Evaluando la composición corporal en ancianos: comparando IMC, circunferencia de la pantorrilla y DXA

Assessing body composition in older adults: comparing BMI, Calf circumference, and DXA

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Resumen

Introducción: Esta investigación tuvo como objetivo investigar la posible correlación entre el índice de masa corporal (IMC), la circunferencia de la pantorrilla izquierda (CC) y la absorciometria dual de rayos X (DXA).
Objetivo: Después del proceso de muestreo, se seleccionaron 287 participantes (X = 66,50 ± 5,75 años) residentes en Aracaju, Brazil, que fueron asistidos por las Unidades Básicas de Salud (UBS) Augusto Franco y Antônio Alves. Los procedimientos de las Normas Internacionales de Evaluación Antropométrica midieron la masa corporal y la altura.
Metodología: El coeficiente de correlación intraclase (CCI) se utilizó para evaluar la confiabilidad de las mediciones antropométricas. La prueba de correlación de Pearson investigó las asociaciones entre las variables DXA, IMC y CC. El coeficiente de determinación (r2) se utilizó para verificar el poder explicativo entre las variables del estudio. El nivel de $p < 0{,}05$ se consideró para la significación estadística. Resultados: la correlación entre DXA e IMC observó una correlación positiva, alta y significativa ($r = 0{,}928$, $p < 0{,}001$) entre los dos parámetros; se identificó una correlación positiva, moderada y significativa entre CC y DXA ($r = 0{,}641$, $p < 0{,}001$); y se mostró una correlación moderada y significativa entre CC e IMC ($r = 0{,}648$, $p < 0{,}001$). Conclusión: Las correlaciones fueron positivas entre IMC y DXA, que fueron fuertes, y CC y DXA, que fueron moderadas, lo que demuestra que ambos métodos se pueden aplicar para la evaluación de la composición corporal en personas mayores debido a su facilidad y bajo costo.

Palabras clave

Composición corporal; absorciometria de fotones; Índice de masa corporal; ancianos; envejecimiento.

Abstract

Introduction: This research aimed to investigate the possible correlation between body mass index (BMI), left calf circumference (CC), and dual-energy X-ray absorptiometry (DXA).
Objective: After the sampling process, 287 participants (X = 66.50 5.75 years) residing in Aracaju, Brazil, were selected and assisted by the Augusto Franco and Antônio Alves Basic Health Units (UBS). The International Standards for Anthropometric Assessment procedures measured body mass and height.
Methodology: The intraclass correlation coefficient (ICC) was used to assess the reliability of anthropometric measurements. Pearson's correlation test investigated the associations between DXA, BMI, and CC variables. The coefficient of determination (r2) was used to verify the explanatory power between the study variables. The level of $p < 0.05$ was considered for statistical significance.
Results: the correlation between DXA and BMI observed a positive, high, and significant correlation ($r = 0.928$, $p<0.001$) between the two parameters; a positive, moderate, and significant correlation was identified between CC and DXA ($r = 0.641$, $p<0.001$); and a moderate, and significant correlation was shown between CC and BMI ($r = 0.648$, $p<0.001$).
Conclusion: The correlations were positive between BMI and DXA, which were strong, and CC and DXA, which were moderate, showing that both methods can be applied for body composition assessment in older people due to ease and low cost.

Keywords

Body composition; photon absorptiometry; Body mass index; elderly; aging

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Introducción

Changes in body composition occur with the physiological aging process, including an increase in fat mass (De Oliveira Damasceno et al., 2024), mainly in central and visceral deposits, and a decrease in fat-free mass. Studies show that overweight older women have worse dynamic balance and a higher prevalence of falls when compared to average-weight older women (Wu & Chen, 2022; Rodrigues et al., 2020). In addition to being associated with increased risks of metabolic and cardiovascular diseases (González et al., 2021). The hallmarks of aging, including age-related muscle and bone mass loss and increased adiposity, may occur universally in later years (Gustafsson & Ulfhake, 2023).

The aging process can contribute to a lower basal metabolic rate, promoting an unfavorable body composition (Palmer & Jensen, 2022). Changes in muscle and fat distribution due to aging and their correlations with health outcomes differ by gender (Kawakami et al., 2020). Furthermore, the regional distribution of fat affects the relationship between obesity, metabolism, and health and plays an essential role in cardiovascular and metabolic diseases.

Of the different options available to assess body composition, the World Health Organization (Żuchowski & Jeka, 2024) recommends using the Body Mass Index (BMI). However, there is ongoing debate regarding the development of different BMI cutoffs for different ethnic groups due to growing evidence that associations between BMI, body fat percentage, and body fat distribution differ across populations (Hagberg & Spalding, 2024).

Body fat percentage changes with age, and the rate of this change differs depending on gender, ethnicity, and individual differences. Although BMI correlates with metabolically healthy fat accumulation in general populations, the actual distribution or location of body fat is not as readily correlated with BMI (Haack, Luz & Farias, 2019). Another validated lean mass measurement is the left calf circumference (CC) test. This procedure is simple, inexpensive, non-invasive, and relevant in diagnosing changes in lean mass with age, influenced by decreased physical activity (Ponti et al., 2020). Diagnostically, the left calf circumference test has been used to assess muscle mass and estimate the prevalence of sarcopenia, predict disability, mortality, and need for care, as well as determine cutoff points for decreased muscle mass in older women (Oliveira et al., 2024; WHO, 2024).

Additionally, studies have shown its applicability in men. For example, Champaiboon et al. (2023) demonstrated that calf circumference can effectively screen low skeletal muscle mass, providing cutoff values for independent elderly Thai men.

When classifying the nutritional status of older people from the calf circumference, the cutoff point of 31cm is used as a moderate classification; above 31 cm represents a probability of good nutritional status, and below it is observed as an indication of malnutrition (Messina et al., 2020).

Despite its greater complexity, need for specific instruments, costs, and specialized facilities, dual-energy X-ray absorptiometry (DXA) is considered a "Gold standard" technique in body composition assessment (Slart et al., 2024) and has become a method of choice for professionals in the field due to its ability to efficiently measure distinct body compartments: total and regionalized fat mass (FM), lean tissue mass (LTM), bone mineral content (BMC), and bone mineral density (BMD) (Laksmi et al., 2019).

The use of DXA for body composition assessment in daily clinical practice should be extended to overweight and obese patients to better assess their cardiovascular and oncological risks related to excess adiposity.

Despite its greater complexity and cost, dual-energy X-ray absorptiometry (DXA) remains the "gold standard" for body composition assessment, efficiently measuring fat mass, lean tissue mass, bone mineral content, and bone mineral density. However, its resource demands limit its accessibility in many primary care settings. Therefore, this study investigates the correlation between simple, readily available measures (BMI and CC) and the gold-standard DXA method to assess body composition in older women. This aims to determine if BMI and CC can serve as practical, cost-effective screening tools for identifying individuals needing further, more sophisticated assessment in primary healthcare settings, improving access and timely intervention.

Método

Study design and sample

The population for this correlational study consisted of 287 older women residing in Aracaju (SE, Brazil). Recruitment was assisted by visits to Basic Health Units (UBS) in the south zone of Aracaju. The research was publicized, and the sampling process was undertaken.

Inclusion criteria included being 60 or older, committing to participating in a physical exercise program, and being independent in daily living activities. Exclusion criteria were participants who, for some reason, had cognitive limitations.

The sample size was calculated using the G*Power 3.1 software (Faul et al., 2009) based on the following information: Two-tailed correlation, power of 0.80, α = 0.05, and an effect size of 0.35. The program estimated the sample size to be 229 participants.

Due to the potential for discontinuity during the intervention phase, more participants were recruited (approximately 20% higher). Thus, after the sampling process, 287 individuals were selected.

The present study meets the standards for conducting research involving human subjects, per Law No. 14,874 of May 28, 2024 (Brasil, 2024) This law covered research with human beings and led to the establishing of the National System of Ethics in Research with Human Beings to which the project adheres. It also complies with the principles outlined in the Declaration of Helsinki - Ethical Principles for Medical Research Involving Human Subjects (WMA, 2008). The Research Ethics Committee with Human Subjects of Tiradentes University approved the research project on 2024 May 4, under Ethics Committee Review, no. 6.847.940 - CAAE: 26524719.4.0000.5371.

Following ethical approval, the research aims and procedures were explained to potential participants, after which they were asked about their interest in joining the study and invited to participate. Those who wished to do so signed the Informed Consent Form - ICF.

Procedimientos

The procedures by the International Society for the Advancement of Kinanthropometry (ISAK) were used to measure body mass and height (Silva & Vieira, 2020, Lohman *et al*., 1988). The same evaluators undertook each measurement to ensure consistency throughout the study. The anthropometrists participating in the study had ISAK level 1 certification.

Body mass (in kilograms) was measured by the participants wearing light clothing and standing on the central part of the platform of the Filizola® (Brazil) mechanical scale. This scale was calibrated to a precision of 100 g. and had a National Institute of Metrology, Quality, and Technology - INMETRO (in Portuguese) certification that confirmed its compliance with Brazilian regulations for medical equipment. ,

An aluminum stadiometer was used to measure height in centimeters, with an accuracy of 1mm. The measurement required that participants stood upright, arms extended along the body, feet together, and heads oriented according to the Frankfurt plane. During the measurement, participants were required to hold their breath.

For the measurement of calf circumference to assess lean mass, a metal tape measure (Lufkin W606 PM, Lufkin® Sparks, Maryland, USA) with a resolution of 0.1 cm was used. This tape measure was positioned horizontally around the calf in the space between the ankle and the knee at the point of greatest diameter. Each older woman was seated, her weight evenly distributed between both feet.

The anthropometric parameter indicated by the Ministry of Health of Brazil to assess the nutritional status of older people is the Body Mass Index (BMI), with cutoffs of < 22 kg/m^2 for malnourished status, between 22 and 27 kg/m^2 for eutrophic status, and above 27 kg/m^2 for overweight categorization (Rodrigues-Bezerra *et al.*, 2021). The measurements of body mass and height, as well as the BMI of the participants, were obtained using the formula BMI = Body mass (kg) / $height^2$(m).

The body composition assessment using whole-body dual-energy X-ray absorptiometry (DXA) was used because it is a standard reference technique in clinical practice for the assessment of body composition (bone, fat, and muscle mass) due to its low cost and wide availability (Laksmi *et al.*, 2019). Participants were instructed to wear light clothing without any metal objects or jewelry. They were also advised to avoid heavy meals and excessive fluid intake before the scan. Throughout the procedure, participants were asked to remain still and breathe normally, without holding their breath, to guarantee accurate measurements.

Análisis de datos

Data were analyzed using the IBM SPSS Statistics 23 program (IBM, 1 New Orchard Road, Armonk, New York 10504-1722, USA) and presented as mean and standard deviation. The intraclass correlation coefficient (ICC) was used to assess the reliability of anthropometric measurements. The normality of the data was analyzed using the Kolmogorov-Smirnov test. Pearson's correlation test was used to analyze the associations between the variables DXA, BMI, and calf circumference. The coefficient of determination (r2) was used to verify the explanatory power between the study variables. The Bland and Altman test was used to observe the level of agreement between the measurement methods. The level of $p < 0.05$ was considered for statistical significance.

Resultados

287 elderly women were evaluated with the characteristics presented in Table 1.

Table 1 presents the characterization of the sample in terms of anthropometric variables and age. All variables analyzed were standard.

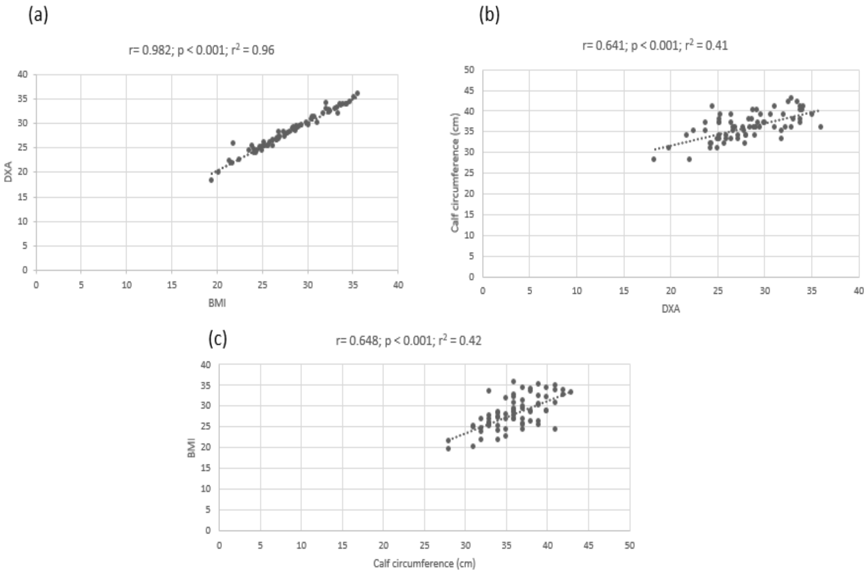
Table 1. Sample characterization (n=287)

	Average	SD	Minimum	Maximum	p-value (KS)
Age (years)	66.50	5.75	60.00	83.00	0.051
Body mass (kg)	66.09	9.64	40.70	89.30	0.359
Height (m)	1.53	0.06	1.42	1.68	0.101
BMI (kg/m2)	28.20	3.92	19.45	35.65	0.200
Calf circumference (cm)	36.10	3.28	28.00	43.00	0.200
DXA (g/cm2)	28.27	3.86	18.30	36.00	0.200

Legend: BMI= Body Mass Index; DXA = Whole Body Dual Energy X-ray Absorptiometry; SD= Standard Deviation; KS = Kolmogorov-Smirnov.

Figure 1 presents the correlation analysis between BMI, left calf circumference (CC), and whole-body DXA. The letter A in Figure 1 shows the correlation between DXA and BMI. Observing a positive, high, and significant correlation ($r^2 = p<0.001$) between the two parameters is possible. The letter B in Figure 1 shows the positive, moderate, and significant correlation between CC and DXA ($p<0.001$). The letter C in Figure 1 presents the positive, moderate, and significant correlation between CC and BMI ($p<0.001$). It is possible to observe that all correlations were positive or directly proportional.

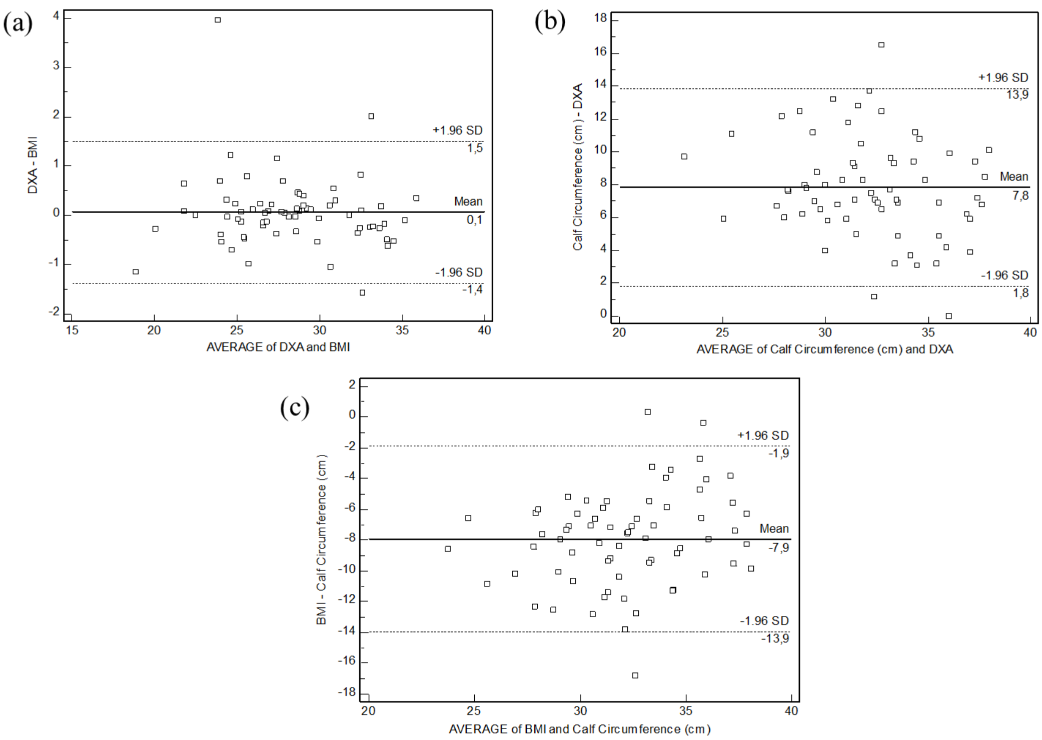
Figure 1. Correlation between BMI, left calf circumference (CC), and whole body DXA.



Legend: (a) Correlation between body mass index (BMI) and whole-body Dual-Energy X-ray absorptiometry (DXA); (b) Correlation between calf circumference and whole-body Dual-Energy X-ray Absorptiometry (DXA); (c) Correlation between body mass index (BMI) and left calf circumference (CC).

Figure 2 shows the level of agreement between the measurement methods using the Bland-Altman test. It was observed that the differences in the means between the measurement methods (DXA, BMI and calf circumference) were concentrated within the acceptable limit (< ± 1.96 SD).

Figure 2: Level of agreement between the measurement methods using the Bland-Altman test: (a) body Dual-Energy X-ray absorptiometry (DXA) and body mass index (BMI); (b) Calf circumference and Dual-Energy X-ray Absorptiometry (DXA); (c) body mass index (BMI) and calf circumference.



Discusión

The study can establish a positive, high, and significant correlation between DXA and BMI ($r = 0.928$, $p<0.001$); a positive, moderate, and significant correlation was identified between CC and DXA ($r = 0.641$, $p<0.001$); and a moderate, and significant correlation was shown between CC and BMI ($r = 0.648$, $p<0.001$).

The older women in this study had a lower mean age than other studies of older women in primary health care in the northeastern region (Watanabe et al., 2022; Fernandes et al., 2022).

The correlation between DXA and BMI observed in this study showed a positive, high and significant association ($p < 0.001$) between the two parameters. This association was also observed in the study by Ponce-García et al. (2024), in which BMI was shown to be highly correlated with DXA measurements of adiposity, total fat percentage and other metabolic biomarkers such as systolic and diastolic blood pressure, plasma cholesterol and triglycerides.

The mean value found in the body mass index of the older women in the study was higher than the value considered normal, therefore classifying them as overweight. When comparing the BMI values found with those of other studies, it is evident that most older women (60.4%) are close to the overweight range. As anticipated, the BMI of the elderly women in this study ($\bar{x} = 28.20 \pm 3.92$ Kg/m^2) was significantly higher than that found in both active ($\bar{x} = 24.50 \pm 2.55$ Kg/m^2) and sedentary ($\bar{x} = 26.08 \pm 2.81$ Kg/m^2) elderly men reported by Hag et al. (2025). While it may not be particularly relevant to directly compare the BMI of men and women, these values highlight the extent of the difference between these groups. When comparing the body mass of older women in the present study ($\bar{X} = 66.50 \pm 5.75$ years) with a sample of postmenopausal women ($\bar{X} = 50.4 \pm 2.35$ years) from the study by Valeh et al. (2020), a difference of $\Delta\% = -12\%$ was found. This difference cannot be explained solely by the age difference but most likely by the distinct social, dietary, and economic realities between the population from the northeast of Brazil and Iran.

The study by González-Correa et al. (2024) with 124 women with an average age of 69.6 ± 3.1 years showed a direct positive correlation between BMI and WC, with a Pearson correlation coefficient of 0.57 (p-value <0.0001). Although González et al. (2021) showed that mean calf circumference values are significantly higher in overweight/obese people and lower in people with a BMI <18.5, regardless of age, ethnicity, or race. This can be explained by the amount of adipose and intermuscular tissue in the calves.

The study by Ya and Bayraktutan (2023) indicates that altered body composition during aging influences the accumulation of subcutaneous fat and contributes to the formation of cellulite, while decreased muscle tone and skin elasticity can facilitate the development of edema.

Calf circumference can be used as a screening tool for reduced muscle mass, as it is positively associated with body mass index, regardless of obesity and age, and is a simple and accurate indicator marker of muscle mass to diagnose sarcopenia (Jeong et al., 2023). The average calf circumference found in this study ($\bar{X} = 36.10 \pm 3.28$ centimeters) is greater than that of the De Oliveira et al. (2024) study, although both were carried out in the northeastern region of Brazil.

The average BMI value was considered above normal parameters ($\bar{X} = 28.27 \pm 3.86$ g/cm2). The results were similar when comparing the values found by DXA and BMI. Haack et al. (2019) also found high agreement in anthropometric data between BMI and DXA.

The correlation between DXA and BMI observed in this study showed a positive, high, and significant ($p<0.001$) correlation between the two parameters (Ponce-García et al., 2024). This association was also observed in the study by Dorgan et al. (2023), in which they found BMI to be highly correlated with DXA measurements of adiposity, fat percentage, and total fat and to be similarly correlated with metabolic biomarkers such as systolic and diastolic blood pressure, plasma cholesterol, triglycerides, glucose, insulin, and C-reactive protein.

According to Messina et al. (2020), DXA is appropriate for determining the regional and total amount of body muscle and is noteworthy for its effectiveness in measuring body composition, including adiposity. However, it should be noted that muscle mass correlates with body size, and therefore, DXA values are usually adjusted to body parameters such as BMI.

Furthermore, in a longitudinal study with obese women, it was observed that BMI measurements were ineffective in documenting changes in body composition at 12-month follow-up. In contrast, DXA can detect regional changes, which were partially parallel to changes in biochemical indices, regardless of changes in BMI (Ponti et al., 2020).

In this study, the correlation between CC and DXA and CC with BMI showed positive, moderate, and significant ($p<0.001$). Kawakami et al. (2020) analyzed 1296 middle-aged adults, 827 men and 412 women and identified that calf circumference was positively associated with measured DXA and BMI (men: $r = 0.78$, women: $r = 0.76$). In the subgroup analyses by obesity and age, calf circumference was also positively correlated with DXA-measured BMI, a simple and accurate indicator for diagnosing sarcopenia.

The correlation between calf circumference and BMI showed a significant positive correlation. Through Pearson's correlation coefficient test, Laksmi et al. (2019) verified this positive correlation in their study involving 120 older people overall ($r = 0.73$, $r2 = 0.53$, $P < 0.05$): among the male group with 46 men ($r = 0.68$, $r2 = 0.46$, $P < 0.05$), and the female group with 74 women ($r = 0.8$, $r2 = 0.66$, $P < 0.05$).

In other studies, it was also observed that the relationship between calf circumference and BMI, CC was found to be better than BMI in predicting the emerging need for care in older people and even had a stronger relationship with mortality (Faul et al., 2009; Fernandes et al., 2020).

This study demonstrates strong correlations between BMI, calf circumference, and DXA in assessing body composition among older women, suggesting the potential of using simpler, more accessible measures like BMI and calf circumference as initial screening tools in primary healthcare settings to aid in sarcopenia and frailty prevention and management. These correlations suggest that simple, cost-effective screening tools can be used to identify individuals at risk, facilitating timely interventions and informing the development of targeted public health policies. However, the study's cross-sectional design limits the ability to establish causality, and the sample, while substantial, primarily represents older women from a specific geographic area, potentially impacting generalizability. Future longitudinal studies with diverse populations are needed to confirm these findings and explore the predictive validity of BMI and calf circumference for long-term health outcomes and their effectiveness in guiding interventions for sarcopenia and frailty.

Conclusiones

Based on the analysis of 287 participants residing in Aracaju and assisted by the Augusto Franco and Antônio Alves Basic Health Units (UBS), this study successfully achieved its objective of investigating the relationship between different body composition assessment methods: BMI, CC, and DXA.

The key findings include a strong, positive correlation between BMI and DXA: This indicates a close relationship between these two methods, suggesting that BMI can be a reliable indicator of body composition in older individuals. A moderate, positive correlation between CC and DXA was found: While not as strong as the BMI-DXA relationship, CC demonstrates a significant association with DXA, suggesting its potential applicability in body composition assessment. Finally, a moderate, positive correlation between CC and BMI was seen. This finding further supports the potential of both CC and BMI as practical and cost-effective tools for body composition assessment in older populations.

These results highlight the potential of BMI and CC as valuable tools for body composition assessment in older individuals, mainly due to their ease of use and low cost. However, further research is recommended to investigate the socioeconomic factors that may influence the applicability of these methods, as well as the feasibility of implementing DXA in practical settings, especially for underserved populations.

The findings of this study hold significant importance for improving the accessibility and affordability of body composition analysis in older adults.

Key benefits of using more straightforward and cheaper methods like BMI and CC include:

Increased accessibility: These methods can be readily implemented in various settings, including primary care clinics, community centers, and individuals' homes. This expands access to body composition assessment for older adults who may face challenges in accessing traditional methods like DXA due to cost, transportation, or mobility limitations.

Reduced cost: BMI and CC require minimal equipment and expertise, making them significantly more cost-effective than DXA. It reduces the financial burden on individuals and healthcare systems, making body composition analysis more feasible for large-scale implementation.

Enhanced feasibility: The simplicity of these methods allows for easier integration into routine health assessments, enabling regular monitoring of body composition and facilitating early identification of potential health risks associated with changes in body composition.

Improved patient engagement is also possible as the non-invasive nature and ease of use of BMI and CC can encourage greater patient participation in body composition assessment, promoting self-awareness and potentially leading to healthier lifestyle choices.

These findings pave the way for broader adoption of more straightforward and affordable body composition analysis methods in older adults. It, in turn, can contribute to improved health outcomes by enabling early detection of health risks and facilitating personalized interventions for maintaining optimal health and well-being in this population.

Future studies could also explore the benefits of combining different methods to provide a more comprehensive body composition assessment in older adults.

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Referencias

Brasil. Lei nº 14.874, de 28 de maio de 2024. Dispõe sobre a pesquisa com seres humanos e institui o Sistema Nacional de Ética em Pesquisa com Seres Humanos. Diário Oficial da União: seção 1, Brasília, DF, 28 maio 2024. Disponível em: https://legislacao.presidencia.gov.br/atos/?tipo=LEI&numero=14874&ano=2024&ato=677Izaq1ENZpWT381. Acesso em: 21 de fevereiro de 2025

Champaiboon, J., Petchlorlian, A., Manasvanich, B. A., Ubonsutvanich, N., Jitpugdee, W., Kittiskulnam, P., ..., & Praditpornsilpa, K. (2023). Calf circumference as a screening tool for low skeletal muscle mass: Cut-off values in independent Thai older adults. BMC geriatrics, 23(1), 826. https://doi.org/10.1186/s12877-023-04543-4

De Oliveira Damasceno, V., Macedo Vianna, J., Barreiros Cardoso Bomfim, A., Edson de Souza, D., Felix da Silva, J., Vinícius Letieri, R., et al. (2024). ¿Cuál es el mejor predictor del porcentaje de grasa corporal en las mujeres brasileñas ancianas? Retos: nuevas tendencias en educación física, deporte y recreación, 59:401–10. https://doi.org/10.47197/retos.v59.104031

Dorgan, J. F., Ryan, A. S., LeBlanc, E. S., Horn, L. V., Magder, L. S., Snetselaar, L. G., ... & Gower, B. A. (2023). A comparison of associations of body mass index and dual-energy X-ray absorptiometry measured percentage fat and total fat with global serum metabolites in young women. Obesity, 31(2), 525-536. https://doi.org/10.1002/oby.23619

Faul, F., Erdfelder, E., Buchner, A., & Lang, A. G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. Behavior Research Methods, 41(4), 1149-1160. https://doi.org/10.3758/BRM.41.4.1149

Fernandes, D. P. S., Juvanhol, L. L., Lozano, M., & Ribeiro, A. Q. (2022). Calf circumference is an independent predictor of mortality in older adults: An approach with generalized additive models. Nutrition in Clinical Practice, 37(5), 1190–1198. https://doi.org/10.1002/ncp.10780

Fernandes, S. G. G., Pirkle, C. M., Sentell, T., Costa, J. V., Maciel, A. C. C., & da Câmara, S. M. A. (2020). Association between self-rated health and physical performance in middle-aged and older women from Northeast Brazil. PeerJ, 8, e8876. http://dx.doi.org/10.7717/peerj.8876

González-Correa, C., Pineda-Zuluaga, M., & Marulanda-Mejía, F. (2020). Skeletal muscle mass by bioelectrical impedance analysis and calf circumference for sarcopenia diagnosis. Journal of Electrical Bioimpedance, 11(1), 57-61. https://doi.org/10.2478/joeb-2020-0009

González, M. C., Mehrnezhad, A., Razaviarab, N., Barbosa-Silva, T. G., & Heymsfield, S. B. (2021). Calf circumference: cutoff values from the NHANES 1999–2006. The American Journal of Clinical Nutrition, 113(6), 1679-1687. https://doi.org/10.1093/ajcn/nqab029

Guembe, M. J., Fernández-Lázaro, C. I., Sayón-Orea, C., Toledo, E., & Moreno-Iribas, C. (2020). Risk for cardiovascular disease associated with metabolic syndrome and its components: a 13-year prospective study in the RIVANA cohort. Cardiovascular Diabetology, 19, 195. https://doi.org/10.1186/s12933-020-01166-6

Gustafsson, T., & Ulfhake, B. (2023). Aging Skeletal Muscles: What Are the Mechanisms of Age-Related Loss of Strength and Muscle Mass, and Can We Impede Its Development and Progression? International Journal of Molecular Sciences, 25(20), 10932. https://doi.org/10.3390/ijms252010932

Haack, A., Luz, C. R. A. N., & Farias, F. B. Q. (2019). Protocolo de assistência nutricional ao indivíduo obeso na atenção secundária à saúde. Portal de Livros Abertos da Editora JRG, 3(3), 29-39. Available at: https://revistajrg.com/index.php/portaljrg/article/view/158. Accessed on: January 15, 2025

Hagberg, C. E., & Spalding, K. L. (2024). 1 White adipocyte dysfunction and obesity-associated pathologies in humans. Nature Reviews Molecular Cell Biology, 25, 270–289. https://doi.org/10.1038/s41580-023-00680-1

Haq, M. A. U., Tiwari, S., & Tiwari, S. (2025). Investigación de las métricas de composición corporal en hombres hipertensos de 60 a 70 años a través del fútbol caminado. Retos, 65, 400–413. https://doi.org/10.47197/retos.v65.109182

Jeong, S. M, Lee, D. H., Rezende, L. F. M., & Giovannucci, E. L. (2023). Different correlation of body mass index with body fatness and obesity-related biomarker according to age, sex, and race-ethnicity. Scientific Reports, 13, 3472. https://doi.org/10.1038/s41598-023-30527-w

Kawakami R, Miyachi M, Sawada SS, Torii S, Midorikawa T, Tanisawa K, et al. Cutoffs for calf circumference as a screening tool for low muscle mass: WASEDA'S Health Study. Geriatrics and Gerontology Int. 2020;20(10): 943-950. https://doi.org/10.1111/ggi.14025

Kim, S, Won CW. (2022). Sex-different body composition changes in aging: A systemic review. Archives Gerontology and Geriatrics, 102:104711. https://doi.org/10.1016/j.archger.2022.104711

Laksmi, PW., Mitayani, SH., Setyohadi, B., Muhadi, M., Ariane, A., Tirtarahardja, G. (2019). Diagnostic merit of using the calf circumference to estimate the muscle mass as a component of sarcopenia in elderly outpatients. Journal of Natural Science, Biology and Medicine, 10(3):126. Available at: https://jnsbm.org/wp-content/uploads/2021/07/JNatScBiolMed-10-1s-126.pdf. Accessed on: Februrary 25, 2025

Lohman, T. G.; Roche, A. F.; Martorell, R. Anthropometrics standartization reference manual. Champaign: Human Kinetics Books, 1988. Available at: https://pt.scribd.com/document/336334654/Anthropometric-Stand-Ref-Manual. Accessed on: January 15, 2025

Maïmoun, L., Alonso, S., Mahadea, KK., Boudousq, V., Mura, T., Mariano-Goulart, D. (2023). Cross-Calibration Study of The Stratos and Hologic QDR 4500A Dual-Energy X-Ray Absorptiometers to Assess Bone Mineral Density and Body Composition. Journal of Clinical Densitometry, 26 https://doi.org/10.1016/j.jocd.2023.101434

Messina, C., Albano, D., Gitto, S., Tofanelli, L., Bazzocchi, A., Ulivieri, FM., et al. (2020). Body composition with dual-energy X-ray absorptiometry: from basics to new tools. Quantitative Imaging in Medicine and Surgery, 10(8):1687–98. https://doi.org/10.21037/qims.2020.03.02

Oliveira, T. de C., Gomes Fernandes, S. G., Silva dos Santos Aguiar Gonçalves, R., Sales, W. B., de Andrade, L. E. L., Vieira, E. R., & Maciel, Á. C. C. (2024). Calf Circumference Cutoff Point for Sarcopenia Screening in Community-Dwelling Older Brazilians. Physical & Occupational Therapy In Geriatrics, 1–13. https://doi.org/10.1080/02703181.2024.2388552

Palmer, AK., Jensen, MD. (2022). Metabolic changes in aging humans: current evidence and therapeutic strategies. Journal of Clinical Investigation, 132(16):e158451. https://doi.org/10.1172/JCI158451

Ponce-García, T., García-Romero, J., Carrasco-Fernández, L., Castillo-Dominguez, A., Benítez-Porres, J. (2024). Asociación entre la composición corporal total y segmentaria y el rendimiento anaeróbico en atletas de Crossfit®: diferencias entre sexos y predicción del rendimiento. Retos: nuevas tendencias en educación física, deporte y recreación, 62:543–52. https://doi.org/10.47197/retos.v62.109115

Ponti, F., Santoro, A., Mercatelli, D., Gasperini, C., Conte, M., Martucci, M., et al. (2020). Aging and Imaging Assessment of Body Composition: From Fat to Facts. Frontiers in Endocrinology, 10:861. https://doi.org/10.3389/fendo.2019.00861

Rodrigues-Bezerra, A., Alves, PAS., Silva, LS., Vasconcelos, MMP. (2021). Prevalence of hypophosphatemia and risk of refeeding syndrome in elderly patients admitted to an intensive care unit. DEMETRA: Alimentação, Nutrição & Saúde, 16:e53791. https://doi.org/10.12957/demetra.2021.53791

Rodrigues, AEC., Sepúlveda-Loyola, W., Facci, LM., Signori, C., Melo, FC. (2020). Obese elderly women with higher prevalence of falls and worse dynamic and static balance? A cross-sectional study. Brazilian Journal of Development, 6(11):89242–54. https://doi.org/10.34117/bjdv6n11-372

Silva, VS., Vieira, MFS. (2020). International Society for the Advancement of Kinanthropometry (ISAK) Global: international accreditation scheme of the competent anthropometrist. Revista Brasileira de Cineantropometria & Desempenho Humano, 22(2):e70517. https://doi.org/10.1590/1980-0037.2020v22e70517

Valeh, S., Fatolahi, H., Azarbayjani, MA. (2020). Effect of eight weeks of low, moderate, and high-intensity TRX training on hot flashes, mood, fat percentage, and muscular endurance in postmenopausal women. Apunts Sports Medicine, 55(207):97–103. https://doi.org/10.1016/j.apunsm.2020.05.004

Watanabe, LM., Delfino, HBP., Pinhel, MAS., Noronha, NY., Diani, LM., Assumpção, LCP., et al. (2022). Food and Nutrition Public Policies in Brazil: From Malnutrition to Obesity. Nutrients, 14(12):2472. https://doi.org/10.3390/nu14122472

WHO - World Health Organization (2024). Obesity and overweight [Internet]. Geneva: WHO. Available at: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight. Accessed on: January 15, 2025.

WMA - World Medical Association (2022). WMA Declaration of Helsinki – Ethical Principles for Medical Research Involving Human Subjects [Internet]. Ferney-Voltaire: WMA. Available at: https://www.wma.net/policies-post/wma-declaration-of-helsinki-ethical-principles-for-medical-research-involving-human-subjects/. Accessed on: January 15, 2025

Wu, SE., Chen, WL. (2022). Calf circumference refines sarcopenia correlating with mortality risk. Age and Ageing, 51(2):afab239. https://doi.org/10.1093/ageing/afab239

Ya, J., Bayraktutan, U. (2023). Vascular ageing: Mechanisms, risk factors, and treatment strategies. International Journal of Molecular Sciences, 24(14):11538. https://doi.org/10.3390/ijms241411538

Żuchowski, P., Jeka, D. (2024). Dual-energy X-ray absorptiometry - is it the gold standard, or is bone mineral density everything? Reumatologia/Rheumatology, 62(1):1–3. https://doi.org/10.5114/reum/185706

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