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Commentary
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Recent Topic of Phase Angle (PhA) by Bioelectrical Impedance Analyses (BIA) Measurement for Anti-Aging Medicine

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Abstract

Anti-aging medicine has been more emphasized in developed countries. For detecting sarcopenia and frailty, bioelectrical impedance analyses (BIA) have recently attracted attention. From BIA by InBody, useful data of water balance, muscle index, and cellular health can be obtained as extracellular water/total body water (ECW/TBW), skeletal muscle mass index (SMI), and phase angle (PhA). PhA shows a close relationship with exercise habits and physical activity. The cut-off values of PhA are approximately 4.05° to 5.05°, which are related to sarcopenia. Average PhA values in males/females showed 7.7°/6.9° in university athletes and 4.1°/3.6° in aged people of 81 years old.

Keywords

Phase Angle, Simultaneous Multi-Frequency Impedance Measurement, Extracellular Water/Total Body Water, Bioelectrical Impedance Analyses, InBody

Abbreviations

PhA: Phase Angle; SMFIM: Simultaneous Multi-Frequency Impedance Measurement; ECW/TBW: Extracellular Water/Total Body Water; BIA: Bioelectrical Impedance Analyses

Commentary

In our real world, meaningful investigation has been found for sarcopenia and frailty from longitudinal and transverse points of view, such as the JUSTICE-TOKYO study [1]. For 1042 elderly cases with an average age of 78.2 years, the results showed sarcopenia in 21.4%, frailty in 16.5%, and prefrailty in 51.9%. Frailty and locomotive syndrome commonly overlap in elderly people [2]. Several methods are known for analyzing sarcopenia, including MRI, CAT scans, dual-energy x-ray absorptiometry (DXA), and bioelectrical impedance analyses (BIA) [3]. BIA can be useful for evaluating extracellular water (ECW), total body water (TBW), the ECW/TBW ratio, and also phase angle (PhA) through recent apparatus like InBody [4]. This article will describe current topics contributing to geriatrics and anti-aging medicine [5].

Authors and co-researchers have continued medical research and practice in light of anti-aging medicine. Among them, research on geriatrics, rehabilitation, sarcopenia, and masters' athletics has garnered

attention [6]. Recent topics include the clinical application of BIA using InBody [7], which can analyze TBW, ECW, ECW/TBW, PhA, and skeletal muscle mass index (SMI) [8]. For theoretical aspects, the physics equation known among impedance (Z), resistance (Rz), and reactance (Xc) is $Z^2 = Rz^2 + Xc^2$ [9]. Another equation calculates the impedance value as $Z = (R^2 + X^2)^{1/2}$, represented as the diagonal line. The BIA result paper reveals SMI, TBW, body fat mass (BFM), soft lean mass (SLM), and fat-free mass (FFM). Additionally, PhA is calculated from the device's resistance (R) and reactance (Xc) at 50 kHz, summarized by the following equation: PhA (degree) = arctangent (R/Xc) x 180 π [10]. When evaluating clinical nutritional status, PhA has gained attention through BIA measurements. For this reason, it seems to act as a proxy for body cell mass and water distribution. Furthermore, it is associated with muscle strength, leading to an effective predictor of various clinical reports [11].

As a reliable and supreme apparatus, InBody BWA (Body Water Analysis) has been applied to analyze body composition through BIA [7]. To calculate correct body water conditions, an electric current was applied from 1kHz to 300okHz (**Fig-1**). This includes five parts

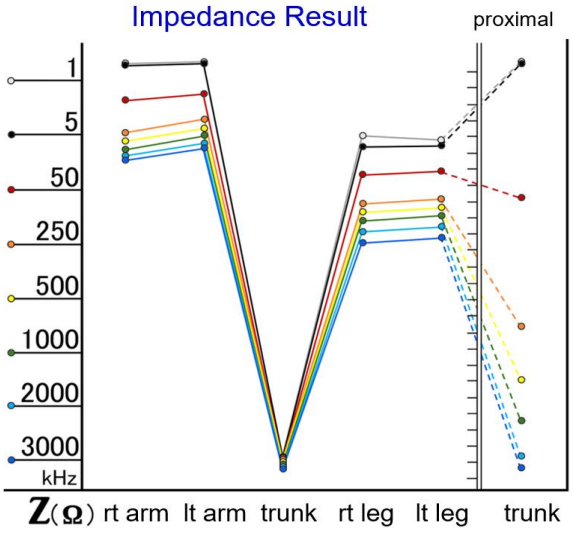

Fig-1:

(bilateral arms, trunk, and bilateral legs) for multi-frequency measurement [12]. A total of 40 impedance data were obtained using the SMFIM (Simultaneous Multi-frequency Impedance Measurement) method [13]. BIA analyses provide important data on PhA. An example is shown in Figure 1, where the case is a 78-year-old male with type 2 diabetes, BMI of 18.0 kg/m^2, SMI of 6.1 kg/m^2, percent body fat of 17.8%, ECW/TBW of 0.398, and whole-body PhA of 4.5°. PhA is known to indicate cell function, cellular health, and cell membrane integrity [5]. Additionally, PhA, exercise habits, and physical activity are closely related. PhA can provide suggestions for evaluating lifestyle, sedentary behavior, muscle function, muscle volume, aerobic training (AT), resistance training (RT), and others [14].

Regarding PhA, a relationship among physical activity, exercise habits, and PhA was investigated for 115 cases ranging from their 30s to 60s [14]. These cases included AT, RT, and no-exercise (No-Ex) groups. The results showed that PhA in AT/RT groups was significantly higher than in the no-Ex group. However, no difference was found between the AT and RT groups. To maintain or improve cellular health and muscle quality, continuing regular exercise at moderate to high levels seems necessary. Recently, ECW/TBW and PhA have been the focus for water balance, cell health, and physical fitness. In sports fields, university athletes received BIA examinations from different kinds of sports [15]. The average PhA levels were 7.7° and 6.9° in male and female athletes, respectively. The results for other groups were as follows: 7.6°/6.8° (M/F) in endurance sports, 7.7°/7.0° (M/F) in velocity and power sports, and 7.6°/6.8° (M/F) in team sports.

Regarding the standard value of PhA, various discussions have been had. An investigation was performed on the analyses of 79 relevant reports. Among them, 7668 cases from 13 papers met the required criteria. Different cut-off values were present, ranging from 4.05° to 5.05°, related to the diagnosis process in sarcopenia [11]. Both PhA and sarcopenia are independent predictors among the population in hospitalized elderly cases and in cancer cases. For elderly people, PhA shows a lower value compared to young and middle-aged people. For patients with osteoporotic fragile fractures, PhA and physical function at discharge were investigated [16]. The study included 127 cases with an average age of 81.2 years. The median PhA values were 4.1°/3.6° for men/women, respectively. Age-related changes are observed in body composition, suggesting an increased risk for diseased states. PhA is linked to sarcopenia,

frailty, malnutrition, and several diseases, disabilities, and interventions [17].

Lower PhA seems to reflect the possibility of an unhealthy status, aging process, and mortality. A study was conducted on the relationship between PhA and dietary habits, nutritional status, and biomarkers using a questionnaire [18]. The study included 212 elderly cases aged 65 and older who received regular health check-ups. The borderline of PhA values was set at ≤4.95°/≤4.35° in male/female. PhA showed a significant relationship with serum cholinesterase values and nutritional markers for male/female. Lower PhA in men showed a significant relationship with low BMI and poor exercise habits. For male analysis, the lower-PhA group showed significantly lower carbohydrate intake amounts/ideal body weight (IBW) than the higher-PhA group. For older people, muscle mass, quality, and function have gradually decreased. Since resistance training (RT) seems to be a valid practice against aging influence, muscle markers were investigated by BIA. The efficacy of RT was studied in elderly people through a systematic review [19]. Out of 7 adequate reports, 344 applicants were analyzed. When continuing RT for eight weeks, bioelectrical PhA showed a significant increase of 0.52°.

In summary, this article has described recent topics concerning BIA, ECW/TBW, SMI, and PhA. For an anti-aging society, such evaluations and treatments for the elderly will be required and beneficial. This commentary is hopefully useful for future research development.

Conflict of Interest

The author has read and approved the final version of the manuscript. The author has no conflicts of interest to declare.

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References

[1] Matsuno K, Asaoka D, Sugano K, Takahashi K, Miyauchi K. Rationale and design of Juntendo Sarcopenia Registration to explore the predictors and prognosis of sarcopenia and frailty in the elderly in TOKYO (JUSTICE-TOKYO). Geriatr Gerontol Int. 2024 Jan;24(1):168-72. [**PMID**: 38102932]

[2] Nagai S, Kawabata S, Michikawa T, Ito K, Takeda H, Ikeda D, Kaneko S, Fujita N. Association between frailty and locomotive syndrome in elderly patients with lumbar spinal stenosis: A retrospective longitudinal analysis. Geriatr Gerontol Int. 2024 Jan;24(1):116-22. [**PMID**: 38140947]

[3] Hioka A, Akazawa N, Okawa N, Nagahiro S. Extracellular water-to-total body water ratio is an essential confounding factor in bioelectrical impedance analysis for sarcopenia diagnosis in women. Eur Geriatr Med. 2022 Aug;13(4):789-94. [**PMID**: 35536459]

[4] Asano Y, Nagata K, Shibuya K, Fujii Y, Kitano N, Okura T. Association of 24-h movement behaviors with phase angle in community-dwelling older adults: a compositional data analysis. Aging Clin Exp Res. 2023 Jul;35(7):1469-76. [**PMID**: 37247128]

[5] Haigis D, Wagner S, Thiel A, Nieß AM; BaSAlt study team. Bioelectrical impedance analysis in the BaSAlt cohort-study: the phase angle as an additional parameter for sarcopenia quantification among German nursing home residents? Eur Geriatr Med. 2023 Jun;14(3):537-46. [**PMID**: 37052833]

[6] Konoike K, Bando H. The Term "Masters" in the Sports Associated with Circumstances and Future Development. J Health Care and Research. 2023 Feb 02;4(1):1-4.

[7] InBody BWA (Body Water Analysis). Japan: InBody. Available from: https://www.inbody.co.jp/inbody-bwa/

[8] Yi Y, Baek JY, Lee E, Jung HW, Jang IY. A Comparative Study of High-Frequency Bioelectrical Impedance Analysis and Dual-Energy X-ray Absorptiometry for Estimating Body Composition. Life (Basel). 2022 Jul 4;12(7):994. [**PMID**: 35888083]

[9] Kilic MK, Kizilarslanoglu MC, Arik G, Bolayir B, Kara O, Dogan Varan H, Sumer F, Kuyumcu ME, Halil M, Ulger Z. Association of Bioelectrical Impedance Analysis-Derived Phase Angle and Sarcopenia in Older Adults. Nutr Clin Pract. 2017 Feb;32(1):103-109. [**PMID**: 27590205]

[10] Barrea L, Muscogiuri G, Pugliese G, Laudisio D, de Alteriis G, Graziadio C, Colao A, Savastano S. Phase Angle as an Easy Diagnostic Tool of Meta-Inflammation for the Nutritionist. Nutrients. 2021 Apr 24;13(5):1446. [**PMID**: 33923291]

[11] Di Vincenzo O, Marra M, Di Gregorio A, Pasanisi F, Scalfi L. Bioelectrical impedance analysis (BIA) - derived phase angle in sarcopenia: A systematic review. Clin Nutr. 2021 May;40(5):3052-61. [**PMID**: 33183880]

[12] Nielsen RL, Andersen AL, Kallemose T, Damgaard M, Bornæs O, Juul-Larsen HG, Strejby Christensen LW, Jawad BN, Andersen O, Rasmussen HH, Munk T, Lund TM, Houlind MB. Evaluation of Multi-Frequency Bioelectrical Impedance Analysis against Dual-Energy X-ray Absorptiometry for Estimation of Low Muscle Mass in Older Hospitalized Patients. J Clin Med. 2023 Dec 29;13(1):196. [**PMID**: 38202202]

[13] Buch A, Ben-Yehuda A, Rouach V, Maier AB, Greenman Y, Izkhakov E, Stern N, Eldor R. Validation of a multi-frequency bioelectrical impedance analysis device for the assessment of body composition in older adults with type 2 diabetes. Nutr Diabetes. 2022 Oct 20;12(1):45. [**PMID**: 36266263]

[14] Yamada Y, Yoshida T, Murakami H, Kawakami R, Gando Y, Ohno H, Tanisawa K, Konishi K, Julien T, Kondo E, Nakagata T, Nanri H, Miyachi M. Phase angle obtained via bioelectrical impedance analysis and objectively measured physical activity or exercise habits. Sci Rep. 2022 Oct 14;12(1):17274. [**PMID**: 36241873]

[15] Campa F, Matias C, Gatterer H, Toselli S, Koury JC, Andreoli A, Melchiorri G, Sardinha LB, Silva AM. Classic Bioelectrical Impedance Vector Reference Values for Assessing Body Composition in Male and Female Athletes. Int J Environ Res Public Health. 2019 Dec 12;16(24):5066. [**PMID**: 31842289]

[16] Ito Y, Yoshimura Y, Nagano F, Matsumoto A, Nomura S. Phase Angle as a Prognostic Predictor for Physical Function in Fragile Osteoporotic Fracture Patients. Prog Rehabil Med. 2023 Dec 9;8:20230044. [**PMID**: 38084364]

[17] Norman K, Herpich C, Müller-Werdan U. Role of phase angle in older adults with focus on the geriatric syndromes sarcopenia and frailty. Rev Endocr Metab Disord. 2023 Jun;24(3):429-37. [**PMID**: 36456777]

[18] Kajiyama S, Nakanishi N, Yamamoto S, Ichikawa T, Okamura T, Hashimoto Y, Kitagawa N, Hamaguchi M, Fukui M. The Impact of Nutritional Markers and Dietary Habits on the Bioimpedance Phase Angle in Older Individuals. Nutrients. 2023 Aug 17;15(16):3599. [**PMID**: 37630789]

[19] Campa F, Colognesi LA, Moro T, Paoli A, Casolo A, Santos L, Correia RR, Lemes ÍR, Milanez VF, Christofaro DD, Cyrino ES, Gobbo LA. Effect of resistance training on bioelectrical phase angle in older adults: a systematic review with Meta-analysis of randomized controlled trials. Rev Endocr Metab Disord. 2023 Jun;24(3):439-49. [**PMID**: 35918569]

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