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Nonbreast-Fed HIV-1-Exposed Burkinabe Infants Have Low Energy Intake between 6 and 11 Months of Age Despite Free Access to Infant Food Aid[1–3]

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Abstract

In a WHO-coordinated, mother-to-child HIV transmission (MTCT) prevention trial in Burkina Faso, HIV-1–infected mothers were advised to either stop breast-feeding by 6 mo or totally avoid it. Participants were provided with cereal-based, infant fortified mix (IFM) from 6 to 12 mo postpartum along with infant feeding counseling. Our objective was to describe nonbreast-fed infants' food consumption and adequacy of nutrient intake. A 1-d weighed food record and one 24-h dietary recall were performed in 68 nonbreast-fed, non-HIV–infected 6- to 11-mo-old infants. Mean food energy density and feeding frequency were satisfactory in 6–8 mo olds [0.8 ± 0.2 kcal/g (3.3 ± 0.9 kJ/g) and 7.2 ± 1.6 times/d] and in 9–11 mo olds [0.9 ± 0.2 kcal/g (3.6 ± 0.8 kJ/g) and 7.7 ± 2.1 times/d]. Median energy intake was 523 kcal [range: 82–1053 (2187 kJ, range: 345–4401)] in 6–8- and 811 kcal [range: 34–1543 (3392 kJ, range: 144–6452)] in 9–11-mo-old infants, respectively. Approximately 75% of their energy intake was provided by subsidized foods (milk that mothers obtained from support networks and IFM). One-half of the infants had intakes < 80 kcal/kg (<334 kJ/kg) on the day of the survey, mainly because IFM and milk were consumed in amounts that were too low. Thus, coverage of energy needs required a diet with sufficient amounts of both IFM and milk in these vulnerable infants. These findings argue for the development of adequate, sustainable infant fortified foods and their rapid integration into MTCT prevention services. They also lend support to the recent revision of WHO infant feeding guidance for future MTCT prevention programming that recommends breast-feeding up to 12 mo postpartum (under cover of antiretroviral prophylaxis) as the safest feeding option for infants of HIV-infected mothers. J. Nutr. 141: 674–679, 2011.

Introduction

Malnutrition contributes to high rates of infectious disease-related mortality in infants and young children in low-income countries, particularly at the age of food diversification (1). Breast-feeding covers ~60% of the energy needs of infants aged 6–11 mo and 40% of those of 12–23 mo old and is an important source of micronutrients (2). It is also responsible for one-half of pediatric HIV infections in the developing world when continued for up to 24 mo postpartum (3). In 2000, exclusive breast-feeding followed by early weaning at ~6 mo was recommended by WHO for the prevention of HIV mother-to-child transmission (MTCT)[7] (4). Alarming preliminary findings from Uganda, Malawi, and Zambia, released in late 2006, reported substantial mortality and morbidity among HIV-exposed infants following early cessation of breast-feeding (5–7). Consequently, the WHO guidelines were revised in 2007 and recommended that mothers cease breast-feeding at 6 mo only if adequate and safe replacement food was available thereafter (8).

Very few data exist on food and energy intake of nonbreast-fed African infants. In the context of HIV, Becquet et al. (9) reported on meal frequency and dietary diversity at 6, 9, and 12 mo in a cohort of 262 initially breast-fed infants (76% were completely weaned at 9 mo) from Abidjan. Lunney et al. (10) provided 24-h recall data on quantitative food intake of 8 nonbreast-fed and 16 breast-fed infants aged 6–9 mo in rural Zimbabwe. To the best of our knowledge, no data have yet been published on quantitative

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[3] Supplemental Table 1 is available with the online posting of this paper at jn.nutrition.org.
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[7] Abbreviations used: ARV, antiretroviral; IFM, cereal-based infant fortified mix; KBS, Kesho Bora Study; LAZ, length-for-age; MTCT, mother-to-child transmission; WAZ, weight-for-age; WHZ, weight-for-length.

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food consumption and nutrient intake of nonbreast-fed African infants using the food weighing method.

The multicenter, WHO-coordinated Kesho Bora Study (KBS) on MTCT prevention recruited HIV-1–infected pregnant women who were assigned to various regimens and durations of antiretroviral (ARV) prophylaxis or treatment according to their stage of HIV disease. Five study sites participated, including one in Bobo-Dioulasso, the second largest city in Burkina Faso. In that country, prolonged breast-feeding is virtually universal (the median duration is 25 mo), delayed introduction of complementary foods is common (only 38% of infants receive complementary foods at 6–8 mo), and the prevalence of infant and young child malnutrition is high (39% of children < 5 y old are stunted) (11). At this study site, mothers were provided with infant fortified food from 6 to 11 mo of infants' age.

We carried out a dietary survey using the precise food weighing method in nonbreast-fed infants aged 6–11 mo at the Bobo-Dioulasso KBS site, coupled with a 24-h dietary recall on the day preceding the survey. This study tested the hypothesis that infants receiving fortified food within the MTCT prevention study would have adequate nutrient intake with respect to infant feeding recommendations and cover their energy requirements. A secondary hypothesis was that an adequate diet from 6 to 11 mo of age would enhance growth until 18 mo of age.

Participants and Methods

Study context: infant feeding recommendations and food support in the KBS

The KBS in Bobo-Dioulasso recruited pregnant HIV-positive women for inclusion in 1 of 2 cohorts or a randomized clinical trial, depending on the stage of disease, between May 2005 and December 2007. In the trial, women in the intervention group benefitted from triple ARV therapy from 28 to 34 wk of pregnancy to 6.5 mo postpartum to prevent MTCT during breast-feeding. Detailed information on the study design and implementation may be found elsewhere (12).

The KBS protocol included sustained pre- and postpartum infant feeding counseling. Women were advised to exclusively breast-feed or formula feed from birth to 6 mo postpartum. Formula was provided free of charge for 6 mo to those who chose the latter option, and those who chose the former were strongly recommended to cease breast-feeding by 6 mo. This strategy was consistent with Burkinabe MTCT prevention policies for 2006–2010, which still recommend early cessation of breast-feeding, between 4 and 6 mo (13), and with WHO recommendations at the time of study implementation (4). The recommendation to cease breast-feeding at 6 mo was maintained in the KBS despite the 2007 update. Indeed, concerns existed that cessation of triple ARV at 6.5 mo might be followed by a rebound in viral load, leading to increased risk of transmission through breast-feeding, if continued (14). In addition, most participants had reached 6 mo postpartum at the time of the early weaning revision.

The WHO guiding principles for feeding nonbreast-fed children 6–24 mo of age mention that replacement food should provide 615 and 686 kcal/d (1 kcal = 4.18 kJ) to infants aged 6–8 and 9–11 mo, respectively. Whatever their age, they should be given animal milk and nutritive replacement food in 3–5 meals and 1–2 snacks/d, depending on the energy density of replacement food (15). Recommended nutrient intake for nonbreast-fed infants was translated into simple advice for dietary components in the KBS. In the Burkinabe site, a cereal-based, infant fortified mix (IFM), locally produced, was provided to optimally meet the nutrient and energy needs of infants 6–12 mo of age (2) on the condition that gruel be given in combination with milk (whole cow milk or formula). The energy content was 414 kcal/100 g of dry matter. The nutrient composition and viscosity had been improved so that 100 g of cooked fluid IFM gruel provided at least 100 kcal (**Supplemental Table 1**). Mothers were advised to give their infants 450 mL of whole cow milk/d in 2–4 feedings and fortified gruel in an amount corresponding to 100 g of dry matter mixed with water (i.e. 450 g of cooked gruel) 2–4 times/d according to appetite. This combination of milk and fortified gruel was proposed, because it covers all nutrient needs in this age range. Mothers were also encouraged to provide nutritious snacks and progressively accustom their infants to family food. As per protocol, all mothers received a free 3-kg monthly allowance from 6 mo (at breast-feeding cessation or at the end of formula supplying) until their infants reached 12 mo of age. However, they had to provide or purchase milk on their own. The conception, implementation, and acceptability of this nutritional and food support program have been described in detail elsewhere (16).

Design

This was a home-based, 1-d quantitative food consumption survey using a food-weighing method coupled with quantitative 24-h dietary recall in a subsample of nonbreast-fed infants from the KBS study site in Bobo-Dioulasso. Inclusion criteria were defined as: age between 6 and 11 mo and absence of any breast-feeding (i.e. either completely weaned or never having been breast-fed). Infants with known HIV-positive status (ARN real-time PCR assay was performed at 6 wk of age) were excluded from the study. In accordance with the WHO recommendations, mothers of HIV-infected infants were encouraged to pursue breast-feeding.

At the time of the food study (March to June 2007), 200 women had been enrolled and were being followed-up in the KBS. Among them, 123 had not yet delivered or had a child outside the required age range and 7 were still breast-feeding (3 had an HIV-infected infant and 4 failed to cease breast-feeding at 6 mo). Finally, 70 had an infant fulfilling inclusion criteria and were given individual information about the study's objectives and procedures. All gave written consent and participated in the study. Because it was discovered during the survey that 2 infants were still being breast-fed, the final sample included 68 mother-infant pairs.

Data collection

Food intake. All foods eaten by the infant from 8 to 20 h were weighed to the nearest gram with a food scale (SECA) and a complete description of their composition was collected. When food had been given between the time the infant awoke and the surveyor's arrival in the morning, the amount ingested was estimated by the mother with the utensil used for that feeding filled with water and weighed. If feeding was planned for later than 20 h, the amount of food to be given was estimated by the mother and weighed in the same manner. These estimations were added to those directly weighed in the 8- to 20-h period. We also conducted quantitative 24-h recalls of infant food consumption on the day preceding the survey. Food amounts were estimated using standard household utensils filled with water according to mothers' reports and a complete description of food composition was recorded. The recall was performed upon staff arrival in the household whenever possible in an attempt to avoid the influence of food given during the day of the survey on the mothers' recollections.

Anthropometry. Anthropometric data were extracted from the KBS database. Within the KBS, weight was taken monthly to the nearest 10 g up to 12 mo of age, then quarterly up to 18 mo of age (SECA baby scale), and length was measured to the nearest millimeter at quarterly intervals up to 18 mo of age.

Demographic characteristics. Characteristics of mothers (age, occupation, education, marital status) and households were extracted from the KBS database.

Data management and analysis

Nutrient intake. We built a food composition table specific to the study using the composition provided by the producers for milk and IFM and the main available references for traditional gruels (17,18), family food (18,19), and various snacks and drinks (18,20). A SAS program was used to generate all nutrient intake variables based on 24-h recall and food weighing records, separately. Energy density of the diet was calculated by dividing total energy intake (kcal) from food by total weight of the recorded food intake (g). Many infants were given food throughout the day. Thus, in this article, "feeding" refers to any food items taken at the same time (meals or snacks). The main computed variables (total energy intake, energy intake from IFM gruel, and energy intake from milk) originating from the 24-h recall and food weighing records were assessed for concordance of intakes. Pearson correlation coefficients were 0.79, 0.86, and 0.84 for the 3 variables, respectively ($P < 0.0001$ for all). The same variables were compared for concordance of methods using the paired Student's t test for energy intake (means did not differ) and the Wilcoxon's Signed Rank test for the feeding frequency (**Table 1**). Dietary data presented in this article result from the food weighing method, which is considered to be the reference method for assessing dietary intake.

Energy requirements. Energy intake per kilogram of body weight was calculated using the weight value measured at the monthly KBS visit closest to the survey. In 6- to 11-mo-old infants, the daily energy requirement defined by Butte (21), ~80 kcal/kg of body weight (variation depends on gender, age, and breast-feeding status), was used in the present study.

Infant growth. Weight-for-age (WAZ), length-for-age (LAZ), and weight-for-length (WHZ) were computed in Z-scores of the 2006 WHO growth standard (22) for the age range 6–18 mo. To describe growth patterns by level of compliance with KBS replacement feeding recommendations, infants were divided into 3 groups using 6 variables: consumption of milk and IFM gruel and on the day of the survey, on the day before the survey, and daily in general. For each variable, we attributed 1 point when the answer was "yes" and 0 when the answer was "no." Thus, the range of values for this score was 0–6. If the score was ≥5, the infant was considered highly compliant with recommendations compared with fairly compliant (if the score was 3 or 4) and poorly compliant (if it was <3).

Statistics. Epidata 3.1 software (Epidata Association) was used for data entry and SAS software 8.1 (SAS Institute) for data management and statistical analysis. Trajectories of nutritional indices (WAZ, LAZ, and WHZ) from 6 to 18 mo of age were compared by level of compliance with feeding recommendations using mixed models (PROC MIXED for continuous data). Mean intakes were compared with one another using ANOVA. Values in the text for nutrient and food intake are means ± SD and median (range). Nutritional indicators are means ± SD. Differences were considered significant at $P < 0.05$.

Ethics

The KBS protocol was approved by the ethical review committees of the Centre Muraz in Bobo-Dioulasso, the Burkinabe Ministry of Health, the U.S. CDC, and the WHO. The study was conducted in accordance with the Helsinki Declaration of 1975 as revised in 1983.

Results

Baseline study population characteristics. Among the 68 mothers included in the study, 46% were illiterate and 54% had no income-generating activity. Most (99%) lived with partners, but only 46% had informed their partner of their HIV status. Housing conditions were as follows: 24% had access to tap water in their yard, 49% had electricity at home, and 90% used a traditional outdoor kitchen (i.e. cooking in a pot over charcoal). Mean infant age was 9.2 ± 1.5 mo; 27 infants were aged 6–8 mo and 41 were aged 9–11 mo. Twelve infants (18%) had received formula from birth.

Compliance of nutrient intake with WHO recommendations. Median energy intake was lower than the recommended nutrient intake in the 6–8 mo age group but higher in the 9- to 11-mo-old children (**Table 2**). One-half of the infants (15 of 27 6–8 mo olds and 18 of 41 9–11 mo olds) did not attain the recommended intake of 80 kcal/kg of body weight on the day of the survey. Feeding frequency was high in both age groups compared with recommendations for food energy densities of 0.8 kcal/g (i.e. the mean density measured in this study). All infants were fed at least 4 times during the recording period and a mean of >7 times in both age groups; this frequency included all feedings (meals and snacks), whereas the WHO recommendation of 4 refers to meals only. The amount per feeding, however, was less than one-half the recommended value based on the theoretical gastric capacity of infants, so the high feeding frequency did not offset the low amounts ingested (Table 2). Mean protein density was satisfactory. Lipids provided slightly more than the proposed minimum value of 30% of total dietary energy, despite the absence of breast milk (a more abundant source of lipids than most other foods) from the diet.

Compliance of the diet with KBS recommendations. We identified 4 main food items in the diet of the study infants: milk, traditional thin porridge (low-energy dense fermented millet-based gruel), IFM gruel, and family/solid foods. Most infants (85%) were given milk on the day of the survey; 77% of them received formula, while the others were fed whole powdered cow milk (**Table 3**). In most cases (71%), milk was subsidized by HIV support networks or the national MTCT prevention program. Other mothers bought milk from shops.

All infants were given gruel, either IFM (85 and 73% of 6- to 8- and 9- to 11-mo-old infants, respectively) or/and traditional porridge (37and 61% of 6- to 8- and 9- to 11-mo-old infants, respectively). Very few infants (n = 3) were fed neither milk nor fortified gruel. Family/solid foods were part of the diet of 52 and 78% of 6- to 8- and 9- to 11-mo-old infants, respectively.

Among 35 infants who covered their energy needs on the day of the survey (intake ≥ 80 kcal/kg), 32 (91%) drank milk and 27 (77%) consumed IFM gruel in median amounts of 458 g (110–1408) and 233 g (21–1225), respectively. Among those who did not attain their energy requirements (n = 33), 26 (79%) consumed milk and/or IFM gruel but at lower median amounts of 350 g (15–775) and 76 g (2–460), respectively. In both cases, the median amount of fortified gruel ingested was lower than the recommended quantity (Table 3). Among the youngest infants, traditional porridge was consumed at higher median amounts than IFM gruel (332 vs. 69 g). Nevertheless, low-energy dense porridge accounted for less than IFM in total energy dietary intake. Family/solid foods were given in small median amounts (17 and 18 g/feed in 6- to 8- and 9- to 11-mo-old infants, respectively) 4 times on the day of the survey (in both age groups).

Overall, milk was the major source of energy in the 6- to 8-mo age group (46.6%) and continued to represent a substantial contribution for 9- to 11-mo-old infants (32.5%) and IFM gruel was the second contributor, representing 25 and 30% of the energy intake, in 6- to 8- and 9- to 11-mo-old infants, respectively.

TABLE 1 Comparison of intakes of nonbreast-fed Burkinabe infants aged 6–11 mo according to the method: 24-h dietary recall or food weighing[1]

	24-h recall	Food weighing	Correlation test	
			r	95% CI
Feeding frequency, *n/d*	6.6 ± 1.4	7.5 ± 1.9*	0.47	(0.25–0.63)
Food intake, *g/d*	879 ± 439	877 ± 387	0.82	(0.71–0.88)
Energy intake,[2] *kcal/d*	695 ± 379	703 ± 327	0.79	(0.67–0.86)
Energy from milk, *kcal/d*	262 ± 226	262 ± 207	0.84	(0.75–0.90)
Energy from IFM gruel, *kcal/d*	252 ± 329	221 ± 296	0.86	(0.78–0.91)

[1] Data are presented as mean ± SD, n = 68 for each method. *Wilcoxon's Signed Rank test, $P < 0.05$.
[2] 1 kcal = 4.18 kJ.

TABLE 2 Nutrient intakes of nonbreast-fed Burkinabe infants aged 6–11 mo compared with WHO recommendations for nonbreast-fed children[1,2]

	Study infants: 6–8 mo	Recommendations: 6–8 mo	Study infants: 9–11 mo	Recommendations: 9–11 mo
Feeding frequency, *n/d*	7.2 ± 1.6	3.9[3]	7.7 ± 2.1	3.8[3]
Food energy density,[4] *kcal/g*	0.8 ± 0.2	—	0.9 ± 0.2	—
Food intake, *g/feeding*	102 ± 42	249	125 ± 53	285
Energy intake, *kcal/d*	523 (82–1053)	615	811 (34–1543)	686
Energy intake, *kcal/kg of body weight*	75 (12–140)	80[5]	88 (4–179)	80[5]
Protein intake, *g/100 kcal*	2.7 ± 0.6	1.0	2.6 ± 0.6	1.0
Lipid intake, *% total energy intake*	32 ± 9	30–45%	30 ± 9	30–45%

[1] Guiding principles for feeding nonbreast-fed children 6–24 mo of age (15).
[2] Food study data are presented as mean ± SD or median (range), *n* = 27 (6–8 mo old), or 41 (9–11 mo old).
[3] Values calculated when the food energy density is 0.8 kcal/g (15).
[4] 1 kcal = 4.18 kJ.
[5] Recommended values from Butte (21).

Compliance with recommended diet in relation to infant growth. Infants were classified into 3 groups according to compliance with the recommended diet in the KBS in terms of daily consumption of milk and IFM: 38 were described as highly compliant, 20 as fairly compliant, and 10 as poorly compliant. Mean energy intakes in highly, fairly, and poorly compliant infants were as follows: 781 ± 309, 713 ± 308, and 389 ± 261 kcal, respectively. Amounts per feed were similar among highly (122 ± 41 g) and fairly (128 ± 57 g) compliant infants and much higher than in the 3rd group (70 ± 45 g) ($P = 0.005$). Mean IFM intake was different in the 3 groups: 239 ± 204, 119 ± 307, and 65 ± 143 g, respectively ($P = 0.05$); mean milk intake was high and similar in the highly (456 ± 274 g) and fairly (469 ± 313 g) compliant infants and lower in the 3rd group (340 ± 226 g).

At the time of the survey, mean WAZ was −1.0 ± 1.0 and 10 infants were underweight (WAZ < -2). Mean LAZ at 6 mo of age was −0.5 ± 0.9 and 1 infant was stunted (LAZ < -2). The prevalence of WAZ, LAZ, and WHZ did not differ according to level of compliance, but there was a significant interaction between age and compliance for WAZ and WHZ, indicating that changes over time for these 2 indices differed according to the level of compliance with the recommended diet ($P < 0.0001$ for both) (**Fig. 1**). From 6 mo of age, the WAZ curve of poorly compliant infants dropped steadily, whereas the decrease among infants in the other 2 groups was more limited. Mean LAZ tended to be lowest for poorly compliant children as early as 1 mo of age (data not shown).

Discussion

Despite the provision of fortified food free of cost, many mothers either did not feed IFM to their infants or fed it in too small amounts to cover their energy needs. We reported satisfactory mean feeding frequency and mean energy, protein, and lipid densities of replacement food compared with the WHO recommendations in nonbreast-fed infants' diet (23). However, mean values hid substantial individual disparities and the finding that in both age groups, one-half of the infants did not cover their energy needs (i.e. 80 kcal/kg) was of major concern.

Most traditional complementary food recipes in developing countries do not meet the energy and micronutrient requirements of breast-fed infants (24). It is now recognized that it is virtually impossible to meet the requirements of nonbreast-fed infants in the absence of fortified complementary food (25). The linear programming method was used by Lunney et al. (10) to construct theoretical diets that maximized nutritional quality for 6- to 9-mo-old nonbreast-fed infants using various food availability scenarios in Zimbabwe. These simulations resulted in an adequate diet only if 64 g of "Plumpy Nut" (a commercial fortified weaning food) entered into the model (10). In our study, IFM was continuously provided and free of cost, and most mothers received subsidized milk from outside the KBS. As a result, ~75% of total energy and protein intake in both age groups was provided by subsidized foods, and the median energy intake of KBS infants was considerably higher than that reported by Lunney et al. (10) (523 vs. 364 kcal in 6–8 mo-old children).

In the present study, the mean amount ingested per feeding (102 and 125 g in 6–8 and 9–11 mo olds, respectively) was very low and reached only 40% of the theoretical gastric capacity. Feeding in such small amounts had negative consequences on total energy intake, particularly among the youngest children. Other studies, conducted in rural and urban areas on 6- to 11-mo-old breast-fed Burkinabe infants, reported even lower intakes per feeding (26,27). These convergent findings suggest that the food intake of healthy infants in such settings might not reach the recommended amounts per feed (i.e. 249 and 285 g in 6–8 and 9–11 mo olds, respectively). They also support the consensus that increasing the energy density of gruel improves the energy intake from gruel feeding (27–29). Thus, it is strongly preferable to increase the energy density of complementary

TABLE 3 Food intakes of nonbreast-fed Burkinabe infants aged 6–11 mo compared with KBS infant feeding recommendations[1]

	n	Study infants: 6–8 mo	*n*	Study infants: 9–11 mo	Recommendations: 6–11 mo
Milk feeding frequency, *n/d*	23	3.0 (1.0–7.0)	35	3.0 (1.0–7.0)	2–4
Milk intake, *g/d*	23	489 (15–1202)	35	380 (72–1408)	450
IFM feeding frequency, *n/d*	23	2.0 (1.0–5.0)	30	2.0 (1.0–5.0)	2–4
IFM gruel intake, *g/d*	23	69 (2–739)	30	233 (10–1225)	450

[1] Food study data are presented as median (range).

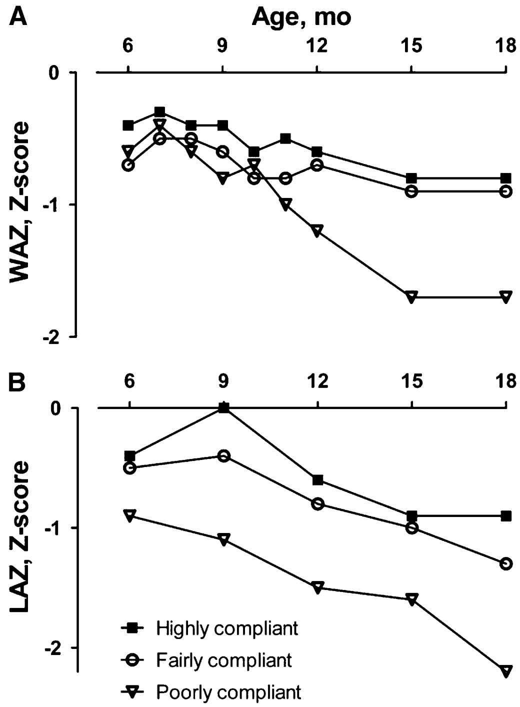

FIGURE 1 Changes in WAZ (*A*) and LAZ (*B*) of infants that were not breast-fed after 6 mo of age, by level of compliance with the study's infant feeding recommendations. Values are means. Differences at 18 mo in WAZ trajectories between highly (n = 38) and poorly (n = 10) compliant groups, and fairly (n = 20) and poorly compliant groups (analyzed by a Mixed Model), *P*-values: age < 0.0001, compliance to the diet = 0.37, age × compliance < 0.0001.

foods rather than increasing the meal frequency or ingested amounts.

These observations raise the question of the availability and accessibility of both fortified infant food and milk in this vulnerable population of nonbreast-fed infants, because both food items are necessary, in adequate amounts, to meet their energy requirements.

We previously reported efforts made to provide locally produced fortified food in this setting, along with nutritional education and monitoring (16). Our findings shed light on how such food aid can enhance the nutritional intake of HIV-exposed infants. However, special attention should be paid to the limitations of such support programs and implementation gaps should be addressed to optimize the impact of food aid on infants' dietary intake and growth. Food aid leakages within the family, suboptimal feeding practices, and appetite saturation when using a unique energy-dense food on a daily basis, all of which have been previously described in this sample (16), negatively affected food and energy intake reported in the present study.

Among study infants, the regular consumption of milk and IFM was associated with a slightly more rapid weight gain up to 18 mo of age, whereas infants who were fed fortified food less optimally presented the expected decrease in WAZ (P < 0.0001). In a MTCT prevention study conducted in Abidjan, HIV-infected breast-feeding mothers were advised to stop at 4 mo and were provided free formula up to 9 mo postpartum (9). Inadequate complementary feeding at 6 mo was strongly associated with the prevalence of stunting during the next 12 mo. In both these MTCT prevention studies, a high standard of care was offered and children diagnosed with malnutrition were clinically and nutritionally treated. Such measures, in addition to food or milk provision, are likely to improve infant health, appetite, nutrient intake, and growth. Outcomes in terms of growth, food intake, and compliance with recommendations were thus very likely more satisfactory than what would have been observed under standard conditions of care.

To our knowledge, this work is the first to provide data on food consumption of nonbreast-fed African infants using the food-weighing method. One limitation, however, lies in the fact that 1-d weighing of food, even when coupled with a 24-h recall, is not necessarily representative of usual feeding practices. However, this work provides detailed and fairly precise information on nonbreast-fed infant energy and macronutrient intakes, because all intakes were recorded with the possible exception of nighttime feeding. The sample size was moderate (68 children) but adequate for our study objectives. In addition, it was considerably larger than that of the only previous study reporting energy intake in nonbreast-fed African infants (10).

Research and programmatic experience describing adverse effects of early breast-feeding cessation (at 3–4 or 6 mo postpartum) and difficulties encountered by mothers in covering the nutritional needs of their nonbreast-fed infants have accumulated since 2007. In addition, recent evidence from the KBS and others showed that ARV prophylaxis in HIV-infected mothers (30) or HIV-exposed infants (31) can significantly reduce the risk of postnatal transmission during the first 5 or 6 mo. Those findings are reflected in the recent revision of WHO guidelines recommending that mothers should breast-feed up to 12 mo postpartum under cover of maternal or infant ARV prophylaxis until breast-feeding cessation (32). Our finding, showing that without any kind of food support most KBS mothers would have been unable to provide appropriate replacement feeding for their nonbreast-fed infant, directly supports this new policy. Nevertheless, how and what to feed nonbreast-fed infants aged 6–11 mo and later remains a crucial issue. Further research on locally based food support should be encouraged and formally tested for efficacy in sustaining nutrition and growth of nonbreast-fed infants. In terms of both operational and financial feasibility, it is highly unlikely that such a strategy (i.e. breast-feeding plus ARV prophylaxis for up to 12 mo postpartum) can be implemented on a wide scale over the short or medium term in sub-Saharan Africa. Indeed, in 2008, 45% of HIV-infected pregnant women in sub-Saharan Africa benefitted from standard MTCT prevention services (27% only in West and Central Africa) (33). Moreover, it has been observed in various settings that HIV-positive mothers who clearly understand that HIV is transmitted through breast milk might show a strong determination to stop breast-feeding early (10,34) or to practice formula feeding from birth (34). Thus, defining strategies for adequate feeding of 6- to 12-mo-old nonbreast-fed African infants is likely to remain a public health challenge for many years.

In conclusion, this study shows that many nonbreast-fed infants had low energy intake even under the extremely favorable conditions provided by the KBS. Scaling-up of the new MTCT prevention policy in the coming years, i.e. prolonging breast-feeding up to 12 mo postpartum, should partly alleviate malnutrition and mortality among HIV-exposed infants. However, due to the critical nutritional situation of nonbreast-fed infants in sub-Saharan Africa, informing mothers and implementing appropriate and sustainable food support programs are of utmost importance.

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