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Anthropometric measures as predictors of cardiovascular risk in a population of employees

Medidas antropométricas como predictores del riesgo cardiovascular en una población de empleados

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Abstract

Background: *There are several scales to calculate the cardiovascular risk of patients at the outpatient level; however, most of them require the measurement of parameters that involve high costs or waiting time for the results.* **Objective:** *The objective of this study was to show the capacity of some anthropometric measures for the prediction of cardiovascular risk in an adult population of a Colombian State University.* **Materials and methods:** *Ninety-eight working individuals of a State university with an average age of 50.6 ± 7.5 years were evaluated in 2014. For each person, the variables gender, age, height, weight, percentage body fat (%BF), body mass index, blood pressure (BP), percentage of hand grip strength (%HGS), midline level waist circumference (MLW), waist-to-hip ratio, waist-to-height ratio, fruit and vegetable portions ingested per day, and cigarette smoking were recorded. Subsequently, in 2018, the participants were contacted and were asked about new medical diagnoses of cardiovascular type that they would have had in the time elapsed since the evaluation.* **Results:** *Eighty-three individuals participated in the new evaluation (2018). The MLW was an independent risk factor associated with type 2 diabetes mellitus (DM) OR: 1214 (95% CI, p = 0.010) and the %BF associated with high BP (HBP) OR: 1137 (95% CI, p = 0.028).* **Conclusion:** *MLW and %BF are economic anthropometric measurements techniques that can help predict the risk of developing DM and HBP at 4 years.*

Keywords: *Cardiovascular disease. Anthropometry. Hypertension. Diabetes mellitus. Cardiovascular risk.*

Resumen

Antecedentes: *Existen varias escalas para calcular el riesgo cardiovascular de los pacientes a nivel ambulatorio; sin embargo, la mayoría requieren de la medición de parámetros que implican altos costos o un tiempo de espera para obtener los resultados.* **Objetivo:** *Demostrar la capacidad de algunas medidas antropométricas para predecir el riesgo cardiovascular en una población adulta de una universidad pública en Colombia.* **Metodología:** *98 empleados de una universidad pública con una edad media de 50.6 ± 7.5 años fueron evaluados en el año 2014. Para cada persona, se registraron las variables de género, edad, estatura, peso, porcentaje de grasa corporal (% GC), índice de masa corporal (IMC), tensión arterial (TA), porcentaje de fuerza de agarre (% FA), circunferencia de la cintura a nivel de la línea media (CCM), índice cintura-cadera (ICC), índice cintura-estatura (ICE), porciones de frutas y verduras (PFV) ingeridas al día, y tabaquismo. Después, en el*

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2018, se contactaron los participantes y se les preguntó por nuevos diagnósticos médicos de tipo cardiovascular que hubieran tenido en el lapso desde la evaluación. **Resultados:** *83 individuos participaron en la nueva evaluación (2018). La CCM fue un factor de riesgo independiente asociado a la diabetes tipo 2 (DM), OR = 1,214 (IC 95%, p = 0.010) y el %GC asociado a la tensión arterial alta (TAA), OR = 1,137 (IC 95%, p = 0.028).* **Conclusión:** *La CCM y el %GC son técnicas de medidas antropométricas económicas que pueden ayudar a predecir el riesgo de desarrollar DM y TAA a 4 años.*

Palabras clave: *Enfermedad cardiovascular. Antropometría. Hipertensión. Diabetes mellitus. Riesgo cardiovascular.*

Introduction

The World Health Organization (WHO) defines cardiovascular diseases (CVD) as a group of disorders of the heart and blood vessels. It is considered the leading cause of death worldwide. More than three quarters of CVD deaths occur in low- and middle-income countries and it is expected that by 2030 they will cause around 23.6 million deaths[1]. Most CVD can be prevented using strategies that cover the entire population and impact behavioral risk factors, such as tobacco use, unhealthy diets that induce obesity, physical inactivity, or harmful alcohol consumption. There are several scales to determine the cardiovascular risk of each patient, most of them requiring data that involve some cost and waiting time such as lipid profile and certain inflammatory markers. This means that, in patients from low-income countries, there is greater difficulty in estimating this risk and the interventions are performed late. In addition, access to health services is more difficult and scarcer, which means that, in many cases, this evaluation is not even carried out[2]. That is why, in these cases, it is pertinent to use anthropometric measures as a cost-effective alternative to predict cardiovascular risk in all population groups regardless of their socioeconomic status. Other advantages of these techniques are their easy application and the fact that the measurement protocols are part of the training of health personnel in countries such as Colombia. The objective of the present study, then, is to show the capacity of some anthropometric measures for the prediction of cardiovascular risk in an adult population of a Colombian State University.

Materials and methods

A prospective study was conducted with a sample of employees, both genders, from the University of Caldas in Manizales (Caldas, Colombia). The study consisted of two phases, the first in 2014 and the next in 2018. Ninety-eight people over 30 years of age were included who agreed to participate in this study and formed the informed consent form. They did not have a previous diagnosis of the pathologies under evaluation such as coronary heart disease, stroke, peripheral vascular disease, high blood pressure (HBP —Hypertension—), type 2 diabetes mellitus (DM), heart failure, angina pectoris, or aneurysm.

The study variables were gender, age, height, weight, percentage body fat (%BF), body mass index (BMI), blood pressure (BP), percentage of hand grip strength (%HGS) of the dominant side, midline level waist circumference (MLW), waist-to-hip ratio (WHR), waist-to-height ratio (WHtR), fruit and vegetable portions (FVP) ingested per day, and cigarette smoking were recorded.

In addition, the calculation of the risk of suffering a cardiovascular episode in the next 10 years, fatal or not, was made taking into account the WHO/ISH Region B risk prediction table (AMR B) for the contexts, in which it is not possible to measure blood cholesterol in order to compare it with our prediction based on anthropometric variables. This table includes: sex, age, systolic BP, smoking, and presence or absence of DM (the WHO, 2008).

Four years later (2018) of the first evaluation, people were contacted again by telephone and were asked if they had had new diagnoses of DM or CVD during this period (2014–2018).

The weight was measured with an ICOB® digital scale model PP20.00. For the stature or size, a SECA® Heigthronic TM digital stadiometer was used. The measurements were made according to the protocol of Lohman et al.[3]. The BMI was determined with the weight ratio in kilograms (kg), over the height in meters squared (m^2) and the WHO classification was used[4].

A stethoscope and a LORD® brand tensiometer were used for the measurement of BP under the recommended semiological standards. Subsequently, individuals were categorized according to the classification proposed by JOINT VII[5].

The %HGS was evaluated three times with a Baseline® digital dynamometer on the dominant side; each time, with a duration of 5 seconds (sec) with 30 sec rest intervals between them. The highest measurement of the three was compared with reference data according to Mathioweitz, 1985[6]. A value ≥ 85% is classified as normal grip strength; in the same way, a lower result was considered as altered.

With the patient standing and an inelastic Lord® tape measure, the midpoint between the costal ridge and the iliac crest was obtained and the abdominal circumference was measured at this level. Values ≥ 90 cm in men and ≥ 80 cm in women were considered altered[7]. For the calculation of the WHtR, the value at the level of the largest hip circumference was recorded. The reference values used as altered were: ≥ 0.9 in men and ≥ 0.8 in women[8]. An altered WHtR value was considered as ≥ 0.5 for both genders[9].

The %BF was estimated with a digital Skyndex System® adipometer from the sum of the triceps, biceps, subscapular, and suprailiac subcutaneous fat folds using the Durnin and Womersley formula[10]. The reference value considered normal in women was < 30% and < 20% in men.

Fruit and vegetable consumption was recorded as the number of servings of fruit and vegetables ingested per day (FVP). Adequate consumption was considered when it was ≥ 5 servings of 1 or both types of food[11].

Characteristics of the subjects included were described as average and standard deviation. A logistic regression with progressive stepwise method was performed using the SPPS version 24 program, which licensed to the University of Caldas. The explanatory variables were gender, age, tobacco consumption, %HGS, BMI, WHR, WHtR, %BF, FVP, systolic BP (SBP), and diastolic BP (DBP). This analysis was univariate. Response variables included the appearance of coronary heart disease, stroke, peripheral vascular disease, HBP, DM, or heart failure after the first evaluation in 2014. Composite unbalance was defined as the probability of having CVD or DM if an alteration was found in the anthropometric variables. Odds ratio and 95% CI were calculated to estimate the probability of suffering DM and CVD associated to the evaluated variables. Significance was stated as $p < 0.05$.

Results

In 2018, when patients were contacted a second time, 15 people (three men and 12 women) were excluded, because their telephone numbers or location had changed and contact with them was not possible. Finally, 83 people were included in the study, of the 98 people evaluated in 2014.

Table 1 describes the characteristics of the subjects included for the final analysis of 2018. Table 2 shows the results of the values of %HGS, WHR, MLW, %BF, FVP, WHtR, and BP. Only 7.2% of the subjects evaluated reported smoking.

Table 1. Characteristics of the subjects evaluated, 2018

Sex	n	Indicator	Age (years)	Height (cm)	Weigth (Kg)	BMI (kg/m²)	%BF	MLW (Cm)	WHtR	WHR (Cm)	%HGS	SBP (mmhg)	DBP (mmhg)	FVP (portion/day)
Men	16	Average	50.6	166.9	72.3	26	29.5	90	0.5	0.9	76.8	114.25	76	2.3
		Standard deviation	7.5	5.6	9.9	3.2	4.9	8.6	0.1	0.1	16.2	12.88	11.1	1.6
Women	67	Average	43.2	155.7	62.1	25.6	37.4	78.9	0.5	0.8	89.8	112.25	71.03	2.19
		Standard deviation	9.8	5.2	10.7	4.4	4.4	10.1	0.1	0.1	14.7	13.74	8.78	2
Total	83	Average	44.6	157.85	64.04	25.67	35.91	81.7	0.5	0.8	87.3	112.6	72	2.2
		Standard deviation	9.82	6.87	11.29	4.18	5.46	10.75	0.06	0.1	15.77	13.53	9.4	1.9

BMI: Body mass index, MLW: midline level waist circumference. WHtR: waist-to-height ratio. WHR: waist-to-hip ratio, %HGS: percentage of handgrip strength, PAS: Systolic blood pressure, PAD: diastolic blood pressure, and PFV: fruit portions and vegetables.

Table 2. Normal or pathological result of the %HGS, WHtR, WHR, MLW, %BF, FVP, and BP

Sex	N	Indicator	%BF	WHtR	WHR	MLW	%HGS	FVP	BP
Men	16	Normal	37.5% (6)	6.25% (1)	56.25% (9)	56.25% (9)	6.25% (1)	6.25% (1)	68.75% (11)
		Pathological	62.5% (10)	93.75% (15)	43.75% (7)	43.75% (7)	93.75% (15)	93.75% (15)	31.25% (5)
Women	67	Normal	65.67% (44)	11.94% (8)	79.1% (53)	64.18% (43)	20.9% (14)	17.9% (12)	76.12% (51)
		Pathological	34.33% (23)	88.06% (59)	20.9% (14)	35.82% (24)	79.1% (53)	82.1% (55)	23.88% (16)
Total	83	Normal	60.24% (50)	10.84% (9)	74.7% (62)	62.65% (52)	18.07% (15)	15.66% (13)	74.7% (62)
		Pathological	39.76% (33)	89.16% (74)	25.3% (21)	37.35% (31)	81.93% (68)	84.34% (70)	25.3% (21)

%HGS: Percentage of handgrip strength, WHtR: waist-to-height ratio, WHR: waist-to-hip ratio, MLW: midline level waist circumference, %BF: percentage body fat, FVP: number of fruit and vegetable portions, and BP: blood pressure.

According to the WHO/ISH AMR B risk prediction table WHO 2008[12], the probability of suffering a cardiovascular episode, fatal or not, in a period of 10 years, was less than 10% for all evaluated, indicating a very low cardiovascular risk.

Despite this, the information obtained concluded that 17 individuals had been diagnosed with HBP, four people had been diagnosed with DM, one other person had coronary infarction, and another individual had peripheral arterial disease from the first evaluation.

After the statistical analysis, it was established the MLW as a predictor of DM, this measurement had a statistical significance of 0.010 and an odds ratio of 1.214 (95% CI) indicating that the probability of suffering diabetes increased by 12.14% for each unit that increased the measure of the hip with respect to an individual with a lower value.

With regard to the HBP response variable, statistical significance of 0.028 was found for the %BF as a predictor of this pathology. The odds ratio in this case was 1.137 (95% CI). This result indicated a probability of suffering from HBP of 11.37% for each unit of percentage of fat above the value established as normal.

In this study, the other variables showed no relationship with the onset of DM or HBP. Nor was a relationship found between these anthropometric variables and any of the other CVD taken into account in this study.

Discussion

Our results suggest that there is an association between the variable MLW and DM, as well as the %BF and HBP. The other variables were not related to the pathologies that were taken into account in the present analysis.

That is, in less than 10 years after the first evaluation, 23 subjects (27.7%) had already presented a CVD or had been diagnosed with DM. This leads us to suggest that in a 10-year follow-up, this percentage could greatly exceed this figure.

%BF and BP

The findings of our study are related to others previously published, as is the case of the relationship between the %BF and BP. In a cross-sectional study, conducted by Thang et al.,[13] 50.436 individuals between men and women were analyzed. The population was divided into five groups according to their BP status, as follows: normotensive individuals, with undetected HBP, with controlled HBP, with uncontrolled HBP and those with untreated HBP. Subsequently, each group was compared with %BF. The authors concluded that BP was inversely associated with muscle mass, as well as positively with fat mass[13].

Trinidades et al.[14] evaluated 408 individuals between the ages of 20 and 59 years old in Brazil and determined that the prevalence of HBP was 23.03%, being higher among women. Likewise, they found a significant association between HBP and smoking, obesity, DM, and dyslipidemia. About 40.38% of hypertensive individuals 50–59 years old had five or more cardiovascular risk factors. Another study, conducted by Alvarez Cortez et al., showed that those who have HBP were at risk of suffering an acute myocardial infarction approximately 3.8 times more compared to those who did not suffer from this condition. Thus, if HBP was controlled, 73.5% of cardiovascular accidents in the studied population would be avoided[15].

MLW and DM

A study conducted in Bogotá (Colombia) by Buendía et al.[16] evaluated 2200 patients attending endocrinology consultation and found, using a multivariate analysis, that male sex and increased MLW were independent risk factors related to diabetes. In this study, the same reference values were considered as in our analysis (90 cm for men and 80 cm for women)[16].

A study, including 982 patients, determined that there was a positive correlation between MLW and blood glucose, uric acid and insulinemia values. MLW in both genders was the variable with the highest predictive power of hyperglycemia, with waist cutoff points of 86.75 cm in men and 80.5 cm in women. Above this value, the risk of type 2 diabetes increased 8.7 times[17].

Others variables and CVD/DM

In the present study, 30.76% of the individuals evaluated had a %HGS altered. Despite this, no relationship was found with the subsequent onset of CVD. However, a systematic review highlights that the measurement of %HGS has prognostic value for cardiovascular disease, as well as being an important indicator of fragility and vulnerability. The authors concluded that this measurement could be a simple and useful tool to identify individuals at risk of CVD that requires closer clinical attention[18].

The Prospective Urban Rural Epidemiology study, conducted in 2015, Corsi et al.,[19] confirmed the prognostic importance of the %HGS in adult populations of all social strata in 17 countries. It was found that low grip strength was associated with a high lethality rate for a variety of incident diseases, including CVD. This result suggests that %HGS could be an important marker of the ability to resist or recover from a disease. These data support the measurement of muscle strength as a key indicator of frailty[20].

The %BF is not only associated with an increased risk of HBP as evidenced in a study that included 182 subjects with a mean age of 38 years. The authors demonstrated that excess BF increased the individual risk of CVD and metabolic syndrome in the population of subjects with no history of CVD. They also demonstrated that the %BF was significantly related to biochemical variables such as serum lipids, fasting blood glucose, and BP[21].

We found that 84.34% of those evaluated do not consume the recommended daily servings of fruits and vegetables. It has been described that diets rich in fruit and vegetables are associated with a reduced risk of chronic diseases. In our country, healthy eating guidelines include the recommendation to consume at least 5 VFP daily, although the exact amount of recommended portions and descriptions of portion sizes vary by country[22]. A meta-analysis suggests an association between increased consumption of FVP intake and reduced risk of CVD and stroke[23]. Another study showed that the intake of more than 8 FVP for 8 weeks decreased SBP by 2.8 mm Hg and DPB in 1.1 mm Hg[24].

An investigation conducted by Valenzuela et al.[24] included 998 people between 22 and 28 years old. In this study, the MLW and the WHtR index were directly associated with both systolic and diastolic BP. The WHtR and the WHR have been classified as better predictors of cardiovascular risk than the BMI; however, in our study, no significant relationship was found between them and the subsequent presentation of HBP[25].

The study by Muñoz-Muñoz et al.[26] supports that this relationship is that of who determined that high WHtR was strongly associated with increased BP, excess weight, increased MLW, fasting hyperglycemia, hypertriglyceridemia, and LDL-cholesterol > 2.6 mmol. Likewise, elevated WHtR was associated with the presence of metabolic syndrome[26].

The study by Luengo-Pérez et al.[27] showed a much more important relationship. The research showed that in men up to 50 years, the WHR remains the one that shows the highest correlation with cardiovascular risk, followed by WHtR. However, for men 50 years of age and older, none of the indices showed a significant correlation. In the case of women under 50, the WHtR and BMI showed a greater correlation with cardiovascular risk. For women 50 years of age and older, only WHR presented a significant correlation[27].

The association between obesity and HBP is a perfectly established fact, although not all obese people develop HBP. However, obesity has been indicated as a contributing factor to the increase in BP, being more frequent among overweight people than among those with normal weight. This relationship is evidenced in the study by Fernandez Díaz et al.[28] who demonstrated a predominance of obesity in hypertensive patients who also had high values in the %BP. This relationship was not observed in our study[28].

Despite the current evidence, based on other research, some of the variables evaluated were not related to the probability of developing CVD. We believe that this could be related to the small sample that we used for the present analysis and for the moderate period of time that the study lasted.

Conclusion

High MLW values may indicate an increased risk of developing DM. Furthermore, high values in the %BF would be associated with a higher risk of HBP, 4 years after an initial evaluation.

The evaluated population is at risk of developing CVD, although the WHO/ISH AMR, risk prediction tables have classified it as a very low risk.

The MLW and %BF measurements are economical, fast, and safe to assess cardiovascular risk in individuals and should be used in routine medical consultations. We recommend its application, especially in remote regions of large urban centers, where access to technology and diagnostic techniques are more difficult.

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Conflicts of interest

The authors declare no conflicts of interest.

Ethical disclosures

Protection of human and animal subjects. The authors declare that no experiments were performed on humans or animals for this study.

Confidentiality of data. The authors declare that they have followed the protocols of their work center on the publication of patient data.

Right to privacy and informed consent. The authors have obtained the written informed consent of the patients or subjects mentioned in the article. The corresponding author is in possession of this document.

References

1. Organización Mundial de la Salud (OMS). Sitio Web Mundial. Enfermedades Cardiovasculares. Available from: https://www.who.int/cardiovascular_diseases/about_cvd/es [Last accessed on 2019 Agu 19].
2. Restrepo-Zea JH, Silva-Maya C, Andrade-Rivas F, VH-Dover, R. Acceso a servicios de salud: análisis de barreras y estrategias en el caso de Medellín, Colombia. Rev Gerenc Polít Salud. 2014;13:242-65.
3. Lohman TG, Roche AF, Martorell R. Anthropometric Standardization Reference Manual. Champaign, Illinois: Human Kinetics Books; 1988.
4. World Health Organization. Overweight and Obesity; 2017. Available from: https://www.who.int/features/factfiles/obesity/en [Last accessed on 2019 Aug 19].
5. Verdecchia P, Angeli F. Séptimo informe del joint national committee para la prevención, detección, evaluación y tratamiento de la hipertensión arterial: El armamento está a punto. Rev Esp Cardiol. 2014;56:843-7.
6. Mathiowetz V, Kashman N, Volland G, Weber K, Dowe M, Rogers S. Grip and pinch strength: normative data for adults. Arch Phys Med Rehabil. 1985;66:69-74.
7. Zimmet P, Alberti KG, M. Rios S. A new international diabetes federation worldwide definition of the metabolic syndrome: the rationale and results. Rev Esp Card. 2005;58:1371-6.
8. Welborn TA, Dhaliwal SS. Preferred clinical measures of central obesity for predicting mortality. Eur J Clin Nutr. 2007;61:1373-9.
9. Browning LM, Hsieh SD, Ashwell M. A systematic review of waist-to-height ratio as a screening tool for the prediction of cardiovascular disease and diabetes: 0.5 could be a suitable boundary value. Nutr Res Rev. 2010;23:247-69.
10. Durnin JV, Womersley J. Body fat assessed rom total body density and its estimation from skinfold thickness: measurements on 481 men and women aged from 16 to 72 years. Br J Nutr. 1874;32:77-97.
11. Moñimo M, Rodriguez E, Tapia MS, Domper A, Vio F, Curis A, et al. Evaluación de las actividades de promoción de consumo de frutas y verduras en 8 países miembros de la Alianza Global de Promoción al Consumo de Frutas y Hortalizas "5 al día"-AIAM5. Rev Esp Nutr Hum Diet. 2016;20:281-97.
12. World Health Organization. WHO/ISH Risk Prediction Charts. Charts in Colour for use in Settings where Total Blood Cholesterol Cannot be Measured Figure 8. WHO/ISH Risk Prediction Chart for AMR A Figure 9. WHO/ISH Risk Prediction Chart for AMR B Figure 10. WHO/ISH risk Prediction Chart for AMR D; 2008. Available from: https://www.ish-world.com/downloads/activities/colour_charts_24_Aug_07.pdf [Last accessed on 2019 Aug 19].
13. Han TS, Al□Gindan YY, Govan L, Hankey CR, Lean ME. Associations of body fat and skeletal muscle with hypertension. J Clin Hypertens. 2019;21:230-8.
14. Trinidades CA, Dos Santos LA, de Barros MD, Marcon SS. Hipertensión arterial y otros factores de riesgo asociados a las enfermedades cardiovasculares en adultos. Rev Latino-Am. Enfermagem. 2014;22:547-53.
15. Álvarez JT, Bello VB, Pérez GA, Duany AO, Bolívar ME. Factores de riesgo coronario asociados al infarto agudo del miocardio en el adulto mayor. MEDISAN. 2013;17:54.
16. Buendía RG, Zambrano M, Morales A, Alejo A, Giraldo L, Gamez D, et al. Perímetro de cintura aumentado y riesgo de diabetes. Acta Med Colomb. 2016;41:176-80.
17. Díaz DO, Rodríguez HJ, Alonso ED. Valor de corte de la circunferencia de la cintura como predictor de disglucemia. Rev Cub End. 2017;28:1-15.
18. Leong DP, Teo KK. Predicting cardiovascular disease from hand grip strength: the potential clinical implications. Expert Rev Cardiovasc Ther. 2015;13:1277-9.
19. Corsi DJ, Subramanian SV, Chow CK, McKee M, Chifamba J, Dagenais G, et al. prospective urban rural epidemiology (PURE) study: baseline characteristics of the household sample and comparative analyses with national data in 17 countries. Am Heart J. 2013;166:636-46.e4.
20. Leong DP, Teo KK, Rangarajan S, Lopez-Jaramillo P, Avezum A Jr., Orlandini A, et al. Prognostic value of grip strength: findings from the Prospective Urban Rural Epidemiology (PURE) study. Lancet. 2015;386:266-73.
21. Valentino G, Bustamante MJ, Orellana L, Krämer V, Durán S, Adasme M, et al. Body fat and its relationship with clustering of cardiovascular risk factors. Nutr Hosp. 2015;31:2253-60.
22. Woodside JV, Young IS, McKinley MC. Fruit and vegetable intake and risk of cardiovascular disease. P Nutr Soc. 2013;72:399-406.
23. Dauchet L, Amouyel P, Hercberg S, Dallongeville J. Fruit and vegetable consumption and risk of coronary heart disease: a meta-analysis of cohortstudies. J Nutr. 2006;136:2588-93.
24. Appel LJ, Moore TJ, Obarzanek E, Vollmer WM, Svetkey LP, Sacks FM, et al. A clinical trial of the effects of dietary patterns on blood pressure. DASH Collaborative Research Group. N Engl J Med. 1997;336:1117-24.
25. Valenzuela K, Bustos P. Índice cintura estatura como predictor de riesgo de hipertensión arterial en población adulta joven: es mejor indicador que la circunferencia de cintura? Rev Invest Clin. 2012;62:220-6.
26. Muñoz-Muñoz MG, Olivas-Aguirre FJ, Ochoa C. El índice cintura-talla como predictor del daño cardiovascular. Rev Cubana Alimentación Nutr. 2016;26:239-51.
27. Luengo-Pérez LM, Urbano-Galvez JM, Pérez-Miranda M. Validación de índices antropométricos alternativos como marcadores del riesgo cardiovascular. Rev Endocrinol Nutr. 2009;56:437-74.
28. Fernández Díaz I, Martínez Fuentes A. Evaluación nutricional antropométrica en ancianos. Comportamiento de la hipertensión arterial. Rev Cubana Med Gen Integr. 2004;20:864-2125.