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Shamba Maisha: Randomized controlled trial of an agricultural and finance intervention to improve HIV health outcomes in Kenya

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Abstract

Objectives—Food insecurity and HIV/AIDS outcomes are inextricably linked in sub-Saharan Africa. We report on health and nutritional outcomes of a multisectoral agricultural intervention trial among HIV-infected adults in rural Kenya.

Design—Pilot cluster randomized controlled trial

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AUTHOR CONTRIBUTIONS

Conceived and designed the experiments: SDW, EAB, SLD, KP, SS, KS, CRC. Study implementation: SDW, EAB, RLS, EW, KP, LMB, CRC. Analyzed the data: SDW, RLS, EAF, CRC. Wrote the paper: SDW, RLS, CRC. Contributed to the writing of the manuscript: SDW, EAB, RLS, EAF, EW, SLD, KP, SS, KS, LMB, CRC.

COMPETING INTERESTS

The authors declare that they have no competing interests.

Trial Registration: This trial is registered at ClinicalTrials.gov, NCT01548599 http://clinicaltrials.gov/ct2/show/NCT01548599?term=shamba&rank=1

Methods—The intervention included a human-powered water pump, a microfinance loan to purchase farm commodities, and education in sustainable farming practices and financial management. Two health facilities in Nyanza Region, Kenya were randomly assigned as intervention or control. HIV-infected adults 18 to 49 years old who were on antiretroviral therapy and had access to surface water and land were enrolled beginning in April 2012 and followed quarterly for one year. Data were collected on nutritional parameters, CD4 T lymphocyte counts, and HIV RNA. Difference in difference fixed-effects regression models were used to test whether patterns in health outcomes differed over time from baseline between the intervention and control arms.

Results—We enrolled 72 and 68 participants in the intervention and control groups, respectively. At 12 months follow-up, we found a statistically significant increase in CD4 cell counts (165 cells/mm^3, $p<0.001$) and proportion virologically suppressed in the intervention arm compared to the control arm (comparative improvement in proportion of 0.33 suppressed, OR 7.6, 95% CI: 2.2–26.8). Intervention participants experienced significant improvements in food security (3.6 scale points higher, $p<0.001$) and frequency of food consumption (9.4 times per week greater frequency, $p=0.013$) compared to controls.

Conclusion—Livelihood interventions may be a promising approach to tackle the intersecting problems of food insecurity, poverty and HIV/AIDS morbidity.

Keywords

HIV; food insecurity; microfinance; agriculture; livelihoods; intervention

INTRODUCTION

HIV/AIDS and food insecurity are two leading causes of morbidity and mortality in sub-Saharan Africa (SSA), linked in a vicious cycle with each enhancing vulnerability to and worsening the severity of the other [1]. In SSA, 240 million persons are food insecure [2]. Food insecurity increases risk of HIV acquisition [3, 4], and food-insecure HIV-infected individuals have worse adherence to antiretroviral therapy (ART) and clinic visits [5], worse mental health [6, 7], and worse nutritional status [1], all contributing to poor HIV treatment outcomes and increased morbidity and mortality [8–11]. HIV/AIDS in turn worsens food insecurity by eroding economic productivity [12, 13], causing loss of social support due to HIV-related stigma [14] and increasing medical expenses.

There has been increasing international recognition that improving food security and reducing poverty are essential for a successful global response to the HIV epidemic [15, 16]. Yet, there is little evidence of the impacts of food-security or poverty-reduction interventions on nutrition and HIV outcomes, particularly from randomized controlled trials (RCTs). The few studies to date have used clinic-based food support, showing improved ART adherence and nutritional status with this strategy [17, 18]. International experts call for sustainable approaches addressing drivers and consequences of food insecurity such as agricultural and other livelihood approaches. In this study, we conducted a pilot cluster RCT to assess the effects of a multisectoral agricultural and finance intervention we initially developed and evaluated in a small feasibility study [19], on health outcomes among people living with HIV/AIDS [PLHIV] in rural Kenya.

METHODS

The study was conducted in Rongo and Migori districts in the Nyanza Region in Kenya which has an HIV prevalence of 15.1%, more than twice the national average [20]. As described elsewhere, we selected two health facilities supported by Family AIDS Care & Education Services (FACES) and randomly selected one as intervention and the other as control [21]. Control participants were eligible for the intervention at the end of the one-year follow-up period.

The *Shamba Maisha* intervention has three components [21]: 1) Loan program: Microfinance loans were provided and managed by *Adok Timo*, a Kenyan microfinance organization, with support from UCSF and KEMRI. Intervention participants were required to save 500 Kenyan shillings (~$6.00 USD) prior to receiving the loan (~$150 USD), which was used to purchase farming implements and a MoneyMaker water pump. Participants were expected to repay the loan in full by the end of two harvest seasons (about one year) and were not asked to forfeit personal belongings, except for the water pump, to cover loan payments. 2) The MoneyMaker pumps enable farmers to irrigate crops year-round, avoiding dependence on seasonal rainfall thus capitalizing on higher crop prices in the marketplace [22]. 3) Agricultural and financial training: Intervention participants received eight training sessions on agriculture and financial management. Agricultural trainings included didactic sessions and practical demonstrations on sustainable farming techniques, use of the MoneyMaker pump, seed selection, plant spacing, soil and water conservation, integrated pest and disease management, pre- & post-harvest handling and marketing. Financial training focused on record keeping, savings, investments, and group dynamics.

Participants, recruitment and data collection

Inclusion criteria were: HIV-infected individual on ART, ages of 18–49 years, access to farm land and surface water, evidence of moderate to severe food insecurity at enrollment or malnutrition during the year preceding the study, and willingness to save the down payment for the loan. Participants were recruited through clinic announcements, followed by individual screening for eligibility, including questionnaires, record review, and home visits to verify access to farm land and surface water. A total of 140 HIV-positive individuals were enrolled from April – July 2012 and followed quarterly for one year; an additional two (1.4%) eligible screened participants declined to participate in the study. All participants gave written informed consent prior to enrollment.

We conducted quarterly home visits with structured interviews on food security, food frequency, household wealth, and agricultural indicators. We collected biannual data at the health facility including anthropometry, phlebotomy for HIV RNA and CD4 cell count, and structured interviews for clinical and sensitive behavioral data. Data were collected using a handheld computer tablet (Morotola™ Xoom Android Tablets operating Open Data Kit Collect). Participants were reimbursed up to 800 Ksh per clinic-based interviews (~$9.4 USD) and 400 Ksh for home-based interviews (~$4.70). The study was approved by the

Committee on Human Research at the University of California San Francisco (UCSF) and the Ethical Review Committee at the Kenya Medical Research Institute (KEMRI). This clinical trial was registered at ClinicalTrials.gov (NCT01548599).

Primary outcomes—Food insecurity was measured using the Household Food Insecurity Access Scale (HFIAS) [23, 24]. Diet quality was measured using a 56-item scale adapted from the World Food Programme Food Consumption Score to capture the number of different food groups and the frequency consumed [25]. A modification of the World Bank Living Standards Measurement Study questionnaire [26] was used to measure household wealth including expenditures, household income, and inter-household commodity and cash transfers. Nutritional status was assessed through body mass index (BMI) and mid-upper arm circumference (MUAC) [27]. HIV RNA testing was performed on venous blood using the COBAS TaqMan HIV viral load (HIV VL) platform (Roche Molecular Diagnostics, Pleasanton, CA) with a lower limit of detection of <40 copies/mL. Absolute CD4 T lymphocyte cell count testing was performed on whole blood using the BD FACSCount (BD Bioscience, San Jose, CA).

Analysis

Intent-to-treat, repeated-measures analyses were done using the xtreg or xtlogit procedure in Stata v13 (StataCorp LP, College Station, TX) [28]. For continuous outcomes, fixed-effects linear models were used to remove all individual-to-individual variability, thereby controlling for any baseline differences between groups and accounting for all potential confounding from measured or unmeasured time-invariant variables. For viral load suppression, a random-effect logistic model was used. The interaction of group (intervention vs. control) and month was used to test differences between groups in the changes from month 0 to each follow-up month.

RESULTS

Screening and Enrollment

We screened 142 and 154 adults, respectively at intervention and control sites. Supplemental Figure 1 describes study screening and enrollment numbers, and reasons for participant ineligibility. We enrolled 72 and 68 participants at the intervention and control sites, respectively, allowing for more withdrawals from the intervention group in case they were unable to save the down payment for the loan. Four intervention participants withdrew from the study, three participants died (two intervention, one control), and one control participant migrated away. We analyzed data for 66 participants from each site.

Baseline Characteristics of Participants

At baseline, intervention and control participants were similar in age, gender, education, number of people in household, food security status, CD4 cell counts, and marital status (Table 1). Intervention participants had a greater proportion with low BMI (<18.5), lower proportion with HIV VL suppressed below 40 copies/mL, and lower monthly expenditures and frequency of food consumption. In both groups, 91% were on efavirenz-based or nevirapine-based regimens and the mean time on ART was 2.8 years.

Intervention impacts

Food insecurity, nutritional, and economic indicators: Intervention participants reduced their food insecurity progressively throughout follow-up (Supplemental Figure 2). Control participants also reduced food insecurity to a lesser extent. At month 12, the difference in reduction in food insecurity from baseline between intervention and control was 3.6 scale points ($p<0.001$, Table 2), an effect size of 1.2 standard deviation units.

Frequency of food consumption improved for intervention compared to control participants throughout follow-up. At month 12, the difference in additional frequency of food consumption from baseline between intervention and control was 9.4 times per week ($p=0.013$, Table 2). BMI tended to improve for the intervention compared to the control group during the follow-up period, with differences of more than a third of a BMI unit at both 6 and 12 months ($p<0.12$), with no significant differences for MUAC (Table 2). There were no significant differences between intervention and control participants in change in food or non-food expenditures (Table 2). There were marginally significant differences ($p<0.10$), however, for expenditures on dairy, beverages, and cooking fat (data not shown).

HIV clinical outcomes: For intervention participants, mean CD4 cell counts increased by 75.6 cells/mm^3, while for control participants, mean CD4 cell counts decreased by 89.3 at endline. The difference in these changes between intervention and control at 12 months was 164.9 cells/mm^3, $p<0.001$. Over follow-up, the percentage virologically suppressed in the intervention increased from 51% to 79% and the percentage suppressed in the control decreased from 72% to 67%. The comparative improvement in the proportion virologically suppressed was 33% (odds ratio 7.60, 95% CI 2.2–26.8, $p=0.002$, Supplemental Figure 3).

DISCUSSION

In this pilot cluster RCT, we found that an agricultural and finance intervention was feasible, acceptable and had high retention, consistent with the high retention seen in FACES-supported clinics broadly. Several previous studies from resource-limited settings found that macronutrient supplementation delivered as part of HIV care can improve food security, BMI, treatment adherence and clinic attendance [15, 17, 18, 29–31]. Our findings extend this literature by demonstrating that a potentially sustainable agricultural and financial intervention improved immunologic and virologic outcomes, food security, and diet quality for HIV-infected individuals. This supports previous research attesting to the critical role of poverty and food insecurity alleviation to improve health outcomes [1].

These findings have important implications for policy and practice. At least 70% of HIV-infected individuals in East Africa are food insecure [32, 33] suggesting relevance of such interventions for a large segment of the population. Food insecurity in the region stems from combined effects of extreme poverty, environmental change, insufficient agricultural output, and rising food prices [34, 35], all factors that may be improved by this intervention. Given that HIV-infected individuals often relinquish food to obtain medical care and stay on treatment [36], adherence to ART in SSA may not be sustainable without incorporating strategies to reduce food insecurity into ART treatment programs. Therefore, locally available and potentially sustainable models for improving food security are needed to improve HIV clinical outcomes. Since food insecurity negatively impacts health for many conditions beyond HIV including other infectious diseases, mental health, reproductive health outcomes, pediatric health outcomes, and diabetes and risk for cardiovascular disease [1, 37–39], similar sustainable food security interventions may be beneficial in prevention and treatment of other illnesses. In line with the obligation of States to implement general health and well-being interventions, our study supports the growing international interest to integrate agriculture, nutrition, and health programs to improve outcomes in these sectors simultaneously.

With only two communities randomized, we could not definitively separate intervention effects from cluster-level variables, highlighting the need for a larger cluster-RCT. There were significant baseline differences between intervention and control participants including several outcomes of interest. The 12-month follow-up could not detect the full range and sustainability of intervention effects. Only participants who had access to farming land and available surface water were eligible to participate in the study, limiting the generalizability to other populations. Yet, these criteria are likely to be met by many HIV-infected individuals in Kenya where the agriculture sector accounts for >75% of the total workforce, and 51% of the gross domestic product [40].

In summary, this multisectoral agricultural and finance intervention improved HIV control, food security, and diet quality among HIV-infected individuals in Kenya. Livelihood interventions may be a promising approach to tackle the intersecting problems of food insecurity, poverty, and HIV/AIDS morbidity. If proven effective and cost-effective in larger trials, such interventions should be incorporated into HIV treatment efforts in Kenya and similar resource-limited settings.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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ABBREVIATIONS

ART	Antiretroviral therapy
BMI	Body mass index

FACES	Family AIDS Care & Education Services
HFAIS	Household Food Insecurity Access Scale
HIV VL	HIV viral load
KEMRI	Kenyan Medical Research Institute
MUAC	Mid upper arm circumference measurements
NGO	Non-governmental organization
PLHIV	People living with HIV/AIDS
RCT	Randomized control trial
UCSF	University of California, San Francisco

References

1. Weiser SD, Young SL, Cohen CR, Kushel MB, Tsai AC, Tien PC, et al. Conceptual framework for understanding the bidirectional links between food insecurity and HIV/AIDS. Am J Clin Nutr. 2011; 94(suppl):1729S–1739S. [PubMed: 22089434]
2. FAO. The State of Food Insecurity in the World—Addressing Food Insecurity in Protracted Crises. Rome: Food and Agriculture Organization of the United Nations; 2010.
3. Weiser SD, Leiter K, Bangsberg DR, Butler LM, Percy-de Korte F, Hlanze Z, et al. Food insufficiency is associated with high-risk sexual behavior among women in Botswana and Swaziland. PLoS Med. 2007; 4:1589–1597. discussion 1598. [PubMed: 17958460]
4. Tsai AC, Hung KJ, Weiser SD. Is food insecurity associated with HIV risk? Cross-sectional evidence from sexually active women in Brazil. PLoS Med. 2012; 9:e1001203. [PubMed: 22505852]
5. Young S, Wheeler AC, McCoy SI, Weiser SD. A review of the role of food insecurity in adherence to care and treatment among adult and pediatric populations living with HIV and AIDS. AIDS Behav. 2014; 18 (Suppl 5):S505–515. [PubMed: 23842717]
6. Tsai AC, Bangsberg DR, Frongillo EA, Hunt PW, Muzoora C, Martin JN, et al. Food insecurity, depression and the modifying role of social support among people living with HIV/AIDS in rural Uganda. Soc Sci Med. 2012; 74:2012–2019. [PubMed: 22513248]
7. Palar K, Kushel M, Frongillo EA, Riley ED, Grede N, Bangsberg D, et al. Food Insecurity is Longitudinally Associated with Depressive Symptoms Among Homeless and Marginally-Housed Individuals Living with HIV. AIDS Behav. 2014
8. Kalichman SC, Cherry C, Amaral C, White D, Kalichman MO, Pope H, et al. Health and treatment implications of food insufficiency among people living with HIV/AIDS, Atlanta, Georgia. Journal of urban health : bulletin of the New York Academy of Medicine. 2010; 87:631–641. [PubMed: 20419478]
9. Weiser SD, Palar K, Frongillo EA, Tsai AC, Kumbakumba E, Depee S, et al. Longitudinal assessment of associations between food insecurity, antiretroviral adherence and HIV treatment outcomes in rural Uganda. AIDS. 2014; 28:115–120. [PubMed: 23939234]
10. Weiser SD, Yuan C, Guzman D, Frongillo EA, Riley ED, Bangsberg DR, et al. Food insecurity and HIV clinical outcomes in a longitudinal study of urban homeless and marginally housed HIV-infected individuals. AIDS. 2013; 27:2953–2958. [PubMed: 23921612]
11. Weiser SD, Fernandes KA, Brandson EK, Lima VD, Anema A, Bangsberg DR, et al. The association between food insecurity and mortality among HIV-infected individuals on HAART. J Acquir Immune Defic Syndr. 2009; 52:342–349. [PubMed: 19675463]

12. Gregson S, Mushati P, Nyamukapa C. Adult mortality and erosion of household viability in AIDS-afflicted towns, estates, and villages in eastern Zimbabwe. J Acquir Immune Defic Syndr. 2007; 44:188–195. [PubMed: 17075384]

13. Russell S. The economic burden of illness for households in developing countries: a review of studies focusing on malaria, tuberculosis, and human immunodeficiency virus/acquired immunodeficiency syndrome. American Journal of Tropical Medicine and Hygiene. 2004; 71:147–155. [PubMed: 15331831]

14. Tsai AC, Bangsberg DR, Emenyonu N, Senkungu JK, Martin JN, Weiser SD. The social context of food insecurity among persons living with HIV/AIDS in rural Uganda. Social science & medicine. 2011; 73:1717–1724. [PubMed: 22019367]

15. Byron E, Gillespie S, Nangami M. Integrating nutrition security with treatment of people living with HIV: lessons from Kenya. Food Nutr Bull. 2008; 29:87–97. [PubMed: 18693472]

16. Mamlin J, Kimaiyo S, Lewis S, Tadayo H, Jerop FK, Gichunge C, et al. Integrating nutrition support for food-insecure patients and their dependents into an HIV care and treatment program in Western Kenya. Am J Public Health. 2009; 99:215–221. [PubMed: 19059851]

17. Cantrell RA, Sinkala M, Megazinni K, Lawson-Marriott S, Washington S, Chi BH, et al. A pilot study of food supplementation to improve adherence to antiretroviral therapy among food-insecure adults in Lusaka, Zambia. Journal of acquired immune deficiency syndromes. 2008; 49:190–195. [PubMed: 18769349]

18. de Pee S, Grede N, Mehra D, Bloem MW. The enabling effect of food assistance in improving adherence and/or treatment completion for antiretroviral therapy and tuberculosis treatment: a literature review. AIDS Behav. 2014; 18 (Suppl 5):S531–541. [PubMed: 24619602]

19. Pandit JA, Sirotin N, Tittle R, Onjolo E, Bukusi EA, Cohen CR. Shamba Maisha: a pilot study assessing impacts of a micro-irrigation intervention on the health and economic wellbeing of HIV patients. BMC Public Health. 2010; 10:245. [PubMed: 20459841]

20. Kenya National Bureau of Statistics and ICF Macro. Kenya Demographic and Health Survey 2008–09. Calverton, Maryland: Kenya National Bureau of Statistics and ICF Macro; 2010.

21. Cohen CR, Steinfeld RL, Weke E, Bukusi EA, Hatcher AM, Shiboski S, et al. Shamba Maisha: Pilot agricultural intervention for food security and HIV health outcomes in Kenya: design, methods, baseline results and process evaluation of a cluster-randomized controlled trial. SpringerPlus. 2015; 4:122. [PubMed: 25992307]

22. Brandsma, T. Newsweek. 2003. Waterworks: Kenyan Farmers Are Getting A Big Boost From A Simple Piece Of Equipment.

23. Swindale A, Bilinsky P. Development of a universally applicable household food insecurity measurement tool: process, current status, and outstanding issues. J Nutr. 2006; 136:1449S–1452S. [PubMed: 16614442]

24. Frongillo EA, Nanama S. Development and validation of an experience-based measure of household food insecurity within and across seasons in northern Burkina Faso. J Nutr. 2006; 136:1409S–1419S. [PubMed: 16614438]

25. Hoddinott, J.; Yohannes, Y. Dietary diversity as a household food security indicator. Washington, D.C: Food and Nutrition Technical Assistance Project, Academy for Educational Development; 2002.

26. Grosh M, Glewwe P. Data Watch: the World Bank's Living Standard Measurement Study household surveys. Journal of Economic Perspectives. 1998; 12:187–196.

27. James WP, Ferro-Luzzi A, Waterlow JC. Definition of chronic energy deficiency in adults. Report of a working party of the International Dietary Energy Consultative Group. Eur J Clin Nutr. 1988; 42:969–981. [PubMed: 3148462]

28. StataCorp. Stata Statistical Software: Release 13. College Station, TX: StataCorp LP; 2013.

29. Rawat R, Faust E, Maluccio JA, Kadiyala S. The impact of a food assistance program on nutritional status, disease progression, and food security among people living with HIV in Uganda. J Acquir Immune Defic Syndr. 2014; 66:e15–22. [PubMed: 24326603]

30. Ivers LC, Chang Y, Gregory Jerome J, Freedberg KA. Food assistance is associated with improved body mass index, food security and attendance at clinic in an HIV program in central Haiti: a prospective observational cohort study. AIDS Res Ther. 2010; 7:33. [PubMed: 20796284]

31. Martinez H, Palar K, Linnemayr S, Smith A, Derose KP, Ramirez B, et al. Tailored Nutrition Education and Food Assistance Improve Adherence to HIV Antiretroviral Therapy: Evidence from Honduras. AIDS Behav. 2014; 18 (Suppl 5):566–577.

32. Nagata JM, Cohen CR, Young SL, Wamuyu C, Armes MN, Otieno BO, et al. Descriptive characteristics and health outcomes of the food by prescription nutrition supplementation program for adults living with HIV in Nyanza Province, Kenya. PLoS One. 2014; 9:e91403. [PubMed: 24646586]

33. Weiser SD, Tsai AC, Gupta R, Frongillo EA, Kawuma A, Senkungu J, et al. Food insecurity is associated with morbidity and patterns of healthcare utilization among HIV-infected individuals in a resource-poor setting. AIDS. 2012; 26:67–75. [PubMed: 21904186]

34. de Onis M, Frongillo EA, Blossner M. Is malnutrition declining? An analysis of changes in levels of child malnutrition since 1980. Bull World Health Organ. 2000; 78:1222–1233. [PubMed: 11100617]

35. The Kenya Food Security Steering Group. The impact of rising food prices on disparate livelihoods groups in Kenya. Nairobi, Kenya: World Food Programme (WFP); 2008.

36. Weiser SD, Tuller DM, Frongillo EA, Senkungu J, Mukiibi N, Bangsberg DR. Food insecurity as a barrier to sustained antiretroviral therapy adherence in Uganda. PloS one. 2010; 5:e10340. [PubMed: 20442769]

37. Weiser, S.; Palar, K.; Hatcher, A.; Young, S.; Frongillo, E.; BAL. Food insecurity and health: A Conceptual Framework. In: Ivers, L., editor. Food Insecurity and Public Health. Boston, MA: CRC Press; 2014. In Press

38. Laraia BA, Siega-Riz AM, Gundersen C. Household food insecurity is associated with self-reported pregravid weight status, gestational weight gain, and pregnancy complications. J Am Diet Assoc. 2010; 110:692–701. [PubMed: 20430130]

39. Seligman HK, Laraia BA, Kushel MB. Food insecurity is associated with chronic disease among low-income NHANES participants. J Nutr. 2010; 140:304–310. [PubMed: 20032485]

40. USAID. Feed the Future Program, country profile for Kenya.

Table 1

Comparison of baseline characteristics of participants enrolled in Shamba Maisha at the intervention and control sites.

	Intervention N=72	Control N=68	P-value
	n (%) or mean (SE)	**n (%) or mean (SE)**	
Mean age in years (SE)	37 (0.80)	38 (0.80)	0.16
Female gender	37 (51)	35 (51)	0.92
Education ≥ secondary school	14 (19)	12 (18)	0.82
Current married	54 (75)	54 (79)	0.25
Number of people in household	6 (0.2)	7 (0.3)	0.12
Severely food insecure (vs. moderately)	57 (80)	53 (78)	0.86
Body mass index (BMI) <18.5	13 (18)	5 (7)	0.054
Food expenditures (Ksh)	1694 (117)	2176 (127)	0.006
Non-food expenditures (Ksh)	5931 (1559)	14788 (1941)	<0.001
Frequency of food consumption (times/week)	69.6 (3.1)	93.9 (3.2)	<0.001
CD4 (cells/mm^3)	497 (32.7)	536 (37.7)	0.428
Viral load < 40 copies/mL	35 (51)	49 (72)	0.010

1 US dollar = 90.00 Kenyan Shillings (Ksh)

Table 2

Differences between intervention and control groups in the changes from month 0 to follow-up months in food insecurity, frequency of foods consumed, body mass index, CD4, and viral load suppression.*

Month of follow up	3		6		9		12	
Outcome	**Differ.**	**p-value**	**Differ.**	**p-value**	**Differ.**	**p-value**	**Differ.**	**p-value**
Food insecurity (scale points)	−1.063	0.142	−2.308	0.002	−2.572	<0.001	−3.685	<0.001
Frequency food consumption (times/w)	3.611	0.333	1.205	0.748	11.854	0.002	9.437	0.013
Body mass index (kg/m^2)			0.386	0.082			0.355	0.114
Mid-upper arm circumference (cm)			0.294	0.308			0.214	0.311
Food expenditures (Ksh)	223.7	0.387	191.7	0.458	273.3	0.293	220.3	0.398
Non-food expenditures (Ksh)	2074.5	0.709	6411.6	0.249	465.3	0.934	5802.1	0.301
CD4 ($cells/mm^3$)			59.129	0.175			169.99	<0.001
Viral load suppression (log-odds)			1.845	0.003			2.028	0.002
Viral load suppression (odds ratio)			6.33	0.003			7.60	0.002

*Each difference shown is a difference-in-differences obtained from a fixed-effects (or random-effects for viral load suppression) model accounting for among-individual variation calculated as: (intervention at follow-up month - intervention at 0 months) - (control at follow-up month – control at 0 months).

1 US dollar = 90.00 Kenyan Shillings (Ksh)