Consumption of vitamin A by breastfeeding children in rural Kenya

Grace Ettyang, Aggrey Oloo, Wauter van Marken Lichtenbelt, and Wim Saris

Abstract

*Vitamin A deficiency remains a significant health risk in developing countries, affecting infants and children in particular. To counter child malnutrition, mothers are encouraged to breastfeed to ensure that their children receive adequate macro- and micronutrients, including vitamin A. However, this assumes that the mother has sufficient vitamin A intake to provide enough vitamin A to her child. This study investigates maternal and infant intakes of locally available foods of high vitamin A content in a rural agricultural community in Kenya. The study aims to establish the community risk for vitamin A deficiency and to assess whether breast milk is adequate to maintain and build retinol reserves of the breastfed infant. The study assesses 62 mother-child pairs and employs several methods to support its objectives, including the Helen Keller International food-frequency survey, maternal and infant anthropometric measurements, and maternal breast-milk and blood samples to determine breast-milk and serum retinol levels. We found that mothers with marginal (< 0.700 μmol/l) serum retinol and breast-milk deficient (< 1.05 μmol/l) in retinol accounted for 45.2% and 77.4%, of our sample, respectively. A significant (*p < 0.05*) proportion (40.3%) of mothers had breast milk deficient in retinol and marginal levels of serum retinol. The risk of vitamin A deficiency in breastfed infants older than six months was high, because 89.5% of them did not consume foods high in vitamin A content three times weekly. The primary source of vitamin A for infants younger than six months was breast-milk deficient in retinol vitamin A. This study suggests that in this rural community, breastfed infants may not receive appropriate foods with high vitamin A content and that although exclusive breastfeeding is advocated, most breast milk is deficient in retinol, further heightening the risk of vitamin A deficiency.*

Key words: Breast-milk retinol, dark-green leafy vegetables, lactation, serum retinol, vitamin A deficiency

Introduction

Vitamin A deficiency remains a significant public health problem, with an estimated 250 million children at risk worldwide [1]. Lack of data from developing countries limits the ability of governments and policy makers to quantify the magnitude of the problem in women and preschool-age children [2, 3]. In healthy populations, less than 5% have subclinical deficiency, defined as serum retinol < 0.70 μmol/l [4]. There are concerns that a high prevalence of marginal vitamin A status may contribute to the etiology of anemia in women [5, 6]. Hemoglobin response to iron supplementation is suppressed in those found to be deficient in vitamin A [7]. Vitamin A–deficient lactating women have been reported to produce inadequate vitamin A in breast milk to maintain and build body reserves in their rapidly growing infants [4, 8]. The consequences of vitamin A deficiency in preschool-age children include increased severity of some infections [9] and an increased risk of death [10]. In populations with vitamin A deficiency, improvement in vitamin A status has reduced infant mortality rates by about 23% [11].

All infants are born with low stores of vitamin A and depend on vitamin A–rich breast milk to initially accumulate and maintain adequate stores until complementary foods provide significant additional amounts of vitamin A, in keeping with the growing child's increasing requirements. Breast-milk vitamin A concentration is therefore considered a unique indicator of maternal

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and infant vitamin A status [12]. Most retinol in breast milk is in the form of retinyl esters and is related to the fat content of breast milk [4, 7]. Breast-milk proximate composition is relatively stable during the period from one to eight months postpartum, and its vitamin A concentration depends on maternal food intake. When diets are adequate in vitamin A, average breast-milk concentrations for vitamin A range from 1.75 to 2.45 μmol/l [13], and few mothers have breast-milk values under 1.05 μmol/l [4, 13]. In this ideal situation, breast milk is likely to be the major source of dietary vitamin A for the infant, with complementary foods contributing little if any additional amount [4].

Breast milk is not a sensitive indicator for predicting the risk of clinical vitamin A deficiency [4]. In surveys to assess whether vitamin A deficiency is a public health problem, breast-milk data need to be supported by nutritional status and diet-related indicators [4]. In situations in which precise weighing of food intake is not feasible, general eating habits are easier to remember and are therefore more reliably reported than specific quantities of foods [4]. The Helen Keller International food-frequency questionnaire is simple and often used to identify communities at risk for low intake of vitamin A [4, 14]. The method has been validated against serum retinol in Tanzania [15]. The questionnaire allows for incorporation of locally available key plant and animal foods that contain at least 100 retinol equivalents (RE) per 100 g. In view of the new knowledge on the relative efficiency of carotenoids in meeting recommended vitamin A intakes, these REs may be updated in the future [16]. The seven-day food-frequency method captures eating patterns during the course of an entire week.

In vitamin A–deficient women, the immediate benefits of vitamin A supplementation are not in dispute and include improvements in the vitamin A status of the breastfed infant [7, 17] and in maternal iron status [18]. However, supplementation alone does not improve overall community consumption patterns for foods of high vitamin A content. Developing countries with a high prevalence of vitamin A deficiency are faced with the challenge of finding community-based alternatives to single-nutrient supplementation [18]. The documented evidence on links between nutritional status at different stages of the life cycle [2] demands sustained, long-term solutions. A starting point is collection of data critical for identifying rural communities and vulnerable groups at risk for vitamin A deficiency [4]. Kenya has a scarcity of data on the vitamin A status of rural communities. The objectives of this investigation were therefore to determine whether, in a rural Kenyan agricultural community, infants and lactating women were at risk for low intake of vitamin A and whether maternal breast-milk vitamin A concentration was adequate to maintain and build body reserves of the breastfed infants.

Materials and methods

Study area

This cross-sectional, population-based survey was carried out in Kokwet, a rural community located in Nandi District, between December 1998 and January 1999. This is the end of the short rains and the beginning of the dry season that ends around March, when the long rains begin. Approval for the research was obtained from both the Moi Ethical and Research Committee and the Government of Kenya. The nearest health center to Kokwet is 7 km away, and it provides health services to a catchment area with an estimated 5,000 households. Kokwet, with its seven villages, falls within this catchment area. The community engages in extensive large-scale maize farming. Due to the climate and zone, the maize crop planted in March and April is not harvested until October and November. The majority of farmers also keep dairy cattle. For many years, both maize and milk were important sources of income for families. This income has become more volatile because of fluctuations in maize prices and liberalization of the milk market. Traditional dark-green leafy vegetables are grown in every homestead and are abundant during the rainy season. Fruits, though not commonly grown, are seasonal and available at reasonable prices from the weekly local market.

Design and subjects

A register of lactating women in the seven Kokwet villages was compiled with the help of the assistant chief and the village elders. With a relative precision of 50%, we required a minimum sample size of 47 mothers for an anticipated prevalence range of 15% to 45% breast milk ≤ 1.05 μmol/l (≤ 8 μg/g milkfat) [4]. In the sampling strategy we used the seven villages of Kokwet as clusters. The number of lactating women in each cluster was recorded, and a maximum of 12 lactating women were selected from each cluster. A total of 88 lactating women between the ages of 15 and 45 years, with their breastfeeding infants aged between 2 weeks and 15 months, were identified to participate in the survey. The women received a detailed explanation of the objectives and procedures of the study and gave consent to participate in the study.

Anthropometric measurements, breastfeeding patterns, and intake of key plant and animal sources of vitamin A were recorded for all of the women; however, 15 declined to provide blood and breast milk out of fear that the researchers would use the samples to test for HIV. At the time of data collection, the stigma attached to a positive HIV/AIDS status was very high. For this vitamin A intake survey, 11 infants aged < 2 months were excluded. This avoided collection of high-colostrum breast-milk samples and ensured inclusion of the period when supplementary feeding was introduced to the breastfed infant. Sixty-two mother-infant pairs met this criterion and provided complete data. Of this group, 48 had infants aged 6 months and older. None of the women in this study received vitamin A supplementation.

Anthropometry and collection of blood and breast milk

Maternal body weight was measured to the nearest 50 g with an electronic scale (Seca) and height to the nearest 0.1 cm with a height meter. The body-mass index (BMI) was computed as the weight in kilograms divided by the square of the height in meters. Mid-upper-arm circumference (MUAC) measurements were also taken. The infant's body weight was measured to the nearest 50 g with a baby-weighing scale, and height was measured with a height meter. A single investigator recorded all of the measurements. Collections of 5-ml samples of serum were drawn and divided into two tubes, with and without anticoagulant. The samples were stored on ice for transportation to the laboratory. Serum was separated from the blood by centrifugation at approximately 2,000 RPM for 15 minutes at room temperature on arrival, and the samples were stored at –70ºC until they were analyzed for serum retinol. Milk was collected during the day from a single breast that had not been used to feed the infant for at least one hour [12]. The mothers used manual expression to collect 10 to 15 ml of breast milk. The breast milk was stored in foiled glass bottles and transported to the laboratory in a cool box with ice packs. Two aliquots were frozen at –70°C, and analysis was carried out within one year of breast-milk collection.

Maternal and infant intake of key vitamin A foods

A questionnaire was used to collect data on breastfeeding patterns. Through observation, focus group discussions, and a rapid survey of the foods available at the local markets, locally available key plant and animal sources of vitamin A were then identified. Of the maximum 28 food items recommended for inclusion in the Helen Keller International food-frequency questionnaire, 11 were replaced by locally available substitutes. The selected substitute foods contained at least 100 retinol equivalents (RE) of vitamin A per 100 g [14, 15]. The modifications resulted in a food-frequency questionnaire based on locally available key plant and animal sources of vitamin A.*

The survey's primary question asked for the number of times a given food item had been consumed during the previous seven days. The survey sought to determine the frequency of consumption of vitamin A–containing food by the Nandi lactating women and their breastfed infants by using qualitative questions. The numbers of days on which dark-green leafy vegetables, yellow fruits and vegetables, and foods of animal origin were consumed were thus determined. A master table adapted to the locally available key plant and animal sources of vitamin A was used to analyze the data. From this table, the frequency of consumption of each category of food was calculated [4, 14, 15].

The community risk for vitamin A deficiency was based on a group of nutrition- and diet-related indicators suggested by the World Health Organization (WHO) [4]. Based on infant nutritional status [< –2 SD WHO/National Center for Health Statistics (NCHS) growth references], the risk of vitamin A deficiency was present if the prevalence of HAZ < –2 SD (stunting) was ≥ 30% or WHZ < –2 SD (wasting) was ≥ 10%. With regard to food availability, vitamin A deficiency was likely to be present if dark-green leafy vegetables were unavailable in the weekly food market offerings for six or more months per year and foods of high vitamin A content were eaten less than 3 times a week by at least 75% of lactating women [4]. For infants under 6 months of age, the risk of vitamin A deficiency was present if fewer than 50% were receiving breast milk; for those aged 6 months or more, the risk was present if fewer than 75% were receiving foods of high vitamin A content three times weekly in addition to breast milk [4].

Biochemical analysis

Breast-milk and serum retinol levels were assayed by high-performance liquid chromatography. Maternal vitamin A status was based on serum retinol concentration; vitamin A status was considered deficient if the retinol concentration was < 0.35 µmol/l (10 µg/dl) and marginal if it was < 0.70 µmol/l (20 µg/dl) [4]. The criterion for vitamin A–deficient breast milk was based on a cutoff of ≤ 1.05 µmol/l [4, 12] with a population prevalence of <10%, 10% – <25%, and ≥25% used to identify vitamin A deficiency as a mild, moderate, or severe public health problem, respectively [4]. Milkfat was determined by using the field-tested [19] "creamatocrit" micromethod [20]. The percentage of cream or % creamatic was read from the hematocrit capillary tube.

* As a result of recent research findings, there are currently two units quantifying vitamin A activity in foods. Both refer to 1 µg of all-*trans*-retinol (vitamin A). The retinol equivalent (RE) is defined as equivalent to 6 µg of dietary all-*trans*-β-carotene. The more recently recommended retinol activity equivalent (RAE) is defined as equivalent to 12 µg of dietary all-*trans*-β-carotene. Current food-composition research may still use the 6:1 ratio, because that is what is available in food-composition tables.

Data analysis

Means and standard deviations were calculated for serum and breast-milk retinol, and percentages were calculated of the frequency of intake of key plant and animal sources of vitamin A. The significance of differences in proportions was determined by chi-square analysis. Pearson correlation coefficients and stepwise and backward linear regression analyses were used to determine the relationship between supposed factors related to breast-milk and maternal serum retinol. Backward regression is useful in identifying the extent to which a combination of independent variables explain the variation in a given dependent variable of interest. When applied to our data the combined intake of pumpkin, egg, and sweet potato explained 12% of the variation in breast-milk retinol. General independent variables were: infant age, maternal BMI, serum retinol, breast-milk retinol, maternal hemoglobin status, and frequency of maternal intake of key plant and animal sources of vitamin A. Two models were developed where dependent variable inclusion was set at a p value of 0.05 and exclusion at 0.01.

The SPSS software package (Windows version 11.1) was used for all statistical analyses, with a p value < 0.05 considered to indicate statistical significance.

TABLE 1. Nutritional status and biochemical characteristics of 62 lactating Nandi women and their breastfed infants

Measurement	Value (mean ± SD)
Anthropometry (infants)	
Age (yr)	8.2 ± 4.7
Weight (kg)	7.63 ± 1.64
Height (cm)	67.3 ± 6.8
Weight-for-age (Z score)[a]	–0.459 ± 1.273
Height-for-age (Z score)[a]	–0.346 ± 2.883
Weight-for-height (Z score)[a]	0.091± 1.420
Anthropometry (mothers)	
Age (yr)	29 ± 6
Weight (kg)	56.39 ± 9.8
Height (cm)	161 ± 6
MUAC (cm)	25 ± 3
BMI	21.3 ± 3.2
Biochemical measurements (mothers)	
Serum retinol (μmol/l)	0.693 ± 0.264
Breast-milk retinol (μmol/l)	0.902 ± 0.778
% Creamatic	4.0 ± 2.4

MUAC, Mid-upper-arm circumference; BMI, body-mass index [weight (kg)/height (m)^2].
a. Based on WHO/NCHS reference for infant growth.

Results

Infant and maternal nutritional status

Infant wasting (WHZ < –2SD) was not evident in this group of infants. The percentage of children stunted (HAZ < –2 SD), underweight (WAZ < –2 SD), and wasted (HWZ < –2 SD), according to the WHO/NCHS reference, were 8.1%, 12.2%, and 4.1%, respectively (table 1). Mean maternal MUAC and BMI were within normal limits (table 1). The percentage of mothers underweight (BMI < 18.5) were 13.5%. Both mean breast-milk and mean serum retinol were below 1.05 μmol/l (table 1). The percentages of lactating women with serum retinol < 0.700 μmol/l and breast-milk retinol < 1.05 μmol/l were 45.2% and 77.4%, respectively. The percentages of children 2 to 5 months and 6 months and older were 14/62 (22.6%) and 48/62 (77.4%), respectively. None of these children was exclusively breastfed. For children 2 to 5 months old the risk of vitamin A deficiency was based on the percentage with breast-milk intake deficient in retinol. For children 6 months and older, the risk of vitamin A deficiency was based on the percentage with intake of breast milk deficient in retinol and with low-frequency, inappropriate, and inadequate intake of foods high in vitamin A content. The mean (± SD) breast-milk retinol of 0.85 μmol/l (0.73 μmol/l) observed for a lactation period of 2 to 5 months was not significantly different from that of 0.92 μmol/l (0.8μmol/l) observed for a lactation period 6 months or more.

Consumption of foods high in vitamin A content

Although these foods were in season, the percentages of infants 6 months old or older receiving pumpkin, papaya, and yellow sweet potato once weekly were only 18.8%, 2.1%, and 18.8%, respectively (table 2). The percentages of mothers and children not receiving dark-green leafy vegetables, and animal sources of vitamin A were 67.6%, and 39.2%, respectively, for mothers, and 77.1%, and 33.3%, respectively, for infants (table 2). The percentages of mothers and children receiving animal sources of vitamin A fewer than three times weekly were 86.5% and 89.5%, respectively.

Breast-milk and maternal serum retinol concentration

The mean (± SD) serum retinol levels were, respectively, 0.561 (0.197) μmol/l; 95% CI 0.533, 0.59 for breast-milk retinol <1.05 μmol/l and 2.065 (0.905) μmol/l; 95% CI 1.820, 2.307 μmol/l for breast-milk retinol > 1.05 μmol/l (table 3). A significant (p < 0.05) proportion (40.3%) of mothers with breast milk deficient (< 1.05 μmol/l) in retinol had marginal (< 0.700 μmol/l) serum retinol (table 3).

TABLE 2. Frequency of consumption of key plant and animal sources of vitamin A by lactating mothers and breastfed infants aged 6 months or more

Vitamin A source	No. (%) of mothers or infants consuming source		
	0 days/wk	1 day/wk	2 days/wk
Intake by mothers ($n = 73$*)			
Dark-green leafy vegetables	50 (67.6)	6 (8.1)	9 (12.2)
Yellow fruits and vegetables			
Mango	66 (89.2)	5 (6.8)	1 (1.4)
Pumpkin	53 (71.6)	9 (12.2)	8 (10.8)
Papaya	70 (94.6)	3 (4.1)	
Yellow sweet potato	45 (60.8)	19 (25.7)	
All plants[a]	36 (49.3)	16 (21.9)	11 (15.1)
Foods of animal origin			
Egg	36 (48.6)	22 (29.7)	10 (13.5)
Small whole fish	62 (83.8)	6 (8.1)	4 (5.4)
Liver	67 (90.5)	5 (6.8)	
All animal sources[a]	29 (39.2)	26 (35.1)	9 (12.2)
Intake by infants ($n = 48$)			
Dark-green leafy vegetables	37 (77.1)	6 (12.5)	4 (8.3)
Yellow fruits and vegetables			
Mango	38 (79.2)	8 (16.7)	
Pumpkin	33 (68.8)	9 (18.8)	4 (8.3)
Papaya	47 (97.9)	1 (2.1)	
Yellow sweet potato	34 (70.8)	9 (18.8)	2 (4.2)
All plants[a]	36 (49.3)	16 (21.9)	11 (15.1)
Foods of animal origin			
Egg	18 (37.5)	18 (37.5)	11 (22.9)
Small whole fish	44 (91.7)	3 (6.3)	1 (2.1)
Liver	45 (93.5)	3 (6.5)	
Cod liver oil	44 (91.7)	4 (8.3)	
All animal sources[a]	16 (33.3)	17 (35.4)	10 (20.8)

* Sample size is 88; it excludes from the 88 the 15 mothers who did not give blood samples.
a. Combined as suggested when using the HKI food frequency method [14].

TABLE 3. Concentration and distribution of serum retinol in 62 lactating Nandi women with breast-milk retinol less than and more than 1.05 µmol/l

Variable	Breast-milk retinol concentration	
	<1.05 µmol/l	>1.05 µmol/l
Serum retinol (µmol/l)		
Mean ± SD	0.561 ± 0.197	2.065 ± 0.905
95% CI	0.533, 0.59	1.820, 2.307
Frequency distribution [no. (%)]		
< 0.7 µmol/l	25 (40.3)	3 (4.8)*
0.77–1.05 µmol/l	16 (26.8)	10 (16.1)*
> 1.05 µmol/l	7 (11.3)	1 (1.6)

*$p < 0.05$ (chi-square test).

Determinants of retinol in breast-milk and maternal serum

Results of an ANOVA (analysis of variance) based on stepwise regression is shown in table 4. Breast-milk retinol as the dependent variable was related to % creamatic, explaining 23.3% of the total variation in breast-milk retinol. Controlling for breast milk % creamatic left frequency of intake of sweet potatoes as the main predictor but it explained only 7% of the variation in breast-milk retinol. Breast-milk retinol was significantly correlated with % creamatic ($r = 0.5$; $p < 0.01$) and frequency of intake of sweet potatoes ($r = .298$; $p < 0.05$). Serum retinol as the dependent variable was related to dark-green leafy vegetables and breast-milk retinol, explaining 11% of the total variation in maternal serum retinol. Controlling for breast milk % creamatic left dark-green leafy vegetables as the

TABLE 4. Effect of % creamatic on breast-milk retinol and dark-green leafy vegetables and breast-milk retinol on serum retinol levels in 62 lactating Nandi women

Variable	Coefficient (*b*)	SE	β	*p* value	*R*	Adjusted R^2
Breast-milk retinol (μmol/l)					0.496	0.233
Constant	0.264		0.155	0.001		
% Creamatic	0.146	0.033	0.496	0.000		
Serum retinol (μmol/l)					0.377	0.111
Constant	0.564		0.058	0.001		
Dark-green leafy vegetables	0.007	0.024	0.313	0.015		
Breast-milk retinol	0.103	0.050	0.259	0.043		

only predictor, explaining 6% of the variation in serum retinol. Serum retinol was significantly correlated with the frequency of intake of dark-green leafy vegetables (r = .287; $p < 0.05$).

Discussion

The prevalence (45.2%) of marginal (< 0.7 μmol/l) serum retinol observed in the Nandi lactating women is higher than the less than 5% recommended for healthy populations [4] but similar to the 40% prevalence observed in lactating women in rural Zimbabwe [21]. With a mean BMI within acceptable limits, a significantly high proportion (40.3%; $p < 0.05$) of mothers had marginal serum retinol levels and breast milk deficient in retinol. In an earlier study done to investigate their vitamin A status, iron stores, and body composition, a close relationship was found between serum retinol, hemoglobin status, and serum ferritin [22]. In a similar study that investigated micronutrient deficiencies in Indonesian lactating women, it was observed that vitamin A deficiency led to an increased risk of anemia and iron deficiency [6].

The percentages of lactating women and breastfed infants (6 months old or older) with no consumption of animal sources of vitamin A were 39.2% and 33.3%, respectively. Despite an average lactation period of eight months, 89.5% of the breastfed infants received foods of animal origin with high vitamin A content fewer than three times weekly. Through focus group discussions, the investigators learned that breastfed Nandi infants were introduced to diluted cow's milk within the first month of life. By the age of 2 months the infants were no longer exclusively breastfed. Complementary feeding with nonmilk foods such as ripe bananas, avocado, and thin millet porridge was started from the age of two months. Unless a woman became pregnant again, breastfeeding usually continued until the child was about 18 months old. The initial pattern of breastfeeding on demand begins to be replaced by supplementary feeding made up of maize or millet porridge. As shown in this study intake of fruits and soft vegetables is likely to be low.

During the survey period, the yellow fruits and vegetables available in the market were papaya and mango, while pumpkin and sweet potato were available in home gardens. Appropriate and adequate complementary foods introduced from the age of 6 months protect breastfed infants from vitamin A deficiency [23,24]. The percentages of infants 6 months old or older receiving papaya and mango at least once a week were 2.1% and 16.7%, respectively. Animal sources of vitamin A were consumed three times a week by 10.4% of the infants.

Although they were available in the local market at reasonable prices, the least-used foods for infant supplementary feeding were papaya, small whole fish, and liver. Cod liver oil, a good source of vitamin A, was consumed at least once weekly by only 8% of the infants. Most mothers knew about cod liver oil but were unable to afford it for their infants. The risk of vitamin A deficiency in breastfed infants 6 months old or older was high, because 89.5% did not receive foods high in vitamin A three times weekly [4]. For infants less than 6 months old, the main dietary source of vitamin A was breast milk deficient in retinol. For this age group, vitamin A requirements can only be met if the infants receive breast milk with retinol levels above 1.05 μmol/l [4, 12].

The vitamin A content of breast milk is closely related to maternal vitamin A status and dietary intake of foods with high vitamin A content [25]. When lactating women have low serum retinol, breast-milk retinol tends to be low [4, 8]. This in turn diminishes the value of breast milk as a key source of dietary vitamin A for the breastfed infant. In the Nandi community, the observed high (40.3%) prevalence of marginal serum retinol and breast milk deficient in retinol may have been due to the fact that none of the women had received any vitamin A supplementation and their intake of foods with high vitamin A content was low. This left a majority (77.4%) of the breastfed infants 6 months old or older receiving breast milk with an inadequate retinol content (< 1.05 μmol/l) to maintain and build their liver stores [4, 12]. The prevalence of stunting in these breastfed infants was 12.2%. At the community level it has been suggested that when the prevalence of breast-milk retinol of less than 1.05 μmol/l is greater than or equal to 25% and the level of stunting is greater than or equal to 30% in children under five years of age, then vitamin A deficiency is a potential problem of public health significance [4, 26]. Nandi infants may not be severely stunted, but nearly a quarter of them experience growth faltering at an early age.

In addition to receiving breast milk deficient in retinol, infants 6 months old or older (65.8%; $n = 48/73$) did not frequently receive appropriate supplementary plant and animal sources of vitamin A. A study investigating infant-feeding practices in Kenya, Mexico, and Malaysia reported that though Kenyan mothers continued to breastfeed for up to 12 months, early supplementation of their breastfed infants with milk and/or other foods was a common practice [27]. In our study population, all infants were breastfed on demand. Breast-milk retinol concentration was found to be low regardless of the duration of lactation. On the other hand, a study investigating factors influencing vitamin A status of lactating Bangladeshi women observed that women with a lactation period of at least six months had significantly lower serum vitamin A levels than women with a lactation period of less than six months. Duration of lactation had an important influence on the vitamin A status of the women [28].

In our study population, % creamatic was identified as a predictor of breast-milk retinol, but when % creamatic was controlled for, intake of sweet potatoes became the main predictor. In turn, dark-green leafy vegetables and breast-milk retinol were the main predictors of serum retinol. Sweet potatoes are a popular snack food and are generally available throughout the year. All homesteads plant dark-green leafy vegetables that are abundant only during the rainy season. A study investigating vitamin A deficiency in rural lactating Zimbabwe women also found dark-green leafy vegetables to be the main source of vitamin A. Retinol-containing foods and yellow fruits and vegetables were rarely consumed. In these women, vitamin A and iron deficiencies were identified as problems of public health significance [21]. Similarly, in lactating Bangladeshi women, intake of vitamin A was identified as a predictor of breast-milk retinol [28].

We did not obtain data on the prevalence of clinical vitamin A deficiency in the breastfed infants. The mothers were not willing to let us draw blood from their infants, and accurate assessment of infant morbidity was not possible. The theoretical cutoff of breast-milk retinol < 1.05 µmol/l has not been confirmed locally but is based on observations made in a population of mothers in central Java, Indonesia. To carry out a three-day precise weighing dietary assessment with biochemical analyses of serum and breast milk posed important financial, logistical, and technical constraints. This limited our sample size to 88 lactating mother-infant pairs. We found the Helen Keller International food-frequency method simple and fast to use. The data collected, though not quantitative, proved to be useful in assessing community risk for low intake of vitamin A–rich foods.

In summary, despite adequate local availability, mothers and children did not frequently receive foods high in vitamin A content. This low intake requires nutritional improvement, as is supported by the biochemical findings among this group of lactating Nandi women. With the apparently low serum retinol during a period of abundance of foods high in vitamin A content, the Nandi women studied may not be able to maintain an optimal vitamin A status during lactation. This may diminish the importance of breast milk as a dietary source of vitamin A for the breastfed infant. This study suggests that increasing vitamin A intake in women of childbearing age may be adequate to ensure that young children receive sufficient amounts of vitamin A. For this study, the low intake of foods high in vitamin A, combined with the high prevalence of marginal serum retinol and breast milk deficient in retinol, identifies vitamin A deficiency as a problem of public health significance for the Nandi community.

Recommendations

Baseline data for monitoring change in vitamin A status over time have been provided, and a modified food-frequency questionnaire that will prove useful in monitoring the impact of community-based vitamin A deficiency interventions has been developed. As a determinant of breast-milk retinol, the % creamatic method is recommended as a simple and easy technique for assessing improvements in breast-milk vitamin A. We recommend that intervention strategies involve a mix of measures that will result in improved vitamin A status. For a long-term permanent solution to the problem, we recommend food-based approaches. To increase the dietary intake of vitamin A–containing foods by vulnerable groups, nutrition and social marketing interventions should be considered.

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Stability of salt double-fortified with ferrous fumarate and potassium iodate or iodide under storage and distribution conditions in Kenya

Toks Oshinowo, Levente Diosady, Rizwan Yusufali, and Louis Laleye

Abstract

The stability of table salt double-fortified with iron as ferrous fumarate, and with iodine as potassium iodide or potassium iodate, has been investigated under actual field conditions of storage and distribution in the coastal and highland regions of Kenya. Seven 200-g sample packets of double-fortified salt in sealed polyethylene bags and a similar packet containing a datalogger for monitoring temperature and humidity were packaged with 21 sample bags of salt from another study into a bundle, which then entered the distribution network from a salt manufacturer's facility to the consumer. Iodine retention values of up to 90% or more were obtained during the three-month study. Double-fortified salt was prepared using ferrous fumarate microencapsulated with a combination of binders and coloring agents and coated with soy stearine, in combination with either iodated salt or salt iodized with potassium iodide microencapsulated with dextrin and coated with soy stearine. Most of the ferrous iron was retained, with less than 17% being oxidized to the ferric state. The polyethylene film overwrap of salt packs in the bundles provided significant protection from ambient humidity. Salt double-fortified with iodine and microencapsulated iron ferrous fumarate premix was generally quite stable, because both iodine and ferrous iron were protected during distribution and retail in typical tropical conditions in Kenya's highlands and humid lowlands.

Key words: Salt, micronutrients, fortification, iodine, iron, datalogger, temperature, humidity, storage, distribution, Kenya

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Introduction

Iodine-deficiency disorders and iron-deficiency anemia are preventable ailments that afflict more than 2 billion people globally, with serious consequences for women and young children and for the economic and social development of entire populations [1]. Iron-deficiency anemia can lead to increased maternal mortality, compromised development of motor skills and learning capacity, and reduced immunity to diseases. A recent national anemia and micronutrient survey in Kenya [2] has shown that nutritional iron-deficiency anemia is a major public health problem affecting some 25% of the population. Iodine-deficiency disorders include a wide spectrum of mental and intellectual effects [3]. Assessments of iodine-deficiency disorders in Kenya reported in 1994 showed prevalence in more than 16% of the population [2].

Deficiencies of iodine or iron can be inexpensively eliminated, prevented, or reduced by increasing dietary intake of these micronutrients by food fortification, which is an important component of the strategy for combating micronutrient malnutrition [4]. It is, however, critical that the vehicle for the fortification be available to the entire population deficient in the micronutrient, and it must be able to be consumed at a constant rate irrespective of social and economic status. Salt is an attractive vehicle for the provision of micronutrients, in view of its almost universal and uniform regional consumption [5, 6]. Encouraged by the progress made globally with salt iodization during the past decade, we have been examining the feasibility of fortifying salt with both iron and iodine. The physical and social infrastructure developed for salt-iodization should facilitate putting in place a cost-efficient method of delivering adequate levels of iodine and iron through double-fortified salt.

The major technical challenge for salt double-fortification lies in developing a formulation in which both iodine and iron are stable and bioavailable. Our food engineering program at the University of Toronto has a major research program, funded by the Micronutrient

Initiative (MI), for the development of technology for salt double-fortification with iodine and iron [7]. In order to verify the validity of our laboratory models for environmental exposure of salt, MI, UNICEF, and our research group arranged to monitor the temperature and humidity experienced by a typical package of household salt in Kenya, and to test the stability of a number of double-fortified salt formulations under actual field conditions. The goal of the work is to confirm the stability of ferrous iron and the retention of iodine during field distribution. This paper reports on the findings of this study of storage and distribution conditions encountered by double-fortified salts, with ferrous fumarate as the source of iron, and potassium iodide or potassium iodate as the source of iodine, as it travels from the facilities of the salt producer to the consumer. The investigation was carried out in two climatic zones of Kenya: the coastal zone consisting of Mombasa and the surrounding regions, and the highland zone of Nairobi and the surrounding region.

Experimental methods

Formulations

All formulations of double-fortified salt investigated contained iodine at the 100 ppm (parts per million) level and iron at the 1,000 ppm level. Iodine was introduced either through commercial iodization or by adding an iodine premix to noniodized salt. The iodine premix was produced by a process of granulation followed by microencapsulation [8] developed in our laboratory. Potassium iodide crystals were first granulated with dextrin as the binding agent. The resulting particles were then coated with a hot, molten soy stearine. Iodated salt and noniodated salt were produced by Mombasa Salt Works, Mombasa, Kenya.

Several iron premixes used in the formulations were produced using the agglomeration and microencapsulation processes developed by the University of Toronto food engineering laboratory. Previous investigations reported in the literature have identified ferrous fumarate as an excellent source of bioavailable iron. It has been shown to be stable, bland tasting, and cost effective [7, 9].

The ferrous fumarate was granulated with various binding, color-stabilizing, and color-masking agents, as listed in table 1. The coating material for encapsulation was fully hydrogenated soy stearine containing titanium oxide (TiO_2) to mask the reddish-brown color of ferrous fumarate.

Sample preparation

Seven formulations of double-fortified salts were prepared by blending the different iron premixes with either iodated salt or iodine (KI) premix and pure salt. The control was commercially iodated salt. These formulations are described in table 2.

Salt in Kenya is typically sold in 200-g packets, usually distributed in bundles of 30 wrapped with a polyethylene film. Each of the seven formulations was prepared as a 200-g sample of double-fortified salt and sealed in a typical commercial polyethylene bag. Each packet was labeled with a random serial number. The seven sample packets and a control packet of commercially prepared iodized salt were packaged together with 21 sample bags from another study into a bundle along with a packet containing a datalogger to make up a typical commercial bundle containing 30 salt packets. A total of six bundles (labeled A–F) were prepared.

Two bundles were sent to each of two distribution zones, but in each zone only one bundle contained a datalogger, which recorded temperature and humidity every 30 minutes. Bundles E and F were each prepared with a datalogger. Bundle E was stored at room conditions in our laboratory at the University of Toronto. Bundle F was stored in our environmental chamber with conditions preset to a temperature of 40ºC and a relative humidity of approximately 100%. The datalogger in each bundle was surrounded with Styrofoam packing material to facilitate air circulation and to absorb shocks during shipping.

Bundles A to D were dispatched by air freight to the UNICEF Kenya Country Office in Gigiri, with A and B designated for the coastal zone and C and D for the highland zone. The bundles were subsequently dispatched to the salt producers, Krystalline Salt in Nairobi and Mombasa Salt Works in Mombasa, for inclusion in their normal distribution networks. The objective was to simulate, as closely as possible, the

TABLE 1. Materials used in making iron premixes

	Granulation		Encapsulation	
Iron source	Material	Function	Material	Function
Ferrous fumarate	Methocel (HPMC)[a] TiO_2 SHMP[b]	Binder Color-masking Color stability	Soy stearine TiO_2	Coating Color-masking

a. Methocel is the trade name for HPMC (hydroxypropylmethylcellulose).
b. SHMP, Sodium hexametaphosphate.

conditions encountered by typical salt during normal distribution. It was therefore essential that the bundles were not expedited or specially handled while in the distribution circuit. The circuit typically continued from the salt producer's factory to the producer's distribution warehouse to the wholesaler's store. From here, the salt then passed on to the retailer's store and subsequently to a preselected consumer who kept it for about two weeks without opening the bundle. The bundle was then picked up and sent to the salt producer's office. then to UNICEF Kenya, and finally back to our laboratory in Toronto. A progress log was kept for each bundle to indicate the time and date that it arrived at and left particular locations in the circuit. Data collection in this investigation was carried out for three months beginning at the time the samples entered the distribution network in Kenya. The programmed dataloggers were activated in Toronto on March 25, 2002, before being sent by air freight to Kenya. At the end of the data-collection period, the four bundles of double-fortified salts, along with the progress log sheets, were boxed and sent by air back to the University of Toronto. Once in the laboratory, the fortified samples were closely examined for color changes, caking, and any other marked physical changes. The samples were then analyzed for their iodine and iron content.

Recording of temperature and humidity data

The temperature and relative humidity data were automatically recorded by a datalogger, Model RHTEMP 101, manufactured by ERTCO, West Patterson, NJ, USA. The datalogger is a miniature battery-powered, stand-alone temperature and humidity recorder, capable of simultaneously measuring and recording up to 10,920 measurements of temperature and humidity in real-time operation with a programmed start time. It operates in a temperature range of –40ºC to +80ºC, with a temperature resolution of 0.1ºC; and a relative humidity range of 0% to 99%, with humidity accuracy and resolution of 3% and 0.5% relative humidity, respectively. Data were recorded at 30-minute intervals.

Analytical methods

Determination of iodine

Iodine in KI. The iodine content of the samples prepared with potassium iodide (KI) containing premix was measured by epithermal neutron activation analysis (ENAA) with the assistance of Professor Ronald Hancock at the Royal Military College, Kingston, Ontario, Canada. In this method, described generally by Heydorn [10], 1- to 2-g samples of salt were weighed into polyethylene vials. These samples were then shielded in a cadmium shell and irradiated at 1.0 kW for three minutes with a neutron flux of 5.0×10^{11} $cm^{-2}s^{-1}$. The cadmium shielding was 0.7 mm thick and was used

TABLE 2. Description of double-fortified salt samples

Formulation no.	Type of iron premix	Type of iodine premix	Type of salt
1	Control: iodated salt (KIO_3) (MSW)		Iodated Salt
2	Ferrous fumarate granulated with TiO_2 and HPMC sprayed SHMP and overcoated with soy stearine [UT]	KI granulated with dextrin and coated with soy stearine	Blank salt [MSW]
3	Ferrous fumarate granulated with Opadry F, talc, and TiO_2 and coated with soy stearine		Iodated salt
4	Ferrous fumarate granulated with Opadry F and coated with a first layer of soy stearine and TiO_2 and overcoated with soy stearine		Iodated salt
5	Ferrous fumarate granulated with TiO_2 and HPMC and coated with soy stearine		Iodated salt
6	Ferrous fumarate granulated with Opadry F, TiO_2, and talc and coated with soy stearine	KI granulated with dextrin and coated with soy stearine	Blank salt
7	Ferrous fumarate granulated with Opadry F and coated with a first layer of soy stearine and TiO_2 and overcoated with soy stearine	KI granulated with dextrin and coated with soy stearine	Blank salt
8	Ferrous fumarate granulated with TiO_2 and HPMC and coated with soy stearine	KI granulated with dextrin and coated with soy stearine	Blank salt

MSW, Mombasa Salt Works; HPMC, hydroxypropylmethylcellulose; SHMP, sodium hexametaphosphate; UT, University of Toronto.

to reduce interferences due to the high proportion of chlorine and sodium present in the samples. Following irradiation, the samples were allowed to rest for six minutes, and then gamma emissions at 44.3 keV were measured with a hyperpure germanium-based gamma ray spectrometer. The iodine concentrations within the samples were calculated based on a calibration obtained using a series of iodine standards covering a range of 0 to 1,000 ppm. The relative standard deviation of the analysis was determined to be 5%.

Iodine in KIO_3. The iodine content of samples prepared with potassium iodate (KIO_3) was measured by a titrimetric method, which is a modified form of the official AOAC method [11] and has been successfully used by previous workers [12]. A solution of 5 g of salt sample in 100 ml of deionized water was titrated with sodium thiosulfate of known concentration (µg I^{+5}/ml $Na_2S_2O_3$). A pinch of potassium iodide crystals and a few drops of hydrochloric or sulfuric acid were added to the solution. The liberated iodine was titrated with the thiosulfate solution until the solution turned pale yellow. Freshly prepared starch solution used as the indicator was added, and the solution turned purple. Titration was then continued until the solution changed from purple to colorless at the endpoint. The concentration of iodine in the sample was calculated from the product of the concentration and volume of sodium thiosulfate consumed per gram of sample.

Determination of iron

The iron content of the double-fortified salt samples was determined by the spectrophotometric method developed by Harvey et al. [13]. In using this method, 5 g of salt sample was dissolved in 50 ml of distilled water slightly acidified with 2 ml of concentrated sulfuric acid to digest the iron compounds in the sample. More distilled water was then added to bring up the solution volume to 100 ml. To 5 ml of this solution, 10 ml of 0.3% 1,10 phenanthroline and 5 ml of buffer solution of 0.2 M potassium biphthalate were added in order to promote the formation of complexes of ferrous and ferric iron with phenanthroline. The solution was topped up to 25 ml with distilled water. The absorbances of the resulting solution were then measured at 396 and 512 µm using an ultraviolet (UV)-visible spectrophotometer. The concentrations of ferrous and ferric iron in the sample were calculated based on a calibration obtained using a series of ferrous and ferric iron standards. The total iron concentration in the sample was calculated from the absorbance at 396 µm, while that for ferrous iron was calculated essentially from the absorbance at 512 µm, because there was very little absorption by the ferric iron complex at this wavelength. Ferric iron concentration was subsequently obtained by the difference between the total iron and the ferrous iron concentrations.

Results

Distribution networks

Four bundles of samples (A–D) were dispatched from Toronto on March 25, 2002, with the dataloggers activated, and were received at UNICEF Kenya on March 28. Bundles A and B were immediately sent to the Mombasa Salt Works plant in Mombasa, where they entered and remained in the distribution network for the coastal zone from April 1 to July 7. Bundles C and D were sent to the Nairobi office of Krystalline Salt and then to the manufacturing plant in Marereni, where they eventually entered the Nairobi distribution network beginning on April 13 and continuing through July 11.

Entries in the logsheets showed that the bundles actually went through the typical network of storage and distribution from the salt producer's facilities to the wholesaler's warehouse to the retailer's store before getting to the consumer's home. At the end of the study, the bundles were sent to the UNICEF Kenya Central Office and shipped back to the University of Toronto. Bundles A and B were received in Toronto on July 10, and bundles C and D were received in Toronto on July 15, 2002.

Temperature and relative humidity

Mombasa

Temperature and relative humidity variations in the Mombasa distribution network as recorded by the datalogger are shown in figure 1. The data have been summarized in table 3. The minimum and maximum temperatures during the period of investigation were 17.9° and 37.2°C, respectively, with an average of 27.3°C. There was a wide fluctuation of about 14°C in the second half of April. This period coincided with the movement of the samples from the retailer's store

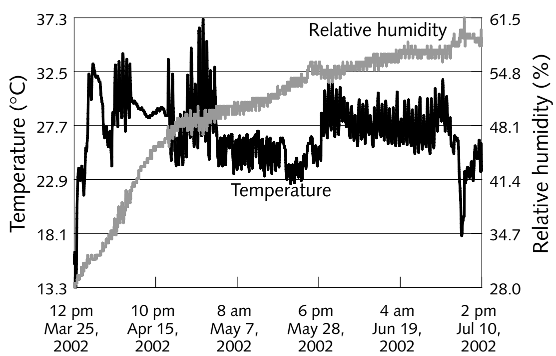

FIG. 1. Datalogger measurements of temperature and humidity of double-fortified salt in the Coastal Zone (Mombasa), Kenya

TABLE 3. Summary of environmental conditions during the study period

Measurement	Mombasa	Nairobi	Room conditions	Environmental chamber
Minimum temperature (°C)	17.9	19.4	18.1	38.2
Maximum temperature (°C)	37.2	30.6	28.0	42.9
Mean temperature (°C)	27.3	25.1	23.7	39.6
Standard deviation of the mean temperature (°C)	2.5	3.2	4.2	0.74
Minimum RH (%)	32.0	33.5	23.5	83.0
Maximum RH (%)	61.5	49.5	38.5	91.0
Mean RH (%)	51.2	46.3	28.9	87.5
Standard deviation of the mean RH (%)	6.5	3.0	4.2	1.4

RH, Relative humidity

into the consumer's house. It is interesting, because unexpected, that lower temperatures were recorded after the samples left the consumer's home for storage at Mombasa Salt Works.

The relative humidity experienced by the packets in the bundles steadily increased from about 32%, when the samples entered the network, to a maximum of 61.5%, attained at the end of the study. The shape of the humidity-time curve indicates that moisture penetrates the salt packages slowly, until equilibrium is established between the salt and the surroundings. About 8 weeks were required for equilibration.

The humidity in the coastal region was expected to be high, and the expectation was confirmed by an equilibrium relative humidity level above 60%. Based on climatic records, the actual humidity in the ambient air was probably higher, in the 70% to 85% range. It is clear from the data that the wrapping protected the salt packages from moisture penetration from the humid surrounding air.

Nairobi

The variations in temperature and relative humidity in the highland (Nairobi) network are shown in figure 2. These variations highlight an important aspect of the coastal zone in the salt industry of Kenya: almost all the distribution networks originate in the coastal region where the salt producers are located. Consequently, placing the salt samples into the Nairobi distribution network required that the samples first travel to Marereni near the coast, where the Krystalline Salt Company has its plant. Thus, the plots in figure 2 consist of two sections. The first section, up to the first week of May, represents the period when the samples were in the humid Mombasa zone, whereas the second section, from May to the end of the investigation, represents the period when the samples were in the drier Nairobi region. The overall average temperature was about 25°C. The minimum and maximum temperatures were 19.4° and 30°C. The temperature in the second section was on average about 4° to 5°C cooler than in the first section.

The rise in the relative humidity and time profile in figure 2 is similar to that in figure 1, with approximately the same equilibration period of eight weeks. However, once in the Nairobi network, the samples experienced a lower relative humidity of about 48% (fig. 2). The minimum and maximum relative humidity for the entire period of investigation were 28% and 50.5%, and are shown in table 3.

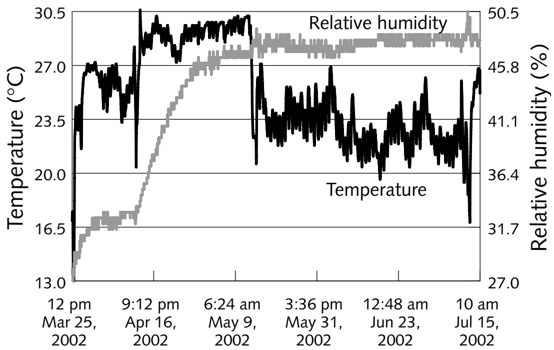

FIG. 2. Datalogger measurements of temperature and humidity of double-fortified salt in the Highland Zone (Nairobi), Kenya

Room conditions and the environmental test chamber

The storage room conditions of the samples in our laboratory are shown in figure 3 and summarized in table 3. The conditions were fairly steady, with a mean temperature of 23.7°C. The relative humidity ranged from a minimum of 23.5% to a maximum of 38.5%, with an average of 28.9%. The conditions in the environmental chamber were kept constant, with a mean temperature of 39.6°C and a relative humidity of 87.5%.

Relative humidity and temperature data for the Mombasa and Nairobi distribution networks, the laboratory room, and the environmental chamber have been plotted for comparison and are shown in figures 3 and 4, respectively. Figure 3 shows that the humidity of the laboratory was always lower than the humidity in the distribution networks. Figure 4 also shows that the laboratory temperatures were always lower than the temperature in the Mombasa network. More impor-

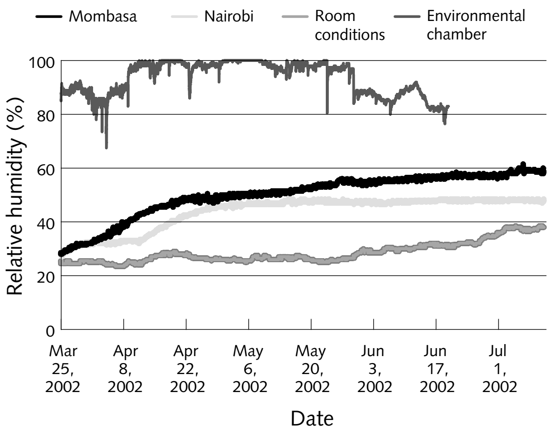

FIG. 3. Comparison of the various levels of relative humidity

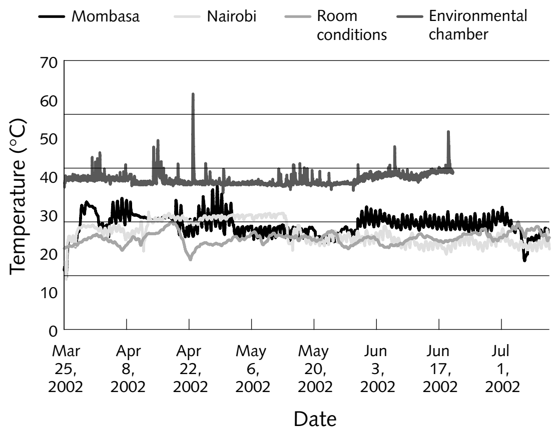

FIG. 4. Comparison of the various temperatures

tant, the two figures show that the conditions of 40°C temperature and about 90% relative humidity in the environmental chamber were always higher than those obtained in the networks. The conditions in the laboratory and the environmental chamber represented valid lower and upper levels of temperature and humidity expected and experienced in the field.

Discussion

Iron stability

The iron added to the salt was in the ferrous state. Ferrous iron can be oxidized to the less bioavailable ferric form by oxygen, potassium iodate, and salt impurities. The stability of ferrous iron in the double-fortified salts is shown in table 4. As expected on the basis of earlier laboratory tests, the ferrous iron concentration was not significantly reduced while in the distribution networks. Ferrous iron retention values were generally greater than 83% for both the Mombasa and Nairobi zones, in all formulations prepared with iodated salt or with microencapsulated potassium iodide premix.

Iodine stability

Iodine stability is critical for the success of salt double-fortification. Many of the earlier attempts to produce double-fortified salts were unsuccessful in protecting iodine from loss through sublimation. The iodine stability of most formulations was satisfactory, as shown in table 4. The commercially iodated salt retained more than 96% of its iodine after going through the distribution networks. Formulations with ferrous fumarate premix and iodated salt or potassium iodide premix generally exhibited good iodine stability in both distribution networks, with the exception of formulation 4. The data confirmed that microencapsulation of iron is effective in preventing the loss of iodine from refined double-fortified salt stored and distributed under tropical conditions.

TABLE 4. Retention of micronutrients in double-fortified salts after three months in the distribution network

Formulation no.[a]	Iodine retention (%)				Ferrous iron retention (%)			
	Mombasa (average of A and B)	Nairobi (average of C and D)	UT lab (E)	UT environmental chamber (F)	Mombasa (average of A and B)	Nairobi (average of C and D)	UT lab (E)	UT environmental chamber (F)
Control	99	96	95	96				
2	92	87	58	68	90	86	90	85
3	51	71	79	79	85	83	91	85
4	71	28	100	100	83	91	98	91
5	67	78	87	98	90	84	88	87
6	92	77	33	39	91	83	96	89
7	91	75	67	85	95	93	100	91
8	91	69	32	100	91	84	92	85

UT, University of Toronto
a. Refer to table 2 for descriptions of the formulations.

Color stability

All the samples, on their arrival back in Toronto from the distribution networks in Kenya, were closely examined for visible physical changes in texture and color. No caking was observed in any of the field samples, but there was some caking in some of the samples stored at high temperature and humidity in the environmental chamber.

Double-fortified salts prepared with various formulations of ferrous fumarate premix were color stable in the Mombasa and Nairobi networks. These salts were also stable in storage at room conditions in our laboratory and in the severe climate of the environmental test chamber. The only exception was formulation 2, which developed pink stains in the Mombasa network and purple spots in the environmental chamber. This was most likely due to the release of iodine by the leakage of iron from the microcapsule, mediated by elevated temperature and humidity. A blue or purple color is expected if free iodine is produced by a redox reaction with impurities or iron in the presence of starch from the encapsulating system. A reddish, brown, or yellow color can be produced by iron oxidation from ferrous to ferric fumarate.

Conclusions

The results confirmed the stability of double-fortified salts prepared with ferrous fumarate under typical environmental conditions of the salt distribution networks in Kenya. The microencapsulated double-fortified salt formulations retained most of the ferrous iron and iodine during the three-month study period.

Although the actual temperatures and the various levels of relative humidity experienced by the data-loggers were somewhat lower than the values in our environmental chambers, the results indicate that tests in our ambient laboratory conditions and in our environmental chamber set at 40°C with a relative humidity of approximately 100% provide realistic lower and upper levels for modeling stability under tropical field conditions.

The polyethylene film bundle wrapping of the salt packs provides significant protection from ambient humidity, as exposure of some eight weeks elapsed before the relative humidity in the packs equilibrated with the ambient humidity levels.

The field tests clearly demonstrated that salt double-fortified with iodine and microencapsulated iron can protect both iodine and the ferrous iron during distribution and retail in typical tropical conditions in Kenya's highlands and humid lowlands. This paves the way for large-scale effectiveness and efficacy testing of double-fortified salt.

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Rethinking food aid to fight AIDS

Suneetha Kadiyala and Stuart Gillespie

Abstract

While the realization that AIDS is far more than a health problem has dawned only recently, many development organizations have yet to undertake thorough analyses of what this means for what they do, and how they do it. Even fewer have actually changed their policies and procedures to adjust to these new realities. We know that food and nutrition are fundamentally intertwined with HIV transmission and the impacts of AIDS. Food and nutrition security is fundamentally relevant to all four of the conventional pillars of HIV/AIDS response—prevention, care, treatment, and mitigation—and food aid can be an important weapon in the arsenal. This paper, based on a detailed review of the relevant literature and the findings of a mission to eastern and southern Africa, highlights the implications of the HIV/AIDS pandemic for food aid strategy and programming. By viewing food aid programs through an "HIV/AIDS lens" and in the context of a livelihoods approach, the authors argue that organizations can effectively design interventions that reduce both susceptibility to HIV and vulnerability to AIDS impacts. Though there is little empirical evidence regarding the effectiveness of food aid in responding to HIV/AIDS, the authors argue that this should not constrain action. Using past experience as a guide, organizations can learn by doing, documenting, and continually reassessing their programs using the evolving lens, so as to ensure maximal relevance and impact.

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Key words: Africa, food aid, HIV/AIDS, HIV/AIDS lens

Introduction

It has taken two decades for HIV/AIDS to be recognized as a serious threat to development and human security by governments and by humanitarian and development agencies. Given the socioeconomic, cultural, and political underpinnings of the pandemic, there is an urgent need for all sectors to reassess their roles, both actual and potential, in combating HIV/AIDS. Such a response is critical if the Millennium Development Goal of halving the spread of HIV/AIDS by 2015 is to be met, just as it is critical for the achievement of other Millennium Development Goals, including the pivotal poverty and hunger goal.

Evidence of the two-way linkages between food and nutrition insecurity and HIV/AIDS is increasingly well documented. The 2002–03 southern African food crisis highlights how vulnerable households, communities, and countries are to shocks that disrupt food production and consumption. Unlike earlier famines, e.g., that in mid-1980s Ethiopia, HIV/AIDS is not only deepening vulnerability, but changing its nature, in ways that have profound implications for response strategies. The response to HIV/AIDS is conventionally disaggregated into the four pillars of prevention, care, treatment, and mitigation. Food and nutrition security is fundamentally relevant to *all* four strategies [1].

Many policy and project instruments exist for tackling food insecurity, including measures to enhance agricultural productivity, investments in market infrastructure, and implementation of community-based nutrition programs. Given the interactions between HIV/AIDS, food, and nutrition, national HIV/AIDS policies are also important, not only for combating the epidemic, but also for promoting food and nutrition security.

No one instrument can deal with the scale and many dimensions of food insecurity, now further exacerbated by HIV/AIDS. In this paper we consider whether food aid* can be an effective weapon in the war against AIDS. It has been argued that such a role might detract from preexisting food security goals. This, however, assumes that AIDS and food insecurity are unrelated problems. They are not. In fact, they are becoming inextricably intertwined. Where food insecurity and AIDS coexist, proceeding with "business as usual" (where AIDS is often viewed as "someone else's responsibility") may compromise not only an organization's ability to achieve its preset goals, but also the very relevance of these goals.

To help practitioners understand the dynamic interactions of HIV transmission and AIDS impacts on different sectoral concerns, and to then identify appropriate policy and program modifications in the face of these realities, we propose the use of an "HIV/AIDS lens" [1]. The lens is essentially a tool to help review situations and/or policy/program actions, drawing upon knowledge of the way HIV/AIDS interacts with another given problem. For example, poverty may force families to split up temporarily as an adult goes in search of work. The *benefits* may include increased household income but—if we apply the lens—we may highlight some major *costs* if this dislocation leads to more frequent sexual interactions. There may be a significantly greater risk of the migrating individual (as well as his/her partner who remains) being infected with HIV. This is just one example of the changes to the policy context wrought by the various HIV risks and AIDS-related vulnerabilities.

Such a reviewing of policies and programs precludes the common reflex of "new problems, new programs." Clearly, not everything needs to change because of AIDS, but it is important to have a mechanism for thinking through the various options. Though there is no hard evidence yet showing the effectiveness of food aid in responding to HIV/AIDS, guidance based on experience is becoming more available [2, 3]. A learning-by-doing approach should be adopted, including documentation and continual monitoring of program relevance and effectiveness so as to maximize impact.

The first section of this paper provides some background on the nature of the HIV/AIDS shock, its implications for people's livelihoods, and thus on the potential role of development food aid, both in terms of preserving livelihoods and in terms of basic survival. We do not discuss the specifics of how to mainstream HIV/AIDS into *emergency* food aid distribution. Rather, we refer the reader to the growing body of knowledge and guidelines on this issue elsewhere [4–7].

We introduce concepts such as susceptibility/resistance and vulnerability/resilience. The next section looks into the important issue of targeting, before analyzing in detail current food aid program types and their possible contribution to reducing susceptibility to HIV and/or vulnerability to AIDS impacts. Prior to concluding, the last section demonstrates how the HIV/AIDS lens can be applied to some cross-cutting strategic issues relating to capacity, advocacy, implementation, monitoring, evaluation, and operational research.

* For the purposes of this paper food aid and food assistance are defined as targeted in-kind transfers to vulnerable groups.

Adopting a livelihoods approach

In order to better understand how interventions may support people's livelihoods, it is useful to differentiate two important aspects of these livelihoods—their susceptibility to HIV and their vulnerability to AIDS impacts [1]. Susceptibility to HIV relates to the chance that an individual, household, community, or livelihood system will become exposed to HIV or to significant HIV infection rates. The positive converse of susceptibility is *resistance*. Vulnerability relates to features of the social, economic, cultural, and physical environment or process that make it more likely that HIV/AIDS will have negative impacts at a certain level (e.g., the individual, household, or community level). Much has been written about this in recent years [8, 9] and more hard data are emerging from new studies [10]. The positive flipside of vulnerability is *resilience*, or the ability to bounce back after a shock.

Figure 1 places susceptibility and vulnerability to HIV/AIDS in a livelihoods context. HIV/AIDS is likely to have an impact on the assets of households and on institutions, community-based or otherwise. The type and severity of these impacts will be conditioned by the vulnerability of the system, community, or household. These impacts will lead to strategic responses made at different levels, which in turn will lead to certain outcomes, e.g., on food security, nutrition, etc. It is important here to realize that these outcomes themselves condition future susceptibility and vulnerability of livelihoods and of the households and communities that depend upon them. These relations demonstrate the interconnectedness and the intergenerational aspect of HIV/AIDS impacts.

Rethinking targeting

Targeting is a dynamic and iterative process that involves defining target groups, identifying individuals within target groups, and ensuring that assistance reaches beneficiaries and meets their needs. Usually a combination of methods is used to identify who is most vulnerable in terms of risks to livelihoods and food and nutrition insecurity, and where they are. Most commonly, geographic targeting (to identify food-insecure

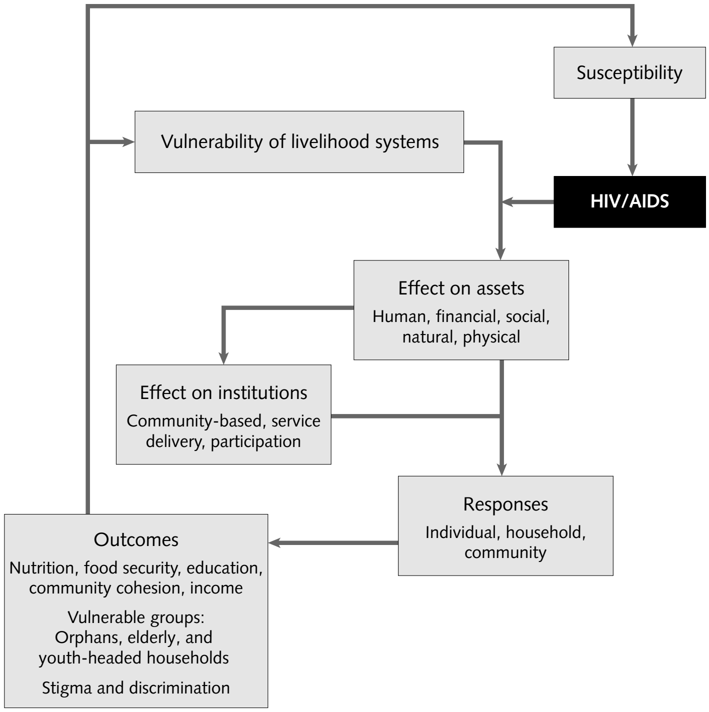

FIG. 1. Understanding HIV/AIDS in the context of people's livelihoods
Source: TANGO International. An initiative to address HIV/AIDS in the region. Paper prepared for the World Food Program, East and Southern Africa Bureau, Kampala, Uganda, 2002.

regions) and institutional targeting (health-care centers, maternal-child health (MCH) clinics, schools) are used to identify the physical location of groups. To select members within a defined target group, indicator-based targeting (such as anthropometric screening, population at nutritional risk, such as pregnant and lactating mothers), community-based targeting (where the community screens participants), and self-selection are most common.

The Vulnerability Assessment Committee (VAC) system, a United Nations interagency collaboration currently in existence in about nine southern African countries, has also adopted the use of an HIV/AIDS lens in their vulnerability assessments.* The World Food Program (WFP) uses its Vulnerability Analysis and Mapping system (VAM) to identify regions that are food insecure. In VAM, HIV/AIDS is considered one of the threats to food security. Seroprevalence data (both national and other datasets where available) and other proxies, such as premature death rates of young adults and adult morbidity (particularly tuberculosis and sexually transmitted diseases), are being used in

* Mdladla P, Marsland N, van Zyl J, Drimie S. Toward identifying the vulnerability of HIV/AIDS affected households to food insecurity. The RVAC-UNAIDS experience: challenges and opportunities. Paper prepared for the workshop on Measuring Vulnerability in the Light of the HIV/AIDS pandemic, Johannesburg, UN RIASCO, 2003.

combination with other indicators to identify areas that are most vulnerable to food insecurity [11]. While such an approach is desirable in high-prevalence countries, it presents some challenges. The dynamics of the spread, distribution, and impact of HIV/AIDS necessitate constant monitoring and updating of databases for informing action in a timely fashion. This requires substantial resources, both financial and technical, at the local level.

In many instances, districts identified as food insecure at any one time may not have high HIV prevalence rates and vice versa. For example, in Garissa, a food-insecure district in the North Eastern province of Kenya, UNAIDS reports only 6% of pregnant women testing HIV positive [11, 12]. In "food-secure" Nyanza, however, 40% of pregnant women in Siaya District and 27% in Kisumu District tested HIV positive. Nyanza and Siaya were found to be food insecure when HIV/AIDS relevant indicators were incorporated into VAM [11].

Cross-sectional district level data may be misleading if taken out of context; they represent a snapshot of the mean at one point in time, and say nothing about intradistrict variation, nor about trends. There is evidence that HIV/AIDS is progressively worsening food security impacts. For example, a 2002 WFP mission to Busia District in the Western Province—with a prevalence of around 30% among pregnant women

[12]—found a large number of households with severely compromised access to food and an unusually high number of orphans on the street. Even though affected households reside in food-secure regions, they are vulnerable to future food insecurity and other developmental impacts of HIV/AIDS.

The effects of the pandemic at an aggregate level are not immediate, and their cumulative effect may not be seen for some time. A food-secure region may have a high prevalence of HIV because it has attracted people ("men, mobility, and money" conventionally viewed as being the first ingredients of an epidemic), but this does not indicate what might happen in the future. Moreover, there is evidence of strong interlinkages between the HIV status of richer households and the food security of poorer households. A study by the Famine Early Warning Systems Network (FEWSNET) in Makueni District, Kenya, has shown that as HIV-related expenditures of richer households increase, there is less money for hiring in labor from poorer households who also suffer. A recent study analyzing current and earlier data has now shown that the 2002 drought in southern Africa interacted with HIV/AIDS in high-prevalence areas to bring about a rapid deterioration in child nutrition, but mainly in areas that previously had better child nutrition, so the effect is not so obvious when averages are viewed. There appears to be a leveling out with regard to child malnutrition rates between urban and rural areas [13].

In this way, food insecurity and HIV/AIDS may increasingly converge over time. Within high-prevalence regions, it may be justifiable to target food assistance to vulnerable groups as defined by the communities, regardless of the food security status of the province as a whole. In Mbeere District, Kenya, which has an HIV prevalence rate of 26% but is food secure at the district level, WFP Kenya aims to provide take-home family rations through the School Feeding Project as an incentive for labor-poor households to send children to school and to make it possible for foster families to absorb orphans [14].

In community-based targeting, community members decide who participates and benefits from a food assistance project. Communities, however, are heterogeneous groups where discrimination, stigma, and social exclusion towards those afflicted by HIV/AIDS are still a serious problem. Exclusively targeting individuals or households affected by HIV/AIDS may exacerbate stigma and discrimination. To ensure that the most vulnerable households and groups are included in food assistance programs, implementing organizations need to establish a dialogue with the community to understand the level of stigma and norms and practices with regard to HIV/AIDS and to gauge the likelihood of HIV-related exclusion from the program.

Rethinking interventions

The choice of the intervention can enable or hinder the participation of HIV/AIDS-affected populations. Food-assisted projects should be relevant to the needs and capacities (including labor, time, and risk-taking capacities) of these populations. Our point of departure is thus the question: How best can food assistance be tailored to respond to the various impacts of HIV/AIDS? We suggest ways in which organizations can design programs that potentially reduce both susceptibility to HIV and vulnerability to its impacts. The application of an HIV/AIDS lens highlights some cross-cutting issues that should be considered in all food aid interventions:

» *First, do no harm*. "Do no harm" should be the minimum standard on which *all* food aid should be programmed.
» *Revise the food assistance package.* The epidemic is drastically changing the composition and size of households. There is a critical need to factor the implications of these changes into the design (size and composition) of a food assistance package.
» *Ensure nutritional quality of the food ration.* Good nutrition is both the first line of defense and the first line of attack against HIV/AIDS. Energy requirements of people living with HIV/AIDS (PLWHAs) are raised by between 10% in the asymptomatic phase and 20% to 30% in the symptomatic HIV infection. Further, children experiencing weight loss have increased energy requirements of 50% to 100% over normal requirements [15]. Although the guidelines do not propose increased requirements for protein, fat, and micronutrients, even a slight shortfall below the recommended dietary allowance (RDA) may hasten the progression of HIV to AIDS. Others affected by the pandemic are highly vulnerable to malnutrition. It is critical that the food assistance package for populations in high-prevalence communities provide adequate macro- and micronutrients. Special efforts should be made to fortify staple foods with multivitamins and minerals and to provide locally acceptable fortified and blended micronutrient foods to PLWHAs, as they are easy to prepare, swallow, and digest and they are highly nutrient dense. In addition, food assistance, to the extent possible, should be coupled with nutrition education, to make the best use of locally available resources.
» *Focus on women*. Women are more susceptible to HIV infection for biological, socioeconomic, and cultural reasons. In sub-Saharan Africa, 58% of the people infected are women. They are also severely vulnerable to AIDS impacts. *All* food aid interventions should aim to increase the resistance and resilience of women to HIV/AIDS.

» *Reduce susceptibility to HIV*. Whenever a food aid program is likely to increase the susceptibility to HIV, it is critical that such interventions be accompanied by effective prevention activities. In addition, food aid and its distributions points can be the entry point for prevention activities. For example, food for training could be provided to teachers in counseling students on safe sexual behavior; food-distribution sites in refugee camps could be used for disseminating information regarding HIV/AIDS, rights of children, encouragement of utilization of health services, and so on.

Enabling vulnerable groups to meet nutritional needs

There is a need to expand and intensify food assistance to respond to the needs of groups who are at risk for malnutrition in the dynamic vulnerability context of HIV/AIDS. Nutrition interventions are crucial to support the increasing numbers of affected populations including, but not necessarily limited to, PLWHAs and orphans and vulnerable children (OVCs). They may also play an important role in reducing the risk of mother-to-child transmission of HIV (MTCT).

Prevention of mother-to-child transmission (PMTCT)

Improved maternal nutrition, combined with HIV testing, information, counseling, and antiretroviral drug provision, is key in PMTCT. Many studies suggest the importance of maternal nutritional status in vertical transmission of HIV by the following:

» Enhancing systemic immune function in the mother or fetus and reducing the rate of clinical, immunological, or viral progression in the mother [16–20];
» Reducing viral load or the risk of viral shedding in lower genital secretions or breastmilk [21–24];
» Reducing the risk of low birthweight and prematurity or by maintaining the child's gastrointestinal integrity [18, 25–28].

A few observational studies suggest that low serum levels of vitamin A among HIV-positive pregnant women are associated with a higher risk of vertical transmission of HIV [29, 30]. However, antenatal supplementation of vitamin A in Malawi and South Africa did not reduce the risk of vertical transmission in utero, intrapartum, and through early breastfeeding, although it decreased the risk of adverse birth outcomes [26, 27]. In Tanzania, multivitamin supplementation of lactating mothers (6 to 24 weeks postpartum) had a protective effect on transmission through breastfeeding and on mortality among nutritionally and imunologically compromised women [31].

In order to reduce the risks of vertical transmission, UN guidelines advise HIV-positive mothers to exclusively breastfeed up to six months after delivery where safe alternatives are not "acceptable, feasible, affordable, sustainable and safe" [32, 33]. After this time, the guidelines suggest that mothers switch exclusively to breastmilk substitutes.

HIV-positive mothers in food-insecure households may require support to enable this. Through the usual MCH channels or PMTCT initiatives, food aid organizations could consider providing take-home, micronutrient-fortified food rations for infants to help the transition from exclusive breastfeeding to complete replacement feeding at six months. Such support could be extended until the infant is 30 months old. This is a difficult area, in which our knowledge of risks, benefits, and operational feasibility is still evolving. Operational research here could shed some light on the practicalities of implementing current World Health Organization (WHO) guidelines and help understand if and where food assistance may be useful.

Food supplementation in home-based care (HBC)

Food aid has a major role to play in providing nutritional support through home-based care. To date, such efforts are still disjointed and inadequate. A majority of the existing HBC programs do not have a food component [34].

Research shows that adequate nutrition has multiple positive effects for PLWHAs, including enhancement of the body's ability to resist opportunistic infections, delaying the progression of HIV to AIDS, increasing the effectiveness of drug treatment, and improving psychosociological status and general quality of life [35–37]. Adequate nutrition can thus prolong the economically active life of PLWHAs and contribute to their "positive living," enabling them to pass on important skills and knowledge to their children, plan for their children's future, prepare them psychologically, and delay orphanhood. Food, indeed, may very well be their most important medicine. Here, operational research is necessary to provide much-needed empirical evidence on the role of food and nutrition in the socioeconomic and nutritional well-being of PLWHAS and their families.

HBC should, as far as possible, be a holistic package, which includes health (basic drugs and hygiene), nutritional and psychological support to the sick individual, guidance to caregivers in taking care of the sick, HIV prevention, and nutrition education.

Ideally, HBC interventions should link other family members to programs that strengthen resilience through preserving livelihoods and/or building human capital. But in many cases, there may be no surviving adult members—just the elderly and children who may need continued assistance. Some children may be placed with extended families. There are many different potential scenarios, and depending on local realities, vulnerable members could be reached through other targeting and programming modalities.

HBC is often constrained by problems of inadequate resources, an unreliable supply of basic medicines, and inconsistent volunteerism [38]. With the burgeoning numbers of people affected by HIV/AIDS, nongovernmental organizations report consistently high dropout rates of volunteers, often leading to compromised program quality and high recurring costs of training new volunteers. It is time to explore new mechanisms to reinforce volunteerism and self-reliance in communities. An important operational research question here is: Can food be used to cover opportunity costs in high-prevalence communities and promote volunteerism, without undermining community self-reliance?

> BOX 1. Mentoring OVCS in Rwanda: *nkundabanas*
>
> CARE Rwanda is currently piloting projects where child heads of households choose a person they trust within the community as mentor or *nkundabana*, ("one who loves children"). CARE provides a family food basket to these child-headed households (covering 70% of their food needs) as well as to *nkundabanas* who are trained in counseling, psychosocial support, and life skills. The food basket allows older children in child-headed households to participate in productive activities, such as skills training and income-generating activities, while the younger ones are able to continue formal education.
>
> Freedom from Hunger International (FHI) also reaches child-headed households in and around Gitarama with its Nkundabanas project. In addition to linking heads of child-headed households and training them in income-generating skills, FHI brings them together in mutual support groups [42].

Supplementary feeding for orphans and vulnerable children (OVC)

One of the most disturbing long-term consequences of the AIDS pandemic is the growing number of orphans. The survival, food security, health, and development of many other children is also increasingly jeopardized due to the effects of AIDS on families and communities. These children are referred to as vulnerable children. A recent WFP report cautions treating orphans and vulnerable children as a homogeneous group, as they face different risks, and boys face different risks than girls. These differences should be taken into account in designing and targeting policies and programs [39]. According to recent estimates, 10 countries in southern Africa have orphan rates higher than 15%. Both the number and the percentage of orphans due to AIDS are estimated to increase rapidly in the next decade [40].

Orphans are particularly vulnerable to a range of problems, including early school dropout, malnutrition, and psychosocial deprivation. Community members themselves have constrained resources, including food and time for child care [41]. Exploitation of orphans may increase the susceptibility of children to HIV.

Strengthening community capacity to care for OVCs is critical in the fight against HIV/AIDS, and food aid has a role to play here. For example, establishment of day-care centers (for all preschool children and not just for OVCs) eases the burden of caring, permitting adults to be involved in economically productive activities (see Box 1). On-site feeding at these centers could ease household food security constraints and supplement the diets of preschool children. Food aid organizations will need to partner with government and other organizations to ensure that interventions are holistic (for example, providing deworming and immunization services). Food for training can be provided to health and nutrition workers who are responsible for growth promotion, immunizations, and other services, depending on the context. Such interventions are critical in an HIV/AIDS context, where health centers may be increasingly overburdened and households increasingly impoverished and thus unable to afford the time, transport, or user fees to access health services.

Given the enormity of the orphan crisis in sub-Saharan Africa, the role of orphanages cannot be ruled out, especially in urban settings. Institutional care may be the only option for orphans in conflict and postconflict situations, where foster care is infeasible [43]. Community-based institutions such as small group homes and children's villages are also emerging in response to the burgeoning orphan population [39]. Food aid organizations should carefully assess the pros and cons of food assistance to orphanages and other community-based institutions. Such interventions should, as far as possible, be conditional on orphans' attendance at school or vocational training (see the next section). Training of youth (especially in community-based care settings) in home gardening and raising farm animals to supplement income and diet has a potential to increase access to food and improve diet quality [39].

Enabling education and training

"Everything—from the demand for education, the supply of education, the availability of resources for education, the clientele, to the actual process of education—is affected" [39].

Food for education (FFE)

Food for education may have an important role to play in combating HIV/AIDS in some of the following ways: in the long run, it has the potential to increase household resilience by expanding the economic opportunities that come with education; educated children are more likely to internalize information on prevention of HIV; and girls especially may become empowered and therefore less susceptible to HIV.

FFE programs usually aim to reach school-going children in chronically food-insecure regions. Food is provided either as on-site school feeding or as take home rations. In some regions, girls are provided a take-home ration as an incentive for families to send their girls to school—counteracting the common tendency of girls' education to be curtailed first [44]. Studies have shown that school feeding can reduce hunger-related lethargy, improve academic performance, and provide an incentive for enrolment and attendance in schools [45, 46]. In response to the crisis in formal schooling due to HIV/AIDS, communities have started informal community schools and other informal education modalities, such as interactive radio listening groups in Zambia, often run by volunteers.

Food has a role to make education more accessible to affected children, including OVCs. This role includes continuing to support school feeding in formal schools in chronic food-insecure regions; expanding formal school feeding to high-prevalence areas regardless of the food security situation at the district level to decelerate dropout of OVCs; expanding food for education to informal community schools in high-prevalence communities where the most vulnerable children tend to access education; providing food to cover the opportunity costs of volunteer teachers and mentors in the informal education system, including for their training, so even the most vulnerable children can access better-quality education; providing food for HIV/AIDS training to all teachers and volunteers (in both formal and informal schools) to ensure that they have necessary skills and information to communicate, guide, and counsel students; and supporting HIV/AIDS education in all schools through appropriate partnerships (Box 2).

In food-secure, high-prevalence areas, a take-home ration for OVCs is less likely to be stigmatizing. For example, in Malawi and Mozambique, WFP aims to provide take-home rations to girls and orphans [47, 48].

Many orphans and vulnerable children drop out or do not go to school because of the prohibitive cost of school fees, textbooks, and uniform. Food aid organizations could work with other partners to provide such nonfood items, which are crucial for increasing the enrolment rate and lowering the school dropout rate.

BOX 2. Comic books for HIV/AIDS education in Ethiopia

WFP Ethiopia along with the Ministry of Education is promoting HIV awareness through the existing program structure in five food-insecure communities. Recognizing that schoolchildren are potential channels of information dissemination and communication to other household members, WFP aims to mobilize resources to develop age–suitable educational materials on HIV/AIDS, including comic books, leaflets, and posters in local languages to be distributed to children in formal and nonformal schools. Anti-AIDS clubs are being supported to provide peer group volunteers and community support groups [49].

Food for training (FFT)

Children who lose one or more parents are less likely to be in school and more likely to be working more than 40 hours a week [40]. Youth should be provided with opportunities for vocational training to enable them to acquire livelihood skills to offset the loss of intergenerational skills transfer when parents die prematurely (e.g., to inculcate agricultural skills required to maintain land productivity). Food rations could be provided as an incentive to attend the training for the duration of training and for a few months after, to enable the beneficiaries to get a foothold in the market. Vocational training of youth may lead to urban migration and therefore increased susceptibility. FFT should therefore be combined with HIV awareness and life skills training. Linkages to microcredit services or start-up financing schemes should be explored wherever possible.

FFT could also be used as an incentive (and to cover the opportunity costs) to train peer-support volunteers, home-based care, and other volunteers involved in prevention, care, and mitigation activities, as illustrated throughout this paper. For example, traditional birth attendants could also be trained in improved delivery techniques to reduce MTCT.

Enabling the poor to preserve and gain assets

As shown in figure 1, asset stripping is a major destructive response to HIV/AIDS impacts at the household and community levels. Food assistance has an important potential in buffering such impacts to the point at which assets may be preserved in the short term and even augmented over a longer period.

Food for work (FFW) programs

Food for work programs use food as an income transfer in exchange for work. They typically seek to address chronic food insecurity by creating assets such as roads to improve access to markets, irrigation facilities, or land terracing to reduce erosion or forestry. But what is the relevance of FFW programs in a high HIV-prevalence, chronically food-insecure area? Self-targeting for labor-intensive programs may leave out a large portion of the needy population who are too weak or busy with intrahousehold caretaking to participate. Households headed by children and the elderly will also be excluded. The premises of labor abundance and self-targeting, on which FFW is based, are unlikely to apply in high HIV-prevalence areas [50]. There may well be skilled labor shortages as a result of HIV/AIDS, and this will need to be addressed in the design and implementation of projects. There is a need also to think creatively about how labor-scarce households can be assisted at times of the agricultural year when labor is especially important, for plowing, for instance. For example, an FFW program could pay labor-surplus households to work the fields of labor-constrained households (Box 3).

On the other hand, by ensuring food wages to other people in the community, FFW projects may indirectly enable communities to deal with the crisis. FFW projects aimed at reducing distress migration have a high potential to reduce susceptibility to HIV. Yet, it is important to understand how certain projects may also increase susceptibility to HIV. For example, von Braun et al. [51] report multiplier effects of an FFW-built road in Ethiopian lowlands, where resulting improved market access led to the establishment of water mills and fruit plantations and revival of traditional spinning and weaving in the three years after the road was built.

Where such projects "crowd in" private investment, they may also potentially increase risky behaviors, especially if they cause greater labor mobility, resulting in the formation of new sexual networks and an expansion of sex work [52]. This is not to suggest that well-conceived and well-managed FFW projects be abandoned, but it is vital to anticipate such potentially risk-increasing effects and address them in project design and implementation. Partnerships should be explored for linking to local community-based organizations and nongovernmental organizations that can help to deliver complementary services such as Voluntary Counseling and Testing (VCT), peer education programs, access to condoms, access to treatment of sexually transmitted infections (STIs), and basic drugs.

BOX 3. Innovations in FFW: labor banks

To counteract neglect of farmland due to labor depletion, some agencies have started exploring the formation of labor banks, where willing laborers are engaged in working on individual plots of land owned by those who cannot tend to them. World Vision in Rwanda is exploring the possibility of providing food aid to such laborers.

In Malawi, the STEPS project supported by Save the Children US encourages the establishment and maintenance of cereal banks and community gardens so that communities can better withstand other shocks. Produce from the community gardens may be used to supplement the diets of OVCs.

In Zambia, in order to ease time constraints of women participating in their FFW project, CARE's PUSH/PROSPECT project has supported women to establish a crèche (day nursery) close to the FFW site. Through a lottery system, women take turns in taking care of children (Eleonore Seumo-Fosso, FANTA Project, Academy of Educational Development [AED], personal communication).

Income-generating activities (IGA) and microcredit

Food rations may be used to permit poor households to dedicate time and energy to developing and expanding income-generating activities. Target groups have conventionally been women's groups. Food assistance is provided to cover the opportunity costs of learning new skills and as an income transfer.

Microcredit can be an important element in initiating income-generating activity and sustaining it. Parker et al. [53] note that the inherent limitation of conventional microcredit in HIV/AIDS contexts is that it cannot serve the most needy, as the terms of loans tend to be fairly inflexible. Microcredit programs are also often limited in reaching the ultra-poor, a group with a high risk of loan default.* Webb et al. [54] report that many ultra-poor women feel that IGA investments are either too risky or too time consuming, thus limiting their participation. A survey carried out by CARE in Lusaka showed that among the participants in the PULSE microfinance project, death and illness of the family members were major causes of loan default [55]. Webb et al. [54] made similar observations in Bangladesh. In places where women depend on men for marketing the outputs, HIV/AIDS poses particular problems, with men often being the first fatality of AIDS within households. Thus, if microcredit activities are not sensitive to the dynamics of the HIV/AIDS shock at the household level, they may drive the recipients into greater destitution [34].

However, there are some examples of innovations within microcredit (e.g., Opportunity International, serving 30,000 clients throughout Africa [55]), including provision of death insurance and health insurance for clients and families (including coverage for AIDS treatment), flexible savings plans, greater flexibility on loan sizes and payment schedules, the writing off of loan failures, emergency loans, and HIV/AIDS awareness training. An understanding of how women and children allocate their time and whether they can make time for additional activities should drive the IGA intervention. Savings mobilization schemes with

* RESAL. Report on the RESAL seminar "Prospects and limitations of income generating activities as instruments for food security of the poor" held on March 27-28, 2000. in Dhaka, 2001.

flexible savings withdrawals and links to innovative microcredit schemes for sustainability of IGAs in an HIV/AIDS context are crucial.

Attention should again be paid to the possible increase in susceptibility to HIV. Frequent contacts with markets to sell outputs could lead to increased adoption of risky behaviors. Vocational training of youth could lead to urban migration and increased susceptibility. Education for behavior change and life-skills training should thus be an integral part of all such programs.

Often, the types of skills that women and youth are trained in are limited by the implementing partners' capacities and expertise. Food aid organizations should seek to partner with organizations that have strong comparative advantage in microcredit activities (rather than food aid management).

HIV/AIDS-related targeting mechanisms, such as PLWHA associations, youth clubs, and child-headed and elderly-headed households should be used in addition to other traditional targeting groups and modalities. The duration of programs that aim to reach those affected by HIV/AIDS may have to change. Rahman [56] notes that longer time is required to motivate the risk-averse hardcore poor to participate in microcredit activities and to ensure that they benefit from the services. Budgets should reflect this with increased administrative costs in the initiation phase of the project. This may also mean that food aid may have to be provided for a longer period of time.

Ensuring the relevance of food aid strategy in an HIV context

In this section we consider some important crosscutting strategic issues. In order to ensure that development assistance of all types remains relevant and appropriate in the context of high HIV prevalence rates, organizations must review their mission, vision, objectives, timelines, and capacities, taking into account these new realities. This may entail restating organizational goals and, within the broad scope of the organization's mandate, embarking on new initiatives. In this section we apply an HIV/AIDS lens to some of these crosscutting issues and then suggest some possible responses.

Capacity development

Rethinking the role of food aid in order to better respond to the changing needs of AIDS-affected populations is impossible unless modifications are made *within* organizations. Organizations need to facilitate a process by which people internalize the implications of AIDS for their work, and harness and develop this capacity to respond at the broadest level. This is the essence of mainstreaming.

Recognizing that employees of organizations may themselves be HIV positive (PLWHA), may be at risk for HIV infection, or may be affected by the illness or death of others is a crucial first step. Employees may be subject to discrimination within and outside the workplace or be perpetrators of such discrimination. These personal impacts can severely compromise organizational ability to perform effectively and efficiently. WFP's HIV/AIDS training project for truck drivers, porters, and stevedores in Ethiopia provides an example of how organizations can seize opportunities to address the issues of HIV/AIDS in the work place [49].

Employees need to be oriented to ask the question: "How does HIV/AIDS affect my work, both what I do and how I do it?" This demands an understanding of what AIDS is doing to their "work," broadly defined, and ultimately the potential advantages and disadvantages of different programming approaches for combating its effects in different situations. To foster such understanding, staff need to employ an HIV lens for reviewing their core business and the way they undertake it. Staff need to be encouraged to think creatively and proactively about these relationships and how they could change their ways of working. Networking with partners and other organizations within the region to exchange ideas and best practices will increase motivation and can go a long way toward improving practice.

Advocacy

Overriding strategy design and linked directly with it, advocacy is crucial. Food aid organizations can and should play a major advocacy role for the following reasons: they are on the front line, with firsthand experience of what is happening; food is an increasingly high priority for affected populations; they have the capacity to monitor, evaluate, and communicate widely, with regard to both the problem and its possible solutions or interventions (what works); food represents a major potential entry point for helping preserve and sustain livelihoods; economically, advocacy is necessary to raise resources and to strengthen capacity to act on a scale commensurate with the epidemic; and socially, advocacy is necessary to destigmatize the problem of HIV/AIDS, emphasizing its nature as a development problem affecting all aspects of a country's economy and society. Such advocacy should be fueled by evaluations of successful initiatives, as well as lessons learned from less successful endeavors.

Forging partnerships

Development of mutually supporting partnerships is critical to the fight against AIDS [3, 14]. Ultimately, the most important partnership is with the community itself, particularly people living with HIV/AIDS. Throughout the paper, we argue that food assistance projects in HIV/AIDS should adopt the dual goal of reducing susceptibility and vulnerability to HIV/AIDS. To enable such synergies, partnering with other organizations for nonfood components will be critical for success. Although this is not unique in the context of AIDS, the issue of complementary resources becomes crucial and urgent, as community capacity to contribute resources is highly weakened in high-prevalence regions.

Fostering such partnerships both with people affected by HIV/AIDS and with professionals within other sectors should be built into strategy, not something undertaken on an *ad hoc* basis. Organizations need to go beyond their usual focus on those partners that have food management capacity, and should seek and identify partners with the capacity to bring to the project the livelihood component, the life-skills development component, or both. Where capacities are weak, investments in developing the capacity of partner organizations, including, for example, providing links to technical support, should also be a part of the core strategy.

Mirroring the shift toward more comprehensive approaches with partners (involving nonfood items), there is also a need for a greater focus on achieving *outcomes*, not just food-delivery outputs. This has implications for monitoring and evaluation systems as well as for project timelines, which may need to be extended.

Monitoring and evaluation

Three forms of monitoring are required: geographic monitoring and monitoring at the levels of project performance and capacity development. A project-monitoring system that is relatively simple but able to track the changing HIV/AIDS situation and its impacts on food and nutrition security, with the required accuracy and reliability to guide timely ameliorative action, is essential. The key data required to improve program decision making in real time need to be generated by such a system and communicated to those who can use them. It will usually not be necessary to reinvent food and nutrition security indicators—rather, the HIV lens should be applied to existing ones.

Given the fact that this type of programming is relatively new, there is an urgent need to demonstrate what works. Evaluations of programs and projects will be key to highlighting success and thus providing the fuel for advocacy to generate the resources to scale up successful approaches.

Finally, there is a need to track the implementation and performance of such organizational capacity-development initiatives. Performance in this case relates to the enhancement of critical capacities (e.g., the ability to apply the HIV lens to different situations) at the levels being addressed by the initiatives.

Operational research

Operational research—which is critical for maximizing the effectiveness of interventions—should be directly linked to the monitoring and evaluation system in a dynamic manner. Project budgets should include a nonearmarked portion that may be mobilized to support such essential work.

There are certain general priorities that need further research, including the continual development, refinement, and application of the HIV/AIDS lens, the appropriateness of different indicators for targeting or monitoring, the nutritional composition of rations, and home-based care modalities. We have highlighted many other key operational research issues throughout the paper.

Conclusions

HIV/AIDS demands a multipronged response, grounded in an understanding of the susceptibility and vulnerability of people's livelihoods. Given the strong linkages between food insecurity, malnutrition, and HIV/AIDS, this paper has highlighted particular opportunities that food assistance may present—not only for care and mitigation, but also for prevention in a broad sense. Food assistance is relevant for the nutritional well-being of vulnerable groups and for strengthening human capital, as well as for preserving assets and livelihoods.

Food aid can enable the marginalized to take advantage of development opportunities. Those affected by HIV/AIDS are arguably among the most marginalized populations, both socially and economically. Not only does stigma foster exclusion, but progressive asset depletion may also render households destitute and unable to participate in the development process. There are opportunities for using food aid to enable these populations to avoid and escape such marginalization. In addition, it will be important to seek opportunities for linking such interventions to HIV-specific interventions wherever possible, thus potentially further reducing susceptibility to HIV.

But many challenges exist, which will need to be dealt with dynamically through ongoing implementation, good monitoring, and timely, focused operational research. Such challenges include how to target the vulnerable in the HIV/AIDS context, how to use food aid to leverage longer-term livelihood options, how to ensure complementary resources through appropriate partnerships, and how to strengthen local capacity. Donor responses have been piecemeal to date, and the involvement of food aid organizations is fairly recent. Though there is little empirical evidence regarding the effectiveness of food aid in responding to HIV/AIDS currently, this should not forestall action. A well-documented learning-by-doing approach is required, of building up, evaluating, and disseminating experiences and lessons learned.

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