HIV-Related Wasting in HIV-Infected Drug Users in the Era of Highly Active Antiretroviral Therapy

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Background. A decrease in the rate of human immunodeficiency virus (HIV) infection–related wasting has been reported in the era of highly active antiretroviral therapy (HAART). We investigated this concern in a hard-to-reach population of HIV-infected drug users in Miami, Florida.

Methods. After informed consent was obtained, 119 HIV-infected drug users were administered questionnaires involving demographic, medical history, and food-security information. Blood samples were drawn for immunological and viral studies. HIV-related wasting over a period of ≥6 months was defined as a body mass index of <18.5 kg/m², unintentional weight loss of ≥10% over 6 months, or a weight of <90% of the ideal body weight.

Results. The prevalence of HIV-related wasting was 17.6%. A significantly higher proportion of those who experienced wasting (81%) reported that there were periods during the previous month when they went for ≥1 day without eating (i.e., food insecurity), compared with those who did not experience wasting (57%). Although a greater percentage of patients who experienced wasting were receiving HAART, their HIV RNA levels were more than twice as high (mean ± standard deviation [SD], 166,689 ± 238,002 copies/mL; median log HIV RNA level ± SD, 10.2 ± 2.7 log₁₀ copies/mL) as those for the group that did not experience wasting (mean ± SD, 72,156 ± 149,080; median log HIV RNA level ± SD, 9.2 ± 2.3 log₁₀ copies/mL). Participants who experienced wasting were more likely to be heavy alcohol drinkers and users of cocaine. In multivariate analysis that included age, sex, food security, alcohol use, cocaine use, viral load, and receipt of antiretroviral therapy, the only significant predictors of wasting were ≥1 day without eating during the previous month (odds ratio [OR], 1.96; 95% confidence interval [CI], 1.18–3.26; P = .01) and viral load (OR, 1.64; 95% CI, 1.00–2.69; P = .05).

Conclusions. HIV-related wasting continues to be common among HIV-infected drug users, even among HAART recipients. Food insecurity and viral load were the only independent predictors of wasting. The social and economic conditions affecting the lifestyle of HIV-infected drug users constitute a challenge for prevention and treatment of wasting.

Despite the benefits of antiretroviral therapy on the survival of HIV-infected persons [1–4], loss of weight and of lean body mass remain independent predictors of mortality in the HAART era [5, 6]. This is of concern, because even modest weight loss of 5% of total weight in a 6-month period has been found to be an independent predictor of opportunistic infections and of shorter survival time, after adjustment for receipt of HAART and baseline CD4+ cell count [5–7]. Moreover, in certain cohorts, long-term HAART has not been found to prevent the high prevalence (18%–40%) of HIV-related wasting among some groups of patients [6, 8–10].

In the United States, where illicit drug abuse ranks second among etiological factors in the transmission of HIV [11], the combination of abuse of drugs and alcohol with HIV infection increases the risk of development of HIV-related wasting [12]. In addition, the social and economic conditions associated with the lifestyle of drug users are further complicated by the sequelae of HIV disease [13], which prevents access to food, social services, and treatments and increases vulnerability to HIV-related wasting [14].

HIV-related wasting is also affected by poor control of viral load observed in HIV-infected patients [15–17], particularly among drug users who are receiving...
HAART. Control of viral load requires a very high rate of adherence to HAART [18, 19], and adherence is hindered by the same social and economic conditions that promote HIV-related wasting, placing indigent patients, ethnic minorities [18], and substance abusers [20–22] at high risk for development of HIV-related wasting. The objective of this study was to document the prevalence of HIV-related wasting and of associated factors, including food intake, viral load, quality of life, and HAART use, in a cohort of mostly homeless HIV-infected drug users in Miami, Florida.

**METHODS**

A community-based cohort of HIV-infected drug users was recruited from Camillus House and other shelters and agencies for poor and uninsured persons in Miami during the period of March 2002 through December 2003. Participants were eligible if they were HIV seropositive, aged ≥18 years, and active drug users (determined by urine toxicology) and were living in Miami–Dade County. After screening, 119 participants were enrolled in a nutritional study. The Florida International University Internal Review Board (Miami) reviewed and approved this study.

At the baseline visit, participants underwent a physical examination that included obtaining of a medical history. The data collection tools emphasized the history of infectious illness, diabetes, coronary artery vascular disease, and trauma. Drug history included data on use of prescribed medications, alcohol, and recreational drugs. Height and weight were measured. Blood samples were obtained for determination of CD4+ cell count, viral load, and complete blood cell count and for blood chemistry analysis; urine samples were collected for toxicology studies. Lymphocyte phenotype was determined with 4-color immunophenotyping panel of monoclonal antibodies. Differential cell counts were determined using a MaxM Hematology Analyzer (Coulter), and the results were corroborated with cytospin smears. Viral load was determined by RT-PCR with use of the Roche Amplicor reagents and protocol.

Questionnaires were used to solicit data on demographic characteristics; “food security” (i.e., access to food in the past month); use of tobacco, alcohol, and illegal drugs; 24-h dietary recall; compliance with routine health care visits; and activities of daily living (ADL) score. The food security questionnaire evaluated the frequency and patterns of food consumption and use of other assistance programs (e.g., food stamps, soup kitchens, shelters, and specialized food-assistance programs for HIV-infected individuals) and health care services (e.g., outpatient, inpatient, and emergency care and care for HIV infection), perceived barriers to participation, and current living arrangements. Four questions were dedicated to assessment of the number of days during the previous 30 days in which the participant did not have food to eat for the entire day or had skipped meals (i.e., “access to food in the past month”). The questionnaire was adapted for this population from the Surveillance of Pediatric Undernutrition protocol developed by the Centers for Disease Control and Prevention [23], which was field-tested and validated for this study.

The 24-h dietary recall interviews were conducted by trained interviewers. The participants were asked to recall what foods were consumed in the previous 24-h period using food models and portion size prompts. The responses regarding all foods, beverages, vitamins, and other supplements were recorded on the recall form. Weight and height were measured for participants while they were wearing light clothing and no shoes, with use of a standard scale that had been calibrated prior to each measurement. The height was measured with the participant’s heels touching the base of the vertical board of the stadiometer. The moveable headboard was brought to the most superior point on the head, with sufficient pressure to compress the hair. HIV-related wasting was defined as a body mass index (BMI) of <18.5 kg/m², unintentional weight loss of ≥10% of weight in a 6-month period, or weight of <90% of the lower limit of ideal body weight (IBW).

Statistical analyses were performed with the nonparametric Wilcoxon rank sum test, Student’s *t* test, and the χ² test. All of the analyses were cross-sectional, using data collected at baseline, including age, education, food security, 24-h dietary recall, CD4+ cell count, and viral load. The diagnosis of HIV-related wasting was made by comparison of body weight at baseline and at the 6-month visit. Logistic regression was used to evaluate determinants of HIV-related wasting, and those factors found to be associated with HIV-related wasting were incorporated into multivariate models to assess whether the association was independent.

**RESULTS**

**Characteristics of the population.** Table 1 shows the mean age, sex, race, income level, education level, and the prevalence of homelessness for the participants. The only statistically significant difference between subjects who experienced HIV-related wasting and those who did not was homelessness: subjects who experienced HIV-related wasting were less likely to be homeless (33% of subjects) than were those who did not experience HIV-related wasting (56%; *P* = .058).

**HIV-related wasting, 24-h dietary recalls, and food security.** Of the 119 participants enrolled, 21 (17.6%) met the criteria for HIV-related wasting syndrome. Of the 21 participants, 8 (38.1%) had lost >10% of body weight since they completed their initial screening, 6 (28.6%) had a BMI of ≤18.5 kg/m², and 7 (33.3%) had a body weight of <90% of the IBW. The 24-h dietary recall revealed that there were no significant differences between subjects who experienced HIV-related wasting and those who did not with regard to daily caloric intake (mean ± SD, 1913 ± 938 kcal).
vs. 210 ± 1081 kcal; \( P = .57 \)) and daily protein intake (mean ± SD, 77.6 ± 24 vs. 116.8 ± 114 g; \( P = .12 \)).

A significantly higher proportion (81%) of participants who experienced HIV-related wasting, however, reported having gone for ∽1 day without having eaten food during the previous month, compared with those who did not experience HIV-related wasting (57%; \( P = .042 \)). In addition, a significantly higher proportion (47.6%) of subjects who experienced HIV-related wasting reported having eaten no food for ∽4 days in the prior month, compared with those who did not experience HIV-related wasting (25.5%; \( P = .044 \)). These differences remained significant after controlling for HAART use, age, sex, and CD4+ cell count (data not shown).

**HAART, viral load, and HIV-related wasting.** Most of the participants (84 [70.5%]) reported receipt of HAART. Subjects who experienced HIV-related wasting were more likely to be receiving HAART (18 subjects [85.7%]) than were those who did not (66 subjects [67.3%]), although the difference was not statistically significant (\( P = .094 \)). As shown in table 2, the CD4 cell count for subjects who had HIV-related wasting did not differ from that for subjects who did not experience HIV-related wasting; however, the mean HIV RNA level among those who experienced HIV-related wasting was more than twice as high (mean ± SD, 166,689 ± 238,002 copies/mL; median log HIV RNA level ± SD, 10.2 ± 2.7 log10 copies/mL) as the mean viral load for subjects those who did not (mean ± SD, 72,156 ± 139,080 copies/mL; median log HIV RNA level ± SD, 9.2 ± 2.3 log10 copies/mL). The mean hemoglobin concentration,
triglyceride level, and high-density lipoprotein (HDL) cholesterol level did not differ between the groups. Patients who experienced HIV-related wasting, however, had significantly lower levels of serum cholesterol (P < .001) and low-density lipoprotein (LDL; P < .001) cholesterol than did subjects who did not experience HIV-related wasting.

**Alcohol, drug abuse, and HIV-related wasting.** The proportion of heavy alcohol users (defined as those who consumed >1 drink per day) was significantly higher among subjects who experienced HIV-related wasting (31.6%) than among those who did not (8.6%; P = .006), as shown in table 3. Patients who experienced HIV-related wasting were more likely to be using cocaine (85.6%) than were those who did not (64.6%; P = .056). The proportion of heavy cocaine users (defined as those who used cocaine ≥5 days per week) among patients who experienced HIV-related wasting (23.8%) was almost double the proportion among subjects who did not experience HIV-related wasting (12.2%), although this difference did not reach statistical significance (P = .169).

**Quality of life and HIV-related wasting.** When ADL scores for patients who experienced HIV-related wasting were compared with scores for those who did not, patients who experienced HIV-related wasting were found to be less likely to hold full or part-time jobs (14 subjects [66.7%] vs. 83 subjects [84.7%]; P = .05). No significant differences were found with regard to the categories of self-reliance, health, support, or outlook between the groups.

**Predictors of HIV-related wasting.** As shown in table 4, univariate analysis of sex, food insecurity (i.e., the number of days without food), heavy alcohol use, cocaine use, occurrence of diarrhea, low hemoglobin level, viral load, receipt of antiretroviral therapy, dietary caloric intake, carbohydrate level, and protein intake from the 24-h dietary recall were used as predictors of HIV-related wasting. The only variables that were found to be significant were viral load (OR, 1.55; 95% CI, 1.03–2.34; P = .037), food insecurity (OR, 1.59; 95% CI, 1.06–2.38; P < .026), and heavy alcohol use (defined as use >5 days per week) (OR, 4.9; 95% CI, 1.5–16.4; P = .01). Although use of cocaine/crack did not attain statistical significance (P < .067), the OR was 3.33, indicating that cocaine/crack use may have a robust potential for predicting HIV-related wasting. Food insecurity was categorized as follows: no days without food in the past month, 1–3 days without food in the past month, 4–7 days without food in the past month, and >7 days without food in the past month. The OR for food security was expressed as change from these categories. This analysis indicates that the more days that the participants went without food, the more likely they were to experience HIV-related wasting.

In the multivariate analysis shown in table 5, which included age, sex, food security, heavy alcohol use, viral load, and antiretroviral therapy, the only significant predictors of HIV-related wasting remained no food eaten for >1 day per month (OR, 1.96; 95% CI, 1.18–3.26; P = .01) and viral load (OR, 1.64; 95% CI, 1.00–2.69; P = .05). Although univariate analysis revealed that heavy alcohol use was a significant predictor of HIV-related wasting, when considered in a multivariate model with viral load and food security, the effect of heavy alcohol use became statistically insignificant (P = .07). Considering that most participants (85.7%) who met the criteria for HIV-related wasting were receiving HAART, the independent relationship between HIV-related wasting and viral load suggests lack of adherence to HAART.

**DISCUSSION**

Our results show a relatively high prevalence of HIV-related wasting (17.6%) in a cohort of HIV-infected drug users, the majority of whom (70.5%) reported receiving HAART. A significantly higher proportion of participants who experienced

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<tr>
<th>Table 3. Prevalence of alcohol and drug use among HIV-infected participants who experienced HIV-related wasting and those who did not.</th>
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<tbody>
<tr>
<td>Substance abuse indicated by self-report</td>
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<tr>
<td>Heavy alcohol usea</td>
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<tr>
<td>Cocaine/crack use</td>
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<tr>
<td>Crack use</td>
</tr>
<tr>
<td>Heavy cocaine/crack useb</td>
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<tr>
<td>Speedball usec</td>
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<tr>
<td>Marijuana use</td>
</tr>
<tr>
<td>a Defined as consumption of ≥1 drink per day.</td>
</tr>
<tr>
<td>b Defined as use of drug ≥5 days per week.</td>
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<tr>
<td>c Use of an admixture of cocaine and heroin.</td>
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<tr>
<th>Table 4. Predictors of HIV-related wasting syndrome assessed by univariate analyses.</th>
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<tbody>
<tr>
<td>Predictor</td>
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<tr>
<td>Male sex</td>
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<tr>
<td>Food insecuritya</td>
</tr>
<tr>
<td>Heavy alcohol useb</td>
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<tr>
<td>Cocaine/crack use</td>
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<tr>
<td>Diarrhea</td>
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<td>Low hemoglobin concentrationc</td>
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<tr>
<td>Viral load</td>
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<tr>
<td>Antiretroviral therapy</td>
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<tr>
<td>Caloric intake</td>
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<td>Carbohydrate intake</td>
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<td>Protein intake</td>
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<tr>
<td>a Food insecurity is defined as no food eaten for a whole day and is coded as 0 days, 1–3 days, 4–7 days, and &gt;7 days in the past month.</td>
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<tr>
<td>b Defined as consumption of ≥1 drink per day.</td>
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<tr>
<td>c Defined as a concentration of &lt;14 g/dL.</td>
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Table 5. Predictors of HIV-related wasting syndrome assessed by multivariate analyses.

<table>
<thead>
<tr>
<th>Variables</th>
<th>OR (95% CI)</th>
<th>P</th>
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<tbody>
<tr>
<td>Age</td>
<td>1.031 (0.953–1.115)</td>
<td>.45</td>
</tr>
<tr>
<td>Male sex</td>
<td>0.539 (0.172–1.689)</td>
<td>.29</td>
</tr>
<tr>
<td>Food insecurity&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.96 (1.18–3.26)</td>
<td>.01</td>
</tr>
<tr>
<td>Heavy alcohol use&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.61 (0.89–14.6)</td>
<td>.07</td>
</tr>
<tr>
<td>Viral load</td>
<td>1.64 (1.00–2.69)</td>
<td>.05</td>
</tr>
<tr>
<td>Receipt of HAART</td>
<td>3.227 (0.833–12.493)</td>
<td>.09</td>
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</tbody>
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<sup>a</sup> Food insecurity is defined as no food eaten for a whole day and is coded as 0 days, 1–3 days, 4–7 days, and >7 days in the past month.

<sup>b</sup> Defined as consumption of >1 drink per day.

HIV-related wasting (81%) reported that there was ≥1 day during the prior month in which they had not eaten, compared with patients who did not experience HIV-related wasting (57%). Although a greater percentage of subjects who experienced HIV-related wasting were receiving HAART, their viral load was more than twice as high as the viral load for the group that did not experience HIV-related wasting. Moreover, patients who experienced HIV-related wasting were more likely to be heavy alcohol drinkers and users of cocaine. When all of the variables were considered together in multivariate analyses, going for ≥1 day without eating in the prior month and high viral load were significant predictors of HIV-related wasting in this cohort.

Before 1996, when HAART became available, HIV-related wasting was one of the 3 most common defining conditions for AIDS in the United States [24]. With the advent of potent antiretroviral therapies, the hope was that the prevalence of HIV-related wasting among HIV-infected persons would have abated [3, 25]. The prevalence of HIV-related wasting in our cohort, however, is in the range observed before the HAART era [17, 26, 27], although most of our participants reported receipt of HAART. Previous studies have shown a decreasing prevalence of HIV-related wasting associated with the introduction of HAART, as well as a subsequent reduction of opportunistic infections [17, 28–30]. The data from the Nutrition for Healthy Living (NHL) Study [13], however, indicate that many HIV-infected participants continue to experience wasting, despite the widespread use of HAART. This finding is also consistent with earlier reports of weight loss being particularly common among drug users [31]. Thus, although there is the desire to provide access to antiretroviral treatment for all persons [32, 33], HIV-related wasting prevails in vulnerable populations, including illicit drug users and members of disfranchised minorities [33–38].

High viral load was a significant predictor of HIV-related wasting in our cohort. This is in agreement with the findings of several previous studies that identified viral load as a predictor of HIV-related weight loss [15, 16], with levels of HIV-1 replication being causally related to the magnitude of weight loss, regardless of a lack of secondary opportunistic complications, gastrointestinal symptoms, or impaired energy intake [39]. In fact, in previous studies, other variables that were significant in the univariate analyses, once adjusted for HIV-1 RNA level, did not remain significant [15]. Our findings regarding the relationship between viral load, other related factors, and HIV-related wasting were similar, with the exception of 1 variable: lack of food for ≥1 day per month remained significantly related to HIV-related wasting, even after adjustment for HIV-1 RNA level.

Most of the participants in our cohort who experienced HIV-related wasting were receiving HAART, justified by the classification of HIV-related wasting as an AIDS-defining condition, which warrants the initiation of HAART [32]. The mean viral load among subjects who experienced HIV-related wasting, however, was more than twice as high as the viral load among participants who did not. Considering that the majority of this group reported receiving antiretroviral medications, the high viral load indicates either poor adherence to medication, lack of compliance with follow-up treatment, or both.

Our results indicate significantly lower levels of serum cholesterol and LDL cholesterol that are similar to levels detected in HIV-infected cohorts observed before the availability of HAART [40]. In a study conducted prior to the HAART era, the serum cholesterol level was positively correlated with nutritional markers used to diagnose HIV-related wasting [41]. Moreover, follow-up data from the Multicenter AIDS Cohort Study, which observed men from before they experienced seroconversion, through HIV infection, and after they commenced HAART, showed a significant decrease in the mean total cholesterol, LDL cholesterol, and HDL cholesterol levels after HIV infection, whereas, after these subjects initiated HAART, there was a large increase in these parameters [42].

Among our participants, alcohol abuse was strongly and significantly associated with HIV-related wasting in univariate analysis. This finding was not surprising, because heavy alcohol abuse interferes with energy utilization and deposition of fat and promotes muscle wasting [43, 44]. During the 24-h food intake interviews, our participants frequently reported that a 6-pack of beer was their only caloric intake for the day. However, the majority of the participants who reported food insecurity were also heavy drinkers. Heavy alcohol consumption was no longer statistically significant when added to a multivariate model that included viral load and food insecurity. Moreover, subjects who experienced HIV-related wasting were more likely to use cocaine, and the proportion of heavier users (i.e., those who used cocaine ≥5 times per week) was twice as high among participants who experienced HIV-related wasting, compared with those who did not experience HIV-related wasting. Cocaine is an anorectic [45, 46] and is one of the most
addictive illicit drugs available, especially when used in its crack form, which was the drug of choice among our cohort of HIV-infected drug users in Miami.

The participants in this study who experienced HIV-related wasting had lower ADL scores and were significantly less likely to hold full-time or part-time work, compared with those who did not experience HIV-related wasting. HIV-related wasting, a sign of advanced disease, produces fatigue and lack of energy, accompanied by diminished capacity for physical and mental work [47, 48]. Unemployment promotes poverty, which contributes to food insecurity. Diminished daily activities and a lack of scheduled tasks may induce psychological depression and decrease incentives to seek food [48]. In the same manner, the mood changes produced by the lack of a steady job can impact compliance with treatment and medical appointments related to the person’s HIV condition [49]. The participants who had HIV-related wasting were also less likely to be homeless, defined as lack of permanent home and as sleeping either in a shelter, in a car, or on the street. Our data indicate that the participants who experienced HIV-related wasting were more likely to have access to housing than were those who did not, as a result of advanced disease, explaining the inverse relationship between HIV-related wasting and homelessness.

The new finding presented in this article is that HIV-related wasting was found to be strongly and significantly associated with food insecurity, in addition to viral load, after controlling for age, sex, alcohol intake, viral load, and receipt of HAART. Previous studies have found a significant relationship between the degree of HIV-related wasting, low caloric intake, and high stool frequency [50], although diarrhea was not significantly related to HIV-related wasting in our cohort. Data from the NHL cohort showed that drug users and nonwhite subjects consumed significantly less energy than other subjects, as determined by 3-day dietary records [51]. In the NHL cohort, the micronutrient intake was adequate for the overall cohort; however, a large percentage of women and minorities had inadequate micronutrient intake [52]. We did not detect reduced food or micronutrient intake in our study through use of the 24-h dietary recall; however, when we determined longer-term dietary intake using the food security questionnaire, we found that not eating for 24-h dietary recall; however, when we determined longer-term dietary intake using the food security questionnaire, we found that not eating for \( \geq 1 \) day per month was a significant predictor of HIV-related wasting in this cohort, independent of viral load or HAART use.

In our study, HIV-related wasting was relatively prevalent and was found to be strongly and significantly associated with food insecurity and viral load, after controlling for HAART use. Among the lifestyle factors associated with HIV-related wasting were alcohol abuse, illicit cocaine use, and inability to hold a full- or part-time job. Food insecurity and viral load (but not receipt of HAART) were the only independent predictors of HIV-related wasting. The relatively high prevalence of HIV-related wasting among HIV-seropositive drug users in Miami appears to be a sign of treatment failure [15]. The other independent predictor of HIV-related wasting in our cohort (no food eaten for \( \geq 1 \) day per month) also indicated a lack of social and nutritional programs to ensure adequate nutrient intake for the infected population. These data indicate that the social and economic conditions affecting the lifestyle of HIV-infected drug users constitute a formidable challenge for the prevention and treatment of HIV-related wasting.

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**Potential conflicts of interest.** All authors: no conflicts.

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