Effect of malabsorption on nutritional status and resting energy expenditure in HIV-infected patients

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Objective: To assess the influence of malabsorption on nutritional status and energy expenditure in patients at different stages of HIV infection.

Design and Methods: Fifty HIV patients were classified into three groups: Group 1, HIV asymptomatic patients (n = 17); Group 2, AIDS without opportunistic infection (n = 16); Group 3, AIDS patients with active infection (n = 17). Clinically-healthy subjects (n = 19) were used as controls. Parameters measured were: anthropometry, body composition by tetrapolar bioelectrical impedance; resting energy expenditure (REE) by open-circuit indirect calorimetry; malabsoption by D-xylose absorption and triolein breath tests.

Results: Malabsorption (defined as abnormality of xylose and/or fat absorption test) was found in 34 (68%) of patients: 9 (53%) Group 1; 11 (69%) Group 2; 14 (82%) Group 3. Twenty-seven (54%) had sugar malabsorption and 21 (42%) fat malabsorption. A significant relationship was observed between malabsorption and weight loss. REE measured was significantly lower in malabsorptive patients than in non-malabsorptive patients and controls (6006.3 ± 846.5 versus 6443.4 ± 985.5 versus 6802.1 ± 862.7 kJ/day, respectively; $P < 0.05$). The REE adjusted for fat-free mass was lower in malabsorptive than in non-malabsorptive patients and slightly higher than in controls, although the differences were not statistically significant.

Conclusions: The results suggest that malabsorption is a frequent feature in HIV infection and is related to the HIV-related weight loss. Hypermetabolism is not a constant phenomenon in HIV infection since, in the presence of malabsorption, our patients show an appropriate metabolic response with a compensatory decrease in REE.

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Introduction

Involuntary weight loss or wasting resulting from severe protein energy malnutrition is a frequent complication of HIV infection [1–5]. It is frequently one of the earliest clinical signs and it may worsen during the course of the disease's progress [2]. In general, weight loss in patients with HIV infection tends to be

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periodic with episodes of stability and others of rapid weight loss which occur especially in relation to secondary opportunistic infection [6].

Malnutrition, with its associated adverse effects on the immune system [7–9], may contribute to the increased morbidity of AIDS and may shorten life expectancy insofar as death has been specifically related to the loss of body cell mass [10]. The causes of malnutrition remain unclear. The aetiology is likely to be multifactorial [11]; the result of interactions between decreased caloric intake, malabsorption and alterations in energy expenditure secondary to hormonal and/or metabolic abnormalities.

Results from published reports of energy expenditure in HIV-infected patients have been equivocal. Some studies suggest that patients with AIDS are hypermetabolic [2,12–16], and others that they are hypo- [2,14,17] or normometabolic [14,18]. Probably, uncontrollable factors that can affect energy balance components, such as the caloric intake [18] or the presence of malabsorption syndromes, may contribute to the discrepancies observed between them.

Although multifactorial nutrient malabsorption in patients with AIDS has been documented [19–22], its influence on REE and total energy balance has not been sufficiently investigated. Some patients with malabsorption decrease their caloric intake to minimize gastrointestinal complications. The resulting energy deficit leads to the breakdown of reserve deposits of protein and/or fat for use as energy and can lead to weight loss. On the other hand, other patients with malabsorption can maintain both the caloric intake and weight [4,17,23] probably as a result of a compensatory decrease in the REE [17]. In normal subjects a chronic decrease in caloric intake and/or energy bioavailability is accompanied by a decrease in REE and by a relative conservation of body mass [24]. However, a variable increase in energy expenditure secondary to stress has been documented, hence when malabsorption or a decrease in caloric intake coexist with sepsis or major injury, the compensatory decrease in REE could, probably, become blunted and, as a consequence, weight loss accelerated [25].

In HIV infection, characterized by the development of opportunistic infection during the course of the disease, the metabolic response to malabsorption has not been well investigated and, to-date, remain unclear. Hence, the aims of the present study were: (1) to determine the incidence and severity of malabsorption at different stages of HIV infection and (2) to compare nutritional status and REE between HIV-infected patients with and without malabsorption.

Materials and methods

Subjects

A total of 50 (36 men and 14 women) HIV-seropositive patients were recruited consecutively from the HIV outpatients department at the Hospital Sant Joan de Reus between November 1995 and December 1996. All patients were seropositive for HIV by enzyme-linked immunosorbent assay and confirmed by Western blot. The mean age was 34.8 years (range, 25–65 years). Of the 50 patients, 42 had been intravenous drug users, one was homosexual and seven (three males and four females) were contaminated through heterosexual contact. Exclusion criteria were patients with known non-AIDS-related malabsorption disease; with malignant or Kaposi's sarcoma; and treatment with drugs that could modify REE such as corticoids. All patients were hospitalized for 3 days for the conduct of the analyses. None of them had received nutritional support such as enteral or parenteral nutrition either before or during the study.

The diagnosis of AIDS was established according to the Centers for Disease Control and Prevention classification [26]. The patients were classified into three groups: Group 1 (n = 17), asymptomatic HIV patients who had not had an AIDS-defining illness; Group 2 (n = 16), AIDS patients without secondary infection; Group 3 (n = 17), AIDS patients who at the time of the study had symptoms or signs of active secondary infection. The patients that were free of clinical and biological signs of secondary infection for more than 2 weeks before the study were included in Group 2. Group 3 included four patients with extrapulmonary tuberculosis, four patients with *Pneumocystis carinii* pneumoniae, six patients with recurrent bacterial pneumoniae and three with fever of unknown origin.

The patients were receiving antiretroviral treatment according to our standard protocols that included combination of the two nucleoside reverse transcriptase inhibitors (zidovudine plus didanosine (DDI) or zidovudine plus zalcitabine (DDC)) that were available in Spain. In addition, several patients (n = 20) were receiving oral fluconazol for antifungal prophylaxis and oral co-trimoxazole or pentamidine aerosol for *P. carinii* prophylaxis. None of the drugs listed above are known to affect intestinal integrity and REE and none were discontinued over the study period [27].

Nineteen (14 men and five women) clinically-healthy volunteers (mean age, 33.2 years; range 27–44 years) from among the hospital and laboratory staff with low risk for HIV infection served as the control group. To compare the results of the fat malabsorption test, the data of another control group of 10 healthy subjects were used.

Fully-informed, written consent was obtained from all subjects before any study parameters were determined. The protocol was approved by the Ethical Committee of the hospital.

Nutritional status and body composition

Weight and height were determined on admission. The weight change in the previous 1 and 3 months were recorded. The ideal body weight (IBW) of each subject was established by use of Spanish population reference data [28–29] and the actual body weight expressed as a percentage of IBW. The body mass index (BMI) was calculated as weight (kg)/height (m^2).

The body composition was measured by tetrapolar bioelectrical impedance analysis (TBIA) at 50 kHz (Human-Im Scan^R; Dietosystem, Sabadell, Spain) [30–32] and the fat-free mass (FFM) was estimated using the equations of Segal *et al.* [33]. The mean coefficient of variation for within-patient impedance measurements in our laboratory was 0.71%. On all occasions, the observed impedance deviated from the expected value by less than 3.5 Ohms.

Indirect calorimetry

The REE was determined using the open-circuit indirect calorimetry method. Measurements were conducted in the fasting state at 0800 h. Oxygen consumption (VO_2) and carbon dioxide production (VCO_2) were measured continuously for 35 min in an open-circuit system (Deltatrac^R Datex Instrumentation; Helsinki, Finland) under a canopy, as previously described [34]. During this period of rest the subjects were requested not to sleep. Before each study, the open-circuit system was calibrated using gas mixtures of precisely known O_2 and CO_2 concentrations. To allow for adaptation to the canopy, the results of the first 5 min were discarded. The precision of the respiratory quotient (RQ) and flow measurements were confirmed periodically by the ethanol combustion test [35]. The intra-individual coefficient of variation for the measurement of REE was 2.3%.

Twenty-four hour urinary nitrogen excretion was measured using the Kjeldahl technique. The REE (REE_m) was calculated from VO_2, VCO_2 and urinary nitrogen excretion using the equation of Weir [36]. In one patient and one control subject, the urinary nitrogen elimination was unavailable and the modified Weir's equation was used to calculate the REE.

Estimated resting energy expenditure (REE_e) was calculated from the Harris and Benedict equations [37]. Measured and estimated values of REE were expressed as kJ/day.

Absorption studies

A standard D-xylose test was used to evaluate sugar absorption. A 25 g xylose dose was given orally after an overnight fast and absorption was assessed by measuring serum concentrations 2 h after load together with the 5 h urinary recovery. Malabsorption was considered when values were ≤ 1.33 mmol/l for serum xylose and/or ≤ 4 g for 5 h urinary xylose.

Fat absorption was determined by the ^{14}C triolein breath test [38–39]. On the day before the test the subjects consumed a lipid-enriched meal. After an overnight fast they were given 15 ml of grape seed oil and 5 ml olive oil plus a capsule containing 2.5 μCi of ^{14}C triolein (Glycerol tri [1-C^{14}] oleate; Amersham, Little Chalfont, UK). Breath samples were collected at baseline and at 3, 4, 5 and 6 h post tri-oleate consumption. The exhaled air was channelled through a solution of hydroxide of hyamine–ethanol (1 : 1) in a scintallation vial containing a colour indicator that signals the completion (saturation of the CO_2) of the hyamine trap. The radioactivity of exhaled [$^{14}CO_2$] was measured in a liquid scintallation counter (Tri-Carb 1500; Packard, Downers Grove, Illinois, USA). We calculated the peak (or highest hourly $^{14}CO_2$) and the cumulative $^{14}CO_2$ production and the results were expressed as a percentage of administered dose. Malabsorption was considered when values were ≤ 2% for peak and/or ≤ 3% for total $^{14}CO_2$ production.

In order to compare the nutritional status and REE, the HIV-infected individuals were re-classified into two groups with respect to the presence or absence of malabsorption as defined by one or other or both of the absorption tests conducted. In patients with diarrhoea (defined as more than three loose bowel movements per day), three stool samples were analysed for enteric pathogens.

Other biochemical analyses

Peripheral blood CD4 lymphocyte subset count was assessed by flow cytometry (Facscan; Becton-Dickinson, San Jose, California, USA). Serum albumin, pre-albumin and transferrin were measured using standard methods.

Statistical analyses

Statistical analyses were performed using the SPSS/PC statistical package. Results are expressed as mean ± SD. The differences between groups were analysed using the Mann–Whitney non-parametric test. Paired data were analysed by the Wilcoxon non-parametric test. Simple correlations were determined using Spearman's correlation coefficient (r). A P-value < 0.05 was considered significant.

As REE was significantly related with the TBIA – FFM (r = 0.80, P < 0.001) the unexplained residual of the REE in each individual was calculated by the general linear model procedure using the FFM as covariant. The adjusted REE (REE_a) for each individual was calculated by adding the individual residual REE to the mean REE of the whole group.

Results

Effect of the stage of progress of the HIV infection on nutritional status, intestinal absorption and REE

The general characteristics of the subjects studied are presented in Table 1. There were no differences between groups with respect to age, gender and height. Weight, percentage ideal body weight and BMI were all significantly lower in patients relative to controls ($P < 0.001$) with significant differences between Groups 1, 2 and 3 as well. Weight loss was higher in patients with active infection (Group 3) than in the other HIV-positive groups. Serum albumin, prealbumin and transferrin were significantly lower in all three groups of HIV-infected patients compared with the controls. The mean CD4 count was substantially below normal in the asymptomatic HIV-positive group (Group 1) and significantly lower in both Groups 2 and 3.

Sugar and fat absorption were altered in patients compared with the control subjects (Table 2). Serum xylose concentrations were lower in the patients groups than in control subjects with a significant difference between Group 3 and controls (2.13 ± 1.89 versus 2.98 ± 0.36 mmol/l; $P < 0.05$). The 5 h urinary excretion of xylose was significantly lower in patients (5.12 ± 3.12, 3.68 ± 2.39 and 2.97 ± 2.12 g for Groups 1, 2 and 3, respectively) compared with the control subjects (10.01 ± 3.27 g), but there were no statistically significant differences between the three groups of patients. The excretion of $^{14}CO_2$ calculated as peak output and total output was significantly lower in patients relative to controls, with statistically significant differences between the patient groups as well. In the overall patient group, a significant correlation between CD4 counts and peak output ($r = 0.49$; $P < 0.001$) as well as total output of [$^{14}CO_2$] ($r = 0.36$; $P < 0.01$) was observed.

With respect to the stage of HIV infection, malabsorption was found in nine patients (53%) of Group 1, 11 patients (69%) of Group 2 and 14 patients (82%) of Group 3.

There was a significant negative correlation between weight loss during the previous 3 months and 5 h xylose excretion ($r = -0.30$, $P < 0.05$) as well as peak triolein output ($r = -0.38$, $P < 0.01$) in the overall patient population. Similarly, there was a negative correlation between weight loss during the previous 1 month and peak output ($r = -0.30$, $P < 0.05$) as well as total output of triolein ($r = -0.29$, $P < 0.05$).

Measured REE (REE_m) values were lower in the three patient groups compared with the control group (Table 3), with a statistically significant difference between patients of Group 3 and controls (5861.6 ± 906.8 versus 6802.1 ± 862.7 kJ/d; $P < 0.005$). When the REE was adjusted for FFM (REE_a), the values of the patient groups were slightly higher than those of the control group but the differences were not statistically significant. Both the measured REE and the adjusted were lower, although not significantly so, in the Group 3 patients compared with the other groups of patients. Measured REE was higher, albeit not statistically significantly, in all three groups of patients relative to that estimated by the Harris-Benedict equations.

Table 1. Biometric characteristics of the study population.

	Group 1 (n = 17)	Group 2 (n = 16)	Group 3 (n = 17)	Patients (n = 50)	Controls (n = 19)
Male : female	13 : 4	10 : 6	13 : 4	36 : 14	14 : 5
Age (years)	34.8 (9.1)	35.2 (9.7)	34.2 (6.9)	34.8 (8.5)	33.2 (4.2)
Weight (kg)	58.6 (10.6)**†	63.2 (12.0)*†	51.8 (7.2)***	57.7 (10.9)***	72.0 (9.2)
Height (cm)	164.9 (6.9)	167.2 (9.2)	168.8 (7.5)	166.9 (7.9)	171.7 (7.8)
Body mass index (kg/m^2)	21.5 (3.5)*†	22.5 (3.7)†††	18.1 (2.1)***	20.7 (3.6)***	24.4 (2.4)
Percentage ideal body weight (%)	84.9 (13.6)**†	91.1 (15.9)*†††	72.4 (9.1)***	82.6 (15.1)***	98.2 (8.2)
Weight loss previous month (kg)	0.7 (0.9)***†††	1.7 (2.6)***††	3.6 (2.4)***	2.1 (2.9)***	0
Weight loss previous 3 months (kg)	1.1 (0.9)***†††	2.6 (2.7)***††	5.2 (3.6)***	2.9 (3.1)***	0
Serum albumin (g/l)	38.1 (3.7)***†††‡‡	34.6 (5.1)***†	29.3 (6.0)***	34.1 (6.2)***	44.2 (1.5)
CD4 count (cells × 10^6/l)	500.9 (206.9)***†††‡‡	86.7 (48.8)***	119.1 (155.2)***	238.6 (242.8)***	1012.11 (367.7)

Values expressed as means (SD). $^*P < 0.05$, $^{**}P < 0.005$, $^{***}P < 0.001$ compared with controls; $^{\dagger}P < 0.05$, $^{\dagger\dagger}P < 0.005$, $^{\dagger\dagger\dagger}P < 0.001$ compared with Group 3; $^{\ddagger}P < 0.05$ and $^{\ddagger\ddagger}P < 0.001$ compared with Group 2.

Table 2. Summary of the absorption tests.

	Group 1 (n = 17)	Group 2 (n = 16)	Group 3 (n = 17)	Controls (n = 19)
Xylose 5-h urine (g)	5.12 (3.12)**	3.68 (2.39)**	2.97 (2.12)**	10.01 (3.27)
Xylose 2-h serum (mmol/l)	2.74 (0.92)	2.82 (1.41)	2.13 (1.89)*	2.98 (0.36)
Peak [$^{14}CO_2$] production (%)	7.29 (3.44)**††	5.50 (4.16)**†	3.06 (2.19)**	14.00 (4.09)
Total [$^{14}CO_2$] production (%)	5.00 (1.94)**†	4.80 (2.27)**†	2.99 (1.73)**	10.64 (3.71)

Values expressed as means (SD). $^*P < 0.05$, $^{**}P < 0.001$ compared with controls; $^{\dagger}P < 0.05$, $^{\dagger\dagger}P < 0.001$ compared with Group 3.

Table 3. Body composition and resting energy expenditure (REE) at different stages of HIV infection.

	Group 1 (n = 17)	Group 2 (n = 16)	Group 3 (n = 17)	Controls (n = 19)
Fat-free mass (kg)	45.3 (8.4)**	46.9 (8.3)	42.2 (7.1)**	54.8 (8.8)
Fat mass (kg)	13.2 (5.3)*	16.3 (6.7)†	9.6 (4.9)***	17.2 (4.1)
Proportion body fat (%)	22.2 (7.4)	25.2 (7.4)	18.5 (8.9)	24.01 (5.7)
REE measured (kJ/day)	6291.7 (963.9)	6294.0 (793.2)	5861.6 (932.1)**	6802.1 (862.7)
REE adjusted (kJ/day)	6466.8 (704.3)	6344.3 (496.5)	6289.2 (589.9)	6220.4 (478.2)
REE estimated (kJ/day)	6017.7 (774.5)	6217.3 (807.3)	5683.9 (541.2)	6862.1 (792.7)

Values expressed as means (SD). * $P < 0.05$, ** $P < 0.005$, *** $P < 0.001$ compared with controls; † $P < 0.05$ compared with Group 3.

Effect of the presence or absence of malabsorption on nutritional status and REE

The patients were reclassified *a posteriori* into two groups based on the presence or absence of malabsorption (Table 4). Thirty-four (68%) patients evidenced malabsorption; 27 (54%) with respect to sugar malabsorption and 21 (42%) to fat. Fourteen (28%) patients had sugar and fat malabsorption. A significant correlation between the sugar and fat absorption ($r = 0.41$; $P < 0.05$) was observed. Half of the individuals with malabsorption reported anorexia. Five patients had diarrhoea during the course of the study, but stool cultures for routine bacterial enteric pathogens, ova and parasites were negative. Four of these patients had malabsorption values.

Both groups were homogeneous with respect to gender, age, height and weight. Body mass index and percentage ideal body weight were significantly lower in patients with malabsorption than in patients without. Both the BMI and the percentage ideal body weight were lower in both groups of patients relative to the control group, but the differences were statistically significant only in those with malabsorption (19.8 ± 2.9 versus 24.4 ± 2.3 kg/m^2; $P < 0.001$; and 78.7 ± 11.9 versus 90.0 ± 17.9%; $P < 0.001$, respectively). Weight loss was higher, while serum albumin, pre-albumin, transferrin and CD4 counts were lower in malabsorptive patients than in those who were not.

Fat-free-mass and FM were significantly lower in malabsorptive patients than in controls and the FM was significantly lower in the malabsorptive group compared to all the others. When body fat was expressed as a percentage of total body weight, no differences were observed between the two HIV-infected groups (Table 4).

Measured REE and adjusted REE were lower in patients with malabsorption than in those without, although the differences were not statistically significant. Compared to the control group, while the REE_m

Table 4. Nutritonal status, body composition and resting energy expenditure (REE) with respect to presence or absence of malabsorption.

	Malabsorption (n = 34)	No malabsorption (n = 16)	Controls (n = 19)
Male : female	27 : 7	9 : 7	14 : 5
Age (year)	33.8 (7.3)	36.7 (10.5)	33.2 (4.1)
Weight (kg)	56.0 (10.0) ***	61.4 (12.4)*	72.0 (9.2)
Percent ideal body weight (%)	78.7 (11.9) †***	90.0 (17.9)	98.1 (8.2)
Body mass index (kg/m^2)	19.8 (2.9) † ***	22.7 (4.2)	24.4 (2.3)
Weight loss previous month (kg)	2.4 (2.6) ***	1.7 (1.5)***	0
Weight loss previous 3 months (kg)	3.3 (2.7) †† ***	2.1 (3.7)***	0
CD4 count (cells × 10^6/l)	188.1 (211.1) ***	345.8 (276.4)***	1012.1 (367.7)
Serum albumin (g/l)	32.9 (5.7)	36.3 (6.6)	44.2 (1.5)
Fat-free mass (kg)	44.4 (7.6) **	45.6 (9.0)*	54.8 (8.8)
Proportion body fat (%)	20.3 (8.0)	25.1 (8.5)	24.01(5.7)
REE measured (kJ/day)	6006.3 (846.5) *	6443.4 (985.5)	6802.1 (862.7)
REE adjusted (kJ/day)	6256.3 (552.9)	6601.9 (637.5)	6220.4 (478.2)
REE estimated (kJ/day)	5935.8 (657.9)	6036.5 (897.2)	6862.1 (792.7)

Values expressed as means (SD). *$P < 0.05$, **$P < 0.005$, ***$P < 0.001$ compared with controls; †$P < 0.05$, ††$P < 0.005$ compared with non-malabsorptive.

Table 5. Resting energy expenditure (REE) at different stages of HIV infection with respect to the presence or absence of malabsorption.

	Group 1		Group 2		Group 3	
	No malabsorption (n = 8)	Malabsorption (n = 9)	No malabsorption (n = 5)	Malabsorption (n = 11)	No malabsorption (n = 3)	Malabsorption (n = 14)
REE measured (kJ/day)	6391.4 (1257.3)	6203.0 (675.6)	6629.1 (599.64)	6141.6 (847.5)	6272.38 (944.2)	5773.6 (940.65)
REE adjusted (kJ/day)	6639.3 (862.9)	6313.4 (533.1)	6586.4 (145.85)	6232.8 (564.1)	6528.2 (619.9)	6237.9 (594.3)
REE estimated (kJ/day)	5871.6 (1067.5)	6147.5 (402.9)	6434.4 (792.9)	6116.7 (830.9)	5806.4 (445.7)	5657.6 (570.7)

Values expressed as means (SD).

was significantly lower in the malabsorption group, the adjusted REE was slightly higher than the control group; the difference not being statistically significant (Table 4). The means of the REE_m of both groups of patients were higher, albeit not statistically significantly, than the estimated values (REE_e). No significant correlation between weight loss and REE was observed.

When REE was analysed at different stages of the disease and, with the presence or absence of malabsorption taken into account (Table 5), we observed that REE_m was lower in patients with opportunistic infection and malabsorption, although the differences were not statistically significant.

Discussion

Malabsorption has been previously documented in patients with HIV infection [19–22]. It appears to be a manifestation of the vulnerability of the intestinal mucosa in an immune deficiency state but the aetiology remains unclear. A large number (68%) of our patient group had evidence of malabsorption; 54% had sugar malabsorption and 42% fat malabsorption. The incidence, as well as the severity of malabsorption was higher in the AIDS patients with opportunistic infection, although a total of 53% HIV-positive asymptomatic subjects had alterations of one or both absorption tests. Also, in our patients, malabsorption was present even in the absence of apparent enteric infections, such as others studies have reported.

The relationship between malabsorption and nutritional status has been sufficiently documented [40]. In the present study, the patients with malabsorption had anthropometric and biochemical parameters lower than those patients without malabsorption, as well as control subjects. Similarly, a significant positive relationship between malabsorption and weight loss was observed. However, although the influence of malabsorption on nutritional status has been well established, the metabolic response to malabsorption has not been sufficiently investigated. In terms of energy balance, disturbances of one component may directly affect another. Under most circumstances, the presence of malabsorption could lead to a compensatory decrease in REE as part of an adaptive response to maintain energy balance. A failure to down-regulate resting energy expenditure as an adaptation to malabsorption has been implicated as the major cause of weight loss in HIV infection [41].

Several studies have been published regarding REE in HIV-infected patients but results have been equivocal. While some of these studies [12,13,15,16] observed an increase in REE especially in patients with secondary opportunistic infections (suggesting a hypermetabolic response) others reported no differences with respect to controls. These contradictory data could be explained by different factors. Firstly, in some studies [14–16], REE was expressed as a function of body weight or as a REE : FFM ratio although adjusted REE (derived from the regression line between REE and FFM) has been suggested [34] as the appropriate method to compare REE between individuals with different body composition. Secondly, the majority of studies [12–16,18] had not evaluated the presence/absence of malabsorption, a factor which directly affects energy balance. Indeed, one of them excluded patients with gastrointestinal infections or clinical evidence of malabsorption [16]. Two studies [17,42] were performed in which malabsorption was a factor and which showed a decrease in REE associated with malabsorption. However no patients with opportunistic infection had been included. In contrast, our study (performed in a larger sample of patients at different stages of the disease progression and including patients with active opportunistic infections) showed a relationship between the degree of malabsorption and REE, even in the presence of active secondary infection, which suggests an appropriate metabolic response. This feature could explain the observation that the REE, either adjusted for FFM or in absolute values, was lower in the malabsorptive patients compared with those without malabsorption, irrespective of the stage of the disease. Thirdly, a previous study [43] reported a different metabolic response in patients with secondary infections affecting the digestive tract and, in whom, there was a lower REE : FFM ratio compared with that of patients with extradigestive infections. Although these authors had not evaluated the absorption ability, presumably the majority of patients diagnosed with intestinal diseases could present with malabsorption, which could explain, as in our study, the appropriate metabolic response to the decrease in energy bioavailability occurring in the course of some opportunistic infections.

In the present study, the measured REE of patients was lower than that observed in control subjects, although the REE adjusted for FFM was not significantly different. In contrast to previous studies describing a hypermetabolism associated with AIDS secondary infections [16,18], our results showed that, within the patient groups, the measured and adjusted REE were lowest in the group of patients with active opportunistic infection. This discrepancy could be explained by the high prevalence of malabsorption in these patients.

Hence, as a consequence of a decrease of nutrient absorption, our HIV-positive patients showed an appropriate metabolic response; a decrease of REE to compensate for the caloric deficit. However, the decrease in the REE associated with the presence of

malabsorption is, probably, not sufficient to compensate for the secondary deficit of nutrient-energy bioavailability. This phenomenon results in an imbalance between energy intake and energy expenditure that is conducive to a progressive weight loss.

Our findings demonstrate that hypermetabolism is not a constant phenomenon in HIV-infection. The moderate increase in REE_a relative to controls, although probably playing a substantial role, would not be sufficient to explain the degree of weight loss and progressive decrease in nutritional status that occurs in HIV patients. Furthermore, a significant correlation was observed between malabsorption and weight loss, but not between REE and weight loss. Hence, factors such as malabsorption and decrease in caloric intake [18] that are often secondary to it are, probably, of greater importance in explaining the observed weight loss.

In summary, the results of this study indicate that malabsorption was a frequent phenomenon in HIV infection and was present in early stages of the disease, as well as in asymptomatic patients. The AIDS patients had an appropriate metabolic response to their energy deficit. Malabsorption and secondary anorexia were those aspects responsible for the weight loss observed in our HIV-infected patients, particularly in those with associated opportunistic infection. The high incidence of malabsorption and its significant correlation with weight loss suggests that this parameter needs to be taken into account in clinical monitoring of AIDS patients.

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