techniques (e.g. modification of food forms), might maintain the skeletal muscle mass, physical function and quality of life of patients with AD. However, this has not yet been investigated. To verify our hypothesis, we investigated 284 patients with very mild to severe AD.

Methods

Participants

The present study evaluated 284 older patients diagnosed with AD by neurologists. They had been certified as requiring long-term care, and were living in Omori town, Yokote city, Akita prefecture and Yokohama city, Kanagawa prefecture, Japan. Table 1 shows patient characteristics and facilities that collected the data. All tests were carried out at each facility or at the participants' home.

We excluded patients who could not follow our instructions because of severe aphasia or could not open their mouth because of factors, such as of temporomandibular joint problems. Furthermore, the patients with cerebrovascular or Parkinson's disease were excluded for differentiating between AD and other dementia, such as vascular dementia and dementia with Lewy bodies. Additionally, we excluded patients with cardiac pacemakers and who could not remain in either a sitting or supine position for a 5-min period. After excluding 52 participants with incomplete data or who could not complete our tests, we analyzed data from 232 participants (31 men, 201 women, average age 85.4±5.9 years) for whom data regarding basic information, dementia severity, skeletal muscle index (SMI), physical function assessment, nutrition status, oral status and function, and swallowing test results were available.

Dementia diagnosis was carried out in accordance with the Diagnostic and Statistical Manual of Mental Disorders, Third Edition, Text Revision.[9] Additionally, AD was diagnosed in accordance with the criteria issued by the National Institute of Neurological and Communicative Disorders and Stroke and the Alzheimer's Disease and Related Disorders Association,[10] and diagnostically classified as the group having a Hachinski Ischemic Score[11] of 4 or less. Mixed dementia and other patients with dementia were excluded as participants of the present study.

Ethical considerations

Informed consent was obtained from each participant, or from their guardian or family before participation in this study. Each participant or their agent was fully informed regarding the purpose, nature and potential risks of the experiments; they were also informed that their participation was voluntary, and that they would not be placed at any disadvantage if they refused to participate in the study or withdrew before its completion. The participants' names and dates were recorded as numbers to prevent the identification of any individual. The study design was

Table 1 Patient characteristics and facilities that collected the data

	Age (years)	*P*-value	Total		Hospitals' disability or nursing care wards		Healthcare facilities for elderly		Special nursing home for the aged		Day service institutions or patients' home		Group homes for elderly patients with dementia	
Men	84.7±5.6	0.514	31	100.0%	5	16.1%	3	9.7%	4	12.9%	5	16.1%	14	45.2%
Women	85.5±6.0		201	100.0%	7	3.5%	15	7.5%	36	17.9%	14	7.0%	129	64.2%
Total	85.4±5.9		232	100.0%	12	5.2%	18	7.8%	40	17.2%	19	8.2%	143	61.6%

approved by the ethics committee of the Tokyo Metropolitan Institute of Gerontology (Issue #38 in 2009) and by the ethics committee of the Showa University School of Dentistry (Issue #2014-010 in 2014). All tests were carried out in accordance with the tenets of the Declaration of Helsinki, as revised in 2008.

Study design

The present study was carried out from September 2013 to February 2014. Oral status and function tests were carried out by dental specialists who had more than 10 h of training for the study and who had experience in more than 10 cases; the evaluation criteria were calibrated to account for interinvestigator differences. Furthermore, the nursing staff providing daily support to the participants also supplied data regarding the participants' basic information, dementia severity, assessments of activities of daily living and nutritional status.

Basic information

Data regarding the participant's age and sex were obtained from the nursing staff.

Dementia severity

Dementia severity was classified by the clinical dementia rating (CDR) as very mild (CDR0.5), mild (CDR1), moderate (CDR2) or severe (CDR3).[12] For multivariate analysis, we classified the patients into a very mild–moderate group and a severe group using the methods described by Sato *et al.*[8]

SMI

The participants' body compositions were measured using the InBody S10 system (Biospace, Seoul, Korea) using the bioelectrical impedance analysis method over a 5-min period.[13] For this test, the participants remained in either a sitting or supine position (body position does not affect body composition measurements). The InBody S10 system uses direct segmental multifrequency technology, and its strong correlation with muscle volume and fat mass has been validated, as measured by dual energy X-ray absorptiometry. The extremity muscle mass (kg) was determined from the sum of the upper and lower extremities. We then divided the measured extremity muscle mass by the squared height (m conversion) of the patient, and the adjusted extremity muscle mass was used as SMI.

We did not test the SMI of participants unable to maintain their posture over a 5-min period or those with cardiac pacemakers. The participants were categorized as having either normal or decreased muscle mass, and the sex-specific lowest quintile was used as the cut-off value (men 5.3 kg/m^2, women 3.9 kg/m^2) for multivariate analysis, as described in previous studies.[14]

Physical function assessment

The participants' ability to carry out activities of daily living was measured using the Barthel Index (BI), with scores ranging from 0 to 100 points.[15]

Nutrition status

Body mass index: We divided the bodyweight (kg) by the squared height (m conversion) for body mass index (BMI). For multivariate analysis, BMI values were classified into two groups using the cut-off value (18.5 kg/m^2) as described by Woo *et al.*[16]

Mini Nutritional Assessment Short-Form: The Mini Nutritional Assessment Short-Form (MNA-SF) was classified into two groups using the cut-off value (score 8) as described by Kikutani *et al.*[17]

Calf circumference: To measure calf circumference (CC), the dominant foot was measured. We made participants sit with a knee angle of 90° and the sole on the ground. The thickest part of the calf was measured with a measuring tape. CC was approximated for participants unable to remain in a sitting posture. CC values were classified into two groups using the cut-off value (30.5 cm) as described by Bonnefoy *et al.*[18]

Oral status and function: Occlusal contacts and tongue function were investigated, because they play important roles in mastication and swallowing.

Occlusal contacts

We evaluated molar occlusion status using the methods described by Kikutani *et al.*[17] The occlusal support region from the first premolar tooth to second molar tooth was defined as the posterior molar occlusion, and a two-level assessment was made. Participants whose molar occlusion was only established with their remaining teeth and/or dentures were evaluated as the "present" group, and participants without dentures and not having molar occlusion were evaluated as the "absent" group.

Tongue function

Participants were asked to stick out their tongues and to move their tongues from side to side (i.e. left to right), using previously described criteria.[8] Participants unable to obey these instructions were examined by an investigator who stuck out their tongue and asked the participants to imitate. If a participant's proglossis could extend past the dental arch, their tongue function was defined as "good." All other participants were defined as having a "poor" tongue function.

Swallowing function

We evaluated swallowing function using a modified water swallowing test (MWST), as previously described.[19] In brief, 3 mL of cold water was poured onto the floor of the participant's mouth using a 5 mL syringe, the participant

was instructed to swallow and their swallowing function was scored. Also, MWST required a combination of cervical auscultation to confirm the swallowing and breathing sounds before and after drinking the water.[20,21] If the score was ≥4, the test was repeated twice; the lowest score was used as the test result. The presence of cough and wet hoarseness after swallowing was classified as a MWST score of "good (i.e. ≤4 or more)" or "poor (i.e. >4)." We did not test the swallowing function of participants at a risk of severe dementia or whose general status was unknown.

Statistical analysis

Continuous variables were analyzed using the Student's *t*-test or Mann–Whitney *U*-test, and categorical variables were analyzed using the χ^2-test. To identify factors related to the maintenance or reduction of SMI, the factors that were significant in univariate analysis ($P < 0.25$) were selected as independent variables for the stepwise logistic regression analyses; these were carried out with the "upper" or "lower" SMI as dependent variables. Before multiple logistic regression analysis, the dependent variables for which the correlation coefficient of was >0.8 were deleted to avoid multicollinearity. SPSS Statistics (version 22; IBM Japan, Tokyo, Japan) was used for all analyses; the significance level was set at $P < 0.05$.

Results

The CDR stratification of the patients was organized as follows: very mild, 21 patients (9.0%); mild, 85 patients (36.6%); moderate, 88 patients (37.9%); and severe, 38 patients (16.3%).

Univariate analysis based on AD severity

Univariate analysis results based on CDR are shown in Tables 2 and 3. For continuous values, a significant decrease with increasing severity was observed in SMI ($P < 0.001$), BI ($P < 0.001$), BMI ($P = 0.001$), CC ($P < 0.001$) and MNA-SF ($P < 0.001$; Table 2). For categorical variables, a significant degradation with increasing severity was observed in occlusal contact ($P < 0.001$), tongue function ($P < 0.001$) and swallowing function ($P < 0.001$; Table 3).

Univariate analysis based on SMI

Univariate analysis results based on SMI are shown in Table 4. A significant difference was observed in CDR ($P < 0.001$), BI ($P < 0.001$), BMI ($P < 0.001$), CC ($P < 0.001$), MNA-SF ($P < 0.001$), occlusal contact ($P < 0.001$), tongue function ($P < 0.001$) and swallowing function ($P < 0.001$; Table 4).

Examination of the relationship between various items and lower SMI by stepwise multivariate logistic regression analysis

Results of the stepwise multiple logistic regression analysis are shown in Table 5. In these results, the CDR "severe" group (odds ratio [OR] 11.68 95% confidence interval [CI] 4.52–30.20), BMI <18.5 kg/m^2 (OR 3.18, 95% CI 1.27–8.00), CC <30.5 cm (OR 9.33, 95% CI 2.01–43.27) and poor swallowing function (OR 4.93, 95% CI 1.10–22.04) were cited as significant related factors (Table 5).

Discussion

This was the first study to investigate the relationship between muscle mass and oral or swallowing function in patients with AD, including known factors regarding decreased muscle mass. Our hypothesis was that decreased skeletal muscle mass might be related to AD progression and decreased oral or swallowing function. In the present results, dementia severity and swallowing function were related to decreased SMI in patients with AD.

Because CDR can be used to evaluate dementia severity, we were able to present changes in SMI and in oral and swallowing functions with varying severity. We believe that these CDR results are easy to understand for medical professionals and nursing staff, and will help in explaining the changes in AD progression.

InBody S10 evaluates SMI by the bioelectrical impedance analysis method, enables evaluation of participants in supine position at the bedside and allows evaluation of bedridden patients with severe AD. SMI data for patients with severe AD were lacking in previous studies. Therefore, the present results provide valuable knowledge.

The lower quintile value was used as the cut-off value for SMI according to the method of Newmann *et al.*[14] Initially, sarcopenia criteria (men 7.0 kg/m^2, women 5.7 kg/m^2) by the Asian Working Group for Sarcopenia was applied. However, the lower SMI group contained 183 participants (78.9%); there were no significant results on univariate analysis. Because the Asian Working Group for Sarcopenia criteria were considered inappropriate for these participants, specific criteria were developed in the present study. Furthermore, the lower quintile value was a method recommended as the cut-off value in the Asian Working Group for Sarcopenia consensus paper.[3] With these criteria, the lower SMI group contained 43 participants (18.5%); significant results were obtained with univariate analysis. Therefore, we used this method for the cut-off value determination.

The combination of MWST and cervical auscultation was an adaptable swallowing function evaluation method for patients with AD. MWST has 70% sensitivity and 88% specificity, and is considered safe because of the

Table 2 Univariable analysis of continuous variables based on clinical dementia rating

	Very mild ($n=21$)	Mild ($n=85$)	Moderate ($n=88$)	Severe ($n=38$)	ANOVA	Bonferroni test	*P*-value
					P-value		
Age (years)	83.8 ± 7.0	84.8 ± 5.4	85.9 ± 6.5	86.2 ± 4.7	0.281		
SMI	5.5 ± 1.0	5.2 ± 1.0	5.2 ± 1.0	3.9 ± 1.3	$P<0.001$	Very mild > severe	$P<0.001$
						Mild > severe	$P<0.001$
						Moderate > severe	$P<0.001$
Barthel Index	88.3 ± 11.1	74.2 ± 21.4	56.1 ± 28.7	11.7 ± 18.1	$P<0.001$	Very mild > moderate	$P<0.001$
						Very mild > severe	
						Mild > moderate	$P<0.001$
						Mild > severe	$P<0.001$
						Moderate > severe	$P<0.001$
BMI	22.5 ± 4.4	22.0 ± 3.9	22.2 ± 3.8	19.2 ± 4.0	0.001	Mild > severe	0.011
						Moderate > severe	0.005
Calf circumference	31.7 ± 2.3	30.4 ± 3.3	30.1 ± 3.6	25.6 ± 4.2	$P<0.001$	Very mild > severe	$P<0.001$
						Mild > severe	$P<0.001$
						Moderate > severe	$P<0.001$
MNA-SF	11.7 ± 1.6	10.5 ± 2.1	10.0 ± 2.0	7.1 ± 2.4	$P<0.001$	Very mild > moderate	0.060
						Very mild > severe	$P<0.001$
						Mild > severe	$P<0.001$
						Moderate > severe	$P<0.001$

Data presented as mean ± SD. Differences as a result of severity were tested by one-way ANOVA with Bonferroni post-hoc test. BMI, body mass index; MNA-SF, Mini-Nutrition Assessment Short-Form; SMI, skeletal muscle index.

Table 3 Univariable analysis of categorical variables based on clinical dementia rating

		Very mild ($n=21$)		Mild ($n=85$)		Moderate ($n=88$)		Severe ($n=38$)		χ^2-test
		n	(%)	*n*	(%)	*n*	(%)	*n*	(%)	*P*-value
Sex	Male	2	9.5%	10	11.8%	15	17.0%	4	10.5%	0.626
	Female	19	90.5%	75	88.2%	73	83.0%	34	89.5%	
Occlusal contacts	Present	20	95.2%	70	82.4%	72	81.8%	17	44.7%	$P<0.001$
	Absent	1	4.8%	15	17.6%	16	18.2%	21	55.3%	
Tongue function	Good	21	100.0%	82	96.5%	80	90.9%	22	57.9%	$P<0.001$
	Poor	0	0.0%	3	3.5%	8	9.1%	16	42.1%	
Swallowing function	Good	20	95.2%	82	96.5%	85	96.6%	28	73.7%	$P<0.001$
	Poor	1	4.8%	3	3.5%	3	3.4%	10	26.3%	

Number and frequency of each item by the severity of Alzheimer's disease, and results of the χ^2-test. The presence of choke and wet hoarseness after swallowing was classified as a modified water swallowing test score of "good" (i.e. score 4 or more) or "poor" (i.e. less than score 4).

Table 4 Univariate analysis based on skeletal muscle index

		Upper SMI group ($n=189$)			Lower SMI group ($n=43$)			*P*-value	
		Mean ± SD	*n*	(%)	Mean ± SD	*n*	(%)		
Age		85.0 ± 5.9	—	—	86.9 ± 5.7	—	—	0.062	t
Sex	Male	—	26	13.8%	—	5	11.6%	0.711	χ^2
	Female	—	163	86.2%	—	38	88.4%		
CDR	Very mild	—	20	10.6%	—	1	2.3%	$P<0.001$	χ^2
	Mild	—	76	40.2%	—	9	20.9%		
	Moderate	—	80	42.3%	—	8	18.6%		
	Severe	—	13	6.9%	—	25	58.1%		
Barthel index		65.2 ± 28.6	—	—	28.5 ± 33.4	—	—	$P<0.001$	u
BMI		22.4 ± 3.8	—	—	18.5 ± 3.7	—	—	$P<0.001$	t
Calf circumference		30.7 ± 3.2	—	—	25.0 ± 3.6	—	—	$P<0.001$	t
MNA-SF		10.4 ± 2.1	—	—	7.8 ± 2.8	—	—	$P<0.001$	u
Occlusal contacts	Present	—	156	82.5%	—	23	53.5%	$P<0.001$	χ^2
	Absent	—	33	17.5%	—	20	46.5%		
Tongue function	Good	—	175	92.6%	—	30	69.8%	$P<0.001$	χ^2
	Poor	—	14	7.4%	—	13	30.2%		
Swallowing function	Good	—	184	97.4%	—	31	72.1%	$P<0.001$	χ^2
	Poor	—	5	2.6%	—	12	27.9%		

Differences as a result of skeletal muscle index (SMI) were tested by Student's *t*-test, Mann–Whitney *U*-test, χ^2-test. The presence of choking and wet hoarseness after swallowing was classified as a modified water swallowing test score of "good" (i.e. score 4 or more) or "poor" (i.e. score less than 4). BMI, body mass index; CDR, Clinical Dementia Rating; MNA-SF, Mini Nutritional Assessment Short-Form.

small amount of water (3 mL).[19] Additionally, Sato *et al.* had examined dysphagia in patients with severe AD and reported MWST validity.[8] However, it can be difficult to detect mild dysphagia with MWST. Therefore, here we used a combination of cervical auscultation and MWST to detect mild dysphagia.[20,21]

Table 5 Examination of relationship between various items and lower skeletal muscle index by stepwise multivariate logistic regression analysis

		Univariate			Multivariate		
		Odds ratio	95% confidence interval	*P*-value	Odds ratio	95% confidence interval	*P*-value
Age	(continuous variables)	1.06	1.00–1.12	0.067		—	
Sex	0: Male 1: Female	1.21	0.44–3.36	0.712		—	
CDR	0: Very mild–moderate 1: Severe	18.80	8.22–43.01	$P<0.001$	11.68	4.52–30.20	$P<0.001$
Barthel Index	(Continuous variables)	0.96	0.95–0.98	$P<0.001$		—	
BMI	0: ≥18.5 1: <18.5	6.87	3.31–14.28	$P<0.001$	3.18	1.27–8.00	0.014
Calf circumference	0: ≥30.5 cm 1: <30.5 cm	19.04	4.48–80.96	$P<0.001$	9.33	2.01–43.27	0.004
MNA-SF	0: ≥score 8 1: <score 8	7.52	3.47–16.30	$P<0.001$		—	
Occlusal contacts	0: Present 1: Absent	4.11	2.03–8.34	$P<0.001$		—	
Tongue function	0: Good 1: Poor	5.42	2.32–12.65	$P<0.001$		—	
Swallowing function	0: Good 1: Poor	14.25	4.69–43.25	$P<0.001$	4.93	1.10–22.04	0.037

The upper skeletal muscle index (SMI) group was assigned a value of 0, whereas the lower SMI group was assigned a value of 1. Left: univariate analysis using logistic regression analysis. Right: multivariate analysis using logistic regression analysis. The presence of choking and wet hoarseness after swallowing was classified as a modified water swallowing test score of "good" (i.e. score 4 or more) or "poor" (i.e. score less than 4). BMI, body mass index; CDR, Clinical Dementia Rating; MNA-SF, Mini Nutritional Assessment Short Form.

SMI, BI, BMI, CC, MNA-SF, occlusal contact, tongue function and swallowing functions were significantly decreased as the disease severity increased in the univariate analysis based on AD severity (Tables 2, 3). These results were consistent with those of previous studies.[5,8,22,23] Additionally, these results showed that skeletal muscle mass decreased as the severity increased. This suggests the necessity for continued nutrition and physical function support in patients with AD, and provides clinically important knowledge.

CDR, BI, BMI, CC, MNA-SF, occlusal contact, tongue functions and swallowing functions were significantly decreased in the univariate analysis based on SMI (Table4). These results were consistent with those of previous studies examining decreases in skeletal muscle mass (Table 4).[4,6,7,24] Additionally, previous studies had not examined the relationship between muscle mass and occlusal contact or tongue function, and the knowledge in the present study could provide important possibilities for future research.

Furthermore, decreased swallowing function and AD severity were independently relevant factors for decreased SMI (Table 5). Burns *et al.* reported that insulin had an influence on the skeletal muscle mass decrease and growth of brain white matter lesions in AD progression.[5,25] Additional study on the relationship between insulin and swallowing function is required, because AD progression was related to a decreased swallowing function and skeletal muscle mass in the present study.

A limitation of this study was that it was a cross-sectional study; it was impossible to clarify causal relationships. This needs to be evaluated with a longitudinal study. Furthermore, there were more excluded participants; the data from those participants might have affected the results. Most participants were excluded because of difficulty with instructions. Therefore, it would be necessary to consider the evaluation items that are easier and usable for patients with severe aphasia and apraxia.

In the present study, a relationship between age and CDR was not observed (Table 2). Participants were located in various living environments. The differences, such as age at AD onset, environment and comorbidities, were possibly related to CDR. Additionally, a relationship of BI and MNA-SF with sarcopenia has been suggested in previous studies.[24] However, we found no significant relationship with BI, MNA-SF and SMI using multivariate analysis in the present study. This could possibly be because we used our own lower SMI criterion in patients with AD. Furthermore, a previous study reported that in the course of reducing AD severity, BI and MNA-SF were influenced by behavioral and psychological symptoms of dementia, such as apathy and depression.[26] In addition, patients with AD have decreased eating independence, which also includes eating initiation disability, confusion with utensil use and decreased appetite.[27] This decreased independence might lead to malnutrition and decreased SMI. Therefore, the difference in living environments (with or without behavioral and psychological symptoms of dementia correspondence and independence eating disorders) might have influenced the present results. In the future, relevant factors, including living environments, behavioral and psychological symptoms of dementia, depression symptoms, and disability of the anticipatory stage of Leopold's five-stage process of ingestion, need to be considered.

Furthermore, some important confounding factors are missing, such as medications related to swallowing function, skeletal muscle mass, and temporomandibular joint and masticatory muscle related to oral function. Therefore, a study that includes these factors is required in a future cohort study.

In conclusion, we found that decreased skeletal muscle mass is related to AD progression and decreased swallowing function, and that these two factors were significantly decreased in the severe AD group. Therefore, decreased skeletal muscle mass in patients with AD requires strategies to manage swallowing dysfunction.

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Disclosure statement

The authors declare no conflict of interest.

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ORIGINAL ARTICLE

The need and availability of dental services for terminally ill cancer patients: a nationwide survey in Japan

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Abstract
Objective Considering the high incidence of oral complications in terminally ill cancer patients, dental services are necessary for high-quality palliative care. However, to our knowledge, there have been no nationwide studies examining the need and availability of dental services in palliative care. In this study, a nationwide survey was conducted to clarify the need and availability of dental services for physicians and nurses engaged in palliative care in Japan.
Materials and methods A questionnaire was distributed to 436 certified palliative care units and palliative care teams registered with Hospice Palliative Care Japan. The questionnaire consisted of questions related to (1) background, (2) need of dental services, and (3) availability of dental services.
Results The response rate was 48.2 % (n=210). As a whole, 93 % of all respondents indicated that dental services were absolutely necessary, highly necessary, or necessary. In addition, 94 % of respondents thought dental treatment by dentists was often or sometimes necessary; 96 % of respondents thought oral care provided by specialists was often or sometimes necessary. As a whole, 71 % of the respondents reported that dental services were always available, but 28 % reported that dental services were available only sometimes. In actuality, in 31 % of the institutions, dental services were available 1 day/week or less, and in 39 %, dental services were dispatched from outside the institution.
Conclusion The results of this study revealed that Japanese palliative care units and teams have a markedly high need of dental services, but there is insufficient availability. To improve oral complications of terminally ill cancer patients, dentistry professionals should be more available in palliative care.

Keywords Dental service · Palliative care · Questionnaire · Nationwide survey · Japan

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Introduction

The incidence of oral complications in terminally ill cancer patients is markedly high due to worsened systemic conditions and adverse drug reactions in the oral cavity [1–7]. For example, xerostomia is a common symptom among terminally ill cancer patients [8–10]. In most medical facilities and hospitals, oral complications are mainly treated with oral care provided by nurses as a part of routine nursing care [11]. However, as the oral cavity has a complex form, some cases can require specialized dental services [12–16]. However, to our knowledge, there have been no large studies examining the need for dental services in palliative care. In this study, a

nationwide survey was conducted to clarify the need and availability of dental services for physicians and nurses engaged in palliative care in Japan.

Materials and methods

Questionnaires, with a document explaining the study objective and Hospice Palliative Care Japan's letter of request for cooperation, were mailed to chief physicians and nurses working in certified palliative care units and palliative care teams registered with Hospice Palliative Care Japan. This organization covers 244 of the 308 certified palliative care units in Japan, and 192 palliative care teams of the 407 designated cancer hospitals in Japan. We asked them to return the questionnaires by mail in January 2013. No reminders were sent and no rewards were offered.

Questionnaire

Owing to a lack of validated instruments, the questionnaire used in this study was developed after discussions among the authors. The questionnaire consisted of questions related to background, need of dental services, and availability of dental services.

Background

We asked respondents to provide background information, such as their profession and place of work.

Need of dental services

We asked respondents about the general need for dental services in daily palliative care using the following six response options: absolutely necessary, highly necessary, necessary, relatively necessary, relatively unnecessary, and unnecessary. Moreover, we asked respondents about specific needs, focusing on dental treatment (such as dentures, dental caries, and periodontal diseases) by dentists and oral care (such as oral cleaning and dry mouth treatment) provided by specialists (such as dental hygienists), using the following three response options: often, sometimes, and never.

Availability of dental services

We asked respondents about the availability of dental services, using four questions. The first question concerned the general availability of dental services. We asked using the following three response options: always available, sometimes available, and unavailable. The second question concerned the frequency of available dental services. We asked using the following five response options: ≥5 days/week, 2–4 days/week, 1 day/week, 1 day/2 weeks to 1 month, and unavailable. The third question concerned the kind of dental services (in-hospital, dispatched from outside the hospital, or unavailable). The fourth question concerned availability, focusing on specific dental services (dental treatment and oral care), using the following three response options: easily available, available but difficult to access, and unavailable.

Results

Among the 436 institutions (palliative care units, 244; palliative care teams, 192) investigated, a total of 210 (palliative care units, 120; palliative care teams, 90) responded (response rate: 48.2 %). The responding persons were physicians or nurses, 74 (35.2 %) and 136 (64.8 %), respectively.

Need of dental services (Table 1)

In total, 93 % of all respondents indicated that dental services were absolutely necessary, highly necessary, or necessary. In addition, 94 % of respondents thought dental treatment by dentists was often or sometimes necessary; 96 % of respondents thought oral care provided by specialists was often or sometimes necessary.

Availability of dental services (Table 2)

As a whole, 71 % of the respondents reported that dental services were always available, but 28 % reported that dental services were available only sometimes. In actuality, in 31 % of the institutions, dental services were available 1 day/week or less, and in 39 %, dental services were dispatched from outside the institution.

Discussion

This study is, to our knowledge, the first nationwide survey to clarify the need and availability of dental services for Japanese palliative care units and teams. Because of the high incidence of oral complications, clarifying the participation rate of dentistry professionals may lead to improving the quality of oral care for palliative care patients.

The first important finding of this study was that almost all respondents considered dental services were necessary in palliative care. This suggests that many doctors and nurses engaged in palliative care actually feel dental services are necessary because of the poor oral condition of terminally ill cancer patients. Oral care is usually mainly provided by nurses. However, it is suggested that oral care by nurses may have limitations in some cases, and special services are necessary

Table 1 The need of dental services (*N*=210)

		N (%)	95 % C.I.
General need of dental services	Absolutely necessary	78 (37.1 %)	31, 44
	Highly necessary	67 (31.9 %)	26, 38
	Necessary	51 (24.3 %)	18, 30
	Relatively necessary	14 (6.7 %)	3, 10
	Relatively unnecessary	0	0
	Unnecessary	0	0
Need of specific dental services			
Dental treatment	Often	57 (27.1 %)	21, 33
	Sometimes	142 (67.6 %)	61, 74
	Never	6 (2.9 %)	1, 5
Oral care	Often	131 (62.4 %)	56, 69
	Sometimes	72 (34.3 %)	28, 41
	Never	5 (2.4 %)	0, 4

CI confidence interval

in complex cases [17, 18]. These results indicate that there is a high need for dental services for palliative care patients [19].

The second important finding of this study was that in about 30 % of respondents, dental services were not easily available. Regarding the frequency of availability, 31 % of respondents indicated less than 1 day/week. In the question about the kind of dental services, 39 % of respondents indicated dental services dispatched from outside or unavailable. These results may link with each other. Because of a limited life prognosis, it is important to quickly intervene for terminally ill cancer patients: if there is an oral cavity problem, dentists and dental hygienists should immediately treat it. Therefore, the presence of in-hospital dental services would be helpful for terminally ill cancer patients. Moreover, regarding the availability of dental services according to specific content, dental treatment (22.9 %) and oral care (25.2 %) were available but difficult to access. Therefore, in some facilities and hospitals, dental services were available but not easily accessible. It is necessary to construct an accessible system for intervention of dental services.

This study has several limitations. First, the response rate was 48 %, and it is impossible to clarify the need and

Table 2 The availability of dental services (*N*=210)

		N (%)	95 % C.I.
General availability of dental services	Always available	148 (71 %)	64, 77
	Sometimes available	55 (26 %)	20, 32
	Unavailable	5 (2 %)	0, 4
Frequency of dental service availability	≥5 days/week	85 (41 %)	34, 47
	2–4 days/week	46 (22 %)	16, 27
	1 day/week	44 (21 %)	15, 26
	1 day/2 weeks~1 month	14 (6 %)	3, 10
	Unavailable	8 (4 %)	1, 6
Kind of dental service available	In-hospital	124 (59 %)	52, 66
	Dispatched from outside	81 (39 %)	32, 45
	Unavailable	3 (1 %)	0, 3
Availability of specific dental services			
Dental treatment	Easily available	153 (72.9 %)	67, 79
	Available but difficult to access	48 (22.9 %)	17, 29
	Unavailable	5 (2.4 %)	0, 4
Oral care	Easily available	140 (66.7 %)	60, 73
	Available but difficult to access	53 (25.2 %)	19, 31
	Unavailable	13 (6.2 %)	3, 9

CI confidence interval

availability of dental services at non-respondent institutions. Second, as this was a survey of healthcare professionals, a patient survey might obtain different results. Third, as this study was performed in Japan, the generalizability to other countries with different healthcare systems and patient backgrounds might be limited. We believe, however, the findings could be probably applied to many countries, because multiple surveys have indicated that oral complications are one of most common symptoms in advanced cancer patients irrespective of country [1–10, 19].

In conclusion, the results of this study revealed that Japanese palliative care units and teams have a markedly high need of dental services, but there is insufficient availability. To improve oral complications of terminally ill cancer patients, dentistry professionals should be more available in palliative care.

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Conflict of interest The authors declare no conflict of interest

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An examination of factors related to aspiration and silent aspiration in older adults requiring long-term care in rural Japan

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SUMMARY **Swallowing disorders are a growing problem among the elderly in long-term care (LTC), and they can cause aspiration pneumonia. In order to detect swallowing disorders early, simple tools are needed to assess aspiration and silent aspiration (SA). To compile a sample of elderly people requiring LTC, and categorise them as having suspected aspiration and/or SA using simple screening tools. In addition, oral ability, severity of dementia, vital functions and nutritional status were compared in these groups. A total of 393 elderly people in LTC (89 men and 304 women; age ranging from 65 to 100 years) were included in the study. The modified water swallow test, cervical auscultation and cough test were used to assess swallowing function. The participants were categorised as having suspected aspiration and/or SA, and the following assessments were performed: (i) oral ability (lips function, tongue function, rinsing and gargling ability), (ii) dementia severity, (iii) vital functions and (iv) nutritional status. Suspected aspiration was apparent in 50·5% of patients, of which 24·0% had suspected SA. Those with suspected aspiration showed worsened oral ability, dementia severity, vital functions and nutritional status. Similarly, those with suspected SA showed worsened dementia severity, vital functions and nutritional status. Logistic regression analysis revealed that lip closure, lingual movement and rinsing ability were significantly associated with suspected aspiration. Dementia severity was the best predictor of suspected SA. Simple screening tools can be used to identify suspected aspiration and SA, which may facilitate early detection of aspiration pneumonia or swallowing disorder risk.**

KEYWORDS: **aspiration, swallowing disorder, oral health, dementia, long-term care, elderly**

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Background

In Japan in 2012, approximately 24·1% of the population was aged 65 years or older (1), and this has been predicted to rise to 30·0% by the year 2025 (2). With the growing ageing population, the number of elderly people requiring long-term care (LTC) due to dementia or being bedridden is also on the rise (3). Based on the LTC insurance system in Japan, there are over five million elderly people (2011 data) requiring support or LTC, and further increases have been predicted (4).

Swallowing disorders are a common problem among the elderly in LTC, and they are associated with aspiration pneumonia and loss of the pleasure of eating. Ageing causes subtle physiological changes in

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swallowing function, affecting both the oral and pharyngeal phases of swallowing (5). In addition, health conditions related to ageing (such as strokes and dementia) can be predictors of the presence and severity of swallowing dysfunction. Aspiration (the intrusion of material below the subglottic area) caused by swallowing dysfunction is a very important clinical condition, particularly because aspiration may occur silently, and early detection of swallowing disorders is difficult (6). Silent aspiration (SA) is defined as aspiration without clinical signs such as coughing or throat clearing (7).

The gold standards for detecting aspiration or SA are the video fluoroscopic swallowing exam (VFSE) or fibreoptic endoscopic examination of swallowing (FEES) (8). However, it is impractical to conduct these procedures on every patient with suspected swallowing dysfunction. Therefore, simple screening tools for potential aspiration risk are necessary. Other tests such as the modified water swallowing test (MWST) and cervical auscultation have been used to assess aspiration (9, 10), although the cough reflex is the main indicator of aspiration, which makes screening for SA difficult with these methods. The cough test can be used to determine SA during the water swallowing test (11, 12). Simple screening methods for aspiration and SA risk could enhance the understanding of swallowing dysfunction in the elderly.

Early detection of swallowing disorders by nurses and care persons requires consideration of the factors associated with them. Previous studies have reported associations between swallowing function and nutritional status (13). However, there are very few reports on factors associated with aspiration and SA measured using simple screening tools, in elderly people.

The purposes of this study were to (i) identify the prevalence of aspiration and SA among elderly people in LTC, using simple screening methods, and (ii) investigate the associations between aspiration, SA, oral ability, dementia severity, vital functions and nutritional status.

Methods

Participants

From among 415 adults aged 65 years or over requiring LTC (including those requiring support) residing in the Omori town region of Yokote in the Akita prefecture, Japan (including all inpatients at the region's only LTC sanatorium, residents at all nursing homes in the region and all users of the region's day care houses and home-visit nursing stations), 393 who could respond to face-to-face surveys with the researchers participated in the study. These participants consisted of 89 men and 304 women, ranging in age from 65 to 100 years. Among the participants, 42·7% had a history of cerebrovascular disease, and 7·2% had a history of degenerative disease. Informed consent was obtained from each patient or their agent before participation in the study. The study was conducted in February, 2011, with the approval of the Ethics Committee of the Tokyo Metropolitan Institute of Gerontology (#44, issued in 2010).

Group designation

Participants were grouped based on the swallowing function test. The swallowing tests were conducted by four dentists, each with more than three years of clinical gerodontology experience, who used methods that were standardised by way of a 2-hour training session before the study. Measurements for the first 10 people were obtained together, and we confirmed that dentists reach consensus on the examination scores. However, each of the dentists evaluated a different sample; therefore, reliability was not a quantifiable parameter. We used the MWST, cervical auscultation and cough test to assess swallowing function. The MWST was conducted via standard methods; 3 mL of cold water was injected into the floor of the mouth with a 5-mL syringe, after which the participant was instructed to swallow, and their swallowing was scored (9). We injected 3 mL of water into the floor of the mouth, preventing premature spillage into the pharynx. After confirming retention of the water in the oral cavity, the participants were asked to swallow. Spontaneous swallowing was not monitored in our study. The test was not performed on those who were not taking food or water orally. Cervical auscultation was performed by listening to the sounds associated with swallowing 3 mL of cold water, with a stethoscope. When a flushing sound was heard prior to the initiation of the pharyngeal swallow, or when the breath sounded wet, had stridor, coughing, throat clearing or if voice distortion was heard after the swallow, the test was determined to be abnormal (10). Participants who had a score of

4 or 5 in the MWST and exhibited normal cervical auscultation results were classified as 'normal', and those who were unable to complete the MWST or had a score of 1–3 and exhibited abnormal cervical auscultation results were classified as having 'suspected aspiration'.

The cough test was administered to participants who were classified as having suspected aspiration. In accordance with the method described by Sato *et al.* (12), an NE-U22 mesh nebulizer®* was used for the cough test. Participants orally inhaled a mist of normal saline containing 1·0% w/v citric acid. Those who coughed within 30 s were classified as 'suspected aspiration with cough', while those who did not were classified as 'suspected aspiration with no cough' (i.e., suspected SA). This test was not administered to participants with asthma, bronchitis or any other pre-existing lung disease. Wakasugi *et al.* (11) proposed an SA detection system that combines the MWST with a cough test. Referring to this system, we first determined whether or not participants had aspiration via the MWST and cervical auscultation, then those with a positive result in the simplified cough test were classified as having 'suspected aspiration with no cough'.

Assessments

Oral ability. Oral function tests were carried out by specialised investigators. The number of remaining teeth, excluding stumps, and the number of residual teeth and missing teeth treated by prostheses, such as dentures, dental bridges or dental implants, were counted. Regardless of prostheses, participants who could maintain the height of the bite were defined as having 'presence' of occlusal contacts, and those who could not were defined as having 'absence' of occlusal contacts. Participants who could not close their lips completely were defined as having 'poor' lip closure, and good function was defined as 'good' lip closure. The participants were asked to stick out their tongues, and if the participant's proglossis could pass beyond the dental arch, they were defined as having 'good' lingual movement, whereas those in which it could not were defined as having 'poor' lingual movement. Participants who could rinse rhythmically and sequentially without leaking water were defined as having 'good' rinsing ability, whereas those who could not were defined as having 'poor' rinsing ability. Participants put water into their mouth, looked upward and gargled. 'Good' gargling ability was deemed present if participants were able to complete this task with no cough, and participants who could not do this were defined as having 'poor' gargling ability.

Dementia severity. Dementia severity was evaluated by medical doctors based on the information provided by the nurses and caretakers in charge. Assessments were conducted using the Clinical Dementia Rating (CDR) (14). The severity of dementia was rated as follows in this study: absent (0 or 0·5), mild (i), moderate (ii) or severe (iii), as described previously.

Vital functions. Vital functions and nutritional status were recorded by a nurse or a care worker. Activities of daily living (ADL) were assessed using the Barthel Index (BI) (15), where a total score of 100 points indicates complete self-sufficiency, whereas a score of 0 indicates complete dependency.

Nutrition. Nutritional status was assessed using the body mass index (BMI). The most recent data available (within 3 months) were obtained from nursing and care records. Three nutritional routes, oral intake, enteral nutrition and parenteral nutrition, were assessed.

Analysis

To test for significant differences between groups, Mann–Whitney *U*-tests were performed on continuous quantitative data, and chi-square tests were performed on qualitative data. Furthermore, multivariate analysis by binomial logistic regression analysis was performed. The factors associated with suspected aspiration were analysed first. Based on this, cerebrovascular and degenerative disease, number of functional teeth, occlusion, lip closure, lingual movement, rinsing ability, gargling ability, dementia severity, BI and BMI were selected as independent variables, and 'normal' and 'suspected aspiration' were the dependent variables. Thereafter, the predictors of 'suspected aspiration with no cough' were analysed, where the number of residual teeth, occlusal contants, lingual

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movement, rinsing ability, gargling ability, dementia severity, BI and BMI were selected as independent variables, and 'suspected aspiration with cough' and 'suspected aspiration with no cough' were the dependent variables.

Results

Demographics

Among the elderly participants in this study, a substantial percentage had severe dementia (CDR3) (Table 1). The most common nutritional route was oral intake, and the percentage of those living in nursing homes was high. SA was present in 50·9% of the sample population, and among these, 23·4% had SA with no cough (Fig. 1).

Suspected aspiration

Compared to the normal group, those with suspected aspiration had reduced oral ability and nutritional status, but also had more severe dementia and disability in ADL as measured by BI (number of functional teeth $P < 0{\cdot}001$, occlusal contacts $P < 0{\cdot}001$, lip closure $P < 0{\cdot}001$, lingual movement $P < 0{\cdot}001$, rinsing ability $P < 0{\cdot}001$, gargling ability $P < 0{\cdot}001$, dementia severity $P < 0{\cdot}001$, BI $P < 0{\cdot}001$, BMI $P < 0{\cdot}001$) (Table 2). Those with suspected aspiration had disabilities in most outcome measures based on the MWST and cervical auscultation.

Suspected SA

The comparison of elderly people with suspected aspiration with and without cough revealed that those with no cough reflex had more severe dementia and ADL disability, as well as reduced nutritional status (dementia severity $P = 0{\cdot}014$, BI $P = 0{\cdot}01$, BMI $P = 0{\cdot}002$) (Table 2). There were no significant differences in oral ability between the two groups.

Predicting suspected aspiration and SA

The logistic regression results are shown in Tables 3. Of the oral ability factors, the most significant predictors of aspiration were lip closure ($P < 0{\cdot}001$), lingual movement ($P = 0{\cdot}001$) and rinsing ability ($P = 0{\cdot}012$). Dementia severity was the most significant predictor of suspected SA ($P = 0{\cdot}01$).

Discussion

The MWST and cervical auscultation were used to detect suspected aspiration in the present study. In a study by Tohara *et al.* (9), the MWST had a sensitivity of 70% and a specificity of 88% for detecting aspiration. As this test involves aspirating a small quantity of water, it is quite safe. The present study included elderly subjects with dementia. Sato *et al.* (16) previously used the MWST to study swallowing function in elderly patients with mild-to-severe Alzheimer's disease, demonstrating that this test can be an effective measure in dementia patients. Cervical auscultation is a test for detecting aspiration by listening with a stethoscope for sounds of swallowing that occur during deglutition, and for differences in respiration before and after swallowing. In a study of 50 older adults requiring LTC, Zenner *et al.* (10) reported that cervical auscultation had a sensitivity of 84% and a specificity of 71% with regard to aspiration detection. They suggested that these results support the use of cervical auscultation as a highly sensitive and specific method of dysphagia assessment in LTC. Thus, we

Table 1. Participant characteristics

Characteristics	Classification	Overall	Normal	Suspected aspiration
Age	Mean ± s.d.	84·6 ± 6·4	84·2 ± 6·7 (n = 193)	85·0 ± 6·2 (n = 200)
Sex	Female	304 (77·4%)	149 (77·2%)	155 (77·5%)
	Male	89 (22·6%)	44 (22·8%)	45 (22·5%)
Nutritional route (%)	Oral intake	310 (79·7%)	191 (61·6%)	119 (38·4%)
	Enteral nutrition	68 (17·5%)	0	68 (8·9%)
	Parenteral nutrition	11 (2·8%)	0	11 (3·3%)
Residence (%)	Living at home	126 (32·1%)	84 (43·5%)	42 (21·0%)
	Nursing home	192 (48·9%)	88 (45·6%)	104 (52·0%)
	Hospital (long-term care bed)	75 (19·1%)	21 (10·9%)	54 (27·0%)

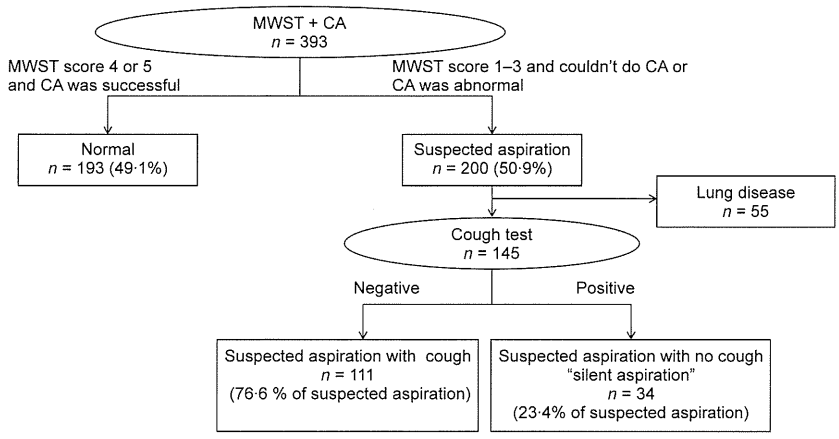

Fig. 1. Results of suspected aspiration with and without cough.

performed MWST in combination with cervical auscultation. The cough test is a screening test for SA, which is difficult to determine with the MWST (11, 12). In a study by Wakasugi *et al.* (11), the cough test had a sensitivity of 87% and a specificity of 89% for detecting SA. Several studies have investigated swallowing function using the water swallow test and cervical auscultation. One such study by Furuta *et al.* (17) reported that 31% of a sample of community-dwelling elderly people had abnormal cervical auscultation results. Nogueira *et al.* (18) found that 38% of elderly people living in a nursing home showed abnormal results in the 3-oz water swallow test. Notably, however, their study did not include many participants engaged in enteral nutrition, which may explain why their results differ from ours. Lin *et al.* (19) found that 51% of elderly people living in a nursing home showed abnormal results in the protocol using the water swallow test, in a study wherein 30% of the participants were engaged in enteral nutrition. Our study of elderly people in LTC included recipients of enteral nutrition. In such cases, the MWST and cervical auscultation appear to give appropriate results. To the best of our knowledge, no other study has used the cough test on a sample of elderly people to examine aspiration.

Examination of oral function is essential when investigating dysphagia. One report claimed that 80% of those complaining of dysphagia had some kind of problem with their oral cavity (20). Leder *et al.* (21) found an incomplete range of lingual motion to be significantly related to aspiration, but did not observe any association between aspiration and incomplete lip closure. However, the lips play an important role in the swallowing sequence, and lip closure is observed when a food bolus is sent from the oral cavity to the pharynx. Reddy *et al.* (22) found a significant difference in lip closure power between patients with dysphagia and those without. The results of the present study also suggest that evaluation of lip closure is necessary to assess aspiration.

Few studies of oral function have focused on rinsing ability. Sato *et al.* (16) examined nursing home residents with Alzheimer's disease and found poor rinsing ability to be the only risk factor associated with dysphagia. In the present study, we demonstrated a link between aspiration and rinsing ability, indicating the potential usefulness of tests of rinsing ability in early screening for aspiration, not only in those with dementia, but also in older adults requiring LTC who do not suffer from dementia. This is a very important finding for older adults requiring LTC.

Garon *et al.* (23) reported that 67·9% of dementia patients had aspiration, of which 68·1% had SA. Dysphagia from dementia usually involves a delay in swallowing processes such as the swallowing reflex, cough reflex and oral phase (24). Studies have shown a correlation between dysphagia severity and dementia severity, and a presentation of pseudobulbar palsy dysphagia in individuals with severe Alzheimer's disease (24, 25). However, no studies to date have reported a relationship between reduced cognitive functioning and SA, and the results of the present study represent extremely useful findings with regard to treating dysphagia in subjects requiring LTC.

Associations between aspiration and dysphagia, ADL and nutrition status have been described previously in the scientific literature (13). In the current study, these factors had weaker associations compared with oral ability and dementia severity. Participants included

Table 2. Comparison of each survey item, suspected aspiration, and SA

Characteristics	Classification	Normal	Suspected aspiration	*P* value	Suspected aspiration with cough	Suspected aspiration with no cough ('silent aspiration')	*P* value
Age	Mean ± s.d.	84·2 ± 6·7 (*n* = 193)	85·0 ± 6·2 (*n* = 200)	0·262	84·9 ± 6·2 (*n* = 111)	84·6 ± 7·7 (*n* = 34)	0·998
Sex	Female	149 (77·2%)	155 (77·5%)	0·944	89 (80·2%)	23 (67·6%)	0·127
	Male	44 (22·8%)	45 (22·5%)		22 (19·8%)	11 (32·4%)	
Cerebrovascular disease	Absence	125 (65·1%)	100 (50·3%)	0·002	59 (53·6%)	15 (44·1%)	0·332
	Presence	67 (34·9%)	99 (49·7%)		51 (46·4%)	19 (55·9%)	
Degenerative disease	Absence	183 (95·3%)	180 (90·5%)	0·062	98 (89·1%)	32 (94·1%)	0·387
	Presence	9 (4·7%)	19 (9·5%)		12 (10·9%)	2 (5·9%)	
Oral ability							
No. of residual teeth	Mean ± s.d.	3·4 ± 6·6 (*n* = 188)	3·7 ± 6·4 (*n* = 199)	0·647	3·25 ± 6·3 (*n* = 110)	3·85 ± 6·0 (*n* = 34)	0·142
No. of functional teeth	Mean ± s.d.	19·3 ± 11·4 (*n* = 192)	10·6 ± 11·9 (*n* = 200)	<0·001	13 ± 12·7 (*n* = 111)	10·3 ± 11·6 (*n* = 34)	0·435
Occlusal contacts	Presence	140 (72·5%)	84 (42%)	<0·001	55 (49·5%)	13 (38·2%)	0·247
	Absence	53 (27·5%)	116 (58%)		56 (50·5%)	21 (61·8%)	
Lip closure	Good	174 (92·1%)	87 (47·5%)	<0·001	65 (62·5%)	17 (56·7%)	0·564
	Poor	15 (7·9%)	96 (52·5%)		39 (37·5%)	13 (43·3%)	
Lingual movement	Good	171 (93·4%)	79 (46·2%)	<0·001	63 (64·3%)	14 (46·7%)	0·085
	Poor	12 (6·6%)	92 (53·8%)		35 (35·7%)	16 (53·3%)	
Rinsing ability	Good	156 (86·2%)	70 (38·7%)	<0·001	53 (54·6)	12 (38·7%)	0·123
	Poor	25 (13·8%)	111 (61·3%)		44 (45·4%)	19 (61·3%)	
Gargling ability	Good	105 (64·8%)	38 (22·1%)	<0·001	33 (35·9%)	5 (17·2%)	0·059
	Poor	57 (35·2%)	134 (77·9%)		59 (64·1%)	24 (82·8%)	
Cognitive function							
Dementia	Absent (0/0·5)	59 (30·9%)	22 (11·1%)	<0·001	19 (17·3%)	2 (5·9%)	0·014
severity (CDR)	Mild (1)	40 (20·9%)	16 (8%)		14 (12·7%)	2 (5·9%)	
	Moderate (2)	56 (29·3%)	45 (22·6%)		34 (30·9%)	6 (17·6%)	
	Severe (3)	36 (18·8%)	116 (58·3%)		43 (39·1%)	24 (70·6%)	
Vital functions							
BI	Mean ± s.d.	49·1 ± 31·7(*n* = 189)	17·0 ± 26·7 (*n* = 197)	<0·001	25·8 ± 30·5 (*n* = 110)	11·5 ± 20·6 (*n* = 33)	0·01
Nutrition							
BMI	Mean ± s.d.	22·0 ± 4·4 (*n* = 181)	19·2 ± 4·1 (*n* = 186)	<0·001	20·6 ± 4·3 (*n* = 102)	17·9 ± 3·9 (*n* = 31)	0·002

Means of basic data by the presence or absence of 'suspected aspiration', 'suspected aspiration with no cough' and results of the Mann–Whitney *U*-test.
Number and frequency of each item by the presence or absence of 'suspected aspiration', 'suspected aspiration with no cough' and results of the chi-square test.

Table 3. Predicting suspected aspiration and silent aspiration

Factor	OR†	95% CI	*P* value
Age	1	0·9–1·0	0·804
Sex	1·3	0·6–2·7	0·486
Lip closure	5·6	2·3–13·8	<0·001
Lingual movement	4·2	1·7–10·1	0·001
Rinsing ability	2·8	1·3–6·1	0·012
Age	1	0·9–1·0	0·292
Sex	0·3	0·1–1·1	0·066
Dementia severity (CDR)	2·2	1·2–4·1	0·01

Upper section: Univariate and multivariate analyses with suspected aspiration as the dependent variable and each of the additional factors as independent variables.
Lower section: Univariate and multivariate analyses with silent aspiration as the dependent variable and each of the additional factors as independent variables.
†Odds ratio, adjusted by age and sex.

elderly people undergoing enteral nutrition management; therefore, their nutritional status may have been adjusted or corrected by overseers. Additionally, oral ability may be more strongly associated with aspiration than ADL or nutritional status, but very few studies have investigated oral ability in detail. The present study had several limitations. The diagnosis of suspected aspiration and SA could not be confirmed by VFSE or FEES. This study included participants with swallowing function problems or severe swallowing disorders. Therefore, performing invasive examinations in all participants was considered to be ethically unsound. The MWST alone may not detect mild aspiration because its sensitivity is slightly low. Therefore, we also used cervical auscultation together with the MWST. The inter-rater reliability was not measured, and the evaluations performed by the different investigators may therefore not have been in agreement. Moreover, as this was not a longitudinal study, we could not confirm any causal relationships with regard to the observed associations. In addition, it may not be feasible to perform VFSE and/or FEES in all geriatric subjects living in rural areas; however, practitioners can at least identify suspected aspiration with the simple water test. Identification of factors related to swallowing impairment (*i.e.* oral ability, dementia severity) could provide further insight into suspected aspiration and SA. Simple assessments of suspected aspiration and SA and identification of associated features and characteristics can facilitate the early detection of aspiration pneumonia and swallowing dysfunction.

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Conflict of interests

No conflict of interests declared.

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REVIEW ARTICLE

Sarcopenia: Prevalence and associated factors based on different suggested definitions in community-dwelling older adults

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The age-related loss of muscle mass and/or strength and performance, sarcopenia, has been associated with geriatric syndromes, morbidity and mortality. Although sarcopenia has been researched for many years, currently there is a lack of consensus on its definition. Some studies define sarcopenia as low muscle mass alone, whereas other studies have recently combined low muscle mass, strength and physical performance suggested by the European Working Group on Sarcopenia in Older People, as well as the Asian Working Group for Sarcopenia. The arbitrary use of various available sarcopenia definitions within the literature can cause discrepancies in the prevalence and associated risk factors. The application of population-specific cut-off values in any sample population can be problematic, particularly among different ethnicities. Using commonly used cut-off points to define sarcopenia, including solely muscle mass and combined definitions, on a community-dwelling elderly Japanese population, the prevalence of sarcopenia ranged from 2.5 to 28.0% in men and 2.3 to 11.7% in women, with muscle mass measured by dual-energy X-ray absorptiometry, and 7.1–98.0% in men and 19.8–88.0% in women measured by bioelectrical impedance analysis. Body mass index was the most prominent related factor for sarcopenia across the definitions in this Japanese sample. However, other associated hematological and chronic condition factors varied depending on the definition.
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Keywords: muscle strength, sarcopenia, skeletal muscle mass, walking ability.

Introduction

Sarcopenia, a term proposed by Rosenburg in 1989 referring to the age-related decline in lean body mass, has become a relatively well-known condition among researchers and physicians.[1] Many investigators have attempted to clarify and establish a definition for the estimation of sarcopenia in older adults, as there is still a lack of consensus on components for the diagnosis of sarcopenia and the corresponding cut-off values.[2–8]

While some investigators maintain that sarcopenia should be characterized solely on muscle mass, since the publication of the European Working Group on Sarcopenia in Older People (EWGSOP) definition, more studies have used the combined definition of muscle mass, strength and performance to define sarcopenia.[9] The issue then, is that the reported prevalence of sarcopenia, or any outcome, varies depending on the definition used.[10–13] Furthermore, the differences in cut-off values used for the definition can also greatly affect the outcome of the results depending on the population on which said cut-off value is applied.[2,6,7,10] The different definitions of sarcopenia and their corresponding cut-off points might also have an effect on the risk factors associated with sarcopenia, which is an area that has not yet been explored. Understanding these risk factors can potentially assist in identifying early markers for sarcopenia prevention.

The purpose of the present review was to determine the differences in prevalence and factors associated with sarcopenia based on different definitions found in the literature, and to investigate how different sarcopenia definitions affect prevalence and associated factors

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