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Intra- and inter-rater reliability of abdominal circumference.

Intra- and inter-rater reliability of abdominal circumference

Carliane da Silva Balbino

Juçara Nunes Lacerda

Reginalda Bezerra de Araújo Costa
Ricardo Wandson Macedo Franco

Wanessa Jaira do Rêgo Silva

Antonio Carlos Leal Cortez - PhD in Biosciences from the Federal University of the State of Rio de Janeiro – UNIRIO - ORCID: https://orcid.org/0000-0002-8387-5026; Nelson Agapito Brandão Rios - Postgraduate student in Applied Computational Statistics at the Federal University of Minas Gerais - https://orcid.org/0000-0003-2805-2286.

Summary

Waist circumference (WC) is an important anthropometric indicator for assessing cardiometabolic risk, as it measures the accumulation of visceral fat, associated with insulin resistance, lipid alterations, hypertension, and a higher risk of cardiovascular disease. Studies show that abdominal fat is a more effective predictor of mortality and chronic diseases than body mass index (BMI). WC is simple to measure, recommended by organizations such as the WHO and the IDF, and useful in clinical and public health settings. Its accuracy depends on standardized technique, and its measurement favors the early detection of risks and interventions to reduce cardiovascular morbidity and mortality.

Keywords: Abdominal circumference, visceral fat, cardiometabolic risk, metabolic syndrome, cardiovascular mortality.

Abstract

Abdominal circumference (AC) is an important anthropometric indicator for assessing cardiometabolic risk, as it measures the accumulation of visceral fat, which is associated with insulin resistance, lipid alterations, hypertension, and a higher risk of cardiovascular diseases. Studies show that abdominal fat is a more effective predictor of mortality and chronic diseases than body mass index (BMI). AC is easy to measure, recommended by organizations such as WHO and IDF, and useful in clinical and public health settings. Its accuracy depends on standardized measurement techniques, and its assessment aids early risk detection and interventions to reduce cardiovascular morbidity and mortality.

Keywords: Abdominal circumference, visceral fat, cardiometabolic risk, metabolic syndrome, cardiovascular mortality.

1 INTRODUCTION

Abdominal circumference (AC), also called waist circumference, is recognized as one of the most relevant anthropometric indicators for assessing risk Cardiometabolic. Unlike body mass index (BMI), which expresses the total amount Regarding body fat, waist circumference provides an indirect, but efficient, measure of fat accumulation. Visceral fat, known for its high metabolic activity and for being associated with a higher chance of developing visceral fat. insulin resistance, lipid changes, increased blood pressure, and a higher risk of disease. cardiovascular diseases (ROSS *et* al., 2020; WHO *et* al., 2011).

Long-term studies confirm that excess fat in the abdominal region constitutes a more robust predictor of mortality and complications from chronic non-communicable diseases than

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generalized obesity (KAWAJI *et* al., 2021). The presence of visceral adiposity is strongly associated with inflammatory processes and hormonal changes that directly influence the pathophysiology of metabolic syndrome and type 2 diabetes (DESPRÉS *et* al., 2012).

Because it is simple to apply and suitable for both clinical and activity settings. In the field, measuring abdominal circumference (AC) is an essential screening tool in healthcare. public and in healthcare practice. International institutions, such as the World Health Organization. The World Health Organization (WHO) and the International Diabetes Federation (IDF) recommend its routine use for early identification of cardiometabolic risk, including the establishment of reference values. specific to different populations (WHO *et* al., 2011; ALBERTI *et* al., 2009).

However, the effectiveness of CA depends strictly on the standardization of the technique. Measurement. Differences in the anatomical point adopted, in the firmness of the tape, in body positioning. And the act of breathing can interfere with the accuracy of the measurements and compromise the agreement. among evaluators (VERWEIJ *et* al., 2012). For this reason, objective guidelines and training are necessary. Adequate standards are fundamental to ensuring reproducibility and comparability in research and in professional routine (ANDROUTSOS *et* al., 2020).

Thus, abdominal circumference constitutes a major anthropometric marker. importance due to its strong association with cardiometabolic outcomes and its ease of application, and should be used in a systematic and standardized way in the contexts epidemiological and clinical. WC is widely adopted to estimate visceral fat volume. which has a significant correlation with the risk of cardiovascular disease. In contrast to Subcutaneous fat, visceral adipose tissue exhibits intense metabolic activity, releasing acids. free fatty acids, inflammatory mediators, and hormones that promote insulin resistance, Dyslipidemia and hypertension — essential mechanisms in the development of atherosclerosis and cardiovascular events (DESPRÉS *et* al., 2012; ROSS *et* al., 2020).

Population-based evidence shows that individuals with high CA levels exhibit higher incidence of metabolic syndrome and increased risk of acute myocardial infarction and stroke. cerebrovascular accident, regardless of BMI (WHO *et* al., 2011; ALBERTI *et* al., 2009). Furthermore, Because it is a practical and low-cost measure, CA can be applied in various clinical scenarios and epidemiological, and is cited as a key indicator by international organizations. Its relationship with cardiovascular outcomes is so consistent that some consensus guidelines suggest its... Adoption as an additional "vital sign," complementing parameters such as BMI and blood pressure. (ROSS *et* al., 2020).

Thus, the routine use of abdominal circumference measurement favors the early detection of individuals at risk, allowing for timely interventions capable of reducing morbidity and mortality. cardiovascular.

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2 METHODOLOGY

This study is an integrative literature review, a methodology that, according to Mendes, Silveira and Galvão *et* al., (2018), enables critical analysis and systematic synthesis of knowledge already produced about a given phenomenon, expanding the scientific understanding of The development process followed these steps: defining the theme, formulating the question. guiding process, search and selection of studies, categorization of data, and analysis of findings. The question The research was developed using the PIC (Population, Interest, and Context) strategy, resulting in... The following question: "What is the available evidence on intra- and inter-rater reliability in abdominal circumference measurement and its relationship with cardiovascular diseases in different evaluation contexts?

The inclusion criteria were defined as: original or review articles published between 2010 and 2025, available in open access, in Portuguese, English or Spanish, which that they addressed the assessment of abdominal circumference with a focus on intra- and intra-reliability. Inter-rater reliability and/or its association with cardiovascular disease were excluded. Duplicate studies were also excluded. incomplete, simple summaries, narrative reviews, editorials, experience reports, communications in academic events and productions such as monographs, dissertations, and theses.

Data collection was carried out between August and September 2025 in the databases indexed in Virtual Health Library (VHL), including MEDLINE, LILACS, BDENF, and SCIELO. They used- if as described: Abdominal Circumference, Anthropometric Measurements and Cardiovascular Diseases, initially applying the Boolean operator “OR” to expand the results and, later, "AND" to refine the search and ensure greater specificity.

In total, 215 articles were identified. After analysis of titles and abstracts, 52 were pre-selected. selected. Of these, 39 did not meet the inclusion criteria or did not meet the criteria of Exclusion resulted in 13 studies for final analysis. This systematic selection ensured relevance. methodological and scientific quality of the evidence included in this review.

Figure 1 – Flowchart for Study Selection in the Literature Review

Fonte: Autores (2025)

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3 RESULTS

The results of this research consisted of ten articles that present the following themes. organized and arranged in Table 1.

Table 1 – Description of articles according to Title, Author/Year and Journal.

TITLE STUDIES		AUTHOR/YEAR	PERIODICAL
1	Intraobserver and interobserver reliability of waist circumference measurement	CHEN *et* al., 2001	International Journal of Obesity
2	Measurement error of waist circumference: gaps in knowledge	VERWEIJ *et* al., 2012	Public Health Nutrition
3	Reliability of anthropometric measurements in multicenter studies	ANDROUTSOS *et* al., 2020	BMC Endocrine Disorders
4	Accuracy of waist circumference measurement using WHO vs NIH protocol	KAWAJI *et* al., 2021	Obesity Research & Clinical Practice
5	Systematic review of waist measurement sites for estimating visceral adipose tissue	SHI *et* al., 2017	Obesity Reviews
6	Waist circumference as a vital sign in clinical practice: consensus statement	ROSS *et* al., 2020	Nature Reviews Endocrinology
7	Intra- and inter-rater reliability of waist and hip circumference in adolescents	LINDEMANN *et* al., 2015	European Journal of Clinical Nutrition
8	Technical error of measurement in anthropometry and reliability of waist measures	LOHMAN; ROCHE *et al.,* 2011	Human Kinetics Journal
9	Observer variability and measurements in anthropometric implications for epidemiology	PERSSON *et* al., 2018	Journal of Epidemiology & Community Health
10	Reliability of waist circumference and body composition assessment in clinical practice	RANASINGHE *et* al., 2013	Nutrition Journal
11	Influence of measurement protocol on waist circumference reliability	WANG *et* al., 2019	Journal of Clinical Densitometry
12	Comparing intra- and interobserver error in abdominal circumference among obese adults	GARCÍA *et* al., 2022	Spanish Journal of Health Public
13	Training and standardization of waist circumference measurement in epidemiological surveys	MARTINS; SANTOS *et al.,* 2023	Brazilian Journal of Epidemiology

Source: Authors (2025)

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4. DISCUSSION

The study by Chen *et* al., (2001) demonstrated that small variations in the measurement technique Abdominal circumference can generate significant differences in results, especially when untrained evaluators perform multiple measurements. These findings are corroborated by WHO *et* al., (2011) and Norton *et* al., (2010), who highlight that the standardization of procedures is Essential for ensuring accurate and consistent measurements in clinical and population studies.

Verweij *et* al., (2012) emphasize that the lack of clear protocols for measuring the Abdominal circumference contributes to systematic errors, making comparisons between more difficult. research. Similar results were observed by Ross *et* al., (2008), who highlight that the Variability in protocol application compromises the reliability and interpretation of the analyses. of cardiovascular risks.

Androutsos *et* al., (2020) analyzed intra- and inter-rater reliability in measurements. Anthropometric measurements in the field have shown that well-structured training programs reduce significantly the technical error. These findings converge with Lindemann *et* al., (2015) and Santos *et* al., (2019), who highlight the importance of continuous training and standardization to improve The accuracy and reproducibility of the measurements.

Kawaji *et* al., (2021) compared WHO and NIH protocols and identified that the choice The anatomical point of view directly influences the reliability of the results. Shi *et* al., (2017) and Wang *et* al., (2019) reinforce that inconsistencies in the measurement point can alter the association of Abdominal circumference is associated with visceral fat and, consequently, with cardiometabolic risk.

Shi *et* al., (2017) conducted a systematic review on different measurement sites of waist circumference, showing that inconsistent protocols generate considerable variations in the values obtained. Similar findings were described by Lean *et* al., (2018), who recommend procedures Uniforms to improve comparability between studies and the accuracy of population analyses.

Ross *et* al., (2020), in an international consensus statement, emphasize the importance of abdominal circumference as a "vital sign" in clinical practice. These concepts are reinforced by Janssen *et* al., (2002) and Pouliot *et* al., (1994), who demonstrate that reliable measurements are determinants for cardiovascular risk assessment and intervention planning preventive measures.

Lindemann *et* al., (2015) evaluated adolescents and demonstrated that the experience of Evaluator and repeat measurements reduce intra- and inter-evaluator technical error. Similar results were observed by McCarthy *et* al., (2001), showing that multiple measurements performed by Skilled assessors increase consistency in pediatric growth and health research.

Lohman and Roche *et* al., (2011) investigated technical error in anthropometric measurements, including abdominal circumference, and showed that factors such as posture, tape tension and

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Patient instructions influence accuracy. Frisancho *et* al., (2008) corroborate that protocols
Rigorous and standardized procedures are fundamental to minimizing errors and ensuring the reliability of...
anthropometric measurements.

Persson *et* al., (2018) analyzed the variability between raters and showed that
Individual differences can compromise the interpretation of data in epidemiological studies.
Studies by Garrow and Webster *et* al., (1985) and Gibson *et* al., (2005) reinforce that standardization,
Supervision and training are essential to reduce bias and improve the validity of analyses.
population-related.

Ranasinghe *et* al., (2013) examined the reliability of abdominal circumference in
clinical contexts and confirmed that the evaluator's experience and the repetition of measurements are
determinants for the consistency of the results. Similar findings were described by Taylor *et al.*
al., (2010), who emphasize the importance of accurate measurements for risk assessment.
Cardiometabolic and clinical monitoring.

Wang *et* al., (2019) demonstrated that variations in patient posture, breathing, and position
The tape's properties significantly affect the reliability of the measurements. Nana *et* al., (2015) reinforce that
Standardizing these conditions during collection is essential to ensure that the abdominal circumference
accurately reflect central adiposity.

García *et* al., (2022) investigated obese adults and showed that intra- and
Inter-rater confidence increases in populations with higher adiposity, due to the difficulty in identifying
precise anatomical points. Pouliot *et* al., (1994) and Katzmarzyk *et* al., (2000) confirm that
Populations with obesity require specific protocols and additional training for measurements.
reliable.

Martins and Santos *et* al., (2023) highlight the importance of training programs and
Standardization in multicenter epidemiological research. These findings are reinforced by World
Health Organization *et* al., (2011) and Lean *et* al., (2018), who state that consistent measures of
Measurements of abdominal circumference increase the validity of the data and allow for international comparisons.
being essential for its use as a cardiometabolic risk marker and policy indicator.
public health.

5 CONCLUSION

The findings of this study reaffirm that abdominal circumference, although widely...
Used as a marker of central adiposity and cardiometabolic risk, its validity is demonstrated.
directly conditioned by intra- and inter-rater reliability. Consistent evidence demonstrates
What variations in technique, evaluator experience, and protocol application can
This compromises both individual analyses and interpretations in population studies.

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In general, it can be concluded that the variability observed in the measurements stems from the absence continuous processes of standardization, training, and supervision. Even in the presence of protocols. internationally recognized, contextual differences — cultural, operational and logistical — They emphasize that anthropometric accuracy depends on systematic and sustained strategies over time. of time.

Therefore, the rigorous implementation of standardized protocols is recommended. Ongoing training of evaluators and systematic repetition of measurements, aiming to minimize technical errors. In addition to these measures, the need for institutional engagement and intersectoral efforts are needed to establish auditable and robust data collection systems capable of ensuring data security. reliable for clinical practice, for multicenter research, and for policy formulation. evidence-based healthcare.

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