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# CONCURRENT VALIDITY OF TWO DIFFERENT TYPES OF OMRON BODY COMPOSITION MEASURING DEVICES IN KARATE ATHLETES

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**Abstract:** The aim of this study was to examine the validity of two types of OMRON body composition analysers (BF 511 and VIVA) in comparison with the InBody 270 body composition analyser, in karatekas. The measurements were performed during the summer national camp of the FUDO-KAN Karate Federation, and the sample of subjects included 20 men and 27 women (Age = 16 ± 5.99 years; Body height = 158 ± 14.13 cm; Body mass = 51 ± 17.29 kg), and the following body composition variables were used: body mass (BM), body fat percentage (%BF) and skeletal muscle mass percentage (%SMM), which were estimated using all three body composition scales. Pearson correlation coefficient (r) and the coefficient of determination (r2) were used to determine the validity of both OMRON body composition analysers. A high correlation of BM InBody with BM OMRON (BF 511 – r 0.99, $r^2$=0.99; VIVA – r=0.99, $r^2$=0.99), %BF InBody with %BF BF 511 (r=0.92, $r^2$=0.84), and %BF InBody with %BF VIVA (r=0.63, $r^2$=0.40), %SMM InBody with %SMM BF 511 (r=0.68, $r^2$=0.46) were observed. The results obtained indicate that there are certain deviations, especially when it comes to assessing skeletal muscle, when compared with the InBody 270 body composition scale.

**Keywords:** body mass, percent of body fat, percent of skeletal muscle mass, OMRON BF 511, OMRON VIVA

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## Introduction

Monitoring body composition is essential in sports science, especially for athletes, as key parameters like body fat percentage (%BF) and skeletal muscle mass percentage (%SMM) play a crucial role in optimising performance and evaluating the effects of training (Santos et al., 2020). Accurate measurement of these parameters enables athletes and coaches to tailor training and nutrition strategies effectively. Body composition assessment plays a significant role in understanding the physiological adaptations during athletic training (Nunes et al., 2019). As the body composition of athletes influences their performance, having reliable and accessible tools for assessment is paramount (Santos et al., 2020).

Various methods are utilised to assess body composition, including the InBody 270 multi-frequency body composition analyser and the OMRON BF 511 and VIVA. While InBody 270 is validated due to its precision in measuring fat and lean mass, its high cost and limited accessibility make it less feasible for widespread use (Larsen et al., 2021). In contrast, the OMRON devices offer a more accessible and affordable alternative for body composition assessment, making them popular tools for athletes and fitness professionals. These devices are widely marketed as reliable and user-friendly, but their accuracy compared to the other devices needs further validation in sports contexts (Ling et al., 2011). Recent studies have raised concerns about the accuracy of BIA devices, particularly in athletic populations where precise measurements are crucial for performance optimisation (Ciccone et al., 2020).

BIA devices, which use electrical impedance to measure body composition, are often marketed as reliable. It works by sending a low-level electrical current through the body, and the resistance encountered by this current is used to predict the amount of body fat. They use proprietary algorithms to measure total body fat and lean tissue mass (muscles, bones, and other tissues), offering simplicity and practicality for athletes and healthcare professionals (Aanstad et al., 2014). Even though it is a safe, non-invasive, cost-effective, and easily transportable technique, this method is affected by the body's hydration level, owing to the electrical conductivity of biological tissues (McLester, 2020). Moreover, population-dependent predictive equations may introduce systematic bias, particularly when precise body composition evaluation is essential (Kabiri et al., 2015).

Despite their widespread use, concerns have been raised regarding the accuracy of BIA devices compared to other body composition devices (Larsen et al., 2021). Several studies have been conducted to assess the validity of BIA devices, yielding mixed results. For instance, studies have shown a high correlation between BIA measurements with different tools for specific parameters such as body fat and lean mass (Silva et al., 2018). However, other findings indicate potential discrepancies in body fat measurement and underestimation of body fat when using BIA devices, especially in specific populations (Stojanović et al., 2017). These variations underscore the urgent need for further research to validate BIA devices in sports populations, where precise body composition measurements are critical for performance optimisation. This emphasis on the need for further research should make the audience feel the urgency and importance of the topic (Feng, 2024).

Despite the widespread use of BIA devices, their accuracy can be influenced by factors such as hydration status, meal scheduling, and physical activity. For example, research on older adults found that multi-frequency BIA equipment provided favourable estimates of body composition. However, it recommended the development of correction equations to reduce errors in body fat percentage and fat-free mass estimates (Silva et al., 2019). A study by Lima et al. (2020) also emphasised that these devices might produce less accurate results in populations with a wide range of body types, including athletes, where deviations in fat mass and muscle mass measurements may occur. These findings suggest that while BIA devices are practical for body composition assessments, their limitations should be considered, especially in athletic populations where precise measurements are crucial (Santos et al., 2020).

The aim of this study is to assess the validity of two types of OMRON body composition analysers (BF 511 and VIVA) compared to the InBody 270 in karate athletes. It is hypothesised that there will be significant correlations between used measuring devices. This study seeks to provide insights into the applicability of OMRON body composition analysers in sports settings and explore the potential deviations while assessing body composition parameters such as body fat and skeletal muscle mass percentage. The findings of this study, which will be crucial for the field of sports science, have the potential to significantly impact the use of BIA devices in sports settings and ensure the reliability of the data used for training and nutrition interventions (Lima et al., 2020).

## Methods

### *Participants*

This study employed a unique cross-sectional research design, a rarity in body composition analysis studies. The sample, comprising 47 participants (Age = 16 ± 5.99 years; Body mass = 158 ± 14.13 cm; Body weight = 51 ± 17.29 kg), was carefully balanced with 20 males and 27 females. All participants were actively involved in Karate, with training and competing experience over 5 years minimum, and they were all healthy (no illness or injuries) and rested. Participants were recruited voluntarily and were provided with comprehensive information about the study's purpose, procedures, and potential risks. The written informed consent, a cornerstone of ethical research, was obtained from each individual, ensuring that the study adhered to the highest ethical standards. The study is performed following the Declaration of Helsinki and the Ethical Guidelines of the Faculty of Sport and Physical Education.

### *Measuring Procedures*

The validity of two OMRON body composition analysers (OMRON Healthcare Inc., Osaka, Japan) and their outputs were compared with those obtained using the InBody 270 (In Body Co. Ltd., Seoul, South Korea) analyser, which served as the reference method or 'gold standard'. Each participant underwent assessment with all three devices (randomly assigned) under meticulously standardised conditions, ensuring the consistency and comparability of the data.

All measurements were conducted in the morning during the summer karate camp organised by the Fudo Kan Karate Association. Anthropometric measurements included body height (cm), which was obtained using a standardised stadiometer. Measurements were performed in the morning under fasting conditions to minimise the potential influence of recent food intake and hydration status on the outcomes. Participants were instructed to refrain from consuming alcohol or caffeine and engaging in any vigorous physical activity for at least 24 hours before the assessment to ensure optimal standardisation and accuracy of the collected data. All measurements were performed following the manufacturer's recommendations and previous studies (Stojanović et al., 2017; Toskic et al., 2024). Measurements were performed by experienced personnel.

### *Statistical Analyses*

Descriptive statistics were calculated for all measured variables, including average value (Mean), standard deviation (SD), minimum (Min) and maximum values (Max), and coefficient of variation (cV%). The validity level of the OMRON devices was determined using Pearson's correlation coefficient (r) based on comparisons with InBody 270 results. The coefficient of determination ($r^2$) and its equation were also reported on scatter plots to express the proportion of shared variance between devices. The strength of the correlation coefficients was interpreted following the classification proposed by Hopkins et al. (2015): trivial (< 0.1), small (0.1), moderate

(0.3), high (0.5), and extremely high (0.9). Statistical analysis was performed in SPSS 19 (IBM, New York, USA) while figures were created in Python (Delaware, USA).

## Results

Descriptive statistics parameters (Mean, SD, Min, Max, and cV%) for all variables (BM, BF, and SMM), measured via three different BCA (InBody 270; Omron BF 511 and Omron Viva), are displayed in Table 1. It can be noticed that In Body 270 showed the lowest values of BM (51.35 kg) and highest values of SMM (42.53 %), BF 511 showed the highest values of BM (52.01 kg) and lowest values of BF (20.13 %), while VIVA showed the highest values of BF (24.12 %) and lowest values of SMM (33.83 %). Based on the cV indicator, it can be concluded that this group of participants was homogen regarding body composition parameters (26.85 %, on average).

**Table 1.** Descriptive statistics of three BCA (InBody 270, Omron BF 511, Omron VIVA) of BM, BF and SMM variables

| | Variables | Mean | SD | Min | Max | cV% |
|---|---|---|---|---|---|---|
| InBody 270 | BM (kg) | 51.35 | 17.29 | 25.80 | 99.40 | 33.68 |
| | BF (%) | 21.03 | 8.15 | 8.60 | 41.70 | 38.75 |
| | SMM (%) | 42.53 | 4.73 | 31.81 | 52.01 | 11.12 |
| Omron BF 511 | BM (kg) | 52.01 | 17.21 | 26.60 | 98.40 | 33.09 |
| | BF (%) | 20.13 | 7.73 | 7.10 | 40.00 | 38.39 |
| | SMM (%) | 35.13 | 4.46 | 18.60 | 43.50 | 12.70 |
| Omron VIVA | BM (kg) | 51.87 | 17.15 | 25.70 | 99.00 | 33.07 |
| | BF (%) | 24.12 | 7.75 | 6.20 | 41.40 | 32.14 |
| | SMM (%) | 33.83 | 2.96 | 30.80 | 38.10 | 8.76 |

Legend: BCA - body composition analyzer; Mean - average value; SD - standard deviation; Min - minimal value; Max - maximal value; cV% - coefficient of variation; BM - body mass; BF - body fat; SMM - sceletal muscle mass

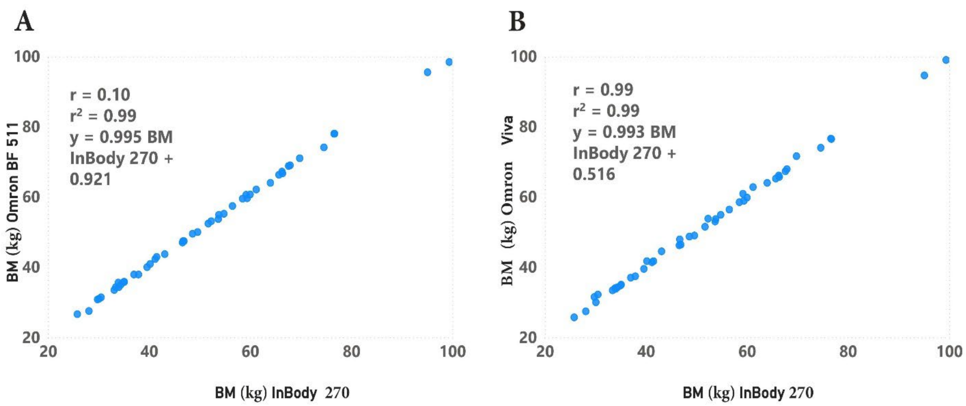
Table 2 and Figures 1, 2, and 3 present the results of Pearson's correlation coefficient, that is, the correlation between BM, BF and SMM parameters of three measuring devices for assessment of body composition. It can be concluded that there is a significant correlation in all measured parameters (r=845, p=0.000, on average), except the SMM parameter between InBody 270 and Omron Viva (p=- 0.325, p=0.529).

**Table 2.** Correlation matrix of analysed variables assessed with different body composition scales (BCA)

| | | BM Omron BF511 (kg) | BM Omron Viva (kg) | BF Omron BF511 (%) | BF Omron Viva (%) | SMM Omron BF511 (%) | SMM Omron Viva (%) |
|---|---|---|---|---|---|---|---|
| **BM InBody 270 (kg)** | r | 1.000** | .999** | | | | |
| | p | 0.000** | 0.000** | | | | |
| | N | 47 | 47 | | | | |
| **BF InBody 270 (%)** | r | | | .918** | .633** | | |
| | p | | | 0.000** | 0.000** | | |
| | N | | | 47 | 47 | | |
| **SMM InBody 270 (%)** | r | | | | | .679** | -0.325 |
| | p | | | | | 0.000** | 0.529 |
| | N | | | | | 47 | 47 |

Legend: BM InBody 270 - body mass measured via Inbody 270 BCA; BM BF511 - body mass measured via Omron BF511 BCA; BM Omron Viva - body mass measured via Omron Viva; BF InBody 270 - body fat measured via Inbody 270 BCA; BF BF511 - body fat measured via Omron BF511 BCA; BF Omron Viva - body fat measured via Omron Viva; SMM InBody 270 - skeletal muscle mass measured via Inbody 270 BCA; SMM BF511 - skeletal muscle mass measured via Omron BF511 BCA; SMM Omron Viva - skeletal muscle mass measured via Omron Viva; r - correlation coefficient; p - statistical significance; N - number of cases, ** - significant at level p<0.01

**Figure 1.** Correlation in BM – In Body 270 vs OMRON BF 511 (A), In Body 270 vs OMRON VIVA (B)



The thoroughness of our measurement methods is evident in the results of r, $r^2$, and the regression equation of the BM measure via InBody 270 and Omron BF 511 and between InBody 270 and Omron Viva, shown in Figure 1. In both cases, r (r=0.10; r=0.99, respectively) and $r^2$ ($r^2$=0.99; $r^2$=0.99, respectively) achieved a high correlation.

**Figure 2.** Correlation in BF – In Body 270 vs OMRON BF 511 (A), In Body 270 vs OMRON VIVA (B)

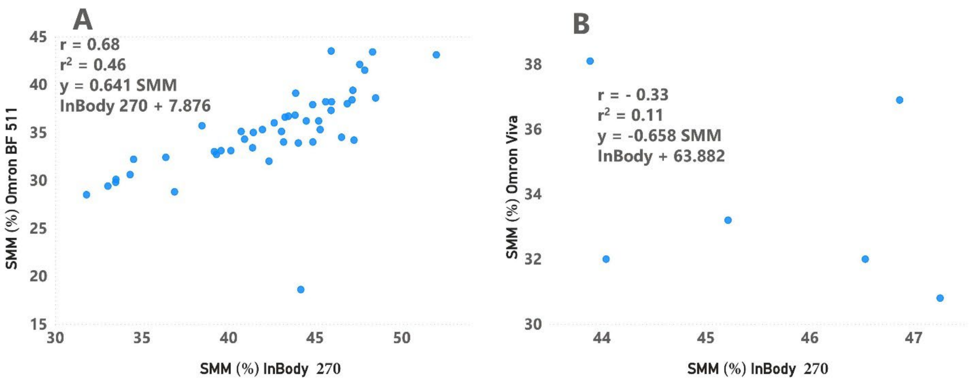
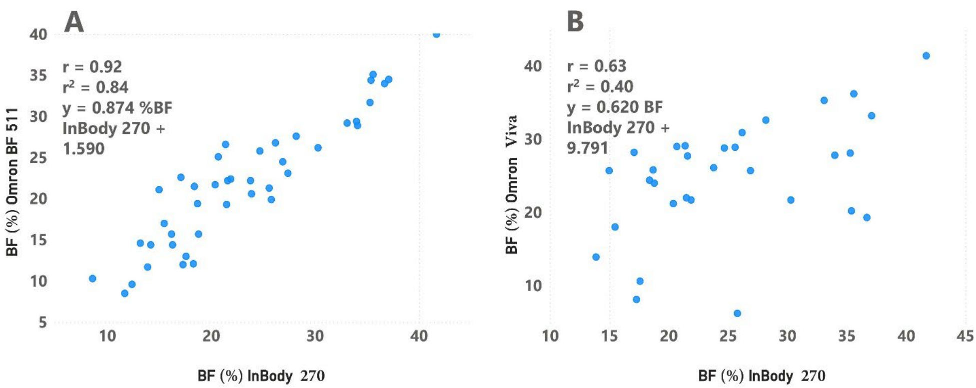



Figure 2 illustrates the results (r, $r^2$, and regression equation) of the parameter used to estimate body fat (BF), which was measured with InBody 270, Omron BF 511, and Omron Viva. It is worth noting that a high relationship was recorded between BF estimated with InBody 270 and Omron Viva (r=0.63; $r^2$=0.40), a finding that piques our inte-rest and invites further exploration. Furthermore, r achieved a high association between BF measured with InBody 270 and Omron BF 511 (r=0.92; $r^2$=0.84).

**Figure 3.** Correlation in SMM – In Body 270 vs OMRON BF 511 (A), In Body 270 vs OMRON VIVA (B)



Finally, Figure 3 showcases the SMM variable's r, $r^2$, and regression equation measured with InBody 270, Omron BF 511, and Omron Viva. The association between InBody 270 and Omron BF 511 of the SMM variable was high, a significant finding (r=0.68; $r^2$=0.46). Equally intriguing, a non-significant inverse correlation was recorded between InBody 270 and Omron Viva for the same variable.

## Discussion

This research aimed to assess the validity of two types of OMRON BIA (BF 511 and VIVA) compared to the InBody 270 in karate athletes. Generally speaking, it was expected that the present findings would provide insights into the applicability of OMRON body composition analysers in sports settings and discover the potential misfunctions with measuring body composition parameters such as body fat and skeletal muscle mass percentage. To our knowledge, this is the first study that has explored the validity of two different OMNON BIA, when compared with InBody 270.

The results have shown a high correlation between almost all applied parameters of three different body composition analysers. However, there are slight deviations of OMRON body composition analysers when they were compared to the widely used "golden standard" InBody 270. Firstly, variable BM (i.e., body mass) was assessed with two OMRON BIA and compared with the results of InBody 270. Results have shown that OMRON BIA was almost perfectly correlated with InBody 270 (BF511: r=0.10, $r^2$=0.99; Viva: r=0.99, $r^2$=0.99). In the case of the variable BF (i.e., body fat), the association was slightly different. OMRON BF511 and InBody 270 accomplished extremely high values of correlation coefficient (r=0.92, $r^2$=0.84), while OMRON Viva and InBody 270 achieved high correlation (r=0.63, $r^2$=0.40). Finally, when it comes to SMM (i.e., skeletal muscle mass), the proportion of the same variance between OMRON BF511 and InBody 270 was 46% with high correlation (r=0.68, $r^2$=0.46), and OMRON Viva and InBody 270 were inversely and non-significantly associated (r=0.33, $r^2$=0.11). These results unequivocally indicate that OMRON BIA are not aligned with InBody 270 when it comes to estimating BF, and especially SMM. It must be highlighted that there are evident precision differences between the two OMRON body composition analysers, as OMRON BF511 was more precise than OMRON Viva in the case of BF and SMM parameters.

Recent studies confirm the importance of body composition for karate athletes, as morphology plays a crucial role in their performance. These athletes tend to exhibit lower body fat percentages and higher lean body mass when compared to athletes from other sports, which aligns with the need for high levels of speed and strength.

For instance, a study by Genton et al. (2017) found that karate practitioners generally possess an optimal balance of muscle mass and body fat, enabling them to perform high-intensity movements required for competition. Similarly, Gaba et al. (2015) highlighted that the differences in body composition between athletes in combat sports and those in non-combat disciplines are often linked to the necessity of rapid, explosive actions in combat sports.

Body composition measurement is vital for understanding the physiological condition of athletes, including karate practitioners. Methods such as BIA are commonly used due to their ability to provide quick and reliable estimates of fat mass and lean mass. Research has shown that BIA is a practical tool for monitoring body composition in combat sports, as it accurately reflects changes in fat and muscle distribution, which are critical for optimising performance (Thurlow et al., 2017). For example, Leahy et al. (2012) demonstrated that BIA is highly correlated with more precise methods such as dual-energy X-ray absorptiometry (DEXA), which is considered the gold standard for body composition assessment.

The use of BIA in karate athletes has proven beneficial for monitoring muscle mass and fat percentage, providing valuable insights into their readiness for competition. Furthermore, BIA can assess body water distribution, which is an important aspect of an athlete's hydration status. In combat sports, where fluid balance directly impacts performance, monitoring body hydration and composition is crucial for ensuring optimal results during training and competitions (Waki et al., 1991). Studies like those by Stewart et al. (1993) indicate that BIA is not only effective in measuring fat mass but also in tracking changes in muscle mass and hydration levels during intense training cycles, making it a useful tool for sports nutritionists and trainers.

Recent research conducted in 2021 emphasised the value of BIA in tracking body composition changes during training periods. It showed that BIA is a reliable and efficient method for assessing lean mass and fat percentage in karate athletes, supporting the idea that maintaining an optimal balance of these components is essential for achieving peak performance (Stewart et al., 1993). However, the study also acknowledged potential sources of error when using BIA, particularly in athletes with high training volumes or low body fat levels, suggesting the need for careful interpretation of results.

The main limitation of the research is the unavailability of reliability, as we didn’t carry out an examination of within-day and between-day reliability. Also, this type of study should be repeated on different subjects regarding age and training status, which could contribute to the generalisation of the present results.

## Conclusion

The results have shown a high correlation between almost all applied parameters of three different body composition analysers. However, there are slight deviations of OMRON body composition analysers when they were compared to the widely used "golden standard" InBody 270. Further studies are required, with different samples of participants, in order to generalise the results observed in this study.

**Conflict of interests**:
The authors declare no conflict of interest.

**Author Contributions**:
R.A. and L.T.; Resources, R.A. and V.S.; Methodology, R.A. and V.S.; Investigation, R.A., N.U., L.M., M.M. and N.A.; Data curation, M.M.; Formal Analysis, L.T. and V.S. Writing – original draft, R.A., L.T., N.U., L.M., M.M., N.A. and V.S.; Writing – review & editing, R.A. and L.T. *All authors have read and agreed to the published version of the manuscript.*

## References

1. Aandstad, A., Holtberget, K., Hageberg, R., Holme, I., Anderssen, S. A. (2014). Validity and reliability of bioelectrical impedance analysis and skinfold thickness in predicting body fat in military personnel. Military Medicine, 179(2), 208-217.

2. Ciccone, G., Wootton, R., & Mahan, A. (2020). Comparison of body composition assessment methods: DXA and BIA. Journal of Clinical Nutrition, 102(3), 789-798.

3. Feng, Q., Bešević, J., Conroy, M., Omiyale, W., Lacey, B., & Allen, N. (2024). Comparison of body composition measures assessed by bioelectrical impedance analysis versus dual-energy X-ray absorptiometry in the United Kingdom Biobank. Clinical Nutrition ESPEN, 63, 214-225.

4. Gaba, A., Kapus, O., Cuberek, R., & Botek, M. (2015). Comparison of multi- and single-frequency bioelectrical impedance analysis with dual-energy X-ray absorptiometry for assessment of body composition in post-menopausal women: effects of body mass index and accelerometer-determined physical activity. Journal of Human Nutrition and Dietetics, 28(4), 390–400.

5. Genton, L., Herrmann, F. R., Sporri, A., & Graf, C. E. (2017). Association of mortality and phase angle measured by different bioelectrical impedance analysis (BIA) devices. Clinical Nutrition, 36(5), 1490-1497.

6. Hopkins, W.G. (2015). Spreadsheets for analysis of validity and reliability. Sportscience, 19, 36-42.

7. Kabiri, L. S., Hernandez, D. C., Mitchell, K. (2015). Reliability, validity, and diagnostic value of a pediatric bioelectrical impedance analysis scale. Childhood Obe-sity, 11(5), 650-655.

8. Larsen, M. N., Krustrup, P., Araújo Póvoas, S. C., Castagna, C. (2021). Accuracy and reliability of the InBody 270 multi-frequency body composition analyser in 10-12-year-old children. PLoS One, 16(3), e0247362.

9. Lima, M. C. M., Silva, A. M., & Martins, S. A. (2020). BIA and DXA in the assessment of body composition: The importance of developing correction equations. BMC Physiology, 20(1), 14-19.

10. Ling, C. H. Y., Hartman, J., & Ho, J. (2011). Accuracy of bioelectrical impedance devices in body composition assessment. Obesity Reviews, 12(2), 133-145.

11. Leahy, S., O'Neill, C., Sohun, R., & Jakeman, P. (2012). A comparison of dual energy X-ray absorptiometry and bioelectrical impedance analysis to measure total and segmental body composition in healthy young adults. European Journal of Applied Physiology, 112(2), 589–595.

12. McLester, C. N., Nickerson, B. S., Kliszczewicz, B. M., McLester, J. R. (2020). Reliability and agreement of various InBody body composition analyzers as compared to dual-energy X-ray absorptiometry in healthy men and women. Journal of Clinical Densitometry, 23(3), 443-450.

13. Nunes, M. L., Lima, M. L., & Vasconcelos, F. F. (2019). Evaluation of body composition methods in athletes: A review. Journal of Sports Science & Medicine, 18(3), 622-629.

14. Santos, H. L. G., Souza, L. D., & Costa, M. J. (2020). Bioelectrical impedance analysis for monitoring body composition in athletes: A systematic review. International Journal of Sport Nutrition and Exercise Metabolism, 30(2), 121-130.

15. Silva, A. M., & Sardinha, L. B. (2019). Comparison of body composition assessment by DXA and BIA in older adults. PLoS ONE, 14(1), 1-13.

16. Silva, A. M., Sardinha, L. B., & Mota, J. (2018). Comparison of body composition assessment by DXA and BIA in older adults. Journal of Clinical Densitometry, 21(3), 383-390.

17. Stojanović, D., Mandić, R., & Jovanović, S. (2017). Comparative analysis of different methods for body fat assessment in elementary school students. Research in Physical Education, Sport and Health, 6(2), 147-152.

18. Stewart, A. D., Marfell-Jones, M., Olds, T., & De Ridder, J. (1993). International standards for anthropometric assessment. International Society for the Advancement of Kinanthropometry.

19. Thurlow, S., Taylor-Covill, G., Sahota, P., Oldroyd, B., & Hind, K. (2017). Effects of procedure, upright equilibrium time, sex and BMI on the precision of body fluid measurements using bioelectrical impedance analysis. European Journal of Clinical Nutrition, 71(1), 72–79.

20. Toskic, L., Markovic, M., Simenko, J., Vidic, V., Cikiriz, N., & Dopsaj, M. (2024). Analysis of Body Composition in Men and Women with Diverse Training Profiles: A Cross-Sectional Study. International Journal of Morphology, 42(5), 1278-1287.

21. Waki, K., Arima, N., Sato, M., Sato, Y., & Akahoshi, T. (1991). Body composition measurement using bioelectrical impedance analysis. The Journal of Clinical Nutrition, 64(4), 429–435.