Artículo Original / Original Article

Anthropometric measures as indicators of the nutritional status of people living with HIV

Medidas antropométricas como indicadores del estado nutricional de las personas que viven con VIH

ABSTRACT

Several studies have noted the increased survival time of people living with HIV (PLH) after the use of antiretroviral therapy. However, impacts on nutritional status (NS) have not been reported. The aim of this study was to evaluate the association between anthropometric measures as indicators of the NS of PLH. A cross-sectional study was conducted with 35 PLH receiving care at a Brazilian public service specialized in HIV/AIDS (2017-2018) was recruited by convenience. Data were analyzed using SPSS 18.0. The anthropometric variables measured were: weight, height, body mass index (BMI), triceps skinfold (TSF), mid-arm circumference (MAC), mid-arm muscle circumference (MAMC), waist circumference (WC) and neck circumference (NC). According to BMI, 48.6% (n= 17) of patients were eutrophic, using criteria based on TSF, MAC and MAMC resulted in 57.1% (n= 20), 48.6 (n= 17) and 48.6% (n= 17) being classified as underweight, respectively. Prevalence of WC-defined central obesity and NC defined central obesity were 42.9% and 37.1%, respectively. Significant correlations were found between BMI and: TSF (r=0.587; p<0.001); MAC (r= 0.885; p<0.001); MAMC (r= -0.690; p<0.001); WC (r= 0.840; p<0.001); NC (r= 0.535; p<0.001). Different NS classifications were attributed by the anthropometric parameters employed, however, due to the complexity of the metabolic factors present in PLH, the combined use of predictors of NS and cardiometabolic risk in clinical practice should be emphasized.

Key words: Anthropometry; HIV; Nutritional status; Out-patient care.

RESUMEN

Las investigaciones muestran el aumento de la expectativa de vida de las personas que viven con el VIH (PVIH) con el uso de la terapia con antirretrovirales. Sin embargo, se reportan impactos sobre el estado nutricional (EN). El objetivo de este estudio fue evaluar la asociación entre las medidas antropométricas como indicadores del EN de PVIH. Estudio transversal, por conveniencia, con 35 PVIH atendidas en un servicio público brasileño especializado en VIH / SIDA (2017-2018). Los datos fueron analizados

Natália Oliveira¹, Nathalia Guimarães², Emanuelle La Santre³,
Sônia Figueiredo^{1,3*}.

1. Programa de Pós-Graduação em Saúde Nutrição, Escola de Nutrição, Universidade Federal de Ouro Preto. Minas Gerais, Brazil.
2. Programa de Pós-Graduação em Ciências da Saúde: Infectologia e Medicina Tropical, Faculdade de Medicina, Universidade Federal de Minas Gerais. Belo Horizonte, Brazil.
3. Núcleo de Pós-Graduação e Pesquisa da Santa Casa de Belo Horizonte. Minas Gerais, Brazil.

*Corresponding author. Dr. Sônia Maria de Figueiredo.
Núcleo de Pós-Graduação em Saúde Nutrição. Escola de
Nutrição. Universidade Federal de Ouro Preto.
Morro do Cruzeiro. Bauxita. CEP. 35.500-000, Ouro Preto.
Minas Gerais, Brazil.
Phone number: +55 31 35591844
E-mail address: smfigue@gmail.com

Este trabajo fue recibido el 24 de octubre de 2018.
Aceptado con modificaciones: 06 de marzo de 2019.
Aceptado para ser publicado: 27 de junio de 2019.

en el SPSS 18.0. Las variables antropométricas medidas fueron: peso, talla, índice de masa corporal (IMC), pliegue cutáneo tricipital (PCT), circunferencia del brazo (CB), circunferencia muscular del brazo (CMB), circunferencias de la cintura (CC) y del cuello (CCUE). De acuerdo con el IMC, el 48,6% (n = 17) de los pacientes fueron eutróficos, utilizando el criterio para PCT, e CB and CMB fueron 57,1% (n= 20), 48,6% (n = 17) y el 48,6% (n= 17) de las PVIH resultaron con bajo peso, respectivamente. La prevalencia de obesidad central definida por la CC y CCUE fue de 42,9% y 37,1%, respectivamente. Se encontraron correlaciones significativas entre el IMC y: PCT (r= 0,587; p <0,001); CB (r= 0,885; p <0,001); CMB (r= -0,690, p <0,001); CC (r= 0,840; p <0,001); CCUE (R= 0,5350; p <0,001).

Diferentes clasificaciones de CCUE fueron atribuidas por los parámetros antropométricos empleados. Sin embargo, debido a la complejidad de los factores metabólicos presentes en la PVIH, el uso combinado de predictores de CCUE y de riesgo cardiometabólico en la práctica clínica debe ser enfatizado.

Palabras clave: Antropometría; Atención ambulatoria; Estado nutricional; VIH.

INTRODUCTION

Since the identification of the first case reports on acquired immunodeficiency syndrome (AIDS) in the 1980s, AIDS has been characterized as a serious worldwide public health issue, requiring improvements in techniques and strategies for prevention, control and treatment of the disease¹. Following the initiation of antiretroviral therapy treatment (ART), an increase in the survival time of people living with Human Immunodeficiency Virus (HIV) infection and a decrease in morbidity rates was observed, especially on the incidence rates of opportunistic diseases². Higher life expectancy has led to the chronicity of the disease and consequently increased risks of people living with HIV (PLH) to acquire comorbidities such as type 2 diabetes, metabolic syndrome and cardiovascular diseases^{3,4}.

Despite the benefits, ART caused the appearance of adverse metabolic alterations and, these, have impacted the nutritional status (NS) of these patients⁵. The NS was also altered by other factors such as eating behavior, physical activity, smoking, alcohol consumption and HIV infection itself⁶.

Nutritional assessment is an important part of the care of PLH, since it can indicate the presence of nutritional disorders and, thus, enables interventions that will aid recovery or maintenance of the adequate NS of the individual⁶. Body composition is one of the variables that integrates the nutritional assessment of individuals, from body measurements such as height, weight, waist and neck circumference and skinfolds^{6,7}. Among the methods used to evaluate body composition, indirect methods (Ultrasound, Dual Energy X-ray Absorptiometry, Computed Tomography of the abdomen) stand out for accuracy⁷. However, these techniques are costly, require complex physical structure, maintenance and specialized professionals. Alternative technique like double indirect methods, such as bioimpedance or anthropometry is employed at an ambulatory, hospital and academic level. Anthropometry is an alternative technique of quantification of body components that has high reproducibility, easy applicability, simplicity and a low operational cost; thus conferring greater viability and practicality of use in public health services or places of care with scarce resources⁸.

In clinical trials with PLH, the most commonly used anthropometric indicators are waist circumference (WC), hip circumference (HC), waist-hip ratio (WHR), waist-to-height-ratio (WHtR), triceps skinfold thickness (TSF), biceps skinfold (BSF), supra-iliac skin fold (SISF), and skin subscapular

fold (SSF)^{9,10}. The anthropometric indices frequently used in assessing adiposity are body mass index (BMI) and conicity index (CI). To assess the amount of protein accumulated the mid-arm circumference and mid-arm muscle circumference are employed (MAC and MAMC)^{10,11}. The skinfolds estimate adipose corporal tissue reserve; TSF is measured in the posterior aspect of the arm⁹. Neck circumference (NC) is a relatively new parameter in the evaluation of PLH. It is a simple and rapid measurement and is an indicator of the distribution of subcutaneous fat in the upper body¹².

Some studies^{7,9,10,11,12} have validated the use of anthropometric techniques in the evaluation of nutritional status in PLH. This information is critical for nutritional assistance to effectively assist in the diagnosis of NS, improving prognosis and preventing disease-related complications. In this context, this study aimed to evaluate association between anthropometric measures as indicators of the NS of PLH accessing public health services in the city of Ouro Preto, Minas Gerais, Brazil.

MATERIAL AND METHODS

The present work was a cross-sectional study, involving 35 HIV/AIDS patients carried out at the Specialized Assistance Service in the city of Ouro Preto, Minas Gerais, Brazil.

The sample was obtained by convenience. All individuals who fulfilled the inclusion criteria, from March 2017 to May 2018 were invited to participate in the study. Inclusion criteria were determined according to age and serological condition: only PLH aged ≥ 18 years that were aware of their serological condition, regardless of the stage of infection, were included in this study. Pregnant women, individuals with liver disease and cancer, those receiving corticosteroids, individuals with a diagnosed eating disorder or psychiatric disorder, were excluded.

Data was collected through individual interviews after a medical appointment; medical records were consulted to obtain clinical and laboratory data. The following information was collected: sex, age, schooling, occupational status, marital relationship, physical activity, drugs included in ART, CD4 lymphocyte count and viral load.

Anthropometric evaluation

Anthropometric variables included weight, height, BMI, TSF, MAC, MAMC, WC and NC. For weight measurement a mechanical scale platform Filizola® brand, with a total capacity of 150 kg and 100 g graduation was used. Height was measured using a stadiometer up to 200 cm with a 0.5 cm graduation. Weight and height were measured according to the World Health Organization (WHO) protocol¹³. To measure MAC, WC and NC an inelastic metric tape with gradation in centimeters was used while the TSF was measured in the posterior aspect of the arm⁹, using a Cescorf® brand clinical adipometer; the result was evaluated in millimeters. The classification of NS by BMI employed the WHO classification points¹³ for individuals <60 years and Lipschitz¹⁴ classification for individuals

aged 60 years. The adequacy of TSF, MAC and MAMC, were evaluated according to Frisancho¹⁵. The criteria used to evaluate central adiposity was WC $\geq$ 80cm for females and $\geq$ 94 cm for males¹³ and NC $\geq$ 34 cm for females and $\geq$ 37 cm for males¹⁶.

BMI and MAMC were calculated using the following equations:

$$\text{BMI (kg/m}^2\text{)} = \text{weight/height}^2 \text{ and}$$

$$\text{MAMC (cm)} = \text{MAC (cm)} - \pi \times [\text{TSF (mm)} \div 10]^{13,15}.$$

Ethical aspects

The study was approved by the Ethics Committee of the School of Nutrition of Ouro Preto - Federal University of Ouro Preto under the protocol n° 14135913.7.0000.5150. The confidential nature of the data was guaranteed to all participants in the survey. The data collection started only after the agreement of the subjects, in a room that protected their privacy, using an informed consent form, following the precepts recommended by the National Health Council, through Resolution 466/2012.

Statistical analysis

The distribution of the continuous variables was verified with the aid of Shapiro-Wilk normality test. The parametric variable description was done by means of average and standard deviation while the median and interquartile intervals were used for non-parametric variables. Categorical variables were described by frequencies. Student's t tests, ANOVA, Mann Whitney and Kruskal-Wallis were used to compare the average and medians evaluated. The Spearman correlation test was used to evaluate the association between anthropometric variables, adopting 95% as a confidence level, using the software program Statistical Package for Social Science (SPSS), version 18.0.

RESULTS

Of the 35 patients included in this study, 51.4% were male (n=18). The mean age was 43.9 ± 11.7 years,

ranging from 24 to 65 years. The sample, was mostly (60%) comprised of people over 41 years of age. Most of the sample 51.4% (n= 18) had more than eight years of schooling and men had a higher level of schooling (p= 0.030); 57% reported working and sedentary individuals comprised most of the sample (51.4%, n= 18).

Regarding ART, 3 patients (8.6%) reported that, even at the suggestion of an attending clinician, they did not use the medication. Most subjects (80%, n= 28) had a stable clinical condition, undetectable viral load (<50 copies) and CD4⁺ lymphocyte count above 400 cells/mm³.

Anthropometric variables and NS classification according to different measures and anthropometric indicators were described in tables 1 and 2. The mean weight of the population studied was 66.7 ± 15.1 kg and, mean height was 164.4 ± 10.1 cm.

According to BMI classification, 48.6% (n= 17) of the patients were eutrophic and 37.1% (n= 13) were overweight or obese. The adequacy of the TSF classified 57.1% (n= 20) of the patients with low weight and 31.4% with excess weight. According MAC and MAMC, in both, the prevalence of underweight in PLH was 48.6% (n= 17).

Comparing anthropometric variables between genders (Table 3), the MAMC showed a higher frequency of malnutrition in men (61.1%, n= 11) and overweight and obesity in women (35.3%, n= 6), with a statistically significant difference (p= 0.015).

According to MAC, 23.5% (n= 4) of the women were classified as overweight and obese, whereas this condition was not observed among men, with no statistical difference (p>0.05). WC and NC indicate that 42.9% (n= 15) and 37.1% (n= 13) of PLH had central obesity, respectively.

Significant correlations between BMI and TSF (r= 0.587; p<0.001) were verified (Figure 1 and 2). In this study, no association between the BMI and ART (p= 0.420) and between BMI and CD4⁺ lymphocyte count (p= 0.324) was observed.

Table 1. Anthropometric variables of patients living with HIV, by gender.

	Gender Males	Females	p Value
BMI (kg/m ²)*	23.07 $\pm$ 6.73	24.49 $\pm$ 13.32	0.355
TSF (mm)†	12.53 $\pm$ 6.78	19.54 $\pm$ 6.31	0.003
MAC (cm)†	27.96 $\pm$ 3.27	28.25 $\pm$ 5.62	0.851
MAMC (cm)†	24.02 $\pm$ 2.71	22.11 $\pm$ 4.21	0.119
WC (cm)	84.5 $\pm$ 13.0	87.0 $\pm$ 18.0	0.642
NC (cm)	36.9 $\pm$ 3.1	33.4 $\pm$ 3.7	0.007

BMI: Body Mass Index; TSF: Triceps skinfold; MAC: Mid-arm circumference; MAMC: Mid-arm muscle circumference; WC: Waist circumference; NC: Neck circumference. *Mann-Whitney Test (median and interquartile range); †Student's t-test (mean and standard deviation).

Table 2. Classification of the nutritional status and central obesity of patients living with HIV, according to anthropometric variables.

	Underweight		Normal		Overweight	
	n	%	n	%	n	%
BMI	5	14.3	17	48.6	13	37.1
TSF	20	57.1	4	11.4	11	31.4
MAC	17	48.6	14	40.0	4	11.4
MAMC	17	48.6	12	34.3	6	17.1
			Normal		Overweight	
	n	%	n	%	n	%
WC	-	-	20	57.1	15	42.9
NC	-	-	22	62.9	13	37.1

BMI: Body Mass Index; TSF: Triceps skinfold; MAC: Mid-arm circumference; MAMC: Mid-arm muscle circumference; WC: Waist circumference; NC: Neck circumference.

Table 3. Nutritional status, by gender, according to anthropometric variables of patients living with HIV.

	BMI*		TSF†		MAC†		MAMC†		WC		NC	
	n	%	n	%	n	%	n	%	n	%	n	%
Males												
Underweight	2	11.1	9	50.0	10	55.6	11	61.1	-	-	-	-
Normal	11	61.1	2	11.1	8	44.4	7	38.9	14	77.8	11	61.1
Overweight	5	27.8	7	38.9	0	-	0	-	4	22.2	7	38.9
Females												
Underweight	3	17.6	11	64.7	7	41.2	6	35.3	-	-	-	-
Normal	6	35.3	2	11.8	6	35.3	5	29.4	6	35.3	11	64.7
Overweight	8	47.1	4	23.5	4	23.5	6	35.3	11	64.7	6	35.3
p value	0.473		0.341		0.105		0.015		0.010		0.832	

BMI: Body Mass Index; TSF: Triceps skin fold; MAC: Mid-arm circumference; MAMC: Mid-arm muscle circumference; WC: Waist circumference; NC: neck circumference.*Kruskal Wallis test; †Student's t-test.

Figure 1: Dispersion graphs (Spearman's correlation coefficients) of BMI and others anthropometrics variables. (A) TSF vs. BMI Kg/m² ($r = 0.587$; $p < 0.001$) (B) MAC vs. BMI Kg/m² ($r = 0.885$; $p < 0.001$) and (C) MAMC vs. BMI Kg/m² ($r = 0.690$; $p < 0.001$).

Figure 2: Dispersion graphs (Spearman's correlation coefficients) of BMI and others anthropometrics indicators. (A) WC vs. BMI Kg/m² ($r = 0.876$; $p < 0.001$) (B) NC vs. BMI Kg/m² ($r = 0.591$; $p < 0.001$).

DISCUSSION

This study showed that the anthropometric indicators presented different diagnostic conclusions in relation to the NS of the PLH evaluated. However, several measures of anthropometry were correlated (TSF vs. BMI: $p<0.001$; MAC vs. BMI: $p<0.001$ and MAMC vs. BMI: $p<0.001$ and WC vs. BMI: $p<0.001$; NC vs. BMI: $p<0.001$).

A predominance of HIV cases was found in men (51.4%), a result corroborated with data from the Ministry of Health¹⁷ and other national surveys^{18,19}.

There was a higher frequency of normal weight (48.6%) and excess weight (37.1%) defined by BMI classification, like the study by Carvalho et al.²⁰, where researchers found a higher percentage of normal weight individuals (60.8%) and more than one-third (37.3%) of those evaluated were overweight or obese. Similarly, Massip et al.²¹ assessed PLH followed in an outpatient clinic and also found a high percentage of eutrophic patients, both in asymptomatic individuals (63%) and in those with AIDS (96.7%). The prevalence of eutrophic PLH was reported in several studies^{22,23,24}.

As in other studies^{18,20,25} it was observed that most of the men (61.1%) were classified with adequate nutritional status, while most women (47.1%) were overweight or obese. In the present study, women had a significantly lower education level compared to men, indicating an inverse relationship between schooling and overweight. In Brazil, in other periods, analyses among groups without HIV infection, have provided evidence for an increase in the prevalence and incidence of obesity associated with lower education in the female population²⁶. Schooling influences obesity through lifestyles, diet, physical activity and, through occupation and income. Individuals with higher socioeconomic status have more access to healthy food and voluntary body weight reduction resources^{26,27}.

BMI is a classic indicator widely used in population studies to evaluate the anthropometric-nutritional profile. However, the accuracy of this indicator is questionable when used alone, since it is an estimation of the body composition based on weight and height of the individual. However, the accuracy of this indicator is questionable when used alone, since it is an estimation of the body composition based on weight and height of the individual. Among the limitations of BMI, are the lack of ability to discriminate fat and lean mass and that BMI does not consider the distribution of body fat²⁸. In PLH, metabolic changes associated with the infection can make evaluation difficult and it is necessary to apply other measures to determine a more adequate nutritional diagnosis.

When evaluating patients according to the other anthropometric variables, prevalence of malnutrition was verified according to TSF (57.1%), MAC (48.6%) and MAMC (48.6%). These findings are in line with a study by Pires et al.²⁹ that found changes in the body composition of HIV patients with predominance of malnutrition according to TSF, MAC and MAMC. However, the study by Santo et al.³⁰, which evaluated only HIV-infected men, revealed low

rates of malnutrition according to TSF (15%) and AMC (8%).

In this context, it is known that HIV-associated lipodystrophy can be present in this population, whose clinical picture is composed of endocrine-metabolic changes and body fat distribution. This modification of body composition is commonly observed, reaching rates of 83%³¹, and may be present as lipoatrophy, lipohypertrophy or a mixed form. Therefore, the diagnostic significance of malnutrition observed in this study may have been overestimated due to the influence of lipoatrophy, characterized by the loss of subcutaneous fat in peripheral regions³².

According to the TSF, MAC and MAMC adequacy, malnutrition was the most common nutritional disorder among men and women evaluated by this study, with men presenting lower DCT values when compared to women ($p<0.01$). Evaluating DCT of ambulatory PLH, Rodrigues et al.³³ found a prevalence of malnutrition in both sexes of 74%. However, when assessing nutritional status through MAC, the majority (70%) of patients were adequate, diverging from the present study.

In the present study, WC identified a significant number of PLH at cardiovascular risk (42.9%), with a higher occurrence of central obesity in females ($p=0.010$). Dimala et al.³⁴ evaluated concordance between BMI and independent predictors of cardiometabolic risk (WC, WHR, WHtR) as anthropometric parameters in the classification of cardiometabolic risk in PLH. In agreement with our study, the association between BMI and WC ($p<0.001$)³⁴ was verified. However, the authors encourage the routine use of indicators such as WC, since they have a better predictive capacity for cardiometabolic risk in patients with HIV infection ($k=0.20$, $p=0.001$)³⁴. Beraldo et al.³⁵ also reinforce the use of WC in the evaluation of PLH, since this parameter evaluates fat deposition in the abdominal region, because abdominal visceral obesity is a more serious cardiovascular risk factor than general obesity, and is usually evaluated by IMC³⁵.

NC is a relatively new anthropometric measure used in the evaluation of the nutritional status to identify body adiposity¹⁶. The distribution of fat in the upper body is recognized to be related to increased risk of cardiovascular disease. In the studied group, 37.1% of the PLH presented increased measures of NC. Higher NC values in patients without HIV infection were positively correlated with overweight and increased cardiovascular risk ($p<0.0001$)³⁶.

However, we emphasize that in PLH, there are few studies evaluating the use of NC. Fitch et al.³⁷ evaluated individuals with and without HIV infection and found that increased NC in both groups was strongly associated with a decrease in HDL cholesterol and changes in glucose homeostasis. Furthermore, the authors found that the increase in NC was associated with an increase in the thickness of the intima and middle layers of the carotid arteries, which is a parameter of evaluation of subclinical atherosclerosis and also of cardiovascular risk³⁷.

In this study, significant positive correlations were observed among BMI, TSF, MAC, MAMC, WC and NC. In

relation to PLH, the MAC measurement showed strongly association with BMI ($r = 0.885$; $p < 0.001$). When the patient was classified as malnourished based on the mid-arm circumference (MAC), in parallel it was also classified as malnutrition, by BMI, characterizing a directly proportional and positive correlation. These findings are in line with research conducted by Kauffman et al.³⁸ among 54 patients. Investigators found a strong correlation between BMI and MAC and significant correlations with MAMC and TSF. As in the study by Pinto et al.³⁹, they concluded that when the patient was classified as malnourished by BMI their nutritional status deteriorated in relation to MAC measurements.

Regarding indirect indicators of central adiposity, other authors, as in our study, found a correlation between BMI and WC ($r = 0.65$, $p < 0.001$)³⁴ and when assessing the neck measurement, significant ($p < 0.0001$) correlations were found between NC and BMI in men and women ($r = 0.70$ and $r = 0.81$, respectively).

It is worth mentioning that, in the absence of infection, muscle mass is a body component that decreases throughout the aging process and is associated with muscle strength reduction. PLH are not only predisposed to lipodystrophic syndrome caused by antiretroviral therapy and HIV infection itself, but also suffer a progressive decrease in lean body mass due to the evolution of the disease⁴⁰.

The limitations of this study include the reduced sample size and the absence of the gold standard method. The use of dual energy X-ray absorptiometry (DXA) to assess body composition would allow the evaluation of the concordance between nutritional status indicators in this population, since it provides accurate information of the body compartments – fat, muscle, bone mass and water.

CONCLUSION

In the present study it was verified that the anthropometric indicators analyzed individually presented a disagreement in the classification of the NS of the individuals evaluated. The frequency of normal weight by BMI analysis was higher among men, and overweight was more common among women. Considering TSF, MAC and MAMC, the patients were underweight; however, using BMI, there was a predominance of PLH with adequate nutritional status.

Considering the importance of an early nutritional assessment and intervention, in addition due to the complexity of metabolic factors involved in the evaluation of PLH, the combined use of predictors of NS and of cardiometabolic risk associated with obesity should be emphasized. Although BMI has been shown to be significantly correlated with other variables, the use of central adiposity measures, such as WC and NC, should be encouraged, since they are convenient and inexpensive options that can be routinely used in clinical practice in public health services.

Acknowledgements. The authors thank the CAPES, CNPq and FAPEMIG for the financial support; the Specialized Service of Assistance (SAE) in Ouro Preto, MG, Brazil, and

especially, all the patients who collaborated in this study.

Conflict of interests. The authors declare that they have no conflict of interests.

REFERENCES

1. Chin J. Public health surveillance of AIDS and HIV infections. *Bull World Health Organ* 1990; 66(5): 529-536.
2. Rodríguez RP, Puerto MJG, Chamorro EM, Duenas C, Villar NGP, Candela CG. Consensus paper on metabolic alterations and cardiovascular risk in patients with HIV Infection. Expert Group of the Study Group on Metabolic Alterations (GEAM), the Secretariat of the National Plan on AIDS (SPNS) and the AIDS Study Group (GeSIDA). *Enferm Infecc Microbiol Clin* 2015; 33(1): 40.
3. Arbeitman LE, O'Brien RC, Somarriba G, Messias SE, Neri D, Gwendolyn B, et al. Body Mass Index and Waist Circumference of HIV-Infected Youth in a Miami Cohort: Comparison to Local and National Cohorts. *J Pediatr Gastroenterol Nutr* 2014; 59(4): 449-454.
4. Thuppal SV, Jun S, Cowan A, Bailey RL. The Nutritional Status of HIV-Infected US Adults. *Curr Dev Nutr* 2017; (10): e001636.
5. Beraldo RA, Santos AP, Guimarães MP, Vassimon HS, Paula FJA, Machado DRL, Fos-Freitas MC. Body fat redistribution and changes in lipid and glucose metabolism in people living with HIV/AIDS. *Rev Bras Epidemiol* 2017; 20(3): 526-536.
6. Costa CS, Neto CLA, Câmpelo WF, Mendes ALR. Association between different methods of nutrition assessment in patients WITH HIV/AIDS in a public hospital. *Rev Bras Promoção Saúde* 2017; 30(3): 1-9.
7. Matheus SC, Santos L, Behenck MS, Both DR. Use of anthropometry to assess body fat distribution of patients with HIV/AIDS. *Arq Ciênc Saúde* 2015; 22(1): 64-69.
8. World Health Organization. Physical status: the use and interpretation of anthropometry: report of a WHO Expert Committee. Geneva: WHO, 1995.
9. Guimarães NS, Fausto MA, Kakehasi AM, Navarro AM, Tupinambás U. Can anthropometry measure the body fat of people living with HIV/AIDS? A systematic review. *Rev Esp Nutr Hum Diet* 2017; 21(2): 101-111.
10. Soares LR, Silva DC, Gonzalez CR, Batista FG, Fonseca LA, Duarte AJS, Casseb J. Discordance between body mass index and anthropometric measurements among hiv-1-infected patients on antiretroviral therapy and with lipodystrophy/ lipohypertrophy syndrome. *Rev Inst Med Trop* 2015; 57(2): 105-110.
11. Beraldo RA, Meliscki GC, Silva BR, Navarro AM, Bollela VR, Schmidt A, et al. Anthropometric measures of central adiposity are highly concordant with predictors of cardiovascular disease risk in HIV patients. *Am J Clin Nutr* 2018; 107(6): 883-893.
12. Mulligan K, Parker RA, Komarow L, Grinspoon SK, Tebas P, Robbins GK, et al. Mixed patterns of changes in central and peripheral fat following initiation of antiretroviral therapy in a randomized trial. *J Acquir Immune Defic Syndr*. 2006; 41(5): 590-597.
13. World Health Organization. Obesity: Preventing and managing the global epidemic. Geneva: WHO; 2000.
14. Lipschitz DA. Screening for nutritional status in the elderly. *Prim Care* 1994; 21(1): 55-67.
15. Frisancho AR. Anthropometric Standards for the assessment of growth and nutritional status. Ann Arbor: University of

- Michigan Press, 1990. 189p.
16. Ben-Noun L., Sohar E., Laor A. Neck circumference as a simple screening measure for identifying over weight and obese patients. *Obes Res* 2001; 9(8): 470-477.
 17. Dartora WJ, Ânfior EP, Silveira LRP. Prevalência do HIV no Brasil 2005-2015: dados do Sistema Único de Saúde. *Rev Cuid* 2017; 8(3): 1919-1928.
 18. Castro ACO, Silveira EA, Falco MO, Nery MW, Turchi MD. Overweight and abdominal obesity in adults living with HIV/AIDS. *Rev Assoc Med Bras* 2016; 62(4): 353-360.
 19. Santos MR, Araujo JV, Junior BJS, Filho, DBM, Ximenes RAA. Lipid profile of HIV positive patients on antiretroviral therapy. *Brazilian Multidisciplinary J* 2017; 20(1): 61-70.
 20. De Carvalho B, Policarpo S, Moreira AC. Nutritional status and quality of life in HIV-infected patients. *Nutr Hosp* 2017; 34(4): 923-933.
 21. Massip NT, Nicot BG, Massip NJ, Valdés VA, Pimienta SA. Nutritional status of people living with HIV/AIDS. *Rev Chil Nutr* 2015; 42(2): 131-138.
 22. Senna AFK, Oliveira SA, Velarde LGC, Setúbal S. Nutritional status of HIV-positive patients in Niterói, Rio de Janeiro, Brazil. *J Health Popul Nutr* 2014; 32(4): 595-599.
 23. Sernizon GN, Fausto MA, Tupinambás U. Prevalence of overweight, central obesity and metabolic comorbidities risk in adults living with HIV/AIDS. *Rev Bras Promoç Saúde* 2016; 29(3): 399-405.
 24. Lima RLFC, Medeiros ARC, Medeiros LB, Salerno AAP, Moraes RM, Vianna RPT. Self-reported and measured weight, height and body mass index for the diagnosis of the nutritional status in people living with HIV/AIDS. *Rev Nutr* 2017; 30(5): 555-566.
 25. Silva IC, Sampaio E, Almeida M, Freire AN, Ramos L, Medeiros JMB. Metabolic profile, anthropometric and lipodystrophy in people living with HIV/AIDS in antiretroviral therapy. *Nutr Clin Diet Hosp* 2016; 36(3): 38-44.
 26. Alves RFS, Faerstein E. Educational inequality in the occurrence of abdominal obesity according to gender and color/race: the Pro-Health Study, 1999-2001 e 2011-2012. *Cad Saúde Pública* 2016; 32(2): e00077415.
 27. Sobal J. Obesity and socioeconomic status: a framework for examining relationships between physical and social variables. *Med Anthropol* 1991; (13): 231-247.
 28. Soares LR, Silva DC, Gonsalez CR, Batista FG, Fonseca LA, Duarte AJS et al. Discordance between body mass index and anthropometric measurements among hiv-1-infected patients on antiretroviral therapy and with lipoatrophy/lipohypertrophy syndrome. *Rev Inst Med Trop* 2015; 57(2): 105-110.
 29. Pires DS, Ferraz SF, Monteiro ML, Reis VAGA, Pontes DB, Andrade MIVAMCN. Nutritional profile and methods for assessing the nutritional status of HIV-infected patients. *Braspen J* 2017; 32(3): 209-213.
 30. Santo RE, Grinsztejn B, Peres WAF, Brito PD. Bioimpedance and anthropometry in determining body composition in HIV men. *Rev Bras Nutr Clin* 2016; 31(1): 60-64.
 31. Diehl LA, Dias JR, Paes ACS, Thomazini MC, Garcia LR, Cinagawa E et al. Prevalence of HIV-associated lipodystrophy in patients outpatients: relationship with metabolic syndrome and cardiovascular risk factors. *Arq Bras Endocrinol Metab* 2008; 52(4): 658-667.
 32. Carr A. HIV lipodystrophy: risk factors, pathogenesis, diagnosis and management. *AIDS* 2003; 17(suppl 1): S141-S148.
 33. Rodrigues EC, Miranda RNA, Guterres AS. Nutritional and food habits profile assessment of patients with HIV. *Rev Paraense Med* 2013; 27(4): 37-46.
 34. Dimala CA, Ngu RC, Kadia BM, Tianyi F-L, Choukem SP. Markers of adiposity in HIV/AIDS patients: Agreement between waist circumference, waist-to-hip ratio, waist-to-height ratio and body mass index. *PLoS ONE* 2018; 13(3): e0194653.
 35. Beraldo RA, Meliski GC, Silva BR, Navarro AM, Bollela VR, Schmidt A et al. Comparing the Ability of Anthropometric Indicators in Identifying Metabolic Syndrome in HIV Patients. *Plos One* 2016; 11(2): e0149905.
 36. Ben-Noun L, Laor N. Relationship of Neck Circumference to Cardiovascular Risk Factors. *Obes Res* 2003; 11(2): 226-231.
 37. Fitch KV, Stanley TL, Looby SE, Rope AM, Grinspoon SK. Relationship between neck circumference and cardiometabolic parameters in HIV-infected and non-HIV-infected adults. *Diabetes Care* 2011; 34(4): 1026-1031.
 38. Kauffmann LKO, Miranda RNA, Guterres AS, Pinto AF. Nutritional and alimentary profile of HIV-1/AIDS patients admitted in a university hospital. *Ciência e Saúde* 2017; 10(2): 82-88.
 39. Pinto AF, Kauffmann LKO, Penha HPS, Rodrigues ELJ, Miranda RNA, Guterres AS. et al. Nutritional status and gastrointestinal disorders in hospitalized patients with HIV/AIDS at the Hospital Universitário João de Barros Barreto in Belém, Pará State, Brazil. *Rev Pan-Amaz Saude* 2016; 7(4): 47-52.
 40. Oliveira RL, Almeida CF, Oliveira RVC, Grinsztejn B, Silva MTT, Brito PD. Malnutrition and Quality of Life in People Living with HIV/AIDS. *Rev Bras Cienc Saúde* 2018; (22)1: 65-72.