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Difference between the measurements of the two-step test taken twice by local residents

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ABSTRACT

Purpose: A two-step test is used to assess patients for locomotive syndrome. The two-step test can easily evaluate a subject's comprehensive gait ability. In this study, we investigated the transition of two measurements and basic attributes affected by the two-step test.

Subjects and Methods: Subjects included 52 local residents (29 men and 23 women). This study analyzed the results of the two-step test performed twice.

Results: The second two-step length was significantly longer than the first two-step length in both the elderly and non-elderly groups. Multiple regression analysis revealed that age and height influence the two-step length. However, there was no correlation between the error in the length of the two-step test taken twice and basic attributes.

Conclusion: The second two-step length was longer owing to the first two-step test results and feedback from previous experience, regardless of factors such as age, height, and weight.

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INTRODUCTION

Decreased exercise habits and disordered lifestyles promote the deterioration of muscle and bone function due to aging[1,2]. Furthermore, changes in the strength of lower limb muscles affect gait speed among individuals of each age group[3]. In 2007, the Japanese Orthopaedic Association (JOA) proposed that a decrease in locomotive ability characterizes locomotive syndrome (locomo) due to age-related decline in muscle function and musculoskeletal disorders. The JOA cautions that the risk of locomo increases with age[4].

In Japan, there have been many care prevention projects introduced for elderly individuals, and the word locomo has gradually spread among the people. The JOA is well known to the public to determine locomo, using the locomo degree test. The locomo degree test consists of a stand-up test, a two-step test, and the locomo 25. The two-step test is an index that can measure gait ability easily[5,6]. The results of the two-step test show a low value due to the influence of diabetic neuropathy and aggravation of neuropathy[7,8], and it can predict the risk of fall in local residents[9]. In addition, older patients with lumbar disease have been reported to have reduced two-step values and an increased risk of falls[10].

The measurement method for the two-step test is simple and convenient because it provides a maximum two-step length. Moreover, there are many opportunities for measuring the two-step test among subjects of care prevention projects. The test is useful for evaluating motor function in local care prevention projects[11]. Its use should continue to spread in care prevention projects in the future. The JOA recommends using the maximum value from the results of measurements obtained from the for the two-step test taken twice[5,6]. However, testing is often a first-time experience, and the results of the two-step test taken twice can vary. We hypothesized that the results of the second two-step test would be better than that of the first test.

This study aimed to understand the difference between the results of the two-step test taken twice using a typical locomo degree evaluation. Individuals may lose their balancing ability if the minimum required step movements are not performed in daily life. Therefore, it is necessary for the evaluator to understand the difference between two two-step tests in order to perform the measurements safely. We compared and analyzed the results of two two-step tests in elderly and non-elderly subjects. We also considered the basic attributes that influence the two-step test.

METHODS

This cross-sectional study analyzed the results of the two-step test taken twice by local residents. We set up a measurement booth at a local cultural event and recruited subjects. Subjects with markedly reduced gait ability were excluded from this study. For example, subjects who used gait aids and those who required assistance were excluded. The subjects comprised 57 local residents. In addition, we excluded five subjects who were out of balance in the two-step test measurement and from whom we were unable to obtain accurate measurements. Therefore, we analyzed 52 people in this study.

The evaluation items were age, height, weight, body mass index, and two-step test taken twice. We asked the subjects to fill in their age, height, and weight in the questionnaire. Unknown attributes were measured individually. Therefore, the analysis included 52 subjects (29 males and 23 females). The mean age was 59.9 ± 13.7 years (median, 61.5 years; range, 26–87 years); height, 163.3 ± 10.9 cm (162.5 cm; 138–189 cm); weight, 61.9 ± 11.9 kg (60 kg; 38–92 kg); and body mass index, 23.1 ± 2.9 kg/m^2 (22.9 kg/m^2; 17.3–31.1 kg/m^2). Data are shown as mean ± standard deviation (median; min–max).

The two-step test was carried out with the method presented by The JOA[6]. The method used was as mentioned. The subject aligned his or her toes of both feet with the start line. The subject attempted to perform a two-step gait as far as possible, stopping with their feet aligned. The attempt was considered a failure if the subject lost their balance, as demonstrated by contact with a part of the knee or hand with the floor. The distance from the start line to the toes of the landing point for the two-step was measured. This distance was the maximum two-step length. After one practice, second measurements were taken to check the operation. The practice was performed to confirm the operation procedure, and it was not carried out at maximum capacity. The analysis was performed using the two-step length results. The error was calculated as the two-step length of the second – first test. In addition, the measurement was performed by the same evaluator.

In many cases, the two-step test is the first action to be performed. When it is unclear whether the subject can understand the action required, it is difficult for the evaluator to perform an accurate assessment. Therefore, before conducting the test, we provided an oral explanation of the measurement mentioned above method to the subjects. To confirm that the subjects could perform the test as described, we asked them to practice only once. However, the subjects were not allowed to do their best in this practice. The measurement was performed indoors with shoes on.

Statistical Analysis

To consider the effects of aging, we divided the subjects into a non-elderly group (<65 years) and an elderly group (≥65 years). To compare the basic attributes of the subjects, an unpaired *t*-test or Mann–Whitney *U* test was performed. The sex ratio was tested using a χ^2 test. We used “1” for representing males and “2” for representing females. In addition, the paired *t*-test was used for the first and second comparisons of two-step length. The Pearson product moment correlation coefficient was calculated for the correlation between the two-step length obtained twice in each group. We then performed correlation and multiple regression analyses to identify the basic attributes that affect the two-step length. The Pearson product moment and Spearman rank correlation coefficients were used for the correlation analysis. In addition, for the multiple regression analysis, we used two-step length as the objective variable, entered sex, age, height, and weight as explanatory variables, and used a stepwise method. The Shapiro–

Wilk normality test was performed prior to the statistical processes. The significance level was set to 5%. Statistical analysis was conducted using SPSS 21.0J (IBM SPSS, Japan, Inc., Tokyo, Japan) as the statistical software.

Ethical Considerations

This study was conducted with the approval of the ethical review of Niigata Rehabilitation University (Murakami, Niigata, Japan; approval number: 112). Subjects received an oral explanation of the study and provided their consent.

RESULTS

Table 1 presents the subjects' basic attributes and two-step length results for both the non-elderly and elderly groups. The assessment of the basic attributes suggested that the elderly group was significantly older in terms of age and shorter in terms of height than the non-elderly group. The two-step length of the elderly group was shorter than that of the non-elderly group. The second two-step length was significantly longer than the first two-step length in both the elderly and non-elderly groups. No significant difference was found between the groups in the error in the length of the two-step test taken twice. Table 2 presents the first and second correlation of the maximum two-step length. Additionally, a high correlation was found between the first and second two-step lengths.

Table 3 shows that the two-step length was correlated with sex, age, height, and weight. No correlation was found with physique. In addition, there was no correlation between the error in the length of the two-step test taken twice and basic attributes. Table 4 shows the result of the multiple regression analysis, which includes the two-step length extracted according to age and height. The two-step length was influenced by age and height.

Table 1. Comparison of basic attributes and two-step length

mean ± SD （Mid: min−max） †, ‡, * p value <0.05

	non-elderly groups		elderly groups		p value
sex(male/female)	16/13		13/10		0.922
age (years) *	50.7 ± 10.7 (55 : 26 − 64)		71.5 ± 5.9 (69 : 65 − 87)		< 0.05
height (cm) †	167.0 ± 10.3 (164 : 151 − 189)		158.5 ± 9.9 (158 : 138 − 174)		< 0.05
weight (kg)	64.4 ± 11.3 (62 : 47 − 92)		58.7 ± 12.1 (60 : 38 − 92)		0.085
BMI (kg/m^2)	23.0 ± 2.6 (22.7 : 17.7 − 27.8)		23.2 ± 3.2 (23.0 : 17.3 − 31.1)		0.800
Two-step length of first†	241.3 ± 34.0 (244 : 178 − 320)	‡	206.9 ± 33.0 (211 : 132 − 245)	‡	< 0.05
Two-step length of second †	253.9 ± 31.8 (251 : 202 − 340)		217.7 ± 28.6 (223 : 154 − 250)		< 0.05
Error of twice two-step length	12.6 ± 14.7 (14 : -24 − 46)		10.8 ± 14.3 (10 : -13 − 40)		0.65

†: un-paired t-test. ‡:paired t-test. *: Mann-Whitney U test.

Normal distribution: height, weight, BMI, Two-step length of first, Two-step length of second, Error of twice two-step length

Non-normal distribution: sex, age

BMI : Body Mass Index

Table 2. Correlation of two-step test taken twice

* p value <0.05

	all	non-elderly groups	elderly groups
Two-step length of twice	0.923*	0.902*	0.902*

*: Pearson product moment correlation coefficient.

Table 3. Correlation between two-step length and basic attributes

*, † p value <0.05

	sex	age	height	weight	BMI
Two-step length of first	-0.497†	-0.532†	0.660*	0.450*	-0.006
Two-step length of second	-0.426†	-0.607†	0.690*	0.504*	0.041
Error of twice two-step length	0.209	-0.013	-0.031	0.063	0.115

*: Pearson product moment correlation coefficient.

†: Spearman's rank correlation coefficient.

Normal distribution: height, weight, BMI, Two-step length of first, Two-step length of second, Error of twice two-step length

Non-normal distribution: sex(male is 1, female is 2), age

BMI : Body Mass Index

Table 4. Multiple regression analysis with two-step length as the objective variable

* p value <0.05

	Two-step length of first			Two-step length of second		
	β	95% confidence	VIF	β	95% confidence	VIF
height *	.509	1.072 – 2.430	1.150	.532	1.125 – 2.317	1.150
age *	-.420	-1.690 – -.609	1.150	-.437	-1.600 – -.650	1.150

β : Standardized regression coefficient

VIF : Variance Inflation Factor

excluded factor : sex, weight, Body Mass Index

DISCUSSION

We investigated the difference in the results of the two-step test taken twice by local residents. Additionally, we considered the factors that influence the two-step length and the error in the results of the two-step test taken twice. Most subjects successfully performed the two-step test twice (52/57 subjects).

The elderly group had a shorter two-step length than the non-elderly group. This finding is consistent with the decrease in step length and gait ability observed with increasing age[12-14]. From the results of the multiple regression analysis, the subject's age and height influenced the two-step length. The two-step length of non-elderly individuals with normal gait was reported to be 45% of their height[15]. Because the length of the step depends on the individual's height, it was suggested that the two-step length is affected by height. Therefore, in locomotive evaluation, the two-step value corrected by height was adopted, and the standard value for each age group for each sex was reported[6]. It was suggested that the effects of age and height might result in a shorter two-step length in the elderly group compared with the non-elderly group.

The first two-step length was considered to influence past experiences in addition to gait ability. Humans integrate their senses as they develop, and thereby can predict motor function both temporally and spatially[16,17]. To predict one's step in gait, a movement image based on internal models[18-20] is formed by past experiences and memories such as gait movements performed in daily life. The step length during gait is predicted by the motion image based on the internal model. We considered that the two-step test can also be influenced by past experiences and memories of daily life. In addition, in the first attempt, subjects might have exceeded their physical limitations and lost their balance, and thereby took measures to prevent their knees and hands from touching the floor. Therefore, it is possible that the two-step length was underestimated, and the two-step test was not performed to the best of the individual's ability.

The same task was performed twice, so the results of the two-step length showed a positive correlation between first and second test. In addition, the second two-step length was longer than the first two-step length. The second two-step length was thought to be longer because of the first test's experience. By experiencing the first two-step test, subjects can receive feedback on their results and error in the marginal motion prediction. For that reason, based on the first test's experience, it is considered that the second two-step length was longer because the subject could modify the prediction of their athletic ability and stability boundaries.

There was an error in the length of the two-step test taken twice in both the non-elderly and elderly groups, but there was no significant difference between the groups. No correlation was found between the error in the length of the two-step test taken twice and basic attributes of the subjects. Therefore, although the second two-step length was longer, factors such as age, height, and weight were not found to affect the error in the length of the two-step test taken twice.

The association between motor dysfunction and aging creates an error between actual motor performance and motor prediction[21]. We find it easy to match the predicted and actual results when there are many movements and training movements in our daily lives. However, it may not be possible to accurately grasp motor function with inexperienced movements. The ability to perform risky movements, such as falls, may be underestimated. The two-step test is also an unfamiliar movement, and it was considered that not only the elderly group but also the non-elderly group had an error in predicting the actual boundary. Regardless of age or height, feedback from the first test's results and previous experience might have helped in adjusting the prediction of the balancing limits and resulted in the second two-step length being longer.

It is important for the evaluator to perform measurements while predicting the two-step length. The first two-step length can be predicted based on age and height. Accordingly, the second two-step length can be assumed to be longer than the first two-step length. Based on these assumptions, the evaluator can easily provide support if the subject loses balance. This makes it possible to perform measurements safely while maximizing the subject's ability.

Limitations and challenges

Subjects consisted of individuals who participated in local cultural event. The subjects voluntarily cooperated with the measurement, and there was a possibility that their health literacy was high. In the future, issues should be investigated regarding social participation and one's own health literacy. The motor function evaluation in this study is only a two-step test, and the original motor function and lifestyle of the subjects were unknown. Moreover, because the two-step length was not actually predicted, it was impossible to strongly consider motion prediction. Furthermore, future studies should increase the number of subjects and analyze the results based on their sex. Evaluation and analysis of items related to gait and balance ability should be included in future studies.

CONCLUSION

We clarified the difference between the results of the two-step test taken twice using a typical locomo degree evaluation. The second two-step length was significantly longer than the first two-step length in both the elderly and non-elderly groups. The second two-step length was longer owing to the first two-step test's results and feedback from previous experience, regardless of factors such as age, height, and weight.

Conflict of Interest

The authors declare no conflict of interest.

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