International Journal of Physical Therapy & Rehabilitation

Original Article **Open Access**

Determining a Cut-off Point for Evaluating the Ability of Activities of Daily Living Using the Short Physical Performance Battery Score in Older Adults Requiring Care

Daisuke Takagi[1,*], Masatoshi Kageyama[2,3] and Akihiro Morikami[4]

[1]Department of Physical Therapy, Health Science University: 7187 Kodachi Fujikawaguchiko-Town, Yamanashi, Japan
[2]Long-Term Care Health Facilities Sunrise, Ohama
[3]Graduate School, Hamamatsu University School of Medicine, Cooperative Major in Medical Photonics (Doctoral Course), Japan
[4]Laboratory of Physiology, School of Health Sciences, Toyohashi SOZO University, Japan

Abstract

Background: Little is known regarding the cut-off value of the short physical performance battery in assessing independence or dependence in carrying out activities of daily living in older adults requiring care. Clarifying the cut-off value for short physical performance battery could be a useful screening test for the detection of participants in whom the ability to carry out activities of daily living may decline.

Methods: In the present cross-sectional study, we recruited 37 participants aged 60 years or older requiring care using long-term care insurance in Japan [12 men, 25 women, average age (standard deviation): 84.0 (7.3) years]. Short physical performance battery and barthel index as the ability to carry out activities of daily living were measured. The relationship between barthel index (Group 1: ≥85 and Group 2: <85) and short physical performance battery was evaluated using multiple logistic regression analysis adjusted for confounding factors. Moreover, a receiver operating characteristic curve was used to define the cut-off value for the division into 2 groups [Group 1 (barthel index ≥85) and Group 2 (barthel index <85)].

Results: Barthel index was independently explained by the short physical performance battery score (Odds ratio; 2.35, 95% confidence interval; 1.25-6.72, p <0.05). The cut-off value for the short physical performance battery score in barthel index was 4 (sensitivity 0.80, specificity 0.81, and the area under the curve 0.88).

Conclusion: These findings suggest that the cut-off value of the short physical performance battery with respect to the ability to carry out activities of daily living could be useful in assessing participants requiring care who will need to be even more assisted in a daily basis.

Background

According to the World Health Organization (WHO), the proportion of older adults, over the age of 60, in the total global population will move from 12% to 22% in 2050 [1]. In Japan, the percentage of individuals aged 65 or older will be almost 40% of the total population by 2065 [2]. In old age, physical function, such as the ability to balance and muscle strength, declines, and is related to disability and dependency in daily life [3-5]. Therefore, it is important to adequately and quickly understand older adults' physical function and prevent a decline in their ability to carry out activities of daily living (ADL).

The short physical performance battery (SPPB) comprises the following tests: standing balance (side-by-side stand, semi-tandem stand, and tandem stand), comfortable 4-m gait speed, and five-repetition chair-stand tests [6]. SPPB can be used to assess multiple physical functions, such as balance, gait, strength, and endurance in older adults [7]. SPPB has been recognized as a standard assessment tool used in clinical trials [7,8]. A lower SPPB score is associated with ADL difficulty in community-dwelling older adults [9].

The ability to carry out ADL declines with age in older adults, and there is a particularly higher incidence of a decrease in ADL ability in older adults requiring care [10-12]. There is a strong possibility that the number of older adults requiring care will increase with an increasing proportion of older adults. However, little is known regarding the cut-off value of SPPB in the explanator of independence or dependence in carrying out ADL in older adults requiring care.

Clarifying the cut-off value for SPPB could be a useful screening test for the detection of participants requiring care in whom the ability to carry out ADL may decline.

The purpose of this cross-sectional study was to clarify the cut-off value for SPPB with respect to the ability to carry out ADL in older adults requiring care. We expected that the cut-off value for the SPPB score should be able to discriminate the older adults requiring care who need even more assistance in doing ADL from those who don't need more assistance in carrying out ADL.

Materials and Method

Participants

In the present cross-sectional study, we recruited 37 participants aged 60 years or older who are adult day care facilities users or

*Corresponding Author: Daisuke Takagi, Department of Physical Therapy, Health Science University 7187 Kodachi Fujikawaguchiko Town, Yamanashi, 401-0380, Japan, Phone No: +81 555-83-5295, Fax No: +81 555-83-5299; E-mail: pt.takadai@gmail.com

geriatric health services facility residents [12 men, 25 women, average age (standard deviation: SD): 84.0 (7.3) years] using long-term care insurance in Japan. Participants were excluded if they: 1) could not provide complete measurements, 2) had difficulty walking alone (except with supervision), 3) had fractures and/or stroke within the past 3 and 6 months, respectively. The level of long-term care insurance is divided as 7 grades (support levels 1 and 2, and care levels 1, 2, 3, 4 and 5) in Japan, and care level 5 is judged as most severe. The level of long-term care is generally judged by converting the time and effort it takes to care in time. The criterion time for support levels 1 and care level 5 is from more than 25 min to less than 32 min, and more than 110 min, respectively. The number of our participants in each category was as follows: support levels 1 (n = 2) and 2 (n = 3); care levels 1 (n = 16), 2 (n = 9), 3 (n = 3), 4 (n = 3) and 5 (n = 1). Frailty is defined as a previous stage of the conditions requiring care in Japan [13]. All participants read and signed an informed consent form, and this study was approved by the Ethics Committee of the Health Science University.

Short physical performance battery (SPPB)

Physical function was measured using the SPPB which consists of standing balance (side-by-side stand, semi-tandem stand and tandem stand), 4-m gait speed and five-repetition chair-stand tests [6]. Each individual test was scored from 0 to 4 points, with a larger score indicating a better physical function; the total (overall) score ranged from 0 to 12 points. Gait speed was measured twice, and the higher speed was used as a representative value.

Barthel index (BI)

BI was used to measure the ability to carry out ADL [14], and was based on 10 items [total score ranged from 0 to 100 points]: moving from a wheelchair to a bed and back (0, 5, 10, or 15 points), walking (0, 5, 10, or 15 points), eating (0, 5, or 10 points), getting on and off the toilet (0, 5, or 10 points), ascending and descending stairs (0, 5, or 10 points), dressing (0, 5, or 10 points), bowel control (0, 5, or 10 points), bladder control (0, 5, or 10 points), grooming activity (0 or 5 points), and bathing (0 or 5 points). The higher point values indicate less need for assistance in ADL. The total BI score of ≥85 points indicates that a subject is able to the ability to carry out ADL with minimum help [15-17].

Statistical analysis

Statistical evaluation was carried out using the JMP 11 software (SAS Institute Inc., Cary, NC, USA). The values were expressed as the mean ± standard deviation (SD) or median [interquartile range (IQR)]. Minimal sample sizes were 8.8 (cases) and 26.3 (controls) [area under the curve (AUC) = 0.80, significant level = 0.05, power 0.80, kappa 3] and 9.8 (cases) and 19.5 (controls) (AUC = 0.80, significant level = 0.05, power 0.80, kappa 2) using the R Package "pROC" (version 1.16.2), respectively. The participants were divided into 2 groups: Group 1 (BI ≥85) and Group 2 (BI <85). According to a shapiro-wilk test, an unpaired t-test (both parametric data), Wilcoxon ran sum test (either or both nonparametric data) and a chi-squared test were conducted to compare gender, age, height, weight, BMI, SPPB score, and BI between the 2 groups. The relationship between BI and SPPB was evaluated using multiple logistic regression analysis adjusted for confounding factors. Moreover, a receiver operating characteristic curve (ROC curve) was used to define the cut-off value for the division into 2 groups [Group 1 (BI ≥85) and Group 2 (BI < 85)]. The significance was set at $p< 0.05$.

Results

The characteristics of 2 groups are shown in Table 1. There were significant differences in height (Group 1 152.1 ± 9.6 cm vs Group 2 140.4 ± 11.0 cm, p <0.05) and central tendency for age (Group 1 82.6 ± 7.5 years vs Group 2 87.8 ± 5.2 years, p = 0.052), but no differences in gender, weight and BMI between 2 groups (weight: Group 1 46.3 ± 10.2 kg vs Group 2 42.0 ± 9.0 kg ; BMI: Group 1 20.0 ± 4.1 kg/m² vs Group 2 21.4 ± 4.5 kg/m², p >0.05). The SPPB score were significantly lower in Group 2 than in Group 1 [Group 1 7(5) vs Group 2 4(1.5), p <0.05]. In multiple logistic regression analysis [Group 1 (BI ≥85) and Group 2 (BI < 85)] adjusted for height and age, BI was independently explained by SPPB score [Odds ratio (OR) 2.35, 95% confidence interval (95% CI) 1.25 - 6.72, p < 0.05, Table 2), but no age and height

Variables	All (n = 37)	Group1 (n = 27)	Group 2 (n = 10)	P value
Gender, n (men/ women)	12/25	10 / 17	2 / 8	0.326
Age (year)	84.0 ± 7.3	82.6 ± 7.5	87.8 ± 5.2	0.052
Height (cm)	149.0 ± 11.2	152.1 ± 9.6	140.4 ± 11.0	0.003
Weight (kg)	45.1 ± 10.0	46.3 ± 10.2	42.0 ± 9.0	0.243
BMI (kg/m²)	20.4 ± 4.2	20.0 ± 4.1	21.4± 4.5	0.358
SPPB (score)	6 (5)	7 (5)	4 (1.5)	0.0005
BI (score)	90 (12.5)	90 (5)	75 (11.25)	< .0001

Table 1: The characteristics of the participants in this study.
Values are expressed as mean ± standard deviation (SD) or median [interquartile range (IQR)].
BMI: body mass index, SPPB: short physical performance battery, BI: barthel index.

Explanators	OR	95% CI	P value
Age	1.05	0.83 ~ 1.35	0.674
Height	1.10	0.99 ~ 1.26	0.098
SPPB	2.35	1.25 ~ 6.72	0.003

Table 2: Association of barthel index with short physical performance battery (SPPB) score using multiple logistic regression analysis (n = 37).
OR: Odds ratio, 95% CI: 95% Confidence interval.

(age: OR 1.05, 95% CI 0.83-1.35 ; height: OR 1.10, 95% CI 0.99-1.26, all p >0.05, Table 2). Furthermore, using a ROC curve for BI, the cut-off value for the SPPB score was 4 points (sensitivity 0.80, specificity 0.81, and AUC 0.88) (Figure 1).

Discussion

The SPPB score in Group 1 (BI <85) was significantly lower compared with that in Group 2 (BI ≥85). The SPPB score was also an independent explanator of BI, and the cut-off value for the SPPB score was 4 points. These findings suggest that the cut-off value of the SPPB with respect to the ability to carry out ADL could be useful in the detection of participants requiring care who will need to be even more assisted in daily basis.

In the present study, the value of AUC using ROC curve is 0.88. The values of AUC that ranged from 0.7 to 0.9 and from 0.9 to 1.0 are classified as a moderate and high accuracy, respectively [18]. In addition, Shimada et al. (2013) in a study involving 6791 participants aged 65 years or older requiring personal care (age; 82.6 ± 6.7 years) have reported that average comfortable gait speed is 0.7 ± 0.3 m/sec [19]. The average age and comfortable gait speed of our participants in this study were 84.0 ± 7.3 years and 0.63 ± 0.23 m/s, respectively. Therefore, we relatively recruited the general population, and the cut-off value for the SPPB score in the present study could be a suitable indicator for the ability to carry out ADL in older adults requiring care.
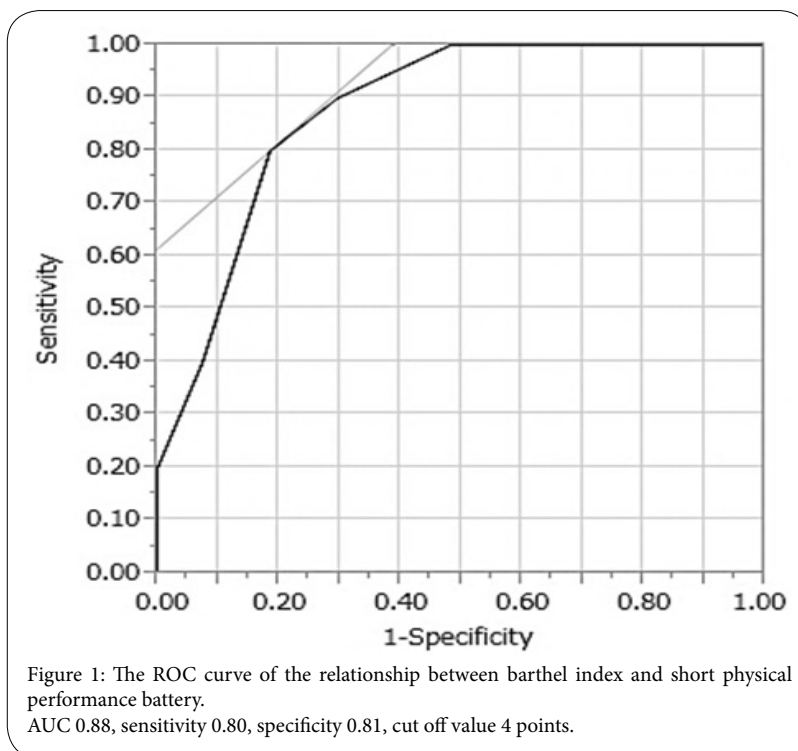
Using the BI, the cut-off value of the SPPB score in the present study was calculated to be 4 points. The total score in SPPB is 12 points and larger score indicate a better physical function [6]. A score of 4-6 points in SPPB is classified as low performance individuals, and the ratio of mobility-related disability in participants who score 4-6 points is approximately 3-5-times higher than in high performance individuals (10-12 points) [11]. The participants in this study acquired

some assistance in carry out the ADL using long-term care insurances. Besides, if the total score of the BI was more than 85 points, a subject is deemed to have the ability to carry out ADL with minimum help [15-17]. Hence, the cut-off value (4 points) of the SPPB score in the present study is a useful indicator of the ability to carry out ADL in older adults requiring care.

One limitation of the present study is the small number of participants. Minimal sample sizes were 8.8 (cases) and 26.3 (controls) (AUC = 0.80, significant level = 0.05, power 0.80, kappa 3) and 9.8 (cases) and 19.5 (controls) (AUC = 0.80, significant level = 0.05, power 0.80, kappa 2) using the R Package "pROC" (version 1.16.2), respectively, but we need to recruit more participants in future studies. Besides, an association between cause and effect could not be revealed due to the cross-sectional design of the present study. Future studies are needed to investigate the manner in which physical function affects the ability to carry out ADL in older adults requiring care in a prospective cohort. Cognitive function is related to the ability to carry out ADL in older adults [20] and we need to clarify the effect of cognitive function on SPPB and the ability to carry out ADL in future studies. Moreover, the functional independence measure (FIM), which is an evaluation method of ADL is divided into 7 scales (1-7) for each item [21], and it can evaluate the ability to carry out ADL in detail. The relationship between FIM and SPPB need to be considered in future studies.

Conclusions

Through the use of the BI, we determined that the SPPB score in the group that had lesser ability to carry out ADL was significantly lower than that in the group that had higher ability to carry out ADL. The SPPB was also extracted as an independent explanator of BI, and the cut-off value for the SPPB score was 4 points. Our results suggest that SPPB could be useful in explaining the ability to carry out ADL in older adults requiring care.

Figure 1: The ROC curve of the relationship between barthel index and short physical performance battery.
AUC 0.88, sensitivity 0.80, specificity 0.81, cut off value 4 points.

Competing Interests

The authors declare that they have no competing interests.

References

1. World Health Organization (2017) 10 facts on aging and the life course.

2. Cabinet Office, Government of Japan (2019) Situation of the ageing population.

3. Bohannon RW, Larkin PA, Cook AC, Gear J, Singer J, et al. (1984) Decrease in timed balance test scores with aging. Phys Ther 64: 1067-1070.

4. Lauretani F, Russo CR, Bandinelli S, Bartali B, Cavazzini C, et al. (2003) Age-associated changes in skeletal muscles and their effect on mobility: an operational diagnosis of sarcopenia. J Appl Physiol 95: 1851-1860.

5. Xue QL, Bandeen-Roche K, Varadhan R, Zhou J, Fried LP, et al. (2008) Initial manifestations of frailty criteria and the development of frailty phenotype in the women's health and aging study II. J Gerontol ABiol Sci Med Sci 63: 984-990.

6. Guralnik JM, Simonsick EM, Ferrucci L, Glynn RJ, Berkman LF, et al. (1994) A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. J Gerontol 49: 85-94.

7. Cruz-Jentoft AJ, Baeyens JP, Bauer JM, Boirie Y, Cederholm T, et al. (2010) Sarcopenia: European consensus on definition and diagnosis: report of the European Working Group on Sarcopenia in older adult. Age Ageing 39: 412-423.

8. Working Group on Functional Outcome Measures for Clinical Trials (2008) Functional outcomes for clinical trials in frail older persons: time to be moving. J GerontolA Biol Sci Med Sci 63: 160-164.

9. Wennie-Huang WN, Perera S, Van Swearingen J, Studenski S (2010) Performance measures predict onset of activity of daily living difficulty in community-dwelling older adults. J Am Geriatr Soc 58: 844-852.

10. Hajek A, Konig HH (2016) Longitudinal predictors of functional impairment in older adults in europe-evidence from the survey of health, ageing and retirement in Europe. PLoS One 11: e0146967.

11. Guralnik JM, Ferrucci L, Pieper CF, Leveille SG, Markides KS (2000) Lower extremity function and subsequent disability: consistency across studies, predictive models, and value of gait speed alone compared with the short physical performance battery. J Gerontol A Biol Sci Med Sci 55: 221-231.

12. Suzukawa M, Shimada H, Watanabe S, Kobayashi K, Suzuki T, et al. (2011) The relationship between physical performances and ADLs decline during 6 months in frail elderly people utilizing long-term care insurance. Rigaku ryohogaku 38: 10-16 (in Japanese).

13. Arai H (2018) Clinical guide for frailty, Life science, Tokyo.

14. Mahoney FI, Barthel DW (1965) Functional evaluation: the barthel Index. Md State Med J 14: 61-65.

15. Geert S, Christel S, Jacques D K (1999) Use of the barthelindex and modified rankin scale in acute stroke trials. Stroke 30: 1538-1541.

16. Granger CV, Dewis LS, Peters NC, Sherwood CC, Barrett JE (1979) Stroke rehabilitation: analysis of repeated barthel index measures. Arch Phys Med Rehabil 60: 14-17.

17. Kay R, Wong KS, Perez G, Woo J (1997) Dichotomizing stroke outcomes based on self- reported dependency. Neurology 49: 1694-1696.

18. Streiner DL, Cairney J (2007) What's under the ROC? An introduction to receiver operating characteristics curves. Can J Psychiatry 52: 121-128.

19. Shimada H, Suzuki T, Suzukawa M, Makizako H, Doi T, et al. (2013) Performance-based assessments and demand for personal care in older Japanese: a cross-sectional study. BMJ Open 3: e002424.

20. McGuire LC, Ford ES, Ajani UA (2006) Cognitive functioning as a predictor of functional disability in later life. Am J Geriatr Psychiatry 14: 36-42.

21. Keith RA, Granger CV, Hamilton BB, Sherwin FS (1987) The functional independence measure: a new tool for rehabilitation. Adv Clin Rehabil 1: 6-18.