Abdominal circumference cut-off point: an overview

Punto de corte de la circunferencia abdominal: una descripción general

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Abstract

Introduction: Obesity is currently considered as a "pandemic" because it is a health challenge both in developed and developing countries, reducing life expectancy by up to 20 years. Abdominal circumference (AC) serves for the diagnosis and prognosis of associations with chronic non-communicable diseases. **Objective**: To provide an overview of the cut- off point for AC. **Methods**: A literature review was performed; the sources of information were Medline, Scopus, Embase, Pubmed, ScienceDirect and Springer Link in Spanish and English, between 2016 and 2021. **Results**: With the bibliography collected, it can be determined that this anthropometric value reflects clinical usefulness for prognosis and diagnosis. The study showed there is a discrepancy regarding the reference point of the AC between WHO, ATPIII and ALAD. **Conclusion**: The impact of this review lies in the urgent search for a cut-off point for AC to provide a reference for health personnel in each country.

Key Words: abdominal obesity, abdominal circumference, abdominal perimeter, cardiovascular disorders, metabolic syndrome.

Resumen

Introducción: La obesidad, considerada actualmente una "pandemia", es un desafío para la salud tanto en países desarrollados como en vías de desarrollo, reduciendo la esperanza de vida hasta en 20 años. La circunferencia abdominal (CA) sirve para el diagnóstico y pronóstico de asociaciones con enfermedades crónicas no transmisibles. **Objetivo:** Proporcionar una visión general del punto de corte para la CA. **Métodos:** Revisión de la literatura; las fuentes de información fueron Medline, Scopus, Embase, Pubmed, ScienceDirect y Springer Link en español e inglés, entre 2016 y 2021. **Resultados:** Con la bibliografía recolectada se puede determinar que este valor antropométrico refleja utilidad clínica para el pronóstico y diagnóstico. Mostrando que existe una discrepancia en cuanto al punto de referencia de la CA entre la OMS, ATPIII y ALAD. **Conclusión:** El impacto de esta radica en la búsqueda urgente de un punto de corte de AC que sirva de referencia para el personal de salud de cada país.

Palabras Clave: obesidad abdominal, circunferencia abdominal, perímetro abdominal, síndrome metabólico, alteraciones cardiovasculares.

Introduction

Obesity is a medical condition now considered a "pandemic" of the 21st century. The global prevalence of overweight and obesity has doubled since 1980, to the point that almost one-third of the world's population now suffers from it[1]. It is characterized by increased weight and excess visceral adiposity and it is a chronic and relapsing disease[2]. Nowadays, obesity is health challenge in developed countries, as well as in developing countries, since the population has adopted unbalanced eating habits, which are detrimental to their health and keep them away from leading a healthy life[3]. Obesity is associated with a wide spectrum of pathophysiological alterations such as arterial hypertension, type 2 diabetes mellitus, dyslipidemias, some types of cancer, neuro-skeletal disorders, and systemic inflammation[4,5].

According to the World Health Organization (WHO), obesity is defined as "an abnormal or excessive accumulation of fat that poses a health risk." In contrast to the view that obesity only represents a risk factor for illnesses, the World Obesity Federation stated that obesity also decreases life expectancy by up to 20 years[6]. Moreover, it adversely affects almost all physiological functions of the body and is a major threat to public health[1].

There is also evidence that the inflammatory cascade resulting from severe acute respiratory syndrome due to coronavirus-2 (SARS-CoV-2) has a greater number of complications in patients with obesity than in subjects of healthy weight[7] probably related to the chronic inflammatory state asso-

ciated with increased visceral adipose tissue, leading to a greater need for invasive mechanical ventilation and increased mortality rates[8].

The abdominal perimeter is useful for the diagnosis and prognosis of the patient because it can determine associations with some diseases, particularly cardiovascular and metabolic conditions, and even cause psychiatric disorders in those who suffer from obesity[9,10]. It is necessary to find an adequate value of AC in each specific population to be able to evaluate the health condition and reduce morbidity and mortality; moreover, this can help reduce public health expenses[11,12]. Likewise, it has been shown that obesity carries comorbidities that increase government budgets and cannot meet the needs of all users, so the search for a cut-off point of AC should be individualized to each geographical region[13,14].

Reference values for AC are set by different organizations, including the World Health Organization (WHO) and Adult Treatment Panel III (ATPIII), which give a reference value for men of 102 cm and 88 cm for women. On the other hand, the International Diabetes Federation (IDF) indicates values for men of 90 cm and 80 cm for women. Finally, the Latin American Diabetes Association (ALAD) gives a value of 94 cm for men and 88 cm for women[15]. The value of the AC is of great importance when calculating indices with other anthropometric measurements such as height, hip circumference, and body mass index percentiles[16].

Due to the above-mentioned and in view of the increase in the prevalence of obesity and its associated comorbidities, it is necessary to have a global vision regarding the AC, which allows us to analyze the cut-off points, considering its evolution, establishing comparisons, and trying to raise the need for local studies for this anthropometric value.

Method

The methodology is a bibliographic review that allows to analyze several updated sources about the AC in different populations, and, at the same time, to show the variations that the reference value exposed by the different organizations with the purpose is to encourage the doctor to take this measurement routinely, to detect future health alterations in time.

A search in both Spanish and English was conducted in scientific databases such as Scopus, Medline, Embase, Science Direct and Springer Link: Scopus, Medline, Embase, Pubmed, Science Direct and Springer Link.

We identified 125 records in the databases, of which 35 were excluded as duplicates. Seventy-one articles were identified as potential sources of information from which the selection criteria were applied, among which articles prior to 2016 were excluded. AC cut-off studies from various countries were included so that the research had a global approach, as well as studies of metabolic syndrome and those in which the AC is related to diseases; additionally, studies of ages between 18 to 80 years were chosen, and studies where the AC is not relevant were excluded. Finally, 18 articles were selected with highly relevant data for this review, which indicate close values of AC in the Latin American population.

Importance of the referential value of AC and abdominal obesity

Obesity plays a dynamic role with a multidisciplinary clinical approach; weight gain leads to an increase in abdominal and hip circumference[17]. Abdominal adiposity accumulates over the years and men are more susceptible to these changes, which is why the reference value given for men is higher[18]. Although both sexes can be affected by the accumulation of fatty tissue in the abdomen, women who are in the menopausal stage suffer this alteration more frequently[19]. Research in adolescent AC shows that, when taking the measurement established by the IDF as a reference and applying it in a clinical setting, it generates several discrepancies with the reference value[20]. Many studies strongly link the consumption of food outside the home with an elevated AC[21].

Anthropometric measurements in general and central obesity have importance now of detection of adjacent pathologies[22]. The fat located in the trunk area and visceral region are significantly associated with type 2 diabetes, systemic arterial hypertension, and metabolic syndrome. Treatment strategies should be aimed at reducing this fat located in the abdomen; therefore, a new cut-off point of AC adjusted to each specific population should be sought[23]. This anthropometric variable is also useful when calculating important indexes such as: waist-hip index (WHI) and body mass index (BMI)[24]. Thus, the use of an adequate value and measurement of abdominal perimeter shows that an increase of 0.01 cm in the ICC ratio is associated with an increase of 5% in cardiovascular risk, being evident that the higher the WC, the greater the risk of disease[25].

Finally, elevated AC values in several individuals may generate an elevation in systolic blood pressure as demonstrated by Darsini et al. (p-values < 0.0017, OR=1.042 (95% CI 1.015-1.068) showing a strong relationship with the likelihood of disease[26].

Waist circumference as a diagnostic value in clinical practice

AC should be routinely measured in clinical practice. The abdominal perimeter is useful in the correct diagnosis of the patient because there is a strong association between metabolic syndrome and related diseases and an AC value above the limits established for each population[27]. Recently it has been discovered that up to 47% of people with the reference value of AC can develop a serious disability, especially those of muscular, skeletal, and joint origin[28].

Comparative socioeconomic analysis shows that obesity is found mostly in developed countries where the circumference of the abdomen is also increasing. Developing coun-

tries are adopting this trend due to industrialization and easy access to unhealthy food[29]. The AC serves as an index of central obesity, as it indicates the amount of fatty tissue that is in the abdominal or trunk area[30]. It is a real public health challenge to be able to detect obesity and its complications in time because it is a significant expense to state budgets. The AC provides important data at the time of predicting cardiovascular diseases and metabolic disorders, within the anthropometric measures to deal with it[30]. In addition, it is observed that there is a relationship of an elevated AC with 23 specific types of cancer, according to a study conducted by Lee KR et al. in 2018, with gastric cancer as the one with the highest correlation[31].

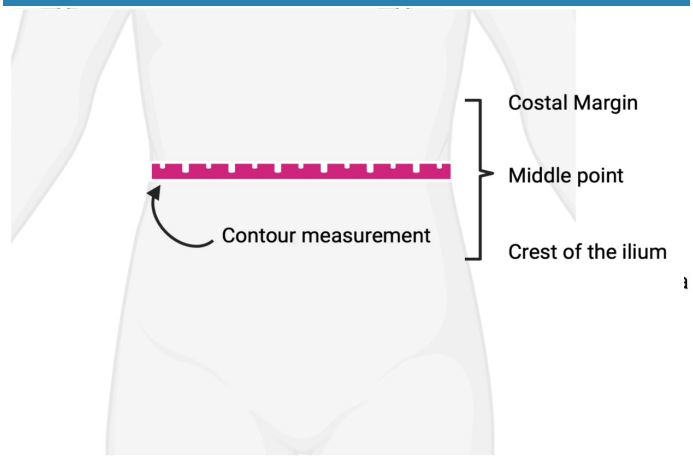
Christiansen MB et al. assessed in 2020 the association of an increasing waist circumference and the risk of joint alterations, observing a predominance in the affectation of the knee joint[32]. Meadows and Bower concluded the same in 2020, where they showed that older adults with prominent abdominal perimeters suffered limitations of movement and physical performance[33]. At the same time, an elevated abdominal perimeter is associated with depression and anxiety disorders, as shown by Kim SH in Korea in 2021[21]. The AC as a predictive value of health complications has been modified by various factors such as industrialization, stress, poor diet and sedentary lifestyle; showing an increase beyond the BMI, which is a challenge for health today[34,35]. Detecting an over-measurement of the AC in time is important for clinical practice since it could modify the increasing morbimortality of the population in general[36].

Anthropometric measurement methods

Nowadays, there are multiple tools and anthropometric indicators for the detection of overweight and obesity, which allow to define the pathology and to analyze its complications; multiple instruments are used to diagnose an increase in the level of abdominal adipose tissue, for the detection of abdominal fat several methods have been established among them are, magnetic resonance, computerized tomography and body bioimpedance, being these methods expensive and/or little accessible[37]. On the other hand, the measurement of AC with a calibrated tape measure is a simple method, easy to use and easily accessible at all levels of healthcare, and this anthropometric data has a high predictive capacity of global cardiovascular risk[35].

It is recommended to measure the patient standing, taking as reference the midpoint between the lower costal edge and the iliac crest at the level of the mid-axillary line, parallel to the floor. Poor measurement can generate an overestimation of disease with an erroneous diagnosis[38]. The AC helps to distinguish in the body tissue, which is visceral or central. However, despite its importance, the waist measurement is not considered as a unique index of adiposity[39]. This anthropometric measurement should be taken without clothes, that is, directly on the skin as shown in figure 1.

Figure 1: Anthropometric measurement of AC, Adapted from Castanheira et al. 2018[40].



Reference values according to the population

Several countries have developed research to determine reference values for waist circumference, since they are different than those established by various public health organizations[41,42]. For example, there are evident differences between the values set by the various organizations and recent studies in many Asian countries[43]. In Malaysia, there is socioeconomic discrepancy; in this study population the results of waist circumference in low-income people are within the proposed average of this study, but the cut-off point in higher-income population is different than the previously established by the WHO[44,45]. Moreover, women in Peninsular Malaysia show a higher AC compared to East Malaysia; likewise, the higher the WC, the higher the metabolic complications were found[46]. Similarly, an analysis by Liao Q et al. in 2018 regarding waist circumference measurement shows that the Beijing population with elevated AC have a higher prevalence of metabolic disorders such as hypertension, cardiovascular disease, chronic obstructive pulmonary disease (COPD), and type 2 diabetes[47]. Data based on a study by Nam GE et al. in Korea in 2018, shows the relationship between BMI, visceral tissue --especially at the abdominal level-- and mortality. These findings associate suffering a cardiovascular event to abdominal perimeters greater than 90 cm in men and 85 cm in women, with a BMI greater than 25 kg/m^2, causing stress, depression, and cognitive fragility. These studies stress the importance of investigating standardized anthropometric measures adjusted for each population[48,49].

Weight and height are not sufficient when making a diagnosis in search of metabolic alterations, nor do they alone serve as a predictor of disease. A study conducted in Germany with respect to anthropometric data emphasized the use of visceral adipose tissue measurement for early detection of associated comorbidities[50].

On the other hand, in its latest revision of criteria for diagnosis of metabolic syndrome, the ALAD has a reference value for AC ≥ 94 cm in men and ≥ 88 cm in women; thus, recognizing that Latin American men have an increased cardiovascular risk with 94 cm waist circumference, unlike the ATPIII, which relates an increased health risk with a value of 102 cm in men[51].

Results and discussion

Several studies have been analyzed by continents, and, in turn, each country shows a different value of the AC. Here lies the importance of the search for a cut-off point for each specific population. The thresholds for AC were different from those established by the WHO, ALAD, IDF and ATP-III; this review highlights the importance of measuring the abdominal perimeter as well as the search for a useful cut-off point for each country or region.

A study conducted in Macedonia in an adolescent population showed, with respect to the reference percentiles for AC, that there is an increasing trend where AC increases progressively with age, putting health at risk[52]. The assessment of the AC according not only to the population but also to age, sex and BMI, is useful at the time of diagnosis, prognosis and monitoring of patients.

Regarding the Asian continent (Table 1), the values published by population studies show a value of AC for men between 85 to 94 cm and women from 80 to 82 cm; this reference point is close to the value given by the IDF[53,54]. Additionally, in Lebanon two studies with different populations were conducted, resulting in a deviation of 9 cm in the measurement in the male sex, and no major differences in women.

Meanwhile, in the European continent (table 2)[55,56] studies show that even within the same country there is a difference. They propose a value of 102 cm for men, and 97 cm for women. Thus, it is evident that the cut-off point for men is similar to the WHO value, but it is far from the WHO value for women.

In the African continent (table 3), a more recent study shows a value of 91 cm for men of 82 cm for women; these values are close to the ALAD reference value. Regarding the American continent (table 4), the values between countries, especially in Latin America, are very close to each other for the male sex with values between 91 to 102 cm, which are similar to the ATPIII and WHO values[57,58]. However, in women the values range wildly from 88 to 100 cm, which was the value in the latest study in Chile. This value is not close to any reference value given by the mentioned organizations, also showing a higher percentage of abdominal obesity in women[59].

In Peru, a study conducted by Ramirez JP in 2019 about overweight, obesity and abdominal obesity, showed a higher prevalence of obesity in women, and that they have a high AC above 88 cm. This study even found that 8.8% of women with normal BMI had abdominal obesity[60].

A study conducted in Colombia called *Metabolic Syndrome: a review of international criteria*, shows that there is difficulty at the time of diagnosis by AC for metabolic diseases; the WHO is the closest to the population, but IDF shows a very small difference for the Latin American population[52]. Additionally, in Mexico, a country with a high prevalence of obesity, there are more female cases of obesity, with an AC of 92.3 ± 13.7, exceeding the value established by all reference organizations, while in men there is not so much divergence[61].

In Ecuador, there are two recent studies that have similar values of AC for men and women: 91 to 95 and 90 to 91, respectively. In both cases, they are above the reference values, hence the importance to research a specific AC cut-off point for each population. This discrepancy in values is due to factors such as customs, physical, ethnic and economic income characteristics[62].

Central obesity is based on AC, which has a predictive value of diseases, especially metabolic diseases, and because of the dissimilarity in its results, it has forced each country to search for a specific cut-off point for each population[53]. By not having values in each country or region for AC, it has generated an inadequate diagnosis[63]. Waist circumference discriminates better than other methods and because of its ease of use it can be applied at all three levels of healthcare. Demographic and socioeconomic disparities call into question the use of AC parameters established as a reference by international organizations[23].

Table 1: Summary of studies showing different AC in Asia.

Study and year of publication	Study site and population	Objective	Reference values	Main finding / contribution
Secular trends in the prevalence of abdominal obesity among Chinese adults with normal weight, 1993-2015. (2021)[43].	China 7745 participants (22-year follow-up)	To demonstrate how the AC measurement pattern changes.	90 cm men 80 cm women	66% of the analyzed population presented abdominal obesity. The study evaluated new individuals each year for 22 years; during this period, the AC was modified from 73.1 cm in women and 75.1 cm in men.
Obesity and visceral fat in Indonesia: An unseen epidemic? A study using iDXA and surrogate anthropometric measures (2021).[64]	Indonesia 2623 participants	To provide anthropometric measurements for its population.	85 cm men 81 cm women	64% of women and 81% of men had elevated AC values and at least one metabolic disturbance.
Proposed cut-off values of the waist circumference for metabolic syndrome based on visceral fat volume in a Japanese population (2016). [63]	Japan 405 participants	To obtain optimal AC value for diagnosis of metabolic syndrome.	85 cm men 80 cm women	The AC is influenced by gender, ethnicity, age and characteristics of each region, which makes it necessary to establish new values.
New proposed cut-off of waist circumference for central obesity as risk factor for diabetes mellitus: Evidence from the Indonesian Basic National Health Survey (2020)[54].	Indonesia 24,660 participants	To analyze an optimal AC point.	76 cm men 80 cm women	Dysglycemic worsening in values higher than those established in this guideline.
Anthropometric Cutoffs for Increased Cardiometabolic Risk Among Lebanese Adults: A Cross-Sectional Study[55].	Lebanon 305 participants	To determine anthropometric values according to your country.	94 cm men 82.6 cm women	Operational characteristics of the participants were analyzed.

Table 2: Summary of studies showing different AC on the European continent.				
Sensitivity and specificity of abdominal adiposity with metabolic syndrome in the elderly (2017).[65]	Málaga, Spain. 208 participants	To evaluate the relationship between abdominal fat and metabolic syndrome.	102 cm men 91 cm women	Fat distribution changes with age.
Correlation between Body Mass Index and abdominal circumference in Belgian adults: a cross-sectional study (2017).[56]	Belgium 705 participants.	To assess health risks based on waist circumference.	98.7 cm men 82.2 cm women	Determining the BMI along with AC is of utmost importance to establish an adequate valuation. Likewise, they are both important in the prevention and prognosis of comorbidities.
Comparison of classic and new anthropometric indexes for the screening of metabolic syndrome on the working population (2020) [66].	Córdoba, Spain 636 participants	To determine the predictive capacity of anthropometric values with metabolic diseases.	Early detection: 98.5 cm for men and women	Shows discriminatory capacity in abdominal fat.

Table 3: Summary of studies showing different AC on the African continent				
Determination of optimal cut-off values for waist circumferences used for the diagnosis of the metabolic syndrome among Botswana adults (ELS 32). (2020).[57]	Botswana 384 male and 416 female participants	To determine AC value in adults.	91 cm men 82.3 cm women	The value established in the study compared to the European population is different.

Table 4: Summary of studies showing different AC in the Americas				
Evaluation of Anthropometric Indices and Lipid Parameters to Predict Metabolic Syndrome Among Adults in Mexico (2021).[67]	Mexico 250 participants	To evaluate differential magnitudes in studies.	101 cm men 95.5cm women[44]	The use of AC contributes to the diagnosis in patients with chronic diseases.
Overweight and Abdominal Obesity Association with All-Cause and Cardiovascular Mortality in the Elderly Aged 80 and Over: A Cohort Study (2017) the MetS[62]	Brazil 236 participants	To evaluate AC with all-cause mortality.	102 cm men 88 cm women[45]	A high CC is associated with higher morbidity and mortality.
Relation of body composition indexes to cardiovascular disease risk factors in young adults (2019)[24]	Mexico 1351 participants	To evaluate the relationship of anthropometric components.	Presence of a metabolic alteration with AC greater than 84.8 cm in men and in women greater than 78.1 cm.	High CC was found in metabolically ill patients.
Comparación de índices antropométricos para agregación de múltiples factores de riesgo en adultos de Cuenca, Ecuador (2016) [68]	Ecuador 318 participants	To define a cut-off point for AC for the population of Cuenca.	95,5 cm men 91.5 cm women[46]	There is variability due to the characteristics of the population.
Age-specific waist circumference cutoff-points for abdominal obesity diagnosis: a personalized strategy for a large Venezuelan population[58]	Venezuela 1902 participants	To determine cut-off points for CC according to age in the adult population of the city of Maracaibo, Venezuela.	94 cm men 91 cm women	There is an underestimation observed in young people and the overestimation observed in older adults when using a single cut-off point.
Prevalence and clinical-epidemiologic characteristics of a Mexican population with metabolic (dysfunction) associated fatty liver disease: An open population study (2022)[59]	Mexico 585 participants.	To know the prevalence of fatty liver disease associated with metabolic dysfunction.	94 cm both sexes	Despite having taken as a reference point the values issued by the WHO for 88 cm for women and 102 cm for men, it is evident in the review of this article a discrepancy especially in women with a value above the standard.
Body adiposity index as marker of obesity and cardiovascular risk in adults from Bogotá, Colombia (2015)[69]	Colombia 517 participants	To determine the usefulness of the body adiposity index as an indicator of obesity.	86 +/- 15 cm both sexes	27% of patients with AC over the standard also had metabolic alterations.
Optimal waist circumference cutoff values for predicting metabolic syndrome among older adults in Ecuador (2019)[70] .	Ecuador 2306 participants	To determine optimal waist circumference cut-off values to predict metabolic syndrome	91.2 cm men 90.7 cm women	In women, the cut-off for CC is found to be high while in men the cut-off is below the established limits.
Relación entre circunferencia de cintura, parámetros metabólicos y presión arterial en universitarios de primer año de la facultad de medicina de la universidad del desarrollo (2021)[71].	Chile 103 participants.	To analyze the association between waist circumference, waist-to-height ratio and waist-to-hip ratio with metabolic parameters.	100 cm for men and women	The value for men agrees with the WHO value, while there is a 12-cm discrepancy for women.

Conclusions

Obesity, with its increasing number of cases, forces us to search for anthropometric measurements adaptable to each population and its physical, ethnic and socio-cultural conditions, thus establishing our own anthropometric values. This study leads us to a real perception of AC and the relationship with cardiovascular and metabolic diseases and to the early detection of risk factors; for an early intervention and decrease of public health expenses. The impact of this review lies in the urgent search for a cut-off point for AC, to provide a reference to health personnel in Latin American countries where women's waist circumference is higher to the reference values.

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