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Artículo Científico

Evaluation of anthropometric indices as metabolic syndrome predictors in Ecuadorian Military Personnel

Evaluación de índices antropométricos como predictores de síndrome metabólico en personal militar ecuatoriano

Germán Muñoz[1], Alberth Muñoz[2*].

[1] Ecuadorian Armed Forces, ESFORSE Physician, Army Polytechnic Superior School (ESPE).

[2] Peoples' Friendship University of Russia, Division of Nervous Diseases and Neurosurgery, Moscow.

* albmu93@gmail.com

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ABSTRACT.- Anthropometric measurements are simple and effective techniques for central or abdominal obesity evaluation. Although it is known by their good predicting value, there is not a consensus about which is the best in Metabolic Syndrome (MetSyn) diagnostic, using Adult Treatment Panel III (ATP III) criteria. Anthropometric measurements included waist circumference (WC), waist hip ratio (WHR), waist height ratio (WHtR) and body mass index (BMI). This study pretended to determine the prevalence of MetSyn and compare anthropometric indices for optimal predicting value with their respective cut-offs for MetSyn diagnosis among Army Members in ESFORSE, Ecuador. The study includes 181 participants (175 male and 6 female), the average age is 37 ± 6 years, MetSyn prevalence is 8%, with WC (p <.001), WHtR (p .009) and WHR (p .020) as statistically significant variables. We analyzed the area under the curve (AUC) in a Receiver Operating Characteristic (ROC) curve, with the anthropometric measurements. Thus, WC and WHtR represent the highest AUC (WC: 0.77, 95% CI 0.69-0.86; WHtR: 0.70, 95% CI 0.59-0.82). The optimal cut-off values for predicting MetSyn are 92 cm in WC, 0.52 in WHtR and 0.93 in WHR. Therefore, the army members have a low prevalence of MetSyn, with WC as the best predicting value.

Keywords: cardiovascular risk, anthropometry, dyslipidemia, ROC curve, metabolic syndrome.

RESUMEN.- Las mediciones antropométricas son técnicas simples y efectivas para la evaluación de la obesidad central o abdominal. Aunque se conoce que tienen un buen valor predictivo, no existe un consenso sobre cuáles son mejores en el diagnóstico de Síndrome Metabólico (MetSyn), utilizando los criterios del Panel de Tratamiento de Adultos III (ATP III). Las medidas antropométricas incluyen la circunferencia de la cintura (WC), el índice cintura-cadera (WHR), el índice de la altura de la cintura (WHtR) y el índice de masa corporal (IMC). En este estudio se evaluó la prevalencia de MetSyn y se comparó con índices antropométricos para determinar el valor de predicción óptimo con sus respectivos puntos de corte para el diagnóstico de MetSyn entre los miembros del ejército en ESFORSE, Ecuador. El estudio incluye 181 participantes (175 hombres y 6 mujeres), la edad promedio es de 37 ± 6 años, la prevalencia de MetSyn es del 8%, con CC (p <.001), WHtR (p .009) y WHR (p .020) como variables estadísticamente significativas. Analizamos el área bajo la curva (AUC) en una curva de Característica Operativa del Receptor (ROC), con las medidas antropométricas. Por tanto, WC y WHtR representan el AUC más alto (WC: 0.77, IC del 95%: 0.69-0.86; WHtR: 0.70, IC del 95%: 0.59-0.82). Los valores de corte óptimos para predecir MetSyn son 92 cm en WC, 0.52 en WHtR y 0.93 en WHR. Por lo tanto, los miembros del ejército tienen una baja prevalencia de MetSyn, con WC como el mejor valor de predicción.

Palabras claves: riesgo cardiovascular, antropometría, dislipidemia, curva ROC, síndrome metabólico.

INTRODUCTION

Metabolic Syndrome (MetSyn) is characterized by a cluster of cardiovascular risk factors, which include metabolic disorders such as hypertension, hypertriglyceridemia, abdominal obesity, hyperglycemia and decrease high – density lipoprotein (HDL) (NCEP 2001; Meng et al. 2015); these factors are associated with the development of cardiovascular diseases (Eckel and Cornier 2014), which represent the main death cause worldwide - 31% of the overall- among which more than 75% are presented in low and middle income countries (WHO 2017).

The prevalence of MetSyn is different worldwide, taking into consideration the definition used; thus, in Iran the prevalence is 26.1% according to the Adult Treatment Panel III (ATP III) and 35.2% according to International Diabetes Federation (IDF) (Hossein et al. 2016), in South Korea 31% according to ATP III (Lim et al. 2011), in the USA 34.1% according to ATP III (Mozumdar and Liguori 2011), and in Ecuador 16.9% according to ATP III and 27.3% according to IDF (Suárez et al. 2019).

Several authors have recognized the association between the central or abdominal obesity with insulin resistance, hypertension and dyslipidemia; nowadays, obesity and overweight have become a challenge in developing countries, and they are considered to have an important role in the development of MetSyn (Bhurosy and Jeewon 2014; Mohammed et al. 2014).

Methods such as Magnetic Resonance Imaging (MRI) and Computed Tomography (CT) are considered as reference for the quantification of visceral and subcutaneous adipose tissue, but these are not available in all health centers (Concepción et al. 2001). While, there is a consensus on the biochemical and blood pressure variables; there is in contrast a debate about which anthropometric measurement is the most efficient for MetSyn diagnosis (Koning et al. 2007; Rodríguez et al. 2010). In clinical practice, several anthropometric measurements are found useful to evaluate obesity, especially in primary care (Liu et al. 2011; Gharipour et al. 2013). However, the studies about this topic have presented different results, without determining the best tool to use in the risk factor evaluation (Bener et al. 2013; Obeidat et al. 2015).
The prevalence of MetSyn varies according to population characteristics, geographic area, age, ethnic group, gender and criteria used; these criteria have changed based on different International Societies. At the beginning, it was necessary the presence of insulin resistance (IR) for the diagnostic of MetSyn (Alberti and Zimmet 1998; Balkau and Charles 1999), but more recent studies use clinical measurements for its definition, without the mandatory presence of IR (NCEP 2001; Einhorn et al. 2003; Alberti et al. 2009; ALAD 2010). For example, there are some differences in the cut off for waist circumference, Latin American Diabetes Association (ALAD) recommends 88 cm for women and 94 cm for men, The National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP – III) recommends 88 cm for women and 102 cm for men, and International Diabetes Federation (IDF) recommends 80 cm for women and 90 cm for men; additionally, the last consensus recommends a specific value for abdominal obesity in each region, for the Latin American population is taken into account values similar to the population in south-eastern Asia, with 90 cm for males, and 80 cm for females (NCEP 2001; Alberti et al. 2009; ALAD 2010).

In Ecuadorian population there is not a consensus about cut-off values for MetSyn, and even though cardiovascular risk factors have been studied in military personnel (Muñoz and Muñoz 2018), there is not information related with MetSyn prevalence and its respective cut-offs in Ecuadorian army.
Considering all the above mentioned, this study pretends to determine the prevalence of MetSyn and to compare several anthropometric indices for optimal predicting value, with their respective cut-offs for MetSyn diagnosis among Army Members in ESFORSE – Escuela de Formación de Soldados del Ejército - (Army Soldiers Training School).

METHODS

This is a cross – sectional investigation, that analyzed previously obtained data, it was conducted in 2020 in Ecuadorian Army Members of ESFORSE, in Ambato - Ecuador. The primary information collection instrument is the "Annual Medical Record" (Historia Clínica Anual) that was carried out in August – September 2019, at Health Center Type A (Centro de Salud Tipo A) within ESFORSE. The Annual Medical Record is a preventive health instrument that allows to evaluate: personal information, medical, laboratory, dental and psychological check-up. Additionally, the "2020 Ficha Atropométrica" (Anthropometric Record) was used", for January-February period, which evaluates: folds (triceps, suprascapular, suprailiac, abdominal, thigh and leg), diameters (fist, humerus and femur), perimeters (thigh, arm and calf), as

well as abdominal and hip circumference, to assess the nutritional status of Military Personnel.

The inclusion criteria involved active duty army members within ESFORSE. Army members with incomplete annual medical record and incomplete anthropometric records were excluded. The total number of army members were 315 (56 officers, 257 soldiers), after the analysis of medical records was carried out, 181 (20 officers, 161 soldiers) members met the required criteria, which correspond to 95 % confidence level and 5 % margin of error.

Assessment of blood pressure: to measure the blood pressure we used a digital sphygmomanometer Riester model Ri Champion N and measured participants' blood pressure two times with at least ten minutes interval. Blood pressure measurement was performed on the right hand, in a sitting position (Stone et al. 2005).

Assessment of anthropometric variables: Participants' heights and weights, were measured using a weighing machine + height rod SECA model 700, year 2012, without shoes. A non-elastic tape was used to measure waist circumference (WC) and hip circumference (HC). Different folds were measured, and with these values it was possible to calculate Body Mass Index (BMI), Waist–Hip Ratio (WHR), Waist-Height Ratio (WHtR), and Body Fat Percentage (BFP).

Laboratory tests: After 12 hours of fasting, venous blood samples were collected and analyzed with the Equipment for Blood Chemistry Erba Mannheim model XL-100. Enzymatic assay method was used to perform all tests including fasting blood sugar (FBS), total cholesterol (TC) and triglycerides (TG).

For the purpose of identifying participants with MetSyn, ATP III criteria were used, with the modification on waist circumference according to the population in Latin América; thus, MetSyn was defined with the presence of three or more of the following variables: waist circumference ≥88 cm for women and ≥94 cm form men, blood pressure (SBP/DBP) ≥130 mmHg and/or 85 mmHg respectively, glucose ≥100 mg/dL, *HDL cholesterol <40 mg/dL for women and <50 mg/dL for men, and triglycerides ≥150 mg/dL (NCEP 2001; ALAD 2010).

*It is important to mention that HDL was not done within the routine blood test at the Health Center, therefore it is possible the presence of false negatives in the study.
The study information was obtained with prior authorization of ESFORSE Director and with the participants informed consent.

Statistical analysis .- Statistical analysis was done using SPSS version 26 and MedCalc for Windows version 19.2.1. The values are expressed as mean ± SD, these variables were compared using Student t test for statistical significance. We carried out a receiver operating characteristic (ROC) curve analysis using a Youden's index to determine the optimal cut-off point of the individual anthropometric indices, including Body Mass Index (BMI), Waist Circumference (WC), Waist–Hip Ratio (WHR), and Waist-Height Ratio (WHtR), for predicting MetSyn. Values of $P < 0.05$ were considered statistically significant.

RESULTS

The characteristics of the 181 participants are shown in Table 1, with an average age 37 ± 6 years (average age of participants with and without MetSyn was 40.6 ± 4.14 and 36.8 ± 6.24 years, respectively). Of all the participants, 175 (97%) were male and 6 (3%) were female; therefore, the analysis does not have values according to the gender. This study included 166 (92%) persons without MetSyn and 15 (8%) persons with MetSyn.

The results showed that the mean values of all anthropometric indices and biochemical values are higher in patients with metabolic syndrome than in subjects without metabolic syndrome and this difference was significant in some of these values. Among the anthropometric indices: WC (p <.001), WHtR (p .009) and WHR (p .020) are statistically significant; and other statistics, such as BMI (p .175), BFP (p .136) and biochemical marker total cholesterol (p. 434) are not significant at all, taking into consideration MetSyn diagnosis.

Table 2 and Figure 1 represent the area under the curve of the Receiver Operating Characteristic curve and the optimal cut-off value of individual anthropometric indexes for predicting MetSyn. WC and WHtR represent the highest AUC (WC: 0.77, 95% CI 0.69-0.86; WHtR: 0.70, 95% CI 0.59-0.82). The values of 27 kg/m2 in BMI, 92 cm in WC, 0.93 in WHR, and 0.52 in WHtR were optimal for predicting MetSyn. Finally, even though BMI is represented in the chart and the graphic, its p value > .174 makes this value not significant.

Table 1. Characteristics of the study population

Variable		Total population n= 181 Mean ± SD	No MetSyn n= 166 Mean ± SD	MetSyn n= 15 Mean ± SD	P Value
Age	years	37.08 ± 6.18	36.8 ± 6.24	40.60 ± 4.14	0.021
Heart Rate	bpm	69.81 ± 9.63	69.54 ± 9.28	72.87 ± 12.86	0.200
Systolic BP	mmHg	116.48 ± 11.23	115.62 ± 10.82	125.93 ± 11.67	0.001
Diastolic BP	mmHg	71.71 ± 7.63	70.97 ± 7.11	79.93 ± 8.51	<0.001
Total Cholesterol	mg/dL	194.23 ± 33.15	193.64 ± 33.07	200.67 ± 34.50	0.434
Triglyceride	mg/dL	158.19 ± 99.73	152.19 ± 98	224.60 ± 97.66	0.007
Fasting Glucose	mg/dL	88.04 ± 9.98	87.63 ± 8.55	92.60 ± 12.29	0.146
Weight	kg	72.10 ± 8.36	71.75 ± 8.47	76 ± 5.89	0.059
Height	m	1.67 ± 0.06	1.67 ± 0.06	1.68 ± 0.04	0.262
BMI[a]	kg/m^2	25.95 ± 2.55	25.87 ± 2.59	26.80 ± 1.93	0.175
WC	cm	90.42 ± 7.08	89.93 ± 7.11	95.87 ± 3.73	<0.001
WHR		0.95 ± 0.05	0.94 ± 0.05	0.97 ± 0.03	0.020
WHtR		0.54 ± 0.04	0.54 ± 0.04	0.57 ± 0.03	0.009
BFP[a]	%	23.83 ± 4.11	23.70 ± 4.19	25.35 ± 2.64	0.136

MetSyn= Metabolic Syndrome, SD= Standard Deviation, BP= Blood Pressure, BMI= Body Mass Index, WC= Waist Circumference, WHR= Waist-Hip Ratio, WHtR: Waist-Height Ratio, BFP= Body Fat Percentage, a= Anthropometric values without significance

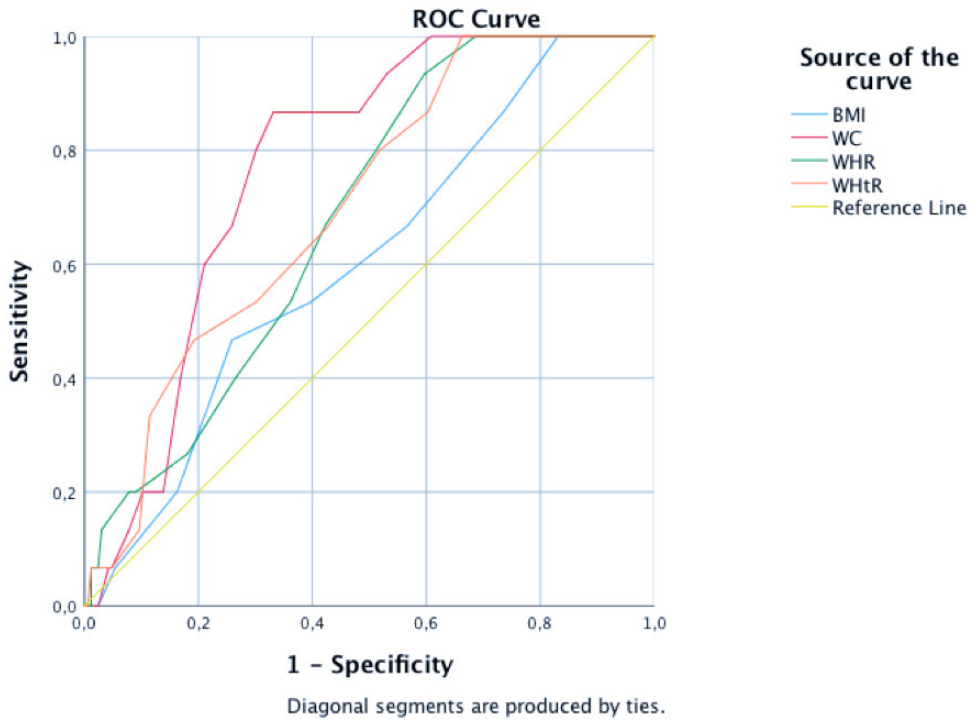

Figure 1. ROC curve for anthropometric indices to predict MetSyn in all the population.
ROC= Receiver Operating Characteristic. BMI= Body Mass Index, WC= Waist Circumference, WHR= Waist-Hip Ratio, WHtR: Waist-Height Ratio

Table 2. Predicting values for MetSyn

	AUC (95% CI)	Optimal cut-offs	Sensitivity, %	Specificity %	P Value
BMI[a]	0.61 (0.47-0.74)	27	46.67	74.10	0.174
WC	0.77 (0.69-0.86)	92	86.67	66.87	<0.001
WHR	0.68 (0.57-0.79)	0.93	93.33	40.36	0.020
WHtR	0.70 (0.59-0.82)	0.52	100	33.73	0.009

AUC= Area Under the Curve, BMI= Body Mass Index, WC= Waist Circumference, WHR= Waist-Hip Ratio, WHtR: Waist-Height Ratio, a= Anthropometric value without significance

DISCUSSION

In Ecuador there are no studies for determining which anthropometric measurements is more adequate in order to diagnose MetSyn with ATP III criteria, nor in the general population neither in military personnel. In order to avoid overestimation, it is necessary to adequate the WC in each country, for Ecuador, there is only one study, which is not determinant (Valdez et al. 2016), and the difference between BMI, WC, WHR and WHtR was not taken into account, but the AUC for WC is 0.73 for women and 0.76 for men, with cut-off 91.5 cm for both genders, which is very similar to our study. Therefore, this is the first study that evaluates anthropometric indices for predicting MetSyn in the Ecuadorian Army.

The prevalence of MetSyn was 8%, it is similar to studies in military population; so, the prevalence in pilots from Madrid is 7.2 %, and slightly different in pilots from Colombia with 13.4 % (Medina and Alonso 2012; Monroy 2018). But, there is a notable difference with studies in non-military population; with values as high as 58.3%, 41.3%, and 37.6% in Chile, Colombia and Mexico, respectively (Martínez et al. 2007; Granfeldt et al. 2015; Rivas et al. 2015), with some exceptional results in some studies, with 19% and 17% in Chile and Ecuador respectively (Camaggi and Molina 2010; Suárez et al. 2019).

Previous worldwide studies have reported different results about the most accurate anthropometric measurement for MetSyn diagnosis and prediction. Analyzing various studies, it seems that different results are due to the heterogeneity between the sample group, influenced by age, ethnic group, among others (Rajput et al. 2014). We found that for the military personnel, without distinction of their gender the most accurate anthropometric indices are WC and WHtR with AUC 0.77 and 0.70 respectively; with the important characteristic that BMI is not considered because its non-statistical significance. In the same way, in a study conducted in Iran it was reported that WC and WHtR are the best predictors for MetSyn diagnostic for males and females, with AUC of 0.65 and 0.64, respectively, and a WC cut-off 91 cm for both genders (Shabazian and Pipelzadeh 2015). Also, according to Yang et al., (2019), WC has the biggest AUC with 0.78 for women and 0.82 for men, followed by WHtR in both groups with 0.78 for women and 0.79 for men; WC optimal cut-off is 80.8 cm and 89.3 cm for women and men respectively; also, it is noted that BMI is an optimal predictor after WC and WHtR (Yang et al. 2019). Similarly, in another Iranian study these two anthropometric indices are presented, but WHtR has more AUC than WC (Delvarianzadeh et al. 2017). Additionally, according to Gharipour et al. (2013), WC has the biggest AUC with 0.85 in women and 0.78 in men, followed by WHR with 0.84 and BMI 0.73, in women and men respectively; it is necessary to mention that WHtR was not taken into consideration within this study, and, in both groups WC cut-off values is 90 cm (Gharipour et al. 2013). In the same way, according to Bener et al., (2013), WC has the biggest AUC with 0.78 for men, and 0.81 for women, with a cut-off values of 100 cm for men and 91 cm for women; there is a difference in the second group with bigger AUC represented by WHR 0.75 in men, and WHtR 0.79 in women (Bener et al. 2013). Opposite to our results, some studies report similitudes in the predict power for BMI and WC, but in populations different from our participants (Barzin et al. 2011; Jahangiri et al. 2013). Finally, in a study conducted in China WC, WHR and BMI are equally useful (Liu et al. 2011). This study has some limitations. First, for

the diagnosis of MetSyn it was not taken into consideration HDL values because it was not part of the routine blood test made months before the study (mentioned in methods); therefore, it is highly recommended to make similar studies with the addition of this lipid test, in order to get more precise data. Second, the study was made in a military population with a predominant number of men over women, therefore it was not possible to make a difference between genders in anthropometric cut-offs.

CONCLUSION

Based on the results of this study, the prevalence of MetSyn in military population is lower than in general population; with WC and WHtR as the most appropriate anthropometric indices for its diagnostic, with a cut-off for WC similar to an Ecuadorian study but different from other worldwide studies.

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