Characteristics of balance ability related to life space of older adults in a day care center

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Abstract: The study aimed to clarify the life space of older adults who use a day care center, to explore for factors related to life space, and to identify the balance elements related to life space. In a cross-sectional study at a day care center located in Japan, 64 adult day care users were assessed using the Life Space Assessment (LSA), Mini-Balance Evaluation Systems Test (Mini-BESTest), Modified Falls Efficacy Scale (MFES), and Stops Walking When Talking test. A correlation analysis between the LSA score and variables and a stepwise multiple regression analysis with the LSA score as the dependent variable and the sub-items of the Mini-BESTest as explanatory variables were performed. The median LSA score was 45.8 (interquartile range: 34–62.8, range: 16–100) points. The LSA score showed a significant correlation with all the sub-items and total scores of the Mini-BESTest and the MFES. Based on the result of the multiple regression analysis, anticipatory postural adjustments (β = 0.31, p = 0.015) and dynamic gait (β = 0.30, p = 0.019) were incorporated into the model (R² = 0.28, p < 0.001). The life space of adult day care users is narrow, and the 28.4% variance of life space is explained with anticipatory postural adjustments and dynamic gait.

Subjects: Rehabilitation; Health and Social Care; Gerontology; Physical Therapy

Keywords: life space; Mini-BESTest; elderly; falls

ABOUT THE AUTHOR
The author is engaged in research on fall prevention for the elderly. Currently, the author is investigating the actual situation of falls among hospitalized patients and community-dwelling elderly individuals and is conducting research on balance ability, which is associated with falls. As balance ability can be divided into several elements, comprehensive evaluation is essential. The author believes that the first step in the development of a specific treatment program for the prevention of falls for each subject is to clarify the evaluation method that appropriately reflects the balance ability related to falls. The development of this fall prevention program will contribute to an active life for the elderly in the community.

PUBLIC INTEREST STATEMENT
The current challenges in the implementation of community rehabilitation in Japan are encouraging participation in activities at the local community level and providing rehabilitation services that are suitable not only for groups but also for individuals. Previous studies have reported that the evaluation of “life space,” including frequency, scope, and independence of activity, is useful as an indicator of community mobility. Several factors that affect life space, such as physical function and psychological characteristics, have been reported so far. However, to the best of our knowledge, there are few studies researching the relationship between life space and balance ability.

In this study, we concluded that balance ability was related to life space among the elderly using a day care center. Interventions for anticipatory postural adjustments and dynamic gait, which are balance elements, may be effective especially for expanding the life space.
1. Introduction

The establishment of “community-based integrated care systems” is being promoted in Japan, with emphasis on the achievement of well-balanced rehabilitation outcomes with respect to the International Classification of Functioning, Disability and Health, as well as on the effects on social participation and physical and mental functions. Various regional frameworks are being developed to provide rehabilitative services; nonetheless, providing interventions cognizant of specific aspects of social participation and patients’ individual abilities and goals remains a challenge. The demand for programs capable of visualizing patients’ physical capacities and degree of social participation through objective assessments, which also account for patients’ individual circumstances to improve service offerings, will continue to increase in the future. When taking patients’ “participation” into consideration, the amount of activity and the range of activity types are factors closely related to their activities within their communities (Baker, Bodner, & Allman, 2003). As such, it is important to evaluate various aspects of mobility influencing the lives of elderly people (Parker, Baker, & Allman, 2002).

The Life Space Assessment (LSA), developed by Baker et al., 2003, has been widely used as a scale for assessing the space where examinees conduct their mobile activities during community life. The LSA classifies life space into five levels ranging from examinees’ bedrooms to areas outside of town. The levels serve as an index for scoring and quantifying examinees’ degree of mobility based on the maximum range accessed during the prior month as well as the frequency of entry/degree of independence for each range. The reliability and validity of this assessment have been verified with respect to elderly people living in communities (Baker et al., 2003; Parker et al., 2002).

There is a mutual relationship between life space and physical function, and research has revealed that narrowing the range of life space leads to decreased physical activity and a subsequent reduction in activities of daily living (ADL) (Shimada, Ishizaki, & Kato et al., 2010). Previous studies on elderly people have reported depression (Peel, Sawyer Baker, & Roth et al., 2005), health conditions, and psychosocial factors (Murata, Kondo, & Tamakoshi et al., 2006) as factors influencing the LSA score. Furthermore, the effect of life space not only on one’s ambulatory parameters (Shimada, Kim, & Yoshida et al., 2010) and ADL but also on postural control capacity (Garatachea, Molinero, & Martinez-Garcia et al., 2009) has been reported. As such, the influence of both environmental factors and physical function has been shown to be important for expanding the range of life space. However, thus far, there have been no published reports on balance ability as it relates to other capacities such as postural control. Currently, there are no specific examples of life space being expanded or intervention approaches being proposed.

Many evaluation scales related to balance ability and fall prediction are used in clinical physical therapy (Lundin-Olsson, Nyberg, & Gustafson, 1997; Muir, Berg, Chesworth, & Speechley, 2008; Posiadlo & Richardson, 1991). Among these scales, the Balance Evaluation Systems Test (BESTest) classifies a participant’s balance ability into six elements: (I) biomechanical constraints, (II) stability limits/verticality, (III) anticipatory postural adjustments, (IV), postural responses (V) sensory orientation, and (VI) dynamic gait, allowing for comprehensive assessment (Horak, Wrisley, & Frank, 2009). Although the BESTest can classify and assess a participant’s balance ability with respect to each element, the test has the disadvantage of requiring significant time to administer. To address this, the Mini-Balance Evaluation Systems Test (“Mini-BESTest”) was developed as an abbreviated version (Franchignoni, Horak, Godi, Nardone, & Giordano, 2010). Four elements are assessed by the Mini-BESTest, including anticipatory postural adjustments factors, postural responses factors, sensory orientation factors, and dynamic gait factors, with assessment focused on dynamic balance. Using this evaluation, we can expect to obtain specific information applicable to the potential therapeutic interventions in the clinic.
The purpose of this study was to clarify the life space of older adults who use a day care center, to explore for factors related to life space, and to identify the balance elements related to life space. By clarifying the balance elements related to users’ life space, we believe that we can contribute to the development of physical therapy interventions involving the expansion of life space.

2. Methods

2.1. Study design and participants
This study is a cross-sectional study investigating the life space and balance ability of older adults who use a day care center in Urayasu-city, Chiba, Japan. We conducted screening for all users who used the day care center between 1 June 2016, and 31 October 2016. Participant exclusion criteria were as follows: (1) those who were unable to understand instructions provided, (2) those who were unable to walk indoors without assistance other than a cane, (3) those with physiological abnormalities or other serious complications, and (4) those who suspended or discontinued their use of the care facility during the study period.

A preliminary explanation of the study details was given to all participants, and written consent was obtained. The study protocol was approved by the ethics committee of Saitama Prefectural University (approval number: 28511).

2.2. Measurements
We collected information related to participant characteristics included age, sex, height, weight, body mass index (BMI), use situation of walking aids during indoor and outdoor activities, and history of fall events occurring within the previous 6 months. For this study, a fall event was defined as an event in which “a part of the body touches the ground or a lower surface in an unintentional manner” (Gibson, 1990). In addition, we also collected the participants’ eligibility level in the Japanese long-term care (LTC) insurance system, which covers in-home care and community-based care such as a day care center. In the Japanese LTC insurance system, eligibility is classified into seven levels, including two support levels and five care levels. Those classified as requiring support level 1 require partial assistance in daily living and can use the LTC service to prevent an increase in care level. Individuals requiring support level 2 have more declined activities of daily living than those requiring support level 1, and they need additional assistance or support. Those who require care ranges from care level 1 (individuals who need partial care for daily life) to care level 5 (individuals who are unable to conduct daily activities without extensive assistance) (Akiyama, Shiroiwa, Fukuda, Murashima, & Hayashida, 2018). An individual's level is primarily determined by a computerized algorithm, based on responses to questionnaire items pertaining to the individual’s current physical and mental status. This algorithm was derived from the estimated nursing time (Tsutsui & Muramatsu, 2005).

2.2.1. Range of life space
The LSA was used to determine the range of participants’ life space; three physiotherapists administered the assessment while explaining its contents and the procedure for providing responses. The levels of mobility/locomotion indicating range included: “other rooms of your home besides the room where you sleep” (life space 1), “an areas outside your home such as your porch, deck or patio, hallway or garage, in your own yard or driveway” (life space 2), “places in your neighborhood, other than your own yard or apartment building” (life space 3), “places outside your neighborhood, but within your town” (life space 4), and “places outside your town” (life space 5). Additionally, the frequency of entry into each life space was divided into four levels: daily (4 points), 4–6 times per week (3 points), 1–3 times per week (2 points), and less than once per week (1 point). Degree of independence was classified as one of three levels: “no equipment or personal assistance” (2 points), “only with equipment” (1.5 points), or “with personal assistance” (1 point). The use of a day nursing service was not included in the assessment of the frequency of life-space entry. The LSA calculated the score for each life-space range from the
product of the sub-items, and the maximum score was 8 points for life space 1 activities, 16 points for life space 2 activities, 24 points for life space 3 activities, 32 points for life space 4 activities, and 40 points for life space 5 activities. The minimum total score was 0 points, and the maximum was 120 points.

2.2.2. Balance ability
The Mini-BESTest was used for assessment. The score of each section of the Mini-BEST test was 6 points each for anticipatory postural adjustments, postural responses, and sensory orientation, and 10 points for dynamic gait, with a maximum total score of 28 points. For items related to dynamic gait, the grading level was adjusted downward by one level when a support tool was used (Franchignoni et al., 2010). This test was conducted in the day care center on the same day as the LSA measurement. To maintain inter-rater reliability of measurement, we restricted evaluators to three specific physical therapists. Evaluators confirmed the assessment methodology and scoring method for each item in advance, and the training of measurement was continued until the scoring criteria were unified across all evaluators.

2.2.3. Attentional aspect of walking
We used the Stops Walking When Talking (SWWT) test (Lundin-Olsson et al., 1997), which is well suited for assessing the degree of attention required for walking and other factors that contribute to determining life space. The assessment result was reported as positive if an examinee stopped walking to respond to a conversation prompted by the examiner, and the result was negative if the examinee continued walking while responding. The results of the SWWT test are believed to be useful in determining the risk of fall events for up to 6 months.

2.2.4. Fear of falling
In addition, the Modified Falls Efficacy Scale (MFES) (Hill, Schwarz, & Kalogeropoulos et al., 1996) was used to assess the fear of falling and other aspects of fall self-efficacy as psychological factors. The MFES is an index used to quantify the self-efficacy required to perform an action without falling with respect to 14 different ADL and outdoor activities; with 0 points indicating “not confident/not sure at all” and 10 points indicating “completely confident/completely sure.” The minimum possible aggregate score is 0 points, and the maximum is 140 points. The higher the score, the less fear the examinee has of falling.

2.3. Statistical analysis
Initially, we performed the Shapiro–Wilk test for the LSA score, age, BMI, sub-items and total scores of the Mini-BESTest, and the MFES to confirm the normality of each variable. Then, we conducted an analysis of the simple correlation between the LSA score and variables including age, BMI, sub-items and total scores of the Mini-BESTest, and the MFES to explore for factors related to life space. When normality of both variables was confirmed, Pearson correlation coefficients were calculated. Otherwise, Spearman correlation coefficients were calculated. The strength of the correlation was interpreted as follows: 0.1–0.29 = small; 0.3–0.49 = medium; 0.5–1 = high (Pallant, 2005).

Furthermore, a multiple linear regression analysis using forward-backward stepwise selection method was performed to identify the balance elements related to life space, with the LSA scores as the dependent variable, sub-items scores of the Mini-BESTest including anticipatory postural adjustments, postural responses, sensory orientation, and dynamic gait as the explanatory variables. The probability of the F value for entry of variables into the model was set at 0.05, whereas the probability of the F value for removal of variables was set at 0.10. The variance inflation factor (VIF) values were used to confirm multicollinearity. A VIF >10 was considered indicative of multicollinearity. SPSS version 24 (IBM Corp., Armonk, NY, USA) was used to conduct statistical analyses, and the level of significance was set to \( p = 0.05 \).
3. Results

3.1. Participants’ characteristics
A total of 87 day care users were screened for participation in this study. Of these, 15 were excluded (the reasons for exclusion are listed in Figure 1). Additionally, eight participants suspended or discontinued their use of the care facility during the study period. Therefore, we analyzed 64 participants including 23 men and 41 women with a mean age of 77.6 ± 7.2 years and a median BMI of 22.2 (interquartile range [IQR]: 19.8–24.4).

Participants’ characteristics are shown in Table 1. In the breakdown of participant’s eligibility level in the Japanese LTC insurance system, 21 participants (33%) were categorized as support level 1, 16 (25%) categorized as support level 2, 16 (25%) categorized as care level 1, 9 (14%) categorized as care level 2, and 2 (3%) categorized as care level 3. Fifteen participants (23%) had a history of fall within the previous 6 months, whereas 49 did not. Twenty-three participants (36%) used walking aids only for outdoor activities, 14 (22%) used aids both indoors and outdoors, and 27 (42%) did not use walking aids.

3.2. Measurement results
The results of the LSA score, level of mobility/locomotion, the frequency of entry into each life space, and the degree of independence are described in Table 2. The median total LSA score was 45.8 (IQR: 34–62.8, range: 16–100) points. Maximum accessible life-space range extended as far as life space 2 for 1 participant (2%), life space 3 for 5 participants (8%), life space 4 for 29 participants (45%), and life space 5 for 29 participants (45%); no participants had a life-space range extending to life space 1.

The results of the Mini-BESTest, SWWT, and MFES are described in Table 3. The median total Mini-BESTest score was 19 (IQR: 11–22, range: 2–26) points, and the median score for each sub-item...
was 3 (IQR: 2–4, range: 0–6) points for anticipatory postural adjustments factors, 3 (IQR: 2–4, range: 0–6) for postural responses, 5.5 (IQR: 2–4, range: 0–6) for sensory orientation, and 7 (IQR: 4–9, range: 0–10) for dynamic gait. SWWT test results were positive for 18 (31%) and negative for 40 participants (69%) of 58 participants; six participants were excluded owing to difficulties in measurement (five participants were temporarily not using the facility due to hospitalization during the study period and one participant had deafness). The median MFES score was 112 (IQR: 89–131, range: 30–140) points.

3.3. Related factors to life space
As a result of the Shapiro–Wilk test, LSA score ($p = 0.03$), BMI ($p = 0.01$), all of the sub-item scores of the Mini-BESTest (anticipatory postural adjustments: $p = 0.002$; other three elements: $p < 0.001$), the total score of the Mini-BESTest ($p = 0.005$), and the MFES ($p < 0.001$) did not show normal distribution. Only age showed a normal distribution ($p = 0.22$). Therefore, the Spearman correlation coefficients had been calculated between the LSA score and variables including age, BMI, the sub-item scores and total score of the Mini-BESTest, and the MFES. The results are shown in Table 4. No significant correlations were observed between the LSA score and the participants’ characteristics.

**Table 1. Participants’ characteristics (n = 64)**

| Variable                        | n   | Representative value or % |
|---------------------------------|-----|---------------------------|
| Age (years), mean±SD            | 64  | 77.6 ± 7.2                |
| Sex                             |     |                           |
| Male                            | 23  | 36                        |
| Female                          | 41  | 64                        |
| BMI, median (IQR)               | 64  | 22.2 (19.8–24.4)          |
| Support/care level              |     |                           |
| Support level 1                 | 21  | 33                        |
| Support level 2                 | 16  | 25                        |
| Care level 1                    | 16  | 25                        |
| Care level 2                    | 9   | 14                        |
| Care level 3                    | 0   | 0                         |
| Care level 4                    | 2   | 3                         |
| Care level 5                    | 0   | 0                         |
| History of fall within the previous 6 months | | |
| With fall history               | 15  | 23                        |
| Without fall history            | 49  | 77                        |
| Use situation of the walking aid|     |                           |
| Outdoor only                    | 23  | 36                        |
| Indoor and outdoor              | 14  | 22                        |
| Not use                         | 27  | 42                        |

BMI: body mass index, SD: standard deviation, IQR: interquartile range.

The seven support/care levels of the Japanese long-term care insurance system are defined as follows:
- Support level 1: Requires partial assistance in the activities of daily living (estimated nursing time = 25–32 min/day).
- Support level 2: A greater decline in the activities of daily living than that in support level 1, with the need of additional assistance or support (estimated nursing time = 32–50 min/day).
- Care level 1: Needs partial care for daily life (Estimated nursing time = 32–50 min/day).
- Care level 2: Needs a small amount of care for daily life (Estimated nursing time = 50–70 min/day).
- Care level 3: Needs a moderate amount of care for daily life (estimated nursing time = 70–90 min/day).
- Care level 4: Needs a large amount of care for daily life (estimated nursing time = 90–110 min/day).
- Care level 5: Unable to conduct daily activities without extensive assistance (estimated nursing time>110 min/day).

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Table 2. Participants’ LSA score, level of mobility/locomotion, frequency of entry into each life space, and degree of independence

| Variable                                      | n   | Median, IQR (range), or % |
|-----------------------------------------------|-----|--------------------------|
| LSA score                                     | 64  | 45.8, 34.0–62.8 (16–100) |
| Maximum accessible life space range           |     |                          |
| Life space 1 (home)                           | 0   | 0                        |
| Life space 2 (outside house)                  | 1   | 2                        |
| Life space 3 (neighborhood)                   | 5   | 8                        |
| Life space 4 (town)                           | 29  | 45                       |
| Life space 5 (unlimited)                      | 29  | 45                       |
| Frequency and degree of independence          |     |                          |
| Life space 1                                  | 64  | 100                      |
| Daily                                         | 62  | 97                       |
| 4–6 times/week                                | 1   | 2                        |
| 1–3 times/week                                | 1   | 2                        |
| Less than once a week                         | 0   | 0                        |
| Without assistance                            | 48  | 75                       |
| With equipment                                | 15  | 23                       |
| With personal assistance                      | 1   | 2                        |
| Life space 2                                  | 64  | 100                      |
| Daily                                         | 39  | 61                       |
| 4–6 times/week                                | 13  | 20                       |
| 1–3 times/week                                | 12  | 19                       |
| Less than once a week                         | 0   | 0                        |
| Without assistance                            | 32  | 50                       |
| With equipment                                | 22  | 34                       |
| With personal assistance                      | 10  | 16                       |
| Life space 3                                  | 63  | 98                       |
| Daily                                         | 16  | 25                       |
| 4–6 times/week                                | 17  | 27                       |
| 1–3 times/week                                | 27  | 42                       |
| Less than once a week                         | 3   | 5                        |
| Without assistance                            | 21  | 33                       |
| With equipment                                | 26  | 41                       |
| With personal assistance                      | 16  | 25                       |
| Life space 4                                  | 58  | 91                       |
| Daily                                         | 9   | 14                       |
| 4–6 times/week                                | 10  | 16                       |
| 1–3 times/week                                | 35  | 54                       |
| Less than once a week                         | 4   | 6                        |
| Without assistance                            | 19  | 30                       |
| With equipment                                | 17  | 27                       |
| With personal assistance                      | 22  | 34                       |
| Life space 5                                  | 29  | 45                       |
| Daily                                         | 0   | 0                        |

(Continued)
but significant correlations were identified among each Mini-BESTest sub-item (anticipatory postural adjustments \( r = 0.48, p < 0.001 \), postural responses \( r = 0.37, p = 0.002 \), sensory orientation \( r = 0.25, p = 0.0045 \), and dynamic gait \( r = 0.44, p < 0.001 \)) as well as between the total Mini-BESTest score \( r = 0.50, p < 0.001 \) and the MFES score \( r = 0.48, p < 0.001 \).

Table 2. (Continued)

| Variable | n   | Median, IQR (range), or % |
|----------|-----|--------------------------|
| 4–6 times/week | 0   | 0                        |
| 1–3 times/week | 11  | 17                       |
| Less than once a week | 18  | 28                       |
| Without assistance | 9   | 14                       |
| With equipment | 8   | 13                       |
| With personal assistance | 12  | 19                       |

LSA: Life Space Assessment, IQR: interquartile range.

Table 3. Measurement results of the Mini-BESTest, SWWT, and MFES

| Variable | n   | Median, IQR (range) or % |
|----------|-----|--------------------------|
| Mini-BESTest | |                           |
| Anticipatory postural adjustments | 64  | 3, 2–4 (0–6)             |
| Postural responses | 64  | 3, 2–4 (0–6)             |
| Sensory orientation | 64  | 5.5, 4.3–2.3 (0–6)       |
| Dynamic gait | 64  | 7, 4–9 (0–10)            |
| Total | 64  | 19, 11–22 (2–26)         |
| SWWT\(^a\) | |                           |
| Positive | 18  | 31                       |
| Negative | 40  | 69                       |
| MFES | 64  | 112, 89–131 (30–140)     |

Mini-BESTest: Mini-Balance Evaluation Systems Test, SWWT: Stops Walking When Talking, MFES: Modified Falls Efficacy Scale.

\(^a\)Data of six participants were missing.

Table 4. Spearman correlation coefficients between the LSA score and age, BMI, the sub-item scores and total score of the Mini-BESTest, and the MFES (n = 64)

| Variable | \( r \) | \( p \)-Value |
|----------|--------|-------------|
| Age      | -0.24  | 0.06        |
| Body mass index | -0.04 | 0.77        |
| Mini-BESTest | |           |
| Anticipatory postural adjustments | 0.47 | <0.001 |
| Postural responses | 0.38 | 0.002 |
| Sensory orientation | 0.25 | 0.045 |
| Dynamic gait | 0.44 | <0.001 |
| Total | 0.51 | <0.001 |
| MFES | 0.48 | <0.001 |

LSA: Life Space Assessment, Mini-BESTest: Mini-Balance Evaluation Systems Test, MFES: Modified Falls Efficacy Scale.
3.4. Balance elements related to life space

The stepwise multiple linear regression analysis with the LSA score as a dependent variable retained the anticipatory postural adjustments ($\beta = 0.31, p = 0.015, \text{VIF} = 1.34$) and dynamic gait ($\beta = 0.30, p = 0.019, \text{VIF} = 1.34$) in the model ($F = 12.12, p < 0.001$). Postural responses ($p = 0.85$) and sensory orientation ($p = 0.91$) were not included. This model independently explained 28.4% of the variance in the life space of participants (Table 5). This result indicated that anticipatory postural adjustments and dynamic gait of balance elements significantly affect the life space of older adults who use a day care.

4. Discussion

In this study, we clarified the life space of older adults who use a day care center and found a significant correlation between the LSA score and the sub-items scores and total score of the Mini-BESTest and the MFES. Moreover, we identified anticipatory postural adjustments and dynamic gait, which are balance elements, as variables explaining the life space of participants.

In a previous study that used data from five international sites, the mean total LSA score was reported as 68.7 points among community-dwelling older adults (Auais, Alvarado, & Guerra et al., 2017). In addition, in a 6-year prospective study of elderly people living in and outside of nursing homes (Sheppard, Sawyer, & Ritchie et al., 2013), the mean LSA scores were 47.3 points for nursing home residents and 65.2 for non-residents. The median total LSA score obtained by the participants of this study was 45.8 points, which is considered to be a worse decline in overall life space compared with that reported in previous studies. This is believed to be partially due to the inclusion of people certified for support/care need in the Japanese LTC insurance system.

The median total Mini-BESTest score was 19 points, and 18 people were determined to be positive on the SWWT test. In a study evaluating the cutoff value of the Mini-BESTest for fall prediction, community-dwelling older adults scored 23 points (Magnani, Genovez, & Porto et al., 2019), patients with Parkinson disease scored 21.5 points (Lopes LKR, Scianni, & Lima et al., 2019), and patients with chronic stroke scored 17.5 points (Tsang, Liao, & Chung et al., 2013); the median score obtained by participants of this study was similar with these cutoff values. SWWT indirectly reflects attention capacity based on the amount of attention required for gait; more attention is needed by examinees who return positive results, and such people are believed to be at risk of falling within the subsequent 6 months (Lundin-Olsson et al., 1997). Based on the results of the Mini-BESTest and the SWWT test, the balance ability of the participants examined in this study tended to be relatively low, and we infer from this that our participant population included many people who were at risk of falling.

Based on the above, the participants of this study are expected to experience a decrease in life space, in addition to a decline in balance ability, as compared with elderly living in communities not using the LTC insurance system. As such, in this study, a moderate correlation was identified among the total LSA and Mini-BESTest total scores, the Mini-BESTest sub-items (anticipatory

Table 5. Results of the stepwise multiple linear regression analysis with the LSA score as dependent variable ($n = 64$)

| Variable | B     | 95% CI of B | t-Value | p-Value | $\theta$ | VIF | $R^2$ |
|----------|-------|-------------|---------|---------|---------|-----|-------|
| APA      | 4.87  | 0.99-8.74   | 2.51    | 0.015   | 0.31    | 1.34|       |
| DG       | 2.10  | 0.36-3.84   | 2.41    | 0.019   | 0.30    | 1.34|       |
| (Constant)| 21.59 | 9.39-33.79  | 3.54    | <0.001  |         |     |       |
| Model    |       |             |         |         |         |     | 0.28  |

LSA: Life Space Assessment, APA: anticipatory postural adjustments, DG: dynamic gait, CI: confidence interval, VIF: variance inflation factor.
postural adjustments and dynamic gait), and the MFES scores. In addition, as a result of a multiple regression analysis, anticipatory postural adjustments and dynamic gait were identified as aspects of balance related to the range of the life space. This indicates a relationship among life space, balance ability, and fear of falling. Furthermore, among the factors related to balance ability, anticipatory postural adjustments and dynamic gait were found to be significantly related to the broadening of participants’ life space. Participants with a history of falls exhibit a great fear of falling again (Tinetti, Speechley, & Ginter, 1988) and often tend to adopt a rigid ambulatory style as a result of this fear (Asaka & Wang, 2008). As such, it can be expected that these participants will be unable to flexibly adapt to obstacles or disturbances. The Mini-BESTest evaluation items in the anticipatory postural adjustment subcategory consisted of rising from a sitting position, standing on one’s toes, and standing on one leg. Declining one-leg position holding time in elderly people has been reported as a factor contributing to the occurrence of fall events (de Rekeneire, Visser, & Peila et al., 2003). In addition, the decline in basic movement capacities, such as the ability to rise from a chair, has been shown to not only be related to falls (American Geriatrics Society, 2001) but to also serve as predictive factors with respect to physical disability and death (Guralnik, Ferrucci, & Simonsick et al., 1995). Furthermore, we believe that these factors greatly influence the degree of independence the elderly can enjoy.

Therefore, to broaden the life space of community-dwelling elderly people with diminishing life space, our findings suggest that striving to reduce fear of falls, developing anticipatory postural adjustments, and improving dynamic gait may be effective interventions. The dynamic gait subcategory consists of sub-items involving gait under dual task such as requiring participants to walk while calculating a cognitive task or to walk while performing neck rotation as a movement task. Fall events involving elderly people occur frequently during body movement (Asaka & Yung, 2008), and some are reported to occur when their attention is devoted to postural control or other tasks (Milisen, Detroch, & Bellens et al., 2004). As such, dynamic performance while engaged in multiple tasks is believed to be important when evaluating practical mobility. Garatachea et al., 2009 reported that life space is affected by postural control abilities including gait ability and mobility functions such as rising from a sitting position. Pollock, Eng, & Garland, 2011 reported that dynamic gait is a dual task in achieving locomotion, and disruptive factors present in outdoor environments, such as calls for attention from others, changes in gait speed, slopes, and steps, have some impact on gait stability.

Based on these findings, anticipatory postural adjustments and dynamic gait were identified during this study as aspects of balance ability related to life-space accessibility. Decreased ability of anticipatory postural adjustments reflects a decline in physical functions that can lead to increased risk of falls, and dynamic gait is reflective of one’s ability to adapt to the environment, which is indispensable for outdoor movement and the state of attention allocation during gait. Our results suggest that physical therapy interventions focusing on anticipatory postural adjustments and dynamic gait may be effective for broadening life space.

Limitations of this study

Because this study covered only a single facility, the generalizability of this study is unclear. The life space of older adults using day care may be easily affected by the environment around the home (urban area or suburb) than healthy older adults. Therefore, to expand the scope of the applicability of our results, expanding our survey to multiple facilities is necessary. We also consider that in addition to participants’ balance ability, environmental factors around where they live and family-related factors such as a degree of their family supports should be considered. Finally, although a significant correlation was found among the LSA score, all the sub-items of the Mini-BESTest, and the MFES in this study, whether these balance elements and psychological factor affect the range of life space is yet unclear. This is because the narrowing of the life space may affect balance ability. To clarify this point, interventional research on balance elements and
psychological factor should be conducted and the effects of changes in balance elements and psychological factor on the life space should be examined.

5. Clinical messages

- The median LSA score obtained by the participants of this study was 45.8 points. This score is low compared with that reported in previous studies for elderly people residing in communities (65.2 points) and is nearly equal to elderly people living in nursing homes (47.3 points).

- The correlations between life space and all the balance elements in the Mini-BESTest were significant. Moreover, among the balance elements, anticipatory postural adjustments and dynamic gait were selected as the variables of a model to explain the life space of older adults who use a day care center.

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