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Relationship between Cognitive Function Physical Function Mental Function and Functional Capacity in Rehabilitation Users

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Abstract

[Purpose] The purpose of this study was to clarify the relationship between cognitive function and physical function, functional capacity among rehabilitation users. [Method] The variables included age, gender, level of care, educational history, cognitive function and physical function, functional capacity of 168 rehabilitation users. We compared cognitive functions between A higher-score group and t A lower-score group of rehabilitation users. [Results] A higher-score group was divided into two groups: A higher-score group with a total MMSE score of 28 or more and A lower-score group with a total MMSE score of 27 or less. In the basic attributes the A higher-score group had significantly higher MMSE scores than the A lower-score group in CS-30, open-eyed one legged stand, and functional capacity, which were related to age and gender, and significantly lower in TUG. [Conclusion] This study indicates that balance function is related to cognitive decline by examining the relationship between cognitive function and physical function.

Keywords

Cognitive Function, Physical Function, Functional Capacity, Rehabilitation Users

1. Introduction

In Japan, there are approximately 36.25 million elderly people aged 65 years or

older, of whom approximately 7.07 million require nursing care or support [1]. 1) Cerebrovascular disease is the leading cause of the need for nursing care, and dementia is the second leading cause [2]. 2) Elderly people with dementia cause increased physical, psychological, and economic burdens not only for the individuals themselves but also for their families and neighbors. Therefore, from the viewpoint of primary prevention, it is important to promptly detect elderly persons with cognitive decline and provide preventive support services. In recent years, there has been a growing interest in the importance of treating mild cognitive impairment (hereinafter referred to as "MCI") in the treatment of dementia. Therefore, in order to obtain basic data for research to detect signs of early transition to MCI and to conduct interventions to prevent dementia, it is necessary to focus on the characteristics of elderly people with MCI, not only in terms of cognitive function but also in terms of physical function, mental function, and daily life function, and to consider social factors such as the type of people who will participate in the survey. The social factors, such as who participates in the survey, should also be taken into account for a comprehensive examination. Previous studies have reported gender differences in the relationship between physical function and cognitive function [3], and that cerebrovascular disease and dementia are the most common causes for requiring nursing care [4]. In addition, the results of an examination of factors related to the life functions of the elderly using functional capacity [5] as a measure of life functions, reported that the index was related to cognitive functions [6] and mental functions [7]. However, there have been few cross-sectional studies of subjects over a long period of time in relation to society, focusing on physical function, mental function, and life function, as well as the type of subjects who participate in the survey [6].

The purpose of this study was to clarify relationships between cognitive function, physical function, functional capacity, and mental function among rehabilitation patients.

2. Subject and Method

2.1. Participants

The Participants were 175 persons requiring assistance who were using a day-care rehabilitation facility in the city of A (**Figure 1**). Exclusion criteria were those who discontinued day-care center rehabilitation and were hospitalized, and 168 subjects (31 males and 137 females, mean age 82.2 years) were included in the analysis, excluding 7 subjects who met these criteria. This day-care service is for persons requiring support 1 and 2. Informed consent was obtained from the subjects after explaining orally that participation in the survey was not mandatory, that the data obtained from the survey would not be used for any purpose other than research, and that the data would be anonymized for use (**Table 1**). The study was approved by the Ethical Review Committee of Kurume Rehabilitation Hospital (approval number: 21-001).

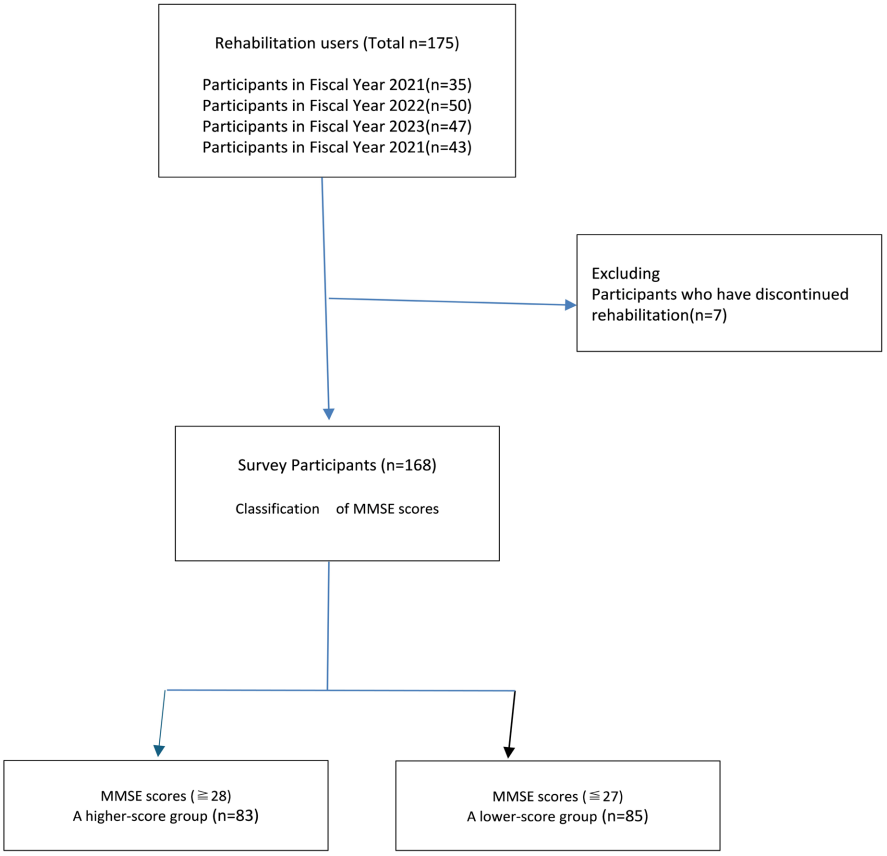


Figure 1. Flow chart of survey Participant.

Table 1. General information of rehabilitation users (n = 168).

Variables	Category	Frequency
Age	Early period elder	16 (9.6%)
	Late period elder	152 (90.6%)
Gender	male	31 (18.6%)
	female	137 (81.6%)
Level of care	Support required1	130 (77.5%)
	Support required2	38 (22.7%)
Educational history	9 years or less	47 (28. 0%)
	10 years or more	121 (72.0%)
MMSE	28 point or more	83 (49.5%)
	27 point or less	85 (50.5%)
History of present illness	Cerebrovascular disease	38 (22.3%)
	Osteoarticular disease	23 (13.8%)
	Heart disease	5 (2.8%)
	Hypertension	79 (47.2%)
	Diabetes mellitus	18 (11.1%)
	Hyperlipidemia	5 (2.8%)

Number (%).

2.2. Methods

1. general information

General information (age, gender, level of care, educational history: number of years attended elementary school, junior high school, high school, and university) was obtained from the staff of the A-city day-care center project.

2. physical function

The grip strength was measured using a digital grip strength meter (OG Giken Co., Ltd.), and the grip width was adjusted so that the PIP joint of the second finger was almost at a right angle. The maximum grip strength was measured twice alternately on the left and right sides, without swinging the grip strength meter, and the maximum value was set as the representative value.

For the CS-30, a 40-cm-high chair without armrests was used. The examiner eliminated any risk of falling. At the beginning of the test, the participants were seated with their backs to the chair and their arms crossed in front of their chests in a uniform posture. After several practice sessions, the participants were asked, on cue, to move from a sitting position to a standing position, extending their hip and knee joints fully, and then back to a seated position; the number of standing–sitting cycles during a 30-second period was counted [8].

In the Timed Up & Go Test (TUG) measurements were taken by measuring the time taken to rise from a chair-sitting posture, walk to a target 3 m away, change direction, return to the chair, and sit down. The measurement started immediately after the participants rose from the chair and stopped immediately after they sat back down. Measurements were taken twice, with the fastest value (in seconds) being representative [9].

For the open-eyed one legged stand, the time to hold the posture was measured with a digital stopwatch. The measurement limb position was the standing posture. The subject stands upright with their arms at their sides. The examiner instructs the subject to close their eyes and lift their left foot slightly off the floor.

The examiner then measures the duration of the one-leg stand. The measurement was stopped until the contralateral foot touched the floor. The higher of the two was taken as the measurement value.

3. mental functions

The MMSE (Mini Mental State Examination) was used to assess mental function.

The MMSE includes writing, document composition, and figure copying tasks, and the score ranges from 0 to 30 points.

MMSE scores below 23 are suspicious for dementia (sensitivity 81%, specificity 89%); scores below 27 are suspicious for mild cognitive impairment (MCI) (sensitivity 45% - 60%, specificity 6590%) [10].

The QOL was assessed using the WHOQOL26 which is widely used globally and has excellent reliability and validity [11] [12]. The WHOQOL26 comprises 24 items in four domains and 2 items regarding overall QOL as follows: Physical QOL (7 items: ADL, medical supplies and dependence on medical care, vitality and fatigue, mobility, pain and discomfort, sleep and rest, and work capacity); Psychological

QOL (6 items: body image, negative effect, positive effect, self-evaluation, spirituality, religion, beliefs, thinking, learning, memory, and concentration); Social QOL (3 items: relationships, social support, and sexual activity); Environmental QOL (8 items: financial relationships, freedom and safety and security, accessibility and quality of health and social care, dwelling environment, opportunities to acquire new information and skills, participation and opportunities for leisure activities, living environment, and transportation.); and overall QOL (2 items: subjective QOL and sense of wellbeing). Up to 5 points were assigned for each item of the four domains, and up to 10 points were assigned for the two items of overall QOL. The QOL survey involved a self-evaluation questionnaire. Respondents were required to indicate "how they felt during the past two weeks", "how satisfied they were during the past two weeks", and "how often they experienced this during the past two weeks", by choosing either "not at all (not good, not satisfied)", "a little (bad, not satisfied)", "somewhat (fair, neither good nor bad)", "a lot (good, satisfied, not satisfied)", and "a little (good, satisfied, not satisfied)".

In this study, we used the total score.

4. functional capacity

Tokyo Metropolitan Institute of Gerontology Index of Competence (TMIG IC) consists of 13 items and is classified into 3 categories: IADL (5 items), intellectual activity (4 items), and social role (4 items) [13]. The TMIG-IC is answered on a "yes" or "no" scale, with higher TMIG-IC scores indicating a greater ability to perform the activity. IADL refers to the basic skills needed to live independently in the community, such as managing transportation, shopping for daily necessities, cooking, and money management. Intellectual activity refers to the ability to engage in activities such as leisure, learning, and creativity, while social role refers to the ability to interact closely with people and society.

The daily life function was assessed by TMIG IC [7] The distribution of scores was 0 to 13, since indexes were designed to be answered using a two-tailed scale (0 and 1).

Questionnaires, higher scores indicate higher activity ability.

2.3. Statistics

MMSE total score was divided into two groups: "A higher group" of 28 or more score and "A lower group" of 27 or less score. Basic attributes (age, gender, level of care, educational history), physical function, functional capacity, and mental function were compared using chi-square or Mann Whitney's U test (**Tables 1-2**). Age was divided into two groups: early elderly (65 - 74 years old) and late elderly (75 years old or older), and educational history was divided into two groups: high school up to 9 years or less, and vocational school, junior college, or university up to 10 years or more, respectively.

Pair analyses were carried out using Mann Whitney's U test (**Table 3**). After all, Binary logistic Analysis for predicting dependent variable (**Table 4**).

SPSS 26.0 for Windows was used for statistical analysis, and the statistical significance level was set at 5%.

3. Results

Table 2 presents demographic characteristics of participants. The variables related to MMSE score were age and gender.

Table 3 presents comparison between A higher-score group, A lower-score group and functional variables. A higher-score group had significantly higher MMSE scores than the A lower-score group in CS-30, open-eyed-one-legged stand and significantly lower in TUG.

Table 2. Demographic characteristics of participants (n = 168).

General information	Category	A higher-score group	A lower-score group	p-value	
Age	Early period elder	8	8		
	Late period elder	75	77	0.003	**
Gender	Male	9	22		
	Female	74	63	0.01	**
Level of care	Support required 1	68	62		
	Support required 2	15	23	0.16	
Educational history	9 years or less	28	29		
	10 years or more	55	56	0.95	

Note: A higher-score group with a total MMSE score of 28 or more and A lower-score group with a total MMSE score of 27 or less; *p < 0.05, **p < 0.01 by Chi-square test; Values are Numbers.

Table 3. Comparison between A higher-score group, A lower-score group and functional variables.

General information	Category		A higher-score group	A lower-score group	p-value	
		(n = 168)	(n = 84)	(n = 84)		
	Grip strength (kg)	22.3 (19 - 27)	21.6 (18.2 - 25.8)	22.8 (19.7 - 27.1)	0.29	
Physical function	CS-30 (sec)	19 (16 - 24)	20 (16.5 - 25.1)	18 (15 - 21)	0.005	**
	Open-eyed one l egged stand (sec)	8 (3.6 - 17.6)	8 (4.1 - 24.2)	8.2 (3.6 - 11.3)	0.01	**
	TUG (sec)	7.8 (6.9 - 10.3)	7.5 (6.8 - 9.4)	8.4 (7.3 - 11.2)	0.001	**
Functional capacity	TMIG-IC (score)	11 (8 - 12)	11 (9 - 12)	10 (7 - 12)	0.08	
Mental function	WHO-QOL-26 (score)	3.1 (3 - 3.8)	3.1 (3 - 3.5)	3.1 (2.9 - 4)	0.77	

Note: A higher-score group with a total MMSE score of 28 or more and A lower-score group with a total MMSE score of 27 or less; Values are median (percentile 25% - 75%); *p < 0.05, **p < 0.01 by Mann Whitney's u-tests.

Table 4. Results of binary logistic regression analysis for predicting dependent variable (n = 168).

	B	SE	Wald	Exp(B)	p-value	95% CI		VHF
						Lower	Upper	
Age (years old)	-0.04	0.71	0.73	0.95	0.19	0.89	1.02	1.33
Gender (1: male, 2: female)	0.61			1.83	0.39	0.45	7.35	2.43
Educational history (1: 9 years or less, 2: 10 years or more)	0.33	0.41	0.66	1.39	0.41	0.62	3.08	1.18
Grip strength (kg)	-0.05	0.04	1.81	0.94	0.17	0.86	1.02	2.19

Continued

CS-30 (sec)	0.07	0.03	4.44	1.08	0.03	*	1.01	1.16	1.56
Open-eyed one legged stand (sec)	0.03	0.01	6.35	1.03	0.012	*	1.01	1.06	1.15
TUG (sec)	-0.05	0.05	1.13	0.94	0.28		0.85	1.04	1.57
TMIG-IC (score)	0.11	0.08	1.81	0.17	0.17		0.95	1.31	1.79
WHO-QOL-26 (score)	-0.47	0.23	3.98	0.62	0.06		0.39	0.99	1.36

Note: dependent variable: MMSE (A higher-score group and A lower-score group) independent variable: age, gender, educational history, Grip strength,CS-30,open-eyed one legged stand, TUG, functional capacity score,WHO-QOL-26; B = unstandardized regression coefficient; SE = standard error; Exp(B) = odds ratio; 95%CI = 95% confidence interval, Variance Inflation Factor(VHF); *p < 0.05, **p < 0.01 by Binomial logistic regression analysis; The model demonstrated a good fit (Hosmer-Lemeshow test p = 0.1).

4. Discussion

The purpose of this study was to clarify the relationship between cognitive function and physical function, functional capacity among rehabilitation users.

A higher-score group was significantly higher than A lower-score group in the CS-30 and open-eyed one legged stand, and significantly lower in the TUG. In general, the postural coordination function of the elderly is impaired due to degenerative degeneration of the musculoskeletal system, nervous system, and sensory receptors, and balance function is a physical ability that can be achieved through proper postural coordination [13]. Normal balance function is related to many factors involved in physical movement, including the perception of the external world via sensory receptors and the sensory nervous system, the integration of sensation and movement by the central nervous system, and the expression of movement via the motor nerves and musculoskeletal system [14]. Furthermore, it has been reported that the visual and vestibular systems play a major role in postural coordination functions in the elderly, and cognitive functions affect balance functions that require attention [15] Yamakawa *et al.* [16] reported that the MCI group showed significantly lower values in one leg stand with open eyes compared to the normal group.

In the present study, the factors that may have contributed to the association between cognitive function and balance functions such as CS-30 on the MMSE, open-eyed onelegged stand, and TUG are that the MCI group had lower attention span than the normal group.

This study suggests that balance is related to cognitive decline in physical function by examining the relationship between cognitive function and physical function.

This study has the following limitations. There were that the cross-sectional design, inability to establish causality, relatively small sample size, single-facility/single-city recruitment, marked female predominance, potential selection bias, possible residual confounding, reliance on MMSE as the sole cognitive screening measure, dichotomization of a continuous MMSE score, and limited generalizability to independently living older adults or other rehabilitation settings. The absence of information regarding medication use, depression, neurological disease

severity, sensory impairment, physical activity, socioeconomic factors, and other potentially relevant confounders should also be considered where applicable to the available dataset.

In the future, we plan to use a causal model to comprehensively examine physical, psychological, and social factors in relation to cognitive function among the elderly in the community, and to quantitatively clarify the direction and strength of influence among these factors for use in a population approach.

5. Conclusion

This study suggests that balance is related to cognitive decline in physical function by examining the relationship between cognitive function.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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