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Oral health management by dental hygienists and older adults' food forms in long-term care facilities: a 1-year longitudinal study

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Abstract

Objective: To date, no studies have directly investigated the association between oral health management (OHM) and food forms. Therefore, this study aimed to investigate the association between OHM by dental hygienists and food forms in older adults admitted to long-term care facilities (LTCFs).

Background: OHM involves oral health maintenance by dental hygienists and may prevent weight loss and pneumonia in older adults admitted to LTCFs.

Materials and Methods: Older adults in LTCFs in Japan (n = 273) who participated in baseline (2018) and follow-up (2019) surveys were evaluated. Basic characteristics, medical history, OHM status, oral maintenance management status, food forms, and oral conditions were investigated at baseline. After one year, a follow-up survey was conducted only on food items. Furthermore, factors associated with the maintenance or improvement in food forms after one year were examined using binomial logistic regression analysis.

Results: Overall, 273 (69.2%) older adults in LTCFs required OHM by dental hygienists during the follow-up year, of whom 142 (52.0%) received OHM and 88 maintained or improved their regular diet. The analyses revealed that the maintenance or improvement in food forms after one year was significantly associated with OHM implementation (odds ratio: 2.01, 95% confidence interval: 1.03–3.90).

Conclusion: OHM in older adults in Japanese LTCFs was associated with the maintenance or improvement in food forms, emphasizing the importance of OHM for these individuals. OHM may also maintain or improve eating and swallowing functions, improving nutritional status.

Keywords: older adults, food form, long-term care facilities, oral health management

1. Introduction

Japan is the world's most prominent super-aging society, with an increasing population of older adults admitted to long-term care (LTC) facilities (LTCFs). In several cases, older adults in LTCFs are prescribed a dysphagia diet to prevent aspiration due to a decline in eating and swallowing functions.[1] However, a dysphagia diet may have poor appearance or taste and reduced nutritional value, resulting in dehydration and an impaired quality of life.[2-7]

The importance of oral healthcare for preventing pneumonia has been recognized by healthcare professionals, such as nursing care workers and nurses, in Japan. Therefore, medical insurance support encouraging home-visit dental treatments and oral health management (OHM) by dental hygienists was introduced into LTC insurance services. In 2018, we conducted a multicenter longitudinal study including older adults in LTCFs in Japan and found an association between OHM and a reduced pneumonia incidence.[8]

Another study using data from our multicenter longitudinal study showed that regular home-visit dental treatments and OHM reduced weight loss.[9] Other studies have found an association between weight loss among older adults in LTCFs and the transition from a regular diet to a dysphagia diet[10](Figure 1).

Based on the abovementioned three studies,[8-10] it was inferred that OHM might maintain or improve food forms and eating and swallowing functions and prevent malnutrition and pneumonia. However, previous studies did not directly examine the relationship between OHM and maintenance or improvement in food forms.

Thus, we hypothesized that implementing OHM in older adults in LTCFs would maintain or improve their food forms and conducted a longitudinal study to clarify this association.

2. Materials and methods

2.1. Study design

This was a one-year multicenter longitudinal study comprising Japanese LTCF residents.

2.2. Participants

Before conducting the survey, 30 members of the Japanese Society of Gerodontology Study Working Group were trained on the evaluation standards of the study to ensure consistency in the study methods. Each committee member subsequently explained the study contents to the institution's chief and staff of their corresponding facilities. The appointed committee members

collaborated with 35 facilities in 17 regions. In 2018, written explanations about the study were provided to all older adults requiring LTC and their families in 35 LTCFs. Written informed consent was obtained from 889 individuals or their surrogates; a baseline survey was conducted. A follow-up survey was conducted in 2019, with 545 individuals admitted to 25 cooperating LTCFs agreeing to participate. This study was approved by the Ethics Committee of the Japanese Society of Gerodontology (approval number: 2018-1, 2019-3) and the Epidemiological Research Ethics Committee of Hokkaido University (approval number: 2020-4) and was conducted according to the ethical principles of the Declaration of Helsinki.

2.3. Survey items

Before the 2018 survey, all nurses and registered dietitians in participating institutions received training on survey item evaluations using unified criteria. Subsequently, questionnaires were distributed to attending nurses and registered dietitians; patient information was collected. The 2019 survey followed a similar approach, with investigations conducted by each facility's nurses and registered dietitians.

2.3.1. Basic characteristics

During the baseline survey, the nurse in charge recorded the participants' age, sex, body mass

index (BMI), medical history (including stroke, respiratory disease, cardiovascular disease, neurodegenerative disease, neoplastic disease, and diabetes mellitus), and denture use using questionnaires. The nurse in charge assessed life function using the Barthel Index (BI).[11] Furthermore, cognitive function was assessed using the Clinical Dementia Rating (CDR)[12] based on Morris's assessment methods. A psychiatrist determined the final CDR scores.

2.3.2. OHM implementation

A facility nurse determined the need for dental hygienist-administered OHM in older adults in LTCFs based on the oral hygiene management manual published by the Japanese Society of Gerodontology. Furthermore, a dental hygienist performed OHM only after obtaining consent from the individual and family members. Older adults in LTCFs were determined to be candidates for OHM by a dental hygienist if their caregivers were unable to provide proper oral hygiene and they had impaired swallowing function or nutritional status or medical history of pneumonia, regardless if they were receiving tube feeding. OHM was prescribed as a combination of two types of management: oral hygiene management, by which the oral condition in older adults in LTCF was checked and technical advice and guidance related to oral care were provided to caregivers or oral cleaning guidance was provided to the patients themselves. The other type was oral function management, by which oral function improvement training and eating and swallowing function

training were provided based on information obtained after oral function and meal rounds were conducted. OHM was conducted on an individual basis according to the participant's oral and physical conditions. Dental hygienists performed OHM at least twice a month and provided specific technical advice and guidance to nursing staff, including oral hygiene and dietary habit guidelines for managing the participants (implementation of oral cleaning according to the risk of older adults in LTCFs [e.g., if older adults in LTCFs had dysphagia, suctioning should be performed during plaque removal or thorough wiping with an oral cleaning sheet because aspiration pneumonia was likely to occur as a complication, etc.], confirmation of eating conditions, eating patterns, and guidance for oral functions such as eating and swallowing).[8,13,14] We defined these cases under OHM.

2.3.3. Implementation of oral maintenance management

Oral maintenance management involves creating an oral maintenance plan for individuals who, despite orally ingesting food, have dysphagia and exhibit signs of aspiration in assessments such as water swallowing tests, video endoscopy, and video fluorography. In situations of multidisciplinary teams conducting monthly observations and meetings, oral maintenance management was implemented when sustained oral intake of meals for these individuals was promoted and appropriate considerations were taken regarding dietary forms and eating methods to prevent aspiration and

facilitate continued oral intake of food.[15]

2.3.4. Nutritional intake status

The facility's dietitian calculated the daily intake (calories) based on the daily amount of provided food (calories) and percentages recorded by the nurses and caregivers after visually checking the amount of food remaining after each meal. Based on dietary intake and weight loss research,[16] the residents were classified into the poorly nourished group if their dietary intake was < 75% of the normal requirement in the preceding week, whereas those with dietary intake ≥75% were classified into the well-nourished group.

2.3.5. Food forms

The dietitian in charge classified the dysphagia diets according to the Japanese Dysphagia Diet 2013 guidelines[17] proposed by the Japanese Society of Dysphagia Rehabilitation. The food form contents investigated this time were not prepared particularly for this study based on the diet taken by older adults in LTCFs. In addition, the diet contents that the participants in this study usually took were referred to. Codes 0–4 denoted dysphagia diets, whereas regular diets comprised those that did not require any other processing or contrivance, those that were finely chopped or thickened, and those that were harder but softer than the dysphagia diet and could be chewed with less force.

2.4. Baseline oral conditions

Overall, 20 trained dentists and 10 dental hygienists (3–10 per facility) surveyed the oral cavities of older adults in LTCFs using the standardized evaluation criteria.

The teeth in the present study were defined as the total number of teeth erupting into the oral cavity, excluding roots with disintegrated crowns and teeth affected by severe periodontitis. The nursing staff in charge confirmed if the participants used removable dentures while eating. The participants who used removable dentures while eating were considered denture users. Conversely, if a patient ate using only their own teeth and possessed dentures but did not use them during meals, they were considered to be non-denture users.

The participants' swallowing function was evaluated using the dysphagia screening questionnaire developed by Ohkuma et al.[18] This questionnaire comprised 15 items reflecting pneumonia history, nutritional status, and oral, pharyngeal, esophageal, and epiglottis functions. Each question is answered on a three-point scale of "A: severe symptoms," "B: mild symptoms," or "C: no symptoms." We rated the participants as "having dysphagia" if their answer to any of the 15 items was A, "having signs of dysphagia" if their answer to any item was B, and "non-dysphagia" if all answers were C.[19]

2.5. Statistical analyses

The participants were classified into two groups, namely those who consumed a regular diet (regular diet group) or a dysphagia diet (dysphagia diet group) in 2018; the two groups were compared based on item-specific criteria. The regular diet group was subsequently divided into two groups: those who maintained a regular diet after one year (RR group) and those who changed from a regular diet to a dysphagia diet (RD group). The dysphagia diet group was also divided into two groups: those who improved to a regular diet (DR group) and those who maintained a dysphagia diet (DD group) (Figure 2). Subsequently, the chi-squared test for categorical variables was used to compare the combined RR and DR group (RR + DR group) and RD group (Table 2). The Kolmogorov–Smirnov test was performed to check for normality. Subsequently, the Mann–Whitney U test was used to analyze continuous variables.

A binomial logistic regression analysis was conducted to investigate factors associated with maintaining and improving food forms among older adults in LTCFs after one year. The dependent variable was the maintenance or improvement in food forms after one year, whereas the independent variable was OHM implementation. The adjustment variables were age, sex, BI[20] reported to be associated with food forms, CDR,[21] swallowing function,[22] present teeth,[23] denture use,[24] implementation of oral maintenance management[15] reported to be associated with swallowing function, and medical history of stroke.[25] Odds ratios (ORs) (with 95% confidence intervals [CIs]) were calculated. Statistical analyses were performed using SPSS Statistics version 29 (IBM,

Armonk, NY, USA), and statistical significance was set at a P-value <0.05.

3. Results

Among the 889 older adults in LTCFs who underwent the baseline survey in 2018, 545 were still living in LTCFs in this follow-up study. Based on the 2018 baseline survey, two individuals in the parenteral ingestion group, 29 in the poorly nourished group, and 133 in the group were not eligible for OHM and excluded from the study. The final analysis dataset included data of 273 patients (51 men [18.7%], 222 women [81.3%], [median age: 87.0 years; 82.0–92.0 years]) who required OHM (Figure 2).

Table 1 lists the baseline characteristics of the study participants. A comparison between 173 participants in the regular diet group (63.4%) and 100 in the dysphagia diet group (36.6%) revealed that the regular diet group had higher BI scores, a lower proportion of cognitively impaired participants with CDR scores of ≥ 1, more participants without dysphagia in the dysphagia screening questionnaire, and significantly fewer participants with OHM and oral maintenance management than did the dysphagia diet group (Table 1).

Table 2 reveals that 100 (36.6%) of the 273 older adults in LTCFs changed from a regular diet to a dysphagia diet. No significant difference was observed in any survey item at baseline between the RR

+ DR and RD groups (Table 2).

Table 3 shows the results of binomial logistic regression analysis, with maintenance or improvement in food forms after one year as the dependent variable. Factors related to maintenance or improvement in food forms were OHM implementation (OR: 2.01, 95% CI: 1.03–3.90), sex (female) (OR: 2.47, 95% CI: 1.02–5.96), and denture use (OR: 2.47, 95% CI: 1.09–5.60) (Table 3).

4. Discussion

This study revealed that OHM implementation was associated with maintaining or improving food forms among older adults in LTCFs. Our previous study[8] showed that OHM was associated with a reduced incidence of pneumonia. In addition, a study on the effect of oral healthcare on airway protective reflexes has shown that oral healthcare once a day significantly improves the swallowing and coughing reflexes in older adults in LTCFs. This suggests that oral healthcare and swallowing rehabilitation can also improve swallowing function.[26] The present findings and those in our previous studies[8-10] suggest the existence of a mechanism through which oral function management, a goal of OHM, can maintain or improve food forms and eating and swallowing functions and reduce the risk of undernutrition and pneumonia (Figure 1).

OHM by dental hygienists not only provides efficient and effective oral cleaning according to the oral health status of older adults in LTCFs, but also is recommended to promote the maintenance and improvement in oral functions such as mastication and swallowing functions, in addition to managing dentures and improving nutritional status.[23]

Dysphagia diets are essential for older adults in LTCFs with impaired swallowing function. However, the transition to a dysphagia diet is associated with an imbalance in nutritional intake, resulting in weight and muscle loss, which may potentially result in sarcopenia.[27,28] Sarcopenia is associated with the loss of masticatory, swallowing, skeletal, and respiratory muscles, which deteriorates masticatory and swallowing functions, induces further undernutrition and sarcopenia, and increases the risk of aspiration pneumonia.[28-31] Conversely, the maintenance or improvement in food forms by implementing OHM may reduce the risk of sarcopenia. This approach can potentially prevent atrophy in muscles crucial for eating and swallowing, reducing the incidence of undernutrition and pneumonia.

Oral hygiene management has garnered attention to date when considering OHM implementation and pneumonia incidence reduction[32]; however, our series of research has demonstrated the mechanism through which oral function management also contributes to the prevention of

pneumonia. By presenting this evidence, we suggest that this study will greatly contribute to the widespread use of OHM.

In this study, experts in swallowing disorders did not determine the food forms of all residents using detailed tests such as video fluorography or video endoscopy. Nevertheless, these tests are not frequently available in LTCFs and do not necessarily allow for routine assessment of eating and swallowing functions since they are performed in different environments. In this study, the food form was determined based on the nutritional status. A previous study found that if the food form provided to older adults in LTCFs is inappropriate, their nutritional intake will be poor[33]; therefore, we excluded the poorly nourished group from the analysis (Figure 2). A 2017 review of texture-modified foods reported that 26–67% of residents in LTCFs consumed a dysphagia diet,[3] which is consistent with our findings. In addition, the BI score was higher in the regular diet group than in the dysphagia diet group in 2018, and fewer people had cognitive decline of CDR ≥ 1 and swallowing decline (Table 1). These findings are similar to those in our previous studies[10,34] on food forms in older adults in LTCFs, and the methods are compliant. Based on these findings, we suggest that the participants in this study were provided with an appropriate food form.

An intervention study is necessary to assess the effect of OHM on maintaining or improving food

forms. However, arbitrarily creating groups that implement and do not implement OHM based on a study by Yoneyama et al.[32] is problematic which formed the basis for introducing OHM to Japan's LTC insurance. In contrast, our study was observational.

The baseline survey aimed to understand the oral health of older adults in LTCFs and prompted collaboration with numerous facilities for participant recruitment. Therefore, 273 participants were followed up for one year. The sample size was considered sufficient, even when compared with previous studies.[35,36]

In Japan, the food forms of the older adults in LTCFs were classified into six stages and regular diets into three stages based on the 2013 classification of dysphagia diet by the Japanese Society of Dysphagia Rehabilitation, a standard for classifying food forms.[17]In the present study, the number of patients, in each of these 9 stages, was taken into account and classified into 2 levels: regular and dysphagia diets. Foods that were finely chopped; thickened; or otherwise processed or devised; and those that were firmer than dysphagia diet but softer and could be chewed with less force, were classified as regular diet. According to the Japanese Dysphagia Diet 2013 guidelines, finely chopped foods that have been sufficiently softened with an intermediate or thickened consistency fell under codes 3 and 4. However, chopped foods that were too hard to be crushed between the upper and lower

alveolar adnexa and those with thin thickening were not appropriate as dysphagia diet, thereby considered regular diet. Since each LTCF had its own cooking methods and standards for food, judging the physical properties of the finished product is necessary.[17] In this study, the distinction between regular and dysphagia diets was made based on discussions with dietitians and prior standardization of food forms, while the distinction between regular and dysphagia diets was made in accordance with previous studies.[9,10,34] Therefore, it should be noted that the International Dysphagia Diet Standardisation Initiative framework criteria and Japanese Dysphagia Diet 2013 guidelines differ in some aspects of the concept of chopped meals.

The average age of participants, proportion of women, proportion of participants with cognitive decline with CDR of ≥1, BI score, proportion of participants with BMI < 18.5 kg/m^2, and proportion of individuals who consumed regular and dysphagia diets in the recent three previous Japanese studies targeting older adults in LTCFs[35-37] were similar to those in this study (Table 1).

In a study involving older adults in LTCFs in Finland,[38] the proportion of female participants was 82%, with a mean age of 83.0 ± 7.3 years, a cognitive decline with CDR ≥1 of 82.0%, and a mean BMI of 25.4 kg/m^2. Another study involving older adults in LTCFs in Korea[39] showed that the proportion of female participants was 76.5%, with a mean age of 80.7 years, mild-to-severe

cognitive impairment of 89.5%, and a mean BMI of 21.0±3.6 kg/m^2. Moreover, among the participants in that study, 23.0% were prescribed dysphagia diets for swallowing difficulties. The mean age and cognitive decline of the participants in the present study were higher than those of the participants in studies performed in other countries. In Japan, 28.4% of the total population comprises older adults, which is the highest globally,[40] and a high percentage of individuals show cognitive decline.[41] Considering these factors, the participants in this study could generally be regarded as older adults living in Japanese LTCFs. In addition, this study's participants may be considered a future model for older adults in LTCFs in countries with an aging population. However, considering the focus of this study on maintaining or improving food forms, it should be noted that those receiving parenteral ingestion, those who were poorly nourished, and those ineligible for OHM groups in 2018 were excluded from the analysis.

In this study, baseline characteristics of the 437 older adults followed up and 452 older adults who were not followed up in LTCF are shown in Appendix 1. Significant differences between older adults who were followed up and those who were lost to follow-up were found to be BI score, CDR, dysphagia, OHM, oral maintenance management, denture use, and stroke. The reason for the significant differences in these results is that the group that did not undergo follow-up included 344 older adults in LTCFs who were hospitalized or died. On the other hand, the characteristics in this

study seem to be comparable to those in the general population of Japanese older adults in LTCFs who can live for 1 year, because they did not differ from the baseline characteristics in longitudinal studies[42,43] investigating mortality in older adults in LTCFs. The baseline characteristics of the 273 older adults in LTCFs who participated in the 2018 and 2019 surveys in this study and then underwent OHM and 164 older adults in LTCFs who were lost to follow-up are shown in Appendix 2. The reason for the significant difference in these results is considered reasonable, as the population did not orally consumed food or was not provided with appropriate food forms, or wherein OHM was deemed unnecessary.

Compared with other factors, the participants in this study demonstrated an association between OHM implementation, sex, and the use of dentures. One of the reasons for this is that, unlike our study, no previous studies used OHM as an independent variable. Other studies[23] that investigated dentures and food forms had similar sample sizes but fewer independent variables. Another study[44] examining the impact of diet improvement on older adults in LTCFs receiving home-visit dental treatments also had a smaller sample size and fewer independent variables than our study, which may be a factor that should be accounted for when considering generalizability.

Among the examined independent variables, only OHM implementation, sex, and denture use were

associated with maintaining or improving food forms. No statistically significant differences were observed in age, CDR, swallowing function, BI, present teeth, medical history of stroke, or oral maintenance management (Table 3). Suspecting multicollinearity, we performed a correlation analysis but found no significant correlation between the independent variables. We suggest that no significant findings were obtained regarding age and CDR because the study participants were very old, with a median age of 87.0 years, and 90.1% had cognitive decline with a CDR of ≥1. Regarding the relationship between food forms and swallowing function, a previous study in Vietnam[45] employed the repetitive saliva swallowing test and found that the proportion of patients with dysphagia was 16.5%, with a mean age of the participants of 75.5±7.3 years. This was a cross-sectional study involving younger hospitalized patients; therefore, the findings may differ from those of the present study. In addition, a longitudinal study of Japanese older adults in LTCFs reported a relationship between food forms and dysphagia[35]. They reported that the proportion of women was 77.6%, the mean age was 85.1±7.7 years, and the proportion of patients with a BI score ≤ 20 was 35.7%, which was almost similar to those of our study. However, the modified water swallowing test and evaluation method differed in the swallowing function evaluation, and number of patients with dysphagia was as low as 28.8%, which differs from the findings of the present study. Regarding the relationship between food forms and BI, participants of a previous study[20] were older Japanese adults in LTCFs. However, the BI score was high at 64.2, and the proportion of people with cognitive decline with a CDR of ≥1

was small (53.0 %). Therefore, these findings may have differed from those of the present study. The present study was a longitudinal study; however, it is necessary to carefully examine the relationship between age, CDR, swallowing function, BI, and food forms in the future because this study was conducted on older adults with a severe need for LTC.

The findings of this study revealed that more women were associated with maintaining or improving food form than men. Consistent with our findings, a previous cohort study in Korea reported that male sex was a risk factor for dysphagia in older adults[46]. Furthermore, an association between dysphagia and food forms has been reported[35]. Therefore, the female sex may have been associated with maintenance or improvement of food forms in the present study.

Regarding denture use, a significant association with food forms was reported in a cross-sectional study using the same participants evaluated in this study[24], and our current longitudinal study showed similar findings. Recovery of chewing ability through wearing a denture has been reported to result in the recovery of bolus transport and shortening of the pharyngeal transit time[47,48]; therefore, dentures may maintain oral function necessary for oral intake, thereby maintaining or improving the food form. In contrast, present teeth showed no association with the change in food form, which is inconsistent with the findings of a previous cross-sectional study[23,24] that reported a significant association between

present teeth and food form. The lack of a significant association in this study may be because the present study was a longitudinal study that focused on changes in food form.

No relationship was observed between oral maintenance management and food forms. The number of participants who implemented oral maintenance management was three (4.1%) in the RR group, four (26.7%) in the DR group, and 16 (16.0%) in the RD group. The higher implementation rate in the DR group suggests a certain level of effectiveness in maintaining or improving food forms. However, the number of service providers may have been small, resulting in no observed significant association. Therefore, further studies including the details of this service are necessary in the future.

Dysphagia occurs in 30–70% of patients with stroke, according to a systematic review of cerebrovascular disorders[25], and is reported to be associated with food forms[35]; therefore, we examined the correlation between food forms and medical history of stroke, but no significant correlation was observed. In a previous study, dysphagia at the onset of stroke was observed in 51% of the patients but decreased to 27% after one week, 17% after one month, and 11% after six months. Dysphagia tends to gradually recover after onset in patients with stroke.[49] The absence of a significant association between a medical history of stroke and maintenance or improvement of food forms in the present study can be attributed to participants being older adults in LTCFs. This population was likely in the

maintenance phase, rather than in the acute phase of stroke. Future studies should include the onset time of stroke.

This study had a few limitations. First, institutional sampling may be biased since the surveyed facilities in this study were members of the Society of Geriatrics and Dentistry. Furthermore, this study focused on maintaining or improving food forms; therefore, a considerable number of individuals were excluded from the analysis, including those who were non-oral users, had poor nutritional intake, and were ineligible for OHM as of 2018 (such as those who could take care of themselves and edentulous individuals who could gargle). Therefore, the large number of excluded individuals may have introduced bias. Second, we did not account for the emergence of new diseases, exacerbation of existing conditions, or performance of dental treatments affecting oral intake during the observation period. However, considering these events' infrequent and individual nature, we suggest that their impact on the findings was minimal. Finally, the need for OHM is almost standardized in the evaluation criteria. However, the content of OHM services was provided by dental hygienists on an individual basis according to the condition of older adults in LTCFs. For instance, this study included older adults in LTCFs with severe dry mouth and crusted skin and those with choking due to hypersalivation who required constant suctioning, each of which required different processes and guidelines. To assess the effects of OHM in more details, further research including details on the type

of care, duration, frequency, and other aspects of the services is necessary.

5. Conclusions

OHM in older adults living in LTCFs in Japan was associated with maintaining or improving food forms. Our findings provide a rationale for elucidating the mechanism through which regular implementation of OHM contributes to the maintenance or improvement of food forms, namely, the preservation or improvement of eating and swallowing functions, resulting in the maintenance of nutritional status and pneumonia prevention. We suggest that our findings will contribute to the further development of OHM.

Author contributions

Conceptualization, K.I., Y.W., Y.O., M.I., and M.Y.; formal analysis, K.I., Y.W., Y.O., and M.I.; investigation, Y.W., M.T., T.K., M.Y., and H.H.; data curation, K.I., Y.W., K.O., M.Y., and H.H.; writing—original draft preparation, K.I., K.O., and Y.W.; writing—review and editing, K.I., Y.W., K.O., Y.O., M.I., H.H., M.T., T.K., M.Y., S.M. and Y.Y.; supervision, H.H., S.M., and Y.Y.; project administration, Y.W., Y.O., M.I., M.Y. and Y.Y.; funding acquisition, Y.W., S.M., M.Y., and Y.Y. All authors have read and agreed to the published version of the manuscript.

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Conflict of interest statement

The authors declare no conflict of interest.

Data availability statement

The data presented in this study are available on request from the corresponding author. The data are not publicly available due to ethical-legal restrictions imposed by the Ethics Committee at the

1 Japanese Society of Gerodontology.

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References

1. Dietitians Association of Australia, The Speech Pathology Association of Australia Limited.Texture-modified foods and thickened fluids as used for individuals with dysphagia: Australian standardised labels and definitions. Nutr Diet. 2007;64(s2):S53-S76. doi:10.1111/j.1747-0080.2007.00153.x.

2. Keller H, Chambers L, Niezgoda H, Duizer L. Issues associated with the use of modified texture foods. J Nutr Health Aging. 2012;16(3):195-200. doi:10.1007/s12603-011-0160-z.

3. Painter V, Le Couteur DG, Waite LM. Texture-modified food and fluids in dementia and residential aged care facilities. Clin Interv Aging. 2017;12:1193-1203. doi:10.2147/cia.S140581.

4. Germain I, Dufresne T, Gray-Donald K. A novel dysphagia diet improves the nutrient intake of institutionalized elders. J Am Diet Assoc. 2006;106(10):1614-1623. doi:10.1016/j.jada.2006.07.008.

5. Newman R, Vilardell N, Clavé P, Speyer R. Effect of Bolus Viscosity on the Safety and Efficacy of Swallowing and the Kinematics of the Swallow Response in Patients with Oropharyngeal Dysphagia: White Paper by the European Society for Swallowing Disorders (ESSD). Dysphagia. 2016;31(2):232-249. doi:10.1007/s00455-016-9696-8

6. Easterling CS, Robbins E. Dementia and dysphagia. Geriatr Nurs. 2008;29(4):275-285. doi:10.1016/j.gerinurse.2007.10.015

7. Swan K, Speyer R, Heijnen BJ, Wagg B, Cordier R. Living with oropharyngeal dysphagia: effects of bolus modification on health-related quality of life--a systematic review. Qual Life Res. 2015;24(10):2447-2456. doi:10.1007/s11136-015-0990-y

8. Hama K, Iwasa Y, Ohara Y, et al. Pneumonia incidence and oral health management by dental hygienists in long-term care facilities: A 1-year prospective multicentre cohort study. Gerodontology. 2022;39(4):374-383.doi:10.1111/ger.12604.

9. Sunakawa Y, Tsugayasu H, Watanabe Y, et al. Relationship between weight loss and regular dental management of older adults residing in long-term care facilities: a 1-year multicenter longitudinal study. Eur Geriatr Med. Feb 2022;13(1):221-231. doi:10.1007/s41999-021-00576-3.

10. Endo A, Watanabe Y, Matsushita T, et al. Association between Weight Loss and Food Form in Older Individuals Residing in Long-Term Care Facilities: 1-Year Multicenter Longitudinal Study. Int. J. Environ. Res. Public Health. 2021;18(20):10776. doi:10.3390/ijerph182010776.

11. Nakazawa A, Nakamura K, Kitamura K, Yoshizawa Y. Association between activities of daily living and mortality among institutionalized elderly adults in Japan. J Epidemiol. 2012;22(6):501-507. doi:10.2188/jea.je20110153.

12. Morris JC. The Clinical Dementia Rating (CDR): current version and scoring rules. Neurology. 1993;43(11):2412-2414. doi:10.1212/wnl.43.11.2412-a.

13. Japan Dental Hygienists Association. Manual for Promotion of Oral Health Care in Facilities. https://www.jdha.or.jp/pdf/outline/suishinmanual.pdf Accessed November 14, 2024.

14. Japan Society of Gerodontology. Manual for Oral Hygiene Manegement for Residents of LTCFs, etc. https://www.gerodontology.jp/publishing/file/manual_2019.pdf Accessed November 14, 2024.

15. Mori H, Nakane A, Tohara H, Nakayama T. Evaluation of preventive care for swallowing difficulty through policy changes in Japanese long-term care insurance: analysis of a nationwide claims dataset for long-term care insurance. BMC Health Serv Res. 2023;23(1):1053. doi: 10.1186/s12913-023-09990-8.

16. Kondrup J. Can food intake in hospitals be improved? Clin Nutr. 2001;20:153-160. doi:10.1054/clnu.2001.0417.

17. Matsuo K, Fujishima I. Textural Changes by Mastication and Proper Food Texture for Patients with Oropharyngeal Dysphagia. Nutrients. 2020;12(6):1613. doi:10.3390/nu12061613.

18. Ohkuma R, Fujishima I, Kojima C, Hojo K, Takehara I, Motohashi Y. Development of a questionnaire to screen dysphagia. Jpn J Dysphagia Rehabil. 2002;6(1):3-8. doi:10.32136/jsdr.6.1_3.

19. Kawashima K, Motohashi Y, Fujishima I. Prevalence of Dysphagia Among Community-Dwelling Elderly Individuals as Estimated Using a Questionnaire for Dysphagia Screening. Dysphagia. 2004;19(4):266-271. doi:10.1007/s00455-004-0013-6.

20. Suzuki R, Kikutani T, Yoshida M, Yamashita Y, Hirayama Y. Prognosis-related factors concerning oral and general conditions for homebound older adults in Japan. Geriatr Gerontol Int. 2015;15(8):1001-1006. doi:10.1111/ggi.12382.

21. Liu W, Williams K, Batchelor-Murphy M, Perkhounkova Y, Hein M. Eating performance in relation to intake of solid and liquid food in nursing home residents with dementia: A secondary behavioral analysis of mealtime videos. Int J Nurs Stud. 2019;96:18-26.

doi:10.1016/j.ijnurstu.2018.12.010.

22. Ott A, Senger M, Lötzbeyer T, Gefeller O, Sieber CC, Volkert D. Effects of a Texture-Modified, Enriched, and Reshaped Diet on Dietary Intake and Body Weight of Nursing Home Residents with Chewing and/or Swallowing Problems: An Enable Study. J Nutr Gerontol Geriatr. 2019;38(4):361-376. doi:10.1080/21551197.2019.1628158.

23. Nomura Y, Okada A, Kakuta E, et al. Consistency of supplied food and dentition status of the elderly in residential care homes. BMC Oral Health. 2019;19(1):74. doi:10.1186/s12903-019-0770-0.

24. Taira K, Watanabe Y, Okada K, et al. Association between denture use and food form in older adults requiring long-term care: A multicenter cross-sectional study. JPR. 2022;67(3):366-375. doi:10.2186/jpr.jpr_d_21_00161.

25. Martino R, Foley N, Bhogal S, Diamant N, Speechley M, Teasell R. Dysphagia after stroke: incidence, diagnosis, and pulmonary complications. Stroke. 2005;36(12):2756-2763. doi:10.1161/01.STR.0000190056.76543.eb.

26. Ebihara S, Kohzuki M, Sumi Y, Ebihara T. Sensory stimulation to improve swallowing reflex and prevent aspiration pneumonia in elderly dysphagic people. J Pharmacol Sci. 2011;115(2):99-104. doi:10.1254/jphs.10r05cp

27. Rodríguez-Rejón AI, Ruiz-López MD, Artacho R. Dietary Intake and Associated Factors in Long-Term Care Homes in Southeast Spain. Nutrients. 2019;11(2):266. doi:10.3390/nu11020266.

28. Okazaki T, Ebihara S, Mori T, Izumi S, Ebihara T. Association between sarcopenia and pneumonia in older people. Geriatr Gerontol Int. 2020;20(1):7-13. doi:10.1111/ggi.13839.

29. Murakami M, Hirano H, Watanabe Y, Sakai K, Kim H, Katakura A. Relationship between chewing ability and sarcopenia in Japanese community-dwelling older adults. Geriatr Gerontol Int. 2015;15(8):1007-1012. doi:10.1111/ggi.12399.

30. Komatsu R, Okazaki T, Ebihara S, et al. Aspiration pneumonia induces muscle atrophy in the respiratory, skeletal, and swallowing systems. J Cachexia Sarcopenia Muscle. 2018;9(4):643-653. doi:10.1002/jcsm.12297.

31. Lo WL, Leu HB, Yang MC, Wang DH, Hsu ML. Dysphagia and risk of aspiration pneumonia: A nonrandomized, pair-matched cohort study. J Dent Sci. 2019;14(3):241-247.

doi:10.1016/j.jds.2019.01.005.

32. Yoneyama T, Yoshida M, Ohrui T, et al. Oral care reduces pneumonia in older patients in nursing homes. J Am Geriatr Soc. 2002;50(3):430-433. doi:10.1046/j.1532-5415.2002.50106.x.

33. Ballesteros-Pomar MD, Cherubini A, Keller H, Lam P, Rolland Y, Simmons SF. Texture-Modified Diet for Improving the Management of Oropharyngeal Dysphagia in Nursing Home Residents: An Expert Review. J Nutr Health Aging. 2020;24(6):576-581. doi:10.1007/s12603-020-1377-5.

34. Takeda M, Watanabe Y, Matsushita T, et al. Observational Variables for Considering a Switch from a Normal to a Dysphagia Diet among Older Adults Requiring Long-Term Care: A One-Year Multicenter Longitudinal Study. Int J Environ Res Public Health. 2022;19(11):6586. doi:10.3390/ijerph19116586.

35. Takahashi N, Kikutani T, Ebihara K, et al. Factors associated with the maintenance in food texture for dependent older people with dysphagia living in nursing home - A retrospective cohort study. Spec Care Dentist. 2023;1-7. doi:10.1111/scd.12937.

36. Sato E, Hirano H, Watanabe Y, et al. Detecting signs of dysphagia in patients with Alzheimer's disease with oral feeding in daily life. Geriatr Gerontol Int. 2014;14(3):549-555. doi:10.1111/ggi.12131.

37. Hoshino D, Watanabe Y, Edahiro A, et al. Association between simple evaluation of eating and swallowing function and mortality among patients with advanced dementia in nursing homes: 1-year prospective cohort study. Arch Gerontol Geriatr. 2020;87:103969. doi:10.1016/j.archger.2019.103969.

38. Saarela RK, Lindroos E, Soini H, et al. Dentition, nutritional status and adequacy of dietary intake among older residents in assisted living facilities. Gerodontology. 2016;33(2):225-232. doi:10.1111/ger.12144.

39. Park YH, Han HR, Oh BM, et al. Prevalence and associated factors of dysphagia in nursing home residents. Geriatr Nurs. 2013;34(3):212-217. doi:10.1016/j.gerinurse.2013.02.014.

40. Ministry of Health Labour, Welfare. General Welfare and Labour. https://warp.da.ndl.go.jp/info:ndljp/pid/13768595/www.mhlw.go.jp/english/wp/wp-hw13/dl/01e.pdf Accessed November 22, 2023.

41. Organization for Economic Cooperation & Development. Health at a Glance 2019. https://www.oecd.org/en/publications/health-at-a-glance-2019_4dd50c09-en.html Accessed November 15, 2023.

42. Morishita S, Ohara Y, Iwasaki M, et al. Relationship between Mortality and Oral Function of Older People Requiring Long-Term Care in Rural Areas of Japan: A Four-Year Prospective Cohort Study. Int J Environ Res Public Health. 2021;18(4):1723. doi:10.3390/ijerph18041723

43. Mikami Y, Watanabe Y, Edahiro A, et al. Relationship between mortality and Council of Nutrition Appetite Questionnaire scores in Japanese nursing home residents. Nutrition. 2019;57:40-45. doi:10.1016/j.nut.2018.05.030

44. Kikuchi H, Komatsuzaki A, Ono S, et al. Factors Affecting Dietary Improvements in Elderly Residents of Long-Term Care Institutions Receiving Domiciliary Dental Care. Medicines (Basel). 2021;8(11):62. doi:10.3390/medicines8110062

45. Tran TP, Nguyen LT, Kayashita J, Shimura F, Yamamoto S. Nutritional Status and Feeding Practice among Dysphagic Older Adult Inpatients in Vietnam. J Nutr Sci Vitaminol (Tokyo). 2020;66(3):224-228. doi:10.3177/jnsv.66.224.

46. Yang EJ, Kim MH, Lim JY, Paik NJ. Oropharyngeal Dysphagia in a community-based elderly cohort: the Korean longitudinal study on health and aging. J Korean Med Sci. 2013;28(10):1534-1539. doi:10.3346/jkms.2013.28.10.1534.

47. Yamamoto H, Furuya J, Tamada Y, Kondo H. Impacts of wearing complete dentures on bolus transport during feeding in elderly edentulous. J Oral Rehabil. 2013;40(12):923-931. doi:10.1111/joor.12107.

48. Yoshida M, Masuda S, Amano J, Akagawa Y. Immediate effect of denture wearing on swallowing in rehabilitation hospital inpatients. J Am Geriatr Soc. 2013;61(4):655-657. doi:10.1111/jgs.12186.

49. Smithard DG, O'Neill PA, England RE, et al. The natural history of dysphagia following a stroke. Dysphagia. 1997;12(4):188-193. doi:10.1007/pl00009535.

Figure legends

Figure 1. Previous studies including older adults in long-term care facilities

Black arrows indicate areas that have been identified in our previous studies, numbered in the respective references. Open arrows indicate areas we wish to clarify in this study.

OHM by dental hygienists is provided twice a month to the nursing staff to provide daily oral care support, including instructions on oral cleaning and professional advice and guidance on oral functions such as eating and swallowing. Home-visit dental treatments are used to treat dental diseases, thus improving the oral health and function of older adults in LTCFs. Based on our three previous studies, it was inferred that OHM may maintain or improve food forms and eating and swallowing functions and prevent malnutrition and pneumonia.

OHM: oral health management; LTCF: long-term care facility

Figure 2. Flowchart of the study participants

A baseline survey was conducted in 889 older adults in LTCFs. Two individuals in the parenteral ingestion group (0.2%), 29 in the poorly nourished group (3.3%), and 133 in the group ineligible for OHM based on the 2018 baseline survey (15.0%) were excluded from the analysis dataset. The remaining 273 (30.7%) participants were grouped according to their food forms in 2018. Of the 173 (63.4%) older adults in LTCFs who were on a regular diet: 73 (42.2%) maintained their regular diet, and 100 (57.8%) changed to a dysphagia diet. On the other hand, of the 100 (36.3%) who were on a dysphagia diet, 85 (85.0%) maintained a dysphagia diet, and 15 (15.0%) improved to a regular diet.

Table 1. Baseline characteristics of study participants and comparison of the regular and dysphagia diet groups

Variable	Overall (n = 273) Median, [Q1, Q3] n (%)	Dysphagia diet group (n =100) Median, [Q1, Q3] n (%)	Regular diet group (n = 173) Median, [Q1, Q3] n (%)	*P-value*
Age (years)	87.0 [82.0, 92.0]	88.0 [83.0, 92.0]	87.0 [82.0, 93.0]	0.886
Sex (female)	222 (81.3)	82 (82.0)	140 (80.9)	0.826
BMI	20.5 [18.5, 22.9]	19.5 [17.6, 21.4]	21.1 [19.0, 23.7]	0.419
BI score	25.0 [5.0, 50.0]	10.0 [0.0, 28.8]	35.0 [12.5, 60.0]	<0.001
CDR				
0,0.5	27 (9.9)	3 (3.0)	24 (13.9)	<0.001
1	52 (19.0)	14 (14.0)	38 (22.0)	
2	86 (31.5)	22 (22.0)	64 (37.0)	
3	108 (39.6)	61 (61.0)	47 (27.2)	
Dysphagia Screening Rating				

No dysphagia	42 (15.4)	5 (5.0)	37 (21.4)	
At risk of dysphagia	98 (35.9)	27 (27.0)	71 (41.0)	<0.001
Possibility of dysphagia	133 (48.7)	68 (68.0)	65 (37.6)	
Oral Condition				
OHM	142 (52.0)	75 (75.0)	67 (38.7)	<0.001
Oral Maintenance Management				
Not subject to implementation	178 (65.2)	32 (32.0)	146 (84.4)	
Not implemented	18 (6.6)	10 (10.0)	8 (4.6)	<0.001
Implementation	77 (28.2)	58 (58.0)	19 (11.0)	
Present Teeth	4.0 [0.0, 14.0]	4.0 [0.0, 12.0]	4.0 [0.0, 17.0]	0.589
Denture use	150 (54.9)	50 (50.0)	100 (57.8)	0.212
Medical history				
Stroke	91 (33.3)	34 (34.0)	57 (32.9)	0.859
Respiratory disease	34 (12.5)	17 (17.0)	17 (9.8)	0.084
Cardiovascular disease	97 (35.5)	43 (43.0)	54 (31.2)	0.050
Neurodegenerative disease	18 (6.6)	7 (7.0)	11 (6.4)	0.837
Neoplastic disease	30 (11.0)	13 (13.0)	17 (9.8)	0.419

Diabetes mellitus	44 (16.1)	15 (15.0)	29 (16.8)	0.703

Categorical variables are shown as numbers (percentages) and were analyzed using the chi-squared test.

Continuous variables were analyzed using the Mann–Whitney U test. Statistical significance was set at a P-value < 0.05.

Q1, first quartile; Q3, third quartile

BMI, body mass index; BI score, Barthel index score; CDR, clinical dementia rating; OHM, oral health management

Table 2. Group comparisons between the RR + DR and RD groups

	RD Group (n = 100)	RR＋DR Group (n =88)	
	Median [Q1, Q3]	Median [Q1, Q3]	
Baseline variable	n (%)	n (%)	*P-value*
Age (years)	86.5 [82.3, 93.0]	88.0 [82.0, 93.0]	0.062
Sex (female)	76 (76.0)	64 (87.7)	0.072
BMI	21.0 [18.8, 23.7]	21.1 [19.4, 23.6]	0.608
BI score	37.5 [10.0, 58.8]	40.0 [20.0, 58.8]	0.347
CDR			
0,0.5	14 (14.0)	11 (12.5)	
1	21 (21.0)	22 (25.0)	
2	38 (38.0)	32 (36.4)	0.929
3	27 (27.0)	23 (26.1)	
Dysphagia Screening Rating			
No dysphagia	19 (19.0)	19 (21.6)	

At risk of dysphagia	39 (39.0)	40 (45.5)	0.442
Possibility of dysphagia	42 (42.0)	29 (33.0)	
Oral Conditions			
OHM	34 (34.0)	42 (47.7)	0.056
Oral Maintenance Management			
Not subject to implementation	80 (80.0)	77 (87.5)	
Not implemented	4 (4.0)	4 (4.5)	0.244
Implementation	16 (16.0)	7 (8.0)	
Present Teeth	3.5 [0.0, 17.0]	6.5 [0.0, 16.0]	0.379
Denture use	52 (52.0)	58 (65.9)	0.053
Medical History			
Stroke	29 (29.0)	34 (38.6)	0.073
Respiratory disease	7 (7.0)	12 (13.6)	0.132
Cardiovascular disease	31 (31.0)	27 (30.7)	0.962
Neurodegenerative disease	5 (5.0)	8 (9.1)	0.270
Neoplastic disease	10 (10.0)	8 (9.1)	0.833

Diabetes mellitus	17 (17.0)	14 (15.9)	0.841

Categorical variables are shown as numbers (percentages) and were analyzed using the chi-square test.

Continuous variables were analyzed using the Mann–Whitney U test. Statistical significance was set at a P-value < 0.05.

Q1, first quartile; Q3, third quartile

BMI, body mass index; BI score, Barthel index score; CDR, clinical dementia rating; OHM, oral health management

RR group, those in the regular diet group who maintained a regular diet after one year; RD group, those in the regular diet group who changed from a regular diet to a dysphagia diet; DR group, those in the dysphagia diet group who improved to a regular diet.

Table 3. Binomial logistic regression with the maintenance or improvement of food forms after one year as the dependent variable

Independent variables	Adjusted OR*	95%CI*	P-value
Age (years)	1.00	0.96 — 1.04	0.933
Sex (female)	2.47	1.02 — 5.96	0.045
OHM	2.01	1.03 — 3.90	0.040
Oral Maintenance Management			
Not subject to implementation	1.00	（Reference）	
Not implemented	0.50	0.17 — 1.46	0.204
Implementation	2.35	0.50 — 11.12	0.282
BI score	1.00	0.99 — 1.02	0.924
CDR			
0,0.5	1.00	（Reference）	
1	1.65	0.56 — 4.84	0.359
2	1.60	0.57 — 4.54	0.375
3	1.83	0.52 — 6.43	0.346

Dysphagia screening rating				
No dysphagia	1.00	（Reference）		
At risk of dysphagia	1.05	0.45	— 2.48	0.908
Possibility of dysphagia	0.76	0.29	— 1.95	0.566
Present Teeth	1.04	0.99	— 1.08	0.106
Denture use	2.47	1.09	— 5.60	0.030
Stroke	1.46	0.73	— 2.90	0.284

*OR: odds ratio　CI: confidence interval

Dependent variable: The maintenance or improvement of food forms after one year.

0 = change from a regular diet to a dysphagia diet; 1 = maintenance or improvement of a regular diet

BMI, body mass index; BI score, Barthel index score; CDR, clinical dementia rating; OHM, oral health management

Appendix1: Characteristics of study participants and participants in 2018-2019 with other groups

Variable	Number of people who could be evaluated n(%)	Overall (n =889)	Participants in 2018-2019 (n =437)	No further participation in 2019 and Missing Data (n = 452)	
		Median, [Q1, Q3]	Median, [Q1, Q3]	Median, [Q1, Q3]	
		n (%)	n (%)	n (%)	*P-value*
Age (years)	877 (98.7)	87.0 [82.0, 93.0]	87.0 [82.0, 92.0]	88.0 [83.0, 93.0]	0.304
Sex (female)	877 (98.7)	699 (78.6)	356 (81.5)	343 (75.9)	0.056
BMI	882 (99.2)	20.1 [17.7, 22.5]	20.7 [18.5, 22.9]	19.5 [17.1, 22.0]	0.200
BI score	885 (99.6)	25.0 [5.0, 50.0]	30.0 [10.0, 55.0]	20.0 [0.0, 45.0]	0.006
CDR	873 (98.2)				
0,0.5		79 (8.9)	46 (10.5)	33 (7.3)	
1		153 (17.2)	92 (21.1)	61 (13.5)	<0.001
2		224 (25.2)	132 (30.2)	92 (20.4)	
3		417 (46.9)	167 (38.2)	250 (55.3)	
Dysphagia Screening Rating	864 (97.2)				
No dysphagia		144 (16.2)	88 (20.1)	56 (12.4)	
At risk of dysphagia		314 (35.3)	168 (38.4)	146 (32.3)	<0.001
Possibility of dysphagia		406 (45.7)	181 (41.4)	225 (49.8)	
Oral Condition					
OHM	885 (99.6)	327 (36.8)	155 (35.5)	172 (38.1)	<0.001
Oral Maintenance Management	886 (99.7)				

Not subject to implementation		598 (67.3)	320 (73.2)	278 (61.5)	
Not implemented		111 (12.5)	22 (5.0)	89 (19.7)	<0.001
Implementation		177 (19.9)	95 (21.7)	82 (18.1)	
Present Teeth	877 (98.7)	5.0 [0.0, 15.0]	5.0 [0.0, 16.0]	5.0 [0.0, 14.0]	0.267
Denture use	877 (98.7)	438 (49.3)	237 (54.2)	201 (44.5)	0.011
Medical history					
Stroke	889 (100)	333 (37.5)	145 (33.2)	188 (41.6)	0.010
Respiratory disease	889 (100)	126 (14.2)	56 (12.8)	70 (15.5)	0.253
Cardiovascular disease	889 (100)	312 (35.1)	146 (33.4)	166 (36.7)	0.300
Neurodegenerative disease	889 (100)	59 (6.6)	31 (7.1)	28 (6.2)	0.590
Neoplastic disease	889 (100)	98 (11.0)	46 (10.5)	52 (11.5)	0.642
Diabetes mellitus	889 (100)	153 (17.2)	65 (14.9)	88 (19.5)	0.070

Categorical variables are shown as numbers (percentages) and were analyzed using the chi-square test.

Continuous variables were analyzed using the Mann–Whitney U test. Statistical significance was set at a P-value < 0.05.

Q1, first quartile; Q3, third quartile

BMI, body mass index; BI score, Barthel index score; CDR, clinical dementia rating; OHM, oral health management

Appendix2: Comparison between groups comparison of subjects undergoing OHM and dropout groups

	Groups receiving OHM (n =273)	Dropout group (n =164)	
	Median [Q1, Q3]	Median [Q1, Q3]	
Variable	n (%)	n (%)	*P-value*
Age (years)	87.0 [82.0, 92.0]	87.0 [81.3, 92.0]	0.847
Sex (female)	222 (81.3)	134 (81.7)	0.919
BMI	20.5 [18.5, 22.9]	21.0 [18.6, 23.6]	0.472
BI score	25.0 [5.0, 50.0]	40.0 [15.0, 60.0]	0.055
CDR			
0,0.5	27 (9.9)	19 (11.6)	
1	52 (19.0)	40 (24.4)	0.490
2	86 (31.5)	46 (28.0)	
3	108 (39.6)	59 (36.0)	
Dysphagia Screening Rating			
No dysphagia	42 (15.4)	46 (28.0)	
At risk of dysphagia	98 (35.9)	70 (42.7)	<0.001
Possibility of dysphagia	133 (48.7)	48 (29.3)	
Oral Condition			
OHM	142 (52.0)	13 (7.9)	<0.001
Oral Maintenance Management			
Not subject to implementation	178 (65.2)	142 (86.6)	

Not implemented	18 (6.6)	4 (2.4)	<0.001
Implementation	77 (28.2)	18 (11.0)	
Present Teeth	4.0 [0.0, 14.0]	5.5 [0.0, 18.0]	0.663
Denture use	150 (54.9)	87 (53.0)	0.700
Medical history			
Stroke	91 (33.3)	54 (32.9)	0.930
Respiratory disease	34 (12.5)	22 (13.4)	0.771
Cardiovascular disease	97 (35.5)	49 (29.9)	0.225
Neurodegenerative disease	18 (6.6)	13 (7.9)	0.599
Neoplastic disease	29 (10.6)	17 (10.4)	0.932
Diabetes mellitus	44 (16.1)	21 (12.8)	0.346

Categorical variables are shown as numbers (percentages) and were analyzed using the chi-square test.

Continuous variables were analyzed using the Mann–Whitney U test. Statistical significance was set at a P-value < 0.05.

Q1, first quartile; Q3, third quartile

BMI, body mass index; BI score, Barthel index score; CDR, clinical dementia rating; OHM, oral health management

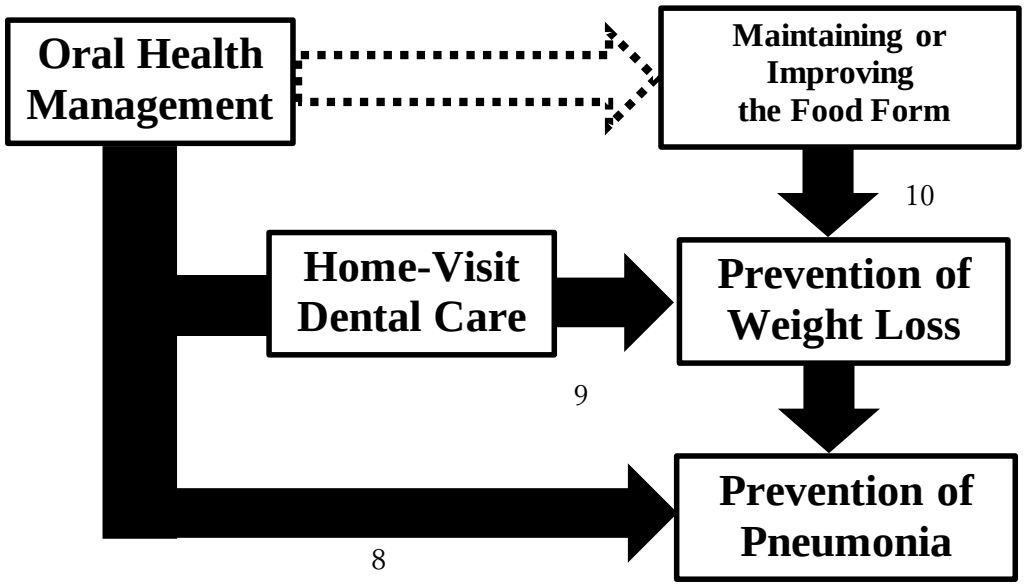


Figure 1. Previous studies including older adults in long-term care facilities

Black arrows indicate areas that have been identified in our previous studies, numbered in the respective references. Open arrows indicate areas we wish to clarify in this study.

OHM by dental hygienists is provided twice a month to the nursing staff to provide daily oral care support, including instructions on oral cleaning and professional advice and guidance on oral functions such as eating and swallowing. Home-visit dental treatments are used to treat dental diseases, thus improving the oral health and function of older adults in LTCFs. Based on our three previous studies, it was inferred that OHM may maintain or improve food forms and eating and swallowing functions and prevent malnutrition and pneumonia.

OHM: oral health management; LTCF: long-term care facility

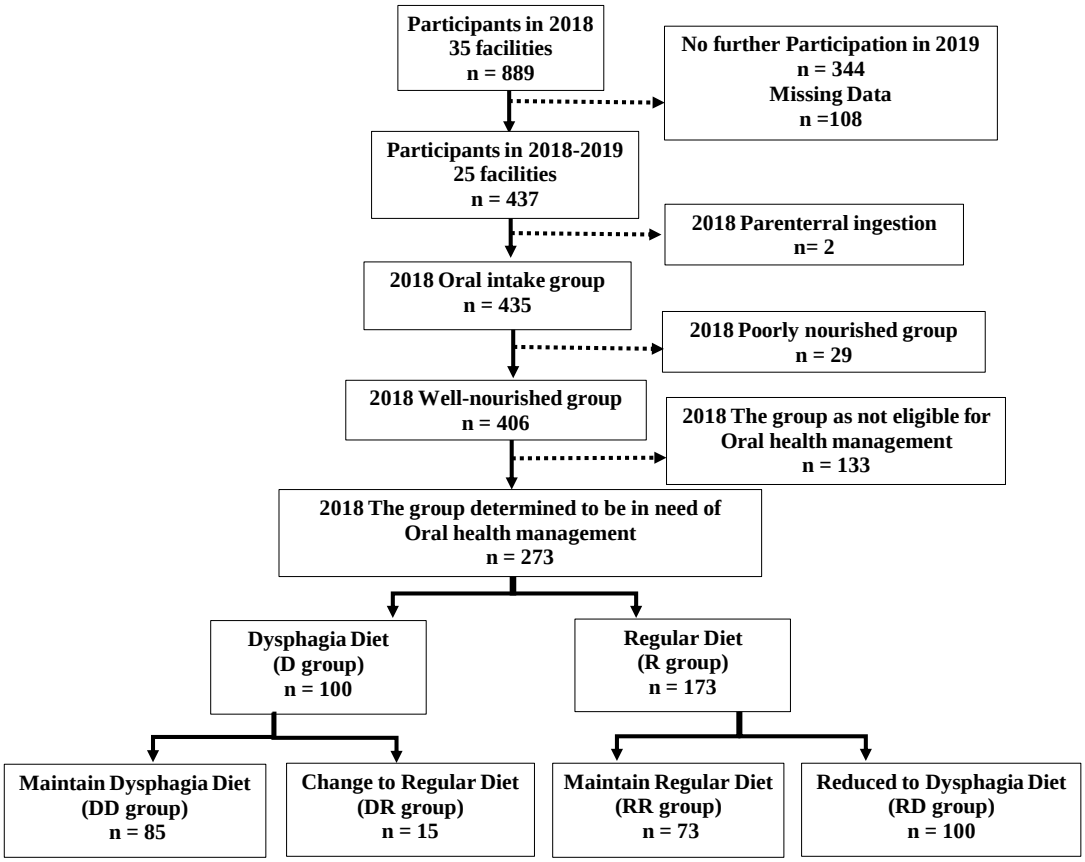


Figure 2. Flowchart of the study participants

A baseline survey was conducted in 889 older adults in LTCFs. Two individuals in the parenteral ingestion group (0.2%), 29 in the poorly nourished group (3.3%), and 133 in the group ineligible for OHM based on the 2018 baseline survey (15.0%) were excluded from the analysis dataset. The remaining 273 (30.7%) participants were grouped according to their food forms in 2018. Of the 173 (63.4%) older adults in LTCFs who were on a regular diet: 73 (42.2%) maintained their regular diet, and 100 (57.8%) changed to a dysphagia diet. On the

other hand, of the 100 (36.6%) who were on a dysphagia diet, 85 (85.0%) maintained a dysphagia diet, and 15 (15.0%) improved to a regular diet.