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CAROLINA CUNHA DE OLIVEIRA

AVALIAÇÃO DA CAPACIDADE PREDITIVA DOS INDICADORES CLÍNICOS E NUTRICIONAIS PARA SÍNDROME METABÓLICA EM IDOSOS

TESE DE DOUTORADO

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Tese apresentada ao Programa de Pós-Graduação em Medicina e Saúde, da Faculdade de Medicina da Bahia, Universidade Federal da Bahia, como requisito para obtenção do grau de Doutor em Medicina e Saúde.

Orientador: Profº Dr. Mansueto Gomes Neto

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Dissertação de autoria de Carolina Cunha de Oliveira intitulada Avaliação da capacidade preditiva dos indicadores clínicos e nutricionais para síndrome metabólica em idosos, apresentada a Universidade Federal da Bahia, como requisito para a obtenção do título de Doutor em Medicina e Saúde.

Salvador, 21 de julho de 2017

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DEDICATÓRIA

Aos meus pais, Romeu e Lucia, meu respeito e gratidão pelo amor, educação e ternura constante e por serem vencedores diante de todas as adversidades;
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“Por vezes sentimos que aquilo que fazemos não é senão uma gota de água no mar. Mas o mar seria menor se lhe faltasse uma gota”

Madre Tereza de Calcutá

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LISTA DE ABREVIATURAS E SIGLAS

AUC	*Area Under ROC Curve*
BMI	*Body Mass Index*
CC	Circunferência da Cintura
CEPNUT	Comitê de Ética e Pesquisa de Nutrição
CI	*Conicity Index*
DBP	*Diastolic Blood Pressure*
FAPESB	Fundação de Amparo à Pesquisa do Estado da Bahia
HDLc/LDLc	*HDL-Cholesterol to LDL-Cholesterol Ratio*
HDLc/TC	*HDL-Cholesterol to Total Cholesterol Ratio*
HDLc	*High Density Lipoprotein Cholesterol*
IDF	*International Diabetes Federation*
IMC	Índice de Massa Corporal
LAP	*Lipid Accumulation Product* – Produto da Acumulação Lipídica
LDLc	Low Density Lipoprotein Cholesterol
MS	*Metabolic Syndrome*
NCEP ATPIII	*National Cholesterol Education Program – Adult Treatment Panel III*
NC	*Neck Circumference*
RCEst	Razão Cintura Estatura
ROC	*Receiver Operating Characteristic*
SAD	*Sagittal Abdominal Diameter*
SENS	*Sensitivity*
SM	Síndrome Metabólica
SPEC	*Specificity*
SBP	*Systolic Blood Pressure*
TG	*Triglyceride*
TG/LDLc	*Triglyceride to HDL-Cholesterol Ratio.*
UFBA	Universidade Federal da Bahia
VAI	*Visceral Adiposity Index* – Índice de Adiposidade Visceral
WC	*Waist Circumference*
WHtR	*Waist-to-Height Ratio*
WHR	*Waist-to-Hip Ratio*
WHO	*World Health Organization*

SUMÁRIO

RESUMO

Os indicadores clínicos e nutricionais podem ser utilizados como preditores de risco cardiovascular. No entanto, existem poucos estudos sobre a precisão dos diferentes parâmetros como preditores de síndrome metabólica (SM) em idosos. Esta tese objetivou analisar criticamente os estudos que avaliaram a capacidade dos indicadores antropométricos e clínicos para predizer a SM, assim como avaliar o desempenho dos indicadores de adiposidade na predição da SM e avaliar a precisão dos componentes do hemograma como método de triagem e marcador de SM em idosos. **Métodos:** A revisão de literatura foi realizada nas bases de dados eletrônicas Medline/PubMed, LILACS e SciELO, e análise das referências dos artigos selecionados. O estudo transversal foi conduzido com 203 idosos, de ambos os sexos, residentes em Instituições de Longa Permanência na cidade de Salvador-BA. As variáveis analisadas foram: Circunferência da Cintura (CC), Razão Cintura-Estatura (RCEst), Índice de Conicidade (IC), Lipid Accumulation Product (LAP), Visceral Adiposity Index (VAI), hemoglobina, hematócrito, leucócitos e plaquetas. A SM foi definida conforme o Critério Harmonizado. Foi realizado a análise da Curva ROC, área sob as curvas (AUC), sensibilidade, especificidade, índice de Youden e Regressão Logística. **Resultados:** A revisão sugere que os indicadores CC, RCEst e LAP apresentam melhor desempenho em identificar a SM, enquanto a circunferência do pescoço foi sugerida como um indicador alternativo, com menor poder discriminatório. Nos 203 idosos avaliados, os indicadores CC, RCEst e LAP apresentaram as maiores áreas sob a curva ROC (AUC > 0,84). No geral, a RCEst e o LAP apresentaram os maiores índice de Youden, com ponto de corte de 0,55 (sensibilidade: 85,6%, especificidade: 80,4%) e 32,3 (sensibilidade: 81,1%, especificidade: 75,0%), respectivamente. A CC e a RCEst apresentaram os melhores valores do Indice de Youden quando analisado por sexo, identificando ponto de corte para CC de 90,9 cm para homens e 80,2 cm pra mulheres, enquanto para a RCEst foi de, aproximadamente, 0,55 para homens e mulheres. O menor poder discriminatório foi para os indicadores IC e VAI. A contagem de leucócitos apresentou correlação com os componentes da SM, com a glicemia (r=0,153; p=0,039), triglicerídeos (r=0,167; p=0,022) e pressão arterial diastólica (r= –0,206; p=0,017). Entre os sexos, a maior área sob a curva ROC foi para contagem de leucócitos para os homens (AUC: 0,690) e das plaquetas para as mulheres (AUC: 0,591). A contagem de leucócitos apresentou o maior índice de Youden para triagem da SM, com ponto de corte de 7.514 10^3/mm³ para homens e 5.626 10^3/mm³ para mulheres. Idosos com leucócitos superior a estes apresentaram 2,4 vezes maior chance de desenvolver SM. **Conclusão:** Os indicadores CC, RCEst, LAP tiveram alta precisão na discriminação da SM. A contagem de leucócitos foi um bom indicador de triagem para identificar idosos com maior risco para desenvolvimento de SM. Esses indicadores demonstram que idosos com alteração nesses parâmetros devem receber mais atenção, por estar relacionado com potencial risco de desenvolver SM, sendo eficazes na avaliação da SM e no acompanhamento da prática clínica individual e coletiva de idosos.

Palavras-chave: Idosos. Síndrome Metabólica. Antropometria. Hemograma. Contagem de leucócitos. Plaquetas.

ABSTRACT

Clinical and nutritional indicators can be used as predictors of cardiovascular risk. However, there are few studies about the accuracy of different parameters as predictors of metabolic syndrome (MS) in the elderly. This thesis aims to analyze critically studies that evaluated the capacity of anthropometric and clinical indicators to predict MS in the elderly, to evaluate the performance of adiposity indicators of MS prediction in the elderly and to evaluate the precision of the blood count components as a screening method and marker of MS in the elderly. **Methods:** The literature review was performed in the eletronic databases Medline/PubMed, LILACS and SciELO, and analysis of the references oh the selected articles. The cross-sectional study with 203 elderly people of both sexes living in Nursing Homes in the city of Salvador, Bahia. The variables analyzed were: Waist Circumference (WC), Waist-to-Height ratio (WHtR), Conicity Index, Lipid Accumulation Product (LAP), Visceral Adiposity Index (VAI), hemoglobin, hematocrit, leukocytes and platelets. The MS was defined by Harmonized Criteria. ROC curve analysis, area under curves (AUC), sensitivity, specificity, Youden Index and Logistic Regression were performed. **Results:** The review suggests that WC, WHtR and LAP indicators presented the best performance to identify MS, while the neck circumference was suggested as an alternative indicator, with lower discriminatory power. In 203 elderly, the WC, WHtR and LAP indicators show the highest areas under the ROC curve (AUC > 0.84). For the general population, WHtR and LAP showed the highest Youden’s index, with a cut-off point of 0.55 (sensitivity: 85.6%, specificity: 80.4%) and 32.3 (sensitivity: 81.1%, specificity: 75.0%), respectively. The WC and a WHtR presented the best values of the Youden index when analyzed by gender, identifying a cut-off point for WC of 90.9 cm for men and 80.2 cm for women, while for the WHtR was, approximately, 0.55 for men and women. The lowest discriminatory power was to CI and VAI. The leukocyte count presented correlation with the components of MS, such as blood glucose (r=0.153; p=0.039), triglycerides (r=0.167; p=0.022) and diastolic blood pressure (r= -0.206; p=0.017). Among the sexes, the largest area under the ROC curve was to the leukocyte count for men (AUC: 0.690) and the platelets for the women (AUC: 0.591). The leukocyte count presented highest Youden index value for MS screening, with a cut-off point of 7.514 $10^3/mm^3$ for men and 5.626 $10^3/mm^3$ for women. Elderly patients with leukocytes higher than these cut-off points presented a 2.4 times greater chance of developing MS. **Conclusion:** The WC, WHtR and LAP indicators had high accuracy in the discrimination of MS. The leukocyte count was a good screening indicator to identify individuals with a higher risk of developing MS. These indicators demonstrate that the elderly people with alterations in these parameters should receive attention because they area individuals with potential risk of developing MS. Therefore, they are effective in MS assessment in the elderly and follow-up for individual and collective clinical practice.

Keywords: Elderly. Metabolic Syndrome. Anthropometry. Hemogram. Leukocytes count. Platelets.

1 INTRODUÇÃO

A Síndrome Metabólica (SM) é caracterizada como um distúrbio complexo de herança poligênica, tendo como base a resistência à insulina (RI) associada ao aumento da gordura abdominal, hipercolesterolemia, elevadas concentrações de proteína C reativa e microalbuminúria. A etiologia da SM não é bem compreendida, mas os fatores que predispõem ao seu desenvolvimento incluem o envelhecimento, a inflamação, a obesidade e o estilo de vida sedentário.

A população idosa é a que mais cresce no mundo, apresentando também a maior prevalência de eventos cardiovasculares e de SM. No Brasil, a prevalência de doenças cardiovasculares na população idosa atinge patamares de 13,7%, enquanto que dados epidemiológicos sobre SM ainda são escassos, com prevalência em torno de 29%, a depender das características do grupo avaliado e do critério para definição da SM utilizado. Para o indivíduo idoso, as consequências da SM parecem ser ainda mais acentuadas, principalmente por estarem relacionadas às mudanças fisiológicas associadas ao envelhecimento, tais como aumento dos eventos cardiovasculares, da dependência funcional, disfunção cognitiva, menor qualidade de vida e maior risco de mortalidade.

Embora o conceito de SM seja cada vez mais discutido em pesquisas, sua definição e utilidade clínica têm sido desafiadas, especialmente para a população geriátrica, uma vez que existem diferentes critérios para definição da SM, inclusive alguns incluindo os aspectos étnicos. Além disso, o conceito da SM ainda permanece obscuro uma vez que não existe consenso nos pontos de corte de determinados componentes e na própria seleção desses elementos. Isto porque, no envelhecimento, os constituintes da síndrome são independentemente associados com doenças cardiovasculares.

A dificuldade em se ter critérios diagnósticos precisos, sensíveis e específicos para a população geriátrica adquire importância para medidas de controle de risco e prevenção das alterações cardiometabólicas a que os indivíduos deste grupo etário estão expostos. Considerando a elevada prevalência de SM e o seu impacto na saúde pública, a identificação precoce e precisa de idosos com elevado risco é de grande importância para tentar prevenir as potenciais consequências. Ações de intervenção preventiva nos fatores de risco em idosos com potencial risco de desenvolvimento de SM, poderão proporcionar promoção do estilo de vida saudável dessa população e redução da mobimortalidade, diminuindo assim, os custos do sistema de saúde pública no tratamento das doenças associada à SM.

Nesse sentido, indicadores clínicos e nutricionais têm sido propostos como alternativa para melhor identificação da SM. Entre os indicadores nutricionais, os estudos revelam que a circunferência da cintura (CC) e a razão cintura-estatura (RCEst) são os indicadores clássicos de melhor desempenho em identificar a SM. Nos últimos anos, indicadores como a circunferência do pescoço e o índice de conicidade têm sido reportados como potenciais indicadores para predizerem a SM. No entanto, ainda sem resultados conclusivos sobre o desempenho desses indicadores entre os idosos.

Entre os indicadores clínicos, o produto da acumulação lípidica (LAP – *Lipid Accumulation Product*), o índice de adiposidade visceral (VAI – *Visceral Adiposity Index*) e os parâmetros hematológicos, tais como níveis de hemoglobina, contagem de leucócitos e plaquetas, têm sido relacionados à identificação precoce da SM pela relação com o processo inflamatório subclínico. A inflamação e o estresse oxidativo são supostos intermediários na patogênese de doenças associadas a SM e ao envelhecimento.

Nesse contexto, é sabido que a RI é o eixo central na fisiopatologia da SM uma vez que esta possui relação direta e bidirecional com o processo inflamatório, isto é, o processo inflamatório crônico induz a RI, o que por usa vez, acentua o processo inflamatório. Diante disso, a utilização de indicadores clínicos como marcadores inflamatórios, a exemplo dos parâmetros hematólogicos, são discutidos como métodos alternativos para predizer a SM. No entanto, são escassos os estudos que relatam pontos de cortes específicos para a população idosa.

Por se tratar de uma alternativa importante para a predição de SM, a qual poderá ser utilizada na prática clínica dos profissionais de saúde, os indicadores clínicos e nutricionais são os objetos deste estudo, especialmente pelo fato de nenhum estudo no Brasil ter estudado a capacidade preditiva dos indicadores clínicos e nutricionais para síndrome metabólica em idosos. A proposta de avaliar esses indicadores implica em reforçar a avaliação de novos indicadores preditores de SM que permitam uma identificação antecipada do risco para o desenvolvimento de SM em idosos, visando também fornecer intervenção custo-efetiva nos sistemas de saúde, além de impulsionar futuras investigações, uma vez que esses parâmetros são considerados de baixo custo e podem ser aplicados na atenção básica em saúde no Brasil, principalmente nos usuários do Sistema Único de Saúde.

2 OBJETIVOS

2.1 Objetivo geral

- Avaliar o desempenho de indicadores de adiposidade e de risco cardiovascular na predição de Síndrome Metabólica em idosos institucionalizados.

2.2 Objetivos específicos

- Comparar o desempenho de indicadores clínicos e nutricionais na predição da SM em uma revisão de literatura;
- Analisar a precisão dos parâmetros hematológicos como método de triagem e marcador de SM em idosos.

3 REVISÃO DE LITERATURA

3.1 Artigo de revisão (Preditors of Metabolic Syndrome in the elderly: a review)

PREDICTORS OF METABOLIC SYNDROME IN THE ELDERLY: A REVIEW

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REVIEW ARTICLE

Predictors of Metabolic Syndrome in the Elderly: A Review

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Abstract

The article aimed to critically analyse studies which evaluated the capacity of anthropometric and clinical indicators to predict MetS in the elderly. Bibliographical research was performed using the electronic databasese Medline/PubMed, LILACS e SciELO , references from selected articles and contact with several authors. Twenty one articles involving anthropometric and clinical indicators in the elderly were analysed, using different MS criteria. Fourteen studies report anthropometric indicators, being the waist circumference (WC) and waist-to-height ratio (WHtR), described as the best MS predictors, with the area under the ROC curve (AUC) over 0.70 ($p < 0.05$). The neck circumference was also described as an alternative indicator but with less discriminatory power. Lipid accumulation product (LAP) was the parameter with the best performance to identify MS, with an AUC over 0.85 and efficiency greater than 70%. The WC, WHtR and LAP indicators were the most sensitive for predicting MS. The use of these parameters may facilitate the early identification of MS, with good accuracy and low cost. In addition, it is important to determine specific cutoff points for the elderly, since obesity alone does not appear to be a strong predictor of MS in the elderly.

Introduction

Metabolic syndrome (MetS) is defined as a set of risk factors that includes resistance to insulin, dyslipidemia, abdominal obesity and high blood pressure, and increases the risk of cardiovascular diseases and diabetes.[1,2] The most up-to-date criteria to define MetS were prepared by the International Diabetes Federation (IDF) task force.[2] In their guidelines, it has been established that abdominal obesity is no longer a compulsory component, and specific cut-off points should be used to classify waist circumference (WC) by ethnic groups, in addition to criteria for changes in glucose and lipid metabolism and high blood pressure.[2]

The use of clinical and anthropometric indicators can help to identify the presence of MetS.[3-5] Clinical indicators are those which associate biochemical parameters to analysis measurements, particularly the lipid accumulation product (LAP) and visceral adiposity index (VAI).[3,4] Anthropometric indicators include body mass index (BMI), WC, waist-to-hip ratio (WHR), waist-to-height ratio (WHtR), the sagittal abdominal indicator (SAD) and neck circumference (NC).[5,6]

The use of indicators to predict MetS may facilitate its identification in clinical practice, as they are simple, quick and functional. However, there is no consensus on the best indicator able to identify MetS in the elderly due to different functional characteristics and varied cut-off points, many of which are specific to young adults, and with different criteria for defining MetS.[1,2] Nevertheless, early identification of MetS is important in this age group since it may assist health teams to decide on strategies aimed at reducing global cardiovascular risk.[1]

This review aimed to critically analyse studies that evaluated the capability of anthropometric and clinical indicators to predict MetS in the elderly.

Keywords

Aged; Body weights and Measures; Risk Factors; Anthropometry; Obesity; Metabolic Syndrome; Indicators.

Methods

Search strategy

The search was performed on the MEDLINE/PUBMED, LILACS and SciELO bibliographic databases,

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using the following word combinations: ("metabolic syndrome" or "syndrome X" or "plurimetabolic syndrome") and ("elderly" or "older adults" or "aged") and ("predict" or "identify" or "ability"). These expressions were searched either in combination with each other or alone. Articles of interest listed in the references were also identified and reviewed. Several authors were contacted for relevant information not provided in the articles.

Criteria for including the articles

Only original articles written in English, Spanish or Portuguese were included in the review. Articles published between January 2010 and January 2016 were selected and classic studies published on the topic prior to this period were also included. Population-based studies in the elderly or studies on institutionalised elderly people that evaluated anthropometric and clinical indicators (LAP, VAI or lipid ratios) as predictors of MetS were included.

Data extraction

After screening of titles and abstracts according to eligibility criteria, relevant articles were selected for full-text reading (Figure 1).

The following data were extracted independently: 1) characteristics of the article (authors, journal and year of publication); 2) location where the study was performed (city and country); 3) characteristics of the population studied (number of participants, sex and age range); 4) indicators studied (anthropometric indicators: BMI,

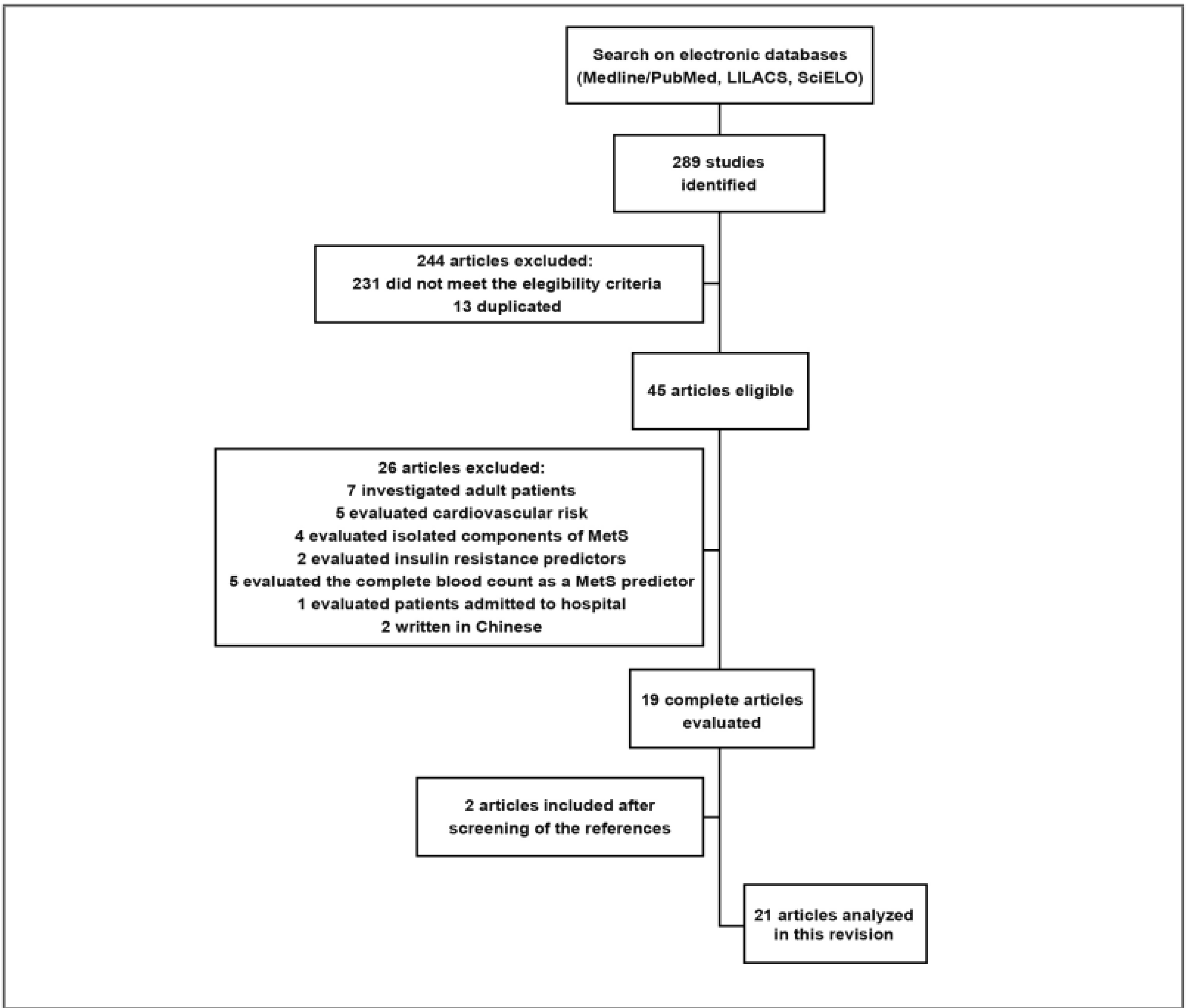

Figure 1 – *Flowchart of selection of papers for the review.*

WC, WHR, WHtR, SAD, NC and clinical indicators: LAP, VAI and lipid ratios: HDLc/TC, HDL/LDL and TG/LDL); 5) MetS classification criteria (IDF, National Cholesterol Education Program-Adult Treatment Panel III or the harmonized criteria[2] for MetS); 6) main results (area under the ROC curve: AUC; 95% CI: Confidence Interval; Cut-off points, SENS: sensitivity and SPEC: specificity).

Results

Two hundred and eighty-nine studies were identified on the bibliographic databases searched. After reading the titles and abstracts, 244 studies were excluded. Thus, 45 articles were eligible for evaluation, and 26 of these papers were excluded as: 7 presented data on a young adult population; 5 evaluated global cardiovascular risk; 4 evaluated isolated MetS components (dyslipidemia, high blood pressure, diabetes or obesity); 2 evaluated predictors of resistance to insulin; 5 evaluated complete blood count components as predictors of MetS; 1 were with patients admitted to hospital and 2 studies written in Chinese. Finally, after reviewing the bibliographic references for articles of interest, two further papers were included. Thus, 21 articles were analysed in this review (Figure 1).

Of the articles analysed, 13 discussed anthropometric indicators (Tables 1 and 2), 7 evaluated clinical indicators (LAP, VAI and lipid ratios) (Tables 3 and 4) and one

Table 1 – Studies evaluating the anthropometric indicators as predictors of metabolic syndrome in the elderly

Authors and publication year (Ref. nº.)	City, country	Number of participants (W, M)	Age range (years)	Indicator	Criteria for MetS diagnosis
Gharipour et al. 2014 [5]	Isfahan, Iran	206 men	71.85±5.44	BMI, WC*, WHR, and WHtR	2 or more factors of NCEP ATPIII without WC
Liang et al. 2013 [7]	Canton, China	4706 women	≥ 50	WC*, WHR, WHtR, BMI	Harmonized criteria for MetS
Yan et al. 2014 [8]	Shanghai, China	2092 subjects (1121 W, 971 M)	≥ 65	NC	Harmonized criteria for MetS
Guasch-Ferré et al. 2012 [9]	Spain	7447 subjects	M: 55-80 W: 60-80	WC*, WHR, WHtR, BMI	Harmonized criteria for MetS
Chu et al. 2012 [11]	Taipei, Taiwan	2848 women	≥65	BMI, WC*, WHR and WHtR	IDF without WC
Gharipour et al. 2013 [12]	Isfahan, Iran	468 subjects (232 W; 236 M)	> 60	WC*, BMI, WHR	NCEP ATPIII
Zeng et al. 2014 [13]	China	221270 subjects (84014 W; 137256 M)	45-79	BMI, WC*, WHtR	2 or more factors
Paula et al. 2012 [14]	Viçosa, Brazil	113 women	60-83	BMI, WC†, WHR, SS	NCEP ATPIII without WC
Risérus et al. 2010 [16]	Stockholm, Sweden	4032 subjects (2096 W; 1936 M)	≥ 60	SAD, BMI, WC* and WHR	Cardiometabolic risk score
Sharda et al. 2014 [17]	Kota, India	400 subjects (200 W, 200 M)	60-90	SAD	IDF
Aoi et al. 2014 [18]	Mihara, Japan	64 women	63.6 ± 7.1	BMI, %BF, WC† and NC	MetS components
Limpawattana et al. 2016 [19]	Khon Kaen, Thailand	587 subjects (386 W, 201 M)	≥ 50	NC	NCEP ATPIII and IDF
Hoebel et al. 2012 [20]	North West Province South Africa	409 subjects (207 W, 202 M)	25-65	NC, WC*	IDF
Liu et al. 2013 [21]	Beijing, China	1698 subjects (593 W; 1689 M)	20-79	BMI, FMI and %BF	NCEP ATPIII

W: women; M: men; MetS: metabolic syndrome; IDF: International Diabetes Federation; NCEP ATPIII: National Cholesterol Education Programme Adult Treatment Panel III; BMI: body mass index; WC: waist circumference; WHR: waist-to-hip ratio; WHtR: waist-to-height ratio; SAD: sagittal abdominal diameter; NC: neck circumference; SS: sum of the four skinfolds; %BF: percentage of body fat; FMI: fat mass index.

** plane the midpoint between the lower costal rib and the iliac crest, perpendicular to the long axis of the trunk. †at the level of the umbilicus.*

Table 2 – Cut-offs and areas under the ROC curve, sensitivity and specificity of anthropometric indicators to determine metabolic syndrome in the elderly

Authors and publication year (Ref. nº.)	Indicator	Men				Women			
		AUC (95% CI)	Cut-off point	Sens (%)	Spec (%)	AUC (95% CI)	Cut-off point	Sens (%)	Spec (%)
Gharipour et al. 2014 [5]	WC	0.683 (0.606-0.761)	94.5 cm	64.0	68.0				
	WHR	0.645 (0.563-0.727)	0.96	6.0	69.0				
	BMI	0.641 (0.561-0.722)	26.65 kg/m^2	48.0	76.0				
	WHtR	0.680 (0.602-0.758)	58.66	52.0	79.0				
Liang et al. 2013 [7]	WC					0.76	79.5 cm	72.7	76.7
	WHR					0.70	0.86	62.8	72.1
	WHtR					0.74	0.53	67.6	72.9
	BMI					0.71	22.47 kg/m^2	64.8	67.3
Yan et al. 2014 [8]	NC	0.76	> 38 cm	80.0	55.0	0.73	> 35 cm	75.0	67.0
Guasch-Ferré et al. 2012 [9]	WHtR	0.74 (0.72-0.75)							
	WC	0.72 (0.71-0.73)			Presented results without stratification by sex				
	BMI	0.69 (0.68-0.70)							
Chu et al. 2012 [11]	WHtR					0.66 (0.58-0.74)	0.54	70	70
	WC					0.68 (0.60-0.76)	82.4 cm	75	69
	WHR					0.63 (0.56-0.71)	0.84	58	72
	BMI					0.58 (0.50-0.68)	24.4 kg/m^2	78	60
Gharipour et al. 2013 [12]	WC	0.78 (0.70-0.85)	92.0cm	81.4	55.8				
	WHR	0.76 (0.68-0.83)	0.93	82.9	52.3	Presented results without stratification by sex			
	BMI	0.77 (0.70-0.84)	28.8 kg/m^2	80.0	61.6				
Zeng et al. 2014 [13]	BMI	0.640 (0.648-0.666)[*]	24.2 kg/m^2 [*]	69.1	54.3	0.637 (0.624-0.650)[*]	23,3 kg/m^2	70.4	49.7
		0.665 (0.654-0.675)[¶]	23.3 kg/m^2 [¶]	71.7	52.3	0.665 (0.648-0.682)[¶]	23,5 kg/m^2	65.3	59.9
	WC	0.640 (0.631-0.654)[*]	83.5 cm	74.3	45.8	0.641 (0.628-0.645)[*]	78,5 cm	65.2	55.6
		0.646 (0.636-0.657)[¶]	82.3 cm	74.0	47.3	0.668 (0.651-0.685)[¶]	78,5 cm	70.1	54.7
	WHtR	0.645 (0.636-0.654)[*]	0.52	62.3	58.4	0.640 (0.627-0.653)[*]	0,49	76.0	44.5
		0.651 (0.641-0.662)[¶]	0.50	71.9	50.2	0.659 (0.642-0.676)[¶]	0,52	65.2	59.6

To be continued

Continuation

Paula et al. 2012 [14]	WC					0.694 (0.600-0.777)	92.0 cm	80	58.2
	BMI					0.619 (0.523-0.708)	25.4 kg/m²	66.7	55.1
	WHR					0.752 (0.662-0.829)	0.98	80	59.2
	SS					0.669 (0.574-0.726)	108 mm	66.7	64.3
Risérus et al. 2010 [16]	SAD	0.80 (0.77-0.82)	22.2 cm			0.77 (0.75-0.80)	20.1 cm		
	WC	0.78 (0.75-0.80)	100 cm			0.77 (0.75-0.80)	88.4 cm		
	WHR	0.74 (0.71-0.77)	0.97			0.76 (0.74-0.79)	0.82		
	BMI	0.78 (0.76-0.81)	27.9 kg/m²			0.74 (0.72-0.77)	27.6 kg/m²		
Sharda et al. 2014 [17]	SAD		> 22 cm	88.0	83.0		> 20 cm	87.0	80.0
Aoi et al. 2014 [18]	NC	NC was associated with BMI (r = 0.747, p < 0.0001), %BF (r = 0.715, p < 0.0001), TG (r = 0.276, p = 0.028), decrease in HDLc (r = –0.401, p < 0.001) and HbA1c (r = 0.298, p = 0.019), HOMA-R and leptin (r = 0.488, p < 0.001)							
Limpawattana et al. 2016 [19]	NC	0.84 (0.79-0.90)‡ 0.71 (0.64-0.78)§	> 39 cm‡	70.89	81.15	0.79 (0.75-0.84)‡ 0.77(0.72-0.82)§	> 33 cm‡	86.54	59.39
Hoebel et al. 2012 [20]	NC	0.70 (0.50-1.00)*	> 35 cm*			0.60 (0.40-0.80)*	> 35 cm*		
		0.70 (0.60-0.90)†	> 41 cm†			0.80 (0.70-0.90)†	> 33 cm†		
Liu et al. 2013 [21]	BMI	0.904 (0.882-0.925)	27.45 kg/m²	80.6	84.3	0.869 (0.869-0.928)	23.85 kg/m²	92.7	72.9
	BF	0.883 (0.859-0.908)	23.95%	84.1	7.8	0.855 (0.818-0.892)	31.35%	77.1	81.4
	FMI	0.920 (0.900-0.940)	7.00 kg/m²	80.2	86.9	0.898 (0.869-0.927)	7.90 kg/m²	78.9	85.7

AUC: area under ROC curve; 95% CI: 95% confidence interval; Sens: sensitivity; Spec: specificity; BMI: body mass index; WC: waist circumference; WHR: waist-to-hip ratio; WHtR: waist-to-height ratio; SAD: sagittal abdominal diameter; NC: neck circumference; SS: sum of the four skinfolds; %BF: percentage of body fat; FMI: fat mass index; HbA1c: glycated haemoglobin.

** Older African group; † Older caucasian group; ‡ IDF Criteria; § NCEP ATP III Criteria; ǂ 60-69 years; ¶ 70-79 years.*

article[7] compared anthropometric indicators and lipid ratios to predict MetS in the elderly (and hence is cited in anthropometric and clinical indicators' tables).

The IDF's and the NCEP-ATP III's criteria were most commonly used criteria for definition of MetS). Only 5 articles used the most recent harmonized criteria for MetS.[7-10] The harmonized criteria states that obesity itself is not a prerequisite for diagnosis of MetS, which should be established based on the presence of any 3 or 5 risk factors (among which obesity is included).

Anthropometric indicators

Fourteen studies reported anthropometric indicators as predictors of MetS (Tables 1 and 2). Among the anthropometric indicators, those most cited were BMI, WC and WHR. The most recent studies analysed WHtR, SAD and NC.

The majority of the papers[5,7,11-13] which evaluated anthropometric indicators highlight WC and WHtR as the best predictors of MetS in the elderly, when compared to BMI and WHR.

Table 3 – Studies evaluating the clinical indicators as predictors of metabolic syndrome in the elderly

Authors and publication year (Ref. n°.)	City, country	Number of participants	Age range (anos)	Indicator	Criteria for MetS diagnosis
Liang et al. 2013 [7]	Canton, China	4706 women	≥ 50	TG/HDL, HDL/TC, HDL/LDL	Harmonized criteria for MetS
Arthur et al. 2012 [10]	Kumasi, Ghana	250 women	20-78	TG/HDL, HDL/TC	Harmonized criteria for MetS
Tellechea et al. 2009 [22]	Buenos Aires, Argentina	601 men	18-65	LAP	NCEP ATPIII
Taverna et al. 2011 [23]	Province of Segovia, Central Spain	768 subjects (416 W; 352 M)	36-77	LAP, TG/HDL, TG, WC and BMI	NCEP ATPIII vs. IDF
Chiang & Koo 2012 [24]	Taiwan	513 subjects (247 W; 266 M)	> 50	LAP, WHtR, BMI and WC	MetS criteria for Taiwanese people
Ejike 2011 [25]	Abia State, Nigeria	40 men	65-84	LAP, VAI, BMI, WHtR and WHR	IDF
Motamed et al. 2015 [26]	Amol, Iran	5511 subjects (2392 W; 3119 M)	18-90	LAP, WC, BMI, WHtR, WHR	IDF
Amato et al. 2011 [27]	Alcamo, Italy	1764 subjects (1179 W; 585 M)	16-99	VAI	NCEP ATPIII

W: women; M: men; MetS: metabolic syndrome IDF: international diabetes federation; NCEP ATPIII: National Cholesterol Education Programme Adult Treatment Panel III; LAP: lipid accumulation product; VAI: visceral adiposity index; WC: waist circumference; WHR: waist-to-hip ratio; WHtR: waist-to-height ratio. BMI: body mass index; HDLc/TC: HDL-cholesterol to total cholesterol ratio; HDL/LDL:HDL-cholesterol to LDL: cholesterol ratio; TG/LDL: triglyceride to HDL: cholesterol ratio.

The works of Liang et al.[7] and Guasch-Ferré et al.[9] reported an AUC over 0.70 for WC and WHtR to detect MetS, considering the harmonized criteria for MetS. For women, Liang et al.[7] identified the cut-off points of 79.5 cm for WC (sens: 72.7%; spec: 76.7%) and 0.53 for WHtR (sens: 67.6%; spec: 72.9%), with efficiency higher than 70%. Zeng et al,.[13] evaluating the presence of a minimum of two MetS components and stratifying the results by sex and age, observed similar AUCs and cut-off points for elderly women at the age range of 60-69 and 70-79 years (Table 2).

Among the indicators with unsatisfactory performance, Paula et al.[14] established that the BMI and the sum of four skinfolds were the anthropometric parameters of adiposity which presented the least efficiency in identifying MetS.

Another indicator cited was SAD, which is able to estimate the excess of visceral fat and, consequently, is a better predictor of cardiometabolic risk than classic indicators.[15] Only two studies[16,17] evaluated SAD in the elderly; Sharda et al.[17] aimed to identify the best SAD cut-off points to predict MetS, and suggested the cut-off points of 22 cm for men and 20 cm for women, with sensitivity and specificity higher than 80% for both sexes. Similar cut-offs were found by Risérus et al.[16] using a cardiometabolic risk in elderly subjects.

In relation to NC, the articles analysed its performance in identifying MetS and its isolated components. Aoi et al.[18] showed that the increase in NC is associated to a rise in metabolic risk factors, such as resistance to insulin (leptin, HbA1c and HOMA-IR) and lipid profile (TG and HDL).

In the studies[8,19,20] which evaluated the predictive capacity of the NC, the cut-off points suggested by the authors were quite similar, varying between 35 and 41 cm for men and 33 and 35 cm for women (Table 2). Hoebel et al.[20] observed that white men presented a higher cut-off point (41 cm) when compared to black men (35 cm). The cut-off points for women were similar between white and black women, although the cut-off point for black women did not predict MetS, in contrast to what was observed for men. Limpawattana et al.[19]

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Table 4 – Cut-offs and areas under the ROC curve, sensitivity and specificity of clinical indicators to determine metabolic syndrome in the elderly

Authors (Ref. nº.)	Indicators	Men				Women			
		AUC (95% CI)	Cut-off point	Sens (%)	Spec (%)	AUC (95% CI)	Cut-off point	Sens (%)	Spec (%)
Amato et al. 2010 [4]	VAI	0.840 (0.98-1.00)[‡]	1.93	77.0	82.3	No stratification by sex			
		0.783 (0.73-0.82)[§]	2.00	68.5	76.0				
Liang et al. 2013 [7]	TG/HDLc					0.84	0.88	77.7	76.0
	HDLc/TC					0.73	0.73	70.1	64.6
	HDLc/LDLc					0.74	0.68	78.3	65.7
Arthur et al. 2012 [10]	TG/HDLc					0.80 (0.70–0.90)	0.61	87.2	80.0
	HDLc/TC					0.80 (0.70–0.90)	0.34	96.6	83.3
Tellechea et al. 2010 [22]	LAP	0.91 (p < 0.05)	53.63	83.0	83.0				
Taverna et al. 2011 [23]	LAP	61-70 years old:				61-70 years old:			
		0.89 (0.82-0.97)[†]	> 51.82[†]			0.79 (0.69-0.90)[†]	> 33.28[†]		
		0.84 (0.74-0.93)[*]				0.78 (0.67-0.89)[Δ]			
		71-77 years old:				71-77 years old:			
		0.89 (0.77-1.01)[†]	> 48.09[*]			0.88 (0.76-0.99)[†]	> 31.7[*]		
		0.91 (0.82-1.00)[*]				0.85 (0.74-0.99)[*]			
	WC	61-70 years old:				61-70 years old:			
		0.82 (0.72-0.93)[†]				0.78 (0.68-0.87)[†]			
	BMI	0.85 (0.75-0.95)[†]				0.74 (0.63-0.85)[†]			
Chiang & Koo 2012 [24]	LAP	0.916 (0.880-0.953)	31.6	88.0	82.0	0.901 (0.855-0.946)	31.6	66.0	93.0
	WHtR	0.827 (0.762-0.892)				0.819 (0.755-0,883)			
	BMI	0.776 (0.709-0.844)				0.793 (0.726-0.859)			
	WC	0.825 (0.760-0.890)				0.817 (0.755-0.879)			
Ejike 2011 [25]	LAP	0.937 (p < 0.05)	43.91	100	81.0				
	VAI	0.640	4.44	67.0	84.0				
	BMI	0.793	30.47 kg/m²	100	73.0				
	WHtR	0.905 (p < 0.05)	0.61	100	78.0				
	WHR	0.635	1.08	67.0	76.0				
Motamed et al. 2015 [26]	LAP	0.901 (0.890-0.913)	39.89	86.0	79.6	0.904 (0.892-0.916)	49.71	85.2	82.3
	WC	0.907 (0.897-0.917)				0.782 (0.764-0.801)			
	BMI	0.862 (0.849-0.876)				0.701 (0.680-0.722)			
	WHtR	0.878 (0.868-0.889)				0.788 (0.769-0.806)			
	WHR	0.840 (0.826-0.855)				0.785 (0.766-0.803)			

AUC: area under ROC curve; 95% CI: 95% confidence interval; Sens: sensitivity; Spec: specificity; LAP: Lipid Product Accumulation; VAI: Visceral Adiposity Index; WC: waist circumference; WHR: waist-to-hip ratio; WHtR: waist-to-height ratio; BMI: body mass index; HDLc/TC: HDL-cholesterol to total cholesterol ratio; HDL/LDL: HDL-cholesterol to LDL: cholesterol ratio; TG/LDL: triglyceride to HDL-cholesterol ratio.
** IDF Criteria; † NCEP ATP III Criteria; ‡ 52 – 66 years old; § > 66 years old.*

and Yan et al.[8] presented similar cut-off points for NC to predict MetS in individuals aged over 50 and 65 respectively, and Limpawattana et al.[19] showed an efficiency over 72% for the cut-off point suggested for men (sens: 70.89%; spec: 81.15%) and women (sens: 86.54%; spec: 59.39%).

A parameter that has been insufficiently investigated was the Fat Mass Index (FMI), which is normalizes body fat for individual's height. This index has been suggested to independently evaluate body fat from changes in fat free mass. In the study performed by Liu et al.,[21] FMI was the parameter with the highest AUC, and high FMI showed significantly higher odds ratio for MetS than the low FMI in both sexes. These authors suggested that a FMI of 7.00 kg/m² for men and 7.90 kg/m² for women, evaluated by bioelectrical impedance analysis, could predict the presence of MetS.

Clinical indicators

Tables 3 and 4 demonstrate the characteristics and results, respectively, of the eight studies which evaluated LAP and VAI clinical indicators and lipid ratios as predictors of MetS according to NCEP and IDF criteria and harmonized criteria for MetS.

LAP is an indicator proposed to estimate lipid concentration in adults, described for the first time by Kahn.[3] It is an emerging cardiovascular risk index based on the product of WC multiplied by fasting triglyceride concentration. LAP has proven to be a reliable marker for cardiovascular disease in adults, outperforms other predictors of this risk as BMI.[3] Most of the studies analysed evaluated a mixed population, stratified by sex and/or age range. The cut-off point for LAP suggested by the authors[22-26] varied from 31.6 to 51.8, with a difference between the sexes (Table 4). Among men, the LAP AUC to predict MetS varied from 0.84 to 0.937, while for women the lowest AUC was 0.78 and highest was 0.904 (Table 4).

Taverna et al.[23] reported a lower AUC for men and women in the 61-70 age range, considering the IDF criteria (area under the curve, AUC: 0.84; 95% CI: 0.74-0.93 for men and 0.78; 95% CI: 0.76-0.99 for women) when compared to the other studies.

Ejike CECC[25] investigated LAP as a predictor of MetS in the elderly (aged between 65 and 84); the authors reported an AUC of 0.937 (p=0.013) and suggested a LAP cut-off point of 43.9 (sens: 100%; spec: 81%). Tellechea et al.[22], Chiang & Koo[24] and Motamed et al.[26] also observed the high predictive capacity of LAP to identify MetS (AUC higher than 0.90). Among these studies, the lowest LAP cut-off point to identify MetS was reported by Chiang & Koo[24] (31.6 for both sexes).

VAI is a gender-specific, empirical-mathematical model based on a combination of anthropometric measurements (WC and BMI) with biochemical parameters (TG and HDLc), which may be and indicator of fat distribution and function.[4] The Alkam Metabolic Syndrome Study[4] introduced VAI as a new marker of adipose tissue dysfunction, independently associated with cardiovascular events, which was not observed for WC and BMI. Only two studies investigated this indicator in MetS.[25,27] For Amato et al.[27], a VAI value higher than 2.00 (sens: 68.5% and spec: 76.0%) for individuals aged over 66 was able to predict MetS. However, in the study by Ejike CECC,[25] VAI showed an AUC of 0.640 but without statistical significance (p = 0.426), suggesting a cut-off point higher than 4.4, with relatively better sensitivity and specificity to identify MetS in the elderly (sens: 67% and spec: 84%).

Two papers[7,10] described the results of lipid ratios, with different cut-off points between the studies. Arthur et al.[10] observed that the TG/HDL and HDL/CT ratios presented AUC of 0.80 (95% IC: 0.70-0.90) for both ratios, suggesting a cut-off point of 0.61 (sens: 87.2% and spec: 80%) for the TG/HDL ratio and 0.34 (sens: 96.6% and spec: 83.3%) for the HDL/CT ratio, therefore demonstrating efficiency of over 83%.

Discussion

The anthropometric indicators that showed a better performance in identifying MetS were WC and WHtR (among the classic indicators) and NC (among the recently studied indicators). Regarding the clinical parameters, LAP was the best indicator, followed by the HDL/CT ratio.

An important point to be discussed is the criteria used to define MetS (IDF, NCEP ATPIII and harmonized criteria), which may justify the diversity of results discussed in this review. In addition, the use of different criteria and measurement techniques, particularly in relation to WC, does not ensure comparability between the studies.

WC and WHtR were the best parameters evaluated,[5,7,9,13] with WC showing higher sensitivity among the obesity indexes. In addition, it was observed that the WC cut-off points suggested were lower than those proposed by the MetS criteria used, revealing that non-specific cut-off points for ethnic and age groups can underestimate the presence of MetS, depending on the criterion used for its classification. However, Chu et al.[11] observed that WC and WHtR showed similar results to BMI and WHR, with an AUC lower than 0.70 to detect a minimum of three MetS criteria in women. This divergence could be attributed to the age of the elderly (average of 71.9 years), with high prevalence of other comorbidities, apart from obesity, that contribute to the development of MetS. Therefore, obesity appears not to be a decisive criterion for MetS detection in this age range.

A further indicator discussed in the literature is SAD. Although very few studies have evaluated this indicator as a predictor of MetS, the cut-off points suggested by Risérus et al.[16] and Sharda et al.[17] are in line with other studies that evaluated SAD as a predictor of visceral fat.[15,28] Despite being related to visceral abdominal fat deposits, SAD has not been widely used in clinical practice since it requires a specific measuring instrument (abdominal caliper – Holtain, Ltd, Dyfed, Wales, U.K).

NC was also evaluated, with similar cut-off points suggested by the authors,[8,19,20] which can be explained by the fact that this measurement is little affected by aging-related changes in body composition. The association between NC and MetS may be related to the fact that subcutaneous fat in the neck area is responsible for higher systemic release of free fatty acids.[19] This excess of free fatty acids is associated with resistance to insulin, hypertriglyceridemia, vascular lesion and high blood pressure, and could predict MetS.

Differences between sexes and ethnic groups were reported in the study by Hoebel et al.[20] The authors observed that a NC cut-off point of 35 cm was not able to predict MetS in black women, in contrast with what was observed in men, suggesting a concept of "healthy obesity". However, a limitation of this study was that the authors considered individuals aged between 46 and 65 as the elderly group and, for this reason, their results cannot be extrapolated to individuals aged over 65. Altogether, the studies[8,18-20] suggested the use of NC, as it is a simple and practical anthropometric parameter, able to identify MetS. Another advantage of the NC is the fact that it is not affected during respiratory movement or in the postprandial period.

FMI was only discussed in the study by Liu et al.[21] Although the authors suggested a cut-off point, it is worth pointing out that there was no stratification by age group in the data analysis. In addition, the study was conducted in China, in a smaller population with brevilineal biotype, which limit the extrapolation of results to other populations.

The studies included showed that the cut-off points for obesity indicators need to be specific for the elderly, with higher values when compared to other age groups, as obesity does not appear to be a strong predictor of MetS in the elderly.

With regards to clinical indicators, LAP was the parameter most discussed in the studies. Kahn[3] highlights that the WC and TG levels tend to increase with age, accumulating over time. From this perspective and considering that lipid accumulation intensifies cardiometabolic consequences, the use of LAP seems an advantageous approach in evaluating MetS and cardiovascular risk.

The cut-off points for LAP suggested by the studied showed a wide variety, which could be justified by ethnic diversity, extensive age ranges and different criteria used to define MetS. In addition, two studies[22,26] did not adequately define the age group of the elderly. While Motamed et al.[26] did not stratify the results between adults and the elderly, Tellechea et al.[22] considered the elderly group to be aged between 45 and 65. These facts limit the understanding of this indicator's performance, specifically among the elderly.

Although Taverna et al.[23] has reported the lowest LAP AUC for the elderly aged between 61-70 years when compared with other studies, these authors show a better performance of LAP as a predictor of MetS in the elderly. Besides, although Ejike CECC[25] demonstrated good results using the LAP indicator, a small sample (only 40 men) was included, which was an important limitation of the study.

The lowest LAP cut-off point to predict MetS suggested by Chiang & Koo,[24] could be related to the criterion used to define MetS and the physical characteristics of the population evaluated. The capacity of LAP to identify MetS, compared with that of other parameters, is associated to the fact that this indicator reflects anatomical and physiological alterations associated to visceral fat and its accumulation,[22,25] indicating that, regardless of how excess lipids are stored, it will be identified by LAP.[25]

Another clinical indicator also related to the dysfunction of the adipose tissue is VAI, which uses WC, BMI, TG and LDL measurements for its calculation. Only two studies[25,27] have analysed its performance and proposed a VAI cut-off point to identify MetS. However, the cut-off points suggested diverged among the authors. It is of note that three of the variables on which VAI is based (WC, TG and HDL) are also MetS components, which makes the use of this index in patients with clear MetS pointless.[29] The studies[7,10] using lipid ratios showed that the use of this indicator in isolation is not able to identify MetS, particularly among the elderly, but rather to identify isolated cardiovascular risk factors.

The results were clear in showing that WC, WHtR and LAP indicators were the most sensitive ones for predicting MetS. Therefore, the use of these parameters may facilitate the early identification of MetS through easily-applied, precise and low cost diagnostic methods. The use of these indicators by health professionals is important to optimise MetS prevention and treatment, and to minimize its complications.

To summarise, the studies included propose different indicators to predict MetS. However, the cut-off points suggested vary between each other, as they are linked to different populations, with different age and ethnic characteristics. Further studies are required to identify the best practical, validated method to predict MetS. Also, studies comparing different indicators are needed, considering specific aspects, such as sex, well-defined age ranges and ethnic groups.

Different MetS classification criteria have been adopted, which makes the comparison between the studies problematic and the standardisation of the criteria essential. In addition, there is no consensus on the best indicator to predict MetS in the elderly, and studies in this population is still scare. These data affect the understanding of the indicators' performance in predicting MetS in this age group.

The most of these studies presented to methodological differences and study designs, as well as limitations inherent to observational studies, which make the comparison between results and the control of population biases difficult.

Conclusion

Analysis of the studies included in this review allowed us to infer that the WC, WHtR and LAP indicators presented the best predictive power for MetS in the elderly because they are strongly related to visceral abdominal fat deposits. However, the disparate values between the studies substantiated that the prevalence of other comorbidities, rather than obesity, may be contributing to the development of MetS in this population. Thus, the results revealed that the distribution of abdominal fat, instead of overweight appears to be a fundamental criterion for this age group, but the distribuition of abdominal fat. The need to identify a simple method which facilitates the approach and detection of high risk for MetS in the elderly is highlighted, allowing the early prevention of cardiovascular events.

Author contributions

Conception and design of the research: Oliveira CC, Roriz AKC, Ramos LB, Gomes Neto M. Acquisition of data: Oliveira CC, Costa ED. Analysis and interpretation of the data: Oliveira CC, Roriz AKC, Ramos LB, Gomes Neto M. Statistical analysis: Oliveira CC. Obtaining financing: Ramos LB. Writing of the manuscript: Oliveira CC, Costa ED, Gomes Neto M. Critical revision of the manuscript for intellectual content: Oliveira CC, Roriz AKC, Ramos LB, Gomes Neto M.

Potential Conflict of Interest

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4 RESULTADOS

4.1 Artigo Original nº 1 (Indicators of Adiposity predictors of Metabolic Syndrome in the elderly)

INDICATORS OF ADIPOSITY PREDICTORS OF METABOLIC SYNDROME IN THE ELDERLY

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Indicators of Adiposity Predictors of Metabolic Syndrome in the Elderly

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Keywords
Elderly · Metabolic syndrome · Anthropometry · Cut-off points

Abstract
Background: Adiposity indicators can be used as predictors of cardiovascular risk in the elderly. However, there are only a very few studies that deal with the accuracy of adiposity indicators as predictors of metabolic syndrome (MS) in the elderly. We evaluated the performance of adiposity indicators of MS prediction in the elderly. ***Methods:*** A cross-sectional study with 203 elderly people of both genders. Variables: MS defined by harmonized criteria, waist circumference (WC), waist-to-height ratio (WHtR), conicity index (CI), lipid accumulation product (LAP), and visceral adiposity index (VAI). Area under the receiver operating characteristic curve (AUC), sensitivity (sens) and specificity (spec). ***Results:*** The WC, WHtR, and LAP indicators showed the highest AUC, with values greater than 0.84. For the general population, WHtR and LAP had the highest Youden index values, identifying a point of approximately 0.55 (sens: 85.6%; spec: 80.4%) for WHtR and 32.3 (sens: 81.1%; spec: 75.0%) for LAP. When analyzed by gender, it was observed that the WC and WHtR had the highest Youden index values for prediction of MS in both genders. The CI and VAI showed the lowest discriminatory power for MS. ***Conclusion:*** Both the adiposity indicators, WC and WHtR, as well as LAP, had high accuracy in MS discrimination. Therefore, they are effective in MS assessment in the elderly and during follow-up for individual and collective clinical practice.

Introduction

Metabolic syndrome (MS) is exacerbated with the aging process and increased obesity [1]. Obesity is an important etiological factor in the grouping of clinical conditions, which form MS in the elderly [2]. Abdominal obesity can be easily estimated by using simple and sensitive adiposity indicators [1, 3], and it is considered to be the best parameter to identify excess body fat that predisposes developing MS [4, 5].

Alterations in body fat distribution inherent to aging can cause significant consequences in this predisposition to MS, especially those related to excess body fat [3, 5, 6]. Thus, the early identification of MS in the elderly is essential in order to avoid detrimental consequences of this condition.

Different adiposity indicators, such as waist circumference (WC) and waist-to-height ratio (WHtR) are used to predict MS [6]. Currently, replacement parameters, such as the conicity index (CI), lipid accumulation prod-

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uct (LAP) and the visceral adiposity index (VAI) are suggested as being more sensitive and specific for identifying MS in adults [6, 7]. However, there are only a very few studies that evaluate the performance of these indicators in the elderly, which could be an obstacle in the early diagnosis of MS [6].

Investigating sensitive and specific parameters to predict MS in order to specify the identification of MS in the elderly using the most appropriate respective cut-off points is essential for early screening in this age group and, above all, investigation on gender-related specificities (spec) is the need of the hour. Therefore, the aim of this study is to evaluate the performance of adiposity indicators to predict MS in the elderly, identifying the cut-off points based on gender.

Methods

Sample and Study Design

A cross-sectional study was performed among elderly people of both genders, residing in institutions that offered long-term care for the elderly in the city of Salvador. This study was approved by the Research Ethics Committee at the School of Nutrition at the Federal University of Bahia (CEPNUT/UFBA), decision No. 11/12.

The following elderly people were excluded from the study: those without biochemical examination data and/or with any physical and postural problem, which may affect verifying anthropometric measurements; those with neural sequelae and dystrophy; those who had recently undergone abdominal surgery; those with lesions and abdominal tumours, hepatomegaly and/or splenomegaly and ascites.

The elderly people were subjected to an anthropometric evaluation (weight, height, and WC), biochemical examinations (lipid profile and glycemia), and reading pressure levels in the same week to avoid alterations in the individual's body composition and/or metabolic profile. Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured by following the technique recommended by the VI Brazilian Guidelines on Hypertension [8].

Laboratory Evaluation

Blood samples were collected by venipuncture, with the individuals having fasted overnight for 12 h. The lipid profile and glycemia were quantified in the serum, using a colorimetric system, dry chemical method that included a kit manufactured by Ortho-Clinical Diagnostics®. The lipid profile was assessed by measuring the following parameters: total cholesterol (TC), high-density lipoprotein (HDL), low-density lipoprotein (LDL), and triglycerides (TGs) level. The LDL value originated from the calculation using the following formula: LDL = TC – (HDL – VLDL).

Anthropometric Evaluation and Obesity Indicators

Anthropometric measurements were calculated by a duly-trained and previously standardized team, with the weight, height, and WC measurements being carried out according to the techniques proposed by Lohman et al. [9] and the World Health Organization (WHO) [10].

The obesity indicators evaluated were WC, WHtR, CI, LAP, and VAI. The WC was evaluated according to the technique proposed by the WHO [10]. The WHtR was calculated by dividing the WC (cm) by height (cm). The weight (kg), WC (m), and height (m) measurements were used for the CI, as suggested by Valdez et al. [11], using the equation: $CI = WC/0.109 \times \sqrt{(weight/height)}$.

The LAP was calculated using specific formulas for men [$LAP = (WC\ (cm) - 65) \times TG\ (mmol/L)$] and women [$LAP = (WC\ (cm) - 58) \times TG\ (mmol/L)$], as proposed by Kahn [12], while the equations suggested by Amato et al. [13] were used to calculate the VAI, being: $VAI = WC\ (cm)/[39.68 + (1.88 \times BMI\ (kg/m^2))] \times (TG\ (mmol/L)/1.03) \times (1.31/HDL\ (mmol/L))$ for men and $VAI = WC\ (cm)/[36.58 + (1.89 \times BMI\ (kg/m^2))] \times (TG\ (mmol/L)/0.81) \times (1.52/HDL\ (mmol/L))$ for women.

The TG and HDL cholesterol (HDLc) concentrations were converted from milligrams per decilitre (mg/dL) into millimoles per litre (mmol/L) by dividing by the constants 0.01129 and 0.02586 mmol/L, respectively, to calculate the LAP and VAI.

MS Diagnosis

The MS diagnosis was established based on the MS-harmonized criterion [4], so the individual should present a minimum of 3 of the other 4: WC ≥80 cm for women and ≥90 cm for men; dyslipidemia (HDLc ≤40 for men and ≤50 for women or specific treatment or TG ≥150 mg/dL or specific treatment); blood pressure (SBP ≥130 mm Hg or DBP ≥85 mm Hg or specific treatment); glycemia (≥100 mg/dL or specific treatment).

Statistical Analyses

The analyses were performed using Stata software, version 12.0. The level of significance adopted was less than 5%. In order to characterize the population studied, the variables were expressed as absolute and relative frequency, central tendency, and dispersion measurements, with the analyses stratified by gender.

The comparison of categorical variables was carried out using the Pearson's chi-square test. Data normality was tested using the Kolmogorov–Smirnov test and homogeneity of variance was tested using the Levene's test. In order to compare 2 averages, when the data was normal and homogeneous Student *t* test was used for independent samples and the Mann–Whitney test when they were not.

In order to evaluate the diagnostic performance of the adiposity indicators to detect MS, receiver operating characteristic (ROC) curve analysis was applied. The areas under the ROC curves (AUCs) and CIs were determined. The difference between the areas under the indicator curve was tested using the Wald test. The sensitivity (sens) values, specificities and Youden index were calculated and the optimum indicator cut-off points were determined.

Results

Two hundred and three elderly people were evaluated, the majority being women (77.8%), with an average age of 80.2 ± 9.0 years. Sample characteristics are presented in Table 1.

Table 1. Descriptive analysis of anthropometric and biochemical indicators and blood pressure, according to gender

	Men (n = 45)	Women (n = 158)	p value
BMI, kg/m^2	21.82 (2.90)	23.64 (5.46)	0.037*
WC, cm	87.74 (10.74)	87.16 (13.30)	0.806*
WHtR	0.53 (0.06)	0.57 (0.08)	<0.001#
LAP	30.07 (18.29)	46.96 (34.33)	0.001*
VAI	1.96 (1.10)	2.82 (1.79)	<0.001*
CI	1.34 (0.13)	1.34 (0.11)	0.961#
Glycemia, mg/dL	93.5 (40.06)	91.89 (31.33)	0.081*
TC, mg/dL	182.69 (29.45)	209.9 (48.20)	<0.001*
LDLc, mg/dL	120.26 (26.39)	134.79 (43.84)	0.036*
HDLc, mg/dL	39.02 (8.62)	47.44 (12.21)	<0.001#
TG, mg/dL	117.02 (44.56)	137.34 (60.92)	0.035*
SBP, mm Hg	128.82 (19.83)	132.78 (18.34)	0.333#
DBP, mm Hg	76.6 (10.18)	75.00 (10.88)	0.466*

Data presented in mean (SD).
* Mann–Whitney test.
# Student t test.
BMI, body mass index; WC, waist circumference; WHtR, waist-to-height ratio; LAP, lipid accumulation product; VAI, visceral adiposity index; CI, conicity index; TC, total cholesterol; LDLc, low-density lipoprotein cholesterol; HDLc, high-density lipoprotein cholesterol; TG, triglycerides; SBP, systolic blood pressure; DBP, diastolic blood pressure.

Table 2. AUC of indicators by gender

Indicator	Population		Men		Women	
	AUC	95% CI	AUC	95% CI	AUC	95% CI
WC	0.844	0.789–0.899	0.903	0.698–0.991	0.872	0.795–0.926
WHtR	0.874	0.819–0.921	0.892	0.712–0.988	0.856	0.782–0.915
LAP	0.849	0.741–0.864	0.765	0.594–0.901	0.859	0.795–0.915
VAI	0.641	0.564–0.718	0.479	0.288–0.659	0.647	0.556–0.734
Conicity index	0.752	0.788–0.897	0.839	0.654–0.956	0.749	0.659–0.825

AUC, area under ROC curve; WC, waist circumference; WHtR, waist-to-height ratio; LAP, lipid accumulation product; VAI, visceral adiposity index.

There were no differences between the genders in terms of WC, CI, glycemia, SBP, and DBP. For the body mass index (BMI), WHtR, LAP, VAI, CT, LDL, and TG variables, it was noted that the women presented high average values when compared to the men ($p < 0.05$), especially between the adiposity indicators WHtR, LAP, and VAI.

The AUC for the indicators and their respective CIs is presented in Table 2. It was verified that the WC, WHtR, and LAP indicators presented the highest AUC for the population, with values over 0.84. However, when the evaluation was based on gender, it was observed that the best indicators for men were WC, WHtR, and CI, while the LAP replaced the CI, maintaining WC and WHtR as the best areas for women.

The ROC areas under the curve for the adiposity indicators to predict MS in the elderly can be observed in Figure 1. Significant differences between the ROC curves in both genders were verified, showing that the ROC curve for VAI has the lowest percentage below the curve in relation to the other indicators ($p < 0.05$).

Analyzing the optimum cut-off points for the indicators, the Youden index and respective sensitivity, values and specificities (Table 3), found that the WHtR and LAP presented the highest Youden index values for the gen-

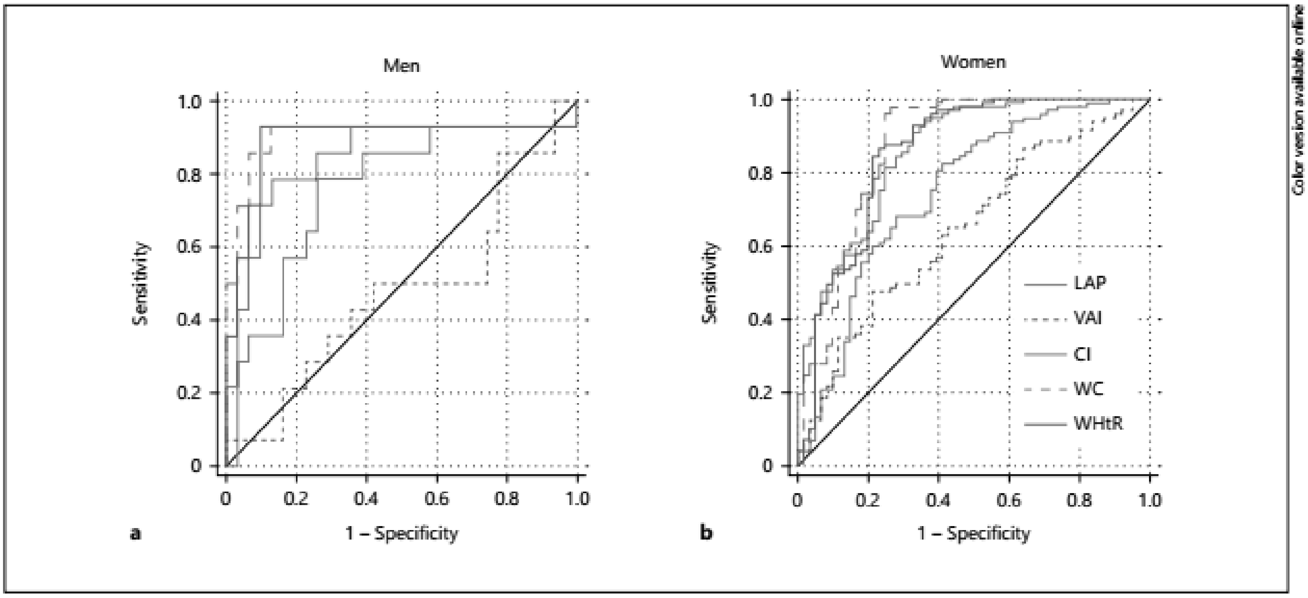

Fig. 1. Comparison of predictive performance of WC, WHtR, LAP, VAI, and CI for MS, based on gender. **a** Men; statistical difference between the area under the curve: LAP and WC ($p = 0.026$), LAP and VAI ($p < 0.001$), CI and VAI ($p < 0.001$), WC and VAI ($p < 0.001$), LAP and WHtR ($p = 0.040$), VAI and WHtR ($p < 0.001$). **b** Women; statistical difference between the area under the curve: LAP and CI ($p = 0.022$), CI and WC ($p = 0.002$), LAP and VAI ($p < 0.001$), WC and VAI ($p < 0.001$), CI and WHtR ($p = 0.008$), VAI and WHtR ($p < 0.001$).

Table 3. Cut-off points, Youden index, sensitivity, and specificity of indicators predicting MS for the population and by gender

Indicator	Optimal cut-off point	Youden index	Sensitivity	Specificity
WC				
Population	87.700	0.512	0.729	0.783
Men	90.900	0.799	0.928	0.871
Women	80.200	0.713	0.959	0.754
WHtR				
Population	0.546	0.660	0.856	0.804
Men	0.556	0.832	0.929	0.903
Women	0.546	0.632	0.845	0.787
LAP				
Population	32.289	0.562	0.811	0.750
Men	32.876	0.527	0.786	0.742
Women	32.289	0.568	0.814	0.754
VAI				
Population	2.261	0.238	0.586	0.652
Men	1.831	0.081	0.500	0.581
Women	2.172	0.223	0.649	0.574
CI				
Population	1.333	0.420	0.703	0.717
Men	1.394	0.657	0.786	0.871
Women	1.333	0.402	0.680	0.721

MS, metabolic syndrome; WC, waist circumference; WHtR, waist-to-height ratio; LAP, lipid accumulation product; VAI, visceral adiposity index; CI, conicity index.

eral population, identifying a point of approximately 0.55 (sens: 85.6% and spec; 80.4%) for WHtR and 32.3 (sens: 81.1% and spec: 75.0%) for LAP. When analyzed by gender, it was observed that the WC and WHtR presented the highest Youden index values to predict MS in both genders.

Discussion

The adiposity indicators, WHtR, WC, and LAP, had the greatest capacity to determine the presence of MS in the elderly in both genders, compared to VAI and CI. The performance of the CI was not as good as that of the LAP and the WHtR, while the VAI presented lower discriminatory power for MS. These results were expected since the CI has its application related to cardiovascular risk [14] and VAI [15, 16], with the cut-off points differing between the authors.

These results are important because the advantages of central adiposity indicators, such as WHtR and WC, are more sensitive and specific for predicting MS in the elderly. This study enabled the identification of specific cut-off points in the elderly, which are lower than those already standardized in literature [10]; therefore, these cut-off points were more efficient for predicting MS in the elderly.

The WC and WHtR presented a similar performance to distinguish MS, with higher Youden index values for both genders. When compared with traditional indicators, such as BMI and waist-hip ratio, other studies also found that the WC and WHtR had a better performance [3, 17–19]. Research by Liang et al. [19] and Guasch-Ferré et al. [20] presented a high discriminatory power for WC and WHtR to detect MS, considering the harmonized criterion of MS, as found in this study.

In relation to WC, it was noted that the best cut-off point to detect MS was 90.9 cm (sens: 92.8% and spec: 87.1%) for men and 80.2 cm (sens: 95.9% and spec: 75.4%) for women. These values are similar to those suggested by the International Diabetes Federation [1] and harmonized criterion of MS [4], noting that the WC classification following the characteristics by ethical group is the most suitable to specify identification of MS. In addition, it is highlighted that the harmonized criterion used to classify MS does not require the presence of a high WC for diagnosis, showing that individuals with MS in this study did not necessarily present an accumulation of body fat, indicating that the cut-off point for WC was not influenced by the presence of MS.

Liang et al. [19], in a study with women aged over 50, identified the cut-off point of 79.5 cm for WC (sens: 72.7%; spec: 76.7%), with efficiency greater than 70% and this finding was similar to the result obtained from our study. However, Zeng et al. [17] demonstrated the results by gender and age range, with cut-off points lower than those included in this study. This could be explained by the fact that the study was conducted with Chinese people, who have a higher percentage of body fat than Caucasians but a lower BMI and WC, consequently using lower cut-off points [21]. While Guasch-Ferré et al. [20] and Gharipour et al. [22] did not present their results stratified by gender, and therefore the results of their study indicate that they cannot be compared with the findings of this study.

For the WHtR, the optimum cut-off point was 0.56 for men (sens: 92.9% spec: 90.3%) and 0.55 for women (sens: 84.5% and spec: 78.7%), with efficiency greater than 81%. Chu et al. [18], in a study including elderly women, identified a similar cut-off point of 0.54. However, the cut-off point obtained for WHtR in this study was higher than the other research available in literature, such as the studies by Zeng et al. [17] and Liang et al. [19]. The discrepancies between the cut-off points could possibly be related to differences in ethnicity, age range, and gender for the elderly, since ethnic and genetic characteristics have an impact on body formation, as well as hormonal factors related to gender and aging, which increase body fat and decrease fat-free mass [23]. In addition, the WHtR is directly influenced by stature and this undergoes an alteration with the aging process in elderly people.

In relation to LAP, the cut-off point identified was approximately 32.3 (sens: 81.1% and spec: 75.0%) for the general population. The studies that evaluated the LAP as an MS predictor in the elderly identified cut-off points that varied between 31.6 and 51.8, with a difference between the genders [7, 16, 24–26]. Among these authors, Chiang and Koo [7] identified the cut-off point of 31.6 for men (sens: 88% and spec: 82%) and women (sens: 66% and spec: 93%) and Taverna et al. [25], where the LAP was >33.28 for the 61–70 age range for women and >31.7 for those aged between 71 and 77. These values resemble the cut-off point detected in this study. However, it should be highlighted that although it is the second indicator of the best result, the WC values and serum level of TGs are required to calculate LAP, both being part of the MS criteria, which may hinder rapid uptake of the indicator in clinical practice.

Considering the AUC and Youden index, the WHtR was the indicator that presented the best discriminatory power to identify MS for the whole sample. When analyzed by gender, WHtR stands out for men, while it is WC that stands out for women. The differences that were observed could be associated to specific accumulation of body fat, since men have an android pattern, with a central and intra-abdominal fat deposit (visceral), while women have a gynoid pattern, that is, an intramuscular fat deposit that can be justified by the alteration in oestrogen, which also influences the body fat distribution [18].

The WHtR presents the best discriminatory power because it considers the regional distribution of fat and has a better reflection of vascular anatomy and metabolic activity [27]. In addition, it reflects the relation between WC and stature, reducing the chance of under- or overestimating central obesity [6].

The use of indicators that are easily applicable can be adopted to predict MS. WHtR is one of these indicators, which is calculated by a simple division between stature and waist measurements. The WHtR has a direct regulation with stature and WC, being an advantage in relation to the other indicators [20], suggesting the superiority of WHtR in predicting MS. The use of simple indicators contributes to the early identification of a health risk, being more accessible and effective if the same indicator and health information were used for all populations.

The results of this study should be interpreted with caution, as there are some limitations. The data was collected from elderly people residing in a long-term care institution, and therefore, is not a probability sample. Although the sample power of the larger project is estimated to be 80%, this study included only half of the elderly evaluated; the reason for this was that there was a high number of frail elderly, with severe physical impairment or there were those who did not undergo the biochemical examination, which compromised the collection. In addition, the data was not analyzed based on age range for a better evaluation of indicator performance.

Prospective studies are required to corroborate this data and evaluate the need for a change in the cut-off points currently adopted for the elderly population. It is suggested that evaluation criteria by gender and age range is adopted, to evaluate the influence of body formation and specificities that occur between the genders to establish new criteria and guidelines for MS and cardiovascular risk. It is important to develop references for indicators predicting MS for the elderly, particularly anthropometric, adapting the cut-off points for this age group.

The WC and WHtR indicators can be used in screening to identify the presence of MS in the elderly, as it is a simple, cost-effective, and a non-invasive method. These findings reinforce the early and periodic use of adiposity indicators in the elderly, as they are accessible, reproducible, and reliable indices, with high sensitivity and specificity, with a low cost. This allows for a better clinical and nutritional evaluation among the elderly with effective intervention to prevent and treat risks related to MS.

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4.2 Artigo Original nº2 (Blood count parameters as marker for metabolic syndrome in older adults)

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Blood count parameters as a marker for metabolic syndrome in older adults

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ABSTRACT

Background and aim: Blood count parameters are associated with the metabolic syndrome (MS). However, few studies have evaluated the precision of blood count components to identify MS in older adults. We evaluated the accuracy of blood count components as a screening method and a marker of MS in older adults.
Methods and results: A cross-sectional study with 203 older adults of both sexes was conducted. The following variables were used: MS as defined by harmonized criteria, hemoglobin, hematocrit, leukocytes and platelets. Area under the receiver operating characteristic (ROC) curve, sensitivity (sens), specificity (spec) and logistic regression were adjusted for age and sex. Leukocyte count showed the highest Youden's index value for MS screening, with an optimal cut-off point of 7.514 10^3/mm^3 (sens: 66.7%; spec: 72.0%) for men and 5.626 10^3/mm^3 (sens: 73.1%; spec: 42.4%) for women. Older adults with leukocyte count higher than these cut-off points presented a 2.4 times greater chance of developing MS.
Conclusion: Leukocyte count can be used as a screening indicator to identify individuals with a higher risk of developing MS. Older adults with high leukocyte count and no associated chronic diseases should receive attention, as they are individuals with a potential risk for MS.

1. Introduction

The metabolic syndrome (MS), characterized by abdominal obesity, dyslipidemia, hyperglycemia and hypertension, is one of the greatest public health challenges around the world (Akbulut et al., 2011). MS is associated with chronic inflammation, in which inflammatory markers originate mainly from inflammation of visceral adipose tissue (Festa et al., 2000). In this context, the inflammation seems to perform a relevant role in developing insulin resistance, which is one of the main characteristics of MS (Festa et al., 2000; Guarner-Lans et al., 2011).

Early identification of MS is related to a representation of the estimate of cardiovascular risk. Inflammatory markers, such as C-reactive protein, adiponectin and leptin, can be used as screening parameters for MS (Oda, 2013; Oda and Kawai, 2010). However, blood tests measuring these markers are not frequently ordered, are little used for this purpose in clinical practice and are expensive.

Low-cost tests can be used for early identification of MS, including blood count. Studies have reported the association of blood count parameters with MS (Babio et al., 2013; Pei et al., 2015). Leukocyte count was one of the first inflammatory markers associated with MS (Hamerman et al., 1999; Odagiri et al., 2011). Other blood count components, such as hemoglobin and platelets, may also be associated with MS, possibly through the mechanism of a mild inflammatory state (Chen et al., 2015; Chuang et al., 2016). Thus, blood count parameters can be used to develop a screening model to identify MS.

Although these parameters are associated with MS, few studies have tested the precision of blood count parameters to identify MS in older adults. Therefore, the aim of this study was to evaluate the accuracy of blood count components as a screening method and a marker of MS in older adults.

2. Methods

2.1. Sample and study design

A cross-sectional study was conducted with older adults of both sexes who lived in long-term care institutions in the city of Salvador, Brazil. The number of older adults was proportional to the total older population living in each health district, thus ensuring a statistical power of 80% to represent the institutionalized older population of the city. This study was approved by the Research Ethics Committee of the

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The following patients were excluded: with physical and postural problems that compromised anthropometric measurements; with neural sequelae and dystrophy; who underwent recent abdominal surgery; and with abdominal lesions and tumors, hepatomegaly and/or splenomegaly and ascites.

Study participants underwent an anthropometric assessment (weight, height and waist circumference), laboratory tests (lipid profile, blood glucose and blood count) and blood pressure measurement in the course of a week to avoid changes in the individual's body composition and/or metabolic profile. Systolic and diastolic blood pressure (SBP and DBP) measurement was consistent with a technique recommended by the VI Brazilian Hypertension Guidelines (Nobre et al., 2010).

2.2. Laboratory evaluation

Blood samples were collected by venipuncture after a 12-hour overnight fast. Lipid profile and blood glucose levels were quantified in serum through a dry colorimetric method, using a kit manufactured by Ortho-Clinical Diagnostics®. The following lipid profile parameters were measured: total cholesterol (TC), high-density lipoprotein (HDL), low-density lipoprotein (LDL) and triglycerides (TG). Blood count analysis based on an impedance method was performed using a CELL-DYN Ruby hematology analyzer (Abbott Laboratories®, Illinois, United States).

2.3. Anthropometric evaluation

Anthropometric measurements were performed by a duly trained and previously standardized team. Weight, height and waist circumference were measured according to the techniques proposed by Lohman et al. (1991) and the World Health Organization (WHO Consultation on Obesity, 2000).

2.4. Diagnosis of MS

The diagnosis of MS was established according to MS harmonized criteria (Alberti et al., 2009), and individuals should present at least three of four criteria: waist circumference ≥ 80 cm for women and ≥90 cm for men; dyslipidemia (HDL ≤ 40 for men and ≤50 for women or specific treatment, or TG ≥ 150 mg/dL or specific treatment); SBP ≥ 130 mm Hg or DBP ≥ 85 mm Hg or specific treatment; and blood glucose ≥ 100 mg/dL or specific treatment.

2.5. Statistical analysis

Statistical analysis was performed using the software Stata, version 12. p value < 0.05 was considered significant. Data were expressed as measures of central tendency and dispersion. The normality of data distribution was assessed using the Kolmogorov-Smirnov test, and the homogeneity of variance was assessed using the Levene's test.

To compare two means, the Student's *t*-test was used for independent samples with normal and homogeneous data, and the Mann-Whitney test was used to variables with non-normal distribution. To test the correlation of two quantitative variables with normal distribution, the Pearson's correlation coefficient was used. When one of the variables did not have a normal distribution, the Spearman's correlation coefficient was used.

An area under the receiver operating characteristic (ROC) curve was estimated for each blood count parameter according to sex. The difference between areas under the ROC curve for these indicators was measured using the Wald test. The Youden's index was calculated, and optimal cut-off points were determined for each blood count parameter according to sex.

Logistic regression models adjusted for age and sex were used to evaluate blood count parameters associated with the presence of MS. Variables with p < 0.20 were included in a multiple model through forward stepwise logistic regression, as well as adjustment variables established in the literature. Independent variables were maintained in the multiple model if statistically significant (p < 0.05) and/or adjusted to the model. Adjustments in the logistic regression models were evaluated using the Hosmer-Lemeshow test.

3. Results

Of the 203 older adults evaluated in the study, 77.8% were women and mean age was 80.2 ± 9 years. Women showed higher mean levels for body mass index (BMI), TC, LDL, HDL and TG (p < 0.05), while men showed higher mean hemoglobin levels (p = 0.008). Other variables did not present statistically significant differences between sexes (Table 1).

Table 2 shows that leukocyte count had a positive correlation with blood glucose and TG (p < 0.05) and a negative correlation with DBP (p = 0.017). Platelet count was correlated with TG ($r = 0.238$; p = 0.001), while hemoglobin and hematocrit levels showed a positive correlation with DBP (p < 0.05).

An analysis of the area under the ROC curve for the indicators and their respective confidence intervals (Table 3) showed better results in leukocyte count for men (AUC: 0.690) and in platelet count for women (AUC: 0.591). However, leukocyte count had a higher Youden's index value for MS screening in both sexes, with an optimal cut-off point of 7.514 $10^3/mm^3$ (sensitivity, sens: 66.7%; specificity, spec: 72.0%) for men and 5.626 $10^3/mm^3$ (sens: 73.1%; spec: 42.4%) for women.

Logistic regression models, with the presence of MS as a dependent variable and with blood count parameters categorized according to the cut-off points obtained through the Youden's index adjusted for age and sex as an independent variable, are shown in Table 4. Older adults with leukocyte count higher than 7.514 $10^3/mm^3$ for men and higher than 5.626 $10^3/mm^3$ for women had a 2.4 times greater chance of developing MS, regardless of sex and age. Other blood count parameters were not associated with the presence of MS.

4. Discussion

Leukocyte count and platelet count were respectively the blood count parameters that showed greatest capacity to discriminate the presence of MS in older adults of both sexes. Furthermore, leukocyte

Table 1
Descriptive analysis of biochemical and anthropometric variables, blood pressure and blood count parameters, according to sex in older adults.

Variables	Men (n = 45)	Women (n = 158)	p
	Mean (SD)	Mean (SD)	
BMI (kg/m^2)	21.82 (2.90)	23.64 (5.46)	<0.037[b]
WC (cm)	87.74 (10.74)	87.16 (13.30)	0.806[b]
Blood glucose (mg/dL)	93.05 (40.06)	91.89 (31.30)	0.081[b]
TC (mg/dL)	182.69 (29.45)	209.90 (48.00)	<0.001[b]
LDL (mg/dL)	120.26 (26.39)	134.79 (43.43)	0.036[b]
HDL (mg/dL)	39.02 (8.62)	47.44 (12.21)	<0.001[b]
TG (mg/dL)	117.02 (44.55)	137.34 (60.92)	0.035[b]
SBP (mm Hg)	128.82 (19.83)	132.78 (18.34)	0.333[a]
DBP (mm Hg)	76.60 (10.18)	75.00 (10.88)	0.466[b]
Hemoglobin (g/dL)	13.02 (1.49)	12.33 (1.39)	0.008[b]
Hematocrit (g/dL)	39.42 (4.39)	38.00 (4.33)	0.076[a]
Leukocytes ($10^3/mm^3$)	7.16 (2.37)	6.63 (3.05)	0.127[b]
Platelets ($10^3/mm^3$)	205.49 (46,68)	212.17 (56.83)	0.508[b]

SD: standard deviation; BMI: body mass index; WC: waist circumference; TC: total cholesterol; LDL: low-density lipoprotein; HDL: high-density lipoprotein; TG: triglycerides; SBP: systolic blood pressure; DBP: diastolic blood pressure.
[a] Student's *t*-test.
[b] Mann-Whitney test.

Table 2
Correlation of blood count parameters with metabolic syndrome components in older adults.

MS Components	Hemoglobin		Hematocrit		Leukocytes		Platelets	
	r	p	r	p	r	p	r	p
Blood glucose	0.103[a]	0.168	0.086[a]	0.250	0.153[a]	0.039	0.099[a]	0.185
HDL	0.101[b]	0.165	0.124[b]	0.088	−0.036[a]	0.618	−0.089[b]	0.219
TG	0.084[a]	0.250	0.086[a]	0.238	0.167[a]	0.022	0.238[a]	0.001
WC	0.133[b]	0.068	0.113[b]	0.122	0.077[a]	0.289	0.028[b]	0.704
SBP	0.096[b]	0.267	0.062[b]	0.471	−0.028[a]	0.746	0.028[b]	0.743
DBP	0.227[a]	0.008	0.236[a]	0.006	−0.206[a]	0.017	0.019[a]	0.827
Number of components	0.019[a]	0.788	0.023[a]	0.755	0.083[a]	0.258	0.102[a]	0.162

HDL: high-density lipoprotein; TG: triglycerides; WC: waist circumference; SBP: systolic blood pressure; DBP: diastolic blood pressure; r: correlation coefficient.
[a] Spearman's correlation.
[b] Pearson's correlation.

count correlated with blood glucose, TG and DBP; platelet count correlated with TG; and hemoglobin and hematocrit levels correlated with DBP.

Liu et al. (2014) analyzed the relation between blood count parameters and MS in older adults. Blood count parameters were associated with MS components, with better results for the association of leukocyte count with SBP and TG. Similar results were described in a study by Pei et al. (2015), in which leukocyte count positively correlated with SBP and TG, but negatively correlated with HDL among men.

Li et al. (2016) observed a correlation between leukocyte count and most MS components among men, except for those aged over 85 years. However, this was less significant among women, especially those aged between 75 and 85 years. Other studies have reported the association of leukocytes (Babio et al., 2013; Chuang et al., 2016) and platelets with MS components (Babio et al., 2013; Chen et al., 2015; Chuang et al., 2016; Li et al., 2016). The evaluation of leukocyte count is related to a subclinical inflammation, that is, there is no need to find changes in its values to observe long-term effects. In addition, the association of leukocyte count with cardiovascular risk is known, which could be explained by the effects of pro-inflammatory cytokines that are released by activated macrophages, contributing to vascular damage, endothelial dysfunction and progression of atherosclerotic disease (Li et al., 2016).

Leukocyte count and platelet count presented the largest areas under the ROC curve for both men and women. However, leukocyte count was the best parameter to discriminate SM, with the highest Youden's indices for both sexes, identifying an optimal cut-off point of approximately 7.5 $10^3/mm^3$ for men and 5.6 $10^3/mm^3$ for women. Similarly, Pei et al. (2015) identified an optimal cut-off point of 5.6 $10^3/\mu L$ for men (AUC = 0.599; $p < 0.001$) and 5.8 $10^3/\mu L$ for women (AUC = 0.606; $p < 0.001$). In a study using harmonized criteria to define MS, Chao et al. (2014) found cut-off points of 5.7 $10^3/\mu L$ for men and 5.0 $10^3/\mu L$ for women. These values are lower than those detected in our study.

Table 3
Area under the ROC curve by sex for blood count parameters associated with the metabolic syndrome in older adults.

	Hemoglobin (g/dL)	Hematocrit (g/dL)	Leukocytes ($10^3/mm^3$)	Platelets ($10^3/mm^3$)
Men				
AUC	0.492	0.470	0.690	0.438
95% CI	0.28–0.70	0.27–0.68	0.49–0.86	0.23–0.68
Optimal cut-off point	13.400	40.500	7.514	235.000
Youden's index	0.227	0.183	0.387	0.090
Sensitivity	0.667	0.583	0.667	0.250
Specificity	0.560	0.600	0.720	0.840
Women				
AUC	0.559	0.547	0.536	0.591
95% CI	0.46–0.65	0.44–0.64	0.44–0.63	0.49–0.68
Optimal cut-off point	11.900	36.000	5.626	201.000
Youden's index	0.150	0.129	0.155	0.134
Sensitivity	0.709	0.688	0.731	0.840
Specificity	0.441	0.441	0.424	0.542

AUC: area under the ROC curve; 95% CI: 95% confidence interval.
There was no statistically significant difference between the curves.

These cut-off points for leukocyte count allow a distinction between individuals with high and low risk of developing MS. Older adults with leukocyte count higher than the cut-off point were at twice the risk of developing MS. A possible explanation for the relationship between leukocyte count and MS components is related to cytokine production, which is involved in the pathogenesis of insulin resistance and atherogenic dyslipidemia, the main underlying MS alterations (Odagiri et al., 2011). Therefore, the cut-off points for leukocyte count could be used to warn about the potential risk of developing MS.

Women showed discrete results in platelet count, as observed in other studies (Chen et al., 2015; Liu et al., 2014). Chen et al. (2015) found an area under the ROC curve significantly higher only among women, so that those with platelet levels higher than 223 $10^3/\mu L$ showed a greater chance of developing MS. More recent studies have used models with blood count components as a simple, low-cost method that is able to predict the development of MS in older adults. Liu et al. (2014) and Fu et al. (2015) concluded that a model with platelets, hemoglobin and leukocytes obtained a greater area under the ROC curve than those with isolated blood count components ($p < 0.05$).

The use of blood count components, particularly leukocyte count, can be a simple and low-cost alternative to predict the development of MS in older adults. In addition, it is more practical and convenient for daily clinical practice and epidemiological studies, facilitating the start of early treatment. This parameter can be used in association with nutritional indicators found in the literature (de Oliveira et al., 2017; Gharipour et al., 2014).

Although leukocyte count was a good screening indicator for MS, the previous presence of potentially inflammatory diseases among the participants was not assessed. Moreover, older adults with chronic diseases or in continuous use of medication were not excluded, which could have been used to minimize a possible bias in the analysis. However, although blood count parameters are not the gold standard to diagnose MS, the convenience and low cost of this test favors its early identification.

Prospective studies are required to corroborate these data and to evaluate the need to change assessment criteria for cardiometabolic risk currently adopted for the older population. An analysis based on sex and age range should be adopted to assess specific characteristics related to these two factors in order to establish new criteria and guidelines for MS and cardiovascular risk.

Leukocyte count can be used as a screening indicator to identify individuals with a higher risk of developing MS. In the present study, it also correlated with MS components, such as TG, blood glucose and DBP. Therefore, older adults with high leukocyte count and without any associated chronic diseases should receive attention, as they are individuals with a potential risk of developing MS.

Table 4
Logistic regression analysis of blood count parameters associated with the presence of metabolic syndrome, categorized according to the optimal cut-off point in older adults.

Blood count parameters	β constant (95% CI)	β age (95% CI)	β sex (95% CI)	β blood count parameters (95% CI)	OR (95% CI)	p
Hemoglobin	0.666	−0.023	1.290	0.595	1.813	0.057
(ref. men > 13.4 and women > 11.9)	(−2.11–3.44)	(−0.06–0.01)	(0.46–2.12)	(−0.02–1.21)	(0.98–3.35)	
Hematocrit	0.677	−0.023	1.279	0.584	1.792	0.061
(ref. men > 40.5 and women > 36.7)	(−2.09–3.45)	(−0.06–0.01)	(0.45–0.11)	(−0.03–1.19)	(0.97–3.30)	
Leukocytes	0.689	−0.024	1.183	0.878	2.407	0.006
(ref. men > 7.514 and women > 5.626)	(−2.12–3.49)	(−0.06–0.01)	(0.34–2.02)	(0.25–1.50)	(1.29–4.49)	
Platelets	0.805	−0.022	1.185	0.527	1.695	0.093
(ref. men > 235 and women > 201)	(−1.95–3.56)	(−0.06–0.01)	(0.34–2.03)	(−0.09–1.14)	(0.91–3.14)	

Models with metabolic syndrome variables as dependent and blood count variables as independent, adjusted for sex and age.
OR: odds ratio; 95% CI: 95% confidence interval; ref.: reference category.

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Author contributions

Oliveira: data collection, analysis and interpretation of data, manuscript preparation. **Roriz**: study design, study conduct, data collection, data interpretation, manuscript preparation. **Ramos**: study design, study conduct, data collection, manuscript preparation. **Gomes Neto**: data interpretation, manuscript preparation. All authors critically reviewed and approved the final version of the manuscript.

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5 CONCLUSÕES

Com base nos resultados encontrados neste estudo pode-se concluir que:

- Os indicadores de adiposidade RCEst e CC, assim como o LAP, tiveram a maior capacidade de discriminar a presença de SM em idosos, em ambos os sexos;
- A contagem de leucócitos foi um bom indicador de triagem para identificar indivíduos com maior risco para desenvolvimento de SM e apresentaram relação com componentes da SM, tais como TG, glicemia e PAD;
- Há poucos estudos que avaliam indicadores clínicos e nutricionais na predição de SM em idosos, sobretudo aqueles que analisam o LAP e o IAV;
- Os indicadores Índice C e IAV apresentaram os menores poder discriminatório para SM, especialmente o IAV.

6 CONSIDERAÇÕES FINAIS

A identificação precoce do desenvolvimento de SM é imprescindível no envelhecimento, com o intuito de minimizar e/ou reduzir as consequências do diagnóstico tardio da SM. Nesse contexto, sugere-se a utilização de indicadores clínicos e nutricionais como métodos alternativos na predição do risco de desenvolver SM em idosos por serem práticos, acessíveis e de boa aplicabilidade, portanto, indicado a aplicação destes na prática clínica.

Constatou-se que a RCEst, a CC e o LAP apresentaram melhor capacidade de discriminar a presença de SM. A contagem de leucócitos apresentou resultados satisfatórios enquanto indicador de triagem para identificar indivíduos com maior risco para o desenvolvimento de SM e apresentou correlação com seus componentes, tais como TG, glicemia e PAD.

Este estudo pretendeu identificar indicadores de triagem custo-efetiva, auxiliando na redução de custos pelo sistema de saúde no tratamento da SM, uma vez que ainda são frágeis os parâmetros e critérios diagnósticos para os idosos. No entanto, é sabido que novos estudos necessitam ser realizados para que esses resultados possam ser generalizados, sobretudo na análise comparativa por sexo e diferentes faixas etárias, especialmente entre os idosos jovens e aqueles longevos.

O profissional de saúde poderá utilizar esses indicadores na rotina de prática clínica com a finalidade de identificar de forma precoce, o risco de desenvolvimento da SM, uma vez que pode facilitar a equipe de saúde a optar por uma estratégia destinada a reduzir o risco cardiovascular global.

7 PERSPECTIVAS DE ESTUDO

Na qualidade de membro do grupo de pesquisa Centro de Estudo e Intervenção na Área do Envelhecimento (CEIAE) da Escola de Nutrição da Universidade Federal da Bahia, pretendo manter a parceria com o grupo de pesquisa e dar continuidade às investigações que envolver o envelhecimento, risco cardiovascular e parâmetros nutricionais.

- Associação entre aspecto cognitivo, risco cardiovascular e síndrome metabólica em idosos.
- Avaliar o desempenho das razões lipídicas na identificação da síndrome metabólica.
- Relação entre obesidade sarcopênica e síndrome metabólica em idosos.
- Avaliar o estilo de vida e influência da dieta na síndrome metabólica em idosos
- Verificar a relação de citocinas pró-inflamatórias com o perfil inflamatório e níveis de leucócitos associados a síndrome metabólica em idosos.

ANEXOS

Anexo A – Parecer do Comitê de Ética

UNIVERSIDADE FEDERAL DA BAHIA
ESCOLA DE NUTRIÇÃO
COMITÊ DE ÉTICA EM PESQUISA - CEPNUT
Rua Araújo Pinho, 32, Canela
40.110-150 Salvador, Bahia, Brasil
Tel: (71) 3283-7704. Fax: (71) 3283-7705

Formulário de Aprovação do Comitê de Ética em Pesquisa

Projeto de Pesquisa: "Avaliação Multidimencional de idosos residentes em instituições de longa permanência na cidade de Salvador-BA".

Pesquisador: Lílian Ramos Sampaio
Área Temática: Grupo III
Parecer: 11/12

Os Membros do Comitê de Ética em Pesquisa, da Escola de Nutrição da Universidade Federal da Bahia, reunidos em sessão ordinária no dia 28 de maio de 2012, resolveram pela aprovação do projeto. O pesquisador deverá seguir as orientações do parecer consubstanciado, bem como comunicar ao CEP a respeito do andamento da pesquisa através de relatórios anuais, conforme disposto na resolução Nº 196 de 10 de outubro de 1996, do Conselho Nacional de Saúde.

Situação: APROVADO

Salvador, 24 de setembro de 2012.

Prof. Vilson Caetano de Souza Junior
Coordenador do Comitê de Ética em Pesquisa
Escola de Nutrição
Universidade Federal da Bahia

Anexo B – Termo de Consentimento Livre e Esclarecido

UNIVERSIDADE FEDERAL DA BAHIA
ESCOLA DE NUTRIÇÃO

PROJETO DE PESQUISA: AVALIAÇÃO MULTIDIMENSIONAL DOS IDOSOS RESIDENTES EM INSTITUIÇÕES DE LONGA PERMANÊNCIA NA CIDADE DE SALVADOR-BA.

TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO

Eu, ...,fui informado(a) sobre o objetivo da pesquisa, sob a coordenação da professora Drª Lílian Ramos Sampaio, com o titulo acima citado. O objetivo principal desta pesquisa é o de avaliar como está a minha saúde, estilo de vida e alimentação e isto será verificado por diferentes equipes de profissionais de saúde. Foi colocada a importância deste estudo uma vez que pretende avaliar as condições de vida, saúde e nutrição dos moradores de casa de longa permanência na cidade de Salvador- BA. Foi explicado que, para a realização das medidas antropométricas, eu terei que vestir roupas finas e leves e que uma das equipes irá acompanhar toda a minha alimentação. A pesquisadora deixou claro que caso eu desista de participar em qualquer fase da pesquisa, não terei prejuízo e que, caso eu necessite de algum tratamento, serei encaminhado(a) para acompanhamento.

Segundo as informações prestadas, a pesquisa consta de levantamento de meus dados pessoais, demográficos, avaliação clínica, antropométrica (peso, circunferências da cintura e panturrilha, comprimento da perna, pregas cutâneas tricipital, subescapular, bicipital e suprailíaca e o diâmetro do abdômen), bioquímica, no qual ficarei em jejum de 12 horas para realização da coleta de sangue (Glicemia, Colesterol total e frações, Triglicerídeos, Creatinina sérica, Hemoglobina, Hematócrito, Vitamina B12 e Ferritina), avaliação da alimentação, do nível de dependência e da atividade física. Foi garantido que receberei os resultados de todos os exames realizados durante a pesquisa para acompanhamento e/ou tratamento, além de receber assistência médica e nutricional prestada por um dos ambulatórios de Nutrição do anexo Profº José Francisco Magalhães Netto do HUPES/UFBA. Foi dito também que a pesquisa não acarretará danos, prejuízos, desconfortos ou lesões que possam por em risco a minha integridade física e psíquica e que todas as informações sobre a minha pessoa serão mantidas em sigilo, e não poderei ser identificado como participante da pesquisa. Também fiquei ciente de que caso tenha alguma reclamação a fazer deverei procurar a professora Lilian Ramos

Sampaio ou o Comitê de Ética em Pesquisa da Escola de Nutrição da UFBA (Rua Araújo Pinho, 32, Canela CEP: 40.110-150 Salvador, Bahia, Brasil Tel: 71-3283-7700/7704. Fax: 71-3283-7705) Assim, considero-me satisfeito(a) com as explicações da pesquisadora e concordo em participar como voluntário(a) deste estudo.

COMO TENHO DIFICULDADE PARA LER (SIM........ NÃO ....), O ESCRITO ACIMA. ATESTO TAMBÉM QUE A(O) ________________________________ (OU UM MEMBRO DA SUA EQUIPE) LEU PAUSADAMENTE ESSE DOCUMENTO E ESCLARECEU AS MINHAS DÚVIDAS, E COMO TEM A MINHA CONCORDÂNCIA PARA PARTICIPAR DO ESTUDO, COLOQUEI ABAIXO A MINHA ASSINATURA (OU IMPRESSÃO DIGITAL).

SALVADOR , _______ DE ____________________DE 2011

PESQUISADO:

NOME...

ASSINATURA: ....

IMPRESSÃO DATILOSCÓPICA (Quando se aplicar)

TESTEMUNHAS:

1. NOME:...

ASSINATURA: ....

2. NOME:...

ASSINATURA: ....

....

ASSINATURA PESQUISADOR

* DOCUMENTO EM DUAS VIAS, UMA PARA SER ENTREGUE AO PESQUISADO.

APÊNDICES

Apêndice A – Certificados e comprovantes de produções científicas

Certificado

Certificamos que o trabalho

PRODUTO DA ACUMULAÇÃO LIPÍDICA COMO PREDITOR DE SÍNDROME METABÓLICA EM IDOSOS

dos autores: CAROLINA CUNHA DE OLIVEIRA; MANSUETO GOMES NETO; ANNA KARLA CARNEIRO RORIZ; LILIAN BARBOSA RAMOS, foi apresentado, na modalidade Pôster, no evento II Congresso Brasileiro de Nutrição e Envelhecimento ocorrido de 08 a 10 de outubro de 2015 no Centro de Eventos do Hotel Plaza São Rafael em Porto Alegre/RS.

Porto Alegre, 10 de outubro de 2015

CBNE 2015
II Congresso Brasileiro de Nutrição e Envelhecimento
08 A 10 DE OUTUBRO 2015
CENTRO DE CONVENÇÕES DO HOTEL PLAZA SÃO RAFAEL
PORTO ALEGRE | RS

Drª Myriam Spínola Najas
Presidente Executiva do II Congresso Brasileiro de Nutrição e Envelhecimento
Diretora Científica da Nutrição

Dr. João Senger
Presidente Executivo do II Congresso Brasileiro de Nutrição e Envelhecimento
Diretor Científico área médica

Apoio: SBGG Sociedade Brasileira de Geriatria e Gerontologia – Rio Grande do Sul; AGAN Associação Gaúcha de Nutrição

Organização: CCM Worldwide Medical Congresses

CONBRAN2016
XXIV CONGRESSO BRASILEIRO DE NUTRIÇÃO
IV SIMPÓSIO IBERO-AMERICANO DE NUTRIÇÃO ESPORTIVA
III SIMPÓSIO IBERO-AMERICANO DE NUTRIÇÃO EM PRODUÇÃO DE REFEIÇÕES
III SIMPÓSIO IBERO-AMERICANO DE NUTRIÇÃO CLÍNICA
26 a 29 de outubro | FIERGS | Porto Alegre | RS

Certificado

Certificamos que o trabalho intitulado **"PREDITORES DE SÍNDROME METABÓLICA EM IDOSOS: UMA REVISÃO"**, de autoria de CAROLINA CUNHA DE OLIVEIRA, EMANUELLE DIAS DA COSTA, ANNA KARLA CARNEIRO RORIZ, LILIAN BARBOSA RAMOS, MANSUETO GOMES NETO, foi apresentado na forma de pôster durante o **CONBRAN 2016 -** XXIV CONGRESSO BRASILEIRO DE NUTRIÇÃO, IV SIMPÓSIO IBERO-AMERICANO DE NUTRIÇÃO ESPORTIVA, III SIMPÓSIO IBERO-AMERICANO DE NUTRIÇÃO EM PRODUÇÃO DE REFEIÇÕES e III SIMPÓSIO IBERO-AMERICANO DE NUTRIÇÃO CLÍNICA, realizados no período 26 a 29 de outubro de 2016, no Centro de Eventos - FIERGS, Porto Alegre - Rio Grande do Sul.

Porto Alegre, 29 de outubro de 2016.

Maria Terezinha Antunes
Presidente da Comissão Científica do CONBRAN 2016

Luciana Zuolo Coppini
Presidente do CONBRAN 2016

REALIZAÇÃO

AGAN

XVII
CONGRESSO
BRASILEIRO
DE OBESIDADE
E SÍNDROME
METABÓLICA

20 A 22
ABRIL DE 2017

CENTRO DE CONVENÇÕES DE
PERNAMBUCO - RECIFE / OLINDA

REALIZAÇÃO

ABESO

CERTIFICADO

CERTIFICAMOS QUE

CAROLINA CUNHA DE OLIVEIRA, ANNA KARLA CARNEIRO RORIZ LOPES DE SOUZA, LILIAN BARBOSA RAMOS, MANSUETO GOMES NETO

Participaram do **XVII Congresso Brasileiro de Obesidade e Síndrome Metabólica**, realizado no período de 20 a 22 de abril de 2017, no Centro de Convenções de Pernambuco, **Autores** do Pôster: **PARÂMETROS DO HEMOGRAMA COMO MARCADOR DE SÍNDROME METABÓLICA EM IDOSOS**.

Recife, 22 de abril de 2017.

P175

Fabio Moura
Presidente do Congresso

Francisco Bandeira
Presidente da Comissão Científica

Maria Edna Melo
Presidente da ABESO
Biênio 2017-2018

Código: 41438 **Temário:** Nutrição do Idoso

Número do Painel: 168 **Modalidade Aprovada:** Pôster

Título: PRODUTO DA ACUMULAÇÃO LIPÍDICA COMO PREDITOR DE SÍNDROME METABÓLICA EM IDOSOS

Instituição: UNIVERSIDADE FEDERAL DE SERGIPE

Autores: Carolina Cunha de Oliveira; Mansueto Gomes Neto; Anna Karla Carneiro Roriz; Lilian Barbosa Ramos;

Resumo: Justificativa: Indicadores de adiposidade corporal tem sido utilizados como preditores de Síndrome Metabólica (SM). Como indicador substituto da Cintura Hipertrigliceridêmica, o Produto da Acumulação Lipídica (Lipid Accumulation Product - LAP) tem sido sugerido como indicador clínico de SM, embora poucos estudos tenham avaliado seu desempenho entre os grupos etários, especialmente entre os idosos. Objetivo: Avaliar o desempenho do LAP como preditor de SM em idosos. Métodos: Foram avaliados 203 idosos institucionalizados, de ambos os sexos, na cidade de Salvador-BA. Avaliações clínica, antropométrica e bioquímicas foram realizadas. Para o diagnóstico da SM, utilizou-se os critérios sugeridos pela IDF (2005). O LAP foi calculado seguindo as recomendações sugeridas por Kahn (2005), conforme o sexo, considerando as variáveis: circunferência da cintura (CC) e concentração sérica de triglicerídeos. Análise descritiva, frequência simples e Curva ROC foram realizados. Resultados: A prevalência de SM foi de 57,6%, sendo superior entre as mulheres (64,6%) ($p<0,001$). O sexo feminino apresentou maior mediana do LAP ($p=0,001$) quando comparado ao sexo masculino. Os indivíduos com SM apresentaram maiores valores descritivos (média e mediana) dos indicadores de adiposidade (IMC, CC e LAP), para ambos os sexos. A CC e LAP foram os melhores indicadores preditores de SM em idosos. Para o sexo masculino, o LAP apresentou uma área sob a curva ROC de 0,86 (IC 95%: 0,75-0,97). Para o sexo feminino, o LAP apresentou precisão semelhante à CC na predição da SM, com uma área sob a curva ROC de 0,92 (IC 95%: 0,87-0,96). Conclusões: O Produto da Acumulação Lipídica foi um indicador simples e preciso na predição da SM em idosos, especialmente entre as mulheres, embora a CC continue sendo o melhor indicador de adiposidade.

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PREDITORES DE SÍNDROME METABÓLICA EM IDOSOS: UMA REVISÃO

CAROLINA CUNHA DE OLIVEIRA; EMANUELLE DIAS DA COSTA; ANNA KARLA CARNEIRO RORIZ; LILIAN BARBOSA RAMOS; MANSUETO GOMES NETO

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Introdução

A síndrome metabólica é conceituada como um conjunto de fatores de risco, os quais aumentam o risco de doenças cardiovasculares e diabetes. O uso de indicadores clínicos e antropométricos podem ajudar a identificar a presença de síndrome metabólica, uma vez que são simples, rápidos e funcionais para utilização na prática clínica. No entanto, não há consenso sobre o melhor indicador capaz de identificar a síndrome metabólica em idosos, isso porque são indicadores com diferentes características funcionais, com variados pontos de corte, muitos deles específicos para adultos jovens, e com distindos critérios de definição da síndrome.

Objetivos

Analisar criticamente estudos que avaliaram a habilidade dos indicadores antropométricos e clínicos enquanto capazes de predizer a SM em idosos.

Metodologia

A pesquisa bibliográfica foi realizada nas bases de dados Medline/PubMed, LILACS e SciELO, referências de artigos selecionados e contato com autores. Os indicadores antropométricos avaliados foram o índice de massa corporal, a circunferência da cintura, as razões cintura-quadril e cintura-estatura, o diâmetro abdominal sagital e a circunferência do pescoço. Para os indicadores clínicos, foram citados o produto da acumulação lipídica, o índice de adiposidade visceral e as razões lipídicas.

Resultados

Foram analisados 20 artigos envolvendo indicadores antropométricos e clínicos em idosos, através de diferentes critérios da SM. Catorze estudos reportam aos indicadores antropométricos, sendo a circunferência da cintura e a razão cintura-estatura descritos como os melhores preditores de síndrome metabólica em idosos, com área sob a curva ROC superior a 0,70. A circunferência do pescoço também foi descrita como indicador alternativo, porém com menor poder discriminatório. Para os indicadores clínicos, o produto da acumulação lipídica foi o parâmetro com melhor desempenho em identificar a síndrome metabólica em idosos, com área sob a curva ROC superior 0,85. O índice de adiposidade visceral e razões lipídicas foram os indicadores de menor desempenho assim como a razão cintura-quadril entre os indicadores antropométricos.

Conclusão

Os indicadores circunferência da cintura, razão cintura estatura e produto da acumulação lipídica foram os mais sensíveis na predicação da síndrome metabólica. Desta forma, o emprego desses parâmetros pode facilitar a identificação precoce da síndrome metabólica através de métodos diagnósticos de fácil aplicação, boa precisão e baixo custo. Além disso, é importante a determinação de pontos de corte específicos para idosos, uma ver que a obesidade parece não ser forte preditor de síndrome metabólica em idosos.

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Palavras-chave: Indicadores; Antropometria; Preditores; Síndrome Metabólica; Idosos

Apêndice B – Outras produções científicas não vinculados ao tema do doutorado

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