EVALUATING THE RELIABILITY OF SELF-MEASURED ANTHROPOMETRIC DATA: A PILOT STUDY IN HEALTHY ADULTS

VALUTAZIONE DELL'AFFIDABILITÀ DEI DATI ANTROPOMETRICI AUTOMISURATI: UNO STUDIO PILOTA SU ADULTI SANI

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ABSTRACT

Introduction: Anthropometric measurements are essential for assessing cardiometabolic risk but require trained personnel. This pilot study evaluates the discrepancy between self-reported and professional measurements.
Methods: Waist and hip circumferences in 20 healthy adults were compared.
Results: No significant difference for waist, significant underestimation for hips.
Conclusions: Self-measurement of hips is underestimated; new technologies may improve accuracy.

Introduzione: Le misurazioni antropometriche sono fondamentali per valutare il rischio cardiometabolico, ma richiedono personale formato. Questo studio pilota valuta la discrepanza tra misurazioni auto-riferite e professionali.
Metodi: Sono state confrontate le circonferenze vita e fianchi in 20 adulti sani.
Risultati: Nessuna differenza significativa per la vita, sottostima significativa per i fianchi.
Conclusioni: L'automisurazione dei fianchi è sottostimata; nuove tecnologie possono migliorare la precisione.

KEYWORDS
Self-measurement, Circumferences, Technologies
Auto-misurazione, Circonferenze, Tecnologie

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1. Introduction

Anthropometry as known as the study of the dimensions and proportions of the human body. Measurements of body circumference, especially the waist (WC) and hip (HC), are essential for athletic monitoring and the clinical treatment of metabolic and endocrine disorders, such as overweight and obesity (Santos, D. A et al. 2014; Ross, R et al. 2020).

While Body Mass Index (BMI) is commonly employed to identify individuals susceptible to weight-related health issues, it possesses certain limitations. Variations in fat distribution, which have a major impact on cardiometabolic risk, are not taken into consideration (Ross, R et al. 2020). Abdominal adiposity, reflected in WC, is a stronger predictor of risk than BMI alone (Gelber, R. P et al 2008; Wang, Y. Et al 2005). Body circumference-based anthropometric indices also enable the differentiation of various body shape phenotypes, which differ between sexes and in connection with particular conditions. Women tend to exhibit a "pear-shaped" distribution of visceral fat, characterized by the prevalence of subcutaneous fat, whereas men tend to present a "apple-shaped" body (Chromy, A. et al 2015).

Anthropometric assessments are crucial in the fitness industry for monitoring physical performance and identifying underlying conditions like eating disorders. Customized exercise regimens based on these metrics have been successful in enhancing physical condition and endurance (Santos, D. A et al. 2014).

Routine anthropometric evaluations, especially WC, are useful, but they are rarely used because they demand a lot of time and skill from medical professionals. Patients measuring themselves is one suggested remedy. However, self-measured data frequently have poor accuracy because of inadequate training (Kushi, L. H. et al 1988). In response to this challenge, digital health technologies are emerging as promising tools to enhance measurement reliability, especially in telemedicine contexts (Graybeal, A. J. Et al 2023).

In this regard, a study in the literature evaluated the accuracy and concordance of automated smartphone-based anthropometry compared to measurements taken with a reference metric tape. Waist and hip circumference (WC, HC), waist-to-hip ratio (WHR), and waist:height ratio (W:HT) were measured on a sample of 115 participants (69 women, 46 men), using both a tape measure and two smartphone applications (MeThreeSixty, myBVI) on different smartphone models. All apps, regardless of device type, provided reliable and statistically significant estimates for each variable ($P < 0.001$), showing a slight underestimation of WC and a slight overestimation of HC (Graybeal, A. J. Et al 2023).

Similarly, a study compared the accuracy and reproducibility of manual anthropometric measurements with those taken using a 3D scanner on a sample of 83 adult volunteers. The results showed greater variability in manual measurements, both between different observers (inter-observer) and in the repetitions made by the same observer (intra-observer). In contrast, the 3D scanner showed less variability and higher reliability in detecting waist circumference (WC), hip circumference (HC), and waist-to-hip ratio (WHR). The differences between the two methods were statistically significant ($p < 0.05$), indicating that the 3D scanner is a more accurate and reproducible tool than the manual method, with potential applications in central obesity monitoring (Medina-Inojosa, J. Et al 2016).

In light of this, the current pilot study examines the disparity between body circumference measurements self-reported by untrained people and those acquired by qualified nutritionists. Patients' inexperience with measurement procedures may be the cause of this disparity, which raises the possibility of inaccuracy.

By providing easily accessible resources to standardize and direct the self-measurement procedure, technology may be able to close this gap. It is still unknown how accurate traditional self-measurements by unskilled patients are, despite prior research suggesting that digital systems increase reliability.

An initial assessment of self-reported anthropometry is represented by this study. It establishes the groundwork for upcoming studies involving bigger and more varied populations. To further support the need for standardized and adaptable instruments, these future studies should also take into account how individual phenotypic differences, such as body composition and fat distribution, affect measurement accuracy (Graybeal, A. J. Et al 2023; Medina-Inojosa, J. Et al 2016).

2. Methods

2.1 Study Design

This experimental pilot study aims to evaluate the discrepancy between self-reported or self-measured body circumference measurements by participants and those taken by a professional, such as a nutritionist. The main objective is to determine the accuracy and reliability of self-reported versus standardized measurements to understand the impact of the absence of specific training in anthropometric data collection.

2.2 Participants

The study included 20 participants with the following characteristics:

• Age between 18 and 34 years.
• Gender: Men and Women
• Health status: healthy subjects without diagnosed diseases or risk factors.
• Weight status: 18,4-33 Kg/m2

The study participants were selected from subjects with no experience in anthropometric measurement. To ensure an unbiased assessment, individuals with training in clinical or nutritional fields were excluded, as even basic knowledge could have influenced their ability to perform accurate measurements. This methodological choice aims to simulate the real-life context in which patients have to perform self-measurements without adequate training.

2.3 Intervention and Procedures

The study consisted of the following phases:

1. Initial professional measurement: A nutritionist measured the weight and height of each participant using a bathroom scale and a stadiometer, and subsequently calculated their BMI.

2. Self-measurement of circumferences: Participants were asked to measure their own waist circumference and hip circumference with a tape measure, based on their own knowledge and following the general instructions given by the practitioner. During the self-measurement, the practitioner merely gave instructions without intervening directly, in order to avoid influencing the results.

- Waist circumference: measured near the navel.

- Hip circumference: measured at the point of maximum extension.

3. Final professional measurement: After the self-measurement, the nutritionist took the same measurements again on the participants.

4. Discrepancy analysis: The differences between the self-reported and professional measurements were noted down and analyzed to assess any systematic deviations.

For statistical analysis, a paired-sample t-test was used to compare the measurements taken independently by the patients (WC_case and HC_case) with those taken by the professionals (WC_pro and HC_pro). The mean, standard deviation, and standard error were calculated for each group. The significance of the differences between the two measurement modes was assessed using the t-test, considering a significance level of $p < 0.05$.

3. Results

The averages of the measurements taken independently by patients and professionals are as follows:

- Waist circumference (WC): 81.63 cm (WC_case) vs 81.83 cm (WC_pro)

- Hip circumference (HC): 94.68 cm (HC_case) vs 99.55 cm (HC_pro)

Statistical analysis showed that the mean difference between the WC measurements taken by patients and professionals was -0.2 cm ($p = 0.742$), indicating that there is no statistically significant difference between the two measurement modes.

The standard deviation analysis shows a greater variability in the measurements performed independently by patients than in those performed by professionals, especially for HC. Furthermore, the range of values observed varies between -4.00 and 5.00 cm for WC and between -12.50 and 2.50 cm for HC, showing greater dispersion in the measurement of hip circumference.

On the contrary, for HC, the average difference between the measurement taken by the patient and the practitioner was -4.87 cm, with a $p < 0.001$.

This result indicates a statistically significant difference between the two measurements, suggesting that patients tend to underestimate their own hip circumference compared to the measurement taken by the practitioner.

The standard deviation analysis shows greater variability in the measurements taken independently by patients than in those taken by the practitioner, especially for HC. Furthermore, the range of values observed varies between -4.00 and 5.00 cm for WC and between -12.50 and 2.50 cm for HC, showing greater dispersion in the measurement of hip circumference.

These results suggest that, while self-measurement of WC can be considered reliable, self-measurement of HC presents a significant underestimation compared to professional measurement.

4. Discussion

The results of this pilot study show that self-measurement of waist circumference is generally reliable. In contrast, hip circumference is frequently underestimated in comparison to measurements by a professional. This discrepancy suggests that although patients can measure waist circumference independently with some accuracy, the assessment of hip circumference requires more attention and training.

Previous studies, such as that of Choudhary et al. 2023, have shown that discrepancies in waist circumference measurements in obese patients are even more pronounced than those observed in normal-weight subjects. This suggests that factors such as the presence of excess adipose tissue and difficulty in positioning the tape measure correctly on the part of the patient may amplify measurement errors.

The introduction of digital tools, such as smartphone applications based on artificial intelligence and computer vision, could be an effective solution to improve the reliability of anthropometric measurements. The work of Choudhary et al. 2023 showed that an application based on deep learning algorithms was able to estimate the waist-to-hip ratio with an accuracy comparable to that of professionals, reducing the errors associated with manual self-measurement.

A study evaluated the effectiveness of a free mobile application (MeThreeSixty) based on 3D imaging in measuring body circumferences such as waist, hips, upper arm, and mid-thigh (Smith, B. et al 2022). Results showed that the measurements obtained with the app were comparable to those obtained with a professional 20-camera 3D system and the traditional flexible tape method, suggesting that such applications can provide accurate estimates of anthropometric measurements in non-clinical settings (Smith, B. et al 2022).

Another critical review examined the use of digital anthropometry, particularly 3D optical imaging, highlighting how these technologies can transform anthropometric assessment in both clinical and home settings (Heymsfield, S. B. et al 2018). The review emphasized that although these technologies offer potential advantages in terms of accuracy and ease of use, rigorous validation and adequate user training are essential to ensure standardized and reliable measurements (Heymsfield, S. B. et al 2018).

Recently, a study compared four different 3D scanning technologies, including two smartphone apps and two professional scanners [12]. The results showed that apps using full-body scanning with rotation provide similar reliability to high-quality 3D scanners, with an acceptable average technical error for body circumferences. However, apps based on 2D images showed greater variability in measurements, highlighting the need for more advanced acquisition methodologies to obtain accurate data (Tinsley, G. M. et al 2024).

5. Limitations

There are various limitations on this study. Only young adults in good health were included in the small sample size. The results' generalizability was limited by the exclusion of people with clinical conditions or obesity.

6. Conclusion

In conclusion, while self-measurement of waist circumference appears to be reliable, that of hip circumference has more limitations. The implementation of digital technologies, such as applications based on artificial intelligence and 3D imaging, could improve the accuracy of anthropometric measurements, reducing errors and facilitating remote monitoring of patients. Future studies should further evaluate the effectiveness of these tools in different populations and clinical settings.

These results highlight the potential of digital technologies to support clinical decision-making, improve patient education, and enable remote monitoring strategies through telemedicine platforms, in addition to increasing measurement accuracy.

Author contribution

In the present study, Mayol D was responsible for data collection, statistical analysis, and the drafting of the first version of the manuscript. The other authors Guerriero M, A, Colecchia F, P, and Vetrani C contributed substantially to the interpretation of the data, the critical revision of the manuscript, and the discussion of the results. Furthermore, all authors collaborated in the definition of the experimental design and the selection of participants and finally approved the final version of the work for publication.

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