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Possibilities of Assessing Respiratory Muscle Strength and Trunk Muscle Mass in the Prevention of Sarcopenia in Older People Living in the Community

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Abstract

Objective: The purpose of this study was to clarify the relationship between respiratory muscle strength and skeletal muscle mass (trunk, upper limbs, and lower limbs) in older people who were certified as requiring nursing or supportive care. **Methods:** Thirty-five older people (65 years or older) who were certified as requiring nursing care or support were included in the study. The subjects were divided into a non-sarcopenic group (n = 12) and a sarcopenic group (n = 23) according to the sarcopenia diagnostic criteria proposed by the Asian Working Group for Sarcopenia. Maximum inspiratory pressure, maximum expiratory pressure, skeletal muscle mass (trunk, upper and lower limbs), and hand grip strength were measured. Pearson's correlation coefficient and multiple regression analysis were used for statistical processing. **Results:** In the non-sarcopenic group, both expiratory muscle strength and hand grip strength were correlated with skeletal muscle mass. In the sarcopenia group, expiratory muscle strength was not correlated with skeletal muscle mass, and only hand grip strength was correlated with upper limb muscle mass. Multiple regression analysis revealed that, in the non-sarcopenic group, trunk muscle mass was the primary factor in expiratory muscle strength and upper limb muscle mass was the primary factor in hand grip strength. In the sarcopenia group, upper limb muscle mass was found to be the main factor in hand grip strength. **Conclusion:** Our results highlight the importance of assessing expiratory muscle strength and trunk muscle mass before sarcopenia develops in older people who require support and nursing care.

Keywords

Respiratory Strength, PIMAX, PEMAX, Trunk Muscle Mass, Skeletal Muscle Mass

1. Introduction

Sarcopenia is considered to be a major health issue among older people worldwide. Sarcopenia not only increases the risk of falls and fractures in older people, but also drastically increases their social economic burden [1] [2]. Sarcopenia is widely recognized as a major social problem in Japan, in which the population of older people continues to increase year by year. Sarcopenia was first defined as a decrease in skeletal muscle mass. However, in 2010, muscle strength assessment by hand grip strength measurement and physical function assessment items, such as walking speed and ability to stand up, were added to the diagnostic criteria [3]. Specific cutoff values for Asian populations were subsequently reported [4]. Patients with muscle weakness and decreased skeletal muscle index are diagnosed with sarcopenia, while those exhibiting a decrease in physical function, such as walking speed, are diagnosed with severe sarcopenia. A previous study reported that 20% of older people who fall over suffer serious injuries, including fractures; thus, it is important to stop sarcopenia before it occurs, to reduce the burden of caregiving, as well as the personal and social economic burden [5]. Accurate detection of older people who have muscle weakness but no decrease in skeletal muscle mass is an important first step in preventing sarcopenia. Several previous studies have attempted to identify predictors of sarcopenia. In one study, older age and lower body mass index values were reported to be predictors of the development of sarcopenia, and larger lower leg circumference was found to be associated with less susceptibility to sarcopenia [6]. Malnutrition was also reported to be a predictor of sarcopenia, with a fourfold increase in the incidence of sarcopenia and severe sarcopenia observed in individuals with malnutrition [7]. Among these potential predictors, respiratory muscle strength has attracted substantial attention in recent years. It has been reported that respiratory muscle strength is correlated with performance on the skeletal muscle index, a definitive diagnostic factor for sarcopenia [8] [9] [10], and measurement of diaphragm muscle pressure during forced deep breathing using ultrasound has been confirmed to be a predictor of muscle mass loss in sarcopenia [11]. The skeletal muscle index, which has been used in many previous studies, is an index obtained by dividing the upper and lower limb muscle mass by the square of the height of the patient. The diaphragm and intercostal muscles, which are the main muscles involved in breathing, and the abdominal and dorsal muscles, which are the auxiliary muscles used for breathing, are located in the trunk. Thus, these muscles are not present in the limbs. The authors stated that the decrease in walking speed in sarcopenia was not correlated with lower limb muscle strength, suggesting a relationship with muscle strength other than that in the lower limbs [12]. Additionally, it was reported that trunk muscle strength declines gradually with age, although not rapidly, and is associated with decreased walking speed, an important risk factor for falls. However, trunk muscle strength was examined in terms of endurance strength of the back muscles, but not in terms of respiratory muscle strength. In the current study, we hypothesized that respiratory muscle strength would be the most relevant factor for predicting sarcopenia. Clarifying the details of this hypothesis may be helpful for identifying a more accurate predictor of sarcopenia. In this study, we measured respiratory muscle strength and muscle mass of the trunk, upper limbs, and lower limbs in older people in need of nursing care to clarify the relationship between the two factors.

2. Participants and Methods

2.1. Participants

Thirty-five older people (aged 65 years or older) who were certified as needing nursing care or support were divided into two groups: 12 in the non-sarcopenic group (age: 77.8 ± 5.2 years; height: 160.7 ± 8.0 cm; weight: 63.8 ± 7.0 kg, 4 males, 8 females) and 23 in the sarcopenic group (age: 84.6 ± 5.2 years; height: 153.0 ± 8.9 cm; weight: 53.1 ± 10.4 kg, 11 males, 12 females). Exclusion criteria were cardiac pacemaker use, inability to stand steadily, respiratory disease as the primary illness, significant cognitive decline, and inability to measure respiratory muscle strength. Sarcopenia was identified using the diagnostic criteria proposed by the Asian Working Group for Sarcopenia [4]. Subjects were individuals who used day-care rehabilitation at least once a week under the long-term care insurance system. Individuals with significantly impaired cognitive function were excluded. Each participant signed the Declaration of Helsinki. This study was approved by the Ethics Committee of the Kanazawa Orthopedic Sports Medicine Clinic (Kanazawa-OSMC-2023-003).

2.2. Measurements

Maximum inspiratory pressure (PIMAX) and maximum expiratory pressure (PEMAX) were measured as respiratory muscle strength. The Autospiro AS-507 (Minato, Tokyo, Japan) was used as the measurement device. The subjects were asked to sit in a natural posture, and a nose clip was used to prevent breath leakage. Skeletal muscle mass was measured with the Bioelectrical impedance analysis method using the Inbody 470 body composition analyzer (InBody Japan Inc., Tokyo, Japan). Measurements were taken by standing upright with both feet on the measuring device. The measured muscle mass was divided by body weight and statistically analyzed. Grip strength was measured using a grip strength meter (Takei Scientific Instruments, Tokyo, Japan).

2.3. Statistical Analysis

Pearson's correlation coefficient and multiple regression analysis were used to examine respiratory muscle strength, hand grip strength, and muscle mass. Multiple regression analysis was performed using the stepwise method, with expiratory muscle strength and hand grip strength as dependent variables and trunk muscle mass, upper limb muscle mass, and lower limb muscle mass as independent variables. SPSS (Version 26.0; IBM, Tokyo, Japan) was used for analysis.

3. Results

The certification level classifications are shown in **Table 1**. **Table 2** shows the correlations among respiratory muscle strength, hand grip strength, and muscle mass. First, in the non-sarcopenic group, expiratory muscle strength was correlated with all muscle volumes of the trunk, upper limbs, and lower limbs. Hand grip strength was also correlated with trunk, upper limb, and lower limb muscle mass. In the sarcopenic group, there was no correlation between respiratory muscle strength and muscle mass. Hand grip strength was correlated only with

Table 1. Certification level classification of long-term care insurance for the subjects.

	Male	Female
Support		
Level 1	4	7
Level 2	1	6
Care		
Level 1	5	5
Level 2	3	1
Level 3	1	1
Level 4	1	-
Level 5	-	-

Table 2. Correlation between respiratory muscle strength, hand grip strength and muscle mass in each area.

	Muscle mass			PIMAX	PEMAX	Hand Grip Strength
	Trunk	Upper limb	Lower limb			
Non-Sarcopenia group						
PIMAX	0.4	0.424	0.411	-	0.713*	0.781*
PEMAX	0.719*	0.704*	0.676*	0.713*	-	0.867*
Hand Grip Strength	0.736*	0.781*	0.659*	0.781*	0.867*	-
Sarcopenia group						
PIMAX	0.234	0.235	0.081	-	0.505	0.274
PEMAX	0.178	0.377	0.154	0.505	-	0.553*
Hand Grip Strength	0.284	0.456*	0.067	0.274	0.553*	-

*$p < 0.05$; PIMAX, Maximum inspiratory pressure; PEMAX, Maximum expiratory pressure.

upper limb muscle mass. Multiple regression analysis in the non-sarcopenic group showed that trunk muscle mass was a significant factor when expiratory muscle strength was used as the dependent variable ($\beta = 0.719$, $p = 0.008$), and upper limb muscle mass was a significant factor when grip strength was used as the dependent variable ($\beta = 0.781$, $p = 0.003$). Multiple regression analysis in the sarcopenic group showed a significant difference in upper limb muscle mass when grip strength was the dependent variable ($\beta = 0.455$, $p = 0.029$). Each regression equation yielded significant results.

4. Discussion

In this study, we examined the relationships between upper limb, lower limb, and trunk muscle mass, respiratory muscle strength, and hand grip strength between a non-sarcopenic and a sarcopenic group. In the non-sarcopenic group, expiratory muscle mass was correlated with muscle mass in all areas, with a slight tendency toward a stronger correlation with trunk muscle mass. Hand grip strength was also correlated with muscle mass in all areas. Multiple regression analysis of the non-sarcopenic group revealed that expiratory muscle strength was one of the main factors in trunk muscle mass, and hand grip strength was one of the main factors in upper limb muscle mass. However, there was no correlation between respiratory muscle strength and muscle mass in the sarcopenic group. Hand grip strength was correlated only with upper limb muscle mass. The results of multiple regression analysis in the sarcopenic group indicated that hand grip strength was one of the main factors contributing to upper limb muscle mass. In the non-sarcopenic group, both expiratory and inspiratory muscle strength were correlated with grip strength, while in the sarcopenic group, only expiratory muscle strength was correlated with grip strength. The correlation of expiratory muscle strength with trunk muscle mass was stronger in the non-sarcopenic group, indicating that our hypothesis was only supported in the non-sarcopenic group.

It has been reported that type II muscle fibers decrease in size and oxidative capacity with aging, while type I muscle fibers remain unchanged or increase [13] [14]. Additionally, there is evidence that the loss of motor units of type II myofibers accelerates as the loss of motor units progresses and workload increases, and that as an adaptive response, the remaining motor units adopt denervation fibers and act as if they have been replaced by type I myofibers [14] [15]. This atrophy of type II muscle fibers (fast-twitch muscle fibers) is thought to cause a decrease in muscle output. In addition, the infiltration of adipose tissue into myofibers is believed to have an effect on the decline in muscle strength with aging. It has been confirmed that fat deposition in muscle fibers increases with aging and that the adipocyte type increases with age among muscle satellite cells, in which case there is no significant change in body weight [15] [16]. These findings suggest that muscle weakness without loss of muscle mass occurs in the early stages of aging and weakness, when fast-twitch muscle fibers are denervated and adipose tissue begins to infiltrate myofibers. Sarcopenia is generally diagnosed when both muscle mass loss and muscle weakness occur. However, in this study, the results indicated that the trunk may also be an important indicator of muscle mass, suggesting that respiratory muscle strength as well as hand grip strength should be focused on as indicators of muscle strength. Thus, the prevention of sarcopenia may be aided by identifying subjects who show a decrease in trunk muscle mass and respiratory muscle strength, especially expiratory muscle strength, before they are diagnosed.

Regarding muscle mass, a previous report suggested that abdominal muscle mass decreases with aging, whereas back muscle mass does not [17]. The authors reported that androgens, which are involved in the increase or decrease in muscle mass with aging, act via hormone receptors that are expressed only in exercised muscles, suggesting a relationship with changes in muscle activity patterns with aging [17]. It is likely that muscles that are no longer actively used selectively atrophy with aging. Although it has been confirmed that the diaphragm also loses motor units of type II muscle fibers, as in the case of sarcopenia [18], the diaphragm is the main active muscle for inspiration, so it functions actively on a daily basis, and is considered to be a muscle that is unlikely to selectively atrophy. The finding that expiratory muscle strength was correlated with trunk muscle mass in our study suggests that the abdominal muscles can be active as auxiliary muscles during maximal expiration, and that it may be important to keep the abdominal muscles active on a daily basis to prevent selective atrophy and sarcopenia.

In the present study, both expiratory and inspiratory muscle strength were correlated with grip strength in the non-sarcopenic group, while expiratory muscle strength was correlated with grip strength in the sarcopenic group. Grip strength has been reported as an index of whole-body muscle strength in many previous studies. In previous studies, inspiratory muscle strength was correlated with hand grip strength, but the results of the present study are inconsistent because not only inspiratory muscle strength but also expiratory muscle strength were correlated in the non-sarcopenic group [10]. The authors also reported a correlation between the skeletal muscle index of the limbs and inspiratory muscle strength, but they tested healthy older people aged 60 years or older as subjects. This is an important finding, because the subjects of our study were older people in need of long-term care, who are likely to be affected by age-related muscle weakness and loss of muscle mass. Thus, it is possible that the abdominal muscles, which are auxiliary muscles for expiration, are selectively weakened in older people who require nursing care, suggesting that expiratory muscle strength, rather than inspiratory muscle strength, may be more important for older people with sarcopenia compared with healthy older people.

The factors mentioned above suggest that, for preventing the worsening of sarcopenia from a frail state requiring nursing care, it is important not only to consider hand grip strength and inspiratory muscle strength, but also expiratory muscle strength, to avoid overlooking muscle weakness. Additionally, it is necessary to evaluate trunk muscle mass as well as upper and lower limb muscle mass.

5. Limitations

Because we did not conduct a longitudinal study, it remains unclear how respiratory muscle strength and trunk muscle mass change over time as a result of sarcopenia. Further studies will be required to clarify this issue in future. In addition, because we were unable to assess lower limb muscle strength, it will be necessary to confirm the relationship between lower limb muscle strength and muscle mass in each region. In addition, no healthy older people or healthy controls were included in this study. Thus, we cannot exclude the possibility that the results were limited to older people at a single facility.

6. Conclusion

Among older people requiring long-term care, expiratory muscle strength was correlated with muscle mass in each area in the non-sarcopenic group, indicating that the main factor of expiratory muscle strength was trunk muscle mass. In the sarcopenic group, respiratory muscle strength was not correlated with muscle mass, but hand grip strength was mainly attributed to upper limb muscle mass.

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Conflicts of Interest

The authors declare no conflicts of interest associated with this manuscript.

References

[1] Bian, A., Ma, Y., Zhou, X., Guo, Y., Wang, W., Zhang, Y., *et al.* (2020) Association between Sarcopenia and Levels of Growth Hormone and Insulin-Like Growth Factor-1 in the Elderly. *BMC Musculoskeletal Disorders*, **21**, Article No. 214. https://doi.org/10.1186/s12891-020-03236-y

[2] Lynch, G.S. (2004) Tackling Australia's Future Health Problems: Developing Strategies to Combat Sarcopenia—Age-Related Muscle Wasting and Weakness. *Internal Medicine Journal*, **34**, 294-296. https://doi.org/10.1111/j.1444-0903.2004.00568.x

[3] Cruz-Jentoft, A.J., Baeyens, J.P., Bauer, J.M., Boirie, Y., Cederholm, T., Landi, F., *et al.* (2010) Sarcopenia: European Consensus on Definition and Diagnosis: Report of the European Working Group on Sarcopenia in Older People. *Age and Ageing*, **39**, 412-423. https://doi.org/10.1093/ageing/afq034

[4] Chen, L.K., Woo, J., Assantachai, P., Auyeung, T.W., Chou, M.Y., Iijima, K., *et al.* (2020) Asian Working Group for Sarcopenia: 2019 Consensus Update on Sarcopenia Diagnosis and Treatment. *Journal of the American Medical Directors Association*, **21**, 300-307.E2. https://doi.org/10.1016/j.jamda.2019.12.012

[5] Ambrose, A.F., Paul, G. and Hausdorff, J.M. (2013) Risk Factors for Falls among

Older Adults: A Review of the Literature. *Maturitas*, **75**, 51-61. https://doi.org/10.1016/j.maturitas.2013.02.009

[6] Kim, H., Suzuki, T., Kim, M., Kojima, N., Yoshida, Y., Hirano, H., *et al.* (2015) Incidence and Predictors of Sarcopenia Onset in Community-Dwelling Elderly Japanese Women: 4-Year Follow-Up Study. *Journal of the American Medical Directors Association*, **16**, 85.E1-85.E8. https://doi.org/10.1016/j.jamda.2014.10.006

[7] Beaudart, C., Sanchez-Rodriguez, D., Locquet, M., Reginster, J.Y., Lengele, L. and Bruyere, O. (2019) Malnutrition as a Strong Predictor of the Onset of Sarcopenia. *Nutrients*, **11**, Article 2883. https://doi.org/10.3390/nu11122883

[8] Sawaya, Y., Ishizaka, M., Kubo, A., Sadakiyo, K., Yakabi, A., Sato, T., *et al.* (2018) Correlation between Skeletal Muscle Mass Index and Parameters of Respiratory Function and Muscle Strength in Young Healthy Adults According to Gender. *The Journal of Physical Therapy Science*, **30**, 1424-1427. https://doi.org/10.1589/jpts.30.1424

[9] Sawaya, Y., Ishizaka, M., Kubo, A., Shiba, T., Hirose, T., Onoda, K., *et al.* (2020) Association between Skeletal Muscle Mass Index and Lung Function/Respiratory Muscle Strength in Older Adults Requiring Long-Term Care or Support. *The Journal of Physical Therapy Science*, **32**, 754-759. https://doi.org/10.1589/jpts.32.754

[10] Shin, H.I., Kim, D.K., Seo, K.M., Kang, S.H., Lee, S.Y. and Son, S. (2017) Relation between Respiratory Muscle Strength and Skeletal Muscle Mass and Hand Grip Strength in the Healthy Elderly. *Annals of Rehabilitation Medicine*, **41**, 686-692. https://doi.org/10.5535/arm.2017.41.4.686

[11] Zeng, B., He, S., Lu, H., Liang, G., Ben, X., Zhong, W., *et al.* (2021) Prediction of Loss of Muscle Mass in Sarcopenia Using Ultrasonic Diaphragm Excursion. *Contrast Media & Molecular Imaging*, **2021**, Article ID: 4754705. https://doi.org/10.1155/2021/4754705

[12] Kato, K. and Hatanaka, Y. (2020) The Influence of Trunk Muscle Strength on Walking Velocity in Elderly People with Sarcopenia. *The Journal of Physical Therapy Science*, **32**, 166-172. https://doi.org/10.1589/jpts.32.166

[13] Sayed, R.K., de Leonardis, E.C., Guerrero-Martinez, J.A., Rahim, I., Mokhtar, D.M., Saleh, A.M., *et al.* (2016) Identification of Morphological Markers of Sarcopenia at Early Stage of Aging in Skeletal Muscle of Mice. *Experimental Gerontology*, **83**, 22-30. https://doi.org/10.1016/j.exger.2016.07.007

[14] Lang, T., Streeper, T., Cawthon, P., Baldwin, K., Taaffe, D.R. and Harris, T.B. (2010) Sarcopenia: Etiology, Clinical Consequences, Intervention, and Assessment. *Osteoporosis International*, **21**, 543-559. https://doi.org/10.1007/s00198-009-1059-y

[15] von Haehling, S., Morley, J.E. and Anker, S.D. (2010) An Overview of Sarcopenia: Facts and Numbers on Prevalence and Clinical Impact. *Journal of Cachexia, Sarcopenia and Muscle*, **1**, 129-133. https://doi.org/10.1007/s13539-010-0014-2

[16] Morley, J.E. (2012) Sarcopenia in the Elderly. *Family Practice*, **29**, i44-i48. https://doi.org/10.1093/fampra/cmr063

[17] Abe, T., Sakamaki, M., Yasuda, T., Bemben, M.G., Kondo, M., Kawakami, Y., *et al.* (2011) Age-Related, Site-Specific Muscle Loss in 1507 Japanese Men and Women Aged 20 to 95 Years. *Journal of Sports Science and Medicine*, **10**, 145-150.

[18] Elliott, J.E., Greising, S.M., Mantilla, C.B. and Sieck, G.C. (2016) Functional Impact of Sarcopenia in Respiratory Muscles. *Respiratory Physiology & Neurobiology*, **226**, 137-146. https://doi.org/10.1016/j.resp.2015.10.001