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Original Article

Association between phase angle and level of independence in daily living among institutionalized super older females requiring nursing care

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Abstract. [Purpose] This study aimed to clarify the association between phase angle (PhA) and the level of independence in daily living among institutionalized super older females requiring nursing care. [Participants and Methods] This three-facility cross-sectional study enrolled 173 nursing home residents (mean age 91.0 years, standard deviation 4.9 years) divided into five groups, from 80+ to 100+ years of age, in 5-year increments. PhA, skeletal muscle mass index, body fat percentage, body mass index, and Barthel Index were measured in the five groups. We measured the relationship between age and PhA and analyzed partial correlation coefficients using these items. The adjusted variables differed significantly among the five groups. [Results] The overall PhA was 2.91 degrees, with a 2.36-degree PhA in patients aged >100 years. Age differences were found between the PhA and the Barthel Index. A significant correlation (0.66) was identified between the PhA and the Barthel Index. The age-adjusted partial correlation coefficient between the PhA and the Barthel Index was 0.56, indicating a moderately significant positive correlation. [Conclusion] This study identified an association between PhA and independence in daily living among female nursing home residents aged 80–107 years, indicating that the PhA is an excellent indicator of physical condition.

Key words: Phase angle, Reference value, Super-old

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INTRODUCTION

Japan has the fastest-aging society in the world. In Japan, a system for certifying that older adults require long-term care has been established, and the extension of healthy life expectancy is being measured[1)]. We believe it is necessary to prevent nursing care and extend healthy life expectancy even after nursing care is required. We are working on the latter, aiming to enable people to live long and healthy lives even after they need long-term care.

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Bioelectrical impedance analysis (BIA) is noninvasive, simple, and inexpensive. Furthermore, it is used in various specialty areas. Phase angle (PhA) calculated by BIA has attracted attention as a prognostic predictor and nutritional indicator because it reflects cellular health and overall nutritional status. PhA may be a potential screening tool in clinical practice to evaluate different biomarkers, cardiovascular risk, and nutritional diagnosis of metabolic diseases in adults[2] and react to physical training and detraining[3]. PhA has been shown to decrease with age and differ between the sexes[4].

BIA is measured non-invasively, and PhA is a valuable indicator. However, reference values of PhA using the same model have not been reported for Japanese residents aged 90 years or older and 100 years or older, that is, those who are considered very elderly. We aimed to clarify the relationship between the reference PhA value and the level of independence in daily living among Female in institutions requiring nursing care. Our hypothesis is that institutional residents have low PhA and that PhA declines with age.

PARTICIPANTS AND METHODS

The three-facility cross-sectional study was conducted between October 2021 and March 2023. This study included 286 residents who entered a geriatric health service facility and special care home for older adults in northern Tochigi Prefecture, Japan. After excluding 113 participants, 173 were included in the final analysis (Fig. 1). Exclusion criteria were as follows: not possible to measure bioelectrical impedance (cardiac artificial pacemaker [1 resident], DBS [1 resident]), male (63 residents), cancer (20 residents), intractable disease (10 residents), and residents under 80 years old (17 residents), and those in which PhA is an outlier (1 resident). The basic information of the resident was as follows: 91.0 ± 4.9 years (mean ± standard deviation), height 155.7 ± 5.5 cm, weight 43.3 ± 7.7 kg, body mass index (BMI) 17.9 ± 3.1 kg/m^2 (Table 1). The residents' required median degree of care was 4, with the first quartiles of 3 and third quartiles of 4. The main diseases of the participants were cardiovascular disease in 58 (33.5%), respiratory disease in 4 (2.3%), cerebrovascular disease in 60 (34.7%), orthopedic disease in 100 (57.8%), osteoporosis in 17 (9.8%), diabetes mellitus in 23 (13.3%) and hypertension in 68 (39.3%). The study protocol was approved by the Ethics Committee of the International University of Health and

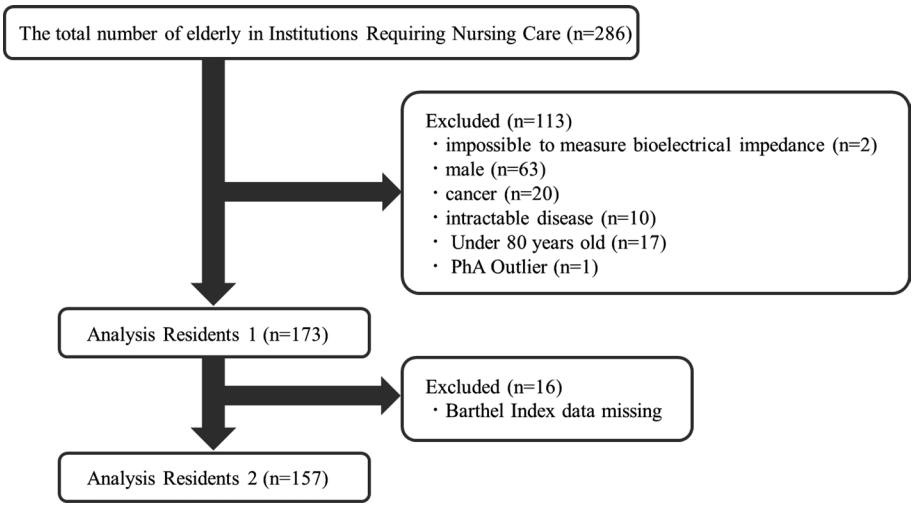

Fig. 1. Research flowchart for study participants.

Table 1. Difference between each age groups of characteristics and PhA

	All (n=173)	80–84 years (n=17)	85–89 years (n=50)	90–94 years (n=63)	95–99 years (n=34)	over 100 years (n=9)
Age (years)**	91.0 ± 4.9	82.4 ± 1.3	87.3 ± 1.5	92.1 ± 1.3	96.0 ± 1.0	101.3 ± 2.5
Height (cm)	155.7 ± 5.5	157.2 ± 4.2	156.7 ± 5.5	155.2 ± 5.4	154.8 ± 6.4	153.6 ± 5.4
Weight (kg)	43.3 ± 7.7	48.2 ± 8.4	42.5 ± 7.2	43.2 ± 8.0	43.0 ± 7.7	41.0 ± 3.8
BMI (kg/m^2)	17.9 ± 3.1	19.5 ± 3.1	17.4 ± 3.0	17.9 ± 3.7	17.9 ± 3.0	17.5 ± 2.0
PhA (°)**	2.91 ± 0.67	3.64 ± 0.42	3.01 ± 0.66	2.81 ± 0.60	2.76 ± 0.64	2.36 ± 0.67

*p<0.05, **p<0.01.
The data are presented as the mean ± standard deviation or median (min–max).
BMI: body mass index; PhA: phase angle.

Welfare (Otawara-shi, Tochigi, Japan: Approval No. 21-Io-13, 23-Io-10), and all participants (or their family members) provided signed informed consent. PhA was measured using a portable, noninvasive, multifrequency bioimpedance device (In Body S10; In Body, Tokyo, Japan). The device can be used while the resident is supine and sitting, which is helpful for residents who cannot stand or sit due to severe dysfunction or are bedridden[5]. The height was calculated using an estimation formula[6]. Body weight was measured 1or 2 days before PhA measurement. The BMI was calculated based on weight and height. The PhA was calculated using the following equation: phase angle = arctangent (Xc/R) × (180/π), where R is the resistance of the right half of the body and Xc is the reactance measured at 50 kHz. Independence in daily living was assessed using the Barthel Index (BI). The BI consists of ten items: eating, moving, dressing, toileting, bathing, walking, climbing stairs, changing clothes, bowel control, and urinary control, with total scores ranging from 0 to 100. The higher the score, the higher the ability to perform activities of daily living (ADL). Basic characteristics of the participants and BI were obtained through Long-term care Information system For Evidence. For statistical analysis, a one-way analysis of variance (ANOVA) was used to compare age, height, weight, BMI, and PhA. To clarify age-related changes in body composition components by age, we divided the residents into five groups of 80–84 years (n=17), 85–89 years (n=50), 90–94 years (n=63), 95–99 years (n=34), and 100 years and older (n=9). We used one-way ANOVA and the Bonferroni method for subtesting to detect differences among the groups (Fig. 1: Analysis Residents 1). Spearman's correlation coefficient was used to examine the relationship between PhA and level of independence in daily activities (Fig. 1: Analysis Residents 2). Moreover, a partial correlation coefficient was used to eliminate the effect of age. All statistical analyses were conducted using SPSS Windows software version 27.0. Statistical significance was set at $p<0.05$.

RESULTS

Table 1 shows the characteristics of the study participants and the PhA and BI scores among the five groups. The overall PhA was 2.91° with a PhA of 2.36° for those aged >100 years. Age differences were observed between the PhA and BI. A significant correlation of 0.53 was found between the PhA and the BI. The age-adjusted partial correlation coefficient between the PhA and the BI was 0.56.

DISCUSSION

This study aimed to determine the relationship between age-related changes in PhA and independence in daily activities among older adult female in need of institutional nursing care. The average age in this study was 91.0 years and was divided into groups of 5 years each, with reference to previous study[7]. Compared to previous previous studies[2–4], the participants in this study were very old.

The PhA decreased with age, with a mean of 2.36° for those over 100 years of age, which was relatively low. As reported in a previous study, the PhA of older female in nursing care facilities decreases with age. PhA generally declines with age, is higher in male than female, and varies according to race[4]. The PhA values in Japan were 5.59° in healthy female Japanese young adults[8] and 4.8° in older adult Japanese female[9]. Additionally, as cutoff values of sarcopenia, 4.62° for female patients with acute stroke[10], ≤4.55° for community-dwelling and hospitalized older adults[11], ≤4.1° for older adult female in Mexico City[12], and 4.20° for older female living in the community[13]. Most of these studies were conducted on relatively independent individuals regarding ADL. In this study, using In-Body S10, which can measure body composition in the supine and seated positions, we could measure body composition in bedridden individuals and older adults requiring care—specifically those who had challenges standing and walking, and living in a wheelchair. PhA has been reported to show a positive correlation with muscle strength[14] and physical activity level[8] among older adults living in the community. Furthermore, PhA was very low in the residents in this study because both muscle strength and physical activity levels were declining due to the need for nursing care. In particular, no data were presented for the age group of 100 years or older, and the mean PhA in the present study was 2.36°, which is relatively low. In the study by Sato et al.[15], the cutoff value for 1-year mortality PhA among institutionalized older adults was 2.95°, and the mean PhA of the group aged 90 years or older was lower than this value. Given that this was a cross-sectional study, we could not pursue the residents in this study. However, it is suggested that those who fell below the cutoff value were more likely to die within one year.

PhA had a moderate relationship ($r=0.66$, $p<0.01$) with ADL (BI) after controlling for age. Regarding the relationship between PhA and the level of independence in daily living, the higher the PhA, the higher the BI. However, a negative correlation was found between age, PhA, and BI, and aging was related to the PhA and level of independence in daily living. Therefore, when the partial correlation coefficients controlling for the effect of age were calculated, even after adjustment, PhA and independence in daily activities were moderately related. Thus, it indicated that cellular health, as measured by PhA, was related to independence in daily activities. Uemura et al.[8] showed that PhA was associated with physical activity levels in older adults. ADL are thought to be related to activity levels among older adults, and a detailed evaluation of nutritional and activity levels is needed in the future.

This study has some limitations. The number of residents was small, especially those over 100 years old (nine residents). This was a cross-sectional study, and causal relationships could not be explained. However, the novelty of our research is twofold. One is that the target group is residents in nursing care. The other is the super older.

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Conflict of interest

None.

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