HIV/AIDS, Undernutrition, and Food Insecurity

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Despite tremendous advances in care for human immunodeficiency virus (HIV) infection and increased funding for treatment, morbidity and mortality due to HIV/AIDS in developing countries remains unacceptably high. A major contributing factor is that >800 million people remain chronically undernourished globally, and the HIV epidemic largely overlaps with populations already experiencing low diet quality and quantity. Here, we present an updated review of the relationship between HIV infection, nutritional deficiencies, and food insecurity and consider efforts to interrupt this cycle at a programmatic level. As HIV infection progresses, it causes a catabolic state and increased susceptibility to other infections, which are compounded by a lack of caloric and other nutrient intake, leading to progressive worsening of malnutrition. Despite calls from national and international organizations to integrate HIV and nutritional programs, data are lacking on how such programs can be effectively implemented in resource-poor settings, on the optimum content and duration of nutritional support, and on ideal target recipients.

Morbidity and mortality related to human immunodeficiency virus (HIV) infection in the developing world remain unacceptably high, despite major advances in HIV therapy and increased international funding for care [1, 2]. People living with HIV infection (themselves or among family members) face not just sickness but also impaired productivity, declining income, and increasingly difficult choices among essential but competing expenses, such as food versus health care or schooling versus rent [3]. The physiological complications of progression of HIV infection are compounded by the problems associated with poverty, because it translates into insufficient consumption of a diet of adequate quality and quantity to bolster immune function and support medical therapy. Recently, several international agencies emphasized that targeted nutritional interventions should be systematically linked to antiretroviral interventions [4–11]. The World Bank has called for a scaling up of action on nutrition and AIDS through “action research” and “learning by doing” [10, p 12]. A recent review of approaches to nutrition in HIV programs in Africa concluded that current HIV/AIDS policies “have tended toward highly medicalized approaches” and called for “a comprehensive approach to link health strategies with community-oriented food-based strategies” [12, p 2–3]. Despite this, few data exist to help guide the development of effective programs that integrate HIV care and nutrition.

Food insecurity (defined as a persistent lack of access to adequate food in needed quantity and quality), undernutrition (including deficiencies in micronutrients as well as macronutrients), and HIV/AIDS overlap and have additive effects [4]. More than 800 million people worldwide are chronically undernourished, and >33 million are living with HIV infection [1, 2, 13]. Combating undernutrition and HIV/AIDS are 2 of the 8 United Nations Millennium Development Goals to be achieved by 2015—international targets that form a blueprint for galvanizing priorities for the world’s poor. The complex interaction between HIV infection and nutrition seriously threatens the achievement of these goals.

HIV CARE IN DEVELOPING COUNTRIES

Advances in the treatment of HIV infection during the last 20 years have resulted in antiretroviral therapy (ART) combinations that can result in reduced HIV RNA level and improved immunologic function, leading to dramatic improvements in health, reductions in morbidity, and prolonged life [14–17]. Increased funding has become available for HIV treatment in the developing world, and the vast majority of such programs have demonstrated excellent clinical outcomes [18, 19]. Despite
this, optimism is tempered by the fact that HIV infection remains a major cause of morbidity and mortality [20] when at the same time malnutrition remains the main cause of child mortality across the developing world [12]. The largest burden of HIV disease still exists in low- and middle-income countries, where >2 million deaths due to AIDS occurred in 2007 alone and just 31% of patients requiring ART have access to treatment [1]. Early mortality while receiving ART is a common feature in many programs, with individuals presenting for care with very advanced disease and multiple comorbid conditions [18, 21]. Comorbidities such as tuberculosis, undernutrition, diarrheal disease, and malaria are highly prevalent in these areas, and all have a negative interaction with HIV infection [22, 23].

Barriers to effective HIV care in the developing world are many, including a lack of trained health care professionals, a lack of infrastructure, and a lack of resources devoted to health [24]. The financial cost of care to individuals also has an important effect on HIV care in resource-constrained environments—paying for care has been associated with both worse outcomes and worse adherence to therapy [25–28]. Both households and governments face competing choices for their expenditures: food (often accounting for as much as 75% of total household spending), health care, and education are frequent competitors [3]. In this context, the complex interaction between HIV infection, undernutrition, and food insecurity can be a critical barrier to effective HIV care, and the development of evidence-based programmatic solutions to these issues becomes essential.

**UNDERNUTRITION AND HIV FEEDBACK**

Undernutrition and HIV status have negative feedback loops, resulting in severe effects on the resilience of individuals, households, and communities. Such interactions manifest at both the level of the HIV-infected individual and the level of the affected household in terms of clinical, nutritional, quality-of-life, and economic outcomes.

At the individual level, a lack of access to appropriate food and the direct effect that HIV has on impaired metabolic functions in absorption, storage, and utilization of nutrients can translate into compromised immunity, nutrient deficiencies, and increased vulnerability to infectious diseases [29, 30]. Lack of sufficient food intake and/or malabsorption leads to weight loss, which further exacerbates the catabolic nature of HIV infection [31, 32]. Weight loss is itself a significant, independent risk factor for AIDS-related mortality, and HIV-associated wasting often persists even with use of ART [33, 34].

HIV infection reduces the efficiency of nutrient absorption and utilization partly because of frequent diarrhea due to compromised immunity [35–37]. Malabsorption of fats and carbohydrates is common, with the former adversely affecting the absorption and utilization of fat-soluble vitamins, compromising immunity and worsening nutrient deficiencies [38]. Infections and nutritional deficiencies cause an increase in levels of prooxidants that results in oxidative stress, which may indirectly accelerate HIV replication [38]. Metabolic changes, including changes in insulin and glucagon levels, result from both reduced food intake and the immune response to infection and may lead to muscle wasting [37]. Because HIV infection increases resting energy expenditure as a function of HIV load, people living with HIV infection have higher protein requirements than do their noninfected counterparts [35, 37–40], and HIV-infected children experiencing weight loss have energy requirements 50%–100% above normal [40]. ART itself increases resting energy expenditure independently of viral load, further contributing to HIV-associated weight loss [33, 39]. As HIV infection progresses, it can cause a catabolic state that is compounded by a lack of caloric intake, increasing the severity of preexisting undernutrition [30, 32, 41]. In children, advanced HIV infection often presents with clinical features that are indistinguishable from severe undernutrition [42]. These facts further highlight the particular need to ensure adequate caloric and multivitamin intake in adults and children living with HIV infection.

Of critical importance is the growing recognition that individuals receiving ART face serious adverse effects, resulting in lack of adherence when faced with a lack of food in the household [43–45]. Undernutrition increases the probability of developing hepatic toxicity to nevirapine [46]. Food facilitates the absorption and effectiveness of drugs, and increased appetite is an intended and desirable effect of drug therapy—one that is needed to reverse loss of body mass and to promote recuperation and enhanced immune function [47, 48].

At the household level, a lack of food can lead to the adoption of risky coping strategies, such as sale of assets, redirection of (wage) labor, or exchange of sex for money or food, all of which increase exposure to HIV and increase economic vulnerability [49–51]. Reduced food intake in the HIV-affected household can also result from loss of income and food-production capacity in the family due to labor loss, psychosocial factors, or adverse effects of medication (such as dizziness and nausea) [36, 37, 52]. ART is difficult to take on an empty stomach, travel to a health facility may become impossible because of weakness and lethargy, time in the fields or at work cannot be spared for medical visits, and migration in search of work affects continuity of care [53, 54]. In other cases, assets are sold to pay for medical care or children are removed from school because of a lack of funds or the need for additional labor, leading families into worsening cycles of poverty [55, 56]. A lack of access to food drives families into social crisis, migration, and displacement, which subsequently puts them at increased risk of HIV infection and its consequences [53, 57]. Rural communities with a high prevalence of HIV infection
may face aggregate reductions in the local food supply and increased labor costs [58]. The result of these interactions is a series of ripple effects extending far beyond the infected individual to the household and societal levels [59]. The overall loss of productivity contributes significantly to hunger and poverty for families and communities. The total economic loss from HIV/AIDS worldwide is estimated at US $25 billion per year and rising [60].

In other words, HIV/AIDS substantially complicates the already multidimensional problem of global undernutrition, and undernutrition in turn complicates the global fight against the HIV epidemic [36, 55].

INTERVENTIONS TO INTERRUPT THE CYCLE

Targeted food and nutritional assistance to individuals with HIV infection and their families has the potential to improve nutrition [10, 61] and may decrease susceptibility to HIV infection [36, 49, 61, 62]. Targeted food rations, for example, may allow infected individuals to improve adherence to therapy while preserving assets by not having to sell possessions to purchase food [61]. In the United States, nutritional interventions to prevent weight loss and wasting in HIV-infected patients have often focused on counseling and nutrient supplements rather than food rations to increase energy and protein intake [47, 63]. Many have been shown to be very successful [47, 64]. Interventions that seek to enhance the knowledge and behaviors of mothers with respect to nutrition have been recognized for decades as being valuable for child nutrition [65, 66]. Although techniques and message content vary widely across programs, communicating specific information on nutrition is consistently associated with a positive outcome [67]. Targeted food interventions may also enable increased labor supply and the productivity of that labor, the benefits of which might include increased home production of food and increased wage earning, both of which contribute to household food security. In other words, food and other nutritional assistance programs have the potential to improve the course of HIV disease in developing countries, where undernutrition and food insecurity are major coexisting factors.

CLINICAL AND NUTRITIONAL EFFECTS OF FOOD ASSISTANCE IN HIV CARE

Despite the current understanding of the complex interaction between HIV infection, food intake, and low income, the quantitative clinical benefits of providing food assistance to individuals with HIV infection, the appropriate enrollment criteria for targeted food programs, the appropriate duration of food assistance, and the effects of such programs on household members remain largely undocumented [68–70]. A recent Cochrane systematic review reported that, on the basis of the current evidence, no conclusions could be drawn regarding the effect that macronutrient supplementation has on morbidity and mortality in people with HIV infection [71]. A pilot study of food ration supplementation in Zambia suggested that food assistance is associated with better adherence to ART; however, no significant effect was observed for weight gain or CD4 cell count. This may in part be attributable to a small sample size; the authors called for a large randomized study to demonstrate the clinical outcomes of food supplementation [72]. Prevention of any adverse effects of food assistance is also important. Although data on the incidence of refeeding syndrome among those with severe wasting due to HIV infection are lacking, these individuals may be at risk for potentially fatal shifts in fluid and electrolyte balance during rapid refeeding [73, 74]. In addition to the direct health benefits of food assistance for the individual, attention must also be paid to the effects that interventions have on households, such as labor productivity and broader measures of household welfare. Understanding these effects will be critical to the development of effective and sustainable food programs [75, 76].

A detailed discussion of interventions other than assistance in the form of food rations is beyond the scope of this review. However, the role played by such potentially complementary interventions as agricultural interventions, socioeconomic assistance, accompaniment, education, and training [59, 77–79] are of the utmost importance and need to receive critical consideration to improve the livelihoods of people living with HIV infection and food insecurity.

IDEAL BENEFICIARIES OF FOOD ASSISTANCE

Efficient targeting of food assistance is critical to the management of scarce resources, but few data exist to guide programs as to which individuals or households to target in locations where there is both high food insecurity and a high prevalence of HIV infection. Programs are often targeted to individuals receiving ART, but it is highly plausible that food assistance would benefit those not yet requiring ART, potentially preventing the progression of HIV disease and delaying the need for ART. It is not clear how food or other nutritional support (whether supplements or nutritional education) is shared within families. Households are not unitary decision-making bodies; food is shared and allocated differently within different types of households depending on demographic composition, who within the household is sick or has died, social standing, socioeconomic status, and other factors [80]. Understanding the differing bases for sharing food is critical to improving the targeting of therapeutic food versus food intended for general household consumption [81–83].
OPTIMAL COMPONENTS OF FOOD ASSISTANCE

Although agreement is growing that nutritional support is beneficial, the optimal form of such support remains unknown and largely unstudied [75]. A recent training manual developed in Ethiopia asserts that food-based approaches to increasing vitamin and mineral intake and optimizing immune function are “the most preferred strategy” and that foods should include local vegetables and fortified staple products [81, 84]. However, there is no international consensus on a universal HIV food ration, making it difficult to determine programatically what any food basket should contain [81, 85]. Furthermore, food rations require resources, but few data exist on the cost-effectiveness of nutritional interventions in the context of HIV care in developing countries [86–88]. This may differ substantially from that of more-general studies of the returns of nutritional interventions [47, 89]. It is increasingly argued that more attention is needed on the importance of complementary community outreach in tandem with food—that is, seeking to empower caregivers or individuals by imparting tailored knowledge about causes and solutions to these conditions.

Recently, the use of ready-to-use therapeutic foods (RUTFs) has received growing attention in food support, with a particular focus on spreads that are semisolid variants of F100 therapeutic milk (a milk formulation used for the treatment of severe childhood malnutrition). The most widely used spread is a mixture of milk powder, sugar, vegetable oil, peanuts, vitamins, and minerals—an energy-dense product that resists bacterial contamination and requires no cooking [90, 91]. Providing a RUTF to HIV-infected individuals in addition to food rations to affected family members appears to have the potential to affect nutritional gains across the household. The RUTF provides a nutrient-dense supplement that can be targeted to the HIV-infected individual, with other foods in the basket serving to protect other family members from consumption inadequacy. That fortified blended foods and RUTFs have significant effects on morbidity and nutritional outcomes has been shown among refugees in Algeria [92, 93], Nepal [94], Bangladesh [95], and Zambia [96]. In Angola, the prevalence of anemia among children decreased from 48% to 24% over a period of 12 months, and vitamin A deficiency among adolescents was reduced from 47% to 20% [97]. RUTFs are also increasingly being used in HIV programs [98, 99].

Quantity of calories is important, but so is quality in terms of the nutrient components and mixes within food baskets. There is growing scientific consensus that food sufficiency is a critical component of the treatment of both malnutrition and malnutrition-mediated disease outcomes and that sufficiency requires close attention to diet quality, not merely quantity or adequacy. By further linking the clinical and nutritional effects of food interventions to determinants of household welfare, one could extend our understanding of the benefits of both to HIV-infected individuals and their household members.

There is considerable debate and uncertainty over the nutritional and health effects of generic food rations, which are used for many programmatic purposes around the world. Their role in preventing starvation in emergencies and in buffering household-level consumption among the very poor is clearly important; however, not only do these uses have different objectives than those of food-assistance programs for chronic diseases such as HIV/AIDS, but the nutritional effect of the so-called standard rations has been questioned [100, 101]. For example, recent research in Haiti demonstrated that one of the common “nutritionally enhanced” components of World Food Programme rations—a micronutrient-fortified corn-soy blend—had little or no effect on childhood anemia unless additionally fortified with a powdered micronutrient mix added to the food at the time of serving [102]. Thus, the World Food Programme and other food-assistance agencies have argued strongly for a need for more insight into appropriate food formulations and nutritional packages that may achieve measurable nutrition and health outcomes in the context of HIV programs [76, 103].

Economists have long proposed the possibility that, in addition to the direct health benefits for individuals and their households, increased caloric intake and improved nutritional status may lead to higher wages and labor productivity (ie, the “efficiency wage hypothesis”) [104]. Strong empirical support for this hypothesis has been established in countries as diverse as Sierra Leone [105] and India [106]. As the labor force in countries with a high prevalence of HIV infection becomes depleted by disease—with potentially devastating economic consequences [107]—understanding and measuring the productivity cost of HIV infection and how food supplementation may affect it is also critical in the design of public health responses.

CONCLUSIONS

HIV infection constitutes a global public health emergency and is most prevalent in areas of the world where undernutrition is also a serious concern. The concept of enhancing access to food among undernourished people, regardless of HIV status, is long-standing; however, critical questions remain as to the most effective ways to incorporate nutritional interventions into HIV programs. The differentiation between food and nutrition must be emphasized, as must the concept that quantity of food is not synonymous with nutritional value. This has been less of a focus because of the urgency of the situation and the understandable reflex to get whatever food is available to those who are hungry during emergencies. The negative inter-
active effects of undernutrition, inadequate food consumption, and HIV infection demand special focused efforts to ensure that effective cross-sectorial solutions are devised and implemented.

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