ABSTRACT. Objective: A poor social network and the decline of physical function are known to be critical risk factors for functional decline in older adults. The aim of this study was to investigate the relationships between social network and physical function in Japanese community-dwelling older adults. Methods: Participants were 339 adults aged 65 years or older (mean age: 73.0 years, women: 70.2%), living independently in their communities. A self-reported questionnaire was used to assess social network on two different scales—the 6-item Lubben Social Network Scale (6LSNS) and frequency of contact with other people. Handgrip strength, knee extension strength, gait speed, Timed Up and Go Test (TUG) results, and 5-repetition chair stand test (CST) scores were used to determine physical function. A multiple regression analysis that adjusted for confounding factors was used to analyze the relationship between the social network scales and each physical function test. Results: According to the results of a multiple regression analysis, a high 6LSNS score was significantly associated with greater handgrip strength (B = 0.63, p = 0.03), faster CST (B = −0.23, p = 0.01), and faster TUG (B = −0.12, p = 0.03), and high frequency of contact was significantly associated with greater handgrip strength (B = 1.08, p = 0.01). Conclusions: Social network was associated with muscle strength and physical performance. Consequently, older adults with poor social networks require an assessment of physical function, since their physical functions have possibly deteriorated.

Key words: cross-sectional study, functional decline, social network, Physical function, older adults

Although life expectancy continues to increase globally in developed countries, including Japan, there is a difference between life expectancy and a healthy life expectancy\(^1\). Healthy life expectancy is defined as the length of a person’s life span that is not characterized by limitations in daily activities due to health problems\(^2\). In order to extend healthy life expectancy, it is important to prevent functional decline. Physical, cognitive/psychological, and social factors influence the functional capacity of older adults. Walking speed and handgrip strength, for example, are risk factors of functional decline that can also lead to adverse health events, such as hospitalization and mortality\(^3,4\). The results of the chair stand test (CST) and the Timed Up and Go Test (TUG) can indicate older adults’ risk of falls and functional decline\(^5,6\). Depression and cognitive decline are also risk factors of functional decline\(^7\). Poor social participation and weak social networks, the structural aspects of various social relationships\(^8,9\), have also been associated with functional decline\(^10\).

It is likely that the physical, cognitive/psychological, and social factors of physical decline are interrelated. Previous studies have shown that social factors are associated with depression and the maintenance of cognitive function\(^11,12\). This suggests that social factors influence cognitive/psychological factors. It has also been hypothesized that a decline of social function precedes a decline of physical function\(^13\). Therefore, to clarify the hypothesis regarding the association between social and physical functions,
an investigation analyzing the influence of cognitive/psychological factors is indispensable. However, few studies have considered the relationship between the adjustment of social and physical factors, after adjusting for the effects of both cognitive/psychological factors and other potential risk factors. This cross-sectional study investigated the relationship between social factors and physical function to indicate the ways in which social factors affect both physical and cognitive/psychological factors. Investigating this relationship could show that social factors can be used to evaluate the functional decline of older adults.

Methods

Participants

Participants in this cross-sectional study included 339 older adults, aged 65 years or older, from Sagamihara city in Kanagawa Prefecture, living independently in their community. We used community newsletters to recruit participants. The inclusion criteria were as follows: older people who were able to perform activities of daily living (ADLs) independently and could independently walk to the location of the research center for this study. Recruitment interviews were used to confirm inclusion criteria. Individuals who did not have a disability certification through long-term care insurance were considered independent and capable of performing ADLs. Participants suspected of having dementia, based on interviews with experienced researchers, were excluded from this study.

The present study was approved by the Institutional Review Board of the School of Allied Health Sciences at Kitasato University (approval number 2016-G021B). Informed consent was obtained from all individual participants.

Social Network

In this study, we measured social network to assess social factors. We used a previously developed assessment scale, with validity and reliability, to measure social network\(^{17-20}\). Previous studies have reported that the type of social network can influence differentially disability and mortality\(^{20,21}\); therefore, in the present study, we used two types of scales to assess social network. First, we assessed participants’ six-item Lubben social network scores (6LSNS)\(^{19}\). Several cross-national and cross-cultural validation studies have demonstrated that the 6LSNS can be used to evaluate social networks among community-dwelling older adults\(^{15,17}\). The 6LSNS measures the size of participants’ active and intimate networks of family and friends, with whom the participants could talk or upon whom they could call for help. Each 6LSNS question was scored from 0 to 5 points. The total score is an equally weighted sum of these six questions, with scores ranging from 0 to 30 points. Higher scores indicate a larger social network. According to a previous study, we categorized respondents with scores of <12 points as being at risk of social isolation\(^{17}\).

We also assessed the participants’ frequency of contact with others\(^{20}\) using an additional social network scale. The frequency of contact with others was measured by: (i) frequency of face-to-face contact with non-co-resident family and relatives; (ii) frequency of face-to-face contact with friends and neighbors; (iii) frequency of non-face-to-face contact (i.e., via telephone, email, letters) with non-co-resident family and relatives; and (iv) frequency of face-to-face contact with friends and neighbors. An 8-point Likert scale was used to measure the frequency of face-to-face and non-face-to-face contact as follows: (1) every day (more than nine times a week); (2) once a day (fewer than nine times a week); (3) fewer than six times a week; (4) fewer than four times a week; (5) fewer than three times a week; (6) less than twice a week; (7) less than once a week; or (8) less than once a month. In a previous study\(^{19}\), social isolation status was defined as engagement in every type of social contact less than once a week, and this definition predicted inverse health outcomes. We similarly determined that respondents who engaged in social interaction less than once a week were experiencing social isolation due to their lack of frequent contact with others.

Physical Function Measurements

To evaluate participants’ physical function, we measured 5 meter (m) walking time at a comfortable pace, 5 m walking time at maximum effort, CST\(^{26}\), grip strength, knee extensor strength, and scores on the TUG\(^{27}\). To assess walking time, a stopwatch was used to measure the time at which participants passed 5 m on a 9 m walkway with 2 m acceleration and 2 m deceleration zones (ALBA W072; Seiko Watch Corporation, Tokyo, Japan). For CST, a stopwatch was used to measure how long it took the participant to stand up from a sitting position and sit down with arms crossed in front of chest five times as quickly as possible (ALBA W072; Seiko Watch Corporation, Tokyo, Japan). A Smedley-type dynamometer was used to measure the handgrip strength of each participant’s dominant hand (T.K. K.5401, TAKEI Scientific Instruments Co., Ltd., Niigata, Japan). A handheld dynamometer was used to measure the isometric contraction of knee extensor strength in the right leg (μ-Tas F-1, Anima Co., Tokyo, Japan), while the participant was in a sitting position with knee and hip joints flexed at 90 degrees. For the TUG, researchers instructed the participants to stand up from a chair without hand support, walk 3 m as quickly as possible, turn around, walk back, and then sit down again\(^{28}\). A stopwatch was used to measure the time that the participant required to complete this task (ALBA W072; Seiko Watch Corporation). All measurements were measured twice, and the best value from both measurements were used for analysis.
**Association Between Social Network and Physical Function**

**Measurements for Confounding Factors**

The age, sex, body mass index, and medical history of participants were recorded as potential confounding factors. Self-reported questionnaires were used to obtain information on comorbidity in participants (hypertension, cerebrovascular disorder, heart disease, diabetes mellitus, liver disease, kidney disease, respiratory disease and other disease), and medications. The Tokyo Metropolitan Institute of Gerontology Index of Competence (TMIG-IC) was used to assess functional capacity greater than ADL. Scores on the TMIG-IC range from 0 to 13 points, with a higher score indicating better function. To assess psychological factors, we evaluated participants’ depressive symptoms and self-rated health (SRH). Depressive symptoms were measured using the 5-item version of the Geriatric Depression Scale (5-GDS). Scores on the 5-GDS ranged from 0 to 5 points. Participants with two points or more on the 5-GDS were identified as having depressive symptoms, while those with zero or one point did not have depressive symptoms. SRH was measured using a 4-point Likert scale as follows: (1) excellent, (2) good, (3) fair, and (4) poor. Responses were transformed into dichotomous variables: excellent/good responses = good, and fair/poor responses = poor. To assess cognitive function, participants used a tablet to complete part A of the Trail Making Test, the reliability and validity of which has been confirmed.

**Statistical Analyses**

The participants were classified into two groups according to their 6LSNS score and their frequency of contact with others: no social isolation (6LSNS) and social isolation (6LSNS); and no social isolation (frequency of contact) and social isolation (frequency of contact). The Shapiro-Wilk test was used to analyze variables that had non-normal distributions. The unpaired Student t-test, Mann-Whitney U-test, and chi-square test were used to compare participant characteristics, physical function, psychological factors, and cognitive function. To investigate the association between social isolation (6LSNS and frequency of contact) and physical function, we conducted a multiple regression analysis to adjust for confounding factors. In the multiple regression analysis, each physical function (usual/max walking speed, CST, handgrip strength, knee extensor strength, and TUG) was set as the dependent variable, and each social isolation score was set as the independent variable. Model 1 of the multiple regression analysis was adjusted for age, sex, and BMI. In Model 2, self-rated health, medications, comorbidities, depression, TMIG-IC score, and Trail Making Test (TMT) A were added.

**Results**

Participants included 238 (70.2%) women with 217 (64.0%) under 75 years of age. Regarding functional capacity, 142 (41.9%) participants had the highest possible score (13 points) on the TMIG-IC. The mean score for 6LSNS was 15.9 ± 5.0 and, based on 6LSNS scores (<12 points), 18.6% of participants experienced social isolation. The mean frequency of contact with others was 25.4 ± 16.8 times/month and, based on the frequency of contact with others, 8.0% of participants experienced social isolation (Table 1). Spearman’s rank correlation coefficient test between 6LSNS and frequency of contact yielded a correlation coefficient of 0.38 (p < 0.001), and the kappa coefficient between the two social isolation categories was 0.25 (p < 0.001). Participants who experienced social isolation (6LSNS) had a lower TMIG-IC score and greater prevalence of depressive symptoms compared to participants who were not socially isolated. Participants who experienced social isolation (frequency of contact) had a lower TMIG-IC score than participants who were not socially isolated.

The results of social isolation categorized by 6LSNS scores showed that participants with social isolation had a significantly slower CST (6.4 sec vs 5.8 sec, p<0.01) and TUG (5.8 sec vs 5.5 sec, p=0.013) than those without social isolation. Handgrip strength (24.9 kg vs 26.5 kg, p= 0.081) and knee extensor strength (27.0 kgf vs 29.3 kgf, p = 0.099) were lower in social isolation. Furthermore, based on the results of social isolation defined by frequency of contact, participants with social isolation had a significantly slower CST (6.5 sec vs 5.9 sec, p=0.028) than those without social isolation; however there were no significant differences between the presence and absence of social isolation in other physical functions.

Table 2 shows the results of the multiple regression analysis of the relationship between each of the two social isolation types and each physical function. In Model 1, which was adjusted for age, sex, and body mass index, social isolation (6LSNS) was significantly associated with CST, TUG, and handgrip strength. In Model 2, which was adjusted for all potential confounding factors, social isolation (6LSNS) was significantly associated with CST, TUG, and handgrip. However, gait speed (comfortable/maximum) and knee extensor strength were not significantly associated with social isolation. In both Model 1 and Model 2, social isolation (frequency of contact) was associated only with handgrip strength.

**Discussion**

In the present study, we sought to clarify the relationship between social network and physical function in community-dwelling older adults. The mean total score for
Table 1. Summary of participants’ characteristics

| Participants (n=339) | Mean (± SD) |
|---------------------|-------------|
| Age, years          | 73.0 (4.8)  |
| Body Mass Index (kg/m²) | 22.2 (2.9) |
| Number of medications | 1.9 (2.1)  |
| Number of comorbidities | 1.1 (1.0)  |
| aTMIG-IC score      | 11.9 (1.3)  |
| Trail Making Test-A (sec) | 54.9 (16.2) |
| 5-repetition chair stand test (sec) | 5.9 (1.3)  |
| Handgrip strength (kg) | 26.2 (6.6)  |
| Knee extensor strength (kgf) | 28.8 (9.6)  |
| Usual walking speed (m/sec) | 1.6 (0.2)  |
| Maximum walking speed (m/sec) | 2.0 (0.3)  |
| Lubben Social Network Scale-6 (points) | 15.9 (5.0)  |
| Frequency of contact with others (times/month) | 25.4 (16.8) |

| Participants (n=339) | Number (%) |
|---------------------|-------------|
| Women               | 238 (70.2) |
| Self-rated health (poor) | 15 (4.4) |
| Depressive symptoms (yes) | 41 (12.1) |
| Hypertension        | 115 (33.9) |
| Cerebrovascular disorder | 12 (3.5) |
| Heart disease       | 27 (8.0)  |
| Diabetes mellitus   | 32 (9.4)  |
| Liver disease       | 7 (2.1)   |
| Kidney disease      | 16 (4.7)  |
| Respiratory disease | 22 (6.5)  |
| Other               | 51 (15.0) |
| Social isolation (6LSNS) | 63 (18.6) |
| Social isolation (frequency of contact) | 27 (8.0)  |

aTMIG-IC: Tokyo Metropolitan Institute of Gerontology Index of Competence

Table 2. Association between social network and physical function using multiple linear regression

| Dependent variables | Social isolation (6LSNS) | Social isolation (frequency of contact) |
|---------------------|-------------------------|-----------------------------------------|
|                     | Model 1c | Model 2d | Model 1c | Model 2d |
| 5-repetition chair stand test (sec) | -0.27 | 0.09 | 0.003 | -0.23 | 0.09 | 0.013 | -0.22 | 0.13 | 0.084 | -0.23 | 0.13 | 0.076 |
| Timed Up and Go Test (sec) | -0.13 | 0.05 | 0.019 | -0.12 | 0.06 | 0.031 | -0.08 | 0.08 | 0.293 | -0.07 | 0.08 | 0.358 |
| Handgrip strength (kg) | 0.70 | 0.28 | 0.011 | 0.63 | 0.29 | 0.032 | 0.87 | 0.40 | 0.030 | 1.08 | 0.41 | 0.009 |
| Knee extensor strength (kg) | 0.89 | 0.60 | 0.139 | 0.62 | 0.64 | 0.330 | -0.06 | 0.87 | 0.944 | 0.24 | 0.91 | 0.790 |
| Usual walking speed (m/sec) | 0.01 | 0.01 | 0.370 | <0.01 | 0.02 | 0.864 | <0.01 | 0.02 | 0.918 | <0.01 | 0.02 | 0.806 |
| Maximum walking speed (m/sec) | 0.01 | 0.02 | 0.546 | <0.01 | 0.02 | 0.898 | 0.02 | 0.03 | 0.461 | 0.02 | 0.03 | 0.579 |

B: Unstandardized coefficient, SE: standard error
Model 1c: adjusted for age, sex, body mass index
Model 2d: adjusted for Model 1c + self-rated health, medications, comorbidities, depression, TMIG-IC score, TMT-A

6LSNS in this study was 15.9 points, and based on 6LSNS, the prevalence of social isolation was 18.6%. In previous studies, the mean score of 6LSNS ranged between 12.5 and 17.9 points, and the prevalence of social isolation ranged from 11% to 20% [10,17,18,31]. In the present study, the prevalence of social isolation based on frequency of contact was
A previous study that aimed at clarifying the relationship between health risk and social isolation in community-dwelling older adults reported that the prevalence of social isolation was 15.8%\(^{19}\). Compared to the previous study, participants in the present study tended to interact more frequently with specific others\(^{30}\), but there was a similar degree of social isolation (as measured by the 6 LSNS) in both studies\(^{0,17,18,31}\).

Social isolation (6LSNS) was associated with CST, TUG, and handgrip strength in the present study. Social isolation (frequency of contact) was also associated with handgrip strength. This relationship was significant even after we adjusted for psychological factors, such as self-rated health, depression, functioning, and cognitive function. In this study, both social network types were significantly associated with handgrip strength. Handgrip strength is widely used as an index to diagnose frailty and sarcopenia\(^{32-34}\), and it is associated with death and functional decline\(^{3,8,35}\). A previous study reported that a lower handgrip strength was correlated with poor social health\(^{36}\). In addition, handgrip strength was a more useful predictor of a decline in higher-level competence of community-dwelling older adults than walking speed\(^{37}\). It is believed that social network reflected higher-level competence in community-dwelling older adults; thus, the results of this study showed that handgrip strength was closely related to social isolation. Further, TUG, which included tasks such as standing and turning around in addition to walking, is believed to be a relatively difficult performance test. Therefore, TUG was less likely to have a ceiling effect in comparison to walking speed and may have a tendency to be related to higher-level competence, such as social network. CST was correlated with lower limb muscle strength\(^{38}\). As discussed, handgrip strength was closely related to social network, thus suggesting that muscle strength was one of the physical functions associated with social network. Therefore, the relationship between muscle strength and social network reflect the correlation between CST and social isolation.

On the other hand, the reason walking speed was not associated with social network was because the influence of the ceiling effect. In fact, the participants of this study performed independently in ADL and had a high functional capacity (41.9% had a full-score in TMIG-IC score). Therefore, walking speed was not an appropriate performance test for our study regarding difficulty of task. Regarding knee extensor strength, a previous study reported that measurement errors were larger than grip strength\(^{39}\). Further, larger measurement errors occurred, because the belt was not used to fix the trunk and thigh during measurements of the knee extensor strength in this study. Moreover, knee extensor strength was not converted into torque. It was possible that these factors influenced the relationship between knee extensor strength and social network in this study.

The two social network scales used in the present study showed different associations between social isolation and physical function. The 6LSNS scale indicated that social isolation was associated with some physical functions; however, social isolation, based on frequency of contact, was associated only with handgrip strength. This suggests that the type of social network can influence the associations between social isolation and physical function. Previous studies reported that the influence of social network on functional capacity differed according to the type of social network\(^{20-22}\). Indeed, the results of the correlation coefficient and kappa coefficient showed that there was a low degree of concordance between the 6LSNS and frequency of contact. These results suggest that the two social network scales used in the present study reflected specifics of each type of social network. To assess frequency of contact, this study used non-face-to-face contact, such as telephone, email, and letters; however, the 6LSNS had some items that did not clearly define whether they were face-to-face or non-face-to-face contact. The maintenance of non-face-to-face contact with other people does not always require high physical function; this might explain why, in the present study, frequency of contact was related only to handgrip strength. However, we could not clarify why social isolation (6LSNS) was strongly associated with physical function but frequency of contact was associated with only handgrip strength. Further research is needed to clarify this point.

Our study has some limitations. Participants in this study had good physical function, and older adults who have frailty, sarcopenia, or require long-term care would not yield the same results. Further, this study did not obtain socioeconomic data, such as income and education level, and therefore, it could not evaluate the impact of income or education level on social isolation or physical function. A participant with cognitive decline, such as mild cognitive impairment, could have been included in this study, because the exclusion criteria was not set using objective cognitive function tests. Further, cognitive function was assessed only using TMT-A because of feasibility of the data collection for this study; thus, estimation of the influence of cognitive function may be insufficient. Furthermore, not only social network but also social support was important with regards to social function for older adults. We determined the relationship between social network and physical functions in this study; however, the relationship between social support and physical functions could not be clarified. Finally, this was a cross-sectional study, which cannot show causality. Future studies should investigate the relationship between social network and physical function longitudinally.

This study clarified the relationship between social network and physical function in community-dwelling older adults with good physical function. It was hypothesized that social factors would decline earlier than physical...
function. The results of the present study confirmed the relationship between social network and physical function. Older adults with poor social networks require an assessment of physical function, since their physical functions have possibly deteriorated. This study suggests that older adults with poor social networks should engage in physical exercise and activity to avoid further decline. Furthermore, older adults with poor social networks are also more likely not to participate in a center or a laboratory based physical function assessment. Therefore, it was suggested that development and establishment of methodology for outreach-type or home-based physical function assessment is necessary.

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References
1) World Health Organization [Internet]: World Health Statistics 2018: Monitoring health for the SDGs. e2018 [cited 2019 Jun. 24]. Available from: https://apps.who.int/iris/bitstream/handle/10665/272596/9789241565585-eng.pdf?ua=1
2) Ministry of Health, Labor and Welfare [Internet]: Healthy Japan 21 (2nd edition) [cited 2019 Jun. 25]. Available from: https://www.mhlw.go.jp/stf/seisakunitsuite/bunya/kenkou_iryou/kenkou/kenkounippon21.html
3) Leong DP, Teo KK, et al.: Prognostic value of grip strength: Findings from the Prospective Urban Rural Epidemiology (PURE) study. Lancet. 2015; 386: 266-273.
4) Studenski S, Perera S, et al.: Gait speed and survival in older adults. JAMA. 2011; 305: 50-58.
5) Buatois S, Perret-Guillaume C, et al.: A simple clinical scale to stratify risk of recurrent falls in community-dwelling adults aged 65 years and older. Phys Ther. 2010; 90: 550-560.
6) Zhang F, Ferrucci L, et al.: Performance on five times sit-to-stand task as a predictor of subsequent falls and disability in older persons. J Aging Health. 2013; 25: 478-492.
7) Bruce ML, Seeman TE, et al.: The impact of depressive symptomatology on physical disability: MacArthur Studies of Successful Aging. Am J Public Health. 1994; 84: 1796-1799.
8) Feng L, Zin N, et al.: Cognitive frailty and adverse health outcomes: Findings from the Singapore Longitudinal Ageing Studies (SLAS). J Am Med Dir Assoc. 2017; 18: 252-258.
9) Tyrovolas S, Koyanagi A, et al.: Mild cognitive impairment is associated with falls among older adults: Findings from the Irish Longitudinal Study on Ageing (TILDA). Exp Gerontol. 2016; 75: 42-47.
10) Chang Q, Sha F, et al.: Validation of an abbreviated version of the Lubben Social Network Scale (“LSNS-6”) and its associations with suicidal ideation among older adults in China. PLoS One. 2018; 13: e0201612.
11) Sakurai R, Kawai H, et al.: Poor social network, not living alone, is associated with incidence of adverse health outcomes in older adults. J Am Med Dir Assoc. 2019; 20: 1438-1443.
12) Tomoioka K, Kurumatani N, et al.: Association between social participation and 3-year change in instrumental activities of daily living in community-dwelling elderly adults. J Am Geriatr Soc. 2017; 65: 107-113.
13) Zunzunegui MV, Rodriguez-Laso A, et al.: Disability and social ties: Comparative findings of the CLESA study. Eur J Ageing. 2005; 2: 40-47.
14) Fratiglioni L, Wang H-X, et al.: Influence of social network on occurrence of dementia: A community-based longitudinal study. Lancet. 2000; 355: 1315-1319.
15) Miceli S, Maniscalco L, et al.: Social networks and social activities promote cognitive functioning in both concurrent and prospective time: Evidence from the SHARE survey. Eur J Ageing. 2019; 16: 145-154.
16) Fujiwara Y, Shinkai S, et al.: Longitudinal changes in higher-level functional capacity of an older population living in a Japanese urban community. Arch Gerontol Geriatr. 2003; 36: 141-153.
17) Lubben J, Blozik E, et al.: Performance of an abbreviated version of the Lubben Social Network Scale among three European community-dwelling older adult populations. Gerontologist. 2006; 46: 503-513.
18) Kurimoto A, Awata S, et al.: Reliability and validity of the Japanese version of the abbreviated Lubben Social Network Scale. Nippon Ronen Igakkai Zasshi. 2011; 48: 149-157 (Japanese).
19) Saito M, Kondo K, et al.: Criteria for social isolation based on associations with health indicators among older people. A 10-year follow-up of the Aichi Gerontological Evaluation Study. Nihon Kosu Eisei Zasshi. 2015; 62: 95-105 (Japanese).
20) Doubova SV, Perez-Cuevas R, et al.: Social network types and functional dependency in older adults in Mexico. BMC Public Health. 2010; 10: 104.
21) Ellwardt L, van Tilburg T, et al.: Personal networks and mortality risk in older adults: A twenty-year longitudinal study. PLoS One. 2015; 10: e0116731.
22) Litwin H and Shiovitz-Ezra S: Network type and mortality risk in later life. Gerontologist. 2006; 46: 735-743.
23) Seeman TE, Bruce ML, et al.: Social network characteristics and onset of ADL disability: MacArthur studies of successful aging. J Gerontol B Psychol Sci Soc Sci. 1996; 51: S191-S200.
24) Guralnik JM, Simonsick EM, et al.: A short physical performance battery assessing lower extremity function: Association with self-reported disability and prediction of mortality and nursing home admission. J Gerontol. 1994; 49: M85-94.
25) Podsiadlo D and Richardson S: The timed “Up & Go:” A test of basic functional mobility for frail elderly persons. J Am Geriatr Soc. 1991; 39: 142-148.
26) Shumway-Cook A, Brauer S, et al.: Predicting the probability for falls in community-dwelling older adults using the Timed Up...
27) Hoyl M, Alessi CA, et al.: Development and testing of a five-item version of the Geriatric Depression Scale. J Am Geriatr Soc. 1999; 47: 873-878.

28) Schnittker J and Bacak V: The increasing predictive validity of self-rated health. PLoS One. 2014; 9: e84933.

29) Makizako H, Shimada H, et al.: Evaluation of multidimensional neurocognitive function using a tablet personal computer: Test-retest reliability and validity in community-dwelling older adults. Geriatr Gerontol Int. 2013; 13: 860-866.

30) Koyano W, Shibata H, et al.: Measurement of competence: reliability and validity of the TMIG Index of Competence. Arch Gerontol Geriatr. 1991; 13: 103-116.

31) Crooks VC, Lubben J, et al.: Social network, cognitive function, and dementia incidence among elderly women. Am J Public Health. 2008; 98: 1221-1227.

32) Chen LK, Liu LK, et al.: Sarcopenia in Asia: Consensus report of the Asian Working Group for Sarcopenia. J Am Med Dir Assoc. 2014; 15: 95-101.

33) Cruz-Jentoft AJ, Bahat G, et al.: Sarcopenia: revised European consensus on definition and diagnosis. Age Ageing. 2019; 48: 16-31.

34) Fried LP, Tangen CM, et al.: Frailty in older adults: evidence for a phenotype. J Gerontol A Biol Sci Med Sci. 2001; 56: M146-156.

35) Sugiura Y, Tanimoto Y, et al.: Handgrip strength as a predictor of higher-level competence decline among community-dwelling Japanese elderly in an urban area during a 4-year follow-up. Arch Gerontol Geriatr. 2013; 57: 319-324.

36) Taekema DG, Gussekloo J, et al.: Handgrip strength as a predictor of functional, psychological and social health. A prospective population-based study among the oldest old. Age Ageing. 2010; 39: 331-337.

37) Suzuki Y, Kamide N, et al.: Absolute reliability of measurements of muscle strength and physical performance measures in older people with high functional capacities. European Geriatric Medicine. 2019; 10: 733-740.

38) Makizako H, Shimada H, et al.: Social frailty leads to the development of physical frailty among physically non-frail adults: A four-year follow-up longitudinal cohort study. Int J Environ Res Public Health. 2018; 15: 490.