HIV 感染並有消耗性症狀的成年男子的身體組成

Body composition of HIV-infected male adults with wasting syndrome

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Chronic weight loss is a common characteristic of HIV infection; its full etiology remains unknown. We report body composition measurements for 39 adult males with wt loss ≥ 10% or a body mass index (BMI) below 19.8 kg •m^{-2} while receiving stable antiretroviral therapy, and no recent history of opportunistic infection, malignancy, Kaposi sarcoma, or therapy with anabolic agents. CD4+ counts ranged from 2 to 531; 30 subjects having counts ≤200. Body composition was measured by ^{40}K counting, dual-energy X-ray absorptiometry (DXA), and anthropometry. The reference body composition measures were total body potassium (TBK), lean tissue mass (LEAN), fat mass (FAT), and percentage body fat (%FAT). In addition, nutritional assessment was based on a 2-d food diary. The mean TBK was 90.2% ± 10.8% of normal controls, while the %FAT averaged only 14.4% ± 5.3%, also below the normal range. Reasonable estimates of these body composition compartments were obtained using a combination of BMI, mid-arm circumference (MAC), and triceps skinfold measurements (TSF).

Introduction

Progressive weight loss is common in the human immunodeficiency virus (HIV)-positive individual[1,2]. Many factors appear to contribute to the chronic wasting, such as diminished and nutritionally inadequate food intake, intestinal dysfunction including malabsorption, and altered metabolism[3]. This weight loss, believed to increase morbidity for the AIDS patient, is sufficiently common; the US Centres for Disease Control have catergorized a wt loss > 10% as 'HIV wasting syndrome.' Although various anthropometric measurements are available, their accuracy for body composition assessment in this instance are unknown. The use of body weight alone or in conjunction with height to provide body mass index (BMI), are not generally recognized as good quantitative indicators of nutritional status in malnourished individuals. Furthermore, only a few studies have examined in detail the alterations in body composition associated with HIV or the HIV wasting syndrome. Therefore, we wanted to determine if anthropometry could provide an appropriate alternate assessment of body composition for this population when it is the only technology available.

Methods

Subjects

All studies performed were approved by Institutional Review Boards and informed consent was obtained from each subject, who was referred by the primary physician or recruited through specific advertisements. All subjects were clinically stable and had been receiving antiretroviral therapy (AZT, ddC, ddI or d4T) for at least three months. Each subject had a BMI below 19.8 kg •m^{-2}, or had experienced a wt loss > 10%. Those subjects who previously (within 30 d) had an opportunistic infection or diarrhoea, malignancy (within 3 y), active Kaposi sarcoma (within 3 mon), or therapy with anabolic or catabolic agents (within 1 mon) were excluded. The final study group consisted of 39 HIV-positive 25–50 y-old males.

Anthropometry and dietary intake

Body wt was measured to ± 0.2 kg, ht to ± 0.5 cm, and skinfold thicknesses to ± 2 mm. The skinfold measurement sites were the biceps (BSF), triceps (TSF), subscapular and suprailiac. The percentage of fat ($\%FAT_{DW}$) was calculated using the age-adjusted equations reported by Durnin and Womersley[4], based on the log of the sum of these four skinfolds. In addition, the measurement of the mid-arm muscle circumference (MAMC) was defined as: MAMC (cm) = MAC (cm) - 0.314 x TSF (mm) where MAC is the mid-arm circumference.

The subjects were also instructed by a registered dietitian on completing a 4-d food diary. Analysis of nutritional intake, kJ/kg and g protein/kg, were calculated using Nutritionist III[5].

Body composition measurements

Total body potassium (TBK) was measured in vivo in a multi-detector whole body counter as described previously[6]. The measurement is based on the natural radioactive fraction (^{40}K, 0.018%) of K. Because more than 97% of body K is normally intracellular, the TBK measurement provides an index of body cell mass (BCM). The precision of this method is 0.7% for adult-sized phantoms and <1.2% for humans. In

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this study, TBK is expressed in absolute grams and as a percentage of 'normal' when adjusted for age, sex and body size[7].

The total body fat (FAT), %FAT, non-bone lean tissue mass (LEAN) and bone mineral content (BMC) were measured by dual-energy X-ray absorptiometry (DXA), using a Hologic QDR-2000 scanner operated in the single beam mode and whole body software version 5.57. The reported precisions for body composition analysis are of the order of 1–1.5%; the whole body dose is <0.01 mSv[8].

Results

The mean BMI was 20.8 ± 2.4 kg •m^{-2} ranging from 16.6 to 26.1. The CD4+/mm^3 counts ranged from 2 to 531, with a mean of 126; 30 subjects had counts below 200 (Table 1). The average $\%FAT_{DXA}$ was 14.3% of body wt. Body K averaged 130.0 g (range 96.4 to 196.1 g). When normalized for body size, sex and age, TBK averaged 90.2% ± 10.8% of the expected normal range. The daily dietary intake, normalized for body wt, ranged from 105–337 kJ/kg, with an average of 199 ± 52 kJ/kg. There was also a three-fold range in the estimated daily protein intake, 0.9 to 3.0 g/kg, averaging 1.8 ± 0.6 g/kg.

Table 1. Descriptive statistics for the anthropometric, CD4, skinfold and body composition measurements.

Anthropometry:

	Age (y)	wt (kg)	ht (cm)	BMI	CD4+
Mean	35.1	65.0	176.5	20.85	126
SD	6.5	8.4	6.0	2.40	144
Min	25.2	51.5	164.5	16.55	2
Max	47.4	87.6	194.5	26.06	531

Skinfold measurements:

	BSFmm	TSFmm	MACcm	SSSmm	SISmm	%FAT
Mean	4.0	7.2	28.2	11.4	8.3	15.7
SD	1.3	2.8	2.9	3.3	6.3	4.1
Min	2.5	3.0	22.5	5.5	3.0	8.8
Max	8.0	15.0	34.5	18.0	27.0	26.6

Body composition measurements:

	TBK (g)	%TBK	Lean (kg)	BMC (g)	Fat (g)	%FAT
Mean	130.0	90.2	52.2	2427	9554	14.3
SD	18.7	10.8	5.9	316	4267	5.3
Min	96.4	66.5	42.5	1644	2765	5.4
Max	196.1	113.3	74.0	3240	19696	25.0

%TBK = % of normal TBK.
%FAT = (fat/wt) x 100.

There were no correlations of LEAN or FAT with nutritional intake, as monitored by the 4-d food diary. Furthermore, CD4+ counts were also not correlated with any of the body composition parameters measured in this study. There were, however, significant correlations between the anthropometric, skinfold, and body composition measurements. The MAC and BMI were strongly correlated with each other, yet the skinfold measurements were not generally correlated with any of the direct measures of body composition obtained by the DXA or TBK measurements. Height was related only with the BMC, whereas body wt was correlated with TBK, MAC and BMI. Total body K was significantly correlated with the LEAN and to a lesser degree with two anthropometric indices, BMI and MAC. The LEAN was equally correlated with the BMC compartment as was BMI and MAC. There was a weak association between FAT and the TSF measurement, but not the other skinfolds.

The correlation between TBK and MAC was substantially improved when the MAC value was adjusted for the arm fat content by using the TSF value. The relationship between TBK and MAMC is shown in Fig 1. The linear regression results are: TBK (g) = 5.35 x MAMC (cm) - 8.2, r = 0.82, SEE = 10.9 g. For comparison, the relationship observed between the two independent reference measures of lean tissue mass is shown in Figure 2. The linear regression results are: TBK (g) = 2.85 x $LEAN_{DXA}$ - 18.7, r = 0.90, SEE = 8.2 g.

Various combinations of the skinfold, wt, and ht measurements were examined for a relationship to %FAT. The TSF combined with BMI provided the best anthropometric equation: $\%FAT_{DXA}$ = 1.106 x TSF (mm) + 0.85 x BMI (kg/cm^2) - 11.13, r = 0.77, SEE = 3.5%.

Discussion

Our findings show that male adults with HIV wasting syndrome have significantly depleted BCM as judged by a loss of body K. This finding is in agreement with those of other studies observed for the AIDS population[9–11]. Additional evidence for a depleted BCM is provided by the TBK/FFM (fat-free mass) ratio, where FFM was independently derived from body weight minus FAT_{DXA}. In this study group, the TBK/FFM ratio varied from 2.10 to 2.73 g/kg, averaging 2.37 ± 0.16 g/kg. The traditional ratio, established by Forbes and Lewis[12], for healthy young males is 2.66 g/kg, about 12% higher than that observed in HIV males of this study. A depletion of BCM, however, is not immediate in HIV infection, since 18/39 subjects had TBK within the normal range. It is worth noting, however, that all those subjects with a CD4+ count above 200 also had %TBK within the normal range. No pattern was evident for %FAT vs CD4+ counts except that all the HIV subjects had a substantially lower %FAT than is normally seen in a healthy male population of a similar age. It was evident that this wt loss consisted of both depleted body K stores and FAT. Therefore, a reliable measurement of body composition in this group can provide a useful index to assist in nutritional assessment, only if some measure of both LEAN and FAT are obtained.

Although the more robust techniques of whole body counting and DXA can clearly provide precise measures of body composition, these instruments are not always available to the HIV patient, especially in many of the world's less developed countries. For the measurement of FAT, established anthropometric equations are usually considered as only suitable for the study of normal healthy subjects. In the malnourished patient, however, these relationships falter, most likely due to changes in visceral fat that are not proportional to total fat and are not detectable by anthropometry, ie skinfold measurements. We have found, however, that reasonable estimates for the body K stores and %FAT can be obtained using BMI, MAC and TSF measurements. In this respect, a clinical anthropometric assessment of the HIV patient may provide an appropriate alternate estimate of the muscle and fat masses when more direct measurements are not available.

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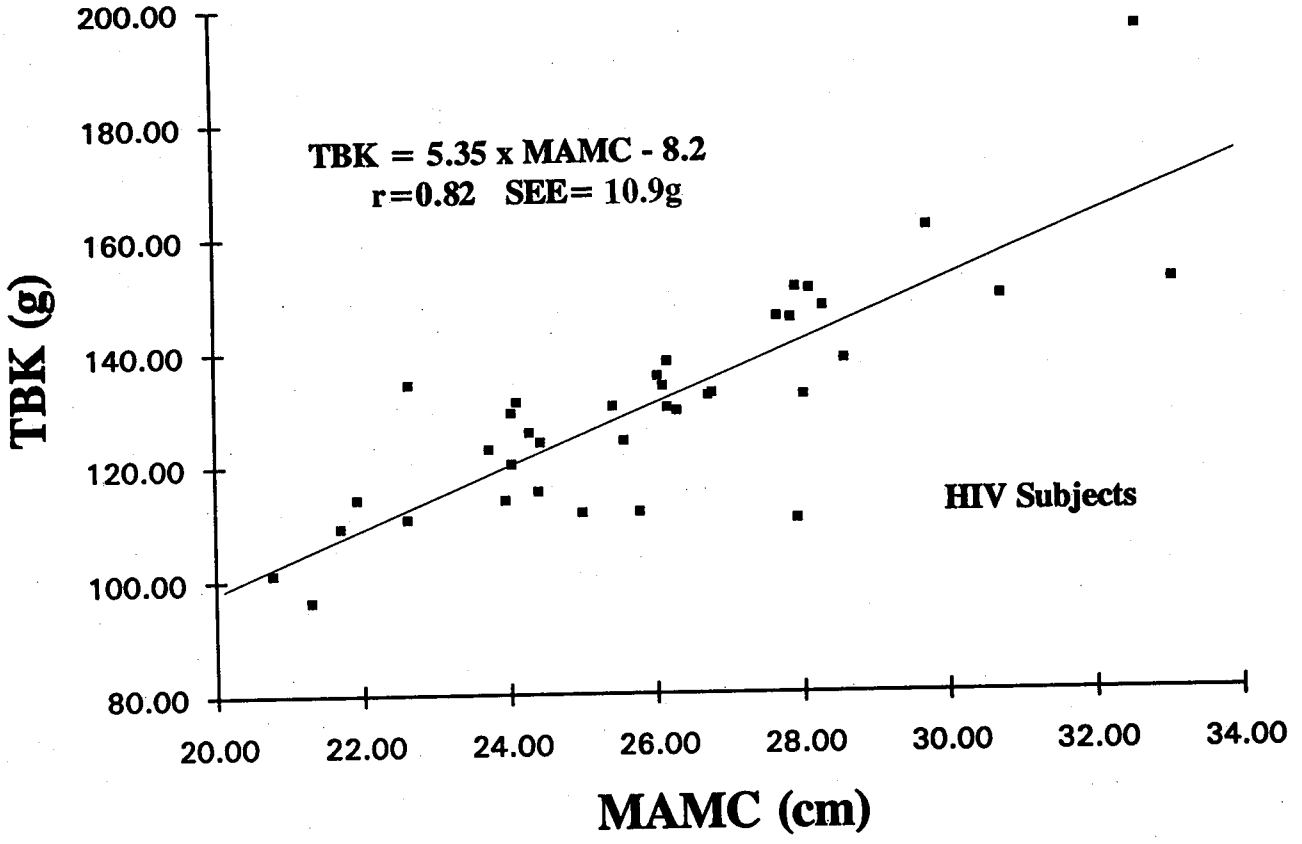

Figure 1. The relationship between total body potassium (TBK) and the mid-arm muscle circumference (MAMC) in HIV-positive males.

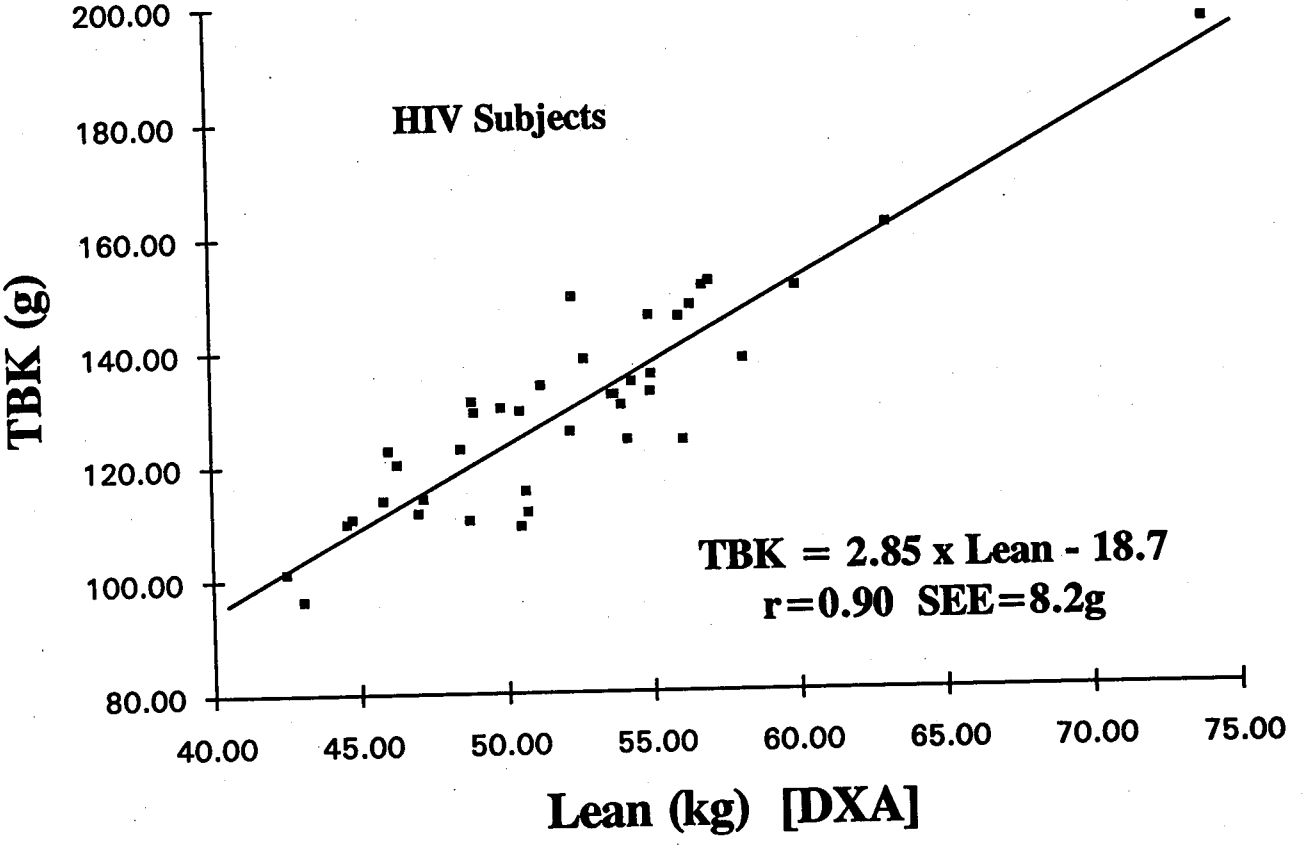

Figure 2. The relationship observed between the lean compartment (LEAN) by dual-energy X-ray absorptiometry (DXA) and body potassium (TBK) by ^{40}K counting.

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Reference

1 Nahlen AL, Chu SY, Nwanyanwu OC, Berkelman RL, Martinez SA, Rullan JV. HIV wasting syndrome in the United States. AIDS 1993; 7:183–188.

2 Zangerle R, Reibnegger G, Wachter H, Fuchs D. Weight loss in HIV-1 infection is associated with immune activation. AIDS 1993; 7:175–181.

3 Kotler DP. Malnutrition in HIV infection and AIDS. AIDS 1993; 3:S175–S180.

4 Durnin JVGA, Womersley J. Body fat assessed from total body density and its estimation from skinfold thickness: measurements on 481 men and women aged from 16 to 72 years. Br J Nutr 1974: 32:77.

5 Nutritionist III (version 7.0). N-Square Computing, Inc., Salem, OR, USA, 1990.

6 Ellis KJ, Shypailo RJ. Whole body potassium measurements independent of body size. In: Ellis KJ, Eastman JD, eds. Human Body Composition, New York: Plenum Press, 1993: 371-375.

7 Ellis KJ. Reference man and woman more fully characterized: variations on the basis of body size, age, sex and race. Biol Trace Element Res 1990; 26:385–400.

8 Ellis KJ, Shypailo RJ, Pratt JA, Mersmann H, Pond WG. Accuracy of DXA-based body composition measurements in pediatric studies. In: Human Body composition: Methods, Models and Assessment. New York: Plenum Press, 1993: 153–156.

9 Kotler DP, Tierney AR, Wang J, Pierson RN Jr. Magnitude of body-cell-mass depletion and the timing of death from wasting in AIDS. Am J Clin Nutr 1989; 50:444-447.

10 Kotler DP, Tierney AR, Brenner SK, Couture S, Wang J, Pierson RN Jr. Preservation of short-term energy balance in clinically stable patients with AIDS. Am J Clin Nutr. 1990; 51:7–13.

11 Kotler DP, Wang J, Pierson RN Jr. Body composition studies in patients with the acquired immunodeficiency syndrome. Am J Clin Nutr. 1985; 42:1255–1265.

12 Forbes GB, Lewis AM. Total sodium, potassium and chloride in adult man. J Clin Invest 1956; 6:596–600.