Table 4. Correlations between changes in basic activity of daily living (ADL) score during 2-year study period and anthropometric measurements during 2-year study period

Changes in levels during 2-year period	Change of ADL score during 2-year follow-up: All participants (n 543)	Excluded basic ADL score of 0 at baseline (n 468)	Basic ADL score of 12 or higher† at baseline (n 291)
BMI (kg/m²)			
Crude	0·123*	0·117	0·134
Adjusted‡	0·149*	0·137*	0·191**
Mid-arm circumference (cm)			
Crude	0·157**	0·169**	0·099
Adjusted‡	0·152**	0·158**	0·169**

Mean values were significantly different: * $P<0·05$, ** $P<0·01$.
† The 50th percentile of basic ADL scores at baseline was 12 in the present study.
‡ Adjusted for age and sex.

measurements and ADL function decline nor between basal poor ADL performance and a decrease in anthropometric parameters.

Previous prospective cohort studies emphasised that weight loss is a risk factor for the functional decline[8–12]. However, no studies allow the evaluation of causal relationships between weight loss and the functional decline. In the present study, we showed that physical functional change was well correlated with change in anthropometric parameters. In addition, logistic regression models demonstrated that the decline in anthropometric parameters was a predictor of the decline in ADL performance, and that, conversely, the decline in ADL performance was also a predictor of anthropometrics decline. These results may indicate that these factors, anthropometric parameters and ADL status, influence each other and decline simultaneously. BMI and AC are parameters of nutritional status in older adults[26,27]. Therefore, the results may indicate that nutritional status and ADL performance were well correlated and changed simultaneously through causal and consequential relationships. Theoretically, inadequate intake of nutrients, one of the manifestations of undernutrition, which can lead to loss of muscle protein as well as body mass, may explain the association between weight loss and decline in physical function. In contrast, physical functional decline may be a cause of weight loss through difficulties in eating, provisioning and cooking, which can be reflected by a decline in the food-related items of the ADL.

It is possible that there are third factors that might produce the association between the loss of anthropometric parameters and the decline in ADL performance during the follow-up period. The occurrence of new diseases or poor control of chronic disease during the follow-up period might be a candidate for the third factor. However, the association persisted even after adjusting for hospitalisation for acute illness during the study period, which suggests that poor health outcomes leading to hospitalisation did not contribute to these relationships.

The present study has several limitations. The results of the present study cannot be transferred to non-frail-independent

Table 5. Logistic regression analysis to identify independent predictors of declining basic activity of daily living (ADL) score, declining BMI and arm circumference
(OR values with 95% CI)

	Unadjusted			Multivariate: Model 1			Model 2		
	OR	95% CI	P	OR	95% CI	P	OR	95% CI	P
Basic ADL decline v. improve/stable*									
Change in BMI levels during 2-year period									
Increase or stable	1·00	Reference		1·00	Reference		1·00	Reference	
Decline (< 1·0 kg/m²)	1·09	0·50, 2·39	0·833	0·90	0·31, 2·09	0·810	0·89	0·30, 2·58	0·822
Decline (≥ 1·0 kg/m²)	3·86	1·96, 7·59	< 0·001	3·64	1·73, 7·65	0·001	4·69	1·89, 11·67	0·001
Change in AC levels during 2-year period									
Increase or stable	1·00	Reference		1·00	Reference		1·00	Reference	
Decline (≤ 0·5 cm)	1·55	0·66, 3·65	0·319	1·52	0·60, 3·83	0·373	1·00	0·31, 3·25	0·998
Decline (0·6–1·5 cm)	1·77	0·91, 3·45	0·092	2·54	1·20, 5·38	0·015	2·80	1·02, 7·69	0·045
Decline (≥ 1·6 cm)	2·75	1·63, 4·64	< 0·001	3·45	1·88, 6·35	< 0·001	3·18	1·40, 7·20	0·006
Loss of BMI levels v. increase/stable†									
Change in basic ADL score during 2-year period									
Improved or stable	1·00	Reference		1·00	Reference		1·00	Reference	
Decline (1 point)	1·95	0·87, 4·42	0·107	1·94	0·77, 4·84	0·158	2·67	0·93, 7·70	0·069
Decline (≥ 2 points)	2·33	1·20, 4·55	0·013	3·28	1·50, 7·17	0·003	3·28	1·32, 8·16	0·011
Loss of AC levels v. increase/stable‡									
Change in basic ADL score during 2-year period									
Improved or stable	1·00	Reference		1·00	Reference		1·00	Reference	
Decline (1 point)	1·40	0·74, 2·66	0·307	1·17	0·55, 2·49	0·678	1·01	0·40, 2·58	0·981
Decline (> 2 points)	2·90	1·72, 4·89	< 0·001	3·62	1·95, 6·73	< 0·001	2·94	1·35, 6·38	0·007

The 50th percentile of basic ADL scores at baseline was 12 in the present study.
* Multivariate analysis includes sex, age, presence or absence of hypertension and neurodegenerative disease, hospitalisation and fall experience during the 2-year period and the score of basic ADL at baseline. BMI: n 135. mid-arm circumference (AC): n 416. Model 2 participants that had a basic ADL score of 12 or higher at baseline. BMI: n 182. AC: n 245.
† Multivariate analysis includes sex, age, living alone, regular medical checkups, cerebrovascular disease, hospitalisation during the 2-year period and the score of BMI at baseline. Participants had a basic ADL score of 2 or higher at baseline (n 225). Model 2 participants that had a basic ADL score of 12 or higher at baseline. n 172.
‡ Multivariate analysis includes sex, age, living alone, regular medical checkups, cerebrovascular disease, hospitalisation during the 2-year period and the score of AC at baseline. Participants had a basic ADL score of 2 or higher at baseline. n 342. Model 2 participants that had a basic ADL score of 12 or higher at baseline (n 228).

older individuals, since there are many differences between the participants in Nagoya Longitudinal Study for Frail Elderly and standard non-frail older people, including differences in ADL levels and comorbidity. There was a possibility that the presence of lower BMI levels and fewer obese individuals in our cohort may have affected the present results. In addition, these findings may not be generalisable to other populations, given that they may have been influenced by cultural differences, health practices and a variety of social and economic factors. The mechanisms underlying the association between the decline in BMI/AC levels and declining ADL score during the 2-year follow-up period are unclear in the present study. Future study is needed to examine whether the ADL scores and anthropometric measurements of these frail elderly with functional limitations in the community decrease concurrently.

The present study showed that anthropometric measurements at baseline were not a predictor of physical function decline during a 2-year follow-up in community-dwelling elderly. An association was found between negative changes in anthropometric measurements during the follow-up period and the decline in ADL function.

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FACTORS ASSOCIATED WITH NONADHERENCE TO MEDICATION IN COMMUNITY-DWELLING DISABLED OLDER ADULTS IN JAPAN

To the Editor: Nonadherence to drug therapy is a serious problem for older people, because adherence to medication is essential for obtaining the optimal therapeutic effects of medication.[1–4] Although numerous studies have identified the factors related to nonadherence to drug therapy, only limited studies have taken a wider perspective, focusing on adherence in older community-dwelling disabled adults and on factors affecting adherence.[5,6] The aim of this study was to identify the factors associated with nonadherence to drug therapy in older community-dwelling disabled adults.

The present study used baseline data on participants in the Nagoya Longitudinal Study for Frail Elderly.[4,7,8] The study population consisted of 1,722 older community-dwelling disabled adults (611 men, 1,161 women; mean age 80.3 ± 7.6, range 65–104) and 1,502 caregivers (375 men, 1127 women; mean age 64.1 ± 12.6, range 31–93). The baseline data included the recipients' demographic characteristics, activities of daily living (ADLs), depressive symptoms as assessed using the short version of the Geriatric Depression Scale (GDS-15), physician-diagnosed chronic conditions, living arrangement, number of prescribed medications, and self-reported difficulty with self-medication management, which was assessed as previously described.[4] The participants or family were also asked whether they were receiving any assistance for taking medication or medication management from others. The participants were divided into two groups: no difficulty with self-medication management, and difficulty with self-medication management. Data were also obtained from caregivers concerning their own personal demographic characteristics, their subjective health status, and burden as assessed according to the Zarit Burden Interview. The adherence rate to the prescribed medication was defined as the total number of pills taken divided by the total number of prescribed pills as assessed by the self-reported average medication adherence during 1 month. It was decided to use self-reporting rather than other forms of adherence measurements because they are prohibitively expensive and cumbersome, and there is little evidence that they are superior to self-report instruments.[1,9] Nonadherence was defined as less than 80% of the adherence rate. Univariate and multivariate logistic regression were used to determine which characteristics of the disabled older adult or caregiver predicted nonadherence to prescribed medication.

Of 1,772 participants, 223 (12.6%) were categorized as nonadherent. Univariate logistic analysis demonstrated that participants living alone (vs living with someone, odds ratio (OR) = 1.43, 95% confidence interval (CI) = 1.04–1.96), with depression (GDS-15 $\geq$ 11 vs $<$5, OR = 1.61, 95% CI = 1.03–2.53), and with dementia (vs its absence, OR = 1.47, 95% CI = 1.10–1.96) and participants who had difficulty with self-medication management (vs no difficulty with self-medication, OR = 1.69, 95% CI = 1.24–2.30) were more likely to be nonadherent. Multivariate analysis (Table 1, Model 1) showed that medication nonadherence was associated with participants living alone, having depression, and having difficulty with self-medication. When participants who had difficulty with self-medication were divided as to the absence or presence of assistance (Model 2), nonadherence was associated with participants living alone, participants with depression, the presence of dementia, participants who had difficulty with self-medication but had no assistance, and participants with assistance. For participants who had difficulty with self-medication and had assistance, none of the variables of care recipients were associated with nonadherence in univariate analysis. Multivariate analysis revealed that a male caregiver and poor subjective health status of the caregiver were likely to result in nonadherence in participants having assistance.

In the present study, it was observed that participants who had difficulty with self-medication management had a high risk of nonadherence to medication. In particular, participants needing support but who did not have any, had a OR of nonadherence 3.2 times as high as those who had no difficulty with self-medication management, suggesting that medication management assessment is needed to determine which older people are at risk of medication management problems and to minimize adverse events attributable to poor medication adherence. Participants receiving medication management assistance had an OR of medication nonadherence 1.64 times as high as participants who had no difficulty with self-medication management. These results may imply that families or relatives living with disabled older patients may not always give appropriate assistance for medication management. A male caregiver and subjective poor health status of the caregiver were associated with recipient nonadherence to prescribed medication, suggesting that caregivers with those characteristics may tend to provide inadequate levels of assistance for medication or that neglectful behavior by caregivers may be involved in this association.

In conclusion, the results suggest that, in older community-dwelling disabled adults, the lack of medication assistance for those needing medication support was associated with a higher risk of nonadherence, although even those receiving assistance had a higher risk of nonadherence than those with no difficulty with self-medication management.

Masafumi Kuzuya, MD, PhD
Hiromi Enoki, PhD
Sachiko Izawa, PhD
Jun Hasegawa, MD
Department of Geriatrics
Nagoya University Graduate School of Medicine
Nagoya, Japan

Table 1. Logistic Regression Analysis for Nonadherence

	Odds Ratio (95% Confidence Interval)		
	Multivariate*		
Characteristic	Model 1†	Model 2‡	Multivariate for Those Having Assistance§
Care recipient characteristics			
Men (vs women)	0.86 (0.61–1.23)	0.89 (0.62–1.28)	—
Age (continuous variable)	0.99 (0.97–1.02)	0.99 (0.97–1.02)	—
Living alone (vs living with someone)	2.00 (1.35–2.95)	1.94 (1.31–2.86)	1.38 (0.59–3.25)
GDS-15 (range 0–15) (vs score 0–5)			
6–10	1.22 (0.85–1.77)	1.25 (0.86–1.81)	—
≥11	1.61 (1.02–2.53)	1.68 (1.06–2.66)	—
Presence of dementia (vs absence)	1.34 (0.91–1.97)	1.56 (1.04–2.36)	—
Medication management (vs self medication)			
Difficulty with self-medication	2.04 (1.37–3.05)	—	—
Absence of assistance	—	3.20 (1.92–5.34)	—
Presence of assistance	—	1.64 (1.05–2.54)	—
Caregiver characteristics			
Men (vs women)	—	—	1.90 (1.18–3.06)
Age (continuous variable)	—	—	1.00 (0.98–1.02)
Subjective health status (vs good to excellent)			
Fair	—	—	0.90 (0.54–1.49)
Poor	—	—	2.09 (1.11–3.94)

*The covariates included in the multivariate analysis were variables associated with nonadherence with $P<.05$ in univariate analysis. Activity of daily living score, presence of comorbid diseases (ischemic heart disease, congestive heart failure, cerebrovascular disease, diabetes mellitus, cancer, or hypertension), number of medication, and regular medical examination were not associated with nonadherence in univariate analysis. All analyses were performed using SPSS version 17.0 (SPSS, Inc., Chicago, IL).

†Model 1 includes sex, age, living alone (vs living with someone), 15-item Geriatric Depression Scale (GDS-15) categories, presence of dementia (vs absence), and difficulty with self-medication (vs no difficulty).

‡Model 2 includes sex, age, living alone (vs living with someone), GDS-15 categories, presence of dementia (vs absence), and absence or presence of medication assistance (vs no difficulty).

§Logistic regression analysis was conducted to identify the predictor of the risk of nonadherence in 929 participants who had difficulty with self-medication and had assistance. The covariates included in the multivariate analysis were variables associated with nonadherence with $P<.05$ in univariate analysis. None of the variables of care recipients, including sex, age, comorbidity, depressive status, and number of prescribed medications, were associated with nonadherence in univariate analysis. The relationship to care recipient (spouse vs nonspouse) and the Zarit Burden Interview score were not associated with nonadherence in univariate analysis.

Yusuke Suzuki, MD, PhD
Nagoya University Hospital Department of Outpatient and Home Medicine
Showa-ku, Nagoya, Japan

Akihisa Iguchi, MD, PhD
Department of Community Care Philanthropy
Faculty of Medical Welfare Aichi Shukutoku University
Nagoya, Japan

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Author Contributions: Masafumi Kuzuya: study concept, design, conduct of study, interpretation of data, study supervision, and preparation of manuscript. Hiromi Enok: and Sachiko Izawa: analysis and interpretation of data. Jun Hasegawa and Yusuke Suzuki: conduct of study and interpretation of data. Akihisa Iguchi: study supervision.

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