Disabilities of the arms, pinch strength, and mild cognitive impairment in patients with coronary artery disease

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(Citation)
Journal of Cardiology,77(3):300-306

(Issue Date)
2021-03

(Resource Type)
journal article

(Version)
Accepted Manuscript

Highlights

- We revealed relation between difficulty in using the arms and MCI in CAD patients.
- The DASH score was higher in CAD patients with MCI.
- The DASH score was independently associated with MCI.
- Manual and cognitive function were independently associated with the DASH score.
- Manual function and activities using the arms could be targets for intervention.

Disabilities of the arms, pinch strength, and mild cognitive impairment in patients with coronary artery disease

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Abstract

Background: We aimed to examine the relationship between the difficulty of activity using the arms and mild cognitive impairment (MCI), the relationship between the difficulty of activity using the arms and manual function, and cognitive function in patients with coronary artery disease (CAD).

Methods: We conducted a cross-sectional study of 263 non-dementia patients who met the study criteria from 2328 CAD patients. MCI was estimated with the Japanese version of the Montreal Cognitive Assessment (MoCA-J). The difficulty of activity using the arms was evaluated using the Disability of the Arm, Shoulder and Hand (DASH) questionnaire. Manual function was evaluated by pinch strength and handgrip strength.

Results: Age (odds ratio, 1.10), three-fingered pinch strength (odds ratio, 0.69), and DASH score (odds ratio, 1.03) were independently associated with MCI in the multivariable logistic regression analysis. Hemoglobin ($\beta = -0.15$), handgrip strength ($\beta = -0.37$), and MoCA-J score ($\beta = -0.15$) were independently associated with DASH score (Model 1: $p < 0.001$, adjusted $R^2 = 0.33$); hemoglobin ($\beta = -0.17$), eGFR ($\beta = -0.14$), three-fingered pinch strength ($\beta = -0.25$), and MoCA-J score ($\beta = -0.14$) were independently associated with DASH score in the multivariate regression analysis (Model 2: $p < 0.001$, adjusted $R^2 = 0.31$).

Conclusions: The difficulty of activity using the arms was independently associated with manual and cognitive function and MCI in CAD patients.

Keywords: Cognitive function; Coronary artery disease; Disability of the Arm, Shoulder and Hand; Mild cognitive impairment; Pinch strength.

Introduction

Cardiovascular disease (CVD) and dementia in the elderly are becoming social problems in Japan [1–3]. Consequently, intervention initiated from the early stage for CVD patients is becoming important [4,5]. There is a mutual relation between CVD and dementia in that CVD is strongly associated with cognitive dysfunction [6], and cognitive dysfunction in CVD patients is related to the poor outcomes such as short- and mid-term mortality, readmission to hospital [7,8], and increased functional disability [9]. Vascular problems such as cerebral hypoperfusion might underlie the pathophysiologic basis of these relations [10].

To prevent cognitive dysfunction in CVD patients, activity using the fingers and the arms has been attracting attention for its relation with cognitive function. In the daily clinical setting, we have observed that in Japanese CVD patients with cognitive dysfunction, activity using the fingers and the arms is difficult. We previously reported that pinch strength was lower in patients with MCI than in those without MCI, and pinch strength was one factor independently associated with MCI in CVD patients [11]. Another study reported that finger dexterity can reflect a decline in cognitive function [12], and the decline in handgrip strength from midlife to late life is associated with dementia in

Japanese people [13].

In addition to pinch strength and handgrip strength, there is a need to investigate the overall problem of activity using the arms. The Disability of the Arm, Shoulder and Hand (DASH) questionnaire [14] would be suitable to assess the difficulty of activity using the arms. DASH is an upper extremity-specific outcome measure and is mainly a measure of disability [15]. A previous study found that the DASH score correlated negatively with handgrip strength in post-cardiac surgery patients [16]. Thus, the DASH score can evaluate the overall problem of activity using the arms, and it may be affected by manual function and cognitive function.

From these points of view, we hypothesized that CVD patients with MCI would experience more difficulty of activity using the arms than would CVD patients without MCI and that the difficulty of activity using the arms would reflect cognitive impairment in CVD patients. Moreover, manual function (such as pinch strength and handgrip strength) and cognitive function are associated with the difficulty of activity using the arms in CVD patients. Presently, however, the extent of these relationships is unknown, and it is important to clarify them as this may lead to targets for intervention in CVD patients with MCI.

Therefore, the purposes of the present study were to determine the following: (1) the differences in the difficulty of activity using the arms in CVD patients with or without MCI; (2) the relationship between the difficulty of activity using the arms and MCI; and (3) the relationship between the difficulty of activity using the arms and manual function (pinch strength and handgrip strength), and cognitive function in CVD patients.

Methods

Study population

We investigated the records of 2328 consecutive patients with coronary artery disease (CAD) who were treated at the Sakakibara Heart Institute in Okayama, Japan, from May 2018 to February 2020, including those with acute myocardial infarction, stable and unstable angina, and acute coronary syndrome. We included patients who received rehabilitation and were hospitalized for more than two days, except those hospitalized for only one night and two days, for percutaneous coronary intervention (PCI) [11]. We excluded patients who did not give informed consent, underwent coronary artery bypass surgery, had mental disease, had orthopedic disease that affected manual function, experienced a cerebral vascular accident, could not walk without total assistance, had probable dementia as shown by a Mini-Mental State Examination (MMSE) score < 24 [17,18], died in hospital, and had missing data [11].

The Sakakibara Heart Institute of Okayama Ethics Committee approved this study (approval no. A2018-0401), and we obtained informed consent from each patient. We complied with the principles of the 1975 Declaration of Helsinki regarding investigations in human subjects.

Clinical characteristics of the patients

The characteristics of the patient were retrospectively assessed from their medical records. Baseline characteristics evaluated included age, sex, body mass index (BMI), educational background (categorized as >13 years of schooling), living alone, diagnosis, number of significant coronary artery stenoses (those ≥75% and especially left main trunk ≥50%), treatments, left ventricular ejection fraction (LVEF) calculated by the modified Simpson method for cardiac echocardiography, maximum creatine kinase-myocardial band level, serum hemoglobin levels, estimated glomerular filtration rate (eGFR), serum albumin levels, HbA1c, comorbidities, and medications. The laboratory and echocardiographic data obtained just prior to patient discharge were evaluated from the patients' medical records

[11].

Measurement of cognitive function

We used the Japanese version of the Montreal Cognitive Assessment (MoCA-J) [19] and the MMSE [17,18] to assess cognitive function in the patients [11]. The MoCA-J is used for screening persons with MCI and has a sensitivity of 93% and specificity of 87% in identifying MCI [19]. The MoCA-J is used to assess multiple cognitive domains, including visuospatial/executive, naming, memory, attention, language, abstraction, delayed recall, and orientation. A cutoff point value for the MoCA-J of 26 was previously used to define MCI [19]; therefore, we defined patients with a MoCA-J score < 26 as having MCI and those with a MoCA-J score ≥26 as without MCI [11].

Although the MMSE is used as a screening tool for dementia worldwide [18], it is not sensitive enough to screen for early cognitive decline associated with MCI [20]. Thus, we used the MMSE solely to select the patients with probable dementia for exclusion [11]. A MMSE cutoff score of < 24 was used to define probable dementia [18]. A physical therapist evaluated cognitive function in the patients at the time of discharge.

Measurement of the difficulty of activity using the arms

We used the Japanese version of the DASH questionnaire [14] to assess the difficulty of activity using the arms. The DASH is a self-reported questionnaire in which patients report their upper extremity disability and symptoms during the past one week [14,15]. The DASH score consists of a 30-item disability/symptom scale that examines the patient's health status, and each item has five response options [14–16]. The items evaluate the degree of difficulty in performing different daily activities using the arms; the severity of each of the symptoms of pain, activity-related pain, tingling, weakness, and stiffness; and the problem's influence on social activities, work, sleep, and self-image [14–16]. The DASH score ranges from 0 to 100 points with higher scores representing more severe disability. The DASH score is a reliable assessment that is sensitive in Japanese patients [14].

Measurement of manual function (pinch strength and *handgrip strength)*

We evaluated pinch strength with a pinch strength dynamometer (Baseline1 Hydraulic Pinch Gauge; Fabrication Enterprises Co., Ltd., White Plains, NY, USA) and handgrip strength with a grip strength dynamometer (T.K.K.5401; Takei Scientific Instruments Co., Ltd., Niigata, Japan) at the time of discharge [11]. All subjects were measured in the standardized testing position recommended by the American Society of Hand Therapists [21] and the study by Mathiowetz et al. [22] to avoid the Valsalva effect. To measure pinch strength and handgrip strength, all subjects were seated in a chair with their shoulders neutral and elbows at 90° flexion, forearms neutral in supination/pronation, and the wrist between 0° and 15° ulnar deviation. Pinch strength was measured by assessing lateral pinch strength and three-fingered pinch strength [11]. To measure lateral pinch strength, the pinch strength dynamometer was positioned between the pad of the thumb and the radial side of the middle phalanx of the index finger. To measure three-fingered pinch strength, the dynamometer was positioned between the pads of the thumb, index, and middle fingers. The higher of the two measured values, each of which was assessed twice, was recorded, and the right- and left-hand values were averaged to obtain pinch strength (kgf) and handgrip strength (kg) in the present study [11].

Statistical analysis

Patient characteristics and evaluated outcomes are shown as percentages for the categorical variables and as the mean ± standard deviation for the continuous variables. The unpaired *t*-test, Mann-Whitney U test, and χ^2 test were used as appropriate to evaluate differences in patients' characteristics and in measured outcomes between the MCI and non-MCI groups. Univariate and multivariable logistic regression analyses were used to clarify the relation between the DASH score and MCI, with the dependent variable being MCI and the independent variables being patient characteristics, handgrip strength, pinch strength, and DASH score. Pearson correlation analysis was used to test the relations between the DASH score and manual function, and cognitive function. Multivariate regression analyses were used to clarify the relation between the DASH score and manual function, and cognitive function, with the dependent variable being the DASH score and the independent variables being patient characteristics, handgrip strength, pinch strength, and MoCA-J score. In model 1, clinical characteristics, handgrip strength, and MoCA-J were included as independent variables. In model 2, clinical characteristics, pinch strength, and MoCA-J were included as independent variables. The overall level of statistical significance was set at 0.05. Statistical analyses were performed with R ver. 2.8.1 (The R Foundation for Statistical Computing, Vienna, Austria).

Results

Clinical characteristics

Of the 2328 consecutive patients with CAD, 823 met the inclusion criteria. However, 560 patients were subsequently excluded because they did not give informed consent (n = 97), underwent coronary artery bypass surgery (n = 316), had mental disease (n = 9), had orthopedic disease that affected manual function (n = 0), experienced a cerebral vascular accident (n = 20), could not walk without total assistance (n = 39), had probable dementia (n = 64), died in hospital (n = 14), and had missing data (n = 1). Therefore, 263 patients were ultimately included in our final analysis and were divided into the non-MCI group (n = 175) and the MCI group (n = 88).

The baseline characteristics according to the presence or absence of MCI are shown in Table 1. Compared to the patients in the non-MCI group, those in the MCI group were significantly older and less frequently of the male sex and had lower BMI, lower serum levels of hemoglobin and albumin, lower eGFR, higher rates of chronic respiratory disease and benzodiazepines use, and lower educational background, MoCA-J score, handgrip strength, lateral pinch strength, and three-fingered pinch strength.

Differences in the DASH score between groups

The DASH score, which indicates the difficulty of activity using the arms, was significantly higher in the MCI group than that in the non-MCI group (Table 1).

Relation between the difficulty of activity using the arms and MCI

The results of the univariate analysis and the multivariable logistic regression analysis of MCI are shown in Table 2. After the significant independent variables and covariates were identified in the univariate analysis, the multivariable logistic regression analysis showed age (odds ratio [OR], 1.10; 95% confidence interval [CI]: 1.06–1.14; $p < 0.001$), three-fingered pinch strength (OR, 0.69; 95% CI: 0.55–0.88; $p = 0.002$), and DASH (OR, 1.03; 95% CI: 1.00–1.05; $p = 0.02$) to be significantly associated with MCI after adjustment for covariates.

Relation between the difficulty of activity using the arms and manual function, and cognitive function

Pearson correlation analysis showed that the DASH scores were negatively associated with three-fingered pinch strength, lateral pinch strength, handgrip strength, and the MoCA-J score (Figure 1).

The results of the multivariate regression analysis for predicting the DASH scores are shown in Table 3. After adjustment for the covariates, hemoglobin ($\beta = -0.15$), handgrip strength ($\beta = -0.37$), and the MoCA-J score ($\beta = -0.15$) remained statistically significant predictors for the DASH score in Model 1 ($p < 0.001$, adjusted $R^2 = 0.33$). In addition, after adjustment for covariates, hemoglobin ($\beta = -0.17$), eGFR ($\beta = -0.14$), three-fingered pinch strength ($\beta = -0.25$), and the MoCA-J score ($\beta = -0.14$) remained statistically significant predictors for the DASH score in Model 2 ($p < 0.001$, adjusted $R^2 = 0.31$).

Discussion

This is the first study, to the best of our knowledge, to show a relation between the difficulty of activity using the arms and MCI in CAD patients. We showed that the DASH score was significantly higher in the CAD patients with MCI than that in the patients without MCI, and it was independently associated with MCI after adjustment for covariates in the CAD patients. Moreover, manual function (pinch strength and handgrip strength) and the MoCA-J score were negatively associated with the DASH score and were independently associated with the DASH score after adjustment for covariates in the CAD patients. The clinical characteristics of our CAD patients with MCI were in line with those of MCI patients reported in previous studies [11,23–27] and thus may partially reflect the characteristics of CAD patients with MCI.

The CAD patients with MCI experienced more difficulty of activity using the arms than those without MCI as indicated by the significantly higher DASH score in the CAD patients with MCI than that in those without MCI in this study. Thus, the DASH score appeared to reflect an overall view of the difficulty of activity using the arms in the present study.

To our knowledge, we showed for the first time the relation between the DASH score and MCI in CAD patients. In addition, we found that the DASH score was significantly associated with manual function (pinch strength and handgrip strength) and cognitive function in the CAD patients. Previous studies reported that the DASH score was negatively correlated with pinch strength and handgrip strength in healthy adults, patients with hand and wrist disorders, and post-cardiac surgery patients [16,28,29]. It was reported that the decline in pinch strength and handgrip strength was associated with the difficulty of activity using the arms in these patients [16,28,29]. To date, however, there have been no reports showing the relation between the DASH score and cognitive function and pinch strength in CAD patients. The DASH score was independently associated with MCI after adjustment for covariates in the present study. Because the items of the DASH score are based on the degree of difficulty in performing different daily activity using the arms [14,15,16], upper limb activity cannot be evaluated solely by pinch strength and handgrip strength. Thus, our results indicate that we need to evaluate the DASH to gain a complete understanding of the problem of activity using the arms, and the DASH may be useful in predicting the early decline in cognitive function.

We also revealed that manual function is closely associated with cognitive function and that these relations between manual and cognitive function can influence the difficulty of activity using the arms. A previous study found that declines in finger dexterity reflected declining cognitive function, and it was different between patients with Alzheimer's disease, elderly patients with MCI, and healthy older adults [12]. In addition, we previously reported that pinch strength was one factor independently associated with MCI in CVD patients, and three-fingered pinch strength predicts the incidence of MCI [11]. Another study reported that handgrip strength was associated with MCI in middle-aged and older adults [30]. These relations between manual function and cognitive function may be explained by microvascular brain pathology that is associated with motor impairment [31] because manual function requires many processes from perception to cognition [32]. In activity using the arms, likewise, many processes from perception to cognition are also required to achieve a desired activity. Thus, our results of the mutual relation between the cycle of manual function, cognitive function, and the difficulty of activity using the arms, could be explained by this pathology.

Furthermore, recent studies reported that motor tasks performed with the application of transcranial direct current stimulation were effective in improving cognitive and hand motor function of stroke survivors [33]. In addition, audiovisual integrative training enhanced cognitive and hand motor function of elderly MCI patients [34]. Thus, manual function and activity using the arms could be targets for intervention in CAD patients with MCI, and interventions for these problems could lead to a new approach to solving problems of cognitive function in CAD patients.

The results of the multivariate regression analysis for predicting DASH scores in the CAD patients showed serum hemoglobin levels and eGFR to be independently associated with the DASH score after adjustment for covariates. There are no reports showing a relation between the DASH score and serum hemoglobin levels and eGFR in CAD patients. However, it was reported that handgrip strength was positively associated with serum hemoglobin levels and eGFR in patients with chronic kidney disease [35]. Thus, kidney function may have an influence on the relation between the DASH score and serum hemoglobin levels and eGFR in CAD patients.

There are several limitations in this study. First, this is a single-center, cross-sectional study with small sample size. Thus, generalizability of the results may be limited. Second, assessment of cognitive functions was limited to a single screening tool, and imaging data were not analyzed. Third, the influence of changes in factors (such as activity using the arms, manual function, and cognitive function) over time is unknown. Fourth, assessment of heart failure and comorbidities was not adequate; pinch strength may be influenced not only by MCI but also by sarcopenia, systemic skeletal muscle weakness associated with heart failure, cervical spondylosis, peripheral nerve disease, and diabetes. Fifth, muscle strength was not calculated according to normalized values for age and sex. Muscle strength may be influenced by patient age and sex. Therefore, further longitudinal studies are needed to clarify the relation between activity using the arms and manual function, and cognitive function in CAD patients.

Conclusions

The difficulty of activity using the arms was independently associated with MCI in CAD patients. In addition, manual function and cognitive function were independently associated with the difficulty of activity using the arms in these patients. Interventions to improve manual function and activity using the arms could lead to a new approach to solving the problems of cognitive function in patients with CAD.

Funding

This work was supported by a grant from JSPS KAKENHI (No. JP17K01500).

Conflicts of interest

The authors declare that they have no conflict of interest.

Acknowledgments

We thank the staff members of the Sakakibara Heart Institute of Okayama and Kobe University who collaborated in this study. This study was also benefitted by the support and encouragement of Masashi Kanai, Asami Ogura, Ikko Kubo, Hiroto Ogi and Dr. Shinichi Shimada, Department of Public Health, Graduate School of Health Sciences, Kobe University.

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Figure legend

Fig. 1. Relationship between DASH score and upper limb motor functions or cognitive function. (A) Scatter plot of the correlation between DASH score and three-fingered pinch strength. (B) Scatter plot of the correlation between DASH score and lateral pinch strength. (C) Scatter plot of the correlation between DASH score and handgrip strength. (D) Scatter plot of the correlation between DASH score and MoCA-J score. DASH, Disability of the Arm, Shoulder and Hand; MoCA-J, Japanese version of the Montreal Cognitive Assessment.

(A)
r = −0.47
p < 0.001
DASH (points)
Three-fingered pinch strength (kgf)
(B)
r = −0.44
p < 0.001
DASH (points)
Lateral pinch strength (kgf)
(C)
r = −0.52
p < 0.001
DASH (points)
Handgrip strength (kg)
(D)
r = −0.39
p < 0.001
DASH (points)
MoCA-J (points)

Table 1

Clinical characteristics, pinch strength, and disabilities of the arms of patients with and without MCI.

	Non-MCI group (n=175)	MCI group (n=88)	t, χ^2, or Z value	p value
Age (years)	63.8 ± 11.8	76.6 ± 9.1	0.51	<0.001
Male sex, n (%)	148 (85)	64 (73)	5.26†	0.02
BMI (kg/m^2)	24.3 ± 3.7	22.4 ± 3.3	0.25	<0.001
Diagnosis, n (%)			5.89†	0.05
Acute myocardial infarction	123 (70)	50 (57)		
Acute coronary syndrome	6 (3)	2 (2)		
Angina	46 (26)	36 (41)		
Significant coronary artery stenosis, n (%)			1.00†	0.61
1-vessel disease	89 (51)	44 (50)		
2-vessel disease	51 (29)	30 (34)		
3-vessel disease	35 (20)	14 (16)		
Treatment, n (%)			3.21†	0.07
PCI	160 (91)	74 (84)		

Medication	15 (9)	14 (16)		
LVEF (%)	52.0 ± 10.6	53.2 ± 13.5	0.08	0.20
Laboratory data				
Maximum CK-MB (IU/L)	168.1 ± 198.9	125.1 ± 164.3	0.11	0.07
Hemoglobin (g/dL)	13.0 ± 1.7	12.1 ± 1.8	0.29	<0.001
eGFR (mL/min/1.73 m^2)	55.9 ± 20.7	47.1 ± 19.3	0.23	<0.001
Albumin (g/dL)	3.6 ± 0.5	3.4 ± 0.4	3.12*	0.002
HbA1c (%)	6.6 ± 1.5	6.6 ± 1.2	0.04	0.47
Comorbidities, n (%)				
Atrial fibrillation	9 (5)	8 (9)	$1.51^{\dagger}$	0.22
Heart failure	10 (6)	10 (11)	$2.66^{\dagger}$	0.10
Pacemaker implantation	9 (5)	5 (6)	$0.03^{\dagger}$	0.85
Post-cardiopulmonary resuscitation	4 (2)	6 (7)	$3.29^{\dagger}$	0.07
Hypertension	85 (49)	53 (60)	$3.19^{\dagger}$	0.07
Dyslipidemia	86 (49)	34 (39)	$2.61^{\dagger}$	0.11
Diabetes	69 (39)	40 (45)	$0.88^{\dagger}$	0.35
Diabetes management			$1.53^{\dagger}$	0.46
Diet	10 (14)	9 (23)		

Oral hypoglycemic agent	44 (64)	25 (63)		
Insulin	15 (22)	6 (15)		
Diabetic neuropathy	32 (46)	25 (63)	2.64†	0.10
Chronic respiratory disease	2 (1)	5 (6)	4.66†	0.03
Orthopedics disease	25 (14)	16 (18)	0.68†	0.41
Medications, n (%)				
ACE inhibitor	82 (47)	37 (42)	0.55†	0.46
ARB	55 (31)	28 (32)	0.004†	0.95
β-blocker	146 (83)	66 (75)	2.66†	0.10
Nitrates	21 (12)	5 (6)	2.62†	0.11
Calcium antagonist	38 (22)	21 (24)	0.16†	0.69
Anticholinergics	0 (0)	0 (0)		
Benzodiazepines	8 (5)	10 (11)	4.24†	0.04
Analgesics	14 (8)	7 (8)	0.0002†	0.99
Educational background				
>13 years (%)	72 (41)	14 (16)	16.94†	<0.001
MoCA-J (points)	28.0 ± 1.3	21.5 ± 2.8	0.82	<0.001
Solitude (%)	37 (21)	16 (18)	0.32†	0.57

Handgrip strength (kg)	30.9 ± 8.9	23.3 ± 7.5	6.92*	<0.001
Pinch strength				
Lateral pinch strength (kgf)	8.5 ± 2.1	7.0 ± 2.0	5.84*	<0.001
Three-fingered pinch strength (kgf)	7.9 ± 1.9	6.2 ± 1.7	7.34*	<0.001
DASH (points)	9.9 ± 12.5	21.7 ± 16.8	0.41	<0.001

Date are presented as mean ± standard deviation or number (%).

ACE, angiotensin converting enzyme; ARB, angiotensin receptor blocker; BMI, body mass index; CK-MB, creatine kinase-myocardial band; DASH, Disability of the Arm, Shoulder and Hand; eGFR, estimated glomerular filtration rate; LVEF, left ventricular ejection fraction; MCI, mild cognitive impairment; MoCA-J, Japanese version of the Montreal Cognitive Assessment; PCI, percutaneous coronary intervention.

* t value, † χ^2 value.

Table 2

Univariate and multivariable logistic regression analysis for predicting MCI.

Variable	Univariate model		Multivariable model	
	OR (95% CI)	*p* value	OR (95% CI)	*p* value
Age	1.12 (1.09-1.16)	<0.001	1.10 (1.06-1.14)	<0.001
Male sex	0.49 (0.26-0.91)	0.02		
BMI	0.84 (0.77-0.92)	<0.001		
Diagnosis: AMI	0.52 (0.30-0.90)	0.02		
Hemoglobin	0.72 (0.61-0.84)	<0.001		
eGFR	0.98 (0.97-0.99)	0.001		
Albumin	0.40 (0.22-0.72)	0.003		
Chronic respiratory disease	5.21 (0.99-27.42)	0.05		
Benzodiazepines	2.68 (1.02-7.04)	0.046		
Handgrip strength	0.90 (0.87-0.93)	<0.001		
Three-fingered pinch strength	0.59 (0.50-0.70)	<0.001	0.69 (0.55-0.88)	0.002

DASH	1.06 (1.04-1.08)	<0.001	1.03 (1.00-1.05)	0.02

AMI, acute myocardial infarction; BMI, body mass index; CI, confidence interval; DASH, Disability of the Arm, Shoulder and Hand; eGFR, estimated glomerular filtration rate; MCI, mild cognitive impairment; OR, odds ratio.

Logistic regression analyses were conducted with MCI present/MCI absent as the dependent variable. Clinical characteristics, handgrip strength, pinch strength, and DASH were included as independent variables. The multivariable model was developed by forward stepwise variable selection.

Table 3

Multivariate regression analysis for predicting DASH score.

Variable	Model 1 ($R^2 = 0.33$, $p < 0.001$)		Model 2 ($R^2 = 0.31$, $p < 0.001$)	
	β	*p* value	β	*p* value
Age	0.0009	0.99	0.04	0.57
Male sex	0.06	0.41	−0.01	0.82
BMI	−0.05	0.41	−0.07	0.21
Diagnosis: AMI	0.04	0.43	0.05	0.43
Hemoglobin	−0.15	0.03	−0.17	0.02
eGFR	−0.11	0.08	−0.14	0.04
Albumin	0.04	0.48	0.02	0.72
Chronic respiratory disease	0.10	0.07	0.10	0.07
Benzodiazepines	0.07	0.16	0.07	0.17
Handgrip strength	−0.37	<0.001		
Three-fingered pinch strength			−0.25	<0.001
MoCA-J	−0.15	0.02	−0.14	0.03

AMI, acute myocardial infarction; BMI, body mass index; DASH, Disability of the Arm, Shoulder and Hand; eGFR, estimated glomerular filtration rate; MCI, mild cognitive impairment; MoCA-J, Japanese version of the Montreal Cognitive Assessment.

Multivariate regression analyses were conducted with DASH as the dependent variable. In model 1, clinical characteristics, handgrip strength, and MoCA-J were included as independent variables. In model 2, clinical characteristics, pinch strength, and MoCA-J were included as independent variables.