

“When I Eat Well, I Will Be Healthy, and the Child Will Also Be Healthy”: Maternal Nutrition among HIV-Infected Women Enrolled in a Livelihood Intervention in Western Kenya

Annie McDonough,¹ Sheri D Weiser,² Afkera Daniel,³ Elly Weke,⁴ Pauline Wekesa,⁴ Rachel Burger,⁵ Lila Sheira,² Elizabeth A Bukusi,^{4,6} and Craig R Cohen⁵

¹San Francisco School of Medicine, University of California, San Francisco, San Francisco, CA, USA; ²Division of HIV, Infectious Diseases, and Global Medicine, University of California, San Francisco, San Francisco, CA, USA; ³Johns Hopkins University School of Medicine, Baltimore, MD, USA; ⁴Centre for Microbiology Research, Kenya Medical Research Institute, Nairobi, Kenya; ⁵Department of Obstetrics, Gynecology & Reproductive Sciences, University of California, San Francisco, San Francisco, CA, USA; and ⁶Department of Obstetrics and Gynecology, University of Washington, Seattle, WA, USA

ABSTRACT

Background: Food insecurity remains a major obstacle to achieving health and well-being for individuals living with HIV in western Kenya. Studies have shown that pregnant women are vulnerable to experiencing food insecurity worldwide, with significant consequences for both maternal and child health. The *Shamba Maisha* cluster randomized controlled trial in western Kenya (which means “farming for life” in Swahili) tested the effects of a multisectoral livelihood intervention consisting of agricultural and finance trainings, farm inputs, and a loan on health and food security among 746 farmers living with HIV in Kisumu, Homa Bay, and Migori Counties.

Objectives: We conducted a qualitative substudy within the *Shamba Maisha* trial to understand the experiences and perspectives of pregnant women living with HIV enrolled in the trial.

Methods: Thirty women who had experienced a pregnancy during the *Shamba Maisha* study period, comprising 20 women in the intervention arm and 10 women in the control arm, completed in-depth interviews using a semistructured interview guide.

Results: Intervention participants interviewed noted improvements in maternal nutrition compared with previous pregnancies, which they attributed to the livelihood intervention. Key identified pathways to improved nutrition included improved access to vegetables, increased variety of diet through vegetable sales, and improved nutritional awareness. Women in the intervention arm also perceived increased weight gain compared with prior pregnancies and increased strength and energy throughout pregnancy.

Conclusions: Livelihood interventions represent a promising solution to alleviate food insecurity for pregnant women in order to improve maternal and child health outcomes. This trial was registered at clinicaltrials.gov as NCT02815579. *Curr Dev Nutr* 2020;4:nzaa032.

Keywords: maternal nutrition, HIV, livelihood intervention, Kenya, qualitative research

Copyright © The Author(s) 2020. This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited. For commercial re-use, please contact journals.permissions@oup.com

Manuscript received December 19, 2019. Initial review completed March 3, 2020. Revision accepted March 3, 2020. Published online March 13, 2020.

Supported by Doris Duke Charitable Foundation (to AM) and NIH grant NIH/NIMH R01MH107330-01 (to CRC).

Address correspondence to AM (e-mail: annie.mcdonough@ucsf.edu).

Abbreviations used: ART, antiretroviral therapy; NEC, nutrition education and counseling; RCT, randomized controlled trial.

Introduction

Food insecurity, which can be defined as the lack of an adequate quantity or quality of safe food or the inability to procure food in socially acceptable ways, remains a substantial barrier to health worldwide (1–3). In the region of western Kenya formerly known as Nyanza Province, comprised of several counties on the shores of Lake Victoria, ~40% of households recently reported lacking food or money to purchase food (4). The high prevalence of HIV among women in the region ($\leq 22\%$ in certain counties) exacerbates the problem of food insecurity, because compromised immune status leads to greater nutrient requirements and impaired productivity may make food acquisition more difficult (5, 6).

This in turn creates a vicious cycle of inadequate nutrition and illness (7). It has been proposed that women may face additional challenges related to food insecurity during pregnancy due to increased nutrient requirements, difficulty in obtaining and preparing food due to factors such as decreased mobility, and financial strain associated with leaving the workforce (8, 9). In turn, maternal food insecurity has been found to be directly associated with a range of adverse maternal and infant health outcomes including maternal anxiety and depression, decreased antenatal care attendance and adherence to antiretroviral therapy (ART) during pregnancy, certain birth defects, and low birth weight (10–14). In addition, food insecurity is associated with micronutrient deficiencies such as anemia which place women and their infants at increased risk

of maternal morbidity and mortality (8, 15–17). HIV-positive women during pregnancy therefore face multiple vulnerabilities to experiencing food insecurity and its many health consequences (18–20).

A variety of nutrition initiatives for pregnant women have been designed and evaluated worldwide. These can be broadly divided into 2 categories: first, nutrition-specific interventions, such as micronutrient supplementation and food fortification programs, address immediate determinants of malnutrition. In contrast, nutrition-sensitive initiatives work to address root causes of malnutrition such as agricultural production, socioeconomic status, gender empowerment, and sanitation through interventions such as household food production or cash transfer programs (21, 22). Evidence suggests that although many nutrition-specific interventions such as micronutrient and energy supplementation are successful in improving nutritional status and health outcomes in the short-term, long-term investments in determinants of nutrition, such as empowerment and economic status, are necessary to address nutritional deficits sustainably (23–26). Nutrition-sensitive livelihood interventions provide a promising solution to simultaneously address both immediate nutritional needs and the long-term social determinants of food security (27). However, there is an overall lack of high-quality evidence on the potential of livelihood interventions to improve food security and health among pregnant women. Furthermore, few qualitative studies have examined the mechanisms through which these nutrition-sensitive interventions may affect maternal nutrition and health (26).

One livelihood intervention, *Shamba Maisha*, consisting of agricultural inputs, a loan, and a series of finance and agricultural trainings, has been implemented to improve HIV and child health in western Kenya. In addition to addressing social determinants of food insecurity, this study has the added advantage of being potentially cost-effective in the long term owing to its finance component and potential health savings. A pilot of the *Shamba Maisha* randomized controlled trial (RCT) conducted at 2 facilities in the Nyanza Region found significant improvements in the proportion virally suppressed [comparative improvement in the proportion suppressed of 33% (OR: 7.6; 95% CI: 2.2, 26.8)], CD4 count level, and food security in the intervention arm as compared with the control arm (28). Qualitative pilot data suggest that there were several key pathways through which the intervention improved HIV health, including improved nutrition, income, empowerment, mental health, and adherence to care (28–30). The intervention was implemented as a cluster RCT in 16 paired facilities in western Kenya from 2016 to 2019.

We conducted a qualitative substudy within the ongoing *Shamba Maisha* trial. We aimed to explore experiences with *Shamba Maisha* among pregnant and postpartum women, perceived impacts of this intervention on maternal–child health, and to elucidate why and how perceived changes may have occurred.

Methods

We conducted a qualitative substudy nested within the *Shamba Maisha* RCT (NCT02815579). For *Shamba Maisha*, 746 men and women living with HIV and on ART aged 18–60 y who met criteria for malnutrition or food insecurity at baseline were enrolled at 16 paired facilities in Kisumu, Homa Bay, and Migori Counties in western Kenya.

Participants at 8 intervention sites received the *Shamba Maisha* intervention consisting of the following components: a series of group trainings on sustainable farming practices and financial management; the “MoneyMaker Max” pump, a low-cost treadle micro-irrigation pump; and a commodity loan of ~\$175 in value, issued upon completion of a down payment, that was used to purchase the pump and other farming implements including seeds, fertilizers, and pesticides. Data were collected at home and the clinic every 6 mo for 2 y after enrollment. Data collection was completed in December 2019.

To assess the experiences of pregnant and recently pregnant women enrolled in the trial and the impact of the intervention on maternal health, we conducted a qualitative substudy with recently and currently pregnant female index participants ($n = 30$). All women interviewed were enrolled in the trial and, if in the intervention group, had paid the down payment and received the components of the commodity loan. Research assistants at all 16 study facilities identified currently and recently pregnant women through record review and subsequently recruited participants through phone calls or discussions during scheduled study visits. All 30 participants who met the inclusion criteria and were approached agreed to be interviewed. For currently pregnant women, we recruited them at ≥ 20 weeks of gestation at time of interview, as confirmed by clinic chart records or self-reported estimated date of delivery, to ensure that women could speak in detail about their pregnancy thus far and any potential impact of the study intervention. For recently pregnant women, we recruited women who had given birth within approximately the last year from the date of interview, as confirmed by chart records or self-reported delivery date, to promote accurate recall of events and ensure that their participation in the *Shamba Maisha* trial coincided with their pregnancy. Similarly, we excluded women whose most recent pregnancy did not result in a live birth, in order to capture pregnancies of longer duration and thus maximize the detail that participants were able to provide about any changes experienced throughout pregnancy. We chose to interview both intervention ($n = 20$) and control ($n = 10$) participants in order to compare perceptions and themes between the 2 groups, and to determine whether impacts and mechanisms described by intervention participants were related to the intervention or to study participation more broadly.

Interviews were conducted in local languages (Dholuo, Swahili, and English) by a team of 3 female qualitative interviewers who are fluent in these languages. They were further trained on qualitative interviewing technique during a 2-d training workshop that included both observed mock and pilot interviews. Each interviewer met with a study investigator (AM) for an in-depth feedback session after completion of the pilot interview, and study investigators (AM, SDW) provided regular feedback based on detailed review of transcripts throughout the interview process.

A semistructured guide was developed by members of our study team before the interviews. The guide contained a list of main questions organized by topic, as well as suggested follow-up questions and probes beneath each main question. It was tailored to explore experiences and perceptions related to health, farming, and pregnancy, and included sections such as “nutrition and weight gain,” “labor and agricultural practices,” and “antenatal care.” In addition, questions were developed to explore the pathways through which the *Shamba Maisha* intervention may exert its impact on health outcomes; the guide therefore included sections on mental health, empowerment, and

relationship power. The questions were developed based on previous literature, including our prior qualitative research conducted during the *Shamba Maisha* pilot study (29–31). Intervention participants were asked additional questions about their experiences and perceptions of the intervention; therefore, interviewers were not blinded to the intervention or control status of interviewees. The guide was modified and further developed through an iterative process based on interviewer feedback and review of early transcripts.

All interviews took place in a private location at or near a study facility and lasted between 45 min and 2 h. Only the interviewer and participant were present in the room during each interview. Interviews were audio recorded and subsequently transcribed and translated by the original interviewer verbatim into English; field notes and contextual information were incorporated into these documents. All transcripts were reviewed and any questions were discussed with the interviewer in order to ensure accuracy of translation. Transcripts were managed using Dedoose qualitative analysis software (SocioCultural Research Consultants). An a priori broad coding framework was established using thematic analysis methods based on the interview guide, and additional inductive codes were subsequently added after a subset of interviews had been reviewed. Two members of the research team coded the interviews using broad codes. One-half of the interviews were double-coded and reviewed through phone discussions to ensure intercoder reliability. Subsequently, 2 investigators developed fine codes for a subset of the broad codes based on emergent themes. We created an analytic report including main findings and contradicting viewpoints for each major theme and included illustrative quotes to support the findings.

All participants provided written informed consent before participating in an interview, and participants were reimbursed 400 Kenyan shillings (Ksh) (~\$4.00) for their time and up to 400 Ksh for transport to the interview location, consistent with ethical research protocols in Kenya. Ethics approval for this study was obtained from the Kenya Medical Research Institute and the University of California, San Francisco.

Results

Participant characteristics

In total, 30 women were recruited and subsequently interviewed (Table 1). Women were included from facilities in all 3 counties participating in the *Shamba Maisha* trial (Kisumu, Homa Bay, and Migori), with the majority residing in Migori County ($n = 21$). Six of the 30 women were currently pregnant at the time of interview, whereas 24 were between 0 and 15 mo postpartum. All but 1 woman had experienced multiple pregnancies and had multiple children (median number of children = 4), thus allowing women to compare their most recent pregnancy with pregnancies before participation in the study. All women interviewed in the intervention arm had participated in *Shamba Maisha* for ≥ 12 mo at the time of interview, with participation defined from the time point of the first agricultural training session.

Diet during pregnancy

The foods women most commonly reported eating during pregnancy included vegetables, especially *sukuma wiki* (kale), fruits, beans, tea, *ugali* (a maize meal staple food), *chapati* (flatbread), rice, and porridge. The majority of women interviewed received either formal nutritional counseling during pregnancy from health care professionals at antenatal

TABLE 1 Participant characteristics

Characteristics	
Participants, n	
Total participants	30
Intervention	20
Control	10
Location	
Kisumu County	5
Homa Bay County	4
Migori County	21
Median $\pm$ SD age at time of interview	32 $\pm$ 5.02
Marital status at baseline	
Single	2
Married	22
Divorced	1
Widowed	5
Pregnancy timing at time of interview	
Gestational age, wk	
20–30	4
30–40	2
Recently pregnant, months postpartum	
0–3	6
3–6	6
6–9	7
9–12	4
12–15	1
Median $\pm$ SD number of children	4 $\pm$ 1.48
Duration of participation in intervention at time of interview (defined as time from first agricultural training session, intervention group only), mo	
12–18	9
18–24	9
≥ 24	2

clinics or informal advice from family and friends on specific foods to eat and avoid during pregnancy. Women reported learning from health care professionals about the importance of a varied diet as well as the need to eat “body-building” foods, such as meat and beans, for strength, and “blood-boosting” foods, such as fruits and vegetables, to increase hemoglobin level. One woman explained:

Whenever we came to the hospital we were told about nutrition, we were told that any food we eat, we should eat any food that we crave for, but we should eat more of vegetables and fruits, that was what they taught us to eat. We should also incorporate body-building foods like beans, meat, eggs with the other foods. (Age 33, Homa Bay County, Intervention Group)

In contrast, many women were advised by family and friends to avoid certain foods, driven by a concern that the fetus will grow too large in the womb and a cesarean delivery will be required. The foods to be avoided in excess included bananas, avocados, eggs, *mandazi* (doughnuts), and milk. An intervention participant from Kisumu County noted:

My mother-in-law told me to stop eating avocado and eggs, it makes the baby grow big, and that can lead to an operation. (Age 21, Kisumu County, Intervention Group)

Despite nutritional counselling and advice, availability emerged as the key thematic determinant of diet during pregnancy. This availability was in most cases determined by income. As one woman noted, “They told me that when I eat well, I will be healthy, and the child will also be

healthy” (age 31, Homa Bay County, Control Group). When asked about her ability to follow this advice, she noted, “At times I could not get the ones I was advised to eat.” Several control participants echoed the clear disconnect that occurred between nutritional counseling and inability to follow recommendations due to financial barriers. One woman described this challenge:

P: We were taught that we should eat a balanced diet. But you can only manage to eat a balanced diet when you have a good income.

I: Why?

P: That is when you can buy the food you need.

I: What does this balanced diet mean?

P: It mean that you get all kinds of food and you mix them, you get some vegetables you eat, at times you eat *omena* [sardines], and some fruits, so you don’t keep eating only one kind of food. (Age 32, Migori County, Control Group)

Another control participant explained her inability to follow her provider’s recommendations:

During this recent pregnancy, now that I was taught on what to eat, had there been money, I could have eaten as was instructed by the doctor, and I would have eaten better quality of food. But for lack of money I did not eat as well as I would have. (Age 32, Migori County, Control Group)

She further revealed how this lack of income led to feelings of inadequacy:

It makes you think, for instance, now that the doctor said we ought to eat flatbread, but I am taking almost a month without eating it, I must not be doing well!

Perceived benefits on maternal diet

Intervention participants interviewed noted significant differences in their diet during their most recent pregnancy concomitant with their participation in *Shamba Maisha* as compared with prior pregnancies. Women noted improvements in both the quantity and quality of foods consumed and attributed the changes to 3 factors. First, women reported that as a result of planting vegetables, they were able to easily access and consume these nutrient-rich foods. Second, owing to increased income from selling vegetables, they were able to supplement their diet with proteins and other costlier food items. Third, women reported an increased awareness of the importance of vegetables as part of a balanced diet due to the series of agricultural trainings attended. To note, the trainings did not cover nutritional topics, including nutrition during pregnancy, in detail but did discuss the benefit of nutritious foods broadly.

Increased consumption of vegetables.

The most-cited contributor to improved nutrition among intervention participants was an increased consumption of vegetables compared with prior pregnancies, due to the provision of farm inputs and agricultural trainings as part of the *Shamba Maisha* intervention. Whereas many women accessed vegetables by purchasing them from the market during prior pregnancies, after enrolling in *Shamba Maisha* they could harvest vegetables from their farm at home for consumption. One woman explained this difference:

During this pregnancy I loved vegetables and I could now access them easily, but in the past I had to go and look for them, I had to look for them and buy. (Age 34, Kisumu County, Intervention Group)

Because of challenges with mobility during pregnancy, this ease of access to healthy produce made a significant difference in their diet during pregnancy. It also enabled women to redirect money that would have previously been spent purchasing vegetables toward other foodstuffs. One woman explained:

There were a lot of changes during my most recent pregnancy, compared to the past pregnancies. At times, I had very little income during my past pregnancies, to say the truth I had not begun farming, and *Shamba Maisha* made me have the heart to farm as we stay near the lake. When I got pregnant with this child, I had vegetables in my farm, I had... it was easy for me to cook them and even if someone wanted to buy, I could sell them, make money as I eat my vegetables, this made things easier as compared to the past when I had to go and buy my vegetables from the market. Whatever I wanted, be it tomatoes, kales, onions, I had to get money to buy them and at times I did not have the money to buy them. Now I can only buy what cannot be grown on the farm. (Age 33, Homa Bay County, Intervention Group)

Vegetables grown in the garden also acted as a buffer against persistent economic difficulties during pregnancy faced by some participants; even if expensive food items were still hard to come by, nutritious vegetables were readily available on the farm. One woman noted that, “even if I don’t have much to sell, I must get vegetables to eat” (age 39, Migori County, Intervention Group).

Increased income leading to increased variety of foods.

In addition to consuming more vegetables, many intervention participants reported improved diet during pregnancy related to their ability to sell vegetables for income, which could then be directed to purchasing supplemental foods and achieving a balanced diet.

Several women who reported increased income and, in turn, improvements in food security during and after pregnancy partly attributed this to the temporal relation between their pregnancies and harvesting season. Farmers who are able to irrigate and cultivate during the dry season frequently report increased prices for their vegetables as compared with the rainy season when markets are more saturated; the *Shamba Maisha* pump enables participants to cultivate year-round and take advantage of these lucrative markets. One woman explained how her pregnancy coincided with the dry season and therefore her income and nutrition benefited as a result of increased sales:

I have not experienced any difficulty. During this period when pregnant, it was a dry season, but my vegetable farm was doing well. I managed to get excess produce. I stay at [name of town] so with my proximity to the market, I also sell a lot. I therefore did not have any difficulty getting food. (Age 25, Migori County, Intervention Group)

Participants directly equated their increased income with ease of access to food and the health benefits brought about by good nutrition:

For this most recent pregnancy, I can say that I had ease of access to food. This is because I had a source of income unlike before when I did not. I was also stronger physically, I can farm, and I can sell my produce and eat whatever I feel. I found it much

easier, comparatively... *Shamba Maisha* brought for us various types of vegetables, like spinach, osuga [a dark, leafy green], and that means that I can change my diet daily and eat different types of food unlike before. I can also sell some of my produce and buy fish, beef, and beans. (Age 35, Migori County, Intervention Group)

Another participant discussed how purchasing chicken helped her after her most recent delivery, a time when she would otherwise feel especially susceptible to food insecurity:

Shamba Maisha brought impact, when you give birth, you can be weak and what you have close by is what can be of assistance. With *Shamba Maisha*, I was able to sell vegetables and buy chicken. I could now eat the young ones of the chicken I had bought a while back, then I could get my vegetables from the farm, I got assistance with *Shamba Maisha*. I had crops, I could easily get food, I could prepare my chicken, I could get my vegetables, eat and continue with my life. (Age 33, Homa Bay County, Intervention Group)

Several intervention participants discussed how they were empowered by their new income earned through vegetable sales, which allowed them increased financial decision-making power within their households. One woman described how she no longer had to depend on others to make decisions about her diet:

The difference is that with the other pregnancies, I would crave for a certain food to eat, but I was unable to afford it and I had to wait for someone else to give it to me. However, with the last pregnancy, I would eat whatever I wanted to. All I had to do was to instruct my children where to get the money from to go buy whatever I wanted. So there was a difference. (Age 37, Migori County, Intervention Group)

Improved awareness of nutrition.

Finally, women discussed dietary changes as a result of a new appreciation for the nutritional content of vegetables and their importance during pregnancy. Most often, they attributed this knowledge to participation in the *Shamba Maisha* agricultural trainings. One woman described how she understood the importance of growing and eating vegetables because of the trainings:

During the time I was pregnant, I used to come here and be taught by the *Shamba Maisha* team and we were taught on nutrition and how to balance the diet. We were taught that someone on medication and even the expectant people like me then had to have some food in the farm so that it would enable you to balance and change your diet. (Age 32, Migori County, Intervention Group)

Another woman laughed as she summarized her change in attitude toward vegetables as a result of the trainings:

Previously I had not thought that vegetables were important for health, I knew that they were for goats. (Age 34, Homa Bay County, Intervention Group)

Weight gain and maternal-child health

In addition to reporting improvements in the quantity and quality of food consumed during pregnancy, many intervention participants noted that compared with previous pregnancies they gained more

weight during their pregnancy after joining *Shamba Maisha*. Some women were able to quantify their weight gain in kilograms; for instance, 1 woman reported that she weighed 6 kg more at the time of her most recent delivery than at time of delivery during prior pregnancies. Several other women did not report specific numbers but noted that they perceived changes in weight gain. All women who reported increased weight gain attributed the changes to increased consumption of vegetables or, more broadly, improved access to good food. One woman explained her perceived changes in pregnancy weight gain and food security:

I: What about your weight, was there a difference in the weights between the prior and most recent pregnancies?

R: My current weight was more than the prior ones.

I: What do you think was the reason for the change?

R: There was a difference because at times you do not have money, at times you have no way of getting good food, but now I have money and when I crave for food from my shamba, I just go and get it. (Age 29, Homa Bay County, Intervention Group)

Women further described how dietary changes affected their health, drawing parallels between improved nutrition during both the antepartum and postpartum periods, health, energy level, and strength during pregnancy. Some women described these improvements in their health broadly: for instance, 1 participant noted that during her most recent pregnancy, "Because my diet was good, I didn't have any complications" (age 25, Migori County, Intervention Group). Others equated nutrition with increased antepartum strength and energy levels. One intervention participant noted how increased food consumption during her *Shamba Maisha* pregnancy led to increased energy, which in turn helped her during childbirth:

I delivered when I was energetic, I was not so tired, even when I was pushing the baby, I pushed the baby when I was full of energy, but during the previous pregnancies, I ran out of energy as I did not have much to eat. (Age 29, Homa Bay County, Intervention Group)

One woman specifically attributed her increased energy to vegetables, stating, "now I am energetic. Vegetables make you feel energetic" (age 34, Kisumu County, Intervention Group), whereas another intervention participant discussed how she was able to follow her provider's counselling regarding "blood-boosting" foods during her most recent pregnancy and treat her anemia:

P: The tests revealed that I had a low HB count, so I was advised to eat fruits and beans.

I: Who told you this?

P: The doctor.

I: What was your take on this piece of advice?

P: I saw a positive change when I ate what I was told to. Because I used to feel dizzy when pregnant and it turned out my HB count was very low. So they advised I take blood-booster foods and I did that and saw a change. (Age 37, Migori County, Intervention Group)

In addition, several intervention participants noted that due to *Shamba Maisha*, they felt that their infant was stronger and healthier. In these cases, the health benefits were once again attributed to improved

maternal diet. One woman explained the positive effect of the program on her child's weight and health:

The vegetables were of great benefit to me, the baby was able to grow. (Age 34, Homa Bay County, Intervention Group)

Another intervention participant described both her and her infant's improved strength after her most recent pregnancy:

There is definitely a difference [between current and prior pregnancies] because even the child is strong and even me as the mother, I feel strong. (Age 35, Migori County, Intervention Group)

Persistent food security challenges

Some intervention participants reported ongoing food insecurity during pregnancy despite participation in *Shamba Maisha*. Most often, persistent income challenges led to difficulties in obtaining certain food items. These persistent challenges faced by participants were attributed to 2 main factors: reduced ability to work, and therefore, earn income, especially later in pregnancy; and lack of support from family members during pregnancy.

Reduced work.

The majority of pregnant women interviewed in both intervention and control groups reported that their ability to perform work was limited during pregnancy. Most often, they reported working fewer hours on the farm each day than when not pregnant; this reduced duration of work each day typically began in the second or third trimester of pregnancy. Some women reported hospitalizations due to pregnancy complications that prevented them from working for weeks at a time. Those who had multiple sources of income from additional jobs or paid labor on others' farms also reported scaling back hours across all occupations. One intervention participant described her reduction in farm work:

There are various heavy works that one can do when you are just fine. But being the way I am, I cannot do most of the work like I used to do it before I got pregnant. Before I got pregnant, I would work in the farm from morning, even up to noon, before going back home. But right now I cannot work up to that time. Right now, by around 10, I get so tired that I just stop working and go back home. (Age 39, Migori County, Intervention Group)

Some intervention participants reported that the process of acquiring foods to supplement vegetables from the farm also posed a challenge. One participant noted, "At times I was so tired that I could not even go to get the food" (age 41, Migori County, Intervention Group). Others noted that selling was now a challenge; one participant who used to sell produce door-to-door noted that she could no longer comfortably traverse these distances during pregnancy.

Although many intervention participants reported improvements in food security in spite of this reduced workload, others noted that this reduction in hours worked during pregnancy contributed to food insecurity. One woman described the challenge she faced in purchasing certain food items:

At times I did not have money to buy what I did not have, and since I was not able to work as I usually did before I got pregnant, this was a challenge. (Age 33, Homa Bay County, Intervention Group)

Lack of support.

Women who noted that they could not count on financial, social, or farm work support from their significant others or other family members during pregnancy were more likely to report persistent food insecurity. One widowed intervention participant in her third trimester of pregnancy described the difficulty she faced in continuing farm work on her own:

When I was not yet pregnant, I could never fail to have vegetables, I had all types of vegetables in my farm, but now, since I am alone and it is just me who has to take care of the farms, I took too long weeding the maize this season that I had no time to prepare the farms for planting vegetables. I have the seeds even now, but at times when I wake up, my joints are so painful that after I dig for a while especially at the maize plantation, I can't manage to farm the vegetables. (Age 39, Migori County, Intervention Group)

Another intervention participant discussed how her husband does not have a regular job; this lack of income support from her husband coupled with her reduced workload limited her ability to access food:

Sometimes the income was little, currently I am not working, I just stay at home. My husband works but sometimes he does not, so we have challenges at times, at times we miss having food and eat the following day. (Age 21, Kisumu County, Intervention Group)

Discussion

In this qualitative study in western Kenya, we found that pregnant women enrolled in an agriculture and microfinance intervention perceived many benefits on their maternal nutrition and, in turn, maternal health. Improvements in maternal nutrition occurred along several perceived pathways: increased availability and variety of vegetables for consumption, increased income secondary to vegetable sales, and increased nutritional awareness. Laraia et al. (9) proposed 3 unique challenges to achieving food security during pregnancy, including increased nutrient requirements, difficulty obtaining food, and financial strain associated with leaving the workforce. The *Shamba Maisha* intervention addresses these challenges through multiple mechanisms of change: vegetables and supplemental purchased foods help satisfy increased nutrient requirements; increased accessibility of produce in one's *shamba* (farm) alleviates the burden of searching for food; and the agricultural training program engages women in the workforce during pregnancy. Of note, these multiple benefits suggest that this multisectoral agricultural intervention may have more far-reaching benefits than programs that address only 1 of the aforementioned pathways, such as fruit and vegetable prescription programs or nutritional counseling programs. Intervention participants perceived multiple health benefits of improved nutrition including increased strength, increased energy, and increased weight gain. Control participants frequently discussed financial barriers to following nutritional counseling recommendations during pregnancy.

Still, some intervention participants reported significant challenges in maintaining their farming businesses during pregnancy, and future iterations of the intervention designed to improve maternal health should address these concerns. Future agricultural training sessions with pregnant women could emphasize ways to plan for and

mitigate mobility limitations; for instance, trainers could focus on identifying land and markets closer to home and easier-to-use irrigation equipment. Furthermore, additional sources of support for farm labor should be identified for women who do not have robust support systems; women could have the option of directing a portion of their asset loan to hire help on the farm, or women in the same training group could assist each other with farm work.

Literature supports the idea that nutrition-sensitive livelihood interventions that target pregnant women's specific nutritional needs are effective in improving maternal and child nutrition (22–26). In addition, nutrition education and counseling (NEC) interventions have been widely implemented and have been found to improve maternal health outcomes (32, 33). One systematic review found that NEC programs significantly increased gestational weight gain and reduced the risk of anemia in late pregnancy; however, the effect on weight gain was only significant when NEC was coupled with nutrition support, which suggests that counseling programs may be most successful if underlying barriers to adequate nutrition are accounted for (33). This evidence should be used to inform future scale-up of the *Shamba Maisha* livelihood intervention to maximize impact for pregnant and postpartum women. Targeted nutritional counseling would be an important addition to the program, and agricultural trainings could focus on growing vegetables and other items tailored to pregnant women's specific nutritional needs.

There are several important limitations to this study. Although our interviewers were unknown to participants and trained on neutral interviewing and probing techniques, it is possible that intervention participants favorably rated their experiences with the *Shamba Maisha* program owing to social desirability bias or a belief that responses would affect future participation. We attempted to mitigate this by stressing during our informed consent process that participation in the interview would not affect trial participation. Furthermore, information about pregnancies may be subject to recall bias, as women were often comparing recent pregnancies with pregnancies that occurred several years prior. Based on review of transcripts, including an in-depth obstetric history conducted at the beginning of each interview, it was determined that women were able to recall their prior pregnancies with great detail. Still, reported improvements in nutrition and health are qualitative in nature and may not accurately reflect objective outcomes.

When sampling participants, we decided to only interview pregnant women whose pregnancies resulted in a live birth in order to capture a greater extent of detail about the pregnancy. In excluding women whose pregnancies resulted in spontaneous abortions or fetal death, we may have biased our sample to include women who experienced fewer health complications during pregnancy.

Finally, because this was a qualitative study aiming to capture the experiences and perspectives of a purposive sample of women enrolled in the *Shamba Maisha* trial based in Kisumu, Homa Bay, and Migori Counties in western Kenya, our findings may not be generalizable beyond this sample of women.

In conclusion, multisectoral agricultural interventions represent a promising long-term solution to combat food insecurity and ameliorate health among pregnant and postpartum women living with HIV by improving nutrition through increased vegetable production and consumption, improved variety of diet due to increased income, and improved nutritional knowledge. Further studies are necessary to

quantitatively evaluate the impact of these programs on maternal and child health outcomes.

Acknowledgments

We thank Cynthia Onyango, Lydia Okinyi, and Belinda Charles Odhiambo for conducting interviews; Monica Getahun for her guidance on qualitative analysis; A Rain Mocello for her assistance with baseline data; and the *Shamba Maisha* research assistants for recruiting participants. The authors' responsibilities were as follows—AM, CRC, SDW, EAB, EW, PW, RB, and LS: designed the research; AM: conducted the research, wrote the paper, and had primary responsibility for the final content; AM, AD, SDW, and CRC: analyzed the data; and all authors: read and approved the final manuscript.

References

1. Radimer KL, Olson CM, Greene JC, Campbell CC, Habicht JP. Understanding hunger and developing indicators to assess it in women and children. *J Nutr Educ* 1992;24(1 suppl 1):36S–44S.
2. Barrett CB. Measuring food insecurity. *Science* 2010;327(5967):825–8.
3. Weiser SD, Palar K, Hatcher AM, Young SL, Frongillo EA. Food insecurity and health: a conceptual framework. In: Ivers L, editor. *Food insecurity and public health*. Boca Raton (FL): CRC Press; 2015. pp. 23–50.
4. Kenya National Bureau of Statistics, Ministry of Health, National AIDS Control Council, Kenya Medical Research Institute, and National Council for Population and Development. Food security [Internet]. In: Kenya Demographic and Health Survey 2014. Nairobi: Kenya National Bureau of Statistics; 2015. pp. 18–19. [Accessed 2019 Dec 1]. Available from: <http://dhprogram.com/pubs/pdf/fr308/fr308.pdf>.
5. Kenyan Ministry of Health. Kenya HIV estimates: report 2018 [Internet]. Nairobi: National AIDS Control Council; 2018. [Accessed 2019 Dec 1]. Available from: <https://nacc.or.ke/wp-content/uploads/2018/12/HIV-estimates-report-Kenya-20182.pdf>.
6. Nagata JM, Magerenge RO, Young SL, Oguta JO, Weiser SD, Cohen CR. Social determinants, lived experiences, and consequences of household food insecurity among persons living with HIV/AIDS on the shore of Lake Victoria, Kenya. *AIDS Care* 2012;24(6):728–36.
7. Weiser SD, Young SL, Cohen CR, Kushel MB, Tsai AC, Tien PC, Hatcher AM, Frongillo EA, Bangsberg DR. Conceptual framework for understanding the bidirectional links between food insecurity and HIV/AIDS. *Am J Clin Nutr* 2011;94(6):1729S–39S.
8. Ivers LC, Cullen KA. Food insecurity: special considerations for women. *Am J Clin Nutr* 2011;94(6):1740S–4S.
9. Laraia BA, Siega-Riz AM, Gunderson C, Dole N. Psychosocial factors and socioeconomic indicators are associated with household food insecurity among pregnant women. *J Nutr* 2006;136:177–82.
10. Whitaker RC, Phillips SM, Orzol SM. Food insecurity and the risks of depression and anxiety in mothers and behavior problems in their preschool-aged children. *Pediatrics* 2006;118(3):e859–68.
11. Carmichael SL, Yang W, Herring A, Abrams B, Shaw GM. Maternal food insecurity is associated with increased risk of certain birth defects. *J Nutr* 2007;137(9):2087–92.
12. Borders AE, Grobman WA, Amsden LB, Holl JL. Chronic stress and low birth weight neonates in a low-income population of women. *Obstet Gynecol* 2007;109(2 Pt 1):331–8.
13. Koss CA, Natureeba P, Nyafwono D, Plenty A, Mwesigwa J, Nzarubara B, Clark TD, Ruel TD, Achan J, Charlebois ED, et al. Brief report: food insufficiency is associated with lack of sustained viral suppression among HIV-infected pregnant and breastfeeding Ugandan women. *J Acquir Immune Defic Syndr* 2016;71(3):310–4.
14. Young S, Wheeler A, McCoy S, 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(5): 505–15.
15. Rahman M, Abe SK, Rahman S, Kanda M, Narita S, Bilano V, Ota E, Gilmour S, Shibuya K. Maternal anemia and risk of adverse birth and health outcomes in low- and middle-income countries: systematic review and meta-analysis. *Am J Clin Nutr* 2016;103(2):495–504.
 16. Tunkyi K, Moodley J. Anemia and pregnancy outcomes: a longitudinal study. *J Matern Fetal Neonatal Med* 2018;31(19):2594–8.
 17. Brabin BJ, Hakimi M, Pelletier D. An analysis of anemia and pregnancy-related maternal mortality. *J Nutr* 2001;131(2):604S–15S.
 18. Widen EM, Tsai I, Collins SM, Wekesa P, China J, Krumdieck N, Miller JD, Weiser SD, Onono M, Young SL. HIV infection and increased food security are associated with adverse body composition changes among pregnant and lactating Kenyan women. *Eur J Clin Nutr* 2019;73: 474–82.
 19. McCoy SI, Buzdugan R, Mushavi A, Mahomva A, Cowan FM, Padian NS. Food insecurity is a barrier to prevention of mother-to-child HIV transmission services in Zimbabwe: a cross-sectional study. *BMC Public Health* 2015;15:420.
 20. Iroez ND, Mindry D, Kawale P, Chikowi G, Jansen PA, Hoffman RM. A qualitative analysis of the barriers and facilitators to receiving care in a prevention of mother-to-child program in Nkhoma, Malawi. *Afr J Reprod Health* 2013;17(4 Spec No):118–29.
 21. da Silva Lopes K, Ota E, Shakya P, Dagvadorj A, Balogun OO, Peña-Rosas JP, De-Regil LM, Mori R. Effects of nutrition interventions during pregnancy on low birth weight: an overview of systematic reviews. *BMJ Glob Health* 2017;2:e000389.
 22. Ruel MT, Alderman H; Maternal and Child Nutrition Study Group. Nutrition-sensitive interventions and programmes: how can they help to accelerate progress in improving maternal and child nutrition? *Lancet* 2013;382(9891):536–51.
 23. Girard AW, Grant F, Watkinson M, Okuku HS, Wanjala R, Cole C, Levin C, Low J. Promotion of orange-fleshed sweet potato increased vitamin A intakes and reduced the odds of low retinol-binding protein among postpartum Kenyan women. *J Nutr* 2017;147(5):955–63.
 24. Bhutta ZA, Ahmed T, Black RE, Cousens S, Dewey K, Giugliani E, Haider BA, Kirkwood B, Morris SS, Sachdev HP, et al. What works? Interventions for maternal and child undernutrition and survival. *Lancet* 2008;371(9610): 417–40.
 25. Berti PR, Krasevec J, FitzGerald S. A review of the effectiveness of agriculture interventions in improving nutrition outcomes. *Public Health Nutr* 2004;7:599–609.
 26. Girard AW, Self JL, Olude O. The effects of household food production strategies on the health and nutrition outcomes of women and young children: a systematic review. *Paediatr Perinat Epidemiol* 2012;26(Suppl 1):205–22.
 27. Helen Keller International. Homestead food production model contributes to improved household food security, nutrition and female empowerment – experience from scaling-up programs in Asia (Bangladesh, Cambodia, Nepal and Philippines). *Helen Keller International Nutrition Bulletin* 2010;8(1):1–8.
 28. Weiser SD, Bukusi EA, Steinfeld RL, Frongillo EA, Weke E, Dworkin SL, Pusateri K, Shiboski S, Scow K, Butler LM, et al. *Shamba Maisha*: randomized controlled trial of an agricultural and finance intervention to improve HIV health outcomes. *AIDS* 2015;29(14):1889–94.
 29. Tsai AC, Hatcher AM, Bukusi EA, Weke E, Lemus Hufstedler L, Dworkin SL, Kodish S, Cohen CR, Weiser SD. A livelihood intervention to reduce the stigma of HIV in rural Kenya: longitudinal qualitative study. *AIDS Behav* 2017;21(1):248–60.
 30. Weiser SD, Hatcher AM, Hufstedler LL, Weke E, Dworkin SL, Bukusi EA, Burger RL, Kodish S, Grede N, Butler LM, et al. Changes in health and antiretroviral adherence among HIV-infected adults in Kenya: qualitative longitudinal findings from a livelihood intervention. *AIDS Behav* 2017;21(2):415–27.
 31. Zakaras JM, Weiser SD, Hatcher AM, Weke E, Burger RL, Cohen CR, Bukusi EA, Dworkin SL. A qualitative investigation of the impact of a livelihood intervention on gendered power and sexual risk behaviors among HIV-positive adults in rural Kenya. *Arch Sex Behav* 2017;46(4):1121–33.
 32. Nielsen JN, Gittelsohn J, Anliker J, O'Brien K. Interventions to improve diet and weight gain among pregnant adolescents and recommendations for future research. *J Am Diet Assoc* 2006;106:1825–40.
 33. Girard AW, Olude O. Nutrition education and counselling provided during pregnancy: effects on maternal, neonatal, and child health outcomes. *Paediatr Perinat Epidemiol* 2012;26(Suppl 1):191–204.