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ORIGINAL ARTICLE

Neck circumference correlation with anthropometric parameters of body adiposity in people living with HIV/AIDS

Correlação da circunferência do pescoço com parâmetros antropométricos de adiposidade corporal em pessoas com HIV/AIDS

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ABSTRACT

Objective: to evaluate neck circumference correlation with other anthropometric and biochemical parameters of body adiposity in people living with HIV/AIDS attended at the infectious diseases outpatient clinic of a teaching hospital in Recife, state of Pernambuco. **Materials and methods:** This is an analytical cross-sectional study, which included individuals with HIV/AIDS attended at the infectology outpatient clinic of the Instituto de Medicina Integral Professor Fernando Figueira - IMIP, located in the city of Recife (Pernambuco) in the period from May 2022 to August 2022 with people living with HIV/AIDS. **Results**: A total of 123 people living with HIV/AIDS of both sexes and aged over 18 years were included, the average age was 40 ‡11.5 years with a predominance of females (55.3%), and in regular use of antiretroviral therapy. A higher rate of overweight was verified through the Body Mass Index (BMI) and when the metabolic risk was evaluated through neck circumference, the result was 50.4%". The strongest correlations associated with neck circumference were observed between the following: body mass index (r=0.51), arm circumference (r=0.61), waist circumference (r=0.59), arm muscle circumference (0.73), and arm muscle area (r=0.69). **Conclusions**: Considering all of the aforementioned, neck circumference seems to have a positive correlation among the anthropometric parameters that are predictors of body adiposity in people living with HIV/AIDS.

RESUMO

Objetivo: Avaliar a circumferência de pescoço e sua correlação com outros parâmetros antropométricos e bioquímicos de adiposidade corporal em pessoas vivencia com HIV/AIDS acompanhados no ambulatório de infectologia em um hospital escola do Recife-PE. **Materiais e métodos:** Trata-se de um estudo transversal analítico, que incluiu indivíduos com HIV/AIDS acompanhados no ambulatório de infectologia do Instituto de Medicina Integral Professor Fernando Figueira - IMIP, localizado na cidade na cidade do Recife-Pernambuco, no período de maio de 2022 a agosto de 2022 com pessoas que vivem com HIV/AIDS. **Resultados:** Foram incluídas 123 pessoas que vivem com HIV/AIDS, de ambos os sexos, com idade superior a 18 anos com média de 40 ‡11,5 anos, predominância do sexo feminino (55,3%) e em uso regular da terapia antirretroviral. Foi observado uma maior taxa de sobrepeso, o risco metabólico avaliado através da circunferência do pescoço foi de 50,4%. As correlações mais fortes associadas a circunferência do pescoço foram observadas entre: índice de massa corporal (r=0,51), circunferência do braço (r=0,61), circunferência da cintura (r=0,59), circunferência muscular do braço (0,73) e área muscular do braço (r=0,69). **Conclusões:** Diante do exposto, a circunferência do pescoço parece ter correlação positiva dentre os parâmetros antropométricos preditores de adiposidade corporal em pessoas que vivem com HIV/AIDS.

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Introduction

Human immunodeficiency virus (HIV) is a retrovirus that affects helper T-lymphocytes, causing immune dysfunction and leading to Acquired Immunodeficiency Syndrome (AIDS), which is characterized by the occurrence of opportunistic infections and rare malignancies[1].

In recent years, the panorama of people living with HIV/AIDS (PLWHA) has shown high survival rates, which has been attributed to the irrefutable benefits of combined antiretroviral therapy (ART). This therapy involves a combination of two or more drugs to control the viral load, which allows the infection to be controlled[2]. From 2007 to June 2021, 381,793 cases of HIV infection were reported in Brazil[3].

Nevertheless, PLWHA have a high prevalence of metabolic and nutritional disorders as a consequence of persistent inflammation associated with the toxicity inherent to ART. These factors, associated with an obesogenic environment, have been modifying the previous thinness model to a pattern of overweight and obesity; therefore, predisposing this population to an altered adiposity (lipodystrophy), insulin resistance, diabetes mellitus, dyslipidemias, hypertension, and liver disease[4].

However, growing evidence indicates that PLWHA are at increased risk of cardiovascular disease (CVD), and the relative risks of its various manifestations are generally 1.5 to 2 times higher for this population compared to uninfected individuals, causing increased mortality rates[5].

Designating body composition, including its distribution, is extremely important in clinical practice, particularly due to the correlation between body fat and cardiometabolic changes, since fat tissue is responsible for causing metabolic changes in chronic diseases, making the redistribution of fat a key point for such changes, which is extremely relevant in the population with HIV/AIDS.[6].

Although BMI is continuously used to determine overweight and obesity, the method does not

differentiate fat from other tissues such as muscle, and does not consider the regional distribution of fat; conversely, the waist circumference (WC) is an advantageous tool to measure central obesity and metabolic syndrome, while simultaneously being a proven anthropometric measure to identify cardiovascular risk[7].

The interest in correlating different anthropometric indicators, such as neck circumference (NC), to estimate body fat and estimate associated risk factors has been of considerable interest and has increased in recent years. NC is an indicator of the subcutaneous adipose tissue distribution in the upper body and is considered an excellent tool to measure overweight and obesity[8].

NC is a simplified, rapid, non-invasive, reliable, culturally acceptable, and low-cost parameter; however, it is not routinely evaluated in most clinical or research contexts, despite being a more practical and probably better measure, which may be especially useful in special populations. Currently, there is not enough relevant data to assert that this association persists in the presence of HIV/AIDS[7]. Increased NC is associated with a 10-year risk of developing cardiometabolic diseases, independently of global and visceral adiposity measures. Increased NC has also proven to be a more efficient indicator of visceral obesity and peripheral insulin resistance compared to WC in the population in general[9].

For this reason, the objective of this study was to correlate neck circumference with other anthropometric and biochemical parameters of body adiposity in PLWHA attended Hospital DIA/SAE, Recife, state of Pernambuco. Noting that the use of CP is an accurate tool to estimate the body adiposity of people with HIV/AIDS.

Methods

Drawing and Sample

This is an analytical cross-sectional study, which was conducted from May 2022 to August 2022 in the outpatient clinic of the Hospital DIA/SAE of infectology of the Instituto de Medicina Integral Professor Fernando Figueira - IMIP. The study population was composed of people living with HIV/AIDS of both sexes, aged 18 years and older.

In order to be convenient, a non-probabilistic sample was used with the following exclusion criteria: children under 18 years old, those who had not started ART, pregnant women, patients with endemic, nodular, multinodular goiter or cervical gibberish, which would make it impossible to measure WC, and those unable to perform the anthropometric evaluation.

Procedures for attracting participants

Data were collected by the researchers in an individual interview through a questionnaire structured by a previously trained researcher, in which information on the sociodemographic, economic, anthropometric, clinical profile and biochemical exams in the last year were collected. The procedures were conducted in a private place, thus preserving privacy and confidentiality. The individuals who agreed to participate in the research signed the Informed Consent (IC), committing themselves to participate voluntarily in this study.

Instruments for data collection

The socio-demographic and economic characterization of the profile was performed through the economic classification methodology of the Associação Brasileira de Empresas de Pesquisa (ABEP/2021). Information on monthly and *per capita* family income, education, and employment relationship was also collected. Regarding demographic characterization, name of the patients, age, gender, and marital status, origin and number of residents at home were registered.

The anthropometric evaluation resulted from the collection of measurements which provided the evaluation of body mass through the sum of all body components, following the medical care. Anthropometry was performed according to the techniques recommended by the Ministry of Health, and all measurements were taken during the consultation. The following parameters were evaluated: weight: measured on a portable scale (digital electronic scale - Digital Magna CA4000, G-Life Ltda.), with capacity of 150kg and precision of 100g, with the participant wearing light clothes and no shoes; height: measured with the aid of a compact stadiometer (HT-01, MD HealthCare) with extension of 2 meters, divided into centimeters and subdivided into millimeters; BMI: obtained by the ratio of weight by height squared, taking into account the cut-off points proposed by World Health Organization (1995) for adults or PAHO (2002) for the elderly; sum of the four skinfolds (SFT): subscapular, suprailiac, triciptal and biciptal, obtained from the average of three measurements with a Lange caliper.

For the result, Durnin & Womersley's (1974) four-site skinfold test was used, and for classification of this percentage, according to Pollock & Wilmore (1993), it was used the following: arm circumference (AC): with the anthropometric tape, avoiding skin compression or looseness (FRISANCHO, 1990; KUCZMARSKI et al, 2000; BLACKBURN et al, 1979); arm muscle circumference (AMC) and corrected arm muscle area (AMBc). The results were calculated based on the equations proposed by Frisancho (1990).

The following parameters were also used: neck circumference (NC): measured at mid-neck height, between the middle cervical spine and the anterior mid-neck, to within 1 mm. In men with laryngeal prominence (Adam's apple), it was measured just below the prominence. The cut-off point, ≥34 for women and ≥ 37 for men, was considered increased (BEN-NOUN et al., 2001); waist circumference (WC): performed with the aid of an inextensible measuring tape, with the individual in

an upright position. The circumference was measured at the height of the umbilical scar.

For measurement classification, the table with the cut-off points according to sex and risk for developing CVD was used, according to which very high risk is considered to be ≥ 88 cm for women, and ≥ 102 cm for men (WHO, 1998); hip circumference (HC): calculated by using an inextensible measuring tape, with the individual in an upright position, in the most prominent gluteal region; waist-to-height ratio (WHtR): obtained by the quotient between waist circumference (cm) and height (cm). Values ≥ 0.52 for women and ≥ 0.53 for men were considered as metabolic risk predictors (HAUN et al, 2009); waist hip ratio (WHR): calculated by dividing the value of WC by the result of WHR (WHR = WC/QC). Classification for cardiovascular disease risk: men = >1.0/ women = 0.85 (WHO, 1998); cardiovascular risk (CVR): The cut-off points suggested by Lean, Han and Morrison (1995), Pereira, Sichieri and Marins (1999) and Pitanga and Lessa (2006) for WC, WHR and WHtR, respectively, were adopted for the classification of CRV. Individuals were classified with high CRC when: WC ≥94cm for males and ≥80cm for females; WHR ≥0.95 for males and ≥0.80 for females; and WHtR ≥0.52 for males and ≥0.53 for females.

For clinical data evaluation: time of HIV/AIDS diagnosis, ART usage time (expressed in months), presence and types of comorbidities. All data were collected through an interview with the participant and/or the medical records of the service.

Blood pressure was measured by the researcher at the beginning of the consultation, following the recommendations of the Diretriz Brasileira de Hipertensão/ Brazilian Guidelines of Hypertension (2020).

The following biochemical parameters were recorded: total cholesterol, low density lipoprotein, high density lipoprotein and triglyceride, fasting glycemia, vitamin D, as well as CD4, CD8 and viral load levels. All [exams] had been routinely performed in the service, considering the exams of the last 12 months at the time of consultation, not requiring a new exam. The classification of the exams occurred according to the SBC (Portuguese abbreviation for Brazilian Society of Cardiology) (2017) and Ministry of Health (2013).

For lifestyle habits characterization, the participants were asked about smoking (if they are smokers, how long they have been smokers, and if former smokers, how long they have been smokers) and drinking (consumption and frequency).

Data processing and analysis

Data were organized and archived by the researcher in charge. Typing was performed through double entry in EXCEL for Windows, version 2013; and statistical analysis was performed in SPSS, version 13.0 (Chicago, IL, USA).

Continuous variables were checked for normality using the Kolmogorov-Smirnov test. Variables with normal distribution were described as means and standard deviations and the respective parametric tests were applied ("Student's t" test for comparison of two means). Whenever they did not present a normal distribution, the variables were described as medians and their respective interquartile ranges, applying the nonparametric Mann Whitney "U" test for comparison of two medians, and the Kruskall Wallis test for comparison of more than two medians.

In the correlation analysis of two quantitative variables, Pearson's correlation was used. For the classification of correlation coefficients, it was considered weak correlation for $r < 0.4$, moderate for $r \geq 0.4$ to $r < 0.5$, and strong for $r \geq 0.5$.

Chi-square and Fisher's Exact tests were used to compare frequencies. A p value of <0.05 will be considered for rejection of the null hypothesis in all statistical tests.

Ethical aspects

The Ethics Committee of the Instituto de Medicina Integral Professor Fernando Figueira in Recife, state of Pernambuco, approved the study under the Certificate of Ethical Appraisal (CAAE) 55561422.4.0000.5201 (approval opinion no. 5.233.049). All participants agreed on participating in the research by signing the Informed Consent (IF) to guarantee their voluntary participation in the research and authorizing the use of the data obtained. A copy of the IF was given to the participant.

Results

The participants included in this study consisted of 123 PLWHA with an average age of 40.72 +-11.57 years old, with a minimum of 19 and a maximum of 76. Females represented the predominant part of the sample (55.3%, n=68). Among the self-declared ethnicities, the one with the highest prevalence was pardo(54.5%, n=67); and among the comorbidities evaluated, dyslipidemia showed the highest incidence with 33.1%, n=39, as seen in **Table 1**.

Table 1 – Sample characterization regarding demographic, socioeconomic and lifestyle profiles of PLWHA treated at a teaching hospital in Recife-PE (2022)

Variables (N=123)	N	%
Sex		
Female	68	55,3
Male	55	44,7
Ethnicity		
White	18	14,6
Black	31	25,2
Pardo	67	54,5
Indigenous	2	1,6
Yellow	5	4,1
Marital Status		

Single	66	53,7
Married	21	17,1
Domestic Partnership	22	17,9
Divorced	10	8,1
Widowed	4	3,3
Educational Stage		
Illiteracy	3	2,4
Elementery School (Incomplete)	34	27,6
Elementery School (Complete)	9	7,3
High School (Incomplete)	13	10,6
High School (Complete)	40	32,5
Higher Education	24	19,5
Occupation		
Employed	55	44,7
Unemployed	63	51,2
Retired	5	4,1
Family Income		
None	2	1,6
< 1 Minimum Wage	35	28,5
1 a 2 Minimum Wage	52	42,3
3 a 4 Minimum Wage	17	13,8
Above 4 Minimum Wage	17	13,8
ABEP* (N=121)		
A	1	8
B1	5	4,1
B2	11	9,1
C1	19	15,7
C2	32	26,4
DE	53	43,8
Alcoholic Beverage (N=123)		
Yes	58	47,2
No	65	52,8
Smoking (N=122)		
Yes	31	25,4
No	91	74,6
Physical activity (N=123)		
Yes	46	37,4
No	77	62,6
Diabetes (N=118)		
Yes	8	6,8
No	110	93,2
Hypertension		
Yes	22	18,6
No	96	81,4
Dyslipidemia		
Yes	39	33,1
No	79	66,9
Cardiovascular disease		
Yes	7	5,9
No	111	94,1

*ABEP: Associação Brasileira de Empresas de Pesquisa.

According to Table 2, BMI showed that 38.5% (n=47) of the PLWHA were classified as overweight, followed by 36.9% (n=45) as eutrophic. By the analysis of WC, 50.4% (n=61) were at risk; however, when analyzing the WC, 49.6% (n=60) of the sample was considered adequate, although the prevalence of WHR 71.9% (n=87) indicated that these PLWHA were at cardiovascular risk. Nevertheless, based on the WHR, 51.6% (n=63), PLWHA were classified as presenting low metabolic risk.

Table 2 - Sample characterization regarding the nutritional profile of PLWHA assisted at a Teaching Hospital in Recife-PE (2022)

Variables (N=122)	N	%
BMI*		
Thinness	6	4,9
Eutrophy	45	36,9
Overweight	47	38,5
Obesity	24	19,7
Arm Circumference (N=121)		
Moderate Malnutrition	9	7,4
Mild Malnutrition	22	18,2
Eutrophy	68	56,2
Overweight	12	9,9
Obesity	10	8,3
Waist Circumference (N=121)		
Adequate	60	49,6
High	29	24,0
Very High	32	26,4
CVR* através da WHR*		
Yes	87	71,9
No	34	28,1
CVR* através da WHtR* (N=122)		
Yes	59	48,4
No	63	51,6
Neck Circumference (N=121)		
Risk	61	50,4
No Risk	60	49,6
Arm Muscle Circumference (N=120)		
Severe Depletion	1	8,0
Moderate Depletion	4	3,3
Mild Depletion	14	11,7
Eutrophy	101	84,2
Classification of the Four-site Skinfold (N=119)		
Below Average Rating	10	8,4
Average	1	8,0
Above Average	47	39,5
Obesity	61	51,3

*BMI: Body Mass Index; CVR: Cardiovascular Risk; WHR: Waist-hip Ratio; WHtR: Waist-to-Height Ratio.

The correlation analysis results between anthropometric and body composition indicators, described in **Table 03**, suggest a strong correlation with statistically significant results in most cases, except WHR and WHtR. The strongest correlations associated with NC were observed for BMI (r=0.51), WC (r=0.61), WC (r=0.59), MAMC (0.73) and MAMB (r=0.69).

Table 3 - Anthropometric indicators correlation among PLWHA assisted at a teaching hospital in Recife-PE (2022)

Anthropometric and body composition indicators	BMI	AC	WC	WHR	WHtR	NC	AMC	CAMA	Sum of Folds
BMI	1	0,881*	0,842*	0,041	0,712*	0,515*	0,610*	0,638*	0,605*
AC	0,081*	1	0,807*	-0,030	0,563*	0,613*	0,822*	0,841*	0,417*
WC	0,842*	0,807*	1	-0,037	0,755*	0,595*	0,642*	0,638*	0,456*
WHR	0,041	-0,030	-0,037	1	0,013	-0,070	-0,050	-0,031	0,040
WHtR	0,712*	0,563*	0,755*	0,013	1	0,370*	0,348*	0,348*	0,478*
NC	0,515*	0,613*	0,595*	-0,070	0,370*	1	0,734*	0,698*	-0,159
AMC	0,610*	0,822*	0,642*	-0,050	0,348*	0,734*	1	0,986*	-0,027
CAMA	0,638*	0,841*	0,638*	-0,031	0,348*	0,698*	0,986*	1	0,052
Sum of Areas	0,605*	0,417*	0,456*	0,040	0,478*	-0,159*	-0,027	0,052	1

Abbreviation: BMI= Body Mass Index; AC= Arm Circumference; WC= Waist Circumference; WHR= Waist-hip Ratio; WHtR= Waist-to-Height Ratio; NC= Neck Circumference; AMC= Arm Muscle Circumference; CAMA= Corrected Arm Muscle Area . Pearson Correlation/ *p<0,05

According to the biochemical evaluation, despite the lack of statistical significance, CT and LDL averages were higher for the risk group, and HDL showed a lower average compared to the no-risk group, as shown in **Table 4**.

Table 4 - Biochemical variables comparison according to neck circumference to evaluate cardiovascular risk in PLWHA assisted at a teaching hospital in Recife-PE (2022).

VARIABLES	NECK CIRCUMFERENCE		
	RISKY (N=61)	NO-RISK (N=60)	P - valor
CT (mg/dl mean± DP)	184,62 ± 42,56	169,25 ± 41,09	0,072[a]
LDL-C (mg/dl mean± DP)	126,16 ± 39,10	111,49 ± 37,77	0,064[a]
TG (mg/d mean [IQ])	180,00 [159,25-246,50]	99,50 [75,25-122,75]	0,221[b]
HDL (mg/dl mean± DP)	42,60 ± 11,72	45,38 ± 41,09	0,351[a]

Data presented as median values (25th - 75th percentile). [a]Student's t-test; [b]Manny Whitney test. Abbreviations: TC= Total Cholesterol; LDL= Low-density Lipoprotein; TG= triglyceride; HDL= High-density Lipoprotein; SD: Standard Deviation; IQ: Interquartile Range.

Table 5 - Sample characterization regarding the biochemical profile of PLWHA assisted at a Teaching Hospital in Recife-PE (2022)

triglycerides (N=98)	N	%
Normal	60	61,2
High	38	38,8
LDL* (N=99)		
Optimal	33	33,3
Desirable	32	32,3
Borderline Risk	19	19,2
High	10	10,1
Very High	5	5,1
HDL* (N=98)		
Low	45	45,9
Adequate	53	54,1
Total Cholesterol (N=99)		
Desirable	63	63,6
High	36	36,4
Viral Load (N=104)		
High	2	1,9
Low	18	17,3
Not Detectable	84	80,8
LymphocytesCD4 (N=102)		
Low	44	43,1
Adequate	58	56,9
Fasting Glycemia (N=87)		
normoglycemia	71	81,6
Increases risk for diabetes	10	11,5
Established Diabetes	6	6,9
Vitamin D (N=69)		
Low	21	30,4
Adequade	48	69,6

*LDL: Low-density Lipoprotein; HDL: High-density Lipoprotein

Discussion

Regarding the correlation analysis of anthropometric variables with NC, a positive and significant correlation was found between the following variables: BMI, AC, WC, BMC, AMC, and WHtR. The results indicated a proportionality between changes in body adiposity and fat accumulation in the subcutaneous region of the neck in PLWHA. Such correlations are in accordance with previous studies involving HIV-uninfected [16,17] people and contribute to validating NC as an appropriate parameter for predicting body fat. There are scarce data on the use of NC in adult and elderly PLWHA, which demonstrates the need for studies that include this indicator as an additional tool for nutritional evaluation of PLWHA[17]; however, a negative correlation was observed between NC and WHR, NC and fat percentage.

When the nutritional status was evaluated, it could be observed that a considerable part of the evaluated patients were overweight, according to the BMI values. A similar study was performed by Gomes; Lourival[15], in which most patients had an overweight BMI. Prior to the introduction of antiretroviral therapy, nutritional disorders were weight loss and malnutrition, consequences of opportunistic infections; however, currently, weight gain, fat redistribution and obesity are nutritional problems that PLWHA on high potency antiretroviral therapy have presented[6].

In this study, most of the patients were female, which is consistent with the study by Gazzi et al.10, according to which male incidence rates were, initially, significantly higher than female. After more than 40 years, men remain the most affected, however, the speed of growth of the epidemic in women is substantially greater, justifying its higher rate in females.

With regard to the average age, similar results were found by Kauffmann et al.[11] who found a high number of people infected with the virus in the 20 to 59 age group. Increasing cases in this population group can be explained by increased sexual activity, non-use of condoms, increase in the number of partners, and a low level of education[12].

Another aspect observed by Alves et al, which could be seen in this study, was related to the level of education, in which a low percentage had completed higher education together with the unemployment rate prevailing in most of the sample. This fact becomes evident when classified by ABEP, in which a considerable part belonged to D and E social classes. The data from the Ministry of Health reported that 60.5% of PLWHA have education until high school[12]. The low level of education and unfavorable socioeconomic conditions are connected with HIV infection, characterizing the pauperization of the disease. Health inequalities are directly related to cases of worsening HIV, as they impact difficulties in accessing health services, adopting a healthy lifestyle, adherence to treatment and quality of life[14].

Regarding the evaluation of cardiovascular risk, according to WC and WHtR, a considerable amount presented values above the average. Lin et al.[18] studied non-infected adult individuals, obtaining results compatible with our study as well as a strong association with excess abdominal fat and with several cardiovascular risk factors. The advantage of applying this indicator is related to the adjustment for height which can facilitate direct comparisons between different populations. Another positive aspect of this technique for PLWHA is that it uses only the height and waistline variables, focusing on the central distribution of fat associated with cardiac risk factors, without suffering the influence of body composition variables in peripheral segments that can be altered by lipodystrophy syndrome and, thus, interfere with the results.[18].

Furthermore, by evaluating cardiovascular risk, the WHR measurement revealed a high risk for developing cardiovascular disease similar to the study of South African women on long-term antiretroviral treatment; moreover, a higher prevalence of abdominal obesity was also observed through increased WC and WHR. Additionally, central fat accumulation associated with HIV is probably a consequence of the treatment of HIV infection, as opposed to a specific adverse reaction to the antiretroviral drug[19].

Based on the measurements of AC and AMC, a higher prevalence of eutrophy was found followed by malnutrition. These findings are similar to the results reported by Pires et al.[20], in which malnutrition was described as a factor possibly related to HIV lipodystrophy, concealing the real nutritional status with excess body fat, which can be seen through BMI, WHR, and fat percentage as evaluated by total sum of the four skinfolds. HIV-associated lipodystrophy is characterized by endocrine-metabolic and body fat distribution changes[20].

With regard to the percentage of fat measured by the sum of skinfolds, more than half of the individuals evaluated were classified as obese, a finding in agreement with the study by Beraldo RA et al6, which possibly is associates the transition in the nutritional profile with some factors which favored the reduction of malnutrition, such as the chronic use of HAART related to changes in the lipid profile, resulting in lipodystrophic syndrome and metabolic alterations such as dyslipidemia, cardiovascular diseases, and diabetes mellitus. other possible factors related to overweight and obesity could be the inadequate diet, with a predominance of processed and ultra-processed foods rich in simple carbohydrates, and physical inactivity[9].

Based on the comparison of biochemical variables, the present study demonstrated that PLWHA classified at risk by means of PC had higher levels of total cholesterol, LDL cholesterol and triglycerides. Although the levels have remained within the normal range, the reduction in HDL levels and increasing levels of cholesterol and triglycerides are cause for concern, since the continued alteration of these markers can lead to the development of dyslipidemia. Primary obesity-related dyslipidemia is characterized by increased triglycerides, reduced HDL levels, and abnormal LDL composition. Although weight gain after initiation of ART is associated with a reduced risk of mortality in underweight and normal weight individuals, the risk of metabolic diseases, including liver disease and cardiovascular disease, increases with excess adiposity[21].

The participants' glycemic levels are in agreement with the recommended levels, and this result agrees with that reported by Galli et al.[22], in which most participants had normal levels of fasting glycemia without being subject to the development of diabetes mellitus, since exposure to ART can lead to insulin resistance indirectly

through regional effects on the body and changes in adipose tissue; additionally, it can cause inflammation and downregulation of free fatty acid metabolism[22].

Both ART and chronic HIV infection have been linked to reduced bone mineral density (BMD), as seen in the study by Guaraldi G. et al[23]. Therefore, osteopenia and osteoporosis are common, with prevalence estimates three times higher than in non-HIV individuals[23]. The study by Brown TT; Qaqish RB[24], in Brazilian PLWHA, confirmed that BMD was decreased in individuals who presented the classic risk factors, such as low BMI and postmenopausal women, characteristics that differ from the population of this study, which explains the majority of values within normality.

Strengths and Limitations

The development of the research enabled the replication and use of simple anthropometric measurements that are capable of predicting cardiometabolic risks associated with body adiposity, which strengthens and corroborates as an instrument to be implemented in clinical practice, mainly due to the fact that after using the ART for the treatment of HIV infection, several researchers and scientists have observed the increase in life expectancy of PLHA and at the same time have been able to identify the appearance of metabolic disturbances and nutritional status.

The main limitations of the present research were mainly due to the reduction in the follow-up of consultations and the adaptations that were necessary, limitations that still coincided with those imposed by the covid-19 pandemic due to its coping measures, where clinical trials in progress were optimized, with the absence of complete information on the patient in the medical record being often observed and the non-continuity of clinical follow-up at an outpatient level.

Conclusion

Based on the explained results, authors can conclude that PC had a positive correlation with anthropometric indicators already used in the evaluation of body fat.

These findings suggest that CP represents an interesting tool for adipose body evaluation in adults and older adults living with HIV/AIDS. Considering that PC is easily obtainable, low cost, non-invasive, the measure is a useful tool to be used in anthropometric evaluation protocols in outpatient care and health services.

Further studies should be developed in order to determine and validate the cut-off points of NC in representative samples, such as groups of PLWHA, for the risk evaluation and classification of body adiposity.

Conflict of interests

The authors declare that there is no potential conflict of interest.

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