Agricultural and finance intervention increased dietary intake and weight of children living in HIV-affected households in western Kenya

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Abstract

We tested whether a multi-sectoral household agricultural and finance intervention increased dietary intake and nutritional status of HIV-affected children. Two hospitals in rural Kenya were randomly assigned as intervention or control arm. The intervention was a human-powered water pump, microfinance loan for farm commodities, and training in sustainable farming practices and financial management. In each arm, 100 children (0-59 months of age) were enrolled from households with HIV-infected adults 18-49 years old. Children were assessed beginning in April 2012 and every three months for one year for dietary intake and anthropometry. Children in the intervention arm had a larger increase in weight (β: 0.025 kg/month, p=0.030), overall frequency of food consumption (β: 0.610 times/week per month, p=0.048), and intake of staples (β: 0.222, p=0.024), fruits and vegetables (β: 0.425, p=0.005), meat (β: 0.074, p<0.001), and fat (β: 0.057, p=0.041. Livelihood interventions have potential to improve the nutrition of HIV-affected children.

Key words: children, dietary intake, nutritional status, HIV, Kenya

Introduction

Human Immuno-deficiency Virus (HIV)/Acquired Immune Deficiency Syndrome (AIDS) and household food insecurity are prominent public health issues in sub-Saharan Africa. The number of people living with HIV aged 15-49 years in sub-Saharan Africa increased to 24.2 million in 2018 from 17 million in 2000 (1, 2), and severe household food insecurity increased from 28% in 2014 to 31% in 2016 (3). Kenya has a high burden of HIV/AIDS and food insecurity. Nyanza region has a high prevalence of HIV (15% among 15-64 years old) (4) with high prevalence of stunting (23%) (5). Undernutrition is prevalent in impoverished Kenya, where 26% of children under five years old are stunted (i.e., height-
for-age < -2 standard deviations of the sex- and age-specific median of the World Health Organization Child Growth Standards), 8% are severely stunted, and 11% are underweight (i.e., weight-for-age < -2 SD of the Standards median) (5).

HIV/AIDS adversely affects household food security and household wealth because of loss of productive household members, decreased income, and increased caregiver burden (6). The coexistence of HIV/AIDS and household food insecurity aggravates health, dietary intake, and nutrition of adults and children living in the HIV-affected households (7-9).

Prior work assessed the impact of nutritional programs on health outcomes of general (non-HIV infected) child populations (10-16). Most interventions provided nutritional education, micronutrient supplementation, food fortification, agricultural training, livestock and seeds, and/or food to households, and have been efficacious for growth, disease reduction, and development. There is increasing but insufficient evidence of effectiveness in real-world scenarios. Few studies involved financial interventions aiming to improve nutritional status. Agricultural interventions, such as home or community gardens including agricultural training, improved dietary diversity of mothers and children (17, 18), growth among children under five years old (19), and household food security (19). None of these interventions were among HIV-affected families or included a financial component.

Livelihood interventions targeted to adults may have downstream benefits for children (20). We conducted an agriculture and finance intervention among HIV-infected adults and HIV-affected children in the Nyanza region of western Kenya in 2011 (21). The results for the adults have been published, showing that the intervention resulted in improved food security, dietary intake, and HIV health outcomes among adults (22). We posited that intervention-driven improvements in household food security and wealth would improve access to food and support caretaker physical and mental health and empowerment, which would in turn translate into improved nutrition for children (23). This study tested the hypothesis that the Kenyan livelihood intervention provided to households with an HIV-infected
adult also improved dietary intake and nutritional status of children under 5 years old living within the same households.

**Methods**

**Setting**

The study was conducted in Rongo sub-County (intervention arm) and Migori County (control arm) government hospitals located in Migori County in the Nyanza region of western Kenya. The population is mostly rural, ethnically homogenous (>95% members are Luo), and living in dispersed settlements. The major livelihood is subsistence farming and/or fishing, with the major crops for consumption being maize, sorghum, and cassava. The Nyanza region is one of Kenya’s most vulnerable regions to food insecurity as rural poor people do not have enough land and irrigation facilities to do subsistence farming (24).

**Study design**

The study design is detailed elsewhere (21, 22). Two rural government district hospitals supported by Family AIDS Care & Education Services were randomly assigned as intervention or control. The hospitals had similar in-patient, outpatient, emergency, maternal, child, and HIV Care and Treatment services. Both had adequate and similar numbers of adults undergoing antiretroviral therapy (2394 in intervention hospital and 2718 in control hospital in 2012) with non-overlapping catchment areas, mitigating contamination; the two locations were similar in rainfall patterns, health, topography, water access, soil composition, and socioeconomic status. The intervention had three components: (1) the KickStart Water pump and required farm commodities, (2) training in sustainable farming and financial management provided by the Kenyan Ministry of Agriculture, and (3) small loan ($150 USD) to purchase the water pump and farming implements provided by AdokTimo, a microfinance institution. Control participants received no intervention; they were eligible for the intervention at the end of the 1-year follow-up period. We enrolled through clinic announcements adults on antiretroviral therapy, aged 18 to 49 years, with access to farmland and surface water, with moderate-to-severe food insecurity at
enrollment or malnutrition during the preceding year, and willing to save the down payment for the loan. A total of 140 HIV-infected adults (72 intervention, 68 control) were enrolled April to July 2012. The present study recruited all children age 0-59 months (biological or legally fostered) living within the households of index adult participants in the parent study (22). We followed children for one year every 3 months, assessing dietary intake, weight, height, and mid-upper arm circumference (MUAC).

Participant enrollment

In each arm, we enrolled 100 children aged 0 to 59 months and their primary caregiver (biological parent or legal guardian age 18 to 49 years old) living within the households of index adult participants in the parent study. We excluded children with severe acute malnutrition (below -3 z-scores of the Standards) and referred them for immediate care if not already in care. We obtained written informed consent from the adult participants for their and for their children’s participation.

Primary outcomes

Dietary intake and nutritional status of children were the primary outcomes. Frequency of consumption of food groups was assessed using a questionnaire adapted from the World Food Programme Food Consumption Score. Mothers or caretakers were asked how often the child drank or ate each of 63 food items in the past three months provided in a list. Response options were every day, 5-6 times a week, 3-4 times a week, 1-2 times a week, 2-3 times a month, once a month, less than once a month, and never. Ten food groups were created based on major nutrients present in the food items adapting guidelines for individual dietary diversity developed by Food and Agricultural Organization: staples, legumes, fruits and vegetables, meat, dairy, egg, fat, sugary foods, condiments (spices, chili, garlic, royco, which were usually served in small quantities), and tea/coffee (25). Each food group was represented as number of times consumed per week. Frequencies of consumption of all food groups were summed to obtain overall frequency of consumption.
Child nutritional status was assessed as weight, height, and MUAC. Three consecutive weights were measured using a SECA portable electronic scale, which can be adjusted to zero and weigh quickly and accurately. Three consecutive measurements of standing height for children greater than 24 months of age and length for children under 24 months of age was taken using a length board. Three MUAC measurements using a measuring tape were taken. If the difference between the first two measurements was less than 0.3 kg or 0.3 cm, the average of the first two measurements was used for the analysis; if the difference was greater than or equal to 0.3 kg or 0.3 cm, the average of all three measurements was used.

In the intervention and control arms, weight of the children had 4.8% and 3.4% missing values respectively over the five visits (i.e., 12 months). Missing values of height and MUAC were 4.6% and 5.8% in intervention arm compared to 3.4% and 4.2% in control arm respectively. Missing values for overall frequency of food consumption were 20.8% in the intervention arm and 21.4% in the control arm, with similar percentages for specific food groups.

Ethical approval

The study was approved by the Committee on Human Research at the University of California San Francisco and the Ethical Review Committee at the Kenya Medical Research Institute. Participants were explained about the study’s purpose and written informed consent was obtained from each adult participant before conducting the survey. The study was registered at ClinicalTrials.gov (NCT01548599).

Analysis

Intention-to-treat, repeated-measures analyses were done in Stata v13 (StataCorp LP, College Station, Texas, USA), with child as a random effect and arm, month of visit, and their interaction as fixed effects. Month of visit was continuous. All available data were analyzed assuming missingness at random. We estimated the difference between arms in the linear trends over months (i.e., fitting a straight line over months for each arm) using the interaction between arm and month. Since we
hypothesized that children in the intervention arm would have a higher slope for the trend over visits in anthropometry and diet (except for condiments and tea/coffee, which would have lower slope) than children in the control arm, we report one-tailed p-values. In sensitivity analyses for dietary intake without 22 children aged less than 6 months, inferences were unchanged, with differences in trends between arms slightly larger; most of the 22 children consumed some complementary foods by visit 2.

**Results**

Children and care and their caretakers in each arm were similar at baseline (Table 1). The overall frequency of food consumption of children and the percentage of female caretakers were higher in the control arm.

Weight of the children across the 12 months of follow-up increased more in the intervention arm than the control arm (β: 0.025 kg per month, P=0.030) (Table 2). Height and MUAC of the children did not differentially increase between intervention and control arm over months.

Compared to the control arm, intervention children had a larger increasing linear trend over the 12 months of follow-up in overall consumption of food (β: 0.610 times/week per month, p=0.048) and in consumption of staples (β: 0.222, p=0.024), fruits and vegetables (β: 0.425, p=0.005), meat (β: 0.074, p<0.001), and fat (β: 0.057, p=0.041). Intervention children had a larger decreasing linear trend in intake of condiments (β: -0.159, p<0.001) and tea/coffee (β: -0.119, p<0.001) than control children. There were no significant differences in the trends over months in intake of legumes, dairy, and eggs between arms.

**Discussion**

The livelihood intervention that improved household food security and dietary intake and health outcomes for HIV-infected adults (22) also improved weight and dietary intake of children living in the households. The three intervention components likely worked together to increase food security and household wealth through improved production of crops and selling surplus in markets (22). The increased food security and wealth likely improved physical (22) and mental health (26, 27) and
empowerment of the caretakers (28), which ultimately led to improved infant and young child feeding and body weight. Height and MUAC of children did not differentially improve between arms. Determinants other than dietary intake such as size at birth, pregnancy duration, water, sanitation, and illness influence linear growth and MUAC of children (29) and more time may have been needed to see effects on height or MUAC.

These findings are consistent with those from a study of ultra-poor households in Bangladesh where women were provided income-earning opportunities and strengthened sociopolitical support to build self-awareness, confidence, and income (20). That program improved economic status and food security and resulted in multiple benefits for women. Children fully exposed to the program (i.e., both before and after birth) had better weight-for-height (but not better height-for-age) compared to children living in households without the program (20).

Although randomizing two hospitals to intervention and control may have reduced selection bias, having only two prevented definitively separating intervention effects from potential other factors and accounting for variation among hospitals. The 12-month follow-up period was enough to test differential increases in weight and dietary intake but perhaps not for other anthropometric outcomes. We included children of adults who visited the hospitals for antiretroviral therapy and who had access to farming land and surface water, which might limit generalizability to other populations.

In conclusion, a nutrition-sensitive (30), agricultural and finance intervention that improved household food security, dietary intake, and health among HIV-infected adults improved the weight and dietary intake of children under five years old living in the households. Livelihood interventions have potential to produce downstream positive effects in children living in HIV-affected households and should be further developed and studied in larger samples with longer follow-up as part of HIV management efforts in Kenya and similar settings.
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TABLE 1 Baseline characteristics of children and caretakers enrolled in the study in control and intervention arms in western Kenya, 2012-2013

| Baseline characteristics                      | Control arm n (%) | Control arm mean (SE) | Intervention arm n (%) | Intervention arm mean (SE) |
|-----------------------------------------------|-------------------|-----------------------|-------------------------|----------------------------|
| **Children**                                  |                   |                       |                         |                            |
| Age (months)                                  | 31.4 (1.8)        | 31.3 (1.9)            |                         |                            |
| Sex (%)                                       |                   |                       |                         |                            |
| Male                                          | 54 (56.8)         | 48 (50.0)             |                         |                            |
| Female                                        | 41 (43.2)         | 48 (50.0)             |                         |                            |
| Weight (kg)                                   | 11.9 (0.4)        | 11.8 (0.4)            |                         |                            |
| Height (cm)                                   | 84.9 (1.6)        | 85.0 (1.6)            |                         |                            |
| Mid-upper arm circumference (cm)              | 15.1 (0.1)        | 14.8 (0.1)            |                         |                            |
| Overall food consumption (times/week)         | 83.2 (4)          | 59.3 (3.6)            |                         |                            |
| **Caretakers**                                |                   |                       |                         |                            |
| Age (years)                                   | 30.6 (0.7)        | 29.8 (0.6)            |                         |                            |
| Sex (%)                                       |                   |                       |                         |                            |
| Male                                          | 6 (6.2)           | 20 (20.8)             |                         |                            |
| Female                                        | 90 (93.8)         | 76 (79.2)             |                         |                            |
| Highest level of education (%)                |                   |                       |                         |                            |
| Primary                                       | 74 (77.1)         | 83 (84.7)             |                         |                            |
| Secondary                                     | 18 (18.8)         | 14 (14.3)             |                         |                            |
| Above secondary                               | 4 (4.2)           | 1 (1.0)               |                         |                            |
TABLE 2 Differences between intervention and control arms across 12 months of follow-up in weight, height, mid-upper arm circumference (MUAC), and frequency of food consumed among children (0 to 59 months) in western Kenya, 2012-2013.$^1$

| Outcomes                             | Trend in control arm (per month) | Trend in intervention arm (per month) | Difference in trend between arms (per month) | P-value (for difference in trend between arms) |
|--------------------------------------|----------------------------------|---------------------------------------|----------------------------------------------|-----------------------------------------------|
| **Anthropometry**                    |                                  |                                       |                                              |                                               |
| Weight (kg)                          | 0.136                            | 0.161                                 | 0.025                                        | 0.030                                         |
| Height (cm)                          | 0.708                            | 0.745                                 | 0.037                                        | 0.122                                         |
| MUAC (cm)                            | -0.011                           | -0.014                                | -0.003                                       | 0.352                                         |
| **Consumption of food groups (times/ week)** |                                  |                                       |                                              |                                               |
| Overall                              | 1.367                            | 1.977                                 | 0.610                                        | 0.048                                         |
| Staples                              | 0.131                            | 0.353                                 | 0.222                                        | 0.024                                         |
| Legumes                              | -0.018                           | 0.034                                 | 0.052                                        | 0.064                                         |
| Fruits & vegetables                  | 0.260                            | 0.685                                 | 0.425                                        | 0.005                                         |
| Meat                                 | -0.009                           | 0.065                                 | 0.074                                        | <0.001                                        |
| Dairy                                | 0.160                            | 0.130                                 | -0.030                                       | 0.274                                         |
| Egg                                  | 0.013                            | 0.011                                 | -0.002                                       | 0.457                                         |
| Fat                                  | 0.155                            | 0.212                                 | 0.057                                        | 0.041                                         |
| Sugar                                | 0.224                            | 0.357                                 | 0.133                                        | 0.028                                         |
| Condiments                           | 0.189                            | 0.030                                 | -0.159                                       | <0.001                                        |
| Tea/coffee                           | 0.180                            | 0.061                                 | -0.119                                       | <0.001                                        |

$^1$Intention-to-treat, repeated-measures analyses specifying child as a random effect and arm, month of visit, and their interaction as fixed effects were used to estimate the difference between arms in the linear trends over months (i.e., fitting a straight line over months for each arm) as the interaction between arm and month.