Food Insecurity and HIV/AIDS: Current Knowledge, Gaps, and Research Priorities

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Food insecurity and HIV/AIDS are intertwined in a vicious cycle that heightens vulnerability to, and worsens the severity of, each condition. We review current knowledge and research priorities regarding the impact of food insecurity on HIV transmission risk and clinical outcomes. Observational studies suggest that food insecurity is associated with increased HIV transmission risk behaviors and decreased access to HIV treatment and care. Among individuals receiving antiretroviral therapy (ART), food insecurity is associated with decreased ART adherence, reduced baseline CD4 cell count, incomplete virologic suppression, and decreased survival. Integration of food security interventions into HIV/AIDS treatment programs is essential to curtail the HIV/AIDS epidemic and improve health and quality of life among those infected. Longitudinal research applying validated measurement tools is needed to better understand the mechanisms through which food insecurity adversely impacts HIV transmission, treatment, and care. Research should compare the effectiveness of various food assistance and livelihood strategies.

Introduction

An estimated 33 million individuals were living with HIV/AIDS worldwide in 2007. During this same year, 2.7 million new HIV infections and 2.0 million AIDS deaths occurred globally [1]. Although access to highly active antiretroviral therapy (HAART) has led to significant decreases in morbidity and mortality, only 31% of clinically eligible individuals in low- and middle-resource countries were receiving treatment in 2007 [2]. Many populations affected by HIV/AIDS also experience high levels of food insecurity. The United Nations Food and Agriculture Organization estimated that 923 million individuals were undernourished globally in 2007, representing an increase of 75 million from 2005. Although 89% of food-insecure individuals live in Asia and Africa [3], the prevalence of food insecurity also appears to be high in resource-rich settings. Approximately 9% of Canadian and 11% of American households reported food insecurity in 2004 and 2007, respectively [4,5].

Food insecurity and HIV/AIDS are intertwined in a vicious cycle that heightens the vulnerability to, and worsens the severity of, each condition [6]. The impact of HIV/AIDS on food insecurity has been well-documented in Africa and manifests through the debilitation of the most productive household members, decreased household economic capacity, decreased household agricultural output, and increased caregiver burden [7,8]. Conversely, food insecurity has been associated with increased behavioral risk of HIV transmission [9••], reduced access to HIV treatment and care, adverse antiretroviral pharmacokinetics [10,11], decreased ART adherence, and worse clinical outcomes among HIV-infected individuals [9••,12,13]. In response to the growing recognition of this vicious cycle, international multilateral and nongovernmental organizations have suggested improved integration of food and HIV/AIDS programming activities [6,14,15].

This article reviews current knowledge and gaps regarding the impact of food insecurity on HIV-related risks and clinical outcomes in low- and high-resource settings, and identifies research priorities for the development of evidence-based programs and policies.

Food Insecurity: Definition, Measurement, and Prevalence

Definition of food insecurity

Operational definitions of food insecurity vary between international organizations [3,14,16]. One of the most comprehensive definitions describes food insecurity as

"the limited or uncertain availability of nutritionally adequate, safe foods or the inability to acquire personally acceptable foods in socially acceptable ways" [16]. Implicit in this general definition is the notion that a food-insecure individual may have one or several of the following characteristics: 1) insufficient quantity of food; 2) limited diversity of food groups; 3) poor safety of food; 4) feelings of hunger or anxiety regarding access to food; and 5) procurement of food in socially unacceptable manners, including begging, relying on charity, scrounging, stealing, exchanging sex for food, and other illicit activities [17].

Measurement of food insecurity

Multiple tools exist for measuring food insecurity prevalence at the individual, household, and population levels. Despite their differences, contemporary food insecurity measurement tools share certain similar features, including a focus on quantifying inadequate access to food, rather than the availability and utilization of food; an emphasis on subjective measures of food insecurity, in addition to objective measures; and a reliance on tangible measures of food insecurity, rather than proxies [18]. The most widely used and validated instruments for measuring food insecurity are the US Household Food Security Survey Module, the Household Food Insecurity Access Scale, and the Radimer/Cornell measure [17]. Common to these tools is the concept that the experience of food insecurity produces predictable reactions that can be captured and quantified through a survey, and summarized in a scale. Importantly, the ability to produce scaled indicators allows one to more finely distinguish between gradations of food insecurity.

Given the daily and persistent reality of food insecurity for millions of HIV-infected individuals globally, there is a need to continue strengthening food insecurity measurement tools. Several challenges remain in the effective population-level assessment of food insecurity, including 1) the development and validation of context-specific indicators to assess food insecurity in diverse HIV-infected populations; 2) the development and validation of measurement tools to assess subcomponents of food insecurity (eg, food insufficiency, quality, safety, and socially appropriate procurement); 3) the ongoing validation of short-questionnaire surveys to assess food insecurity in context of widespread, acute hunger; and 4) the operational assessment of the ability of available measurement tools to inform food security interventions [18].

Prevalence and correlates of food insecurity among HIV-infected individuals

Food insecurity is highly prevalent, and well above general population estimates, among people with HIV/AIDS living in both low- and high-resource contexts. A study in British Columbia, Canada, found that 48% of individuals receiving HAART through the free provincial health care system were food insecure, approximately five times the prevalence of the general Canadian population. Twenty-one percent of respondents indicated the presence of food insecurity with hunger, the most severe category of food insecurity [19]. Approximately 64% of HIV-infected injection drug users (IDUs) in the same province reported frequent hunger and either an inability to afford food or the purchase of drugs instead of food [20]. Similarly, 49% of HIV-positive homeless and marginally housed individuals in San Francisco, CA are estimated to be food insecure, nearly five times the prevalence of US national estimates [9••].

Although data are limited on the prevalence of food insecurity in resource-limited settings, a recent summary of 67,038 individuals enrolling in HIV care programs at Academic Model Providing Access to Healthcare clinics in western Kenya reported that 33.5% of enrollees were food insecure, with a range from 20% to 50% depending on clinic site [21••]. A Ugandan survey of 144 households, involving primarily HIV-infected women, found that 59% had low dietary diversity and 44% were accessing food aid. HIV-affected households coped with food insecurity by reducing household meal portion sizes on a daily basis and selling nonproductive household assets [8].

A consistent theme that has emerged in both resource rich and limited settings is a significant inequity in the experience of food insecurity by gender, with women most at risk [19,22••]. For example, among a sample of HIV-infected individuals in British Columbia, 33% of women were categorized as hungry, compared with 20% of men [19]. Similarly, among a population-based sample in Botswana and Swaziland, 32% of women were found to be food insufficient, compared with 22% of men [22••]. In addition to gender, poverty and indicators of low socioeconomic status, including unemployment, unstable housing, and lack of health insurance, have been strongly correlated with food insecurity among HIV-infected individuals [9••,19,23]. Drug use has also been a consistent correlate of food insecurity in HIV-infected populations in British Columbia and California. Additional correlates of food insecurity include living with children, recent incarceration, and worse physical and mental health status [19,23]. Few published studies to date have examined correlates of food insecurity among HIV-infected individuals in a low-resource setting. In Uganda, having an elevated number of household dependents has been significantly associated with household food insecurity among HIV-infected individuals [8]. Additional research is warranted in both high- and low-resource settings to better understand and address factors contributing to the experience of food insecurity in diverse HIV-infected population groups.

Food Insecurity and Adverse Health Outcomes

Impact of food insecurity on general health outcomes

Food insecurity can affect health directly or indirectly through the impact of poor nutritional status [24], or through social and behavioral mechanisms that influence choices and behaviors [25]. Food insecurity is associated

with adverse health outcomes for several diseases other than HIV. Food insufficiency has been associated with poor mental health status among adults and adolescents in the United States, including symptoms of depression, dysthymia, and suicide [25,26]. Food insecurity has been associated with elevated rates of obesity, diabetes, hypertension, and heart disease in North America [27–30]. Many of these associations persist even after controlling for measures of socioeconomic status [26,28,29]. A study among 11,539 young children in the United States suggests that a dose-response relationship may exist between food insecurity and fair/poor health status [31]. Additional research is needed to investigate the extent to which food insecurity contributes to metabolic and cardiovascular complications of HIV. This research is particularly important in light of the increasing contribution of cardiovascular and metabolic complications of HIV to overall morbidity and mortality among HIV-infected individuals [32].

The Impact of Food Insecurity on HIV Transmission Risk

Food insecurity and horizontal HIV transmission

In many parts of the world, women lack authority to manage household resources, including food procurement [33,34••]. At the same time, they are invariably responsible for feeding household members, notably children and the infirm [33]. As a coping mechanism, women may become involved in sex work or intergenerational relationships to gain access to food-related resources, where they lose ability to negotiate safe sex practices [34••,35]. For example, South African women who reported hunger were more likely to engage in transactional sex [36]. Similar findings were reported in Nigeria, where 35% of female sex workers said that poverty and lack of means to obtain food caused them to join the sex trade, and to engage in unprotected sex with clients [37]. A population-based survey in Swaziland and Botswana found that women reporting food insufficiency in the previous 12 months had 80% increased odds of selling sex for money or resources, 70% increased odds of engaging in unprotected sex and reporting lack of sexual control, and 50% increased odds of intergenerational sex [22••]. These associations remained even when controlling for other markers of socioeconomic status. Similar findings were identified in British Columbia, where a study of HIV-positive IDUs found self-reported frequent hunger was significantly associated with unprotected sex in the past 6 months [38].

In addition to risky sex, food insecurity may also increase vulnerability to HIV through other mechanisms. For instance, in a population-based case-control study of black men and women conducted in North Carolina, food insufficiency was found to be associated with heterosexually acquired HIV infection, both in the entire study population and in the subset without identifiable high-risk sexual behavior [39]. This may occur because food insecurity can lead to malnutrition, which heightens risk of HIV transmission by compromising immunostatus and gut and genital mucosal integrity [34••]. Food insecurity has also been associated with unsuppressed viral loads among those receiving HAART [9••], which may heighten risk of HIV transmission via vertical, sexual, and drug-using routes [40].

No current studies have examined the relationship between food insecurity and HIV transmission risk longitudinally. Longitudinal data using scaled, validated measures will permit a better understanding of the causal pathways and mediating factors in this relationship and how they are modified by gender. Investigations into household food insecurity and transmission among serodiscordant couples or within social networks could also shed light on this topic. More studies are needed to evaluate whether and the extent to which food insecurity may predispose to HIV transmission through mechanisms other than risky sex. For example, research is needed to examine the relationship between food insecurity and unsafe injection practices among HIV-infected individuals. Food insecurity may indirectly influence needle-sharing behavior by compromising IDUs' ability to access health care and social support services, including access to safe injection education and clean syringes. Research is also needed to assess the role of targeted food assistance and income generation programs in decreasing HIV transmission risk, particularly for women who appear to bear the greatest burden.

Food insecurity and vertical HIV transmission

Although there is limited literature on the specific impact of food insecurity on mother-to-child transmission (MTCT), parallel literature linking poor dietary diversity, malnutrition, and micronutrient deficiencies to MTCT does exist. Food insecurity may represent a proximal risk to many of these nutritional and micronutrient deficiencies, thus predisposing risk of MTCT. Insufficient micronutrient intake and poor dietary diversity have been associated with elevated risk of MTCT. A cohort study in Tanzania, Zambia, and Malawi found that 28% of women with severe iron deficiency, and 16% of women with moderate iron deficiency, had transmitted HIV to their infants by the end of 6 weeks [41]. An observational study in Malawi found that low vitamin A levels in pregnant women also increase risk of MTCT [42]. Low maternal body mass index (BMI) and low middle upper arm circumference, which are measures of malnutrition, have each been associated with intra- and early postpartum MTCT in Zimbabwe [43]. In Tanzania, maternal weight loss during pregnancy has been associated with a 2.3-fold increased risk of HIV intrauterine transmission in the second trimester, and a 1.7% increase in intrapartum and early breastfeeding MTCT during the third trimester of pregnancy [44]. Food insecurity may represent a measurable, modifiable, and early marker of maternal and fetal risk. Studies are needed to directly evaluate relationships between food insecurity and MTCT, and the mechanisms through which food insecurity might increase risk for MTCT.

Impact of Food Insecurity on Access to Treatment and Care Services

Food insecurity is a barrier to accessing health care in resource-rich and resource-poor settings. In the United States, food insecurity has been associated with postponing needed medications and care, and increased emergency department use and hospitalizations [28,31,45]. In a survey of 100 households in rural Gabon, poor nutritional status among children aged 0 to 23 months was associated with limited access to health care services [46]. Among 2889 households surveyed in eastern Burma, 4.1% of Karen, 2.0% of Karenni, and 26.6% of Shan experienced food security–related violations (ie, theft and/or destruction of food supplies). Women in households experiencing violations related to food insecurity exhibited decreased access to antenatal interventions [47]. Such findings highlight the potential for ethnic and gender-based inequalities both in the experience of food insecurity and its potential impact on access to essential medical care.

Few studies have evaluated the specific impact of food insecurity on access to treatment and care services among HIV-infected populations. In a qualitative study in Tanzania, hunger and household food insufficiency were cited by respondents as significant concerns regarding access to HIV health services. Reluctance to initiate ART was associated with anxiety regarding being able to maintain consumption of sufficient food and a balanced diet [48]. A qualitative study conducted in an urban Kenyan slum found fear of taking medication on an empty stomach due to lack of food was a widely cited reason for refusing to take antiretrovirals, despite ART clinical eligibility and free access [49]. Among individuals with low income in many parts of the world, accessing health care services must be balanced against competing demands for food and other resources. In India, being unemployed and having a lower income were both associated with not accessing ART among HIV-infected individuals [50]. In a qualitative study in Uganda, individuals receiving free antiretroviral medications often had to choose between using their limited income on paying for transportation to the clinic versus being able to adequately feed themselves and their children [51]. As a result of these impossible choices, some individuals in this study either missed health care appointments or were unable to pick up their antiretroviral medications. These qualitative studies all suggest that food insecurity has an adverse impact on ART access and uptake. There is now a need to quantify the extent of this relationship, and to identify the context-specific mechanisms capable of mitigating this adverse impact.

Impact of Food Insecurity on HIV Treatment and Clinical Outcomes

Impact of food insecurity on ART adherence

Several qualitative studies in sub-Saharan Africa have identified food insecurity as a risk factor for ART nonadherence. Among patients surveyed in Rwanda, 76% described fear of "having too much appetite and not enough to eat" as a major obstacle to their ART adherence. In contrast, thoughts about drug toxicities, disruption of the daily routine, and acceptance of their HIV illness were of concern to only a minority of participants [13]. In a conflict-affected population in northeastern Uganda, individuals consuming only one meal a day and those dependant on caregivers for food were particularly prone to missing ART doses [52]. In Zambia, the belief that antiretrovirals must be taken with food has led individuals to skip doses in the absence of available or accessible food [53]. The impact of food insecurity on adherence is not limited to developing countries. In British Columbia, individuals who were food insecure had over two times the odds of being less than 95% adherent to treatment, compared with individuals who were food secure [54]. In San Francisco, CA, food insecurity and ART nonadherence were associated in a nonlinear manner. Participants with severe food insecurity were less likely to have more than 80% adherence than were those who were not severely food insecure [9••].

Some recent research demonstrates a strong positive impact of nutritional support on ART adherence and retention in care. An ecological analysis of 177 ART care and treatment clinics supported by the President's Emergency Program for AIDS Relief across seven sub-Saharan African countries found that access to nutrition support services was the strongest predictor of non-attrition from HIV treatment [55]. A qualitative study in Kenya found that ART patients enrolled in a food support program self-reported greater antiretroviral adherence than those not receiving nutritional support [56]. In 2004, a pilot study of the effect of food supplementation on ART adherence was initiated in Zambia with the support of the Zambian Ministry of Health and the United Nations World Food Programme (WFP). In adjusted analyses, individuals receiving food supplementation had higher levels of adherence as recorded using a variation of the medication possession ratio (MPR). Two hundred and fifty-eight of 366 (70%) patients in the food supplementation group achieved an MPR of 95% or greater, compared with 79 of 166 (48%) among controls [57••]. This intervention study is an important first step in investigating the benefits of food supplementation to food-insecure individuals on ART. Additional operational and clinical research is urgently needed to assess the benefits of food security interventions for patients receiving ART.

Food insecurity and antiretroviral pharmacokinetics

Several studies have found that the absence of food adversely impacts the pharmacokinetic efficacy of protease inhibitor–based regimens [10,11]. Studies focused on darunavir have shown that drug intake without food results in a 30% decrease in drug plasma concentration [11]. The impact of food intake on bioavailability has also been noted for other protease inhibitors. The bioavail-

ability of saquinavir, nelfinavir, lopinavir/ritonavir, and atazanavir has been found to increase by 700%, 200% to 300%, 48% to 97%, and 35%, respectively, when taken with food, compared with a fasted state [10]. As a result of pharmacokinetic impacts, it is possible that food insecurity may contribute to reduced treatment effectiveness. Studies are needed to specifically evaluate this, particularly as availability of second-line regimens increases in low-resource settings.

Food insecurity and HIV immunological outcomes

Several studies have assessed associations between food security and immunological status. In British Columbia, individuals reporting food insecurity had significantly lower CD4 counts at ART initiation, compared with food-secure individuals [19]. Food insecurity was also associated with lower CD4 cell counts among HIV-infected individuals in San Francisco, CA [23]. Because these studies were cross-sectional, the direction of causality is not known. Studies from the pre-HAART era show strong associations between malnutrition and immunologic decline [58,59], but none of these studies specifically focused on food insecurity. In a large, randomized controlled trial of HIV-infected pregnant women, micronutrient supplementation was found to significantly elevate CD4 cell counts [60]. However, a recent food supplementation pilot study among food-insecure adults in Zambia did not show additional increases in CD4 counts at 6 or 12 months in individuals initiating ART [57••]. Additional research is needed to clarify the impact of food insecurity on absolute CD4 cell count and CD4 cell count decline pre-HAART, and on potential immunologic recovery after HAART initiation.

Food insecurity and HIV virological outcomes

In a recent study among HIV-infected homeless and marginally housed individuals on HAART in San Francisco, CA, food insecurity was found to be associated with incomplete HIV RNA suppression [9••]. In this study, the odds of viral suppression were 70% lower among participants who reported severe food insecurity, compared with those who were food secure or had only mild or moderate food insecurity, even after adjusting for nonadherence [9••]. The authors also looked at separate models stratified by high versus low levels of adherence, and found that the effects of food insecurity on viral load suppression were more pronounced among less adherent individuals. Finally, the authors looked at associations between food insecurity and viral load suppression stratified by regimen type. They found that for participants on protease inhibitor–based regimens, the association between food insecurity and viral load suppression was similar to that in the entire sample, and the study was underpowered to look at this association for participants on non-nucleoside reverse transcriptase inhibitor–based regimens. They concluded that the impact of food insecurity on viral suppression may be due to the combined effect of behavioral and biologic mechanisms that lead to suboptimal drug levels required for viral suppression. Future research should further examine the mechanistic pathways of suboptimal viral suppression among food-insecure individuals on HAART.

Impact of food insecurity on survival

Although there is limited literature looking at specific impacts of food insecurity on mortality, studies from resource-rich and resource-poor settings show strong associations between markers of poor nutritional status and mortality among ART-treated patients [34••,61,62]. One recent study found that food insecurity has an adverse impact on the survival of individuals living with HIV/AIDS. In a longitudinal cohort study of 1119 individuals receiving HAART in British Columbia, individuals who were food insecure and underweight (BMI < 18.5 kg/m^2) were two times more likely to die over an 8-year follow-up period compared with those who were neither food insecure nor underweight. This relationship remained statistically significant after controlling for adherence, baseline CD4 counts, substance use, and socioeconomic variables [12]. There was also a trend toward increased risk of mortality among people who were food insecure but had normal weight, but not among people who were food insecure and underweight. More studies from both resource-rich and resource-poor settings are needed to confirm these relationships and to better understand the extent to which associations between food insecurity and mortality are mediated by malnutrition versus other biologic and behavioral mechanisms.

Conclusions

The recognition of the role of food security in responding to the HIV epidemic is increasingly gaining momentum. As a result of the vicious cycle of food insecurity and HIV/AIDS, international organizations such as the World Health Organization, WFP, and others are now recommending the integration of nutrition interventions into HIV/AIDS treatment and care programs [6,15]. As countries and communities put these program and policy guidelines into practice, there is a need to fill critical gaps in understanding about the context-specific determinants of food insecurity, and about the impact of food insecurity on risk of HIV transmission and on clinical outcomes in both high- and low-resource settings.

We have presented here the emerging evidence on the role of food insecurity in HIV prevention, treatment, and care. Specifically, we have highlighted evidence that food insecurity increases risk for HIV transmission, impedes access to HIV treatment and care services, and is associated with worse clinical outcomes for individuals on HAART. Recognizing the implications of this unfolding reality for people living with HIV/AIDS in contexts of pervasive chronic food insecurity and

malnutrition, many HIV care and treatment providers across sub-Saharan Africa are increasingly integrating livelihood programs [63].

Although the current literature strongly argues that addressing food insecurity should be an integral part of HIV prevention and treatment programs in both resource-rich and resource-poor settings, important gaps in this literature remain. Studies have found a strong link between food insecurity and sexual risk-taking behaviors, yet studies evaluating these associations have rarely used validated scales, and none has examined this relationship longitudinally. No studies to date have examined whether food insecurity predisposes to needle-sharing among HIV-infected IDUs or whether food insecurity specifically predisposes to increased risk of MTCT of HIV. In addition, there is a need to identify the pathways that prevent food-insecure individuals from accessing HIV treatment and care, and from adhering to HAART regimens. Longitudinal research is also critical to clarify the relationship between food insecurity and immunologic, virologic, and mortality outcomes. Finally, research evaluating the impacts of targeted food assistance, sustainable livelihood strategies, and income generation programs on food insecurity's contribution to HIV transmission risk, access to care, and HIV clinical outcomes is needed in high- and low-resource settings.

Despite these gaps in our understanding about the interaction between existing HIV/AIDS, food insecurity, and malnutrition crises, lack of conclusive evidence-based knowledge in this area should not impede efforts to expand nutritional and livelihood support to people living with HIV/AIDS. There is a need to "learn by doing" and to integrate operational research into the programmatic response to these overlapping crises in order to identify successful context-specific, sustainable, and participatory food-insecurity interventions. The compelling evidence linking food insecurity and HIV/AIDS points toward the need for an urgent response to these overlapping epidemics, and toward the danger of ignoring an issue as basic as food and hunger in response to the global HIV pandemic.

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Disclosure

No potential conflicts of interest relevant to this article were reported.

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