 2010). One reason for this may be that most studies were powered to detect changes in nutritional outcomes, not disease or survival.

None of the studies described above examined the role of the fourth programmatic pathway—providing livelihood linkages and other services to improve food security and to support the gains of nutrition and disease stabilization after patients have "graduated" from nutrition

therapy. One study did examine the persistence of effects three and nine months after a three-month period of supplementation, without controlling for potential exposure to wraparound services (Ndekha, van Oosterhout et al. 2009). Though the differences in BMI between a RUSF and corn-soy blend group were no longer observed at the three and nine month follow-up, the average BMI of those still alive and in the program after nine months in both groups had actually improved from the total average across patients observed at the end of food supplementation period. Though some of the explanation for this phenomenon is undoubtedly related to the death of those with lower initial BMIs before the nine month follow-up (thus automatically raising the time two average BMI), unfortunately, the authors do not present any longitudinal subanalyses on the changes in post-intervention BMIs of those who remained alive after nine months, nor do they acknowledge this important pattern in their data.

Despite the inconclusive effectiveness studies described above, there is ample evidence to suggest that BMI and weight gain are significant risk factors for mortality (van der Sande, Schim van der Loeff et al. 2004; Zachariah, Fitzgerald et al. 2006; Madec, Szumilin et al. 2009; Ahoua, Umutoni et al. 2011; Gupta, Nadkarni et al. 2011), and that early ART combined with nutrition therapy results in more successful clinical outcomes than delayed ART (Kim, Cox et al. 2012), making a strong and compelling case for the integration of nutrition and HIV care as early as possible. However, effectiveness studies are few, and the little available research has been beset by limitations that include a small sample size, a lack of randomization and/or a control group, a short treatment phase, high default rates, and the resulting inability to distinguish the effects of nutrition inputs from other aspects of clinical care. The challenge of drawing conclusions across this handful of studies is compounded by variations across studies with regard to eligibility criteria, intervention design, and the definition of endpoint measures. Clearly, more systematic evidence across well-designed studies is required to determine whether and how the types of interventions typically on offer through programs combining HIV and nutrition can best achieve the impacts suggested by these four theory-of-change pathways.

Cost-effectiveness Evidence

To our knowledge, no research has systematically estimated the program and/or societal costs of delivering a take-home therapeutic nutrition ration within the context of HIV care and other nutrition assessment and counseling services.

There is a sizeable body of evidence suggesting that Plumpy'Nut™ and other forms of RUTF are cost-effective in treating acute malnutrition among children. Community-based management of acute malnutrition (CMAM) using RUTF has been called a "proven intervention" (Horton 2010) based on evidence of CMAM programs cost-effectiveness in treating acute malnutrition in a variety of settings, when compared with in-patient treatment models (Collins, Dent et al. 2006; Bachmann 2009; Puett, Sadler et al. 2012). For example, in Malawi the estimated CMAM cost of USD 42 per disability-adjusted life year (DALY) averted is significantly less than the per capita Gross National Income (GNI) of USD 250, suggesting that by one criterion CMAM is a highly cost-effective approach to the treatment of malnutrition (Wilford, Golden et al. 2012). In one region of Ethiopia, an outpatient treatment model for severe acute malnutrition (SAM) among children was found to be twice as cost-effective as the alternative inpatient model (Tekeste 2007). None of this cost-effectiveness evidence focuses on the treatment of adults with HIV in an outpatient clinic-based model, leaving a big gap in our knowledge. However, such studies are suggestive of potentially cost-effective results from the use of RUTF to treat malnourished adults with HIV, particularly in decentralized outpatient settings where the costs of participation (time forgone, transport, etc.) can be reduced and program effectiveness improved through increased participation and adherence (Zachariah, Harries et al. 2006).

Despite the lack of detailed costing studies, a few HIV-nutrition intervention studies have presented estimates of their program costs. For instance, The AMPATH (Academic Model Providing Access to Healthcare) program in

Kenya calculated the cost of its comprehensive nutritional support program for PLHIV at USD 0.27 per patient per day (Mamlin, Kimaiyo et al. 2009). Bahwere et al. (2009) reported that the costs of their Chickpea Sesame RUTF intervention delivered through home-based care in Malawi for three months of intervention totaled USD 137.70 per patient, based on an estimate of USD 3 per kg of RUTF distributed and USD 50/MT of operational costs. The authors compared these results to the cost of a WFP-funded home-based care program in Bangwe, Malawi, which estimated USD 10 per person per month of CSB and oil ration, USD 40 per household per month for household food support, and USD 50/MT of operational costs leading to a monthly cost of per patient of USD 53 (Bowie, Kalilani et al. 2005). Though the monthly costs of the two Malawi studies were not hugely different, the intervention period of the Bangwe study was longer, bringing the total per patient cost to USD 629 versus USD 137.70 in the CS-RUTF intervention. Ndheke et al. (2009) described only the relative cost of the RUTF and CSB food supplements (USD 16 versus vs. USD 5.40 per patient per month, respectively) and concluded that "formal cost benefit analyses are required to determine whether supplementary feeding strategies are cost effective when compared with other elements of clinical care given to those with HIV in sub-Saharan Africa" (p. 7).

Closing the Evidence Gap

The research presented in this report seeks to contribute to filling these gaps in the literature through a systematic investigation of the Ethiopia Food by Prescription program's 1) effectiveness, 2) cost-effectiveness, and 3) client perceptions of benefits and constraints to participation in the treatment protocol.

The study of effectiveness aims to clarify current understanding of the first two theory-of-change pathways, by determining the impacts of providing, through a large-scale program, nutrient-dense RUTF for up to six months to malnourished HIV+ adults (BMI at or below 18.5) who are also receiving nutrition assessment, counseling, and standard care through an ART program. Unlike many previous studies that lacked suitable controls, this study isolates the role of the nutrition intervention by comparing changes in the supplemented group to those seen in a group of comparable patients in ART clinic sites who received only standard clinical care. The cost-effectiveness research offers the first evidence of its kind of the marginal program and societal costs of the delivery of, and participation in, a large-scale Food by Prescription program—in relation to the marginal benefit. And finally, the results of the client-centered inquiry into participation and adherence challenges broadens existing insights into factors that lead to, or impede, the effect on outcomes described above.

The combination of results from these three inter-related studies are intended to inform decision-making in Ethiopia and more globally about whether the benefits of nutrition supplementation, counseling, and assessment to malnourished HIV+ patients justify replication in light of the cost. It is critical that donors and national health ministries have access to this kind of information as they make decisions about continued global investments in this area. ■

THE FOOD BY PRESCRIPTION PROGRAM

The Food by Prescription program, as mentioned above, was funded by USAID, with Save the Children US as a technical implementing partner. Through the Ethiopian Federal Ministry of Health, the program targets a combined package of nutrition assessment, counseling, and support (NACS) to malnourished adults with HIV as well as orphans and vulnerable children (OVC). In addition, the program seeks to link participants to economic strengthening opportunities following their graduation from the program. Implementation began in 2010, initially in 58 health facilities, and has been scaled up in each subsequent program year.

Although the program serves both adults and children, and included several intervention components, the research described in this report focused specifically on the impact of therapeutic food (the "support" element of the NACS approach) on adult participants. Under this element of the program, adult HIV+ patients with moderate acute malnutrition (MAM) are provided with two sachets of RUTF daily until recovery from malnutrition or for a maximum of three months. Those with severe acute malnutrition (SAM) are provided with four sachets daily until recovery or for a maximum of six months.

The program is aligned with the national protocol for treatment of HIV, and used outcomes for individual participants at the time of program exit according to the following definitions:

- *Graduated/Recovered*—Participant reached a BMI of 18.5 for two consecutive visits within three or six months, depending on nutritional status at baseline (MAM or SAM, respectively).
- *Non-response/Unrecovered*—Participant did not reach a BMI of 18.5 for two consecutive visits within three (MAM) or six (SAM) months.
- *Default*—Participant did not reach a BMI of 18.5 and dropped out of the program before the end of three (MAM) or six (SAM) months.
- *Died*—Participant died during course of program participation, and death was documented by clinic staff in the register book.
- *Transferred out*—Participant transferred out of the program at the clinic where they first enrolled. ■

OBJECTIVES

Impact Study

This study aimed to examine the effect on health and nutrition outcomes of food offered "by prescription" to malnourished adults living with HIV/AIDS who were at different stages of treatment. Stages of treatment included: pre-ART, ART for less than six months, and ART for more than six months. The food offered by prescription was "Plumpy'Nut™," a ready-to-use lipid-based therapeutic food. Nutritional status at baseline of participants was classified as either severe or moderate acute malnutrition, defined by BMI < 16, and BMI < 18.5, respectively.

The objectives of the study were to examine the effect of prescribed food on:

1. recovery from malnutrition, as observed through a change in body weight and body mass index;
2. disease progression and quality of life, reflected through CD4 counts and a quality of life index;
3. survival/mortality;
4. persistence of the noted effects, and relapse versus maintenance of nutritional and health status of participants after discharge from the program.

The research questions were:

1. What is the effect on recovery from malnutrition of a food ration prescribed to malnourished HIV+ adults?
2. What is the effect on HIV disease progression of a food ration prescribed to malnourished HIV+ adults?
3. What is the effect on patient survival of a food ration prescribed to malnourished HIV+ adults?
4. Do HIV+ individuals who complete food by prescription treatment maintain their improved nutritional status six months after program exit?

In addition, the analysis was disaggregated by ART status and nutritional status at baseline.

Qualitative Component of the Impact Study

Two qualitative data collection rounds were included, with the following objectives:

a) *Adherence and compliance:* The objective of the first was to elaborate and contextualize the findings of the quantitative impact study, by exploring ration utilization and participant perceptions of the costs and benefits of participation in the FBP program.

It sought to validate the assumption that participants were receiving and consuming the rations prescribed as per the program protocol and to identify the constraining factors and solutions for improved participant adherence.

This component of the study also addressed issues of service provider participation, and the barriers and constraints to delivery that may have impacted the effects of the program on individuals.

b) *Default and non-response:* While the first qualitative study sought to identify constraints to adherence from a group of "successful" participants, a second study was designed to investigate the experience of "unsuccessful" participants, aiming to identify possible limitations to adherence among individuals who either defaulted from the program or failed to respond to the intervention.

The objective of the second qualitative study was to understand in greater depth the range of reasons for default among FBP program participants, as well as the range of reasons for poor weight gain among other participants.

Cost Study

This component of the study aimed to identify the cost-effectiveness of the FBP program by first assessing the marginal cost of incorporating a supplementary food ration into an ongoing health program for HIV+ patients, and then relating it to the marginal benefits of this intervention. More specifically, the study sought to determine the cost of achieving the following

primary impacts (though the calculation of each cost-effectiveness ratio depended on the collection of adequate effectiveness data through the quantitative impact study):

- Marginal cost per patient recovered, i.e., moved from malnutrition (BMI < 18.5) to adequate nutrition (BMI >= 18.5) for two consecutive clinical visits
- Marginal cost per patient who reached a BMI of 18.5 at least once in the course of treatment
- Marginal cost per patient raised at least one BMI point
- Marginal cost per additional BMI point
- Marginal cost of treatment per patient ■

Methods

As previously described, the Tufts' research was composed of three linked research approaches: a quantitative impact study, a qualitative element meant to inform the understanding of the impact data results, and a cost-effectiveness analysis. This section outlines the quantitative and qualitative methods used to measure impact of the nutrition intervention on health and nutrition outcomes. The cost and cost-effective methodology is outlined in the next section.

Quantitative Methods

Study Design: The study was designed as a quasi-experimental effectiveness evaluation, with a comparison group of clinics selected from a geographic area similar to those in which the intervention was being evaluated. Originally, the study was designed to reflect the existence of a food support program being implemented by WFP in limited urban areas for households containing individuals with HIV. As the WFP program was providing a household ration to participant households, there was a concern that the measured impact of the FBP program could be biased by the presence or absence of the WFP program. Therefore, the study sample was stratified to include three cohorts of participants who were followed longitudinally: two groups of adult PLHIV meeting FBP enrollment criteria in ART clinics at selected health facilities, one from sites offering both the FBP program and the WFP program, and another from sites offering FBP only. Participants from these two groups were recruited for the study at the time when they enrolled in the FBP program. The third group, a comparison group, was composed of FBP-eligible adults recruited from FBP Phase II sites, i.e., where the program had not yet been rolled out but would do so during Year Two of the program.

However, after the FBP program and the impact study had commenced, the WFP program was phased out. Despite this, the three study groups were maintained, with the idea that the two treatment groups could be pooled eventually if the baseline characteristics of the two did not differ significantly.

Sample Size Calculation: The sample size was initially calculated to allow pair-wise comparison of any two of the three groups (FBP+WFP, FBP only, and control) for a quantitative outcome with 80% power to detect a difference of 0.25 standard deviations at a significance level of 0.05. With equal sample sizes in each group, 252 participants were required per group. This sample size was increased by 20% to account for pregnant and lactating women who would be enrolled in the program but could not be included in the study and subsequent analysis.[1] A design effect of 2 was then applied to account for the clustering of participants in health facilities. Clustering with respect to the primary outcomes, particularly malnutrition and weight change, was expected to be low (Bilukha 2008). Finally, the sample size was increased to allow for 30% loss to follow-up. With these adjustments, 862 participants were required per group.

Study Site Selection: The process of selecting sites—both treatment and comparison—was lengthy and subject to changes resulting from external, programmatic factors. Treatment sites were randomly selected from among two sampling frames—one of sites offering FBP only, one of sites offering both FBP and the WFP program—of sites which were originally randomly selected by FBP/USAID for inclusion in baseline data collection, plus four additional sites in order to reach a total of 16 sites, eight from each group. In three instances, sites were dropped and replaced, in general when it was logistically impossible to participate in the study, particularly because the study was dependent on the participation and cooperation of the health staff for data collection. For example, one of the initial treatment sites, a large hospital, was not willing to participate without additional payment and had to be replaced prior to the start of the study. One health center was excluded after the start of the study on the grounds of falsified data collection, and the participants from another

1 In most health facilities, however, pregnant and lactating women were enrolled in FBP through PMTCT clinics (Preventing Mother to Child Transmission), not through the ART clinics where study participants were being recruited, and therefore only a very small number of these women were enrolled in the study.

health center were lost to follow-up when the property was flooded by a rising nearby lake.

The comparison sites were first randomly selected from among FBP Phase II sites, from a sampling frame developed according to characteristics including FBP eligibility, no WFP program, and similar regions and agro-ecological zones. The sites initially selected, however, were rejected by the donor as they were sites with large caseloads; thus, due to ethical reasons, the donor preferred to roll out the program to these areas during the first phase rather than waiting until Phase II. Due to these valid considerations, the comparison sites were replaced by other sites selected according to caseload size and region. Annex 1 provides a table that compares demographic and geographic characteristics of intervention and comparison sites.

Data Collection: Information on the study was provided to participants at enrollment and clinic staff obtained informed consent prior to enrollment into the impact and cost study. Clinic staff were in charge of collecting all the study data, along with other routine health information, from study participants at the time that participants were recruited into the FBP program, and during their routine monthly program visits to the ART clinics. All data were recorded in a FBP program register book. Additional tools were developed for the collection of other study data, including a food security questionnaire and monthly information on participant receipt of additional food or nutritional support. Clinic staff were requested to administer these additional tools to study participants only. Initially, these documents were perceived as a large burden on top of existing workloads, and there was strong resistance to participation on the part of the staff in the ART clinics. Eventually, it was determined that a small payment (ETB 40/study participant) offered to the responsible health workers for the completion of participant data would be necessary for effective data completion. The payments were offered in two parts—ETB 20 for data up to the point of program exit, and the second ETB 20 for the six-month follow-up data. The Tufts' study monitor visited each study site regularly to abstract data from the FBP register into an SPSS database, and to provide support and guidance to the clinic staff assisting with the data collection. All data were de-identified in SPSS.

Variables of interest collected through the FBP register book included the following:

- Age
- Sex
- ART/pre-ART status
- Number of RUTF sachets prescribed monthly
- Height (first visit only)
- Weight/BMI
- Nutritional status
- CD4 count
- Functional status
- Presence of other opportunistic disease
- Presence of edema
- Outcome (at exit only)

Variables collected via the additional study tool:

- Number of months on ART
- Employment status
- Receipt of other food support

Monthly data were collected from treatment site participants from the time of their enrollment in the program until their exit, whether by discharge/graduation, default, death, transfer to another facility, or admission to an inpatient facility. According to protocol, MAM patients may receive FBP support for three months, and SAM patients for six months. So the majority of study participants were followed for a total of three to six months. As will be discussed in the results section, in practice, length of enrollment was somewhat variable and at times up to the discretion of the health worker.

The same data collection procedures were followed in the comparison sites. Following the introduction of the study and tools to the clinic staff, study participants were assessed for nutritional status upon their next presentation to the ART clinic, and those with a BMI of less than 18.5 were recruited to the study. All indicators—except for number of RUTF sachets prescribed, since this was not applicable in comparison sites—were collected and recorded on a monthly basis for up to six months.

Data Analysis: Data were entered into SPSS, and analyzed using both SPSS and SAS. Multiple linear regressions were used to determine the effect of treatment group on BMI change and CD4 change, controlling for baseline variables and other potential confounders. These regressions were also run stratified by groups of interest, differentiated by baseline nutritional status and ART status. Logistic regressions were used to determine factors associated with binary outcomes such as recovery, non-response, and default. All models were adjusted for the cluster-randomization design, with the cluster defined as the health center.

Qualitative Methods

Two separate qualitative data collection rounds were included as part of the impact study to contextualize and understand the quantitative findings. First, a series of focus group discussions (FGDs) were held to gather data from participants on issues of program compliance and adherence. The FGDs were conducted at 8 of the 16 implementation sites, with groups of 8 to 10 FBP participants. Two FGDs were held at each facility, one each for women and men, in order to identify gendered differences in behavior and program compliance. At each site, one key informant interview was also performed with a health worker from the ART clinic.

Sites were selected according to the criteria used for selection in the quantitative component, in order to represent the diversity of sites and participants included in the program. Participants from each site were selected with the assistance of clinic staff from each facility.

Data were collected using semi-structured discussions, including the use of a number of participatory activities. Facilitators began each discussion by introducing the purpose of the discussion, the relationship (and differentiation) between the program and the study, and the informed consent process for participants. The discussion was carried out in the language appropriate for the region, and recorded for future translation and transcription.

The second qualitative study collected data on participant perceptions of reasons for default and non-response, using semi-structured interviews with individuals identified from amongst the existing sample of impact study participants. A two-stage selection process was used, in which health facilities were selected for participation from among the impact study sites. Then, defaulters and non-responders were identified from the total sample, and individuals were randomly selected from each of these groups. Case managers from the facilities located the selected individuals and appointed them for an interview at a location of the participant's choice. If an individual declined to participate, a replacement was selected from the identified cohort. A total of 11 defaulters and 15 non-responders were interviewed.

Semi-structured interviews began with key questions relevant to the identity of the respondent (i.e., whether defaulter or non-responder). Initial questions helped to define and guide the overall conversation, while also providing space for respondents to answer freely and to provide information as they saw relevant, as well as allowing the interviewer to respond with additional related questions, creating a more detailed and relevant picture.

In addition, interviewers were responsible for the completion of a case history form for each individual interviewed. This form summarized several key indicators already collected in the FBP register book, as well as one additional item on participant's household size.

Results

Participant Characteristics at Admission

A sample of 2059 program participants was recruited for the study treatment group, and 663 participants were recruited for the comparison group.

We describe the characteristics at admission for the 2,722 participants in intervention and comparison groups (Table 1). There were important differences between these two groups. Comparison participants were significantly older on average than treatment participants (37.1 and 34.8 years, respectively, $p<0.001$). Treatment participants were significantly more malnourished at the time of recruitment, with an

average BMI of 16.8 compared to 17.2 for the comparison group (p<0.001), and with 26.2% of the treatment sample severely malnourished (BMI < 16), compared to 14.2% of the comparison sample. The treatment group also had a lower average CD4 count (321 and 354, p=0.014) at baseline.

There were 91 treatment patients and 18 comparison patients recruited for the study who were "not malnourished" according to their BMI values calculated from reported height and weight. These individuals were likely recruited mistakenly for the study when the responsible health worker miscalculated their BMI values. While they have been included in Table 1, they were excluded from the rest of the analysis. As a result, treatment and comparison group sample sizes used for analysis were 1956 and 639, respectively.

Table 1: Participant characteristics at recruitment, by intervention group

	Treatment	Comparison	P-value
No. of sites	15	8	
No. of participants	2059	663	
Demographic factors			
Women (%)	1353 (65.7)	451 (68.0)	0.280
Age, n	2046	655	
Years, mean (SD)	34.8 (9.8)	37.1 (10.5)	< 0.001
Unemployed, n (%)	1758 (85.4)	632 (95.3)	< 0.001
Nutritional indicators			
BMI, n	2043	657	
Kg/m2, mean (SD)	16.8 (1.5)	17.2 (1.2)	< 0.001
not malnourished, BMI >= 18.5, n (%)	91 (4.5)	18 (2.7)	
MAM, 16 <= BMI < 18.5, n (%)	1417 (69.4)	546 (83.1)	
SAM, BMI < 16, n (%)	535 (26.2)	93 (14.2)	< 0.001
Clinical and immunological factors			
CD4 count, n	1844	318	
Cells/mm3, mean (SD)	321.3 (227.0)	354.9 (214.8)	0.014
On ART, n (%)	1618 (79.7)	505 (76.2)	0.053
Time on ART at recruitment, n	1291	483	
Months, mean (SD)	30.4 (29.6)	27.7 (19.3)	0.030
Opportunistic disease at recruitment,* n (%)	310 (15.1)	23 (3.5)	< 0.001
Functional status at recruitment, n	2055	633	
Working, n (%)	1490 (72.5)	582 (91.9)	
Ambulatory, n (%)	531 (25.8)	50 (7.9)	
Bedridden, n (%)	34 (1.7)	1 (0.2)	< 0.001

* *Including TB, Other, TB + Other*

Table 2: Program outcomes at exit as defined by national protocol, by intervention group

Outcome *All participants*	Treatment n = 1956	Comparison n = 639	P-value
Graduated/Recovered, n (%)	221 (11.3)	47 (7.4)	0.005
Non-response/Unrecovered, n (%)	310 (15.9)	204 (31.9)	< 0.001
Defaulted/Lost to follow-up, n (%)	1380 (70.6)	381 (59.6)	< 0.001
Died, n (%)	29 (1.5)	5 (0.8)	0.177
Transferred out, n (%)	16 (0.8)	2 (0.3)	0.182
MAM only	n = 1417	n = 546	
Graduated/Recovered, n (%)	208 (14.6)	46 (8.4)	< 0.001
Non-response/Unrecovered, n (%)	245 (17.3)	190 (34.8)	< 0.001
Defaulted/Lost to follow-up, n (%)	943 (66.6)	304 (55.7)	< 0.001
Died, n (%)	12 (0.9)	4 (0.7)	0.219
Transferred out, n (%)	9 (0.6)	2 (0.4)	0.227
SAM only	n = 535	n = 93	
Graduated/Recovered, n (%)	13 (2.4)	1 (1.1)	0.258
Non-response/Unrecovered, n (%)	65 (12.2)	14 (15.1)	0.436
Defaulted/Lost to follow-up, n (%)	437 (81.7)	77 (82.8)	0.797
Died, n (%)	14 (2.6)	1 (1.1)	0.235
Transferred out, n (%)	6 (1.1)	0 (0)	0.381

Effect on Recovery from Malnutrition

Of the 1956 participants recruited into the nutrition intervention and followed up to outcome, 221 (11.3%) graduated/recovered from malnutrition, 1380 (70.6%) defaulted or were lost to follow-up, 310 (15.9%) were defined as non-responders, and 29 (1.5%) died. Nutrition outcomes in the intervention group were significantly better than those observed in the comparison group, where 47 (7.4%) recovered from malnutrition, 381 (59.6%) defaulted, 204 (31.9%) were defined as non-responders, and 5 (0.8%) died (Table 2). If we look at only those participants who completed the intervention protocol (i.e., those who were classified as recovered or non-responder), recovery increases considerably to 41.6% (221/531), compared to 18.7% (47/251) in the comparison group. These differences in outcomes remain when data is disaggregated by nutrition status (MAM and SAM) at admission (Tables 2 and 3).

Among all participants, 32.6% achieved BMI greater than or equal to 18.5 at least once during the course of treatment, compared to 18.8% in the comparison group (Table 3).

Weight and BMI gain: Overall 84.3% (1279/1517) of participants increased BMI among the intervention group, compared to 54.2% (242/447) in the comparison group (See Tables in Annex 2). The intervention group gained on average 1.1 BMI points during treatment, while the comparison group gained on average 0.3 BMI points ($p<0.001$). The Tables in Annex 2 show that of those who recovered in the intervention group, the median (IQR) of weight and BMI gain were 3.4 (2.1–4.2) g/kg/day and 4.5 (4.2–5.6) kg/m2 respectively for SAM patients (n=13), and 1.2 (0.8–2.0) g/kg/day and 1.6 (1.1–2.4) kg/m2 respectively for MAM patients (n=207). Median BMI (IQR) at discharge of those patients

Table 3: Program outcomes at exit when recovery is defined as "ever reached BMI 18.5," by treatment group

Outcome *All participants*	Treatment n = 1952	Comparison n = 639	P-value
Graduated/Recovered, n (%)	636 (32.6)	120 (18.8)	< 0.001
Non-response/Unrecovered, n (%)	1316 (67.4)	519 (81.2)	
MAM only	n = 1417	n = 546	
Graduated/Recovered, n (%)	573 (40.4)	114 (20.9)	< 0.001
Non-response/Unrecovered, n (%)	844 (59.6)	432 (79.1)	
SAM only	n = 535	n = 93	
Graduated/Recovered, n (%)	63 (11.8)	6 (6.5)	0.130[a]
Non-response/Unrecovered, n (%)	472 (88.2)	87 (93.6)	

[a] *While the chi-square value is 0.130, the Fisher's exact test p-value is 0.048.*

classified as "non-responders" (according to the outcome definitions described in the Methods section) in the intervention group was 18.1 kg/m2 (17.1–18.7), and 17.8 kg/m2 (16.8–18.7) for "defaulters." Non-responders and defaulters gained significantly (p<0.001) less weight and BMI (see Annex 2) than those who recovered. Weight and BMI gain among non-responders and defaulters in the intervention group was however significantly greater (p<0.001) than that seen among the same outcome group in the comparison sites. See below for more detailed analysis for these two outcome groups.

Length of stay: Recovered SAM patients were discharged from the intervention group after a median of 128 days (85–144) of treatment and recovered MAM patients after a median of 63 days (59–86). Where recovery did occur among MAM participants in the comparison group, it took on average 83 days longer (p<0.001) than in the intervention group, despite the fact that the intervention participants were more malnourished at baseline. There was little difference between the two groups in time to default, which happened around the two month mark on average (See Tables in Annex 2).

Table 4: Difference in BMI change between FBP and control group, adjusted for baseline BMI, sex, ART status at baseline, clinic type (Model 1) for all participants and stratified by baseline nutritional status and baseline ART status

	Adjusted BMI change (model 1)			
	n	*Mean difference (SE)*	*P-value*[3]	*Adj R-squared*
All participants				
	1654	0.77 (0.12)	<0.001	0.16
By nutrition status at baseline				
MAM	1226	0.75 (0.13)	<0.001	0.14
SAM	359	0.92 (0.28)	0.004	0.08
By ART status at baseline				
Pre-ART	371	0.78 (0.15)	<0.001	0.14
On ART < 6 months	253	0.88 (0.30)	0.009	0.13
On ART >= 6 months	1030	0.76 (0.11)	<0.001	0.14

Recovery adjusted for differences in baseline characteristics: Adjusting for important differences at baseline (including BMI, sex, clinic type, and ART status as discussed above), recovery in the intervention group remained better than that observed in the comparison group. Intervention participants gained, on average, 0.77 kg/m2 more during treatment than those in the comparison group (p<0.001, Table 4) and overall were 2.4 times as likely to recover compared to those in the non-FBP group, and 3.1 times as likely to achieve BMI >= 18.5 during treatment (p=0.010 and p=0.004, respectively, Table 5), after adjusting for baseline characteristics. Treatment had a similar effect on BMI change when the model was stratified by MAM (mean difference of 0.75 BMI points gained, p<0.001) and SAM (mean difference of 0.92 BMI points gained, p=0.004) (Table 4); however, those with SAM were less likely to recover than those admitted with MAM (OR=0.2, p<0.001) (Table 5).

Across all ART strata, FBP participants had larger BMI change at outcome than non-FBP, controlling for baseline BMI, sex, and clinic type (Table 4). This effect remained when baseline CD4 was controlled for (data not shown). There was no significant difference between the ART groups in likelihood of recovery among study participants (Table 5).

Table 5: Logistic regression: Factors associated with recovery among study participants

	Model 1: Recovery[2] n=2220		Model 2: Recovery at all[3] n=1721	
Factors	*OR (95% CI)*	*P-value[4]*	*OR (95% CI)*	*P-value*
Treatment group				
Control	1.0		1.0	
FBP	2.4 (1.6-3.4)	0.011	3.1 (2.4-4.0)	0.004
Sex				
Male	1.0		1.0	
Female	1.4 (1.0-1.9)	0.092	1.4 (1.1-1.7)	0.013
ART status at baseline				
Pre-ART	1.0		1.0	
On ART < 6 months	1.4 (0.9-2.2)	0.137	1.3 (0.9-1.8)	0.064
On ART >= 6 months	1.1 (0.8-1.6)	0.603	1.2 (0.9-1.5)	0.432
Clinic Type				
Health center	1.0		1.0	
Hospital	0.5 (0.4-0.7)	0.045	0.6 (0.3-1.3)	0.238
Nutrition status at baseline				
MAM	1.0		1.0	
SAM	0.2 (0.1-0.3)	<0.001	0.2 (0.16-0.3)	<0.001
Overall R-squared of model	0.08		0.13	
Wald Chi-square	66.5	<0.001	166.3	<0.001

2 Based on protocol recovery definition of reaching BMI of 18.5 for two consecutive visits within three months for MAM and six months for SAM.

3 Based on less stringent recovery definition of reaching BMI of 18.5 at all during study period.

4 All regression models are adjusted for cluster analysis (cluster=clinic/hospital).

Factors associated with recovery: For all FBP participants who adhered to program protocol (i.e., did not default), factors associated with recovery are shown in Table 6. Females were 1.5 times more likely than males to recover (p=0.092). Participants who were on ART for less than six months at baseline were two times more likely to recover than those who were not on ART at baseline (p=0.033), while there was no significant difference in the likelihood of recovery between those who were on ART for more than six months and those who were not on ART. Those who were SAM at baseline were 75% less likely to recover than those who were MAM at baseline (p=0.001). Counterintuitively, participants with some household food insecurity

Table 6: Factors associated with recovery among FBP participants who followed protocol and stratified by baseline nutritional status

	All FBP who followed protocol		MAM only		SAM only	
	OR (95% CI)	*P-value*	*OR (95% CI)*	*P-value*	*OR (95% CI)*	*P-value*
Factors in recovery	n=358		n=303		n=55	
Age	0.96	0.030	0.97	0.101	0.81	.003
Sex						
Male	1.0		1.0		1.0	
Female	1.54	0.033	1.85	0.027	1.93	0.474
ART status at baseline						
Pre-ART	1.0		1.0		1.0	
On ART < 6 months	2.09	0.033	3.14	0.027	2.25	0.495
On ART >= 6 months	0.95	0.922	1.01	0.992	0.73	0.874
Clinic type						
Health Center	1.0		1.0		1.0	
Hospital	0.34	0.066	0.36	0.090	0.06	0.071
Baseline BMI			8.74	<0.001	1.43	0.583
Nutrition status at baseline						
MAM	1.0					
SAM	0.25	0.001				
Other disease at baseline						
No other disease	1.0		1.0		1.0	
Other disease (TB, …)	1.26	0.561	2.22	<0.001	0.90	0.944
Household food security						
Secure	1.0		1.0			
Some insecurity	1.65	0.037	1.88	0.020	Sample size too small to include	
Severe insecurity	2.92	0.003	2.62	0.124		
CD4 count						
< 200	1.0		1.0		1.0	
200–350	1.77	0.004	1.56	0.214	0.63	0.586
>350	0.80	0.606	0.46	0.071	1.90	0.706
Overall R-squared of model	0.23		0.52		0.36	
Wald Chi-square	<0.001		<0.001		<0.001	

were 1.7 times as likely to recover (p=0.013), and those with severe food insecurity were almost three times as likely to recover (p=0.003), compared to those who came from food secure households. CD4 count between 200 and 350 at baseline was associated with an increased likelihood of recovery of 1.7 times, compared to a CD4 count of less than 200 (p=0.004). There was no significant difference in the odds of recovery between those with CD4 counts above 350 versus those with CD4 counts less than 200.

When disaggregating those who were moderately and severely malnourished at baseline, a slightly different regression model was used, adjusting for BMI at baseline rather than nutritional status. For FBP participants who were moderately malnourished at admission, factors associated with recovery remained similar to those included in the overall model (presented in Table 6); those reporting another disease[5] at baseline, however, were more than twice as likely to recover than those reporting no other disease (p<0.001), and CD4 count at baseline was no longer a significant predictor of recovery. In participants who were SAM at baseline, none of the factors from the overall model remained significant, but the sample size was low for this group.

Non-response

Of those participants who complied with the program protocol, 58.4% (310/531) in the intervention group did not respond to treatment (i.e., they remained in the program for the maximum duration of treatment and did not reach graduation criteria) and gained very little weight overall (see above). At baseline they were thinner (BMI of 16.7 vs. 18.0, p<0.001) than the group of participants who eventually recovered (see Tables in Annex 2).

The Tables in Annex 2 show that at exit, the median BMI (IQR) of non-responders in the intervention group was 18.1 (17.1–18.7) compared to 19.5 (19.1–20.1) for those who recovered (p<0.001). In the comparison group it was 17.5 (16.0–18.2) compared to 19.0 (18.4–19.6) for those who recovered (p<0.001). The change in BMI for non-responders between admission and exit was found to be 1.1 (IQR 0.4–2.0) and 0.4 (IQR 0.0–0.8) for intervention and control, respectively. Though non-responders did not reach the program's graduation criteria of maintaining a BMI of at least 18.5 for two consecutive visits, those in the intervention group showed significant (p<0.001) gain in BMI from baseline. Furthermore, 37.4% (116/310) of non-responders attained a BMI of at least 18.5 for one visit in this group.

Among participants who were MAM at baseline, attending the program at a hospital was associated with an increased likelihood of non-response (OR=1.75, p=0.021), while severe food insecurity was associated with a decreased likelihood of non-response (OR=0.46, p=0.016) compared to those who were "food secure." Among participants who were SAM at baseline there were no significant predictors of non-response (Table 7).

Quantitative results were supported by the evidence collected through FGDs and key informant interviews. Participants identified five primary explanations for their failure to reach graduation, with relatively equal frequency. These included the following: 1) sharing of the RUTF within the household (with children, in particular), due to limited availability of other household resources; 2) treating the RUTF as a primary food source rather than as a supplement; 3) inadequate supply of RUTF distributed to participants relative to the monthly amount stipulated in the program protocol; 4) the presence of other illness or infection; and 5) instruction from health workers to stop participating in the program (whether according to program protocol for non-response or inappropriately).

Default, Adherence, and Compliance to RUTF/ FBP Regimen

Overall, 70.6% of participants in the intervention group defaulted from the FBP intervention and gained less weight than those who graduated. At baseline, participants who eventually defaulted were more likely to have attended a hospital rather than health center for treatment, have a

5 Another disease at baseline refers to presence of tuberculosis, other, or both.

Table 7: Factors associated with non-response among all FBP participants

	MAM		SAM	
	OR (95% CI)	*P-value*	*OR (95% CI)*	*P-value*
Factors	n=1085		n= 426	
Sex	NS		NS	
Age	NS		NS	
ART status at baseline	NS		NS	
Clinic type			NS	
Health center	1.0			
Hospital	1.75	.021		
Other disease at baseline			NS	
No other disease	1.0			
Other disease (TB, …)	1.4	.226		
Household food security			NS	
Secure	1.0			
Some insecurity	NS			
Severe insecurity	0.46	.016		

lower BMI and be categorized as SAM, have spent less time on ART, have a lower CD4 count, and have a greater frequency of other diseases in comparison to those participants who complied with treatment (see Tables in Annex 2).

There were a large number of moderately malnourished who participated in the program for two months (until visit three) and then defaulted (41% of all defaulters in the intervention group and 24% in the comparison group fall into this category)—see Figures 1 and 2. In addition, according to the register book, a considerable proportion of the defaulter group (33% of all defaulters) attended the intervention for only one visit (the admission visit) and then failed to return.

In the intervention group, defaulters had a median exit BMI (IQR) of 17.8 (16.8–18.7), compared to 17.4 (16.4–18.1) for those in the control group. The median change in BMI was 0.9 (0.4–1.6) and 0 (0–0.7) for treatment and control, respectively. For patients with MAM in the intervention group who were one visit away from exit when they defaulted (i.e., discontinued at three visits), the median BMI at the third visit was 18.3 (17.6–18.8) and the median change in

Figure 1: Percent dropout by visit for defaulters who were MAM at admission

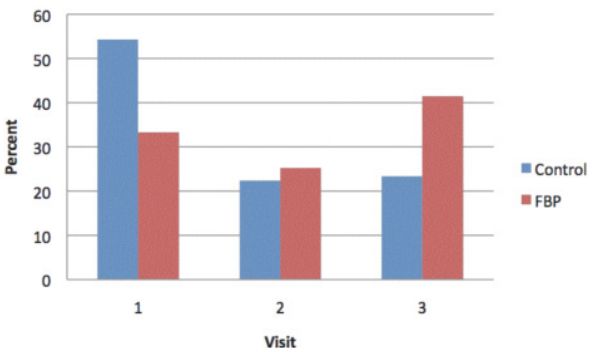
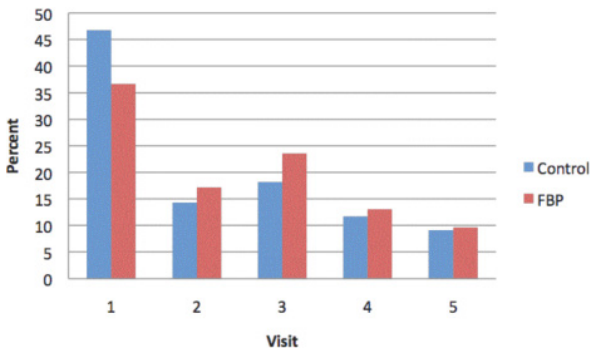


Figure 2: Percent dropout by visit for defaulters who were SAM at admission



BMI between the first and third visit was 0.8 (0.4–1.5). In the comparison group, the median BMI for defaulters at the third visit was 17.6 (17.1–18.0), and the median change in BMI between the first and third visit was 0 (-0.3–0.4). For SAM defaulters who were one visit away from meeting the exit criteria (i.e., discontinued at five visits), the median BMI at the fifth visit, and median BMI change between the first and fifth visit, were 16.8 (15.9–17.9) and 1.9 (0.8–3.0) for treatment, and 16.0 (15.1–16.7) and 1.2 (0.0–2.3) for control. Among the defaulters in the treatment group, 82.6% (743/900) showed a positive weight gain overall, compared to 46.1% (83/180) in the control group. Among defaulters in the treatment group who were MAM at baseline, 38.4% (236/614) had attained a BMI of at least 18.5 by the third visit before they defaulted. For defaulters in the treatment group who were SAM at baseline, 49.7% (137/276) were able to improve to the level of MAM between visits two and five, while another 13.8% (38/276) attained a BMI of at least 18.5.

Only baseline nutritional status was significantly associated with an increased likelihood of default among all FBP participants: those who were SAM at baseline were almost twice as likely to default as those who were MAM at baseline (OR=1.89, p=0.003). Among participants who were MAM at baseline, experiencing severe household food insecurity was associated with

Table 8: Factors associated with default among FBP participants (controlling for CD4 only in SAM)

	All participants		MAM		SAM	
			OR (95% CI)	*P-value*[3]	*OR (95% CI)*	*P-value*[3]
Factors	n=1511		n=1085		n=426	
Sex						
Male	1.0		1.0		1.0	
Female	0.95	0.750	0.94	0.765	1.05	0.844
Baseline nutritional status						
MAM	1.0					
SAM	1.89	0.003				
ART status at baseline						
Pre-ART	1.0		1.0		1.0	
On ART < 6 months	1.03	0.794	1.1	0.622	0.60	0.035
On ART >= 6 months	1.01	0.886	0.97	0.820	0.82	0.373
Clinic type						
Health center	1.0		1.0		1.0	
Hospital	1.20	0.647	1.26	0.496	0.72	0.592
Other disease at baseline						
No other disease	1.0		1.0		1.0	
Other disease (TB, …)	1.32	0.268	1.12	0.662	2.5	0.015
Household food security						
Secure	1.0		1.0		1.0	
Some insecurity	1.01	0.905	1.1	0.608	0.85	0.523
Severe insecurity	1.32	0.075	1.5	0.029	1.14	0.835
Overall R-squared of model	0.03		0.01		0.04	
Wald Chi-square	<0.001		<0.001		0.001	

increased likelihood of defaulting (OR=1.5, p=0.029); for those who were SAM at baseline, reporting another disease at baseline was associated with increased likelihood of defaulting (OR=2.5, p=0.015), while being on ART for less than six months at baseline was associated with decreased likelihood of defaulting (OR=0.60, p=0.035) (Table 8).

Program records were used to identify participants who defaulted from the program, 11 of whom were then randomly selected to participate in key informant interviews in which they were asked why they ceased participation in the program before reaching graduation. The most frequent response was that they had been told by clinic staff that they were no longer eligible for the program, whether because they had reached their RUTF quota, the patient had gained weight, or the health worker was unclear on the program protocol. Also frequently mentioned by interviewees was discomfort or illness resulting from RUTF consumption, which led them to discontinue use. Finally, the burden of transport costs and distaste for the product were mentioned one time each by respondents.

Effect on HIV Disease Progression

CD4 count (cells/microliter) was employed as the primary indicator for monitoring disease progression. At enrollment, CD4 was collected for 89.6% of the treatment sample (n=1844) and 48.0% of the comparison sample (n=318). The comparison group, as mentioned earlier, showed a significantly higher average CD4 count at recruitment (p=0.014). Among the treatment group, 33.9% had CD4 less than 200 at study admission, 27.7% between 200 and 350, and 38.5% above 350. In the comparison group, 24.2% had CD4 less than 200, 31.2% between 200 and 350, and 44.0% greater than 350. Standard protocol for treating HIV in Ethiopia has participants starting an ART regimen at a CD4 count of 200. Similar proportions of the two groups were already on an active ART regimen at the time of enrollment in the study: 79.7% and 76.2% of the treatment and comparison groups, respectively. The average number of months participants had been receiving ART at the time of study enrollment was not significantly different between the two groups (p=0.030).

While disease progression was a key indicator for identifying the impact of the food supplement on participants, logistical limitations in acquiring CD4 measurement at health facilities prevented the collection of CD4 data for many participants. As a result, pre- and post-CD4 data were available for only 428 intervention and 53 comparison participants (20.8% and 8.0% of the samples, respectively). From among these participants, the median change for treatment participants was an increase of 29 cells/microliter (IQR=114), with no change recorded for the comparison group (IQR=99). This difference was statistically significant (p=0.015) (See Table in Annex 2).

Due to the small number of participants with CD4 data at admission, participants with complete data were compared to those without, and those with CD4 data were observed to be more malnourished, more often in the FBP group, reported more other symptoms of disease at baseline, and more often on ART at baseline. Specifically, the following significant differences were identified: BMI (16.7 vs. 16.9, respectively, p=0.020), in FBP group (85% vs. 38%, respectively, p<0.001), reporting other symptoms of disease (13.0% vs. 8.0%, respectively, p=0.001), on ART (81% vs. 72%, respectively, p<0.001). No significant differences were found between the groups for sex, age, or number of months on ART for those who were already on ART at baseline.

When participants are disaggregated by nutritional status at baseline, the difference in CD4 count change from enrollment to discharge between treatment and comparison groups remains significant for those with MAM but is insignificant for those with SAM (p=0.031 for MAM, and p=0.258 for SAM). The sample size for these groups however is low, particularly for the SAM group.

In addition to CD4 count as an indicator for disease progression, participant functional status was also examined using the WHO-defined scale of "working," "ambulatory," and "bedridden." At the time of enrollment, the comparison group had a significantly larger proportion of working participants and a much lower proportion of bedridden participants (p<0.001). This significant

difference, however, may reflect the nature of enrollment in the study comparison group, whereby fewer bedridden participants from the comparison areas are likely to have made the effort to visit the ART clinic without the added incentive of the FBP RUTF ration.

Over time, the treatment group demonstrated greater improvements in functional status than the comparison group, with 21.9% and 3.8% of the treatment and comparison groups, respectively, showing improvement. This difference is maintained when the groups are stratified by nutritional status at baseline as well (Tables in Annex 2).

Table 9: Difference in CD4 change (cells/microliter) between FBP and control group, adjusted for baseline BMI, baseline CD4 status, sex, ART status at baseline, and clinic type for all participants and stratified by baseline nutritional status and baseline ART status

	Adjusted CD4 change (cells/microliter)			
	r-squared	*n*	*Mean difference (SE)*	*P-value*
All participants	0.10	327	75.2 (18.2)	0.001
By nutrition status at baseline				
MAM	0.08	278	68.1 (16.5)	0.001
SAM	0.11	38	64.3 (120.8)	0.606
By ART status at baseline				
Pre-ART	0.12	68	132.4 (35.0)	0.003
On ART < 6 months	0.05	54	87.2 (51.2)	0.117
On ART >= 6 months	0.09	205	56.3 (29.7)	0.136

Controlling for a number of other factors, including BMI, CD4 count, and ART status at enrollment, as well as sex and clinic type, participants receiving an RUTF supplement demonstrated an average increase in CD4 count from baseline to discharge of 75.2 cells/mm3 (p=0.001) (Annex 2) more than those in the comparison group. Stratified by baseline nutritional status (Table 9), the model showed that the effect of treatment was significant in participants who were MAM at baseline (mean difference of 68.1 cells/mm3, p=0.001) and stratified by ART status at baseline, the effect was significant in participants who were pre-ART at baseline (mean difference of 132.4 cells/mm3, p=0.003).

Effect on Survival

Recorded mortality rates during the study period were very low, with only 1.5% of treatment participants (n=29) and 0.8% of comparison participants (n=5) dying during study follow-up. Numbers of deaths were however too small for statistical comparison. Within the treatment group, the proportion was larger for those participants who enrolled as SAM (2.6%, n=14), than among those who enrolled as MAM (0.6%, n=12).

Among intervention participants with MAM at admission who died, the median length of time from study/program enrollment until death was 67 days (IQR=58–68, n=7), while among SAM participants the median length of time was 38 days (IQR=17–98, n=4). Within the comparison group, data on length of time until death was only collected for two MAM patients.
This study was not able to identify the proportion of defaulters for whom death was the reason for default.

Persistence of Effects

Nutritional data at six months after exit was collected for 353 participants, 17.1% of all study treatment participants (45.3% of those who had

graduated from treatment and 54.7% of those who did not respond to treatment)—see Table 10. Of those who graduated, 80.0% maintained or improved their BMI at >= 18.5, while 20.0% relapsed to become malnourished again. Of those who were discharged from the intervention as non-responders, 33.7% maintained or improved their BMI, while the nutritional status of 66.3% remained malnourished. Figures 3 and 4 below show mean BMI at baseline, outcome, and six month follow-up visit for those participants for whom data was collected at all three time points.

As the number of participants among compliant treatment group participants for whom follow-up data were available was small (n=318 for MAMs, n=35 for SAMs), these participants were compared to those for whom no follow-up data were available on a number of characteristics. The only indicator that was observed to be significantly different between the two groups was BMI at baseline for MAM participants (p=0.002), with the average for those with follow-up data 17.5 kg/m2, and 17.3 kg/m2 for those without available follow-up data. Variables for which differences were found to be insignificant included sex, age, CD4 count at baseline, nutritional status at baseline, program outcome at exit, change in BMI from baseline to exit, and BMI at exit.

Discussion

This research finds that adding a therapeutic food ration to an ART regimen (that includes nutrition assessment and counseling) for malnourished adults with HIV in Ethiopia led to considerable nutritional and health benefits for those participants who complied with the food intervention protocol. These benefits included improved BMI, recovery from malnutrition, CD4 count, and functional status compared to a similar group that did not receive food assistance. This is one of very few studies, and the first in Ethiopia, that demonstrates a quantitative benefit of macronutrient supplementation on HIV health and nutrition outcomes over and above that provided by ART alone.

Impact on Nutritional Outcomes

Controlling for other factors, participants receiving the therapeutic food package were 2.4 times more likely to meet the program criteria for graduation (i.e., to reach a BMI of 18.5 for two consecutive clinic visits within the defined

Table 10: Nutritional characteristics at 6 month follow-up, treatment group

	Recovered n = 221	Non-responders n = 310	P-value
Change in BMI from exit to follow-up			
All participants, n	162	192	
change in BMI, median (IQR), kg/m2	0.0 (-0.6–0.8)	0.0 (-0.7–0.7)	0.294
MAM, n	155	164	
change in BMI, median (IQR), kg/m2	0.0 (-0.6–0.8)	0.0 (-0.7–0.7)	0.356
SAM, n	7	28	
change in BMI, median (IQR), kg/m2	0.0 (-0.7–1.7)	-0.2 (-1.0–0.8)	0.741
Change in nutritional status from exit to six month follow-up			
Recovered, n (%)	128 (80)	n/a	< 0.001
Relapsed, n (%)	32 (20)	n/a	
Remained malnourished, n (%)	n/a	128 (66)	
Improved in follow-up, n (%)	n/a	65 (34)	

Figure 3: Mean BMI by outcome, MAM at baseline

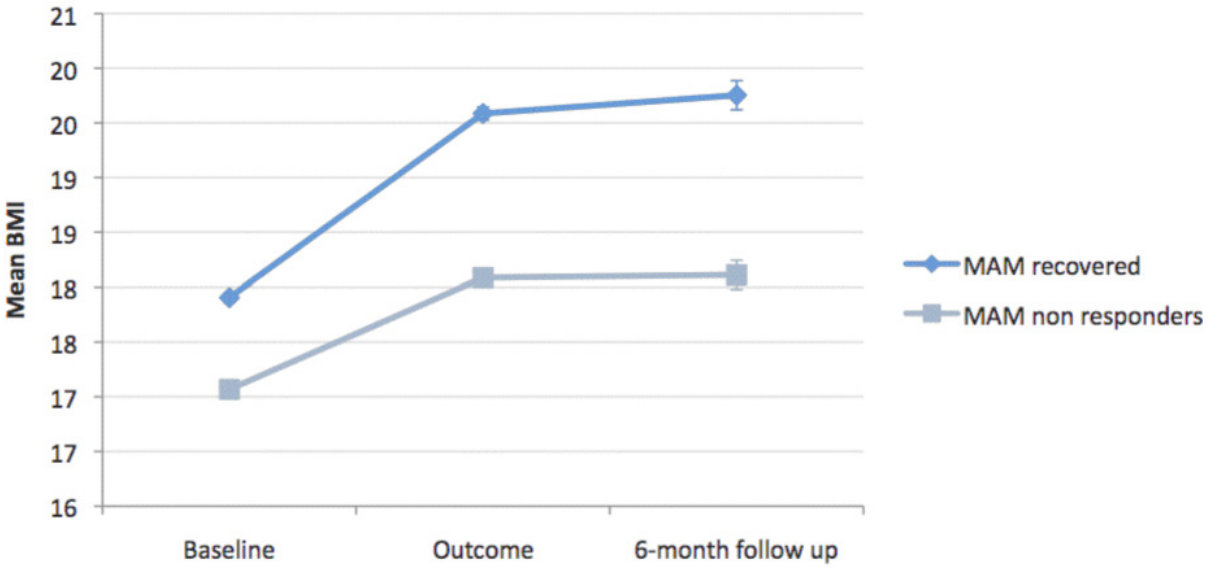
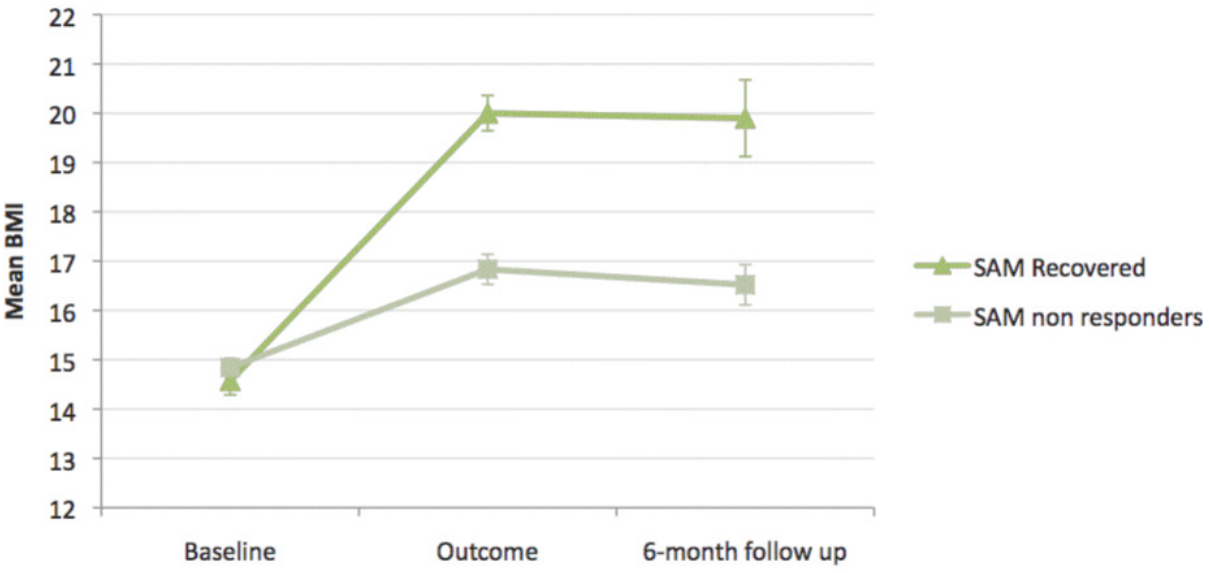


Figure 4: Mean BMI by outcome, SAM at baseline



time period) than similar patients who did not receive the additional food in their ART treatment regimen. The same group of participants was 3.1 times as likely to have ever reached a BMI of 18.5 as those not receiving food. Other recent studies that have examined the impact of targeted food assistance on the nutritional status of people living with HIV have either found that BMI decreases across both supplemented and comparison groups, albeit less severely in the supplemented groups (Ivers, Chang et al. 2010), or have found no significant difference in nutritional status between participants who did receive a supplement and those who did not (Cantrell, Sinkala et al. 2008; Swaminathan, Padmapriyadarsini et al. 2010; CRS 2011). Other recent evaluations of FBP programs that have not used comparison groups but have examined nutritional outcomes have generally recorded lower weight gains than those observed here—the FBP program in Kenya (Food and Nutrition Technical Assistance II Project (FANTA-2) 2009) for example, recorded a rate of weight gain of 0.3 to 0.4 kg/m2/month

compared to an average weight gain of 0.55 kg/m2/month seen here.[6] In addition to the direct benefits of recovery (i.e., increased BMI), weight gain—and the prevention of weight loss—have been associated with other benefits, most notably reduced risk of mortality (Tang, Forrester et al. 2002; Koethe, Lukusa et al. 2010). The low number of deaths, the large number of defaulters, and the relatively short follow-up time prevented this study from examining the relationship between nutritional supplementation, weight gain, and mortality. However, the positive impact of nutritional support on BMI seen in this study would suggest that this benefit (reduced risk of mortality) is likely to have been experienced in the supplemented group. The nutritional benefits of the food supplementation seen in this study were demonstrated in both moderately and severely malnourished patients. Participants with SAM who received food showed slightly larger increases in BMI than those with MAM, though were significantly (80%) less likely to recover. SAM patients receive more food for a longer period of time, and as they are admitted with a lower BMI, they have more to gain from the additional nutrients/energy. With a lower BMI starting point, however, they must also gain a lot more weight in order to reach the criteria for graduation from the program, which may explain this apparent discrepancy between the dual outcomes of weight gain and recovery. This stresses the importance for recovery of closely monitoring the nutritional status of HIV patients, treating malnutrition at early stages, and increasing early access to HIV/AIDS care.

Due to a very large proportion of the sample that either defaulted or were lost to follow-up during the data collection period (see discussion on this below), only 11% of the entire sample were classified as fully "recovered" from acute malnutrition according to program protocol. If, however, only those FBP participants who complied with the program protocol (i.e., did not default) are considered, the proportion of participants who achieved recovery according to program criteria increased to 42% of all participants. This suggests that there is good potential to improve the impact of this type of nutritional program if additional efforts are made to improve both patient adherence and health worker understanding of the protocol, program needs, and record-keeping approach (discussed further below). This study was performed in the very early stages of program implementation, with roll-out of the study occurring at the same time as roll-out of the program itself. During this time, health workers were still being introduced to and trained on the program protocol. This may have contributed to the low recovery rates and high default that we see here. In other programs it has been observed that once health workers observe program benefits to participants it serves as a strong motivational factor to enroll (and consistently follow) patients in the program (Puett, Sadler et al. 2012; Collins 2006.

Factors Related to Recovery in the Intervention Group

If we consider only the compliant participants, i.e., those individuals who did not default from treatment in the intervention group, several factors appear to be linked to recovery. We have already discussed the importance for recovery of nutritional status at admission (see above). In addition, females were 1.5 times more likely to recover than males. The fact that men tend to access HIV care at a more clinically and/or immunologically advanced stage of disease than women has been documented elsewhere and is likely to explain this finding (Ahoua, Umutoni et al. 2011).

Among MAM participants, the individuals who have been on an ART regimen for less than six months are three times more likely to recover than those patients not on ART at all or those who have been on ART for more than six months. Similar differences have been noted by other research groups. Ahoua et al. 2011 found that patients eligible for and started on ART at or after admission to the nutrition program were less likely to fail nutritional therapy (OR 0.6, 95% CI 0.4–0.9). This group represents clients whose HIV disease has recently progressed to a level of illness that fulfilled eligibility for ART.

6 The units of weight gain used in the Kenya FBP program were different from those used here. To make a valid comparison we used the average length of stay and the average BMI change seen in this study (Table in Annex 2) and estimated an average BMI change/month.

It is likely that, in these cases, the worsening illness was the cause of the malnutrition and that as both drugs and food were initiated they boosted recovery more than the addition of food alone, or that could occur if the food were added to a more established ART routine. For those who had been on ART longer than six months, there are likely to be factors other than access to food related to their malnutrition.

Related to this, CD4 count at baseline is significantly associated with recovery for the group of participants with a count between 200 and 350 (the threshold levels for ART initiation at any WHO stage, and at WHO stage 3 criteria, respectively). These individuals are 1.8 times more likely to recover than those with CD4 below 200. This is similar to the significant relationship between length of time on ART and recovery, as it seems that those individuals whose disease has recently progressed and who are on the cusp of being sick enough to start ART (and are also malnourished) are likely to experience greater benefits from the addition of food than those with either very low or high CD4 counts. These findings, like those around nutritional status at admission, could have important implications for the prioritization of resources for nutritional supplementation in ART programs.

Household food security categories of secure, some insecurity, and severe insecurity were calculated using the HFIAS data collected from study participants at baseline (Coates, et al. 2007). Overall, for those participants who complied with treatment protocols, the likelihood of recovery increases with the severity of household food insecurity. While the phenomenon of worsening food security being associated with nutritional recovery may appear strange, it is plausible that in this group, the causal factors of malnutrition are different from those for food secure and food insecure individuals. Participants from food insecure households may be malnourished due to a general lack of household access to food, in which case the addition of an RUTF supplement represents a larger marginal nutritional benefit than for an individual with regular access to more energy/nutrients. In contrast, a malnourished individual in a household with higher levels of food security may be malnourished due to other illness or factors related to HIV, in which case the addition of an RUTF supplement would be expected to have less impact on their BMI. While some qualitative evidence points to an increased likelihood of intra-household sharing of the FBP supplement when food insecurity is high, it may be that this additional food continues to represent a critical contribution to overall food intake, even if it is occasionally (or regularly) shared with other family members. This points to the need for careful targeting of food assistance in HIV programs to ensure that access for and coverage of those from the most food insecure households is maximized.

Nutritional Non-response

While non-response, as defined by program criteria as not reaching recovery for two consecutive visits, was lower in the intervention group than in the control (15.9% vs. 31.9%, $p<0.001$), overall the rate of non-response among those participants that *complied* with treatment (i.e., stayed in the program until discharge) in the intervention group was high (58.4%) and even higher for those that were sickest at baseline. Being severely malnourished and having a low CD4 count at enrollment were both associated with increasing risk of non-response and this, again, highlights the need to reach malnourished HIV patients early with nutritional support if recovery is to be maximized. The fact that increasing food security was also associated with increasing risk of non-response reinforces the complex relationship between malnutrition and the HIV disease discussed above. However, it is important to note that of those classified as "non-responders" according to program protocol in the treatment group, weight and BMI gain in this group was still significantly higher than that recorded among both non-responders *and* recovered participants in the comparison group. On average, non-responders in the treatment group increased their BMI by 1.1 points by exit, and 37.4% of them had reached a BMI of 18.5 once during their treatment. As discussed above, any nutritional improvement is likely to reduce the risk of negative outcomes such as death, underscoring the possibility that while recovery may not be achieved according to program

definitions, it is likely that considerable benefits remain in supporting interventions that increase access to nutritional support and thereby weight gain, even if program criteria for recovery are not achieved for some participants.

One important observation in this study is that the likelihood of non-response (when the original program protocol outcome definitions are followed) is significantly higher for participants recruited and treated at hospitals than for those recruited at health centers, with hospital-based patients only half as likely to reach the BMI requirements for recovery as those coming from health centers. There are several differences between these two facility settings and the types of participants recruited at each; in particular, hospital-based patients are more malnourished and have lower CD4 counts when they enroll in the program. In addition, hospitals have higher caseloads, greater burdens, and more staff. The observed difference in recovery is likely related to a combination of these reasons, with hospital staff more overwhelmed or less informed on program protocol (especially with high levels of staff turnover or rotations through units), while also drawing participants from a population that is more sick and more malnourished in general. These findings concur with other reports from India (Sharma and Narang 2011) and Kenya (English, Esamai et al. 2004), where quality of care and/or outcomes in larger referral facilities was also found to be poorer than that delivered by smaller facilities because of these specific constraints. This has implications for the type and level of support needed for these kinds of interventions at hospitals versus the smaller health centers, and suggests that increasing levels of training, supervision, and medical support in the latter may be necessary to improve outcomes for participants.

When participants were asked to self-report reasons that they believed the program was unable to successfully raise their BMIs to the level required for graduation, the responses clustered around several thematic areas; in brief: 1) intra-household sharing; 2) limited household access to other food; 3) inadequate monthly quantity of RUTF; 4) presence of other illness; and 5) health workers telling patients to stop participation. The first three categories can all be interpreted as issues of household resources, or of household food insecurity. The RUTF ration was conceived in program design as a supplement to other foods eaten in the home. Its effectiveness depends upon recipients adding it to an existing diet, rather than treating it as a primary food source. In cases of food insecurity, this may not be feasible for all patients. In addition, participants with less food available at a household level may be more likely to share their FBP prescription/ration with other members of the household (children, in particular), thus diluting the impact achieved against their own BMI. However, it is worth noting that while this phenomenon makes logical sense in theory, and several participants have noted it anecdotally, the quantitative data suggest a different story, with increasing food insecurity actually associated with increased odds of recovery. As both the links between food security and nutrition, as well as between HIV and malnutrition, are highly complex and multi-faceted, the associations observed in this study warrant further analysis.

The fifth reported reason for non-response, that health workers informed participants to stop attending FBP appointments, strongly suggests a need to ensure the program protocol is understood, not only by the clinic staff implementing the program but also by the participants themselves. In many of these anecdotal reports, patients claim they were gaining weight and feeling better at the time when they were told they would be removed from the program, and it is possible that this was indeed the case, but that they simply had not reached the threshold for an outcome of "recovery." Potential misunderstandings on the part of the participants can be reduced if health workers effectively communicate the FBP protocol, thresholds, expectations for weight gain, and outcomes to patients when they are first enrolled.

Nutrition Program Default

This study detected very high rates of patient default and loss to follow-up within the FBP sites: 71% of the treatment group, 67% of those who enrolled as MAM, and 82% of those who

enrolled as SAM. The data records did not allow for distinction between those individuals who stopped attending their appointments entirely, and those who may have continued to come but whose study (and program) data were not recorded by the clinic staff. These numbers were observed when default was defined according to the FBP program protocol, and they include individuals who disappeared from the data register before reaching two consecutive visits with a BMI of 18.5 or above, and before the protocol-defined period of time allowed for recovery had elapsed (three months for MAM, six months for SAM).

According to this definition, MAM patients were allowed four visits under the program in order to reach a participation period of three months. There were a large number of moderately malnourished that participated in the program for two months (until visit three) and then defaulted (41% of all defaulters who were MAM at admission in the intervention group fall into this category). It is likely that this represents, in part, a misunderstanding of the protocol on the part of the health workers or the participants, a hypothesis supported by our qualitative data. The median BMI at the third visit of this group was 18.3, suggesting they were close to reaching the target BMI of 18.5.

A number of factors appeared to increase the risk of default among program participants. In general, the participants who defaulted from the study were more malnourished; a larger proportion were severely malnourished and the average BMI (16.6) was significantly lower than among the compliant group (17.1). The defaulting participants were also more likely to be suffering from other co-infections when they enrolled in the program and were more likely to be either pre-ART or on ART for > six months. Also importantly, a significantly larger proportion of the default group than the compliant group came from hospitals rather than health centers and were classified as being from severely food insecure households (vs. food secure).

These observed associations suggest two reasons why participants may have defaulted. If participants who went on to default were more malnourished and sicker when they started the program, they may have be too weak to attend their appointments regularly, or they may have died during the study period, unbeknownst to the clinic staff. Similar to the issue of factors related to recovery, hospitals are already host to sicker and more malnourished FBP patients in general, which likely explains the observation that a greater proportion of hospital-based participants defaulted as compared to health center-based.

Qualitative data also suggests that a not insignificant proportion of recorded defaulters was still participating in the program and had not defaulted at all. In the process of identifying default participants to be interviewed, a large number of those who in the facility register books appeared to have stopped attending FBP appointments reported that they were in fact still participating in the program. In this regard, hospitals experienced greater challenges in record keeping than health centers, as they often had multiple treatment rooms within the ART clinic and could not guarantee that returning FBP patients would be seen in the room with the register book. Similarly, one of the most frequently self-reported reasons for "default" was that health workers had instructed participants that they had either reached their quota for the RUTF, that they had gained sufficient weight, or that the health worker was unclear on program protocol, all of which point to possible clinic staff error as one explanatory factor for the large number of participants who do not appear to have been compliant with program protocol.

Furthermore, the theory that sickness may serve to deter adherence was also supported by qualitative data. Focus group participants of current patients reported that travel to health facilities was made more difficult, and often impossible, by bouts of illness. Health workers as well reported the inability to travel to clinics during times of sickness as a cause of default, or of preventing participants from picking up rations on the intended schedule.

Other Food by Prescription programs have noted similar challenges with default. In an FBP program in Kenya, Lost to Follow-up (LTF) made up 98.3% of all cases of attrition (LTF,

death, and transferring out), which itself comprised 50% of program clients (Food and Nutrition Technical Assistance II Project (FANTA-2) 2009). Here also, an important predictor of default was severe acute malnutrition at admission and pre-ART status. It would be useful if all FBP-type programs could identify risks for default in the program design stage in order to subsequently incorporate possible mitigating interventions.

Impact on Clinical Outcomes

This study observed that the provision of a food supplement may help to slow the progression of HIV over time. Individuals receiving the RUTF in addition to their ART clinic treatment showed an increase in CD4 count of approximately 75 cells/mm3 more than those who did not receive the food supplement. This difference was most significant for those participants who were not on an ART regimen—they demonstrated an average increase in their CD4 count of 132 cells/mm3 more than other participants. Functional status also served as an informative indicator of disease progression. From our data, a greater proportion of the treatment group showed an improved functional status by the time of discharge than did the comparison group, at 22% and 4% ($p<0.001$), respectively. These observations underline once more the benefit to targeting malnourished HIV+ patients with nutritional support early in the course of their HIV disease. If malnourished clients are targeted before CD4 count drops to a level that warrants ART, the potential for impact of a food ration on disease status appears to be greater. Our observations also warrant more in-depth examination of the relationship and possible interactions between the RUTF and drug treatments. Provision of supplementary food has been shown to improve adherence to ART medications for example (Cantrell, Sinkala et al. 2008, Lamb, El-Sadr et al. 2012), but this study was not able to examine this for the Ethiopia program.

Persistence of Effects

Our finding that at six months after exit a large proportion (80%) of those who graduated (recovered from malnutrition) and for whom follow-up data was available managed to maintain a healthy nutritional status is an interesting one. While this finding should be interpreted with caution because of the low proportion of total exits that this study managed to follow up at six months, it does suggest that nutritional support that promotes recovery from malnutrition in the short term can have longer term benefits for health and nutrition status of people on ART. ■

The cost and cost-effectiveness analysis was conducted in two stages. The first stage estimated the marginal program costs from key program cost centers, and derived a cost-per-patient figure based on these results. The second stage combined information on key impact indicators with these cost figures to create cost-effectiveness ratios. Scenarios were modeled by varying key parameters in the assumptions underlying these ratios. The following section describes the elements that were measured in order to calculate the program cost. A methods section describes how the data were collected and analyzed. The subsequent section presents the results of the cost analyses. A final section summarizes the results of the cost-effectiveness analyses.

Program Cost

The cost analysis was designed to assess the marginal cost of providing therapeutic food (RUTF) to an existing treatment protocol for ART clinic patients. As such, we did not attempt to assess the total cost of providing care to HIV+ patients. Rather, the study considered only those costs expected to differ between sites implementing the FBP program and a set of comparison sites in which the program had not yet been introduced. The goal was to disaggregate these additional costs by component, in order to understand the cost structure and to identify potential efficiencies that could reduce these costs if the FBP program is continued and brought to scale.

The cost of the RUTF includes not only its purchase price but also the costs of shipping and handling from the point of production to Addis Ababa, from Addis to regional warehouses, and from regional warehouses to the individual clinics. Within the clinics, there is an additional cost of labor to transport the boxes of RUTF from the truck to the clinic storeroom or other storage location and from there to the dispensary or pharmacy from where the product is distributed to patients. The product incurs storage costs in Addis and at regional warehouses, and occupies storage space within the clinics as well. The RUTF is procured and distributed by a US contractor, Supply Chain Management Systems (SCMS); this group is responsible for the procurement of a wide range of drugs and medical supplies for public hospitals and clinics In Ethiopia. SCMS works with the Pharmaceutical Fund and Supply Agency (PFSA) within the Federal Ministry of Health, which is responsible for the delivery of these drugs and supplies to clinics; RUTF is just one of the many products they handle. Nonetheless, some additional management costs were expected to be incurred for the handling of the RUTF product. We also examined whether additional management time is required to track inventory, stock, and re-order the RUTF within the clinic, at the store room, and at the dispensary.

We hypothesized that the provision of RUTF would require clinical care providers to spend additional time with patients, counseling them on the proper use of the supplement and assessing their compliance with the supplementary food regimen. We also posited that the FBP program could place more demands on clinical care providers for tracking patient progress (i.e., his/her weight gain). The FBP program also required special training of clinic staff, and the cost of this training needed to be considered in the total marginal cost.

Using the societal approach to costing, we also took into account potential costs to patients. The need to spend extra time during a clinic visit was hypothesized as a likely patient cost. Beyond the extra time spent in the clinic visit, we anticipated that FBP patients might require more time and perhaps different transport when returning home from a clinic visit, because of the need to carry the bulky packages of RUTF.

Methods

Data Collection

Eight ART clinics were selected from among the impact study implementation sites, and the eight comparison site clinics were included in the costing study. The clinics had not been randomly assigned to FBP or the comparison group, and in fact we observed significant differences among

them (presented below). Each clinic was visited by a team of interviewers over a period of five days between August and September of 2011. During the five days, data were collected on the following items:

- A sample of patients coming to the ART clinic was followed from the time they arrived at the clinic to the time they left, and each clinical interaction was timed, in order to see whether the FBP program imposed an additional time burden on the patients and staff. Waiting time between clinical interactions was also measured. At the time of measurement, it was not possible to identify the patients as SAM or MAM, but we were able to link about half the patients to their medical records, in order to see whether the time spent differed for MAM and SAM patients.
- The patients were interviewed about the time and money costs of attending the clinic, including transportation, the cost of paying substitute workers in household tasks, and income forgone due to lost paid work.
- Interviews were conducted with the ART coordinator to obtain information about clinic staff, their roles and their salaries, caseload, patients seen each day over the five days of observation, and days of operation.
- Individual interviews were conducted with ART clinical staff randomly selected from the list of staff provided, to obtain estimates of the time spent in specific activities. They were also asked about their attitudes toward the FBP program.
- Interviews were conducted with the managers of the clinic store room and dispensary, to obtain information about their respective staff and staff salaries. Information was obtained on the frequency of deliveries of medical supplies including RUTF, and the time and money cost of unloading boxes of RUTF from the delivery truck to the store room, and from the store room to the dispensary.
- Individual interviews were conducted with representative staff members working in the store room and dispensary, to obtain estimates of time spent in specific activities.
- Observations were conducted at the store room and dispensary at randomized times over five days to observe the work load and the constraints to storage capacity in those locations.
- Information was obtained from clinic records on the flow of RUTF through the clinic over three delivery cycles: beginning stocks, delivery, product losses, and ending stock, with consumption calculated as a residual. This information was used to assess the average number of RUTF boxes delivered per month.

In addition to the information collected during visits to the sample clinics, we collected the following information:

- Information was obtained from SCMS on the costs (2011) of procuring, storing, and distributing RUTF to the clinics.
- Information was obtained from SCMS on the aggregated staff cost (2011) attributable to the management of RUTF, based on interviews with SCMS staff (not on direct observation).
- Information was obtained from the SC office responsible for the implementation of the FBP program on the annual costs (2011) of managing the program: staff, office costs, equipment, supplies, and overhead. We excluded any costs exclusively associated with the SC/Tufts research.

Cost Estimation

Cost per Sachet of RUTF

Cost of the RUTF per patient was estimated based on the cost of the RUTF per sachet, multiplied by the number of sachets received over the course of treatment. The cost per sachet of RUTF was estimated using the cost estimates received from SCMS for the cost per box, shipping and handling, storage, and delivery to the clinic. The cost estimate received from SCMS includes, on a per box basis, the purchase cost as well as the costs of shipping and handling, storage, and distribution to the individual clinic. The cost per box of the product was based on the average per box cost over the past three shipments, to account for any fluctuations in price. The management cost of PFSA is included in the per box cost of distribution, estimated at USD 2.25 per box. The management cost of SCMS was estimated based on their provision of an aggregated operating budget and an estimate of

the percent of time spent on the management of RUTF, among all the products they handle. We used 2011 as the year on which to base our cost estimates, as it is the most recent complete year. The estimated dollar cost of the management time was divided by the number of boxes of RUTF handled in 2011 to derive a per box (and from there, per sachet) SCMS management cost.

The cost of unloading boxes of RUTF from the truck into the clinic storeroom is incurred by the clinic. We obtained information from each clinic on the staff time and staff cost of unloading their most recent PFSA delivery. Because of the wide variation in clinic size (as measured by caseload), this was estimated per 100 patients, to account for the fact that clinics with a larger caseload would have more commodities of all kinds (not just RUTF) to unload. We made the assumption that any difference between the average time and cost of FBP and comparison clinics, adjusted for caseload, would be due to the addition of RUTF to the delivery. Using information on the average number of RUTF boxes delivered at a time (averaged over the three previous deliveries), adjusted for caseload, we estimated the marginal cost of unloading one box of RUTF from truck to store room. Because of the systematic differences between treatment and control clinics, however, this process did not provide usable estimates. Based on the data obtained, the estimated marginal cost of unloading would have been negative. We truncated the estimate at zero since the value for time spent unloading RUTF cannot be negative.

A similar calculation was performed for the FBP clinics based on the staff time, converted to birr using salary information, to estimate the cost of carrying boxes of medical supplies from the store room or other storage location to the dispensary, based on interviews with store room and dispensary staff: we identified the staff members responsible for this task, took their estimate of the time required and frequency of the task, and converted it to birr based on their salaries (or average salary of this type of worker, if we couldn't associate the task with one particular staff member). The difference in time between FBP and comparison sites was assumed to be due to management of RUTF. As with the cost of transport from truck to store room, the estimates of time and cost to transport product from store room to dispensary were negative, and were truncated at zero.

The last component of the cost of RUTF is the shadow cost of storing the boxes in the clinic prior to distribution. With information on the timing and amount of the last three deliveries of RUTF to each clinic, and on starting and ending stocks for each period, we were able to estimate the average duration of a box of RUTF in the store room or other storage area, assuming the first boxes in are also the first out. We used the monthly local cost of warehouse space using regional warehouse costs obtained from SCMS, and the volume of each box of RUTF, to estimate the average shadow cost of storing one box. While the clinics at present do not pay anything extra to store RUTF, it was clear from field visits that storage is a challenge in some locations: the store room cannot always accommodate the RUTF boxes, and they may be stored in hallways and offices. Should the FBP program expand, or should a more bulky product (such as CSB) be provided, outside storage would very likely be required.

From these components we were able to build an estimate of the cost to the program of one box of RUTF; a box contains 150 sachets, permitting us to estimate the cost per sachet.

Staff Costs

The staff cost of the clinical visit was estimated by taking, for each patient, the minutes of time spent in each component of the clinical visit multiplied by the salary level of the appropriate staff member or the average salary of staff members in the relevant category at that clinic. The sum of these costs (minutes converted to salary in birr) represented the cost of a given clinic visit. The average minutes and money cost of treatment and control were compared to derive a marginal cost of each clinic visit. Since the clinical visit times were on average significantly longer for SAM than for MAM patients, since they were presumably sicker, this was calculated separately for SAM and MAM patients.

Clinical interactions were summed to derive a total number of minutes for the visit. Using information on time in/time out of the clinic, we

also derived a number of minutes spent waiting. Wait time was not associated with a staff cost. In addition, minutes coded as "other" or "keeping queue" were not associated with a staff cost.

The cost of one clinic visit was multiplied by the average number of total visits for SAM and MAM patients during their period of time in the FBP program. As mentioned earlier, we assume that once a FBP patient is no longer receiving RUTF, s/he is treated as any other patient. Thus the marginal staff cost of a clinic visit *per patient* is the cost of a single visit, multiplied by the number of visits during FBP participation. This was compared with the number of visits in the comparison clinics over the comparable period of time. We also measured the average number of visits per month, to see whether receiving RUTF influenced the frequency of visits.

Some tasks performed by clinical staff are not included in the time spent in clinical visits with patients. In general, these tasks would not be assumed to be affected by the provision of supplementary food, and therefore are not included in the marginal cost calculation. The same reasoning applies to the completion of the data collection instruments required by the research: both the FBP and the comparison sites filled out similar paperwork, so there should be no systematic difference in the time spent. The one exception is the FBP register book, which is completed as part of the FBP program, but was completed in the comparison sites only as part of the research. In both FBP and control sites, virtually all the clinical staff completed the registers during the clinical visit, while they were interacting with patients. Since we could not (for privacy reasons) measure the time taken for record keeping during the clinical visit, we asked clinical staff to fill out a "mock" register as a separate task, so that we could time it. However, we concluded that this timing was unrealistic, as clinical staff during the "mock" record keeping were devoting their full attention to the task and knew they were being assessed. The "mock" paperwork produced unrealistically high time estimates which, when subtracted from the time of a clinical visit, resulted in some negative numbers. We therefore decided not to subtract the time spent on the FBP register in the comparison sites. (In fact, the averages were little affected by this decision.)

We expected that management of RUTF at the clinic store room and dispensary would require additional time aside from the direct cost of carrying boxes from truck to store room (or storage location) and from store room to dispensary. These management tasks include activities such as stocking shelves, tracking inventory, filling out order forms and other reporting forms, and removing expired products (RUTF as well as medicines) from the shelves. We took the estimated time spent in these tasks and calculated (for each clinic), the time spent in each of these tasks. All tasks were converted to monthly time and monetized using the salary of the appropriate staff member (or average salary of the type of staff member). This was done for store room and dispensary staff. When data were available for only one staff member, the times were multiplied by the number of staff reported to be working at any one time. These times were adjusted for caseload size.

The marginal time and money costs of store room and dispensary tasks per month were assumed to be due to the additional burden of handling RUTF. Once again, due to systematic differences between treatment and comparison clinics, this method produced unrealistic estimates that were truncated to zero.

Management Costs—Save the Children

We obtained from SC senior management a breakdown of the annual budget for managing the FBP program. All these costs were, of course, considered part of the marginal cost of the FBP program. Costs for the calendar year 2011 were used for the calculation, since that was the most recent completed year. Cost of the research on impact and cost of the program was not included. The costs were divided by the number of (unduplicated) patients in the program in 2011 to derive a per patient management cost, based on the simplifying assumption that patients seen at the beginning of the year started in 2010, but would be balanced by patients starting late in 2011 and continuing into 2012. The number of patients in the program in 2011 was 41,180; the number expected for 2012 is 48,000, and this number is expected to continue rising.

Costs to Patients

Patients were interviewed to determine what activities they had to forgo as a result of coming for a clinic visit, whether they had to pay someone to do the activities, and their estimate of any lost income as a result of the visit. The time and money cost of transportation to and from the clinic were also measured, to see whether the need to carry boxes of RUTF resulted in FBP patients having to take more time or more expensive transportation on their return from the clinic compared with traveling to the clinic. The treatment clinics were more likely to be located in more densely populated areas where patients needed to travel shorter distances than in the comparison clinics, which means differences in travel time between FBP and comparison clinics is not attributable to the program itself, but rather is likely related to systematic differences in clinic location. Similarly, any difference in estimates of the income forgone and need to pay for substitute activities during clinic visits could not be attributed to the FBP program.

Total Cost per Patient

The marginal costs described above were then estimated on a per patient basis. The protocol for the treatment of patients with moderate acute malnutrition (MAM) is to provide two sachets of RUTF daily for three months; for patients with severe acute malnutrition (SAM), the protocol is to provide four sachets daily for six months. As we learned from the impact analysis, the implementation of the program frequently differed in practice from the protocol as planned. On average, SAM patients received 108 sachets of RUTF per month for an average of 3.53 months (time in the program); MAM patients received 77 sachets per month for 2.82 months.[7]

We estimated the cost per patient based on the actual quantity of RUTF delivered and the actual number of months of treatment. Underlying the cost analysis is the assumption that once a patient stops receiving the supplement, he or she is treated like any other HIV+ patient; hence the marginal additional cost of the FBP program is limited to those months when the patient is receiving the food and any additional associated counseling, monitoring, and assessment. Since we are interested in marginal cost, the monthly costs for each type of patient (i.e., SAM or MAM) multiplied by the months of receiving the supplementary food represent the marginal cost per patient. These were estimated separately for patients initially diagnosed with SAM and with MAM, because of the difference in program protocol for these two groups. Patients in the FBP program represented about 18 % of the HIV+ caseload in the ART clinics; of these, on average 71% were MAM and 29% were SAM at entry. Among the clinics included in the costing study, the percentages of FBP patients in the total ART clinic caseload varied considerably from one clinic to another.

Conversion of Birr to US Dollar Cost

SCMS and SC costs were reported in US dollars. All other costs—staff time, patient costs, storage costs—were estimated in Ethiopian Birr. To estimate a dollar cost, we used the World Bank average exchange rate for 2011 (World Development Indicators, The World Bank).

Results

Clinic Characteristics

There were eight clinics in the FBP group and eight in the comparison group. Among the FBP clinics, three were located in large urban hospitals in Addis Ababa, while all the comparison clinics were in smaller health centers. Many of the differences between FBP and comparison clinic costs are likely explained by these differences. Patients travel farther on average to the comparison clinics; patients wait longer in the more crowded FBP clinics. These differences in time cost probably cannot be attributed to the implementation of the FBP program, but rather to the differences in the locations themselves.

These differences are also reflected in the number of patients seen per day (Table 11). In

7 Much of the shorter-than-expected duration of treatment may be explained by the large number of patients who defaulted after their initial visit. Further discussion of the default issue can be found in the previous section.

Table 11: Average number of patients seen per day, over five days

	Treatment sites	Comparison sites
Total patients	**40.20**	**19.38**
ART clinic patients		
New	1.44	0.42
Ongoing	39.20	18.39
FBP patients		
New	2.79	
Ongoing	3.77	
Total FBP	**6.56**	

FBP clinics, the average number of patients seen daily in the ART clinic was 40.2, compared with 19.4 in the comparison clinics. Average caseload in the FBP clinics is 3219, compared with 1077 in the comparison sites (Table 12). Ongoing patients far outnumbered new patients to the ART clinic, but the number of new vs. ongoing FBP patients was similar, due to the recent initiation of the FBP program.

Staffing patterns are also different. FBP clinics have on average 1.3 more staff members. Two comparison clinics reported a physician on staff, and no FBP clinics did, though only in the FBP clinics did patients spend time with a physician, possibly because in larger hospitals, the physicians were not explicitly assigned to the ART clinic. FBP clinics on average had slightly more nurses, health officers, and case managers, again presumably reflecting the larger patient population.

These differences between FBP and comparison clinics affect many of the comparisons we made, and are discussed in the relevant sections.

Average salaries also differ between the FBP and comparison clinics, with some salaries being higher in treatment but others higher in the comparison group, as shown in Table 13. Since the marginal cost of a patient visit is a product of the extra time spent and the cost of the staff member participating in that interaction, systematic salary differences affect the marginal cost comparison for an individual clinic visit. The monetary value of a clinic visit was evaluated using the ETB cost specific to each clinic. To account for the difference in salary levels between treatment and control, we also assessed the cost using the average across all clinics (treatment and comparison) of the salary level for the relevant staff category (although these were not the values used in the cost-effectiveness calculations).

Cost of a Clinical Visit

Client Time in Clinical Visit

Clients in the FBP clinics were divided into newly enrolled (enrolled in FBP on the day of observation) and ongoing FBP patients. In the comparison clinics, they were divided into newly enrolled in the ART clinic and ongoing HIV patients. Of 175 patients in the FBP clinics, 53% were newly enrolled, and 47% were ongoing in the FBP program. In the comparison clinics, only 5% of the 145 patients observed were newly enrolled, and the rest were ongoing.

We timed each component of the clinic visit. The components measured were:

- Check in at the card room (receiving area for all patients)
- Introductions (of the survey researcher)
- Weight and height measurement
- Visit with ART nurse or health officer
- Visit with physician
- Visit with case manager
- Laboratory visit
- Visit to general dispensary

Table 12: Cost study clinic characteristics

	Caseload	Average number of daily patients
Treatment sites		
Arsi Negele Health Center	1066	9.8
Chiro Hospital	1357	30
Zeway Health Center	2951	24.8
Metahara Hospital	1436	19.6
Bishoftu Hospital	6673	75.5
Dilchora Hospital	6402	79
Kality Health Center	4071	43.6
Meshualakia Health Center	1793	45.5
Average	**3218.6**	**40.2**
Comparison sites		
Sendafa Health Center	635	17.5
Sheno Health Center	1016	17.7
Chancho Health Center	765	14.7
Gindeberet Hospital	611	16.5
Wenji Hospital	921	16.6
Atayie Health Center		22.3
Bure Health Center	2774	36.3
Merawi Hospital	814	12.8
Average	**1076.6**	**19.4**

Table 13: Average hourly clinic salaries in ETB, by intervention group

	Treatment		Comparison		
Title	**Average hourly salary (Birr)**	**N**	**Average hourly salary (Birr)**	**N**	**P- Value**
ART Clinic Case Manager	4.1	15	4.3	7	0.276
ART Clinic Health Officers	15.9	10	20.5	7	0.115
ART Clinic Nurse	12.4	9	9.3	11	0.189
ART Coordinator	29.4	2	16.8	3	0.044
Druggist—ART Dispensary	9.3	2	7.5	3	0.520
Druggist—General Dispensary	8.4	13	8.5	16	0.863
Head Pharmacist	17.1	4	17.4	4	0.874
Other	3.6	10	15.5	1	
Pharmacist	15.5	5	17.8	1	
Storeroom Manager	8.7	6	17.9	2	0.010

Table 14: Percent of caseload participating in FBP, by clinic

Facility	Percent of caseload
Arsi Negele Health Center	0.21
Bishoftu Hospital	0.10
Chiro Hospital	0.14
Dilchora Hospital	0.23
Kality Health Center	0.10
Meshualakia Health Center	0.10
Metahara Hospital	0.47
Zeway Health Center	0.21
Average percent FBP (n=38)	**0.18**

- Visit to ART dispensary
- Visit to cashier
- Waiting in line
- Other

The percentage of total clinic caseload that was eligible for FBP varied from one clinic to another. Table 14 shows the proportion of FBP patients seen daily in each of the clinics in the cost study.

Not every patient completed every component of the visit. Table 15 shows the average time spent in each component of the visit for those who used it, as well as the percent of patients in each group (FBP and comparison) who used it, and the average time over all patients. Note that only some of the patients in the sample could be identified as SAM or MAM, so the average of all patients includes many patients not included in the SAM and MAM columns.

The total time spent in clinical interactions was about 11 minutes longer for FBP patients: 35.39 minutes compared with 24.06 minutes for the control. For those who used the component, FBP patients spent longer checking in at the card room (initial entry), at the ART dispensary, and with their case managers, though they did not spend longer with the nurse or health officer. Only 5% of FBP patients saw a doctor on their visit, and none of the comparison patients saw a doctor.

Among FBP patients, 69% were weighed and measured during their visit, while only 39% were weighed and measured in the comparison group. More newly enrolled FBP patients were weighed (88%) than ongoing (48%). Comparison group patients were about as likely to have a lab visit during their visit (17% as compared with 15% for FBP), and the visits took about the same amount of time. Almost all patients visited the ART dispensary during their visit, and about 14% visited the general dispensary. In both cases, among those who visited, the interaction took slightly longer for the FBP patients.

These results are for new and ongoing patients combined (in each group). Among the FBP patients, newly enrolled patients spent about six minutes longer in clinical interactions: 38 minutes, compared with 32.33 for ongoing FBP. However, ongoing FBP patients spent much longer waiting between interactions: almost 71 minutes total, compared with 43 minutes for newly enrolled patients. Similar differences were seen between newly enrolled and ongoing HIV patients in the comparison clinics. Total clinical interaction time was about eight minutes longer for newly enrolled patients: 32 minutes compared with 24 minutes for ongoing patients. Wait time was much shorter for newly enrolled HIV patients: 16.57 minutes, compared with 32 minutes for ongoing HIV patients. (Only seven patients in the comparison group were newly enrolled.)

As mentioned above, we had information on SAM/MAM status for about half of the patients who were timed. Based on this limited number of cases, in the FBP clinics, SAM patients spent about 4.2 minutes longer in clinical interaction than MAM patients: 38.16, compared with 33.93. The same was true of patients in the comparison clinics: SAM patients took about 6.3 minutes longer than MAM patients: 30.3 minutes, compared with 24.06.[8] The difference between FBP and comparison patients in total clinical time was greater for SAM patients by about eight minutes, compared to about 3.5 minutes for MAM patients.

In addition to spending more time in clinical

8 This calculation was done without subtracting from the comparison sites the time taken to fill out the FBP register book; a calculation that subtracted the mock register book timings produced almost identical results.

Table 15: Time (in minutes) spent in clinical interactions★

Station codes		Treatment					Comparison				
	Name	SAM avg.	MAM avg.	Avg. of all patients	Avg. of patients using this service	% using this service	SAM avg.	MAM avg.	Avg. of all patients	Avg.of patients using this service	% using this service
1	Check in—ART card room	12.63	7.23	11.09	11.83	0.94	3.00	1.97	2.38	2.40	0.99
2	Introductions	1.26	1.67	1.49	1.48	1.00	1.22	1.38	1.29	1.31	0.99
3	Weight & height	4.11	1.05	1.29	1.86	0.69	0.33	0.40	0.45	1.16	0.39
4	ART Nurse/ Health Officer	9.79	12.21	10.35	7.54	0.98	12.78	13.39	11.99	9.24	1.00
5	Doctor	0.00	1.11	0.51	6.43	0.05	0.00	0.00	0.00		0.00
6	Case Manager	0.00	1.00	0.93	10.31	0.08	1.67	1.06	0.86	7.81	0.10
7	Lab visit	2.26	3.18	2.56	14.19	0.15	5.44	1.68	2.65	13.24	0.17
8	Gen. dispensary	0.53	0.05	0.98	4.44	0.15	0.44	0.42	0.87	4.85	0.14
9	ART dispensary	3.89	5.63	4.64	4.05	0.93	5.33	3.51	3.46	3.86	0.87
10	Cashier	0.16	0.00	0.09	2.00	0.04	0.11	0.22	0.58	7.00	0.07
91	Injection room	0.00	0.00	0.00		0.00	0.00	0.00	0.02	3.00	0.01
92	Care and support room	0.00	0.04	0.02	1.50	0.01	0.00	0.00	0.01	2.00	0.01
93	Archive room	0.00	0.00	0.02	2.00	0.01	0.00	0.00	0.01	1.00	0.01
94	Mother support room	0.00	0.00	0.03	5.00	0.01	0.00	0.00	0.00		0.00
95	Exit process	0.00	0.23	0.07	13.00	0.01	0.00	0.00	0.00		0.00
96	HC head office	0.00	0.00	0.00		0.00	0.00	0.03	0.02	1.50	0.01
97	Store room	0.00	0.18	0.16	3.50	0.05	0.00	0.00	0.00		0.00
98	Keep queue	0.11	0.02	0.27	3.13	0.08	0.00	0.00	0.00		0.00
99	Other	3.42	0.35	0.89	5.41	0.12	0.00	0.01	0.01	1.00	0.01
	Total station time	38.16	33.93	35.39	5.74		30.33	24.06	24.59	4.24	
	Wait time★★			57.31					31.41		
	Total visit time			**91.65**					**56.00**		
	No cases:	**n=19**	**n=57**	**n=177**			**n=9**	**n=74**	**n=135**		

★*This table does not subtract the time to fill out the FBP register book from the clinical visit.*
★★*Calculated as a residual.*

interactions, FBP patients spent more time waiting between visits: a total of almost one hour (57.31 minutes), compared with half an hour (31.41 minutes) in the comparison group. This probably reflects the fact that the FBP clinics included hospital-based clinics, where FBP clinics are busier in general than in the small health centers.

We made a note of whether the patient was accompanied by a helper during the clinic visit. Of the FBP patients, 12% brought a helper compared to 10.4% of comparison patients, but that helper generally did not accompany the patient during the clinical interactions. Of those who did bring a companion, about a third of FBP patients and a quarter of comparison patients actually were accompanied during one or more clinical interactions.

Monetary Value of Staff Time in Clinic Visit

The marginal time spent in a clinic visit was converted to monetary value using the salaries of the appropriate staff members at each clinic. The

Table 16: Average value of each station in ETB*

	Station code	Treatment			Comparison			Difference (of averages)
No.	Name	SAM (n=19)	MAM (n=57)	Average (n=177)	SAM (n=9)	MAM (n=77)	Average (n=145)	
1	Check in—ART card room	1.71	0.97	1.50	0.41	0.27	0.32	1.17
3	Weight & height	0.64	0.15	0.20	0.04	0.06	0.06	0.14
4	ART Nurse/Health Officer	2.51	3.02	2.69	2.86	3.38	3.01	-0.32
5	Doctor	0.00	0.57	0.26	0.00	0.00	0.00	0.26
6	Case Manager	0.00	0.07	0.07	0.12	0.08	0.06	0.00
7	Lab visit	0.28	0.45	0.39	0.86	0.24	0.38	0.02
8	Gen. dispensary	0.06	0.01	0.18	0.05	0.08	0.15	0.03
9	ART dispensary	0.92	1.21	1.08	1.33	0.67	0.63	0.44
10	Cashier	0.02	0.00	0.01	0.02	0.03	0.08	-0.07
91	Injection room	0.00	0.00	0.00	0.00	0.00	0.00	0.00
92	Care and support room	0.00	0.00	0.00	0.00	0.00	0.00	0.00
93	Archive room	0.00	0.00	0.00	0.00	0.00	0.00	0.00
94	Mother support room	0.00	0.00	0.01	0.00	0.00	0.00	0.01
95	Exit process	0.00	0.03	0.01	0.00	0.00	0.00	0.01
96	HC head office	0.00	0.00	0.00	0.00	0.00	0.00	0.00
97	Store room	0.00	0.10	0.09	0.00	0.00	0.00	0.09
	Weighted average using clinic-specific salaries	**6.46**	**7.22**	**5.21**	**6.46**	**4.49**	**4.93**	
	Marginal cost of FBP	**0.00**	**2.73**	**0.28**				
	Weighted average using average salaries across all clinics	**6.33**	**7.01**	**5.17**	**7.04**	**4.57**	**4.96**	
	Marginal cost w/ avg. salaries	-0.71	2.44	0.21				

**This table does not subtract the time to fill out the FBP register book from the clinical visit.*

results, presented in Table 16, show that the average marginal cost of a clinic visit is 0.28 birr (where the average is weighted by caseload). When we look at the marginal cost of SAM and MAM patients, it seems that the difference is largely accounted for by the difference in MAM patients; there is no difference in the birr value of a clinic visit for SAM patients, while for MAM patients, the difference is 2.73. Note, though, the small number of patients who could be identified as SAM; this average is based on very few cases.

In the FBP clinics, clinic staff were expected to follow up when patients failed to come for their next visit or to pick up their RUTF ration. In our interviews, only one clinic reported spending time tracking defaulters, and only one staff member in that clinic reported performing this task, spending a reported 30 minutes per week on the task.

Cost of Non-clinical Management Tasks

Store Room and Dispensary Staff Time

A clinical visit takes longer for a patient in the FBP program than it does for a patient in the comparison clinics, and this additional time has a monetary cost. In addition, we expected that additional time would be required of staff working in the clinic's store room and dispensary, because of the responsibility for managing the additional commodity, RUTF. We asked staff in the store room and dispensary to estimate the time they spent in various management tasks. For the store room, these activities included stocking shelves, tracking inventory, removing expired products, filling out order forms and other reports; for the dispensary, activities included dispensing prescriptions, tracking inventory, filling out reports.

For the store room, we found that, adjusting for caseload, the time spent by store room staff in management of the store room was in fact lower in the clinics handling RUTF than in the comparison clinics. Due to the small number of cases (eight FBP clinics, and only five comparison clinics due to missing data), outliers had a disproportionate influence on the comparison. As a result, we calculated the caseload-adjusted time spent in store room management after eliminating those values that fell outside of one standard deviation above or below the mean. This procedure eliminated one FBP and one comparison clinic. We still found that the truncated mean of time spent was higher in the comparison than in the FBP clinics. In estimating the marginal cost of implementing the FBP program, we set this value to zero, since there is no clear reason why an additional management task (handling RUTF) would reduce the time spent in these tasks.

Results were similar for management of the clinic dispensary. Even after eliminating extreme outliers, the caseload-adjusted amount of time spent in management tasks at the dispensary was greater in the comparison than in the treatment clinics. It is possible that in smaller clinics with a lower caseload, management tasks could be performed at a more measured and less hurried pace.

Monetary Value of Staff Time in Store Room and Dispensary Management

Since the comparison clinics on average spent more time in management of the store room and the dispensary, adjusted for caseload, the monetary cost was also higher in the comparison clinics, despite the fact that FBP clinics had additional management tasks due to the addition of RUTF to the commodities to be managed.

For purposes of estimating the cost-effectiveness ratio of the FBP program, the marginal costs of staff time, which were calculated to be negative, were estimated to be zero.

Clinic Staffing Patterns

The implementation of the FBP program had little impact on staffing patterns. Only one FBP clinic reported hiring one additional staff member as a result of the FBP program; the title of this individual was not reported.

Cost of RUTF Product

A major cost of the FBP program is the cost of the product itself. As described above, this cost includes not only the purchase of RUTF, but its

Table 17: Cost per sachet calculation

Cost	USD	ETB
Cost per box	$ 63.07	
Storage + shipping to clinic	$ 2.25	
SCMS costs per box	$ 0.48	
Total cost per box	$ 65.80	
Total per sachet	**$ 0.44**	
Transfer to store room	-	-
Transfer to dispensary	-	-
Shadow cost of storage per box	$ 0.02	0.32
Shadow cost of storage per sachet	$ 0.00	0.002
Store room management cost	-	-
Dispensary management cost*	-	-
Total per box	$ 65.82	1112.29
Total per sachet	**$ 0.44**	**7.42**

**Birr costs were converted to US dollars using the average World Bank exchange rate for 2011: USD 1.00 = ETB 16.8992258 (World Development Indicators, World Bank).*

shipping and handling, storage, transportation, and distribution to the clinics. An additional cost occurs after the clinic receives the product, as it must be unloaded and carried to the store room (or other storage location), stored, and then carried to the clinic's dispensary as required. Unloading a PFSA delivery from the truck to the store room is sometimes done by clinic staff, including store room workers, guards, and laborers; in other clinics, day laborers are hired to unload the delivery.

Among the eight FBP clinics in the study, seven used only their own staff for the tasks of unloading and carrying. Of these, four paid extra (on top of salary) for the task. Calculating the marginal cost of unloading a PFSA delivery due to RUTF required estimating a caseload-adjusted time to unload for each clinic, and then assuming the difference between FBP and comparison clinics was due to the RUTF. The calculation, however, resulted in a caseload-adjusted time to unload that was greater for the comparison clinics than for the FBP clinics. One reason may be that the treatment clinics were significantly larger. Two of the FBP clinics had caseloads over 6000, while the largest of the comparison clinics had a caseload under 3000, and the rest had caseloads under 1000. We hypothesized that the very large clinics were able to take advantage of economies of scale and efficiencies due to their large size. The same was true for the cost of transporting RUTF from the store room (or other storage location) and the dispensary.[9]

The components of the cost of a box of RUTF provided to a patient are shown in Table 17, along with the percent of cost associated with each component. The cost of a sachet is simply the cost of a box divided by 150, the number of sachets in a box.

The cost of RUTF per patient is calculated by multiplying the cost of a sachet by the number of sachets prescribed per month, multiplied by the number of months a patient receives RUTF. The treatment protocol specifies that patients with MAM at enrollment receive RUTF for three months, and patients with SAM receive it for six months. On average, however, the number of months of participation in FBP was much lower,

9 Excluding these two FBP clinics, the difference between FBP and comparison clinics in caseload-adjusted time for unloading was positive, as was the caseload-adjusted time for transport from store room to dispensary. By calculating the marginal unloading time per month and the number of RUTF boxes received per month, a cost per box of ETB 45.89 (ETB 0.31 per sachet) was derived. After excluding the two very large clinics, the cost per box for carrying RUTF from the store room to the dispensary was ETB 0.22 (ETB 0.001 per sachet).

Table 18: RUTF prescribed during course of treatment, by nutritional status at baseline

Baseline nutritional status	Variable	N	Mean	Std. deviation	Total cost (USD)
MAM	Total RUTF prescribed	1415	168.1	89.7	74.00
	RUTF per day	1037	3	1.6	
	RUTF per visit	1415	64.8	21.3	
SAM	Total RUTF prescribed	534	261.5	169	115.11
	RUTF per day	332	4.2	2.2	
	RUTF per visit	534	92.1	29.8	

due to the high number of patients who defaulted after only one visit. About 71% of FBP patients were MAM at enrollment, and 29% were SAM. Table 18 shows the number of sachets received per patient, and months of receipt.

Administrative Costs—Save the Children

An administrative unit was established by SC to implement and administer the Food by Prescription program. All the costs of this unit are attributable to the FBP program. Note, though, that as the FBP program is a relatively new program, many of the administrative costs associated with this unit would not increase even with a significant increase in the size of the case load. Based on the 2011 caseload, the administrative cost per patient was USD 49.71. A breakdown of the costs of the program for calendar year 2011 is shown in Table 19 below.

Training Cost

As part of the implementation of the FBP program, clinic staff received training on implementation of the program protocol. About half of the clinic staff in the FBP clinics in our costing sample had received some training as part

Table 19: Save the Children administrative costs

	Description	2011 budget
1	Salaries and wages	$324,772.99
2	Fringe benefits	$135,524.91
3	Contractual payments	$79,484.54
4	Travel and transports	$122,804.49
5	Equipment and supplies *(depreciated)*★	$74,582.52
6	Allowances	$109,417.89
7	Trainings and workshops	$493,560.06
8	Program delivery costs and other direct costs	$606,754.56
9	Office space rental cost	$19,765.24
	Total	**$1,669,169.60**
	Overhead (17.93%)	$ 299,282.10
	Fee (4.00%)	$78,738.07
	Grand total	**$2,047,189.78**
	Number of clients who received therapeutic and/or supplementary food in 2011	41,180
	SC cost per patient	**$49.71**

★*Equipment under USD 5000 depreciated over 5 years; equipment USD 5000 and over depreciated over 10 years.*

of the program. The direct costs of the training are accounted for by the SC budget, which includes the time of SC staff involved in training as well as the costs of the venue and reimbursement of clinic staff travel expenses. The only additional cost is the value of the time of clinic staff, each of whom spent one to two days in training. Their salaries were used to estimate the value in birr of the time spent in training, and this cost was divided by the FBP caseload in the respective clinic to derive an average training cost of ETB 1.68 per patient.

Cost to Patients of Participation

The cost to patients of participating in the FBP program includes the time spent in clinic visits, as well as the time spent in travel to and from the clinic (see Table 20). Direct costs of participation include the cost of traveling to and from the clinic (if paid transportation was used). In some cases, patients were unable to participate in paid activity because of the need to attend the clinic, and therefore lost potential income, or they had to pay someone to perform activities that they normally would have done on that day.

Only 25% of treatment and 36% of comparison patients reported lost income as a result of the clinic visit, and fewer than 2% of treatment and no comparison patients reported paying someone to do work they would normally have done themselves. The average amount of lost income was ETB 8.11 in the treatment group and ETB 9.70 among comparison patients (this average includes those who did not lose any income). There is no reason to believe that these costs differ due to participation in the FBP program.

The percentage of patients who used paid transportation to and from the clinic was 57.7% among the FBP patients and 37.2% among comparison patients. Notably, there was no difference in time or money cost between traveling to and returning from the clinic, suggesting that the need to carry home supplies of ART drugs or sachets of RUTF did not affect the mode of transportation.

Table 20: Time and income lost (opportunity cost to patients),by intervention group and sex

Description		Treatment			Control			Diff.
ID	**Activity**	**Male**	**Fem.**	**All**	**Male**	**Fem.**	**All**	**All**
7	% no activity missed	36.4	19.8	**26.0**	34.0	18.6	**23.6**	2.4
1	% yes cooking	3.0	42.3	**27.7**	0.0	36.1	**25.1**	2.6
2	% yes working in field	13.6	2.7	**6.8**	23.4	8.3	**13.2**	-6.4
3	% yes fetching water	1.5	7.2	**5.1**	0.0	21.7	**14.6**	-9.5
4	% yes cleaning	3.03	31.5	**20.9**	2.1	20.6	**14.6**	6.3
5	% yes paid employment	33.3	14.4	**21.5**	19.2	13.4	**15.3**	6.2
6	% yes childcare	0.0	4.5	**2.8**	0.0	5.2	**3.5**	-0.7
99	% yes other	13.6	20.7	**18.1**	21.3	26.8	**25.0**	-6.9
	N: 321	66	111	**177**	47	97	**144**	**321**
	Average amount paid for activities missed (birr)	0.6	2.1	**1.5**	0.0	0.0	**0.0**	1.5
	% paid > 0	1.5%	1.8%	**1.7%**	0.0%	0.0%	**0.0%**	0.02
	N: 321	66	111	**177**	47	97	**144**	**321**
	Average total income forgone (birr)	10.8	6.5	**8.1**	10.2	9.2	**9.7**	-1.6
	% reporting income loss	28.8%	22.5%	**24.9%**	36.2%	35.1%	**36.1%**	-11.3%
	N: 321	66	111	**177**	47	97	**144**	**321**

FBP patients spent longer in clinical interactions and longer waiting between these interactions than those in comparison clinics, as shown in Table 21 below.

Patients in the FBP clinics spent significantly less time traveling to and from the clinic than did patients in the comparison clinics, on average 54 minutes for the FBP patients and 70 for the comparison site patients. This time cost is attributable to the systematic differences in the locations of the clinics, and not to any characteristic of the FBP program itself.

Table 21: Time cost (in minutes) of clinical visit

	Treatment			Comparison		
	SAM average	MAM average	Average of all patients	SAM average	MAM average	Average of all patients
Total station time	38.2	33.9	35.4	30.3	24.1	24.6
Wait time*	103.9	39.1	57.3	19.2	29.4	31.4
Total visit time	138.9	73.0	91.9	49.6	53.5	56.0
No cases:	n=18	n=57	n=176	n=9	n=77	n=135

**This table does not subtract the time to fill out the FBP register book from the clinical visit.*

Table 22: Patient cost of participation per visit, summary

Component	Treatment			Comparison		
	SAM	MAM	All	SAM	MAM	All
Time costs						
Station time (mins.)/visit	38.7	33.9	35.4	5.3	30.3	24.1
Wait time (mins.)/visit	103.9	39.1	57.3	19.2	29.4	31.4
Travel time to clinic (mins.)/visit	52.1			72.1		
Travel time from clinic (mins.)/visit	55.6			67.5		
Total time cost of clinic visit (mins.)	211.6	146.7	165.0	158.8	169.0	171.0
Cash costs						
Payment for activities missed (ETB)	1.5			0		
Income forgone (ETB)	8.2			9.6		
Payment for travel to clinic (ETB)	3.7			2.7		
Payment for travel from clinic (ETB)	3.6			2.7		
Total cost (ETB) of clinic visit	17.1			15.1		
Total cost (ETB) of clinical visits per patient (multiplied by number of visits)	49.4	43.8		42.3	40.4	

The differences shown in Table 22 represent the marginal cost of a FBP clinic visit compared with that of a comparison site visit. In terms of the cost per patient, these costs need to be adjusted for the number of visits patients make in the FBP and comparison sites. The number of visits differed slightly between FBP and comparison patients. SAM patients in the FBP clinics made 2.9 visits, compared with 2.8 in the comparison clinics. Among MAM patients, those in the treatment group made 2.6 visits, compared with 2.7 in the comparison clinics. These numbers reflect the very high number of patients who made only one visit and then dropped out, as well as those who defaulted before the end of their expected treatment period: 70% of the FBP patients and 59% of the comparison clinic patients.

Summary of Costs per Patient

Table 23 provides a summary of the estimated costs per patient per month and total cost per patient based on the above reported results. Note that the calculated cost per patient in the treatment group of USD 166.03 for SAM and USD 124.91 for MAM patients is similar to the total cost of intervention of USD 137.70 per patient identified by Bahwere et al. (2009) in a similar program providing RUTF to HIV+ patients in Malawi.

Other Impacts of the FBP Program on Clinic Operation

Workload and Physical Capacity

While we were interested in estimating the marginal cost of implementing the RUTF program, these figures do not fully account for the possibility that there is excess capacity in the clinics to absorb some additional costs due to the program without seriously affecting clinic operation. We conducted spot observations at clinic store rooms and dispensaries in order to assess the degree to which the staff and the physical space were functioning at full capacity, and whether this differed between the treatment and comparison clinics.

Table 24 shows these differences at the store room. The FBP clinics had more staff members working at any one time, and a greater proportion were busy with a task at the time of observation. None of the treatment clinic store rooms were relatively empty, compared with

Table 23: Summary of cost per patient (USD)

Component	Cost per unit				Cost per patient (course of treatment)				Marginal cost per patient		Percent of marginal cost by component	
	Treatment		Comparison		Treatment		Comparison		Treatment		Treatment	
	SAM	MAM	SAM	MAM	SAM	MAM	SAM	MAM	SAM	MAM	SAM	MAM
No. of visits					2.9	2.6	2.8	2.7				
No. of sachets					261.5	168.1	0	0				
Cost of RUTF (sachet)($)	0.4	0.4	-		114.7	73.8	-		114.7	73.8	69.7%	59.5%
Staff cost of clinical visit ($)	0.4	0.4	0.4	0.3	1.1	1.1	1.1	0.7	0.04	0.4	0.02%	0.3%
Staff cost in other functions ($)	-	-	-	-	-	-	-	-	-	-		
SC admin. cost per FBP patient ($)	49.7	49.7			49.7	49.7	-	-	49.7	49.7	30.2%	40.1%
Staff time cost for training per patient ($)	0.1	0.1			0.1	0.1	-	-	0.1	0.1	0.1%	0.1%
Total ($)					**165.67**	**24.67**	**1.07**	**0.71**	**164.59**	**123.96**	**100%**	**100%**

Table 24: Store room observational data

	Treatment	Comparison	Difference
Avg. # working	1.0	0.3	0.7
Avg. % engaged in a task	85.9%	77.8%	8.1%
Of 8 clinics in each group, % of responses "empty"	0.0%	5.6%	-5.6%
% of responses "full"	77.6%	94.4%	-16.9%
% of responses "crowded"	22.5%	0.0%	22.5%

Table 25: Dispensary observational data

	Treatment		Comparison		Difference	
	General	ART	General	ART	General	ART
Avg. # working	2.0	1.2	1.4	0.8	0.5	0.4
Avg. % engaged in a task	94.2%	89.1%	89.2%	70.3%	5.1%	18.9%
Of 8 clinics in each group, % of responses "empty"	8.2%	16.7%	0.0%	0.0%	-8.2%	16.7%
% of responses "full"	91.8%	83.3%	100.0%	100.0%	-8.2%	-16.7%
% of responses "crowded"	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
% of times patients are waiting inside	78.7%	65.6%	83.9%	51.1%	-5.2%	14.5%
% of times patients are waiting outside	79.3%	37.3%	63.9%	20.0%	15.4%	17.3%

5.56% of the comparison sites, and almost a quarter of the treatment clinic store rooms were judged to be "crowded" (at the limit of their storage capacity), while none of the comparison sites were. Recall, though, that the treatment clinics were generally considerably larger in terms of caseload, and it cannot be concluded that these differences were due to the FBP program.

We made similar observations at the clinic dispensaries. Seven of the treatment clinics and six of the comparison clinics had both an ART and a general dispensary. In five of the eight treatment clinics, patients received their ART drugs and their RUTF prescriptions in the same dispensary; in three, they went to two different dispensaries to collect their prescriptions. Table 25 shows results for both the ART and the general dispensaries. The treatment dispensaries had more staff members working at one time, and at the ART dispensary, a higher likelihood of staff being actually engaged in a task at the time of observation. No dispensaries were reported to be "crowded" (at or beyond their physical capacity), but all the comparison site dispensaries were judged to be "full," while a small percentage of the treatment site dispensaries were judged "empty." There are some differences in the likelihood of dispensaries having patients waiting either outside or inside, but these are not dramatic.

Attitudes toward FBP Program

We asked clinical staff in the FBP clinics how their jobs had changed as a result of the FBP program. These were open responses: the staff volunteered their opinions without being prompted. Of the 16 respondents, 11 mentioned a higher caseload and more time spent in clinical assessment; 14 reported spending more time counseling patients; and 11 reported more time in record keeping. All 16, however, specifically mentioned the positive benefits of the FBP program to the patients. See Table 26.

Cost-Effectiveness of the FBP Program

Table 27 shows the cost for achieving several key program outcomes. We calculated the marginal cost per marginal impact by dividing the marginal cost of treatment for SAM and MAM patients by the percent of treated patients achieving that outcome. This calculation was performed on an "intent to treat" basis; that is, cost per patient is applied to all patients in the program, including defaulters. A significant number of patients failed to return after their first visit, and more patients dropped out after several visits but before completing the three or six months of treatment. The rate of default was greater in the FBP program than it was in the comparison clinics.

Discussion

Clearly, the largest component of the cost of the FBP program is the cost of the product itself. The RUTF represents about 70% of the total cost per SAM patient, and about 60% of the total cost for MAM. If a less expensive source of therapeutic food were available this would have a significant effect on program cost, and therefore on the cost-effectiveness.

The second largest cost component is the cost for Save the Children to implement the program. SC administration accounts for 30% and 40% of total cost for SAM and MAM, respectively. This is still a program in its start-up phase. As the program expands and the number of beneficiaries increases, we expect that the administrative costs will not rise at the same rate, so the cost per patient will drop.

It is notable that after these two components are accounted for, the marginal costs from the remaining cost components are relatively minor. The management cost on the part of SCMS and PFSA are quite small, because the structure is already in place for the procurement and distribution of other medical products and supplies; the marginal cost of managing an additional product is not zero, but at this point

Table 26: Clinic staff responses to FBP-related changes

Task	Frequency
More patients in the caseload	11
Positive benefits to patients	15
I spend more time with each patient	9
I spend more time in administrative record keeping	11
I spend less time in administrative record keeping	1
I spend more time in clinical assessment	11
I spend less time in clinical assessment	2
I spend more time counseling patients	14
BMI calculation takes more time	1
I am helping patients better than before	1
Many complaints from clients who don't fulfill the criteria (non-beneficiaries)	1
Other (specify)	5

Table 27: Marginal costs per effectiveness outcome

Marginal cost per patient recovered

Marginal cost of treatment per 100 patients		Percent of patients graduated				Marginal number recovered in treatment per 100 patients		Cost per patient recovered	
		Treatment		Comparison					
SAM	MAM	SAM	MAM	SAM	MAM	SAM	MAM	SAM	MAM
$16,459	$12,396	2.4	14.7	1.1	8.4	1.4	6.3	$12,192	$1,980

Marginal cost per patient raised above BMI 18.5

Marginal cost of treatment per 100 patients		Percent of patients raised above a BMI of 18.5 during treatment				Marginal number raised above 18.5 per 100 patients		Cost per patient raised above 18.5	
		Treatment		Comparison					
SAM	MAM	SAM	MAM	SAM	MAM	SAM	MAM	SAM	MAM
$16,459	$12,396	11.8	40.4	6.5	20.9	5.3	19.5	$3,106	$636

Marginal cost per patient raised at least one BMI point

Marginal cost of treatment per 100 patients		Percent of patients raised at least one BMI point				Marginal number raised at least one BMI point per 100 patients		Cost per patient raised at least one BMI point	
		Treatment		Comparison					
SAM	MAM	SAM	MAM	SAM	MAM	SAM	MAM	SAM	MAM
$16,459	$12,396	60.0	49.0	32.1	18.8	27.9	30.2	$590	$410

Marginal cost per BMI point raised

Marginal cost of treatment per patient		Number of patients (treatment)		Marginal cost of treatment		Marginal BMI points gained by treatment group		Cost per BMI point gained	
SAM	MAM	SAM	MAM	SAM	MAM	SAM	MAM	SAM	MAM
$165	$124	363	1086	$59,747	$134,619	598.7	1082.1	$100	$124

appears not to raise the cost of the program greatly. Nonetheless, if a supplementary food were produced locally, international shipping and handling (ocean freight) cost would be eliminated, though of course the product would still need to be transported from the factory to the warehouse and from there to the individual clinics.

On the management side, we were unable to measure the cost of managing the RUTF at the clinic. The difference between treatment and comparison clinics in management cost was swamped by other differences among clinics within each group, and by the systematic difference between treatment and comparison clinics. In our interviews, though, it was clear that the task of carrying boxes of RUTF from the truck to the store room and from there to the dispensary was seen as a burden. We heard anecdotally that clinic staff considered the boxes as food rather than medicine, and that they felt their jobs should involve medical supplies and products, not food. We did not observe a difference between treatment and comparison in the number reporting that they use only their own staff (as opposed to hiring outsider labor) to unload PFSA deliveries, and the caseload-adjusted cost of unloading was not higher in the FBP clinics.

The shadow cost of storage of the boxes of

RUTF in the FBP clinics added only a tiny amount to the money cost of the product. Nonetheless, storage of RUTF may well emerge as an important issue in implementing and expanding the FBP program. Our informal observations showed several clinics where boxes of RUTF were stacked in hallways and offices, presumably because there was no room in the store room. In our structured observations of the clinics, store rooms were more likely to be reported crowded with stock than in the comparison clinics. If the number of patients on FBP increases, or if consideration is given to providing a more bulky food supplement (such as CSB), storage at the clinic may well emerge as an issue. Clinics may need to request more frequent deliveries from PFSA (as is the case now for the two largest clinics, Dilchora and Bishoftu, which receive monthly rather than bimonthly deliveries), or may need to contract for outside storage.

In addition, in the FBP clinics the store room staff were more likely to be engaged in a specific task, suggesting perhaps a higher work load. Treatment clinics were also considerably more likely to have patients waiting inside or outside the dispensary. It is difficult to interpret these results, however, since the FBP clinics were much larger than the comparison clinics; it is quite likely they would be busier irrespective of the management of RUTF. In both treatment and comparison clinics, staff were in fact quite likely to be engaged in a task during our spot observations, even though the percentage was higher in the FBP clinics.

The FBP program does increase the time that clinical staff spend with patients. This is especially notable among the MAM patients. FBP patients may be benefiting from more intensive interaction with clinical staff during their visits. Clinic staff are aware of the additional burden imposed by the program, citing increased time in record keeping and a higher patient load, but they also report more time spent counseling patients and performing clinical assessments. Clinic staff also universally noted that the program provided positive benefits to their patients.

On the side of the patients, FBP patients spent more time in a clinical visit, and more time waiting in between interactions with clinic staff of different kinds, than did comparison patients. The time spent in the clinical visit may reflect a positive benefit of the program. The longer time spent waiting might be due to the fact that FBP clinics are larger and busier than the comparison clinics. Patients in the comparison clinics spent more time traveling to and from the clinic than did patients in FBP clinics, but this is entirely due to the fact that the comparison clinics are in less densely populated areas, and thus patients are more dispersed. There was no evidence that carrying the RUTF added to the cost or time burden of traveling to and from the clinic. Among FBP patients, there was no difference in the time nor in the cost or need to pay for transportation between getting to and from the clinic, suggesting that transporting the RUTF home did not pose a burden.

Cost per impact indicator is in almost every case considerably higher for SAM than for MAM patients, suggesting the importance of identifying patients who are wasted and intervening early. The lower cost per patient for SAM patients of adding one BMI point suggests that, starting from a lower BMI to begin with, they had more scope for increasing their BMI.

We have seen already that the FBP program demonstrated positive impacts compared to the programs that did not provide the food. Given the significantly better outcomes among treatment than comparison group patients, even including defaulters (and therefore incorporating the differential rate of default), lowering the rate of default among FBP patients would probably greatly increase the cost-effectiveness of the program.

Modeling Program Modifications

We conducted some additional analyses to examine the effects of some hypothetical program changes on the cost and cost-effectiveness calculations presented above (see Annex 3 for Tables).

It was noted above that a significant number of patients were considered defaulters because they failed to attend their final visit; that is, they

attended three out of four prescribed visits for MAM and six out of seven for SAM patients. This may be because they expected no additional RUTF on their last visit, and didn't see the point of returning. It may be that clinic workers stopped recording their visits once the prescription of RUTF was finished. We modeled a hypothetical situation in which we assumed that patients defaulting on their final visit actually attended, and that they continued to gain BMI at the same monthly rate as in previous visits. The cost of this would be only the cost of one more visit, since no additional RUTF would be prescribed.

Based on these assumptions, we would expect to see considerable additional recovery among FBP patients, and indeed that was the case: percent of MAM patients recovered rises to 25.3%, compared with 9.3% for comparison; among SAM patients, recovery rises to 3.9% for FBP, compared with 1.1% for comparison. Because the additional cost is only the small marginal cost of one more clinical visit, the marginal cost per recovered patient falls from USD 1980 to USD 775 for MAM and from USD 12,192 to USD 5878 for SAM patients.

A second hypothetical model assumed that it would be possible, with better counseling, to reduce the rate of default among all patients. We estimated a model in which we assumed that half of those who defaulted after only two visits could be motivated to continue through the fourth visit. We then applied the rate of recovery to those patients, assuming that if it were possible to lower the default rate, the recovery rate would rise commensurately. In this model, the cost per patient would be that of two additional clinical visits and two months' worth of prescribed RUTF. Based on the average per visit quantity received, the additional RUTF would add USD 57.02 to a MAM patient (64.8 sachets/month for two months), and USD 81.04 to a SAM patient (92.1 sachets/month for two months). The overall marginal cost per patient is therefore USD 125.45 per MAM patient and USD 170.66 per SAM patient. The rate of recovery would rise to 18% for MAM patients on FBP compared with 9.7% for comparison, and to 3.7% for FBP SAM patients as compared with 1.5% for SAM comparisons. Marginal rates of recovery would be 8.3% for MAM and 2.2% for SAM. As a result, the marginal cost per recovered patient would fall to USD 1511 for MAM and USD 7757 for SAM.

In the third hypothetical model, we assessed the effect of adding one more visit and one more month of RUTF to those patients who did not default, but did not reach the criterion of BMI = 18.5 in two consecutive visits by the final visit. In this model, we assume that patients would continue to add BMI points at the same rate as before if they had one additional visit and one additional month of food supplement. Using the data on patients in the sample, we estimated that the rate of recovery would rise to 23.1% for FBP MAM patients, compared with 8.42% for MAM comparisons, and the rate of recovery would rise to 4.7% for FBP SAM patients, compared with 1.08% for the SAM comparisons. The marginal rate of recovery would be 14.68% for MAM and 3.62% for SAM patients under these assumptions. The cost would be the cost of adding one month of RUTF (for FBP patients) and one additional clinical visit for all patients classified as non-responders after completing the prescribed number of visits. For each patient extended, the cost would be USD 28.50 per MAM patient (64.8 sachets), and USD 40.52 per SAM patient (92.1 sachets). Based on these assumptions, the marginal cost per patient would be USD 126.39 for MAM and USD 165.51 for SAM patients; the overall marginal cost per MAM patient recovered would be USD 861, and for SAM, it would be USD 4572.

These models provide a rough idea of how possible changes in the program might alter our estimate of the cost- effectiveness of the FBP intervention; each of these changes results in a lower estimate of cost per recovered patient.

All the calculations presented in this report are based on figures from 2011, the most recent year for which complete information was available. But we recognize that during 2011, the program was still in start-up mode. Save the Children expects the caseload to increase from about 41,000 in 2011 to 48,000 in 2012, without affecting the total administrative costs of the program, thus lowering the SC administrative cost per patient from USD 49.71 to USD 42.65

per patient. Assuming all other costs remain the same, the marginal cost of treatment per patient would fall from USD 164.59 to USD 157.49 for SAM and from USD 123.96 to USD 116.51 for MAM. The percent of costs represented by SC administration would fall from 40.1% to 36.61% for MAM and 30.2% to 27.08% for SAM patients.

Information on the costs for delivering a box of RUTF to the clinic was based on information received from SCMS during interviews conducted in 2011. We calculated the cost of a box delivered to Addis Ababa (that is, purchase price plus overseas shipping) based on information on boxes received and amount paid for three deliveries during 2011. To this was added an estimated USD 2.25, just under 5% of the per box purchase price for in-country shipping and storage, a figure provided by several informants within SCMS. In discussions with USAID, it was suggested that a more realistic estimate of the cost of in-country shipping, handling, and storage would be 10% of the per box cost, or USD 5.00. If this were the case, then the cost of a box of RUTF delivered to the clinic would be USD 68.55 rather than the USD 65.80 reported above, and, if no other costs were changed, the marginal cost of treatment per FBP patient would rise from USD 123.96 to USD 127.04 for MAM and from USD 164.59 to USD 169.39 for SAM patients, an increase of 2.5% for MAM and 2.9% for SAM. ■

STUDY LIMITATIONS

There were several limitations to the design of this study that all underscore the challenges that impact evaluations of operational programs commonly face. These limitations threaten both the external and internal validity of findings through bias, confounding, contamination and spillover effects, as well as implementation problems encountered. The main issues in this evaluation were lack of randomization and comparability of intervention and comparison sites and implementation issues such as poor record keeping. While we have attempted to control for many of these issues in analysis and used qualitative data where possible to confirm quantitative findings, it remains possible that these issues have resulted in some confounding and bias of our results. Nevertheless, we believe that the relatively large numbers of clients in the review in combination with rigorous analyses allow conclusions pertinent to FBP services in Ethiopia to be made. It is also important to note that the costs collected and used in our analysis were all from 2011, during the early stages of the program when numbers of participants were at their lowest. Ideally, the cost analysis would have been performed at a later stage in program delivery, after it had been scaled up and streamlined. It is likely that overall cost effectiveness will improve over time, and our models suggest that during 2012 alone, cost per patient treated is likely to have dropped by about 6% based on the increase in number of admissions expected. ■

This study has demonstrated that the addition of therapeutic food to a treatment program for malnourished, HIV+ patients added considerable value. As one of the first studies to examine the effect of the addition of therapeutic food to an HIV treatment regimen using a comparison group, this study generated rigorous, useful evidence to inform multiple programmatic recommendations relevant to Ethiopia's Food by Prescription Program, as well as to other similar efforts being scaled up globally.

Patients who received food were significantly more likely to recover from malnutrition than those who did not receive food, and treatment with supplementary food was much more successful, and more cost-effective, when malnourished individuals were identified and treated early. Additionally, patients who recovered through the addition of supplementary food experienced long-lasting positive effects on their health and nutrition status. While the marginal cost per patient recovered in the FBP program was high, the marginal cost of improving nutritional status by at least one BMI point (USD 590 for SAM patients and USD 410 for MAM patients) in the FBP group was much lower and close to Ethiopia's 2011 per capita Gross Domestic Product (GDP) of USD 400 (World Bank 2011). Loss of a single BMI point significantly increases the chances of mortality in HIV+ patients (Tang, Forrester et al. 2002). In light of these results, we would recommend that nutritional assessment counseling and support remains an integral component of ART programs in Ethiopia. The current (2008) version of the National Nutrition Program in Ethiopia supports the implementation of nutrition support for pre-ART/ART HIV/AIDS patients, and this should remain a priority in the 2012/13 version being developed by the Ministry of Health now.

Recommendations

Identifying mechanisms for reducing the high level of program default will be critical for improving both effectiveness and cost-effectiveness. While the 70 percent default rate observed in the study may be due in part to poor record keeping and misunderstandings around program protocols, it is clear that the number of participants who did not complete FBP treatment protocol remains quite high. Our data identified several characteristics that appeared to increase risk of default in this cohort (suffering from SAM and from higher levels of sickness at admission, being pre-ART or on ART for > six months, being treated at a hospital, and coming from a food insecure household). These characteristics could be used to classify risk of default for participants at admission and a set of mitigating interventions implemented to reduce this risk. These "mitigating interventions" should include the strengthening of links to community-based follow-up and home-based care for these "high risk" individuals particularly. Other FBP-type programs have shown success in reducing default rates by strengthening these linkages (CRS 2011). In Ethiopia, there may be a role in this process for the case managers employed through the ART clinics, as they are generally well connected to communities and patients or for the emerging "health development army" that will be made up of a cadre of health extension volunteers responsible for promoting maternal health, nutrition, communicable disease control, and environmental health. Our qualitative data also suggested that the taste and consistency of the food ration itself (RUTF) may have played a role in the poor compliance of some participants, and this has been highlighted as an issue (for adults particularly) before (Dibari, Bahwere et al. 2012). It will be important to assess the potential and acceptability of new ready-to-use foods, made from local ingredients such as chickpea, for use in FBP programs as they come on to the market. While some of the new fortified flours may also be acceptable for this patient group, they are unlikely to be as cost-effective due to the high transport and storage costs required and may reduce weight gain among participants, as seen in the Kenya FBP program.

The benefits of a stronger community-based follow-up process should also include a focus on the early identification of eligible participants

from groups that were seen in this study to gain particularly high benefits from a FBP intervention. This includes referral of malnourished individuals who are suffering from MAM and of individuals from food insecure households, for example. Identifying eligible patients at an earlier time, before they become severely malnourished, has particular potential to increase the success of the program as a whole, including the cost-effectiveness. The cost study data collection found that 70% of FBP patients were weighed and measured as part of their clinic visits—while this was considerably higher than the proportion of patients assessed in the non-FBP sites, there remains room for improvement. It is recommended therefore that greater attention be given to identifying MAM patients as part of their regular ART clinic visits, and that anthropometric measurements be included as part of the standardized visit procedures, not only for those individuals who are visibly malnourished.

Many of the patients identified as defaulters may have simply been lost within the FBP tracking system, as the record-keeping process was new for the staff of the ART clinics. A streamlined and improved record-keeping system would help to improve patient follow-up, and therefore to reduce default rates. Accurate record keeping relies upon the knowledge and capacity of the staff responsible for this activity. While training is currently provided to clinic staff from FBP facilities prior to the start of the program, we recommend closer oversight of staff practices and capacity as the program continues. Through the research, it was observed that many facilities experienced high rates of turnover among staff, as well as rotations within the facility, which in many cases led to staff members who had once been trained in FBP no longer serving in the relevant positions. To reduce the frequency of these situations, we believe that increased advocacy efforts should be made by SC/FBP with the facility administrators and medical directors who have the authority to prevent this from occurring. Additionally, the research suggested that hospitals and other larger, busier facilities have more problems with record keeping and data management, and we recommend that support to ART clinic staff be preferentially provided to these types of sites.

Health workers also reported concerns about the burden of record keeping placed on them by the many parallel programs that they deliver. While accurate and detailed monitoring is required by all of these programs, it is recommended that this burden be taken into consideration, and that partners actively work to consolidate data management and reporting needs between existing programs to the degree possible, reducing the number of register books and monthly reports that health workers are required to fill. To support this, simplification and integration of FBP reporting into the standard HMIS should be explored as well as mainstreaming nutritional support for HIV positive adults and children across ongoing health and nutrition services as implemented through the health extension program, rather than through the parallel systems that exist for FBP presently.

Although FBP is a clinical intervention, individual patients remain members of households for which there may be more fundamental issues of vulnerable livelihoods and food insecurity. While the links between nutritional status, recovery, and household food security are not entirely clear, this research does suggest that household access to food is an important constraint to program effectiveness. Through addressing these issues, it may be possible to reduce intra-household sharing, and to improve individual adherence to the program. It is recommended that FBP continue to develop the economic strengthening component of the program, linking food insecure households to improved livelihood opportunities, which is particularly important as an exit strategy for ensuring longer-term sustainability of the therapeutic feeding results. ■

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ANNEX 1: TREATMENT AND COMPARISON SITES

Site comparisons:

	Sites	Facility type	Current ART caseload ⋆	Daily ART visits	Staffing	Region	Zone	Livelihood zone
		Hospital or Health Center		*mean # daily client visits*	*# ART clinical staff*			*see acronyms below*
FBP only	Arsi Negele	HC	134 **(1066)**	9.8	3	Oromia	West Arsi	RVM (maize)
	Chiro	Hospital	500 **(1357)**	30.0	5	Oromia	West Hararghe	CGC
	Metahara	HC	100	7.4	3	Oromia	East Shoa	[a] MKP (plus factory and state farms)
	Metahara	Hospital	354 **(1436)**	19.6	4	Oromia	East Shoa	[a] MKP
	Wolenchiti	HC	244			Oromia	East Shoa	RVM/MKP
	Dera	HC	239 (?)	22	7	Oromia	Arsi	RVM
	Ziway	HC	606 **(2951)**	24.4	4	Oromia	East Shoa	RVM
	Deder	Hospital	188 (?)			Oromia	East Hararghe	CGC
FBP/WFP	Adama	Hospital	5930	153.4	15	Oromia	East Shoa	RVM
	Bishoftu	Hospital	1788 **(6673)**	75.5	4	Oromia	East Shoa	BAT (teff, chickpea)
	Dilchora	Hospital	1564 **(6402)**	79.0	7	Dire Dawa	Dire Dawa	CGC/NAP
	Ras Desta	Hospital	1008	36.6	13	Addis Ababa	AA	[b]
	Kality	HC	605 **(4071)**	43.6	7	Addis Ababa	AA	[b]
	Pawlos	Hospital	3170			Addis Ababa	AA	[b]
	Meshualakia	HC	583 **(1793)**	46.8	6	Addis Ababa	AA	[b]
	Zewditu	Hospital	5685	125.8	14	Addis Ababa	AA	[b]
Comparison	Sendafa	HC	202 **(635)**	17.6	2	Oromia	North Shoa	AMT
	Sheno	HC	143 (+69?) **(1016)**	10.6	3	Oromia	North Shoa	AMT
	Chancho	HC	203 **(765)**	8.8	3	Oromia	North Shoa	SAW
	Gindeberet	Hospital	209 **(611)**	13.2	5	Oromia	West Shoa	AMT
	Wenji	Hospital	249 **(921)**	16.4	4	Oromia	East Oromia	SAW
	Atayie	HC	292 **(1588)**	17.8	3	Amhara	North Shoa	CHV (maize/ horse bean)
	Bure	HC	653 **(2774)**	36.3	9	Amhara	West Gojam	SWM
	Merawi	HC	250 **(814)**	12.8	4	Amhara	West Gojam	SWM

⋆ ART caseload numbers represent "Currently on ART" from HAPCO monthly report, February 2010 (most recent available on website)—current numbers do not include pre-ART cases, so can only be used as a proxy for total caseload. (Note: Dire Dawa did not report in this month; used last available report from March 2009 instead). Bold ART caseloads in parentheses were previous months' numbers reported by sites during cost study data collection (i.e., July–September 2011)

⋆⋆ Ethiopian Livelihood Zones, from WFP:

- RVM – Rift Valley Maize and Horse Bean
- CGC – Chercher and Gololcha Chole Coffee, Maize and Chat
- MKP – Kereyu Pastoral
- BAT – Becho-Adea Teff and Chickpea
- NAP – North-East Agro-Pastoral
- AMT – Ambo Selale Gindeberet Teff and Wheat
- SAW – Selale-Ambo Highland Barley, Wheat and Horsebean
- CHV – Cheffa Valley
- SWM – Southwest Maize, Finger Millett and Teff
- WMB – South Wollo Meher and Belg
- KCE – Hadiya-Kembata Cereal and Enset – Kembata sub-zone

[a] Although Metahara officially falls within a pastoral livelihood zone, the region also contains a number of state farms as well as the sugar factory where the hospital is located.

[b] Addis Ababa is solely urban; it has no additional livelihoods assigned.

ANNEX 2: NUTRITIONAL AND CLINICAL CHARACTERISTICS AT ADMISSION AND EXIT BY OUTCOME, BY INTERVENTION GROUP, AND BY NUTRITIONAL STATUS AT ENROLLMENT

Patient characteristics	Recovered		Unrecovered		Non-response		Defaulted		Died		Other		Total	
	Treat.	*Comp.*	*Treat.*	*Comp.*	*Treat.*	*Comp.*	*Treat.*	*Comp.*	*Treat.*	*Comp.*	*Treat.*	*Comp.*	*Treat.*	*Comp.*
All participants (N= 2595)	n=221	n=47	n=1735	n=592	n=310	n=204	n=1380	n=381	n=29	n=5	n=16	n=2	n=2059	n=663
n	221	47	1236	388	310	204	902	180	11	2	13	2	1528	450
Length of stay in program, days, median	**64**	**144**	**65**	**91**	**108**	**149**	**60**	**55**	**61**	**82**	**33**	**77**	**64**	**102**
(IQR)	(59-89)	(83-153)	(54-99)	(52-150)	(91-148)	(122-160)	(37-76)	(30-60)	(32-68)	(74-90)	(30-63)	(51-103)	(56-96)	(56-151)
Nutritional indicators														
n	221	47	1732	592	310	204	1380	381	26	5	16	2	2043	657
BMI at admission, kg/m2, median	**18.0**	**18.0**	**16.7**	**17.3**	**16.7**	**17.3**	**16.8**	**17.3**	**15.8**	**16.9**	**16.9**	**16.9**	**17.0**	**17.4**
(IQR)	(17.4-18.3)	(17.7-18.2)	(15.7-17.5)	(16.4-17.9)	(16.1-17.4)	(16.7-17.7)	(15.6-17.6)	(16.3-17.9)	(14.6-16.7)	(16.4-16.9)	(15.5-17.7)	(16.0-17.8)	(15.9-17.8)	(16.5-18.0)
n	220	47	1230	387	307	203	900	180	10	2	13	2	1514	445
BMI at exit, kg/m2, median	**19.5**	**19.0**	**17.9**	**17.5**	**18.1**	**17.5**	**17.8**	**17.4**	**17.5**	**16.2**	**17.6**	**17.4**	**18.3**	**17.7**
(IQR)	(19.1-20.1)	(18.4-19.6)	(16.9-18.7)	(16.6-18.1)	(17.1-18.7)	(16.9-18.2)	(16.8-18.7)	(16.4-18.1)	(15.9-18.7)	(15.4-16.9)	(16.2-18.5)	(16.0-18.7)	(17.1-19.1)	(16.9-18.4)
n	220	47	1230	387	307	203	900	180	10	2	13	2	1512	445
BMI change recruitment to exit, kg/m2, median	**1.7**	**0.9**	**0.9**	**0.2**	**1.1**	**0.4**	**0.9**	**0**	**0.9**	**-1.5**	**0.7**	**0.5**	**1.1**	**0.3**
(IQR)	(1.1-2.5)	(0.4-1.7)	(0.4-1.6)	(0.0-0.8)	(0.4-2.0)	(0.0-0.8)	(0.4-1.6)	(0.0-0.7)	(0.3-1.6)	(-2.9-0.0)	(0.0-1.2)	(0.0-1.0)	(0.4-1.8)	(0.0-0.8)
n	220	47	1226	387	307	203	896	180	10	2	13	2	1513	447
Weight gain, g/kg/day, median	**1.3**	**0.4**	**0.8**	**0.1**	**0.6**	**0.1**	**0.9**	**0**	**0.7**	**-0.9**	**1.4**	**0.3**	**0.9**	**0.1**
(IQR)	(0.8-2.2)	(0.2-0.8)	(0.3-1.5)	(0.0-0.4)	(0.2-1.1)	(0.0-0.3)	(0.3-1.7)	(0.0-0.9)	(0.3-1.5)	(-1.8-0.0)	(0.0-1.9)	(0.0-0.5)	(0.4-1.6)	(0.0-0.5)
Clinical & immune factors														
n	199	27	1555	279	290	97	1229	177	22	3	14	2	1844	318
CD4 count at admission, cells/mm3, median	**303**	**347**	**278**	**320**	**324**	**327**	**271**	**318**	**99**	**92**	**125**	**226**	**280**	**321**
(IQR)	(175-482)	(228-517)	(150-437)	(204-455)	(189-464)	(225-502)	(152-434)	(181-440)	(62-159)	(22-204)	(89-304)	(78-374)	(155-440)	(206-456)
n	88	16	342	84	160	82	179	2	2	0	1	0	446	105
CD4 count at exit, cells/mm3, median	**370**	**322**	**374**	**368**	**396**	**368**	**360**	**516**	**256**	**-**	**94**	**-**	**374**	**344**
(IQR)	(243-599)	(239-442)	(238-537)	(220-550)	(265-565)	(220-544)	(227-494)	(162-870)	(61-451)	-	-	-	(244-545)	(220-544)
n	85	8	328	41	155	39	170	2	2	0	1	0	428	53
CD4 change recruitment to exit, cells/ mm3, median	**29**	**65**	**29**	**0**	**45**	**0**	**12**	**0**	**94**	**-**	**1**	**-**	**29**	**0**
(IQR)	(0-115)	(25-113)	(0-114)	(-61-33)	(-14-132)	(-70-34)	(0-105)	0	(0-187)	-	-	-	(0-114)	(-39-60)
n	221	44	1232	360	310	201	898	155	11	2	13	2	1522	419
Functional status change recruitment to exit, improved, n	**55**	**0**	**261**	**15**	**77**	**6**	**180**	**9**	**2**	**0**	**2**	**0**	**334**	**16**
%	25	0	21	4	25	3	20	6	2	0	2	0	22	4

ANNEX 2: CONTINUED

Patient characteristics	Recovered		Unrecovered		Non-response		Defaulted		Died		Other		Total	
	Treat.	Comp.	Treat.	Comp.	Treat.	Comp.	Treat.	Comp.	Treat.	Comp.	Treat.	Comp.	Treat.	Comp.
MAM only (n=1963)	n=208	n=46	n=1209	n=500	n=245	n=190	n=943	n=304	n=12	n=4	n=9	n=2	n=1417	n=546
n	208	46	885	333	245	190	626	139	7	2	7	2	1093	379
Length of stay in program, days, median	**63**	**146**	**62**	**91**	**97**	**149**	**59**	**50**	**67**	**82**	**31**	**77**	**62**	**108**
(IQR)	(59-86)	(83-153)	(52-92)	(52-150)	(89-121)	(119-158)	(35-66)	(29-59)	(58-68)	(74-90)	(22-63)	(51-103)	(56-91)	(56-151)
Nutritional indicators														
n	208	46	1209	500	245	190	943	304	12	4	9	2	1417	546
BMI at admission, kg/m2, median	**18**	**18**	**17.2**	**17.5**	**17.1**	**17.4**	**17.3**	**17.6**	**16.7**	**16.9**	**17.6**	**16.9**	**17.3**	**17.6**
(IQR)	(17.5-18.3)	(17.8-18.2)	(16.7-17.7)	(16.9-18.0)	(16.5-17.5)	(16.7-17.7)	(16.7-17.8)	(16.9-18.0)	(16.6-17.2)	(16.7-17.6)	(17.1-17.7)	(16.0-17.8)	(16.7-17.9)	(16.9-18.0)
n	207	46	879	332	242	189	623	139	7	2	7	2	1086	378
BMI at exit, kg/m2, median	**19.5**	**19**	**18.2**	**17.6**	**18.2**	**17.6**	**18.2**	**17.7**	**18.3**	**16.2**	**18.5**	**17.4**	**18.5**	**17.8**
(IQR)	(19.0-20.1)	(18.4-19.6)	(17.4-18.8)	(17.0-18.3)	(17.4-18.7)	(17.1-18.3)	(17.5-18.8)	(17.0-18.2)	(17.0-18.9)	(15.4-16.9)	(17.8-18.8)	(16.0-18.7)	(17.6-19.1)	(17.1-18.4)
n	207	46	879	332	242	189	623	139	7	2	7	2	1086	378
BMI change recruitment to exit, kg/m2, median	**1.6**	**0.9**	**0.8**	**0.1**	**1.1**	**0.4**	**0.8**	**0**	**1.4**	**-1.5**	**1.1**	**0.5**	**1**	**0.3**
(IQR)	(1.1-2.4)	(0.4-1.7)	(0.4-1.5)	(0.0-0.7)	(0.4-1.6)	(0.0-0.8)	(0.4-1.3)	(-0.1-0.4)	(0.4-1.7)	(-2.9-0.0)	(0.6-1.2)	(0.0-1.0)	(0.4-1.6)	(0.0-0.8)
n	207	46	876	332	242	189	620	139	7	2	7	2	1083	378
Weight gain, g/kg/day, median	**1.2**	**0.4**	**0.7**	**0**	**0.5**	**0.1**	**0.8**	**0**	**1.3**	**-0.9**	**1.9**	**0.3**	**0.8**	**0.1**
(IQR)	(0.8-2.0)	(0.2-0.7)	(0.3-1.3)	(0.0-0.4)	(0.2-1.0)	(0.0-0.3)	(0.3-1.5)	(-0.1-0.6)	(0.3-1.6)	(-1.8-0.0)	(1.1-2.4)	(0.0-0.5)	(0.4-1.5)	(0.0-0.4)
Clinical & immunological factors														
n	187	27	1098	236	235	94	843	137	11	3	9	2	1285	263
CD4 count at admission, cells/mm3, median	**308**	**347**	**300**	**326**	**336**	**327**	**290**	**334**	**121**	**92**	**127**	**226**	**301**	**326**
(IQR)	(180-487)	(228-517)	(174-447)	(218-454)	(197-474)	(224-502)	(174-442)	(207-440)	(84-173)	(22-204)	(89-304)	(78-374)	(174-454)	(219-465)
n	85	16	277	74	135	73	141	1	1	0	0	0	362	90
CD4 count at exit, cells/mm3, median	**373**	**322**	**383**	**408**	**404**	**398**	**348**	**870**	**451**	**-**	**-**	**-**	**382**	**338**
(IQR)	(255-600)	(239-442)	(256-542)	(247-567)	(284-570)	(247-556)	(237-497)	-	-	-	-	-	(255-549)	(247-544)
n	82	8	268	37	133	36	134	1	1	0	0	0	350	45
CD4 change recruitment to exit, cells/mm3, median	**26**	**65**	**42**	**0**	**51**	**0**	**27**	**0**	**187**	**-**	**-**	**-**	**39**	**0**
(IQR)	(-1-115)	(25-113)	(0-132)	(-61-33)	(-23-133)	(-66-34)	(0-110)	-	-	-	-	-	(0-131)	(-39-60)
n	208	43	885	309	245	187	626	118	7	2	7	2	1093	352
Functional status change, improved, n	**49**	**0**	**160**	**7**	**56**	**4**	**101**	**3**	**2**	**0**	**1**	**0**	**209**	**7**
%	24	0	18	2	23	2	16	3	29	0	14	0	19	2

Patient characteristics	Recovered		Unrecovered		Non-response		Defaulted		Died		Other		Total	
	Treat.	Comp.	Treat.	Comp.	Treat.	Comp.	Treat.	Comp.	Treat.	Comp.	Treat.	Comp.	Treat.	Comp.
SAM only (n=628)	n=13	n=1	n=522	n=92	n=65	n=14	n=437	n=77	n=14	n=1	n=6	n=0	n=535	n=93
n	13	1	350	55	65	14	276	41	4	0	5	0	363	56
Length of stay in program, days, median	**128**	**91**	**89**	**87**	**162**	**157**	**69**	**60**	**38**	**-**	**57**	**-**	**89**	**89**
(IQR)	(85-144)	-	(58-140)	(50-151)	(145-183)	(151-168)	(50-108)	(43-93)	(17-98)	-	(30-60)	-	(58-141)	(53-151)
Nutritional indicators														
n	13	1	522	92	65	14	437	77	14	1	6	0	535	93
BMI at admission, kg/m2, median	**15**	**15.9**	**15.1**	**15.2**	**15.1**	**15.6**	**15.1**	**15.2**	**14.7**	**14.4**	**15.1**	**-**	**15.1**	**15.2**
(IQR)	(14.4-15.4)	-	(14.3-15.6)	(14.7-15.6)	(14.3-15.6)	(14.7-15.8)	(14.3-15.6)	(14.7-15.5)	(14.5-15.4)	-	(13.2-15.7)	-	(14.3-15.6)	(14.7-15.6)
n	**13**	**1**	**350**	**55**	**65**	**14**	**277**	**41**	**3**	**0**	**5**	**0**	**363**	**56**
BMI at exit, kg/m2, median	**19.7**	**20.2**	**16.5**	**15.6**	**16.8**	**16.1**	**16.4**	**15.4**	**15**	**-**	**15.9**	**-**	**16.6**	**15.7**
(IQR)	(19.2-20.1)	-	(15.6-17.6)	(14.9-16.7)	(15.8-17.9)	(14.7-16.7)	(15.6-17.6)	(15.1-16.7)	(13.9-15.9)	-	(14.4-16.2)	-	(15.6-17.8)	(14.9-16.8)
n	**13**	**1**	**350**	**55**	**65**	**14**	**277**	**41**	**3**	**0**	**5**	**0**	**363**	**56**
BMI change recruitment to exit, kg/m2, median	**4.5**	**4.3**	**1.4**	**0.4**	**2**	**0.4**	**1.3**	**0.4**	**0.3**	**-**	**0.5**	**-**	**1.4**	**0.4**
(IQR)	(4.2-5.6)	-	(0.7-2.7)	(0.0-1.5)	(1.1-2.9)	(0.0-1.5)	(0.7-2.6)	(0.0-1.5)	(0.0-1.4)	-	(0.0-1.2)	-	(0.7-2.9)	(0.0-1.6)
n	**13**	**1**	**349**	**55**	**65**	**14**	**276**	**41**	**3**	**0**	**5**	**0**	**362**	**56**
Weight gain, g/kg/day, median	**3.4**	**2.9**	**1**	**0.4**	**0.8**	**0.2**	**1.2**	**0.4**	**0.5**	**-**	**0.2**	**-**	**1.1**	**0.4**
(IQR)	(2.1-4.2)	-	(0.4-2.0)	(0.0-0.9)	(0.3-1.3)	(0.0-0.6)	(0.5-2.2)	(0.0-1.2)	(0.0-0.7)	-	(0.0-1.4)	-	(0.5-2.1)	(0.0-1.0)
Clinical & immunological factors														
n	12	0	455	43	55	3	386	40	10	0	4	0	467	43
CD4 count at admission, cells/mm3, median	**207**	**-**	**227**	**272**	**270**	**395**	**227**	**258**	**70**	**-**	**108**	**-**	**227**	**272**
(IQR)	(92-356)	-	(105-400)	(131-466)	(126-408)	(322-885)	(109-402)	(130-453)	(36-126)	-	(75-239)	-	(105-400)	(131-466)
n	3	0	65	10	25	9	38	1	1	0	1	0	68	10
CD4 count at exit, cells/mm3, median	**188**	**-**	**360**	**290**	**368**	**366**	**364**	**162**	**61**	**-**	**94**	**-**	**353**	**290**
(IQR)	(90-597)	-	(178-471)	(162-389)	(225-537)	(178-389)	(202-467)	-	-	-	-	-	(174-504)	(162-389)
n	3	0	60	4	22	3	36	1	1	0	1	0	63	4
CD4 change recruitment to exit, cells/mm3, median	**86**	**-**	**1**	**0**	**29**	**0**	**0**	**0**	**0**	**-**	**1**	**-**	**5**	**0**
(IQR)	(6-158)	-	(0-42)	(-73-34)	(0-45)	(-146-67)	(-6-30)	-	-	-	-	-	(0-45)	(-73-34)
n	13	1	346	51	65	14	272	37	4	0	5	0	359	52
Functional status change recruitment to exit, improved, n	**6**	**0**	**100**	**8**	**21**	**2**	**79**	**6**	**0**	**-**	**0**	**-**	**106**	**8**
%	5	0	29	16	32	14	29	16	0	-	0	-	30	15

**Note: Totals are based on numbers of recruited participants, including those with missing values.*

ANNEX 3: COST PER PATIENT RECOVERED, GIVEN HYPOTHETICAL PROGRAM MODIFICATIONS

Model 1

Marginal cost per patient recovered, assuming patients with BMI 18.3 who defaulted one month before program completion recovered

Marginal cost of treatment per 100 patients		Percent recovered assuming one additional visit led to recovery of patients with BMI 18.3 or above				Marginal number recovered in treatment per 100 patients		Marginal cost per patient recovered	
		Treatment		Comparison					
SAM	MAM	SAM	MAM	SAM	MAM	SAM	MAM	SAM	MAM
$16,459	$12,396	3.9%	25.3%	1.1%	9.3%	2.8	16.0	$5,878	$775

Model 2

Marginal cost per patient recovered, assuming half who defaulted after 2 visits completed 4th visit

Marginal cost of treatment per 100 patients		Percent of patients recovered assuming half of defaulters completed 4th visit				Marginal number recovered in treatment per 100 patients		Marginal cost per patient recovered	
		Treatment		Comparison					
SAM	MAM	SAM	MAM	SAM	MAM	SAM	MAM	SAM	MAM
$17,066	$12,545	3.7%	18.0%	1.5%	9.7%	2.2	8.3	$7,757	$1,511

Model 3

Marginal cost per patient recovered, with one additional visit added to non-responders

Marginal cost of treatment per 100 patients		Percent of patients graduated				Marginal number recovered in treatment per 100 patients		Marginal cost per patient recovered	
		Treatment		Comparison					
SAM	MAM	SAM	MAM	SAM	MAM	SAM	MAM	SAM	MAM
$16,551	$12,639	4.7%	23.1%	1.1%	8.4%	3.6	14.7	$4,572	$861

1 Based on protocol recovery definition of reaching BMI of 18.5 for two consecutive visits within three months for MAM and six months for SAM.
2 Based on less stringent recovery definition of reaching BMI of 18.5 at all during study period.
3 All regression models are adjusted for cluster analysis (cluster=clinic/hospital).

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