Original Article

Factors associated with the life space assessment and timed up and go test ratio among community-dwelling older people

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Abstract

Objective: The purpose of the study was to examine factors related to the ratio of life-space assessment (LSA) to timed up and go test (TUG) in community-dwelling older adults.

Methods: This cross-sectional study involved Japanese, community-dwelling older adults aged ≥ 65 years. The study was conducted using semi-structured interviews related to characteristic and the basic attributes. The LSA and TUG test were evaluated as primary endpoints and the Japanese version of the montreal cognitive assessment (MoCA-J), the frontal assessment battery (FAB), fall efficacy scale (FES), the short version of the geriatric depression scale (GDS), and the 6-item Lubben social network scale (LNSN-6) were evaluated as secondary endpoints.

Results: Factors associated with the LSA/TUG ratio were MoCA-J and FES. In the MoCA-J sub-scale, the LSA/TUG ratio was associated with attention, graphic rendition, and delayed word recall.

Conclusion: Our findings indicate that attention should be paid to spatial cognition and attentional function in participants with preserved physical function but reduced living space.

Key words: Community-dwelling older adults, Life-space Assessment, Timed Up and Go test

I. Introduction

Several reports have identified the increased risk of disease morbidity, mortality, and cognitive decline caused by physical inactivity in older adults[1-3]. In Japan, described as a 'hyper-aged society'(the rates of aging were 28.8%[4]), improving physical activity of older adults and preventing the need for nursing care has become an important issue.

Multiple studies reported that physical function[5], environmental[6], and psychological and social[6] factors are associated with improved physical activity in older adults. In order to improve physical activity, it is necessary to evaluate it, which usually involves the use of activity meters[7] and/or questionnaire surveys[8-10].

Among the various methods, one way to evaluate physical activity is the concept of living space[11]. May et al reported that living space was defined as "an activity that extends from the home to the town and beyond the community"[11]. Life-space assessment (LSA) is widely used as a measure of living space[12].

The LSA evaluates physical activity in terms of range, frequency, and independence in the living space, and measures total score and maximum range of activity per level of independence. Physical factors for the LSA have been shown to be associated with the Short Physical Performance Battery and timed up and go test (TUG), which is a measure of balance and walking ability[12,13]. In addition, associations with psychological factors such as fall self-efficacy (FSE)[14], cognitive function[15], and subjective sense of health[16], as well as environmental factors such as housing surroundings[17] were also reported. In particular, the LSA has been shown to be strongly associated with walking speed and motor function, and some reports indicate that LSA scores were improved with regular exercise.

The LSA has been reported to be associated with physical function as expressed in TUG test, however, there are many older adults who have well-maintained physical function but have a narrowed or reduced living space. In such individuals, it is important to expand their living space for health promotion, to which end it is necessary to evaluate living space considering the of level of physical function. It is expected that intervention methods for living space will differ for participants who have low physical function and a narrowed living space, and high physical function but a narrowed living space. In a survey conducted by the Japan Physical Therapists Association, the difference between LSA and TUG indicates the need to consider preventive interventions[18]. However, no relevant factors have been identified for older adults with high physical function but reduced living space. Although there are a few reports of investigations into frailty older people using LSA and TUG indices, there are no clear criteria for utilization of these assessments. Few reports have examined the relationship between LSA and TUG and their associated factors in community-dwelling older adults. In addition, the factors related to the mental parameters using LSA and TUG scores in community-dwelling older adults have not been identified.

In this study, to evaluate individual physical capacity to spatial physical activity using the available measures, the score of the LSA divided by TUG (seconds) was used and defined as the LSA/TUG ratio. The purpose of this study is to determine the factors associated with the LSA/TUG ratio, a life space assessment that takes physical function (mobility) into account.

II. Methods

1. Participants

The participants, aged 65 years or older, were recruited from May to August, 2019, from care-prevention classes held in two cities in the same Japanese prefecture. The rates of aging were 28.4% and 35.8% in the two cities, respectively. The Participants were given a written overview of the study and consent was obtained during the care-prevention classes. Exclusion criteria were participants who could not complete the

questionnaire and measurements.

2. Research procedures

This cross-sectional study was conducted using semi-structured interviews, a self-administered questionnaire, and physical function measures. The primary endpoints measured were LSA and TUG scale for physical activity and secondary endpoints were measured cognitive function, fall efficacy, and depression. The time required for all questionnaires was about 30 minutes. The measurements in this study were conducted by trained physical therapists and occupational therapists.

1) Basic Characteristics

The data collected regarding participant characteristics were: age, sex, body mass index (BMI). These data were used for the evaluation of the LSA/TUG ratio.

2) Life-space Assessment (LSA)

The LSA is an instrument to assess the spatial extent of an individual's life. The LSA is scored on the basis of the frequency of activities and the degree of independence for five levels of activity (residence, near living space, near home, in town, and out of town). A total score (0-120) is calculated, with higher scores indicating greater activity[10].

3) Timed Up and Go (TUG) test

The TUG test was developed as a mobility test for the older adults[19]. Its reliability and validity as a quantitative assessment of functional movement ability have been demonstrated. A chair was used, 40 cm high, with a backrest and without a handrail. The maximum speed was instructed and no walking aids were used; after one practice session, two measurements were taken and the fastest value was adopted. Change of direction was instructed to go around to the left.

The association between frequency of going out and TUG score has also been shown; approximately 20% of those with a TUG of less than 7 seconds did not go out every day, while of those with a TUG of 8.5 seconds or more approximately 35% did not go out every day[20].

4) Japanese Version of the Montreal Cognitive Assessment (MoCA-J)

The MoCA-J is a screening tool for mild cognitive decline, which assesses multidisciplinary cognitive functions (attention, concentration, executive function, memory, language, visuospatial cognition, conceptual thinking, calculation, and disorientation) in a short time of approximately 10 minutes. To assess those cognitive functions, subitems include the follows; trail making, copy cube, draw clock, naming, repeat in the forward order, repeat in the backward order, tap the hand, serial 7 subtraction, repeat the language, similarity, delayed recall, orientation. The total score is 30 points, with a score of 26 or more in the Japanese version considered to be in the healthy range[21].

5) Frontal Assessment Battery (FAB)

Frontal lobe function was measured using the FAB, which is a tool that can distinguish between various forms of dementia. The maximum total score of the FAB is 18 points and higher scores indicate better frontal lobe function[22].

6) Fall Efficacy Scale (FES)

Self-efficacy for falls was quantitatively assessed using the FES. Higher scores indicate lower self-efficacy, in other words higher levels of fear or concern, for falling[23].

7) Geriatric Depression Scale: Short Version (GDS)

The presence and the level of depression were evaluated based on GDS scores. The GDS is a 15-item scale, with higher scores indicating higher levels of depression[24].

8) Lubben Social Network Scale: 6-item version (LSNS-6)

The LSNS-6 was used as a scale to screen for social isolation and social support among older adults. The six items are scored on a 5-point Likert scale with a higher total score indicating more social engagement[25].

9) LSA/TUG ratio

The LSA/TUG ratio was calculated as the ratio of TUG seconds to LSA scores. A large LSA/TUG ratio was interpreted as a tendency toward high activity relative to physical function, while a

small LSA/TUG ratio was construed as a tendency toward low activity relative to physical function.

3. Statistical Analysis

Unpaired t-test and Mann-Whitney U test were used to analyze difference in baseline values regarding age, height, and weight. A t-test was used for items where normality was found, and a Mann-Whitney U test for items where normality was not found. Baseline comparisons were also conducted to check for possible confounding by sex, because there were differences in the sample size by gender. To evaluate individual physical capacity to spatial physical activity due to available indicators, the score of LSA divided by TUG score (seconds) was used and defined as the LSA/TUG ratio.

The LSA and LSA/TUG ratios with gender as the control variable and partial correlation coefficients for each item were calculated. The data were analyzed using multiple regression analysis to detect the factors of association with LSA and the LSA/TUG ratio. Data are shown present mean ± standard deviation (SD) and $p < 0.05$ were set to indicate significance. Statistical analyses were performed using SPSS Statistics ver. 25.0 (IBM).

4. Ethical Considerations

All participants provided informed consent. This prospective study was conducted with the approval from the ethics committee of the Ahru Medical Care and Welfare College (No. CC-017).

III. Results

In this study, a total of 105 participants were included for eligibility. Of those, 4 who could not complete the questionnaire and measurements were excluded and the remaining 101 participants (83 women and 18 men) were analyzed. Table 1 shows the participants characteristics. The mean age of participants was 75.8 ± 6.9 years. Baseline comparisons were conducted to check for possible confounding by sex; however, no significant differences were found between males and females

Table1. Characteristics of the participants

	Total (n = 101)	male (n = 18)	female (n = 83)	*p*-value	Cohen's d
Age (years)[a)]	75.8 ± 6.9	75.7 ± 5.3	75.8 ± 7.2	0.922	0.01
BMI [a)]	21.8 ± 6.1	23.8 ± 1.9	21.3 ± 6.5	0.124	0.42
LSA (scores)[a)]	92.1 ± 24.8	91.9 ± 23.7	93.3 ± 24.4	0.836	0.06
TUG (sec)[a)]	7.3 ± 2.0	7.1 ± 1.7	7.4 ± 2.1	0.617	0.15
LSA/TUG ratio[a)]	13.9 ± 6.0	14.0 ± 5.5	14.1 ± 6.0	0.927	0.02
MoCA-J (scores)[a)]	23.3 ± 4.2	24.1 ± 3.3	23.2 ± 4.4	0.392	0.21
FAB (scores)[a)]	14.8 ± 2.6	15.1 ± 2.8	14.8 ± 2.5	0.721	0.12
FES (scores)[a)]	37.0 ± 3.7	37.9 ± 2.8	37.0 ± 3.9	0.326	0.24
GDS (scores)[b)]	2.6 ± 2.8	1.5 ± 1.5	2.8 ± 2.9	0.097	0.48
LNSN-6 (scores)[a)]	18.0 ± 6.7	18.0 ± 7.3	18.4 ± 6.3	0.840	0.06

Mean±SD. a) Unpaired t-test and b) Mann–Whitney U test. Effect size : Cohen's d. * : $p < 0.05$ ** : $p < 0.01$
BMI: Body mass index; LSA: Life space assessment ; TUG : Timed up and go test ; MoCA-J: Japanese version of Montreal Cognitive Assessment ; FAB: Frontal Assessment Battery ; FES: Fall Efficacy Scale ; GDS: Geriatric Depression Scale-Short Version ; LNSN-6: Lubben Social Network Scale (6-itme version)

Table 2. Relationships between LSA or LSA/TUG ratio and other variables

	LSA		LSA/TUG ratio	
	Partial correlation coefficient	*p*-value	Partial correlation coefficient	*p*-value
TUG	-0.508	0.000 **		
MoCA-J	0.288	0.016 *	0.476	< 0.001 **
FAB	0.186	0.124	0.382	0.001 **
FES	0.19	0.190	0.309	0.009 **
GDS	-0.246	0.040 *	-0.215	0.074
LNSN-6	0.168	0.165	0.060	0.622

Partial correlation analysis. Control variable: sex. * : $p < 0.05$ ** : $p < 0.01$

in each scale.

Table 2 shows the relationship between LSA score or LSA/TUG ratio and the other variables. A significant correlation was observed between LSA and TUG (r = -0.508, $p < 0.001$), MoCA-J (r = 0.288, $p = 0.016$), and GDS (r = -0.246, $p = 0.040$). There were no significant correlations between LSA and FAB, FES, and LMSM-6. There was a significant correlation between LSA/TUG ratio and MoCA-J (r = 0.476, $p < 0.001$), FAB (r = 0.382, $p = 0.001$), and FES (r = 0.382, p =0.009). There were no significant correlations between LSA/TUG ratio and GDS score and LMSM-6.

Multiple regression analysis was performed to determine whether the TUG, MoCA-J, FAB, FES, GDS, LNSN-6 were associated with the LSA score and LSA/TUG ratio. The results related to LSA are shown in Table 3. The factors retained in this model were TUG (β = -0.506, $p < 0.001$) and LNSN-6 score (β = 0.214, $p = 0.001$, Adjusted $R^2 = 0.327$). Overall, the LSA score was explained by this regression model (Adjusted $R^2 = 0.327$).

We performed multiple regression analysis to determine whether MoCA-J, FAB, FES, GDS, or LNSN-6 were associated with LSA/TUG ratio. The results related to LSA/TUG ratio are shown in Table 4. The factors retained in this model were the MoCA-J (β ＝ 0.399, $p < 0.001$), and the FES score (β = 0.219, $p = 0.033$, Adjusted $R^2 = 0.223$). Overall, the LSA score was explained by this regression model (Adjusted $R^2 = 0.223$).

Multiple regression analysis was performed to determine the MoCA-J subscales were associated with the LSA/TUG ratio. The results are shown in Table 5. The factors retained in this model were “Attention” (repeat the number in the same order) (β ＝ 0.287, $p < 0.001$), “Graphic rendition” (copy cube) (β = 0.292, $p = 0.002$), and “Delayed recall”

Table 3. Factors associated with the LSA score identified using multivariate analysis

	β	95%CI (Lower limit – Upper limit)	*p*-value	
TUG	-0.506	(-8.288 – -4.278)	< 0.001	**
LNSN-6	0.214	(0.395 – 1.585)	0.001	**

Stepwise selection method. Adjusted R^2 : 0.327, Durbin-Watson : 1.890. * : p ＜ 0.05 ** : p ＜ 0.01
β: standardized regression coefficient ; 95%CI : 95% Confidence Interval
Independent variable: TUG, MoCA-J, FAB, FES, GDS, LNSN-6

Table 4. Factors associated with the LSA/TUG ratio score identified using multivariate analysis

	β	95%CI (Lower limit – Upper limit)	*p*-value	
MoCA-J	0.399	(0.304 – 0.834)	< 0.001	**
FES	0.219	(0.053 – 0.655)	0.033	*

Stepwise selection method. Adjusted R^2 : 0.223, Durbin-Watson : 1.384. * : p ＜ 0.05 ** : p ＜ 0.01
β: standardized regression coefficient ; 95%CI : 95% Confidence Interval
Independent variable: MoCA-J, FAB, FES, GDS, LNSN-6

Table 5. Factors associated with the LSA/TUG ratio score identified using multivariate analysis (Independent variable: MoCA-J subitems)

	β	95%C (Lower limit – Upper limit)	*p*-value	
Attention (Repeat the number in the forward order)	0.287	(1.362 – 6.079)	0.002	**
graphic rendition (Copy cube)	0.292	(1.385 – 5.731)	0.002	**
Delayed recall	0.257	(0.949 – 5.669)	0.007	**

Stepwise selection method. Adjusted R^2 : 0.2870 * : p ＜ 0.05 ** : p ＜ 0.01
β: standardized regression coefficient ; 95%CI : 95% Confidence Interval

($\beta = 0.257$, $p = 0.007$, Adjusted $R^2 = 0.287$). Overall, LSA score was explained by this regression model (Adjusted $R^2 = 0.287$).

IV Discussion

In the multiple regression analysis, the factors related to LSA were TUG and LNSN-6. In the case of the LSA/TUG ratio, the corresponding factors were MoCA-J and FES. The extracted MoCA-J sub-items related to LSA/TUG ratio were Attention, Graphic rendition, and Delayed recall. In our study, the mean of age the community-dwelling older adults was 75.8 ± 6.9 years. The mean TUG among older adults in their 70s has been reported to be in the 9 second range[26]. The mean MoCA-J score among our cohort was 23.3 ± 4.2 points, which is below the cutoff of 25 points[27] for cognitive decline. The mean LSA in our study was 92.1 ± 24.8 points; the cut-off for the fall prediction index for LSA and TUG were 47.3 points[28] and 8.5 seconds[29], respectively. The ratio was 3.5 that calculated using the aforementioned cut-off value, which was higher for the participants at 13.9. We estimated that living space and high mobility were maintained in our study population.

In the current study[30], the factors shown to be associated with LSA were TUG and LNSN-6, which supported the findings of a previous study. This result suggests that the improvement of motor function is a priority in the expansion of living space. By contrast, the LSA/TUG ratio was related to MoCA-J and FES. We surmised that cognitive tendencies would have an influence on behavioral choice.

Among the MoCA-J sub-items related to LSA/TUG ratio was “Attention” which is considered a measure of working memory and concentration. Previous reports have indicated that a decrease in working memory increases the risk of falls[31]. Studies involving the trail making test (TMT), which is a measure of attentional function have similarly indicated an association between working memory and the risk of falls with lower TMT scores indicating increased risk of falls[32]. Although the physical function of the older adults in this study were maintained, the decline in working memory suggested that making living spaces smaller was a behavior choice to reduce the risk of falls.

Another of the MoCA-J sub-items shown to be associated with the LSA/TUG ratio was “Graphic rendition”. It has been reported that three-dimensional graphic imitation could nonverbally assess visuospatial cognitive functions and compositional abilities and suggested that spatial cognitive abilities might be related not only to complex information processing such as self-localization[33], path selection, and place memory, but also to simple action slips such as inattention and errors in perceptual-motor coordination[34]. It was suggested that the decline in spatial cognition might have been caused by negative experiences when going out, leading to a narrowing of the living space. In this study, the association with fall self-efficacy was also observed and one underlying factor we considered was that the negative failure behaviors would include experiences of falls.

Baker et al.[10] reported that narrowing of the LSA is observed prior to the decline in ADL capacity. Our results indicated that expansion of LSA requires consideration of cognitive functions such as attentional function and spatial cognition. The association with falls was identified as a common element of attentional and spatial cognitive functions. The results suggest that further examination of multiple factors, such as attention function, spatial cognitive ability, fall experience, fall self-efficacy, and living space, are required to more comprehensively consider improvement of physical function among older adults.

The limitation of the current study is its cross-sectional design; therefore, longitudinal studies are required to clarify the causal relationship between cognitive function and LSA/TUG ratio. Since the survey was conducted in only two cities, it was limited to generalize the results.

V. Conclusion

The LSA/TUG ratio was found to have a strong association with cognitive function. In community-

dwelling older adults who have preserved physical function but also a reduced living space, efforts assess their attentional function and spatial cognition might be required to promote health life expectancy.

Conflict of Interest

There are no conflicts of interest of any kind in relation to the content of this study.

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