Nutritional Status of Persons with HIV Infection, Persons with HIV Infection and Tuberculosis, and HIV-Negative Individuals from Southern India

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We compared the nutritional status of individuals with human immunodeficiency virus (HIV) infection alone, individuals with HIV infection and tuberculosis (after completion of antituberculosis treatment), and HIV-negative individuals and found that malnutrition, anemia, and hypoalbuminemia were most pronounced among HIV-positive patients with tuberculosis. Weight loss was associated with loss of fat in female patients and with loss of body cell mass in male patients.

Individuals at all stages of HIV disease are at risk of nutritional deficiency, and nutritional status is a strong predictor of disease progression, survival, and functional status during the course of the disease [1, 2]. Tuberculosis (TB), which is the most common opportunistic infection among individuals with HIV infection, is also associated with wasting, weight loss, loss of muscle mass, and hypoalbuminemia. Therefore, the combination of both infections results in a greater decrease in body cell mass and fat mass than does HIV infection alone [3].

There are few data on the nutritional status of people living with HIV infection or AIDS, especially from the lower socioeconomic strata in India. While free antiretroviral treatment is being rapidly scaled up, a national policy for TB-preventive therapy and nutritional support for patients in India is being considered. Our aim was to assess the nutritional status of HIV-positive individuals and the impact of TB on various nutritional parameters, including body composition.

Received 9 August 2007; accepted 14 November 2007; electronically published 14 February 2008.

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Clinical Infectious Diseases 2008; 46:946–9

1058-4838/2008/4606-0028$15.00
DOI: 10.1086/528860

Methods. The study population consisted of HIV-positive adults enrolled in 2 different randomized clinical trials at Tuberculosis Research Centre clinics in Chennai and Madurai, India, from 1 July 2003 through 31 July 2004. The first trial compared the efficacy of 2 different regimens for the treatment of latent TB infection: a 6-month daily regimen of isoniazid and ethambutol versus a 3-year course of isoniazid alone daily. The study group consisted of asymptomatic HIV-positive individuals without evidence of active TB who had normal chest radiograph findings and negative acid-fast bacilli smear results.

The second trial compared the efficacy of treating active pulmonary TB with a 6-month versus 9-month course of anti-TB therapy, consisting of 2 months of treatment with ethambutol, isoniazid, rifampicin, and pyrazinamide followed by either 4 or 7 months of treatment with isoniazid and rifampicin given 3 times per week as directly observed therapy. Diagnosis of active TB was made on the basis of history, physical examination findings, and chest radiograph findings and was confirmed by positive acid-fast bacilli smear results or culture results positive for *Mycobacterium tuberculosis* in either sputum samples or extrapulmonary specimens. All patients in this group completed a full course of anti-TB therapy and were declared to be cured at the time of the study. In addition to the treatments described above, all patients received multivitamins and cotrimoxazole prophylaxis. During this period, HIV-negative volunteers from the same community were recruited for comparison.

This study was approved by the Institutional Ethics Committee of the Tuberculosis Research Centre. Informed written consent was obtained from all participants.

A validated, quantitative 24-h dietary recall questionnaire was used to obtain dietary details by a trained nutritionist [4]. Nutrient intake was calculated using Digest software, version 1.5, a software package specially designed to analyze South Indian diets. Anthropometric measurements (including height; weight; mid-arm, waist, and hip circumference; and triceps skin-fold thickness) were performed in triplicate, and the mean value was recorded. Blood samples were collected for hematological analysis, biochemical testing, and $CD4^+$ cell counts. A bioelectric impedance analyzer (RJL Systems) was used to measure body composition using standard techniques [5].

The data were analyzed using SPSS software, version 13.0 (SPSS), and the results were expressed as mean values and standard deviations. Analysis of variance was performed to test differences between groups. The Bonferroni multiple comparison test was used to compare pairs of groups. Differences were considered to be significant if the P value was <.05.

Results. A total of 662 patients (488 HIV-positive, TB-negative patients and 174 HIV-positive, TB-positive patients who had completed anti-TB therapy) and 160 HIV-negative control subjects were studied. The mean age (±SD) for all patients and control subjects was 31.1 ± 7.5 years, and the mean $CD4^+$ cell count was 363 ± 247 cells/mm^3.

In all 3 groups, the daily consumption of calories and proteins was below the recommended dietary allowance for Indian individuals of the same weight and activity type [6]. The mean caloric intake ranged from 1545 to 2016 calories/day and did not differ significantly between the 3 groups. Protein and fat consumption were lower among HIV-positive men than they were among HIV-negative men.

Table 1 shows the anthropometric, body composition, and laboratory parameters for the 3 groups. Body weight, body mass index (BMI; defined as the weight in kilograms divided by the square of the height in meters), mid-arm circumference, waist circumference, and hip circumference were all significantly lower in the 2 HIV-positive groups, compared with the HIV-negative group, and in the HIV-positive, TB-positive group, compared with the HIV-positive, TB-negative group, for both men and women. Triceps skin-fold thickness was significantly lower for women in both of the HIV-positive groups.

Analysis of body composition was done only at the Chennai center. For female subjects, the body fat content was significantly lower in both of the HIV-positive groups, compared with the HIV-negative group. For male subjects, the body cell mass was significantly decreased in both of the HIV-positive groups, compared with the HIV-negative group, whereas the body fat content—although lower—was not significantly different. Fat content, expressed both as a percentage and in absolute weight, was higher among women than it was among men in all groups. Hemoglobin level, serum albumin level, and total cholesterol level were each lower in the HIV-positive, TB-positive group than in the HIV-negative group for both sexes, whereas serum globulin level was significantly higher.

The percentage of men with a BMI <18.5 was 44% in the HIV-positive, TB-positive group and 32% in the HIV-positive, TB-negative group, whereas the percentage of women with a BMI <18.5 was 56% and 26%, respectively. In the HIV-negative group, 27% of men and 17% of women had a BMI <18.5. Logistic regression analysis revealed that the OR for body weight being less than predicted (i.e, <60 kg for men and <50 kg for women [6]) was 2.3 ($P < .001$) and that the OR for a blood

Table 1. Anthropometric, body composition, and laboratory parameters for HIV-positive patients without tuberculosis (TB), HIV-positive patients with TB, and HIV-negative control subjects, by sex.

	Female sex			Male sex		
Variable	HIV-positive patients without TB	HIV-positive patients with TB	HIV-negative control subjects	HIV-positive patients without TB	HIV-positive patients with TB	HIV-negative control subjects
Anthropometric parameter						
No. of patients with data	327	50	86	161	124	74
Weight, kg	48.6 ± 9.7[a]	43.3 ± 6.9[b,c]	53.6 ± 11.4	55.6 ± 10.7[a]	50.2 ± 8.1[b,c]	62.3 ± 11.9
BMI	21.1 ± 4.0[a]	18.7 ± 2.9[b,c]	23.6 ± 4.6	20.5 ± 3.7[a]	18.7 ± 2.5[b,c]	22.4 ± 4.0
Mid-arm circumference, cm	23.6 ± 3.8[a]	21.7 ± 2.6[b,c]	26.5 ± 3.4	25.0 ± 3.7[a]	22.7 ± 2.9[b,c]	27.8 ± 3.9
Waist circumference, cm	71.6 ± 10.6[a]	65.7 ± 7.9[b,c]	76.7 ± 10.9	72.6 ± 10.2[a]	70.6 ± 9.1[c]	80.4 ± 10.6
Hip circumference, cm	82.9 ± 11.8[a]	77.8 ± 9.2[c]	93.3 ± 9.7	84.6 ± 10.2[a]	79.9 ± 10.4[b,c]	91.1 ± 7.9
Triceps skin-fold thickness, mm	16.3 ± 6.6[a]	12.1 ± 5.3[b,c]	19.9 ± 6.4	11.8 ± 6.3	11.1 ± 4.9	12 ± 6.0
Body composition parameter						
No. of patients with data	129	14	47	93	45	39
Body fat, kg	15.7 ± 7.1[a]	9.3 ± 4.5[b,c]	20.5 ± 8.7	7.1 ± 4.7	5.7 ± 3.5	8.9 ± 6.7
Body fat, %	30 ± 8.6[a]	19.5 ± 7.8[b,c]	35.5 ± 10.2	11.8 ± 5.9	10.1 ± 4.7	13.1 ± 8.8
Body cell mass, kg	15.3 ± 2.2	15.2 ± 2.0	16.3 ± 2.3	22.3 ± 3.4[a]	21.4 ± 3.3[c]	25.6 ± 4.2
Laboratory parameter						
No. of patients with data	323	49	33	149	122	29
Hemoglobin level, g/dL	11.4 ± 1.5	10.4 ± 1.7[b,c]	12.1 ± 1.2	13.4 ± 1.7[a]	11.8 ± 2.2[b,c]	15.3 ± 1.2
$CD4^+$ cell count, cells/mm^3	409 ± 235	314 ± 249	…	309 ± 208	236 ± 178	…
Serum albumin level, g/dL	4.0 ± 0.5[a]	3.6 ± 0.6[b,c]	4.4 ± 0.4	4.0 ± 0.7	3.6 ± 0.7[b,c]	4.4 ± 0.3
Serum globulin level, g/dL	4.5 ± 1.1[a]	5.1 ± 1.5[b,c]	3.5 ± 0.6	4.6 ± 1.5[a]	5.1 ± 1.2[c]	3.3 ± 0.6
Total cholesterol, mg/dL	147 ± 31[a]	139 ± 52[c]	196 ± 38	137 ± 31[a]	134 ± 31[c]	166 ± 35

NOTE. Data are mean value ± SD, unless otherwise indicated. BMI, body mass index (defined as the weight in kilograms divided by the square of the height in meters).

[b] $P < .005$ statistical significance between group 1 and group 2.
[c] $P < .005$ statistical significance between group 2 and group 3.
[a] $P < .05$ statistical significance between group 3 and group 1.

hemoglobin level <11 g/dL was 1.8 ($P<.004$) for HIV-positive, TB-positive patients. They also had a 3.6 times greater likelihood of having a CD4+ cell count <200 cells/mm^3 ($P<.001$).

Discussion. In our study, HIV-positive individuals—including both those without TB and those treated for TB—had significantly lower body weight, BMI, mid-arm circumference, hip circumference, and waist circumference, compared with HIV-negative individuals from the same socioeconomic background. Among HIV-positive, TB-positive patients, 80%–90% remained underweight even after completion of anti-TB therapy. This underscores the negative impact of TB on the nutritional status of patients and the synergistic effect of these 2 infections in worsening malnutrition. Of note is the fact that the "healthy" HIV-negative individuals were also underweight and had caloric consumption well below the recommended limits. In this setting, where HIV infection and TB are operating in a population characterized by poverty and malnutrition, there is a greater need to focus on nutrition in those individuals with HIV infection or with HIV infection and TB.

Approximately one-third of the HIV-positive, TB-negative group and one-half of the HIV-positive, TB-positive group had a BMI <18.5, which defines clinically significant malnutrition for an adult. A gradient in all of the anthropometric parameters was observed across the groups in our study, with the HIV-positive, TB-negative patients having worse parameters than the HIV-negative individuals and the HIV-positive, TB-positive patients having the worst nutritional status. This is of concern, because weight loss and BMI have both been shown to be strong and independent predictors of survival in HIV-infected patients, especially when associated with lower CD4+ cell counts [7].

Literature on the body composition of HIV-positive individuals varies. Some studies have shown that HIV-associated weight loss involves greater loss of lean body mass than of fat mass [8], whereas other studies have shown the opposite. The former situation is likely to be associated with more-advanced HIV disease, and the latter is likely to be associated with weight loss occurring earlier in the course of HIV infection in individuals whose health is less compromised. In our study, there was lower body fat among females in the HIV-positive, TB-negative group and the HIV-positive, TB-positive group than among females in the HIV-negative group; fat-free mass and body cell mass were significantly lower among men in the HIV-positive, TB-negative group and the HIV-positive, TB-positive group than they were among men in the HIV-negative group. Together with the finding of lower triceps skin-fold thickness and a smaller waist and hip circumference, this is worrying, because it indicates an almost-complete loss of fat stores in these women. The reduction in body cell mass among HIV-positive, TB-positive men, compared with that among HIV-negative men, is consistent with the findings of other studies [9, 10] and is suggestive of a loss of muscle mass. These distinctions may be attributable to inherent biological differences between the sexes. The nature of body composition changes in HIV-associated weight loss in different settings needs further evaluation.

Among HIV-infected patients, low serum albumin and hemoglobin levels have been identified as predictors of faster disease progression and decreased survival [1, 11]. In our study, statistically significant differences were noticed in serum albumin level between the HIV-positive, TB-positive group and the HIV-negative group, although there was virtually no difference between the mean nutrient intakes of these 2 groups. We also found that serum cholesterol levels were significantly lower in HIV-positive patients, even during the early, asymptomatic stage of infection, compared with levels in HIV-negative individuals.

One of the limitations of this study was that we enrolled only a select group of patients, most of whom were from the lower socioeconomic strata and were treated at government hospitals. Therefore, the results cannot be generalized to other populations. Furthermore, many of these patients had received multivitamins and iron supplementation before enrolling in our study. The data reported here may, therefore, underestimate the extent of anemia and nutritional deficiency in this population. An additional limitation of this study is the cross-sectional nature of the design and data collection, which means that we cannot comment on changes within groups but only on differences between groups.

To summarize, this study found that HIV-positive patients in southern India are more malnourished, anemic, and hypoalbuminemic than are socioeconomically matched HIV-negative individuals, despite similar caloric intake. In a resource-poor setting with a high background level of malnutrition, HIV infection has an adverse effect on the nutritional status of the individual, which is further worsened by TB. Both nutritional counseling and supplementation and preventive therapy for TB could help to maintain optimal nutritional status, especially among HIV-positive patients who are not yet receiving antiretroviral therapy.

Acknowledgments

We thank Dr. Christine Wanke, Director of the Nutrition/Infection Unit at Tufts University School of Medicine (Boston, MA), for giving us the bioelectric impedance analyzer instrument used in this study and for her helpful comments in preparing this article; Dr. Pedro Medrano, Country Director for the World Food Program, for his personal interest and encouragement; and all of the study participants, for their cooperation.

Financial support. World Food Program (New Delhi, India).

Potential conflicts of interest. All authors: no conflicts.

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