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RESEARCH ARTICLE

Can anthropometry measure the body fat of people living with HIV/AIDS? A systematic review

Nathalia Sernizon Guimarães[a,*], **Maria Arlene Fausto**[b], **Adriana Maria Kakehasi**[a], **Anderson Marliere Navarro**[c], **Unaí Tupinambás**[a]

[a] Universidade Federal de Minas Gerais, Brasil.
[b] Universidade Federal de Ouro Preto, Minas Gerais, Brasil.
[c] Universidade de São Paulo, Brasil.

*nasernizon@hotmail.com

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Can anthropometry measure the body fat of people living with HIV/AIDS? A systematic review

KEYWORDS

Anthropometry;

Body Composition;

Adipose Tissue;

HIV;

Acquired Immunodeficiency Syndrome.

ABSTRACT

Introduction: Assessment of the quantity and distribution of body fat in people living with HIV/AIDS is of great importance in clinical practice, due to the association of body fat changes with clinical conditions. The aim of this systematic review was to answer the central question: Can anthropometry accurately measure the body fat in people living with HIV/AIDS?

Material and Methods: Systematic review carried out using four databases: Medline, LILACS, Scopus and BDTD.

Results: Of the 581 studies found, 11 met the eligibility criteria. To assess the validate of anthropometry, only two studies employed regress analysis to development of predictive body fat equations in people living with HIV/AIDS and nine studies employed correlation analysis. This coefficient only measures the strength of the relation between two variables, and there is not concordance between them and therefore, these studies did not accurately evaluate whether or not the anthropometric information showed good concordance with the gold standard. The other two studies developed five equations to evaluate the total fat and limbs (arm, leg and trunk) in people living with HIV/AIDS using antiretrovirals and showed R^2 between 0.50 and 0.83.

Conclusions: Further research needs to be conducted to answer the central question of this review, as the small number of articles that applied the correct statistical test and the absence of research on people living with HIV/AIDS without the use of antiretrovirals.

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¿Puede la antropometría medir la grasa corporal de las personas que viven con el VIH/SIDA? Revisión sistemática

PALABRAS CLAVE

Antropometría;

Composición Corporal;

Tejido Adiposo;

VIH;

Síndrome de Inmunodeficiencia Adquirida.

RESUMEN

Introducción: La evaluación de la cantidad y distribución de la grasa corporal en personas que viven con el VIH/SIDA es de gran importancia en la práctica clínica, debido a la asociación de los cambios de grasa corporal con condiciones clínicas. El objetivo de esta revisión es responder a la pregunta central: ¿Puede la antropometría medir con precisión la grasa corporal en las personas que viven con el VIH/SIDA?

Material y Métodos: Revisión sistemática llevada a cabo por medio de cuatro bases de datos: Medline, LILACS, Scopus y BDTD.

Resultados: De los 581 estudios encontrados, 11 cumplieron con los criterios de elegibilidad. Para evaluar la validación de la antropometría, sólo dos estudios emplearon análisis de regresión para el desarrollo de las ecuaciones de predicción de grasa corporal en las personas que viven con el VIH/SIDA y nueve estudios emplearon análisis de correlación. Este coeficiente sólo mide la fuerza de la relación entre dos variables, y no hay concordancia entre ellos y, por lo tanto, estos estudios no evaluaron con precisión si la información antropométrica mostró buena concordancia con el estándar de oro. Los otros dos estudios desarrollaron cinco ecuaciones para evaluar la grasa total y en las extremidades (brazos, piernas y tronco) en personas que viven con el VIH/SIDA y usan antirretrovirales y mostraron R^2 entre 0,50 y 0,83.

Conclusiones: Más investigación debe llevarse a cabo para responder a la pregunta central de esta revisión, dado el pequeño número de artículos en que se aplicó la prueba estadística correcta y la ausencia de investigaciones sobre personas que viven con el VIH/SIDA que no usan antirretrovirales.

CITA

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INTRODUCTION

Over the course of 2015, there were approximately 2.1 million new cases of HIV infection, making a total of 36.7 million people living with HIV/AIDS (PLWHA) worldwide. Approximately, 20 million of these individuals do not make use of antiretroviral therapy[1,2].

When compared to the general population, people living with HIV/AIDS undergo more frequent changes to their body composition, principally in relation to the quantity and distribution of body fat[3,4]. This redistribution of body fat is referred to as lipodystrophy or lipodystrophy associated with HIV and is subdivided into lipoatrophy, lipohypertrophy or mixed form. Lipoatrophy is characterized by the reduction of fat in the face, arms, legs and buttocks. Lipohypertrophy is characterized by the accumulation of fat in the abdomen, back, neck and breast area. Mixed form is characterized the two forms described above[5]. These morphological changes in body fat have multifactorial causes such as duration of HIV infection, type of medicine used in the antiretroviral therapy, duration of exposure to antiretroviral therapy, genetic predisposition or lifestyle (physical inactivity and inadequate diet)[6,8].

Current studies shows that changes in fat distribution by region, especially intra-abdominal adipose tissue, have been associated with the incidence of dyslipidemia, insulin resistance, metabolic syndrome, type 2 diabetes *mellitus* and hepatic steatosis[9,10]. These metabolic changes can lead to an increase in morbimortality from cardiovascular diseases[11]. For these reasons, assessing body fat distribution and determining the quantity of fat in PLWHA is of vital importance in clinical practice.

Assessing the quantity of body fat can be performed using methods with different levels of sensitivity, specificity, clinical practicality and cost[12,13]. Dual energy X-Ray absorptiometry (DXA) and computed tomography (CT) are considered "gold standard" methods in estimating the body composition of individuals and quantifying body fat[13,14]. Nevertheless, as with MRI and ultrasound, DXA and CT are body composition assessment techniques less favored in clinical practice due to the high costs involved, including the acquisition of the appropriate equipment, use of specific software, trained professionals, and the regular expenses incurred in the maintenance and calibration of the machines[15].

In comparison to the gold standard methods (DXA or CT), anthropometry is widely used in contexts of limited resources due to its low cost, shorter execution time and greater simplicity[16]. This technique is used by health professionals in clinical practice with the objective of recording body measurements such as weight, height, skinfolds and body circumferences[16]. When linked to indexes or predictive equations, these body measurements, also referred to as anthropometric indicators, can provide information on the quantity of the individual's fat mass[17,18].

Several studies have been carried out with the objective of investigating the accuracy of anthropometric measurements in the description of body fat quantity in different populations, justified by the need to gather measurements in a shorter timeframe, with lower cost and greater simplicity[19–22]. Therefore, this review proposes a response to the following central question: Can anthropometry accurately measure the body fat of PLWHA?

MATERIAL AND METHODS

The search for information and the presentation and interpretation of data were carried out based on the PRISMA-P method[23]. The PROSPERO protocol[24] of this systematic review was registered in the Centre for Reviews and Dissemination of the University of York, under number CRD42015025347 and may be consulted at: http://www.crd.york.ac.uk/PROSPERO/display_record.asp?ID=CRD42015025347.

Observational and intervention studies were included that evaluated anthropometry through indicators, anthropometric indexes and predictive equations and were compared with at least one of the methods considered as gold standard in assessing body fat, namely, DXA or CT, in the PLWHA group aged 18 to 60 years.

The exclusion criteria were divided into: Group 1 – duplicate articles; Group 2 – studies that only evaluated fat free body mass, such as bone, water or muscle, not considering the assessment of the individuals' body fat or when evaluated facial fat; Group 3 – absence of a comparison between anthropometry and the gold-standard methods (DXA or CT) or theme not connected to the objective of this review; Group 4 – study designs: narrative, systematic reviews or meta-analyses, experimental studies carried out on animals, report or case series; Group 5 – Individuals using corticosteroids or anabolic steroids, studies performed on pregnant women or nursing mothers, people living with HIV/AIDS with chronic infections. There was no restriction in relation to language and publication year of the studies.

Studies were identified by means of five electronic databases: (I) OVID-Medline (1982 to July 2015); (II) LILACS (2000 to July 2015); (III) Scopus (1982 to July 2015) and (IV) Brazilian Digital Library of Theses or Dissertations (2001 to July 2015). Selection of the search terms (keywords or descriptors) was done through a consultation of the Health Sciences Descriptors (DeCS), Medical Subject Headings (MeSH) and Emtree.

In every database, the descriptors shown in Table 1 were subdivided into three groups (assessment method for body composition/body fat changes/HIV-AIDS) and were then matched up using Boolean search operators: inverted commas, brackets, "AND" and "OR".

Table 1. Search strategy used in the Medline-OVID database.

1. exp Anthropometry/
2. exp Absorptiometry, Photon/
3. Tomography, X-Ray Computed/
4. 1 and 2
5. 1 and 3
6. Fat Body.mp.
7. Adipose Tissue.mp.
8. Abdominal Fat.mp.
9. Intra-Abdominal Fat.mp.
10. Subcutaneous Fat.mp.
11. Body Composition.mp.
12. Body Fat Distribution.mp.
13. 6 or 7 or 8 or 9 or 10 or 11 or 12
14. Acquired Immunodeficiency Syndrome.mp.
15. HIV.mp.
16. 14 or 15
17. 4 or 5
18. 13 and 16 and 17

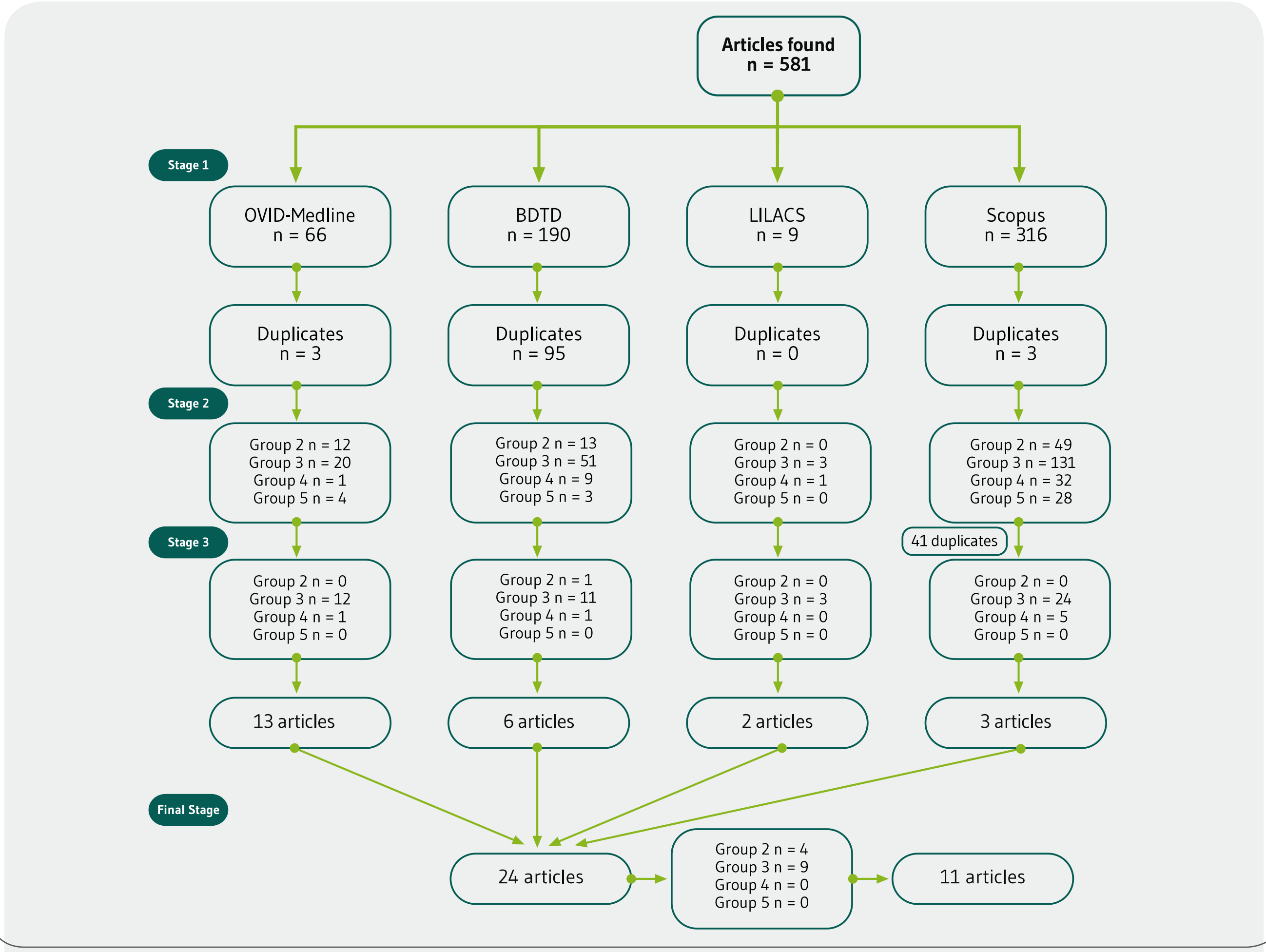
All exclusion stages of the studies were carried out independently by two authors of this review, with the objective of identifying studies that potentially met the inclusion criteria described previously. Any disagreement on the eligibility of the studies was resolved by a third reviewer.

RESULTS

Selection and overall characteristics of the studies: The information search returned 581 articles. 101 duplicate studies were excluded and, after applying the inclusion criteria through the reading of titles and abstracts, 557 were discarded. In the text analysis stage, 13 studies were excluded. The absence of a comparison between anthropometry and the gold-standard methods was the main reason for exclusion in all stages. In the end, 11 studies published between 1993 and 2015 were selected for the systematic review (Figure 1).

The types of study designs noted in the 11 selected articles were: cross-sectional (n=09)2[5–33], cohort (n=01)[34] and case-control (n=1)[35] (Table 2).

Figure 1. Stages of the selection process for article inclusion in the systematic review about anthropometry and others methods assessing body fat in people living with HIV/AIDS.



n: sample; **LILACS:** Latin American and Caribbean Health Sciences Literature;
PubMed: International Literature on Health Sciences; **SCIELO:** Scientific Electronic Library Online.
Stage 1: Removal of duplicates by reading titles; **Stage 2:** Application of further exclusion criteria by reading titles;
Stage 3: Application of exclusion criteria by reading abstracts; **Final stage:** Application of exclusion criteria by textual analysis.

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Six studies were exclusively focused on men[27,28,32,33,35] and five studies were on both sexes[22,25–27,29–31,34].

Mean HIV infection diagnosis time was assessed in only five studies[25,27,29,32,35] and was equal to 10 years, with minimum and maximum range of 8 and 12.5 years for infection. Mean duration of antiretroviral therapy was observed in eight studies[25–27,29,30,32,34,35]. Among the 11 selected studies, only one was carried out on PLWHA who had never undergone antiretroviral therapy[34] (Table 2).

Anthropometric parameters and measures used in the studies: The anthropometric parameters and measures evaluated in the 11 selected studies were expressed in indicators, indexes or predictive equations for fat quantity.

Table 2. Summary of the comparative study results for anthropometric information and gold standard methods in assessing body fat in HIV infected individuals.

Reference	Population and Study Design	Anthropometric Information	Diagnostic Exam	Estimated Fat	Statistical Analysis	Results
Beraldo y Cols., 2015 (Brazil)	n = 100 43.6 years 100% ♂ Cross-sectional	Indicators: weight, height, WC, AC, HC, TC, CC, BSF, TSF, SSF, ICSF, LegL.	DXA	% Arm Fat, % Leg Fat, % Trunk Fat.	Multiple Linear Regression	% Arm Fat= -1.499+(0.021xW)+(0.018xAC)+(0.023xTSF)+(0.002xA). R^2=0.66 % Trunk Fat= -18.043+(0.114x)+(0.169xWC)+(0.117xICSF)+(0.038xA). R^2=0.76 % Leg Fat= -7.346+(0.022xW)+(0.134xTC)+0.015xLegL. R^2=0.50
Florindo y Cols., 2008 (Brazil)	n = 15 36.9 years 66.6% (n=10)♂ Cross-sectional	Indicators: BSF, TSF, SSF, ICSF, AxSF. ASF, CSF. Equations: Durnin & Womersley, HIVE, Siri.	DXA e CT	% Total Fat, Visceral Fat, Subcutaneous Fat, Abdominal Fat.	Multiple Linear Regression and Pearson Correlation	% Total Fat ♂: 3.385+0.279*(AxSF+SSF). R^2=0.83 % Total Fat ♀: -24.343+0.736*(ICSF+ASF+CSF). R^2=0.81 % Fat HIVE *vs* % Fat TC: r=0.69 *p*=0.012
Aghdassi y Cols., 2007 (Canada)	n = 47 49.2 years 100% ♂ Cross-sectional	Indicators: WC, BSF, TSF, SSF. Indexes: BMI, WHR, ΣSF: BSF+TSF+SSF	DXA	% Total Fat.	Pearson Correlation	BMI *vs* % Total Fat: r=0.628 *p*<0.01 WC *vs* % Total Fat: r=0.784 *p*<0.01 WHR *vs* % Total Fat: r=0.525 *p*<0.01 BSF *vs* % Total Fat: r=0.538 *p*<0.01 TSF *vs* % Total Fat: r=0.669 *p*<0.01 SSF *vs* % Total Fat: r=0.665 *p*<0.01 ΣSFs *vs* % Total Fat: r=0.759 *p*<0.01 (WHR>0.9)ΣSFs *vs* % Total Fat: r=0.775 *p*<0.001 (WHR<0.9)ΣSFs *vs* % Total Fat: r=0.497 *p*<0.316
Batterham y Cols., 1999 (Australia)	n = 36 42.6 years 100% ♂ Cross-sectional	Equations: Sloan, Wilmore, Forsyth, Katch, Durnin & Womersley, Thorland, Withers.	DXA	% Total Fat.	Pearson Correlation	Sloan *vs* % Total Fat: r=0.847 *p*<0.001 Wilmore *vs* % Total Fat: r=0.769 *p*<0.001 Forsyth *vs* % Total Fat: r=0.786 *p*=0.001 Katch *vs* % Total Fat: r=0.848 *p*<0.001 Durnin *vs* % Total Fat: r=0.828 *p*=0.002 Thorland *vs* % Total Fat: r=0.849 *p*<0.001 Withers *vs* % Total Fat: r=0.810 *p*<0.001

Reference	Population and Study Design	Anthropometric Information	Diagnostic Exam	Estimated Fat	Statistical Analysis	Results
Antunes y Cols., 2011 (Brazil)	n = 26 48.6 years 76.9% (n=20)♂ Cross-sectional	Indicators: HC, WC, CC, TC, BSF, TSF, SSF, ICSF. Indexes: Arm fat area.	DXA	Arm Fat (kg), Leg Fat (kg), Trunk Fat (kg). % Arm Fat, % Leg Fat, % Trunk Fat.	Pearson Correlation	TSF *vs* Arm Fat(kg): r=0.605 *p*<0.01; TSF *vs* Arm Fat(%): r=0.833 *p*<0.01 WC vs Trunk Fat(kg): r=0.833 *p*<0.01; WC *vs* Trunk Fat(%): r=0.583 *p*<0.01 CC vs Leg Fat(kg): r=0.328 *p*=0.10; CC *vs* Leg Fat(%): r=0.133 *p*=0.51 TC *vs* Leg Fat(kg): r=0.482 *p*<0.01; TC *vs* Leg Fat(%): r=0.367 *p*=0.06
Florindo y Cols., 2004 (Brazil)	n = 15 36.6 years** 66.6% (n=10)♂ Cross-sectional	Indicators: WC, HC, BSF, TSF, SSF, ICSF, AxSF, ASF, CSF. Indexes: WHR.	CT	Visceral Fat, Subcutaneous Fat, Abdominal Fat.	Pearson Correlation	WC *vs* Visceral Fat: r=0.61 *p*<0.037 WC *vs* Subcutaneous Fat: r=0.88 *p*<0.001 WC *vs* Abdominal Fat: r=0.89 *p*<0.001 WHR *vs* Visceral Fat: r=0.74 *p*<0.006 WHR *vs* Subcutaneous Fat: r=0.61 *p*<0.035 WHR *vs* Abdominal Fat: r=0.75 *p*<0.005
Meininger y Cols., 2002 (EUA)	n = 41 43 years 100% ♂ Control case	Index: WHR.	DXA e CT	% Total Fat and % Trunk / Limb Fat. Visceral Fat, Subcutaneous Fat, Abdominal Fat.	Pearson Correlation	WHR *vs*. Abdominal Fat: r=0.72 *p*<0.0001 WHR *vs* % Total Fat: r=0.38 *p*=0.012 WHR *vs* Trunk/Limb: r=0.68 *p*<0.0001
Mulligan y Cols., 2006 (EUA)	n = 157 S.I 87% (n=136)♂ Cohort- 64 months	Indicators: weight. WC, HC, TC, AC.	DXA	Total Fat(kg), Arm Fat(kg), Lower Limb Fat(kg), Trunk Fat(kg), Leg Fat(kg).	Spearman Correlation	weight *vs* Fat(kg): r=0.724 *p*<0.001 WC *vs* Fat (kg): r=0.616 *p*<0.001 HC *vs* Fat(kg): r=0.557 *p*<0.001 TC vs Fat(kg): r=0.556 *p*<0.001 AC *vs* Fat: r=0.639 *p*<0.001 weight *vs* Trunk Fat(kg): r=0.743 *p*<0.001 WC *vs* Trunk Fat(kg): r=0.638 *p*<0.001 HC *vs* Trunk Fat(kg): r=0.573 *p*<0.001 TC *vs* Trunk Fat(kg): r=0.500 *p*<0.001 AC *vs* Trunk Fat(kg): r=0.589 *p*<0.001 weight *vs* Lower Limb Fat(kg): r=0.631 *p*<0.001 WC *vs* Lower Limb Fat(kg): r=0.540 *p*<0.001 HC *vs* Lower limb Fat (kg): r=0.504 *p*<0.001 TC *vs* Lower Limb Fat(kg): r=0.555 *p*<0.001 AC *vs* Lower Limb Fat(kg): r=0.603 *p*<0.001 weight *vs* Arm Fat(kg): r=0.560 *p*<0.001 WC *vs* Arm Fat(kg): r=0.558 *p*<0.001

Reference	Population and Study Design	Anthropometric Information	Diagnostic Exam	Estimated Fat	Statistical Analysis	Results
Mulligan y Cols., 2006 (EUA)	n = 157 S.I 87% (n=136)♂ Cohort- 64 months	Indicators: weight. WC, HC, TC, AC.	DXA	Total Fat(kg), Arm Fat(kg), Lower Limb Fat(kg), Trunk Fat(kg), Leg Fat(kg).	Spearman Correlation	HC *vs* Arm Fat(kg): r=0.402 *p*<0.001 TC *vs* Arm Fat(kg): r=0.496 *p*<0.001 AC *vs* Arm Fat(kg): r=0.575 *p*<0.001 weight *vs* Leg Fat(kg): r=0.619 *p*<0.001 WC *vs* Leg Fat(kg): r=0.510 *p*<0.001 HC *vs* Leg Fat(kg): r=0.501 *p*<0.001 TC *vs* Leg Fat(kg): r=0.534 *p*<0.001 AC *vs* Leg Fat(kg): r=0.579 *p*<0.001
Segatto y Cols., 2012 (Brazil)	n = 67 43.6 years 58.2% (n=39)♂ Cross-sectional	Indicators: WC, HC, TC. Indexes: BMI, CI, WHR, WHeR, WTR.	DXA	Trunk Fat(g).	Pearson Correlation	♂BMI *vs* Trunk Fat: r=0.77 *p*<0.01 WHR *vs* Trunk Fat: r=0.60 *p*<0.01 CI vs Trunk Fat: r=0.52 *p*<0.01 WHeRvs Trunk Fat: r=0.80 *p*<0.01 WTR *vs* Trunk Fat: r=0.58 *p*<0.01 ♀BMI *vs* Trunk Fat: r=0.67 *p*<0.01 WHR *vs* Trunk Fat: r=0.52 *p*<0.01 CI *vs* Trunk Fat: r=0.58 *p*<0.01 WHeR *vs* Trunk Fat: r=0.87 *p*<0.01 WTR *vs* Trunk Fat: r=0.35 *p*>0.05
Siqueira y Cols., 2011 (Brazil)	n = 32 44.5 years** 100% ♂ Cross-sectional	Index: ΣSF: BSF +TSF+SSF+ICSF.	DXA	% Total Fat.	Pearson Correlation	LIPO+: ΣSF *vs* % Total Fat: r=0.46 *p*>0.05 LIPO-: ΣSF *vs* % Total Fat: r=0.79 *p*<0.001
Wang y Cols., 1993 (EUA)	n = 18 41 years 100% ♂ Cross-sectional	Equations: Steinkamp, Durnin & Womersley.	DXA	% Total Fat.	Pearson Correlation	Steinkamp *vs* % Total Fat: r=0.82 *p*<0.05 Durnin *vs* % Total Fat: r=0.69 *p*<0.05

WC: waist circumference; **AC:** arm circumference; **HC:** hip circumference; **TC:** thigh circumference; **CC:** calf circumference; **BSF:** biceps skinfold; **TSF:** triceps skinfold; **SSF:** subscapular skinfold; **ICSF:** iliac crest skinfold; **LegL:** leg length; **AxSF:** axillary skinfold; **ASF:** abdominal skinfold; **CSF:** calf skinfold; **HIVE:** equations for estimating fat mass in HIV/AIDS subjects; **BMI:** Body Mass Index; **WHR:** waist/hip ratio; **WHeR:** Waist/ height ratio; **WTR:** Waist/thigh ratio; **ΣSF:** sum of skinfolds; **CI:** conicity index; **DXA:** Dual energy X-Ray Absorptiometry; **CT:** computed tomography; **W:** weight (kg); **A:** age (years); **R^2:** coefficient of determination; **LIPO+:** presence of lipodystrophy syndrome; **LIPO-:** absence of lipodystrophy syndrome.

The anthropometric indicators used in the studies were: weight, height, waist circumference (WC), arm circumference (AC), hip circumference (HC), thigh circumference (TC), calf circumference (CC), biceps skinfold (BSF), triceps skinfold (TSF), subscapular skinfold (SSF), iliac crest skinfold (ICSF), axillary skinfold (AxSF), abdominal skinfold (ASF), calf skinfold (CSF), thigh skinfold (ThSF), and leg length (LegL).

The anthropometric indexes presented by the studies were: Body mass index (BMI), waist/hip ratio (WHR), sum of skinfolds (ΣSF: BSF + TSF + SSF or ΣSF: BSF + TSF + ICSF + SSF); Arm fat area (AFA); conicity index (CI), waist/height ratio (WHeR), and waist/thigh ratio (WTR).

The equations of Durnin & Womersley; HIVE (equations for estimating fat mass in HIV/AIDS subjects[26]); Siri; Sloan, Wilmore, Forsyth, Katch, Thorland, Withers, Steinkamp were used with the objective of calculating the percentage of body fat based on anthropometric information validated in different populations (Table 3)

Statistical methods used to compare collected data with the gold standard: Two studies[25,26] developed predictive equations to estimate the body fat of PLWHA through linear regression analysis.

Nine studies[27–35] used correlation coefficients (Pearson and Spearman) to assess the association between quantity of body fat using anthropometry in comparison to the gold standard (DXA or CT) for PLWHA.

Principal results: Beraldo y Cols.[25], noted that the predictive equation composed of weight, age, AC and TSF corresponded to 66% of arm fat variability measured by DXA, while the predictive equation that used weight, age, WC and ICSF corresponded to 76% of trunk fat calculated by DXA.

In stratifying the sample by sex, the study performed by Florindo y Cols.[26] noted that, in male people living with HIV/AIDS, the comparison of body fat percentage measured by DXA and the sum of ASF and SSF accounted for 83% of data variability. For female people living with HIV/AIDS, the comparison between the sum of ICSF, ASF and CSF and the body fat percentage measured by DXA explained 81% of data variability.

In comparison with anthropometric indexes or indicators, predictive equations for fat showed stronger correlations with total body fat percentage, especially the expressions from Thorland (r=0.849), Katch (r=0.848), Sloan (r=0.847), Steinkamp (r=0.82), Durnin (r=0.828; r=0.69)[28,33].

When evaluating isolated anthropometric indicators, waist circumference was the anthropometric measurement that showed strongest association with fat percentage (r=0.853; r=0.784)[27,34].

TSF showed a strong and positive association with arm fat percentage (r=0.833)[29]. Trunk fat was strongly associated to waist circumference (r=0.833 and r=0.854)[29,34] and strong correlations were not noted between leg fat and calf or thigh circumference[29,31,34].

When evaluating fat types by CT, Florindo y Cols.[30] noted a strong correlation between WC and abdominal fat (r=0.89) as well as subcutaneous fat (r=0.88). However, on evaluating the relation between WC and visceral fat, moderate correlation was noted (r=0.61). Visceral fat showed greater correlation with waist/hip ratio (r=0.74)[30].

Table 3. Predictive equations of body fat in people living with HIV/AIDS used by three studies of this review.

Reference	Equation
Durnin & Womersley, 1974	1.1765-0.0744 Log(ΣSF: BSF+TSF+SSF+ICSF)
HIVE, 2008	♂: 3.385-0.279*(AxSF+SSF)
HIVE, 2008	♀: -24.323+0.736*(ICSF+ASF+CSF)
Siri, 1961	%G = [(4.95/D) - 4.50] x 100
Sloan, 1967	1.1043-0.001327(ThSF)-0.00131(SSF)
Wilmore, 1969	♀ 18–48 years: D= 1.06234 - 0.00068 (SSF) - 0.00039 (TSF) - 0.00025 (AxSF)
Wilmore, 1969	♂ 17–37 years: D= 1.08543 - 0.000886 (AC) - 0.00040 (AxSF)
Forsyth & Sinning, 1973	1.10647-0.00162(SSF)-0.00144(AC)-0.00077(TSF)+0.000071(AxSF)
Katch & McArdle, 1973	1.09665-0.00103(TSF)-0.00056(SSF)-0.00054(AC)
Thorland, 1984	1.1136-0.00154(TSF+SSF+AxSF)+0.00000516(TSF+SSF+AxSF) 2
Withers, 1987	1.0988-0.0004(BSF+TSF+SSF+ICSF+AC+AxSF+CC)

D: body density; **ΣSF:** sum of skinfolds; **BSF:** biceps skinfold; **TSF:** triceps skinfold; **ICSF:** iliac crest skinfold; **SSF:** subscapular skinfold; **ASF:** abdominal skinfold; **CSF:** calf skinfold; **ThSF:** thigh skinfold; **%F:** fat percentage; **AC:** abdominal circumference; **CC:** calf circumference; **AxSF:** axillary skinfold.

DISCUSSION

There have been few studies validating the use of anthropometric techniques as predictors of body fat in HIV infected individuals. Among the investigated studies, only two to develop predictive equations for body fat in PLWHA. The main limitation of one of these studies is its sample size (n=15)[30], which makes it necessary to validate these equations, stratified by sex, using a larger sample. The study by Beraldo y Cols.[25] investigated men living with HIV/AIDS and presented three mathematical equations involving the fat percentage in the arm, trunk and legs. The equation to estimate the amount of fat in the arm involved the patient's weight, arm circumference, triceps skinfold thickness and age, with estimated value of R^2=0.66. To evaluate the trunk fat, the study cited propos equation involving weight, age, waist circumference and skinfold suprailiac (R^2=0.76). Finally, the equation estimating the amount of fat in the legs, in percentage, involving weight and waist circumference (R^2=0.50). Besides the investigation be unilateral in relation to sex, this study did not show a sub analysis with only HIV-infected individuals without the use of antiretroviral therapy, cannot be applied these equations found in these individuals[25].The other studies (n=9) used correlation coefficients to compare anthropometric data with information gathered using the gold standard. This coefficient only measures the strength of the relation between two variables, and not concordance between them[36]. It is possible to obtain a high correlation coefficient and, at the same time, have the data return poor concordance. The statistical test of the correlation coefficient is irrelevant when concordance between continuous measurements is assessed[36]. The investigated studies did not accurately evaluate whether or not the anthropometric information showed good concordance with the gold standard.

In this studies that evaluated correlation coefficients, two studies evaluated BMI and sum of skinfolds in PLWHA. The use of this index as anthropometric information, poorly sensitive and specific to metabolic assessment, has encouraged researchers to develop other anthropometric methods to estimate the quantity of body fat[22]. In this review, among the development and use of other indexes to determine fat quantity through the anthropometry of PLWHA, we noted that the predictive equations for body fat and WC were strongly correlated with total body fat. On assessing fat types, we noted a strong correlation between WC and abdominal fat (r=0.89) and subcutaneous fat (r=0.88), suggesting that WC can be a good indicator for the quantification of fat, particularly abdominal fat, and could be used in the prior diagnosis of abdominal lipohypertrophy.

About the sum of the four skinfolds, this has been used to predict the quantity of fat, through predictive equations, based on the relation between subcutaneous fat, internal fat and body density[37,38]. In the light of the redistribution of body fat in PLWHA, it is necessary to discuss the feasibility of calculating the sum of skinfolds in order to diagnose changes, given that these predictive equations were developed and validated for healthy individuals and athletes[22]. It is worth emphasizing that we did not note any associations between the sum of skinfolds by body region in relation to fat types (total abdominal, visceral and central subcutaneous fat), demonstrating the need to reassess this method.

This review presented as a limitation the fact that they have not been researched congress summaries, as part of the gray literature. Publication bias, which occurs due to non-publication of studies with negative results, may have influenced the findings of this review.

CONCLUSIONS

This review found that nine of 11 investigated studies did not evaluate the correct statistical analysis use to assess if anthropometric information had good agreement with the gold standard, since the statistical tests used did not evaluate the correlation between continuous measures. Two studies that would answer central question of this review have proposed equations that used anthropometric information only for individuals using antiretroviral therapy, invalidating the answer to PLWHA without antiretroviral therapy. As a result of limitations in statistical treatment and sample size that studies selected in this review have is difficult to propose or not the assertion that anthropometry is a suitable method for the evaluation of the fat in PLWHA, especially without the use of antiretroviral therapy.

COMPETING INTERESTS

Authors state that there are no conflicts of interest in preparing the manuscript.

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