Factors Associated with Food Form in Long-Term Care Insurance Facilities

Abstract

We examined factors related to dietary intake status (food form) of long-term care facility (LTCF) residents to identify factors related to proper food form choice for older individuals requiring nursing care. We surveyed 888 residents from 37 LTCFs in Japan. We evaluated basic information (age, sex, body mass index [BMI]), food form (swallowing-adjusted diet class), Barthel Index (BI), Clinical Dementia Rating (CDR), simply evaluated eating and swallowing functions, the number of present/functional teeth, oral diadochokinesis, repetitive saliva swallowing test (RSST), and modified water swallowing test. To clarify factors associated with food form, participants who had good nutrition by oral intake were categorized into the dysphagic diet (DD) and normal diet (ND) groups. Multi-level analyses were used to detect oral functions associated with food form status. Among objective assessments, BMI (odds ratio [OR]: 0.979, 95% confidence interval [CI]: -0.022- to 0.006, $p=0.001$), BI (OR: 0.993, 95% CI: -0.007 to -0.004, $p<0.001$), CDR 3.0 (OR: 1.002, 95% CI: 0.002–0.236, $p=0.046$), present teeth (OR: 0.993, 95% CI: -0.007 to -0.001, $p=0.011$), functional teeth (OR: 0.989, 95% CI: -0.011 to -0.005, $p<0.001$), and RSST (OR: 0.960, 95% CI: -0.041 to -0.007, $p=0.006$) were significantly associated with DD vs ND discrimination. Simple evaluations of coughing (OR: 1.056, 0.054–0.198, $p=0.001$) and rinsing (OR: 1.010, 0.010–0.174, $p=0.029$) could also discriminate food

form status. These simple evaluations provide insight into the discrepancies between food form status and eating abilities of LTCF residents. Periodic evaluations by the nursing caregiver may help to prevent aspiration by older individuals with dysphagia.

Keywords: Coughing, Dysphagic Diets, Food Form, Long-Term Care Facility, Rinsing, Deglutition disorders

Introduction

It is anticipated that the number of older people with eating and swallowing dysfunction would increase in Japan, which is a super-aging society [1]. The prevalence of swallowing dysfunction has been reported to vary from 11.4% to 38.0% in community-dwelling elderly and from 40.0% to 68.0% in long-term care facilities (LTCFs) [2].

Providing adequate diet (food form) to older adults with eating and swallowing dysfunction may help prevent aspiration, asphyxia, and undernutrition [3-5]. However, in LTCFs lacking experts on dysphagia, caregivers may often not be able to determine rapidly whether an adequate food form was provided in cases where the eating and swallowing function of the residents declines. When a caregiver does not recognize that the eating and swallowing function of an LTCF resident has reduced in time, change to the appropriate food form may be delayed, thus, leading to an increased risk of aspiration, choking, and malnutrition. In cases of patients with diseases such as stroke and Parkinson's disease, such a reduced function is expected and is understandable, and the nursing caregiver should be typically aware of the possibility of eating and swallowing dysfunction. These residents also undergo medical follow-up examination by a clinician, and it is easy to respond quickly to eating and swallowing dysfunction [6]. However, when aging and disuse are the main causes of reduced eating and swallowing function, this reduction could not be easily noticed as the change is small [6].

Video fluorography and video endoscopy performed by experts on dysphagia are critical for assessing the eating and swallowing function and determining the appropriate food form [7, 8]. Nevertheless, they are difficult to implement frequently for people in all health institutions, nursing homes, and those living at home [9]. Thus, the eating and swallowing function of older individuals requiring care should be routinely observed by their nursing caregivers (nurses, those in the nursing professions, and, in some cases, their families) and not be impacted by the illness affecting these functions. Moreover, they should examine whether such function gradually decreases because of aging. This may facilitate detection of signs of mismatch between function and food form, and may allow prompt referral of such individuals to medical institutions specializing in eating and swallowing dysfunction to ensure the provision of an adequate food form. In cases where nurses, caregivers, families, and others can work together to assess eating and swallowing function and identify food form incompatibilities early, a timeous change to the appropriate food form may be facilitated, thus, reducing the risks of pneumonitis, undernutrition, asphyxia, and aspiration in older individuals with swallowing dysfunction. Consequently, home care may be continued when hospitalization treatment can be avoided, and medical expenditure and nursing care expenditure may also decrease.

We hypothesized that it would be possible for nursing caregivers to screen for cases of older individuals with difficulty in eating a normal diet (ND) in need of care and transition to a dysphagic diet (DD) using brief eating and swallowing function assessments that can be implemented on a daily basis.

To evaluate this hypothesis, we investigated the diet (food form) type provided to LTCF residents and examined brief eating and swallowing function assessments that could be performed by nursing caregivers on a daily basis. The main aim of this study was to identify the factors that could be considered when transitioning from an ND to DD. We also evaluated factors related to the discrimination between NDs and DDs in a cross-sectional study.

Materials and methods

Study design

This was a cross-sectional study of Japanese LTCF residents. The study was conducted with the approval of the Ethics Committee of the Japanese Society of Gerodontology (approval number: 2018–1) and the Ethics Committee of the Graduate School of Dentistry, Hokkaido University (approval number: 2020–4).

Participants

We first conducted a workshop for 30 members of the Special Committee of the Japanese Society of Gerodontology to explain the content of this study and unify the evaluation criteria for the contents of the survey. The members explained the content of this study to the director and staff of the LTCF institution at which they worked. In total, we collaborated with 37 LTCF facilities in 17 regions in Japan. In September 2018, we informed all residents and their families regarding the content of this study in writing; written informed consent was obtained from 888 residents and their families for participating in the study. Then, we conducted the survey from October 2018 to February 2019.

Survey items

Before the survey, the research members provided training on the assessment of survey items to all nurses and administrative dietitians at the institution, and standardized the evaluation criteria. Subsequently, we distributed a questionnaire and conducted the following survey regarding residents for whom the nurses and administrative dietitians in each facility were responsible.

Survey by questionnaire

The following information was obtained in the survey: The administrative dietitian in charge of each participant transcribed the data concerning the age, sex, and body mass index (BMI) from the long-term care record. Other items, such as oral survey data, Barthel Index (BI), and Clinical Dementia Rating (CDR) were evaluated by the nurse in charge. The final decision on the CDR was made by a trained specialist.

Basic information

Assessment of life function and cognitive function

A nurse in charge conducted a life-function assessment using the BI [10]. Cognitive function was assessed using the CDR, based on Morris's assessment methods [11]. A psychiatrist made the final determination of the CDR.

Oral conditions

The nurse in charge performed an oral cavity investigation. The oral cavity investigation was explained in advance using a manual, and each nurse in charge tried to unify the standards. This survey included 12 items: language, drooling, halitosis, masticatory movement, tongue movement, perioral muscle, left-right asymmetric movement of the mouth angle, swallowing, coughing, changes in voice quality after swallowing, respiratory observation after swallowing, and rinsing. These brief assessments were based on prior discussions with LTCF personnel regarding the assessments that could be used as a reference for dietary morphology and were summarized by the study members. In advance, we discussed the manual with nurses, and researchers assessed four to five participants together with the nurses to ensure standardized evaluations.

The language was evaluated on a three-point scale: 0, capable of speaking a language; 1, capable of speaking a language but with poor articulation; and 2, unable to speak a language. Zero was considered a good score, while 1 and 2 were considered poor scores.

Drooling was assessed as follows: 0, none; 1, occasional; and 2, constant drooling. A score of 0 indicated a good function, while scores of 1 and 2 indicated poor function. Halitosis was assessed as follows: 0, none; 1, slight halitosis; and 2, severe halitosis. A score of 0 indicated a good function, while scores of 1 and 2 indicated poor function. Masticatory movement was evaluated as follows: scores of 0, 1, and 2 corresponded to cases of chewing movement when food was put in the oral cavity, cases of chewing movement when prompted by the voice of another person, and cases of no chewing movement even prompted by another person, respectively. A score of 0 was considered good, while those of 1 and 2 were considered poor. Tongue mobility was also evaluated in three grades: 0, nearly complete mobility; 1, mobility within a small range; and 2, tongue immobility. A score of 0 was considered good, while those of 1 and 2 were considered poor. Perioral muscle movement was assessed in three grades: 0, mobility; 1, slightly difficult movement; and 2, immobility. A score of 0 was considered good, while those of 1 and 2 were considered poor. Left-right asymmetric movement of the mouth angle was assessed in two phases: 0, absent; 1, present. Similarly, swallowing was assessed in two grades: 0, possible, and 1, delayed.

Coughing was rated on a 2-point scale: 0 was defined as no coughing, while 1 was defined as coughing. Coughing or no coughing was judged in cases when the patient coughed or did not cough during the meal, respectively. Changes in voice quality after swallowing were assessed as follows: 0, absent; and 1, present. Respiratory observations after swallowing were assessed as follows: 0, no anomaly; and 1, shallower and faster respiration after swallowing. The ability to rinse their mouths was assessed as follows: 0, able; 1, incomplete; and 2, unable. A score of 0 was considered good, while those of 1 and 2 were considered poor. For rinsing, when water was put in the mouth, the cheeks should be moved to the extent that the leftover food left in the oral cavity could be removed. Moreover, the patient's ability to gargle was evaluated. For example, if a patient placed water in their mouth and expectorated without moving their cheeks, this was evaluated as an inability to rinse his/her mouth.

The oral residue after swallowing was classified at three levels as follows: 0, none; 1, small amount of residue; and 2, marked amount of residue. A score of 0 was considered good, while those of 1 and 2 were considered poor.

Total energy intake and food form

We used the Japanese Society for Feeding and Swallowing Rehabilitation classification code 2013 as the reference standard for the food form [12, 13]. In this survey, the members of the Special Committee of the Japanese Society of Gerodontology who participated in the workshop and unified the contents of the survey actually ate the meals of the facility in charge. And I confirmed the compliance with the aforementioned rehabilitation classification code. In addition, while constantly observing the diet, it was ensured that the patients ate the meal step by step, a safe form was selected, and the diet form was adjusted.

In addition, ND was judged to be a diet other than the four-stage dietary form belonging to the Swallowing Rehabilitation Classification Code 2013. The DD based on the Swallowing Rehabilitation classification code 2013 in this study was similar to the “minced & moist” or “soft & bite size” forms proposed by the International Dysphagia Diet Standardization Initiative (IDDSI).

Actual survey

A survey was conducted by 30 dentists and dental hygienists who had been pre-trained in the use of uniform evaluation standards. The examined items were the following: number of remaining teeth, number of functional teeth, oral diadochokinesis (ODK) evaluation, the

Modified Water Swallowing Test (MWST), and the Repetitive Saliva Swallowing Test (RSST).

Assessment of oral condition

The remaining teeth were considered the total number of teeth erupting into the oral cavity, excluding the roots with disintegrated crowns and the teeth affected by severe periodontitis. Functional teeth were considered the sum of the remaining and prosthetic teeth (e.g., implants, pontics, and dentures).

Objective assessment of oral function

The oral function was assessed using the ODK evaluation, MWST, and RSST.

ODK

ODK tests comprehensively measure the sophistication of movements in the lips and tongue. As many pa//ta//ka/ syllables as possible were repeatedly pronounced in 5 s, and the number of pronunciations of each syllable per second was measured using automated instrumentation (Healthy Mouth Smoking Handy, Takei Instrument Industry Co. Ltd., Niigata, Japan) [14].

MWST

The MWST [15] was performed in combination with the cervical auscultation technique [16]. According to the usual method, 3 mL of cold water was poured into the oral floor with a 5-mL syringe, and swallowing was indicated. Then, changes in swallowing and breath sounds, before and after swallowing, were evaluated with a stethoscope. They were classified as abnormal when the pharyngeal swallowing sounds were wet or in cases where bubbling sounds, wheezing, or coughing reflexes were present [16].

RSST

Swallowing function assessment was also performed using the RSST [17]. Each participant was instructed to repeat an empty swallow as many times as possible in 30 s while seated. The examiner placed the index and middle fingers on the participant's hyoid bone and laryngeal prominence, and counted the number of times the hyoid bone crossed the fingers during the swallowing reflex.

Statistical analysis

We first divided the participants into the parenteral ingestion and oral intake groups according to whether they had received parenteral nutrition or enteral nutrition, respectively. Next, the oral intake group was divided into the poor nutrition status (daily dietary intake <75%

of the number of meals provided by the administrative dietitians) and well-nourished groups (daily dietary intake ≥75% of the number of meals). In addition, the group with good nutrition intake status was divided into subgroups of patients consuming either DD or ND. The examined items were compared between the groups. Sex, oral context, and CDR were compared using the chi-square test. Continuous variables were first assessed for normal data distribution. This was followed by an unpaired *t*-test for comparison of age and BMI, and the Mann–Whitney U-test was performed for the BI, functional teeth, ODK, MWST, and RSST.

To investigate the factors associated with the food form of older individuals requiring long-term care, two levels of food form (ND or DD) were used as objective variables. BMI [3], BI [18], and CDR [5], which have previously been reported to be associated with age, sex, and dietary morphology, as well as the remaining teeth, functional teeth, ODK, RSST, and MWST, were used as explanatory variables in the objective assessment of the oral cavity.

Similarly, two levels of food form were used as the objective variables in the simplified assessment of the oral cavity, with age, sex, BMI, BI, CDR, remaining teeth, and functional teeth used as covariates. Similarly, language, drooling, halitosis, masticatory movement, tongue movement, perioral muscle, left-right asymmetric movement of the mouth angle, swallowing, coughing, changes in voice quality after swallowing, respiratory observation after swallowing, rinsing, and oral residue were used as explanatory variables. Moreover, the explanatory variables were divided into objective and simple evaluations, and a crude analysis was performed. All significant items from the crude analysis were included in a multilevel analysis. All statistical analyses were performed using SPSS Statistics 26 (IBM, Armonk, NY, USA) with a significance level of <5% ($p < 0.05$).

Results

We conducted a survey of 888 residents from 37 LTCFs. After the exclusion of 33 individuals who received parenteral nutrition, the data of 855 individuals (191 male and 664 female; mean age, 86.7 ± 7.9 years) were included in the analyses (Fig. 1).

The analyzed participants had a BMI of 20.4 ± 3.6 kg/m^2 and a BI of 30.0 [10.0, 50.0] (median [interquartile range (IQR)]). CDR values of 0, 0.5, 1, 2, and 3 were observed in 77 (9.0%), 160 (18.7%), 246 (28.8%), and 359 (42.0%) patients, respectively. The median numbers of the remaining and functional teeth were 5.0 [0.0, 15.0] and 26.0 [13.0, 28.0] (median [IQR]). Overall, 506 (59.2%) individuals received an ND.

The MWST could be assessed in 97.5% of all participants, while the ODK and RSST could only be assessed in 67.0% and 57.8% of the participants, respectively. In comparison, in the brief assessment of the oral cavity, the items could be assessed in 98.6–100% of individuals. The groups with poor and good nutritional intake consisted of 85 (10.0%) and 770 (90.0%) individuals, respectively. A comparison between the two groups showed that the proportions of people consuming an ND in the groups with poor and good nutritional intake status were

50.6% and 60.1% (43 and 463 individuals, respectively). The group with good nutritional intake status had significantly lower age and CDR and included a lower proportion of women than the group with poor nutritional intake status. In addition, BMI, BI, and the number of functional teeth were significantly higher, and the outcome of ODK and MWST was satisfactory in the group with good nutritional intake. Significantly more individuals with masticatory movement, tongue mobility, perioral muscle movement, left-right asymmetric movement of the mouth angle, coughing, changes in voice quality after swallowing, rinsing, and oral residue also had good outcomes (Table 1).

The comparison showed that the group consuming an ND had significantly lower age and CDR values as well as higher BMI and BI values. Therefore, in this group, oral function was more objectively assessed compared to the group consuming a DD. In addition, all brief assessments were associated with a significantly greater percentage of participants with good survey outcomes (Table 2).

Assuming that the participant characteristics differed by site, a multilevel analysis was conducted when the comparison analysis confirmed whether the multilevel analysis was suitable. Therefore, we classified the received food forms into two types (i.e., ND or DD) and performed multilevel analyses with the two food forms as dependent variables. In the objective assessment of oral function, BMI ($p = 0.001$), BI ($p < 0.001$), CDR score of 3.0 ($p = 0.046$), number of remaining teeth ($p = 0.011$), number of functional teeth ($p < 0.001$), and RSST ($p =$

0.006) were significantly associated with discrimination between ND and DD (Table 3).

In addition to BMI and BI, coughing ($p = 0.001$) and rinsing ($p = 0.029$) were significantly associated with the discrimination between ND and DD (Table 4) in the brief assessment of oral cavity conditions.

Discussion

Key results

The aim of this study was to discover observational items that would allow recognition of the difficulty in ND intake and indicate the need to consider a transition to a DD. Therefore, we investigated the actual condition of food forms consumed by residents of Japanese LTCFs and examined the factors associated with the discrimination between ND and DD using cross-sectional data. Concerning the items of objective assessments, which were performed by medical professionals, we found that the MWST, number of remaining teeth, and number of functional teeth were significantly related to the received food form. We also investigated whether coughing and rinsing ability, which could be easily observed and evaluated by nursing caregivers, were significantly related to food form. Interestingly, we found that both items could distinguish between individuals consuming an ND or DD.

Simplified assessments were made using items that can be assessed during daily food assistance given by the nursing caregiver close to the older individual requiring long-term care.

If changes in these assessments are a sign to consider transitioning from ND to DD, it would be easy to disseminate them to nursing care settings and would be a useful finding to prevent undernutrition, aspiration, and asphyxiation.

Coughing associated with the received food form is a characteristic of the pharyngeal stage of Leopold's five-stage models of ingestion, while rinsing may be related to the preparatory stage [19]. The finding of the significance of rinsing was meaningful, as this ability could be determined by gargling during oral health care. Conversely, most aspects related to the preparatory stage, other than rinsing (i.e., mastication), appear to be related to the received food forms. However, we found no such association in practice. In this regard, the group consuming a DD, which does not require chewing or bolus formation, may not have been accurately assessed because preparatory stage issues often arise in a dietary context.

Consequently, the decision to provide an ND or DD was based on the lower oral and pharyngeal stages, namely swallowing function, in the actual nursing site. In particular, a decrease in the swallowing function suggested the risk of aspiration; thus, it could easily prompt the caregiver to change the food form. Therefore, it should be carefully considered together with the eating function to ensure that the food form is not changed prematurely.

In this study, there was no significant association between the food form and age or CDR. Although it has been reported that having dementia is associated with the presence of swallowing dysfunction [20], the mean age of the participants in this study was approximately

86 years, and the proportion of cognitively impaired individuals with CDR score ≥1 was 89.1%, which might have been insignificant. However, the association between rinsing inability and cognitive decline has been reported previously [21]. A previous study also reported an association between cognitive decline and the received food form [5], and the finding of an association between rinsing and food form in this study complements the findings of these previous studies.

ODKs and RSST, which are objective assessments of oral function, were not significantly associated with the received food form. For ODKs and RSST, the participants should understand the content of the test and need to be motivated to perform it more than for the MWST. When water is placed in the mouth, the MWST can assess instinctive swallowing movements, regardless of the participant's comprehension, the test content, or willingness to perform the test. Therefore, the lack of significant differences between the two former tests may have been influenced by the small number of people who could perform and understand the purpose of the tests and were willing to perform them. The MWST was found to be highly sensitive and specific for detecting swallowing dysfunction with small amounts of water [15], as also observed in this study.

Regarding the brief simplified assessment, the researchers used the manual to explain these observations to nurses in advance and evaluated four to five participants along with the nurses to achieve standardization of the criteria. Video endoscopic evaluation of swallowing

[22, 23] or video fluoroscopic examination of swallowing [24], the gold standard for eating and swallowing function work-ups, could not be performed in this study. As these tests are difficult to be performed frequently in LTCFs and are performed in non-routine settings, daily eating and swallowing function may not always be assessed. The simplified assessment used in this study was significantly associated with the received food form, and could detect inconsistencies between the usual eating and swallowing function and the food form. It seems to be a valid screening assessment that can provide valid outcomes without specific training or other measures and may indicate the need to seek medical attention from specialized medical institutions and experts on dysphagia. It is likely that this easy assessment would be useful and can be disseminated among LTCFs in the future.

Generalizability

The mean age of the analyzed individuals was 86.5 years, the percentage of cognitively compromised individuals with CDR score ≥1 was 89.1%, and 39.9% of the individuals consumed a DD. In a survey of nursing home residents (average age, 84 years) in the United States, it has been reported that half consumed puree-like meals and thickened foods [25]. In the investigation of a special nursing home in Korea, the average age of the residents was 80.7 years, the proportion of patients with mildly to severely reduced cognitive function was 85.8%, and 23.0% of the patients consumed a DD [20]. In a survey focused on Japanese

LTCFs, the mean age of residents was 85.2 years, the percentage of cognitively impaired persons with CDR score ≥1 was 91.3%, and 52.3% of the patients consumed a DD [26]. The participants of Japanese studies were older, with a higher proportion of people with cognitive decline. However, older individuals comprise approximately 28.4% of Japan's population, which is the highest worldwide, and the percentage of people with cognitive decline is also high. Consequently, the participants of this study were typical Japanese LTCF residents and likely to be representative of future LTCF residents of the super-aging country. However, those on parenteral nutrition were excluded from the analyses of food form in this study. Therefore, not all residents of Japanese LTCFs were considered in this study.

Validity of the research methods

We assumed that when the individuals included in the group with good nutritional intake had a poor nutritional intake despite receiving a food form appropriate for their eating and swallowing function, the food form might not have been suitable for them. In the comparison between the groups with good and poor nutrition intake, the proportion of the group with a good nutrition intake status consuming an ND was approximately 60.1% (n = 463) compared to 50.6% (n = 43) in the group with poor nutrition intake status. In addition, those in the group with good nutritional intake were significantly younger, had a lower CDR, and significantly higher BMI, BI, and number of functional teeth than those in the group with poor nutritional intake. In addition, the results of the performed ODK evaluations and RSST were good, with a significantly higher proportion of people showing good results, even in the short-form assessment of nine out of 15 items. Thus, those with good nutritional status were unlikely to have received a food form that exceeded their functional ability.

In the comparison between the ND and DD groups, there were significant differences in all items, except for sex. These findings also suggested that the food forms suited to the eating and swallowing function of residents were provided.

Significance of the study

As dementia progresses, appetite decreases and the amount of received food reduces. It has also been reported that changes in eating behavior because of the progression of dementia are preceded by a decrease in independent eating and swallowing dysfunction [27]. These changes have been reported to reduce food intake and cause undernutrition, dehydration, reduced performance status, and decreased immune and cognitive function, thus, resulting in aspiration pneumonia and increased risk of mortality [27, 28].

For those who need to rely on care for most of their daily life activities, eating is one of the few remaining desires. It has been reported that reduced eating and swallowing function increases the risk of undernutrition and the risk of asphyxia and aspiration, while improving the food form allows the patient to continue eating palatably and safely [29].

The signature that examines the transition from ND to DD revealed by this study may become a valid tool for maintaining dietary safety and appetite in older individuals with a reduced cognitive function requiring nursing care and may inhibit the development of undernutrition, choking, and aspiration in LTCF residents of institutions where experts on dysphagia are not available.

Study limitations

It should be noted that the facilities surveyed in this study are members of the Society of Geriatrics and Dentistry and that biases in institutional sampling may exist. This study did not perform gold standard tests for assessing eating and swallowing function, such as video fluoroscopy and videoendoscopy. However, as objective assessments of the MWST were conducted by dentists specializing in eating and swallowing dysfunction and geriatric dentistry, and an association with the food form was also observed, we believe that the primary endpoint of the food form and its consequences were reasonable. In addition, in this research, we investigated the levels of all examined items in the participants that received the DD, but as the sample size was small, the analysis for all levels did not provide significant results. In addition, as we focused on the distinction between DD and ND, we divided the analysis into those receiving ND and DD. Therefore, we could not analyze each DD separately. Regarding the DD provided in each facility, the viscosity and hardness were not measured. Given that only subjective evaluations were performed according to the IDDSI, it is possible that the standards for thickening were not consistent within and across facilities. We may have had to evaluate factors, such as hardness, adhesivity, and cohesivity objectively for the DDs provided by each facility to identify and consider DD biases. Therefore, a study focused on these issues should be conducted in the future. Finally, as the current study was a cross-sectional study, we could not determine the causality between the simplified assessment and the received food form. We plan to follow-up our study's participants and investigate causality.

Conclusion

In conclusion, this study showed that deterioration in the results of a simple assessment, such as the ability to cough and rinse, that can be implemented on a daily basis by nursing professionals may signal a need to consider changing from ND to DD. It is difficult to perform frequent specialized assessments on eating and swallowing function in nursing care settings. Appropriate switching of food forms may help prevent undernutrition, pneumonitis, asphyxia, and aspiration in older individuals with eating and swallowing dysfunctions. If this simple assessment can be performed periodically by nursing professionals, a mismatch between the received food form and eating and swallowing function can be identified early. The simple evaluation derived in this study should be more widely disseminated.

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Table 1. Characteristics of study participants, comparison between Poor nutritional status group and Good nutrition status group

Variable	Participants n (%)	Overall (*n* = 855) Mean ± SD *n* (%)	Overall (*n* = 855) Median, [Q1, Q3]	Poor nutritional status (*n* = 85) Mean ± SD *n* (%)	Poor nutritional status (*n* = 85) Median, [Q1, Q3]	Good nutrition status (*n* = 770) Mean ± SD *n* (%)	Good nutrition status (*n* = 770) Median, [Q1, Q3]	*P*-value
Age (years)	851 (99.5)	86.7 ± 7.9	87.0 [82.0, 93.0]	88.5 ± 7.8	89.0 [85.50, 94.0]	86.5 ± 7.9	87.0 [82.0, 92.0]	0.022
Sex (male: female)	855 (100)	664 (77.7)		74: 87.1		590: 76.6		0.028
Body mass index (kg/m^2)	852 (99.6)	20.4 ± 3.6	20.1 [17.8, 22.7]	18.2 ± 2.9	17.7 [16.2, 20.2]	20.7 ± 3.6	20.5 [18.2, 22.9]	< 0.001
Barthel Index (Total points)	855 (100)	32.6 ± 26.0	30.0 [10.0, 50.0]	23.3 ± 24.2	15.0 [0.0, 40.0]	33.6 ± 26.0	30.0 [10.0, 50.0]	<0.001
Clinical dementia rating (Total points)	842 (98.5)							
0,0.5		77 (9.0)		5 (5.9)		72 (9.3)		
1		160 (18.7)		7 (8.2)		153 (19.9)		<0.001
2		246 (28.8)		22 (25.9)		224 (29.1)		
3		359 (42.0)		50 (58.8)		309 (40.1)		
Food form (Normal Diet)	855 (100)	506 (59.2)		43 (50.6)		463 (60.1)		0.089
Objective evaluation of oral function								
Remaining teeth	845 (98.8)	8.38 ± 8.80	5.0	7.06 ± 8.00	4.0	8.53 ± 9.00	5.00	0.203

			[0.0, 15.0]		[0.0, 13.0]		[0.0, 16.00]	
Functional teeth	845 (98.8)	19.9 ± 10.3	26.0 [13.0, 28.0]	15.6 ± 11.4	15.5 [4.0, 28.0]	20.3 ± 10.1	26.0 [14.0, 28.0]	<0.001
ODK (/ta/)	573 (67.0)	3.40 ± 1.70	3.6 [2.2, 4.8]	2.98 ± 1.80	2.7 [1.95, 4.25]	3.47 ± 1.70	3.6 [2.4, 4.8]	0.039
RSST	494 (57.8)	2.54 ± 1.50	3.0 [1.0, 4.0]	2.33 ± 1.60	2.0 [1.0, 3.0]	2.56 ± 1.50	3.0 [1.0, 4.0]	0.211
MWST	834 (97.5)	3.11 ± 2.00	4.0 [0.0, 5.0]	2.48 ± 2.20	3.0 [0.0, 4.0]	3.18 ± 2.00	4.0 [0.0, 5.0]	0.004
Simple evaluations (oral conditions)								
Language (possible)	854 (99.9)	570 (66.7)		57 (67.1)		513 (66.7)		0.948
Drooling (none)	852 (99.6)	638 (74.9)		59 (69.4)		579 (75.5)		0.220
Halitosis (none)	855 (100)	558 (65.3)		52 (61.2)		506 (65.7)		0.404
Masticatory movement (move)	855 (100)	730 (85.4)		61 (71.8)		669 (86.9)		0.001
Tongue movement (move)	841 (98.4)	574 (68.3)		46 (55.4)		528 (69.7)		0.008
Perioral muscle (move)	843 (98.6)	671 (79.6)		56 (66.7)		615 (81.0)		0.002
Left-right asymmetric movement of the	851 (99.5)	735 (86.4)		66 (77.6)		669 (87.3)		0.014

mouth angle (not)								
Swallowing (possible)	854 (99.9)	682	(79.9)	62	(72.9)	620	(80.6)	0.094
Coughing (not)	854 (99.9)	539	(63.1)	41	(48.2)	498	(64.8)	0.003
Changes in voice quality after swallowing (not)	851 (99.5)	735	(86.4)	65	(76.5)	670	(87.5)	0.005
Respiratory observation after swallowing (No abnormality)	855 (100)	816	(95.4)	79	(92.9)	737	(95.7)	0.267
Rinsing (possible)	855 (100)	491	(57.4)	36	(42.4)	455	(59.1)	0.003
Oral residue (none)	854 (99.9)	401	(47.0)	26	(30.6)	375	(48.8)	0.001

Categorical variables are shown as the number (percentage) and were analyzed by the chi-square test. Continuous variables (Age, Body mass index) were analyzed with the *t*-test. Continuous variables (Barthel Index, Clinical Dementia Rating, functional teeth, Oral diadochokinesis, Modified Water Swallowing Test, Repetitive Saliva Swallow Test) were analyzed with the Mann–Whitney U-test. All P-values < 0.05 were considered statistically significant.

MWST: Modified Water Swallowing Test; ODK: Oral Diadochokinesis; Q1: first quartile; Q3: third quartile; RSST: Repetitive Saliva Swallowing Test; SD: standard deviation.

Table 2. Comparison of characteristics of study participants in the Normal diet group and Dysphagia diet group

Variable	Dysphagia diet (n = 307) Mean ± SD / n (%)	Median, [Q1, Q3]	Normal diet (n = 463) Mean ± SD / n (%)	Median, [Q1, Q3]	P-value
Age (years)	87.7 ± 7.4	88.0 [83.0, 93.0]	85.6 ± 8.1	86.0 [81.1, 92.5]	<0.001
Sex (male: female)	240: 78.2		350: 75.6		0.407
Body mass index (kg/m^2)	19.4 ± 2.9	19.2[17.3, 21.3]	21.5 ± 3.7	21.5[19.0, 23.7]	< 0.001
Barthel Index (Total points)	17.6 ± 19.1	10.0 [0.0, 30.0]	44.2 ± 24.4	45.0 [25.0, 65.0]	< 0.001
Clinical dementia rating (Total points)					
0, 0.5	10 (3.3)		62 (13.4)		<0.001
1	27 (8.8)		126 (27.2)		
2	69 (22.5)		155 (33.5)		
3	191 (62.2)		118 (25.5)		
Objective evaluation of oral function					
Remaining teeth	6.65 ± 8.0	3.0 [0.0, 11.75]	9.77 ± 9.3	7.0 [0.0, 18.0]	< 0.001
Functional teeth	15.9 ± 11.5	18.0 [3.0, 28.0]	23.3 ± 7.8	28.0 [21.0, 28.0]	< 0.001
ODK (/ta/)	2.75 ± 1.90	3.0 [1.2, 4.15]	3.79 ± 1.53	4.0[2.8, 5.0]	< 0.001
RSST	2.15 ± 1.43	2.0[1.0, 3.0]	2.69 ± 1.44	3.0[2.0, 4.0]	<0.001
MWST	2.11 ± 2.1	3.0[0.0, 4.0]	3.9 ± 1.58	4.0[4.0, 5.0]	< 0.001
Simple evaluations (oral conditions)					
Language (possible)	150 (49.0)		363 (78.4)		< 0.001
Drooling (none)	177 (57.8)		402 (87.2)		< 0.001
Halitosis (none)	182 (59.3)		324 (70.0)		0.002

Masticatory movement (move)	224	(73.0)	445	(96.1)	< 0.001
Tongue movement (move)	147	(48.8)	381	(83.4)	< 0.001
Perioral muscle (move)	201	(66.8)	414	(90.4)	< 0.001
Left-right asymmetric movement of the mouth angle (not)	249	(81.9)	420	(90.9)	< 0.001
Swallowing (possible)	188	(61.4)	432	(93.3)	< 0.001
Coughing (not)	125	(40.8)	373	(80.6)	< 0.001
Changes in voice quality after swallowing (not)	230	(75.4)	440	(95.4)	< 0.001
Respiratory observation after swallowing (No abnormality)	281	(91.5)	456	(98.4)	< 0.001
Rinsing (possible)	100	(32.6)	355	(76.7)	< 0.001
Oral residue (none)	106	(34.5)	269	(58.2)	< 0.001

Categorical variables are shown as the number (percentage) and were analyzed by the chi-square test. Continuous variables (Age, Body mass index) were analyzed with the *t*-test. Continuous variables (Barthel Index, Clinical Dementia Rating, functional teeth, Oral diadochokinesis, Modified Water Swallowing Test, Repetitive Saliva Swallow Test) were analyzed with the Mann–Whitney U-test. All P-values < 0.05 were considered statistically significant.

MWST: Modified Water Swallowing Test ODK: Oral Diadochokinesis; Q1: first quartile; Q3: third quartile; RSST: Repetitive Saliva Swallowing Test; SD: standard deviation.

Table 3. Objective evaluation of oral function

	OR crude	95%CI crude	OR adjusted	95%CI adjusted	*P*-value
Age	0.999	-0.001 - 0.006	0.999	-0.001 - 0.006	0.242
Sex (1:male, 2:female,)	0.946	-0.056 - 0.075	0.939	-0.063 - 0.068	0.940
Body mass index	0.979	-0.021 - -0.006	0.979	-0.022 - -0.006	0.001
Barthel Index	0.993	-0.007 - -0.004	0.993	-0.007 - -0.004	< 0.001
Clinical dementia rating					
0, 0.5	Reference		Reference		
1	0.900	-0.105 - 0.104	0.904	-0.101 - 0.109	0.938
2	0.918	-0.085 - 0.126	0.918	-0.086 - 0.125	0.719
3	1.024	0.024 - 0.257	1.002	0.002 - 0.236	0.046
Remaining teeth	0.993	-0.007 - -0.001	0.993	-0.007 - -0.001	0.011
Functional teeth	0.989	-0.011 - -0.006	0.989	-0.011 - -0.005	< 0.001
ODK (/ta/)	0.967	-0.033 - 0.008			
RSST	0.961	-0.040 - 0.007			
MWST	0.960	-0.041 - -0.007	0.960	-0.041 - -0.007	0.006

CI: confidence interval; MWST: Modified Water Swallowing Test; ODK: Oral Diadochokinesis;

OR: odds ratio;

RSST: Repetitive Saliva Swallowing Test.

Table 4. Simple evaluations (oral conditions)

	OR crude	95%CI crude			OR adjusted	95%CI adjusted			*P*-value
Age	0.999	-0.001	-	0.006	0.999	-0.001	-	0.006	0.122
Sex (male:female,)	0.946	-0.056	-	0.075	0.425	-0.855	-	0.049	0.590
Body mass index	0.979	-0.021	-	-0.006	0.980	-0.020	-	-0.004	0.003
Barthel Index	0.993	-0.007	-	-0.004	0.995	-0.005	-	-0.001	< 0.001
Clinical dementia rating									
0,0.5		Reference				Reference			
1	0.900	-0.105	-	0.104	0.895	-0.111	-	0.096	0.889
2	0.918	-0.085	-	0.126	0.913	-0.091	-	0.119	0.793
3	1.024	0.024	-	0.257	0.963	-0.038	-	0.197	0.182
Remaining teeth	0.993	-0.007	-	-0.001	0.994	-0.006	-	0.000	0.044
Functional teeth	0.989	-0.011	-	-0.006	0.990	-0.010	-	-0.004	< 0.001
Language (1: good, 2: bad)	1.013	0.013	-	0.144	0.924	-0.079	-	0.066	0.865
Drooling (1: no, 2： yes)	1.037	0.037	-	0.177	0.942	-0.060	-	0.091	0.688
Halitosis (1: no, 2： yes)	0.952	-0.049	-	0.075			-		
Masticatory movement (1: good, 2： bad)	1.092	0.088	-	0.260	0.989	-0.011	-	0.187	0.082
Tongue movement (1: good, 2： bad)	1.095	0.091	-	0.226	0.997	-0.003	-	0.169	0.058
Perioral muscle (1: good, 2： bad)	1.024	0.024	-	0.179	0.848	-0.165	-	0.029	0.168
Left–right asymmetric movement of the mouth angle (1: good, 2： bad)	0.935	-0.067	-	0.095			-		
Swallowing (1: good, 2： bad)	1.131	0.123	-	0.272	0.995	-0.005	-	0.174	0.063
Coughing(1: no, 2： yes)	1.124	0.117	-	0.242	1.056	0.054	-	0.198	0.001

Changes in voice quality after swallowing (1: no abnormality，2： abnormality)	1.069	0.067	-	0.236	0.952	-0.049	-	0.135	0.364
Respiratory observation after swallowing (1: good，2： bad)	0.891	-0.116	-	0.145			-		
Rinsing (1: possible，2: impossible)	1.091	0.087	-	0.227	1.010	0.010	-	0.174	0.029
Oral residue (1: no，2: yes)	1.008	0.008	-	0.136	0.926	-0.077	-	0.058	0.779

CI, confidence interval; MWST, Modified Water Swallowing Test

; ODK, Oral Diadochokinesis;

OR, odds ratio;

RSST, Repetitive Saliva Swallowing Test.

Figure Captions

Fig. 1 Flow chart of study participants