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Association of Age, Obesity, Joint Pain, and Chewing Ability with Chair Stand Difficulty among Community-dwelling Elderly People in Nagasaki, Japan

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Difficulty in standing up from a chair is associated with weakness of the muscles of the lower extremity and is an important factor that indicates frailty in elderly people. Little is known about the factors that influence this difficulty among the elderly. To elucidate these factors, we studied 323 community-dwelling people from Nagasaki Prefecture, Japan, who were aged 65 years and over. The body weight and height of the subjects were measured, and their body mass index (BMI) was calculated. Obesity was defined as BMI ≥ 25 (kg/m^2). The subjects were asked whether they experienced any difficulty in standing up from a chair (chair stand difficulty). Information on comorbidities, back pain, pain in any joint, and chewing ability was collected. The proportion of people who experienced chair stand difficulty increased with age ($p = 0.061$ for men and $p = 0.005$ for women). The results of multiple logistic regression analysis showed that older age (odds ratio (OR): 2.16; 95% confidence interval (CI): 1.22-3.71), obesity (OR: 3.00; 95% CI: 1.47-6.14), pain in any joint (OR: 2.73; 95% CI: 1.42-5.26), and poor chewing ability (OR: 2.65; 95% CI: 1.33-5.28) were significantly associated with chair stand difficulty. Intervention to reduce the risk of frailty among the elderly would be decided on the basis of physical factors such as obesity, musculoskeletal pain, and chewing ability.

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Introduction

The average life expectancy in Japan has dramatically increased as the mortality rate has decreased, resulting in an increase in the elderly population. In 2005, 20.1% of the population was aged 65 years or older, and this proportion has been projected to increase to over 25% of the population in 2015.[1] Therefore, the development of health and social care for the elderly is a public health concern.

The long-term care insurance law was enacted in 2000, and long-term care is now supported by the entire society. In 2006, the law was revised to extend to services that improve mobility function, nutrition, and oral function in the elderly, and these services are collectively referred to as disability prevention.[2] Disability prevention is defined as the prevention of the requirement of long-term care in the elderly and the prevention of further functional deterioration in elderly persons who require long-term care.[3]

The ability to stand up from a chair is associated with the muscle power of the lower extremity. The time required to stand up from a chair increases with increasing age.[4,5] Several studies have reported that poor lower extremity function, as assessed by the chair-stand test, was an important risk factor for falls in the elderly.[6,7] Thus, difficulty in standing up from a chair may be an important factor that indicates frailty in the elderly. Occlusion or chewing with rigid mandibular position is reported to be one of the enhancing factors of muscle strength.[8,9] However, little is known about the factors that influence this difficulty. We examined the prevalence of this difficulty in people of different ages and elucidated the factors associated with this difficulty in community-dwelling elderly men and women.

Subjects and Methods

The subjects were community-dwelling men and women of ages 65 years and over from Nagasaki Prefecture, Japan, who were in-

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vited to participate in periodic health examinations in 2007. A total of 372 subjects (142 men and 230 women) participated in the study.

The body weight (kg) and height (cm) of the subjects were measured when the subjects were wearing light clothing and no shoes. Body mass index (BMI) was calculated as the body weight (kg) divided by the square of the height (m). Obesity was defined as BMI ≥ 25 (kg/m^2). The subjects were asked whether they experienced any difficulty in standing up from a chair (chair stand difficulty). They were asked whether they could stand up from a chair without supporting themselves with their arms. If they responded as 'yes', we defined them as 'no difficulty'. If responded as 'no', we defined them as 'difficulty'. We collected information about any comorbidities, back pain, joint pain, and the ability to chew through face to face interviews conducted by trained nurses. Comorbidities included the following diseases: heart disease, stroke, hypertension, diabetes, thyroid disease, hyperuricemia, kidney disease, urinary tract disease, anemia, dyslipidemia, liver disease, and respiratory disease. The subjects were asked if they had been diagnosed with any of the abovementioned comorbidities and instructed to respond "yes" or "no." The specific diagnostic criteria for hypertension, diabetes, hyperuricemia, anemia, and dyslipidemia were determined in subjects who responded as "no." The diagnostic criteria were as follows: systolic blood pressure ≥ 140 mmHg or diastolic blood pressure ≥ 90 mmHg for hypertension, fasting blood sugar ≥ 126 mg/dl or random blood sugar ≥ 200 mg/dl plus HbA1c level ≥ 6.5% for diabetes, uric acid ≥ 7.0 mg/dl for hyperuricemia, hemoglobin < 12 g/dl (men) and < 10 g/dl (women) for anemia, and total cholesterol ≥ 220 mg/dl or high-density lipoprotein cholesterol < 40 mg/dl for dyslipidemia.

The subjects were asked about their chewing ability and were instructed to select 1 of the 3 following responses: "able to chew all foods," "able to chew soft foods only," and "unable to chew any food". In the present study, chewing ability was classified as good ("able to chew all foods") or poor ("able to chew soft foods only" and "unable to chew any food").

Written informed consent was obtained from all subjects prior to the study procedure. The study was approved by the ethics committee of Nagasaki University Graduate School of Biomedical Sciences (no. 07062201).

Statistical analysis

Subjects who gave incomplete responses to the questions were excluded from the study, and thus, a total of 323 subjects (116 men and 207 women) remained. Student's *t* test was used to compare continuous variables between subjects with and without chair stand difficulty. Fisher's exact test was used for categorical variables. The Cochran-Armitage test was used to test for a trend in the prevalence of chair stand difficulty according to age group. Multiple logistic regression analysis was used to assess the effects of each variable on the chair stand difficulty. The odds ratio (OR) and its 95% confidence interval (CI) were calculated. Statistical analysis was performed using SPSS software version 11.0 for Windows (SPSS Japan, Tokyo, Japan).

Results

The characteristics of the subjects are shown in Table 1. The mean ages of the men and women were 72.8 and 71.9 years, respectively. The mean numbers of comorbidities in the men and women were 1.6 and 1.4, respectively. Approximately one quarter of the total number of men and women were obese. The prevalence of joint pain was significantly higher in women than in men ($p < 0.001$). Approximately one-fifth of the total number of men and women showed poor chewing ability.

Table 1. Characteristics of the subjects (n = 323)

Variable	Men (n = 116)	Women (n = 207)
Mean (SD)		
Age (y)	72.8 (6.2)	71.9 (5.3)
Height (cm)	161.1 (5.3)	148.0 (5.6)
Weight (kg)	60.3 (10.1)	49.9 (7.9)
Body mass index (kg/m^2)	23.2 (3.2)	22.8 (3.2)
Number of comorbidities	1.6 (1.2)	1.4 (1.0)
Number (%)		
Obesity	28 (24.1)	50 (24.2)
Back pain	38 (32.8)	89 (43.0)
Pain in any joint	23 (19.8)	86 (41.5)
Poor chewing ability	20 (17.2)	40 (19.3)

The prevalence of chair stand difficulty categorized according to the age group is shown in Table 2. The proportion of people who experienced this difficulty increased with age ($p = 0.061$ for men and $p = 0.005$ for women). Only 11% of the women aged between 65 and 69 years experienced difficulty in standing up from a chair, whereas approximately 30% of the women aged 75 years and over experienced this difficulty.

Table 2. Prevalence of chair stand difficulty categorized according to the age group

Age group (y)	Men (n = 116) (%)	Women (n = 207) (%)
65-69	2/39 (5.1)	9/84 (10.7)
70-74	7/38 (18.4)	13/62 (21.0)
75-79	3/18 (16.7)	12/37 (32.4)
80+	5/21 (23.8)	7/24 (29.2)
Total	17/116 (14.7)	41/207 (19.8)
p value for trend	0.061	0.005

Table 3 shows the comparisons between subjects who experienced chair stand difficulty and those who did not. Men and women who experienced this difficulty were older than those who did not. Obesity was defined as BMI ≥ 25, and the proportion of

Table 3. Comparison between the subjects who experienced chair stand difficulty and those who did not

Variable	Men (n = 116)		p value	Women (n = 207)		p value
	Difficulty (n = 17)	No difficulty (n = 99)		Difficulty (n = 41)	No difficulty (n = 166)	
Mean (SD)						
Age (y)	75.4 (6.5)	72.3 (6.0)	0.054	73.8 (5.2)	71.4 (5.3)	0.010
Height (cm)	163.0 (6.1)	160.8 (5.1)	0.123	145.3 (5.8)	148.6 (5.4)	0.001
Weight (kg)	64.3 (13.1)	59.7 (9.3)	0.077	51.1 (9.2)	49.6 (7.5)	0.276
Number of comorbidities	1.5 (1.0)	1.7 (1.3)	0.698	1.4 (0.9)	1.4 (1.0)	0.753
Number (%)						
Obesity	8 (47.1)	20 (20.2)	0.029	13 (31.7)	37 (22.3)	0.207
Back pain	7 (41.2)	31 (31.3)	0.423	26 (63.4)	63 (38.0)	0.003
Pain in any joint	5 (29.4)	18 (18.2)	0.325	29 (70.7)	57 (34.3)	<0.001
Poor chewing ability	7 (41.2)	13 (13.1)	0.010	14 (34.1)	26 (15.7)	0.007

Obesity: body mass index (BMI) ≥ 25 (kg/m^2)

obesity among the men who experienced difficulty was significantly higher than that in those who did not experience difficulty ($p = 0.029$). No significant difference was noted in the proportion of obesity among the women who experienced this difficulty and those who did not. The number of comorbidities did not differ between the subjects who experienced difficulty and those who did not, regardless of their gender. The proportion of back pain ($p = 0.003$) and any joint pain ($p < 0.001$) was significantly higher in the women who experienced the difficulty than in those who did not; however, such differences were not observed in the men. In both men and women, the proportion of poor chewing ability was significantly higher in the subjects who experienced the difficulty than in those who did not.

Table 4 shows the OR and 95% CI for chair stand difficulty, as assessed using multiple logistic regression analysis. Older age, obesity, pain in any joint, and poor chewing ability were significantly associated with chair stand difficulty. Back pain was marginally associated with this difficulty, while neither gender nor the number of comorbidities was significantly associated with the difficulty.

Table 4. Odds ratio (OR) and 95% confidence interval (CI) for chair stand difficulty, as assessed using multiple logistic regression analysis

Variable	Unit	OR	95% CI	p value
Age (y)	+10	2.16	1.22-3.71	<0.001
Gender	women/men	1.08	0.54-2.17	0.827
Obesity	yes/no	3.00	1.47-6.14	0.003
Number of comorbidities	+1	0.82	0.59-1.13	0.214
Back pain	yes/no	1.75	0.92-3.31	0.089
Pain in any joint	yes/no	2.73	1.42-5.26	0.003
Chewing ability	poor/good	2.65	1.33-5.28	0.006

Obesity: body mass index (BMI) ≥ 25 (kg/m^2)

Discussion

The chair-stand test is an important physical performance measure.[10] Recent studies have shown that elderly people with poor physical performance suffer from musculoskeletal pain,[11] exhibit difficulty in performing the activities of daily living,[12] and have chronic medical conditions.[4] These findings indicate that physical performance measures, including the chair-stand test, capture information regarding several physical factors.

Our results showed that older age was significantly associated with chair stand difficulty. Several studies have shown that the ability to stand up from a chair deteriorates with age.[13-15] Forrest et al.[14] reported that the decline in performance during the follow-up period was greater for patients who were older at the time of the baseline evaluation: 16% more time was required for women aged between 65 and 69 years to stand up from a chair 5 times, while 38% more time was required for women aged 80 years or older. The strength of the lower extremity muscles decreases with age in most people,[16] and this contributes to the chair stand difficulty in people.

Our study revealed that obesity was significantly associated with chair stand difficulty. Sibella et al.[17] reported the differences in motion strategy between normal and obese subjects for performing the sit-to-stand movement; obese subjects rose from the chair by limiting trunk flexion and moving their feet backwards from the initial position, unlike the normal subjects. It has been reported that high BMI is significantly associated with decreased performance in the timed chair-stand test;[13] this result is consistent with our findings.

Our results showed that joint pain and back pain were associated with chair stand difficulty. Onder et al.[18] reported that daily pain is associated with impaired physical performance and muscle strength. Reid et al.[19] reported that restricting back pain was independently associated with the worsening of the physical function of the lower extremity (reflected by the chair stand performance) among community-dwelling elderly persons. Pain may affect physical function by reducing the range of joint movement or by inducing reflex

inhibition of the skeletal muscles, resulting in muscle weakness and impaired strength and physical performance.[20] Alternatively, pain may limit physical activity and thus gradually reduce physical function.[18] Furthermore, the risk of poor self-rated health increased with the increase in the number of painful joints in the lower extremities and with the existence of back pain.[21]

Several studies[20-22] have shown that poor chewing ability or poor occlusion is associated with physical fitness in elderly people. Impaired dental occlusion is associated with the dynamic strength of the lower extremity muscles.[22] Takata et al.[23] reported the relationship between perceived chewing ability (number of foods considered chewable) and physical fitness (leg extensor strength or one-leg standing time). Self-assessed chewing ability was a significant factor related to physical performance.[24] The present study also showed that poor chewing ability was significantly associated with chair stand difficulty.

This study has several limitations. First, because the study was cross-sectional in nature, it was difficult to prove causal relationships between chair stand difficulty and the related factors. A longitudinal study is required to determine the causality. Second, since we neither conducted a dental examination nor collected information on whether the subjects wore dentures, we could not assess the relationship between the chewing ability and the actual dental condition of the subjects. Nevertheless, our results would be indicative for developing programs on improvement of mobility and oral function.

Our results indicate that older age, obesity, musculoskeletal pain, and poor chewing ability are associated with chair stand difficulty observed in the elderly population. Poor strength of the muscles of the lower extremity may indicate dependence on others for the performance of the activities of daily living, and the maintenance of muscle strength may reduce the risk of dependence.[25] Furthermore, maintaining or improving lower extremity functions such as ability to stand up from a chair may be useful to prevent frailty. Intervention to reduce the risk of frailty among the elderly would be decided on the basis of physical factors such as obesity, musculoskeletal pain, and chewing ability.

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