



## **Impact of the Comprehensive Awareness Modification of Mouth, Chewing and Meal (CAMCAM) Program on the Attitude and Behavior Towards**

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# Impact of the Comprehensive Awareness Modification of Mouth, Chewing and Meal (CAMCAM) Program on the Attitude and Behavior Towards Oral Health and Eating Habits as Well as the Condition of Oral Frailty: A Pilot Study

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## Abstract

**OBJECTIVES:** Preserving sufficient oral function and maintaining adequate nutrition are essential for preventing physical frailty and the following long-term care. We recently developed the 6-month Comprehensive Awareness Modification of Mouth, Chewing And Meal (CAMCAM) program, in which participants gather monthly to learn about oral health and nutrition while eating a textured lunch together. This study examined whether the CAMCAM program could improve attitude and behavior towards oral health, mastication, and diet as well as ameliorate oral frailty in community-dwelling older adults.

**DESIGN:** Single-arm pre-post comparison study.

**SETTING AND PARTICIPANTS:** A total of 271 community-dwelling adults (72.3 ± 5.7 years of age; 159 women [58.7%]) in 4 Japanese municipalities were recruited, of which 249 participants (92%) were assessed at the final evaluation.

**INTERVENTION:** Participants gathered once a month at community centers to learn about oral health and nutrition while eating a “munchy” textured lunch containing proper nutrition.

**MEASUREMENTS:** Oral frailty, frailty, and eating behavior were evaluated with the Oral Frailty Index-8 (OFI-8), Kihon checklist (KCL), and CAMCAM checklist, respectively. Participants were divided into Oral frailty (OF) and Robust groups according to OFI-8 scores. The differences in KCL and CAMCAM checklist results between the OF and Robust groups were statistically tested along with changes in scores after the program.

**RESULTS:** KCL and CAMCAM checklist scores were significantly lower in the OF group at the initial assessment. OFI-8 and KCL findings were significantly improved in the OF group after completing the program (all  $P < 0.05$ ). Regarding the CAMCAM checklist, awareness of chewing improved significantly in the Robust group ( $P = 0.009$ ), with a similar tendency in the OF group ( $P = 0.080$ ).

**CONCLUSION:** The findings of this pilot study suggest that the CAMCAM program may improve both oral and systemic frailty in addition to attitudes towards chewing, oral health, and meals, especially in individuals with oral frailty. The CAMCAM program merits expansion as a community-based frailty prevention program.

**Key words:** Oral frailty, textured lunch, oral frailty prevention program, frailty, nutrition.

## Introduction

Frailty is multidimensional and is a risk factor for long-term care and mortality, with oral frailty and malnutrition as predisposing factors for a physical frailty phenotype (1-4). Since the oral cavity is the starting point of nutrition, oral function is tightly associated with nutrition status. Defined as deteriorated oral health, oral frailty has recently been proposed as a phenotype of frailty (1, 5). Oral frailty hampers nutritional balance and eventually progresses to malnutrition (6, 7), sarcopenia, and long-term care. Deteriorated oral health not only hinders nutritional balance and oral intake, but also influences general health through multiple pathways and outcomes, including infectious diseases, cognitive impairment, functional disability, and mortality (8). Thus, preserving sufficient oral health and adequate nutrition are essential to prevent frailty and maintain good general health.

Oral health can be divided into oral function and oral hygiene, which can be further separated into several components (5, 9). Dibello et al. described relationships between poor oral health and major adverse health-related outcomes in their systematic review (5). They also identified 12 determinants of poor oral health that might influence the progression of physical or cognitive frailty. However, since the deterioration of oral function is easily overlooked due to the integrated coordination of oral processes, quantitative assessments of specific oral functions are needed to detect declines in each component. The concept of oral hypofunction as 7 measurable sub-symptoms was proposed by the Japanese Society of Gerodontology to diagnose the deterioration of oral function through quantitative instrumental assessments (9). Oral hypofunction can now be clinically tested for early detection of reduced oral function in dental practice. To prevent the deterioration of oral health in older adults, easy screening methods of oral status and early intervention at the community level may be useful.

Although the proper intake of meat and vegetables is important for oral and general health, older adults tend to avoid textured foods in favor of softer and easy-to-chew

meals. Dietary preference in elderly individuals is significantly influenced by occlusion and denture status (10). According to the National Health and Nutrition Survey in Japan, more than 40% of respondents over 60 years of age answered that they could not chew firmly on both sides of the molar teeth and were less able to eat hard foods compared with 6 months earlier (11). Maintaining the habit of chewing textured foods is therefore important to uphold a balanced diet. We earlier developed a program of comprehensive oral and physical exercises along with textured lunch gatherings to prevent oral and general frailty (12). This 12-week intensive oral frailty prevention program had positive effects on several oral and physical parameters in community-dwelling older adults (12) and significantly reduced the number of individuals with oral hypofunction (13).

As our prior study on an intensive 12-week program demonstrated its efficacy in a randomized controlled trial (14), we next sought to test the effectiveness of implementation of the oral frailty prevention program with educational components towards oral health, mastication, and nutrition in the “real world” community settings (14). We hypothesized that individuals harboring oral frailty had low awareness of chewing and nutrition, with possible difficulties in chewing and meals. Therefore, the 6-month Comprehensive Awareness Modification of Mouth, Chewing And Meal (CAMCAM) program was developed, in which participants gathered once a month to learn about oral health and nutrition while eating a textured lunch at a community center. This single-arm, pre-post comparison study aimed to evaluate whether the CAMCAM program could ameliorate attitudes towards oral health, mastication, and diet in addition to improving oral frailty in community-dwelling older adults.

## Methods

### Participants

The protocol of this investigation was approved by the Institutional Review Board of Tokyo Medical and Dental University (D2021-004) and Matsumoto Dental University (approval ID: 327). The study was registered as a University Hospital Medical Information Network Clinical Trials Registry (UMIN-CTR) clinical trial (unique trial ID: UMIN000043909). The main outcomes in this investigation were eating behavior attitudes and oral health.

The study participants were recruited in Toyoake, Aichi Prefecture, and at Nagano Prefecture Senior College facilities in Omachi, Suwa, and Matsumoto, Nagano Prefecture. The inclusion criteria were community-dwelling individuals over 65 years of age who were willing to participate in the 6-month program and complete evaluations before and afterwards. The exclusion criteria were an edentulous status without using dentures, food allergies, severe kidney failure, and severe dysphagia. All participants provided written informed consent prior to enrollment in this study.

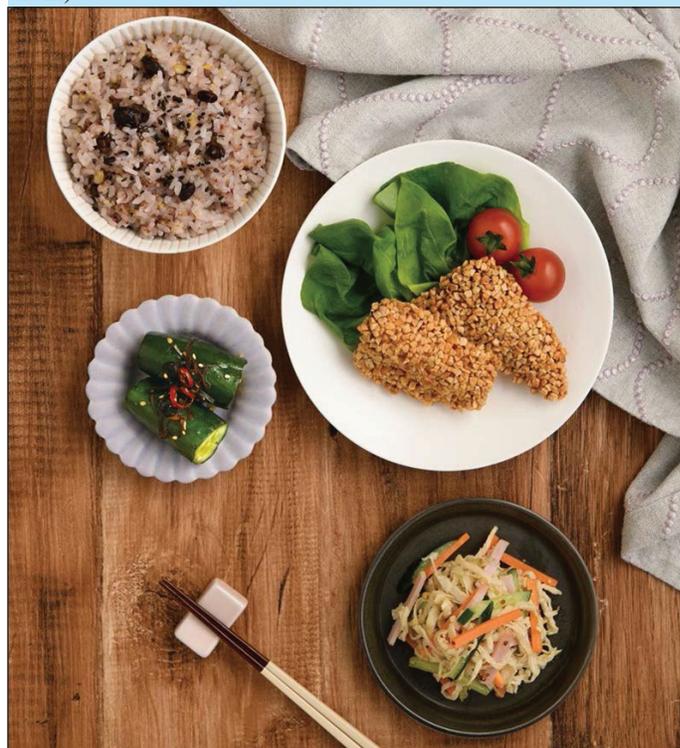
## Intervention

The CAMCAM program was conducted for 6 months in 2021 or 2022 at selected community centers. In the 6-session program held every month for approximately 30 minutes each, 15-64 participants learned about oral health, oral function, nutrition, and food intake to prevent systemic frailty and oral frailty while eating a so-called “CAMCAM textured lunch.”

### CAMCAM textured lunch box preparation

We introduced the concept of gathering to eat a munchy textured lunch in this comprehensive program to increase masticatory load (15) and raise participant awareness of the importance of chewing, oral health, and composition and consistency of their diet. The CAMCAM textured lunch is a packaged lunch box meal consisting of cooked rice, a main dish, and side dishes (Figure 1) (12, 16). The lunch boxes provide higher masticatory load by means of the following preparation principles (17): 1) using hard or textured food ingredients, 2) cutting ingredients into larger pieces, 3) shortening cooking time for vegetables, and 4) using less water. Each lunch recipe satisfied the criteria for calories (>600 kcal), protein (>25 g), vitamin D (>2.75  $\mu$ g), and sodium (<2.5 g) based on the Dietary Reference Intakes for Japanese males over 70 years of age (18). The lunch boxes were served along with the lectures every month.

**Figure 1.** An example of CAMCAM textured lunch boxes used in this trial (<https://kamkam-okg.jp/recipe/handbook.html>)



The foods in the lunch box were devised to contain harder food ingredients (crashed almond, cucumber, carrots, grain rice, etc.) that were cut into larger pieces and had shortened cooking time. The lunch box contains 27.5 g of protein, 2.5  $\mu$ g of vitamin D, 2.2 g of sodium, and 595 kcal.

**Table 1.** Correlation between CAMCAM scores and validated questionnaire scores

	KCL	SNAQ	Chew 20	OFI-8
Total score	0.228**	0.238**	0.198**	-0.204**
Q1. How often do you eat textured meals?	0.211**	0.164**	0.273**	-0.220**
Q2. How much do you like textured food?	0.186**	0.141*	0.344**	-0.323**
Q3. How often are you aware of chewing your food?	0.019	-0.013	0.023	0.009
Q4. How often do you think of nutritional balance?	0.117	0.129*	-0.011	-0.098
Q5. How often do you eat sufficient protein?	0.172**	0.208**	0.056	-0.116
Q6. How often do you enjoy mealtime?	0.221**	0.326**	0.069	-0.054

CAMCAM, Comprehensive Awareness Modification of Mouth, Chewing And Meal; KCL, Kihon Checklist; SNAQ, Simplified Nutrition Appetite Questionnaire; Chew 20, Chewing Score 20; OFI-8, Oral Frailty Index-8; \*, P <0.05, \*\*, P <0.01

### *Learning program of nutrition, diet, and oral health*

Standardized learning materials including presentation slides and handouts for nutrition, diet, and oral health were prepared in advance of meetings, and the handouts were distributed to participants at each session. Dieticians and dental professionals taught the material content while participants ate the textured lunch.

### *Measures*

Attitudes towards chewing and oral health, oral frailty status, and other parameters were assessed with questionnaire checklists before and after the 6-month CAMCAM program at each community center. The questionnaires were distributed to participants, a dentist explained the contents, and then participants answered the survey questions by themselves at the venue.

### *Awareness and attitude towards chewing and oral health*

We developed the CAMCAM checklist as an assessment tool to evaluate participant awareness and attitude of chewing behavior and meals (Table 1). The self-administered checklist consisted of 6 questions on the frequency of activities related to chewing and meals, and was graded as never (1 point) to always (5 points) for a total score of 6 to 30 points. Higher scores indicated more favorable attitudes towards chewing behavior and meals.

### *Oral frailty*

Oral frailty was assessed by the Oral Frailty Index-8 (OFI-8) (19). The self-administered OFI-8 consists of 8 yes-no questions regarding the risk of oral frailty and is scored from 0 to 11. Higher scores suggest an increased risk of oral frailty and long-term care. An OFI-8 score over 4 points was defined as oral frailty (19), based on which and participants were divided into the Oral frailty (OF) group and the Robust group.

### *Other established questionnaires*

Appetite was assessed by the Simplified Nutrition Appetite Questionnaire (SNAQ) (20). The SNAQ is a short and simple

self-administered assessment tool in which subjects are asked to answer 4 questions using 1- to 5-point ordinal scales (total score range: 4 to 20 points). Lower scores indicate a reduced appetite. The self-administered Kihon Checklist (KCL) developed by the Japanese Ministry of Health, Labor and Welfare was used to evaluate for systemic frailty and consisted of 25 yes-no questions to identify the risk of long-term care (21). Subjective awareness of chewing efficiency was assessed by the self-administered Chew Score 20 (Chew 20) (22). The Chew 20 evaluated the subject's self-awareness of chewing ability as 1 of 3 levels: can eat normally (score of 2), can eat with some modifications (score of 1), and cannot eat (score of 0). The total Chew 20 score (range: 0 to 40 points) was used for the analysis.

After completing the program, participants also answered the following open-ended questionnaire items regarding the program: «How did you feel after the program?» (Impression) and «What do you want to do from now?» (Prospects). Answers were used for text mining analysis.

### *Data analysis*

#### *Baseline characteristics of oral frailty and eating behavior*

The proportion of participants meeting the criteria for oral frailty was calculated first. Then, baseline scores of the CAMCAM checklist, KCL, SNAQ, and Chew 20 were compared between the OF and Robust groups using Student's t-test.

The correlations between the sub-item and overall total CAMCAM scores with the other validated assessment items were tested using Spearman's correlation to validate the CAMCAM checklist as an evaluation tool for chewing behavior and meals.

#### *Changes in characteristics of oral frailty and eating behavior*

Changes in the total scores of the CAMCAM checklist, KCL, SNAQ, and Chew 20 by the 6-month intervention were assessed with paired t-tests. Changes in each question in the CAMCAM checklist by the 6-month program were evaluated with the Wilcoxon signed-rank test and were also tested separately in the OF and Robust groups. Changes in

**Table 2.** Comparison of scores between the Robust and Oral frailty groups at pre- and post-CAMCAM oral frailty prevention program

	Pre-program				Post-program					
	All groups (N=271)	Robust (N=149)	OF (N=122)	Robust vs. OF P-value	All groups (N=249)	Pre vs. Post P-value	Robust (N=141)	Pre vs. Post P-value	OF (N=108)	Pre vs. Post P-value
CAMCAM checklist	22.8 (4.1)	23.7 (3.5)	21.7 (4.6)	<0.001	22.9 (3.7)	0.851	23.9 (3.5)	0.395	21.6 (3.6)	0.236
OFI-8	3.5 (2.5)	1.6 (1.1)	5.8 (1.6)	0.013	3.3 (2.3)	0.087	2.0 (1.5)	0.004	4.9 (2.1)	<0.001
Oral frailty (n, %)	122 (45.0)	0 (0.0)	122 (100)	-	100 (40.2)	0.312	20 (14.2)	-	80 (74.1)	-
KCL	19.1 (3.2)	20.5 (2.4)	17.4 (3.2)	<0.001	19.4 (3.1)	0.068	20.4 (2.5)	0.704	18.1 (3.2)	0.008
SNAQ	15.6 (1.4)	15.8 (1.2)	15.3 (1.4)	<0.001	15.6 (1.3)	0.722	15.8 (1.3)	0.877	15.3 (1.4)	0.460
Chew 20	36.3 (4.8)	38.5 (2.5)	33.6 (5.6)	<0.001	36.6 (4.7)	0.395	38.5 (2.7)	0.499	34.2 (5.5)	0.091

CAMCAM, Comprehensive Awareness Modification of Mouth, Chewing And Meal; OF, Oral frailty; OFI-8, Oral Frailty Index-8; KCL, Kihon Checklist; SNAQ, Simplified Nutrition Appetite Questionnaire; Chew 20, Chewing Score 20

each question of the OFI-8 by the 6-month intervention were evaluated with McNemar's test in the OF and Robust groups.

The critical value for rejecting the null hypothesis was  $P < 0.05$ . Statistical analyses were performed using SPSS version 28.0 software (SPSS Inc., Chicago, IL).

### Text mining analysis

Co-occurrence network and hierarchical cluster analyses were conducted on the open question answer data using KH Coder (Ver 3, Koichi Higuchi, Japan). The co-occurrence networks were generated based on the relationships among co-occurring words in the survey answers. Words collocating in text data or with similar patterns were connected by lines in the network diagram, with larger circles representing higher occurrence frequency. The co-occurrence network was useful to uncover relationships among wordings in the text.

## Results

### Baseline characteristics for oral frailty and eating behavior

A total of 271 participants were recruited and answered questionnaires at the first evaluation, among whom 249 participants (91.9%) completed questionnaires at the final evaluation following the last session. Five subjects withdrew from the study due to a lack of interest, with the remainder unable to attend the final assessment. No participants reported major oral changes or severe diseases within the 6 months of the intervention period.

The CAMCAM total score was mildly but significantly correlated with those for the KCL, SNAQ, Chew 20, and OFI-8 (Table 1). Concerning each question, Q3 (Aware of chewing) was not significantly correlated with the other questionnaires. Q1 (Eat textured diet) and Q2 (Like textured diet) were mildly but significantly correlated with all questionnaires. Q5 (Eat sufficient protein) and Q6 (Enjoy mealtime) were mildly but significantly correlated with the KCL and SNAQ.

The baseline characteristics of participants at the initial assessment are summarized in Table 2. Mean  $\pm$  standard deviation age was  $72.3 \pm 5.7$  years old, and the proportion

of women was 58.7%. According to OFI-8 scores, 122 participants (45.0%) were classified into the OF group and 149 participants (55.0%) were placed into the Robust group. The OF group was significantly older than the Robust group. At the initial evaluation, the scores of all assessments were significantly worse in the OF group than in the Robust group (all  $P < 0.05$ ) (Table 2). In the CAMCAM checklist, scores for Q1 (Eat textured diet), Q2 (Like textured diet), Q4 (Think about nutritional balance), and Q5 (Eat sufficient protein) were all significantly lower in the OF group (all  $P < 0.05$ ).

### Changes in characteristics of oral frailty and eating behavior

The changes in scores of the assessments after the 6-month intervention program are summarized in Table 3. The KCL was significantly improved after the program in the OF group ( $P=0.008$ ), but not in the Robust group ( $P=0.704$ ). Scores for the SNAQ and Chew 20 did not change significantly after the program in either group.

The proportion of OF of 45% at the initial assessment decreased to 40% at the final assessment (Table 2). In the OF group, 26% of participants could be reclassified as Robust, although 14% of participants in the Robust group changed to a status of OF. The mean score of the OFI-8 decreased significantly in the OF group ( $P < 0.001$ ) but increased significantly in the Robust group ( $P=0.004$ ). For each OFI-8 sub-item, the proportion of participants satisfying Q1, Q5, and Q8 significantly decreased, while that for Q6 marginally decreased, in the OF group (Table 3). In contrast, the proportion of participants satisfying Q2 and Q3 significantly increased in the Robust group after the program.

The overall CAMCAM score did not change significantly in either subject group. CAMCAM checklist items Q2 and Q5 significantly improved in the OF group, and Q3 improved significantly in the Robust group. Q1, Q4, and Q6 were not changed significantly after the program (Figure 2).

### Text mining analysis

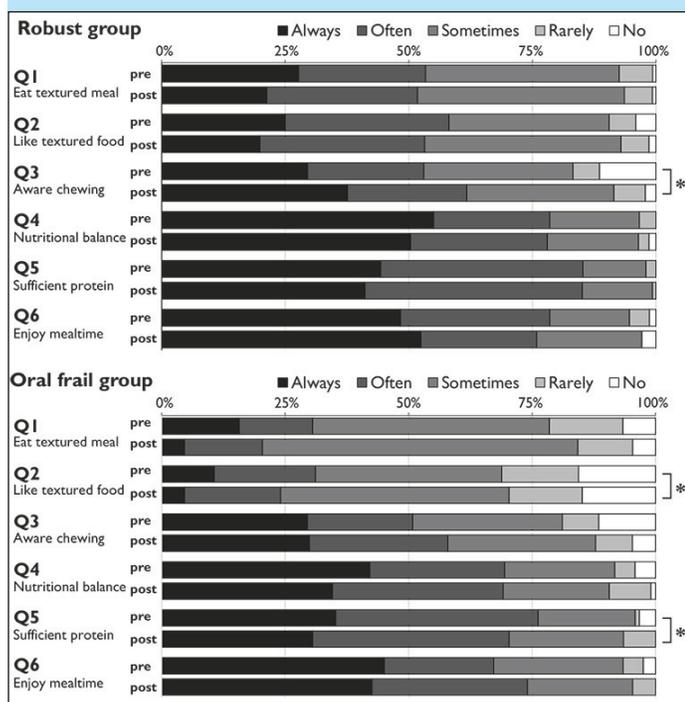
In total, 7,212 words for Impression and 5,257 words for Prospects were extracted from the answers of 411 and 318

**Table 3.** Comparison of questions in Oral Frailty Index-8 between pre- and post-CAMCAM oral frailty prevention program

	All groups			Robust			Oral frailty		
	Pre-program (N=271)	Post-program (N=249)	P-value	Pre-program (N=149)	Post-program (N=141)	P-value	Pre-program (N=122)	Post-program (N=108)	P-value
Q1. Do you have any difficulties eating tough foods compared with 6 months ago? (Yes)	80 (29.5)	58 (23.3)	0.098	12 (8.1)	14 (10.1)	0.503	68 (55.7)	44 (40.7)	0.005
Q2. Have you choked on your tea or soup recently? (Yes)	82 (30.3)	83 (33.3)	0.451	17 (11.4)	29 (20.9)	0.036	65 (53.3)	54 (50.0)	0.210
Q3. Do you use dentures? (Yes)	123 (45.4)	112 (45.3)	0.845	28 (18.8)	34 (24.5)	0.039	95 (77.9)	77 (72.6)	0.180
Q4. Do you often experience dry mouth? (Yes)	87 (32.1)	75 (30.1)	0.522	38 (25.5)	37 (26.6)	1.000	49 (40.2)	37 (34.3)	0.359
Q5. Do you go out less frequently than you did last year? (Yes)	79 (29.2)	54 (21.7)	0.018	24 (16.1)	19 (13.7)	0.332	55 (45.1)	35 (32.4)	0.041
Q6. Can you eat hard foods like squid jerky or pickled radish? (No)	63 (23.3)	51 (20.5)	0.551	9 (6.0)	14 (10.1)	0.238	54 (44.6)	37 (34.3)	0.052
Q7. How many times do you brush your teeth per day? (<3 times/day)	58 (21.4)	55 (22.1)	0.541	21 (14.1)	24 (17.3)	0.180	37 (30.3)	31 (28.7)	1.000
Q8. Do you visit a dental clinic at least annually? (No)	93 (34.3)	70 (28.1)	0.004	35 (23.5)	30 (21.6)	0.754	58 (47.5)	40 (37.0)	<0.001

CAMCAM, Comprehensive Awareness Modification of Mouth, Chewing And Meal

sentences, respectively. Words associated with mastication and the textured lunch box were ranked highly in the answers for both Impressions and Prospects (Table 4). The word “teeth” was the fifth most frequent word in Prospects. “Awareness” was in 10th place in Impressions and 4th place in Prospects.

**Figure 2.** Proportion of answers to questions in the CAMCAM checklist for Robust and Oral frailty groups

Asterisks indicate P < 0.05.

The connection among words and frequency were analyzed by co-occurrence networks for Impressions and Prospects (Figures 3). Eight connections each were visualized for both parameters. The strongest impression was the connection of the textured lunch box and the importance of chewing and oral health (Figure 3a). The impression of the lunch box, including its visual contents, was connected to the impression

of nutritional balance. Awareness towards the texture and hardness of food, recipes, and number of chews in a usual meal were also represented in the network.

**Table 4.** Word occurrence frequencies

Rank	Impressions		Prospects	
	N	Word	N	Word
1	110	eating	66	eating
2	63	bento	50	meal
2	57	chewing	39	chewing
4	48	CAMCAM	34	awareness
5	48	meal	33	teeth
6	46	taste	27	cook
7	45	important	26	CAMCAM
8	42	good	26	ingredient
9	38	ingredient	24	cooking
10	29	awareness	23	important

CAMCAM, Comprehensive Awareness Modification of Mouth, Chewing And Meal

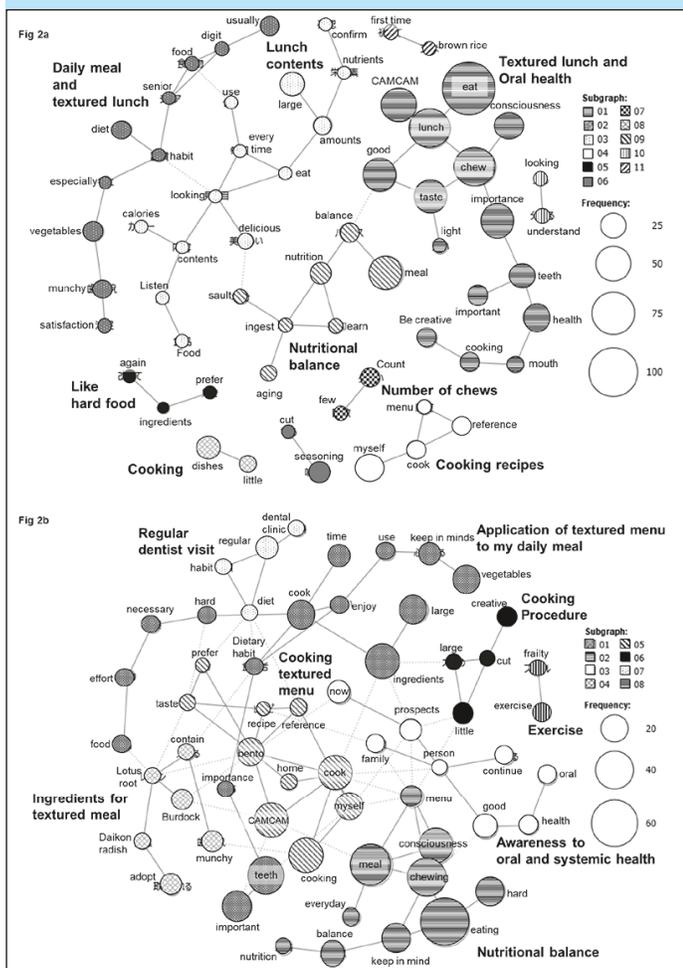
For Prospects, connections among awareness and recognition of chewing, nutritional balance in daily meals, and desire to cook textured meals in daily and family life were strongly represented in the network (Figure 3b). A desire to apply the CAMCAM recipes in usual meal preparation also appeared. Regular dental check-ups and the recognition of oral and general health were visualized in the network as well.

## Discussion

This study presents the results of a comprehensive oral frailty improvement program for consideration as a community-based initiative. Our previous randomized controlled trial demonstrated the “efficacy” of a 12-week intensive comprehensive oral frailty prevention program to improve oral and physical functions (12, 13). The next

important step for the program was its social implementation to expand the “efficacy” to “effectiveness” in community settings (23). Therefore, we aimed for the program to be more easily implemented in community-based activities. In the current project, the CAMCAM program was held in 4 municipalities after modification for better applicability in the general community. The frequency and period of gatherings were changed from the original twice weekly for 12 weeks to once a month for 6 months to increase the adherence and continuity of participants. We omitted the oral and physical exercise gathering components from the original program while retaining the main lunch learning program to focus more on the participants’ attitudes.

**Figure 3.** Co-occurrence network diagram for participant (a) Impression and (b) Prospects



Eight connections were visualized in both graphs. (a) For Impression, the items of textured lunch box and importance of chewing and oral health showed the strongest impressions. (b) For Prospects, the connection of the items of awareness and need of chewing, nutritional balance in daily meal, and desire to cook textured food as usual meals or for family were strongly represented in the network.

Our findings indicated program effectiveness on raising awareness and behavior towards chewing and meals and improving oral frailty. We initially observed that the scores of all assessment items, including the CAMCAM checklist, KCL, SNAQ, and Chew 20, were significantly worse in the OF group than in the Robust group. However, by completing

the CAMCAM program, KCL and OFI-8 scores became significantly improved in the OF group, with a positive tendency for Chew 20. These findings suggest that older individuals at risk of oral frailty may also have problems with chewing and meals and a tendency for systemic frailty. The CAMCAM program appears able to impart awareness of chewing, oral health, and meals as well as the improvement of oral frailty.

### Oral frailty and eating behavior at baseline

The OFI-8 has recently been proposed as a simple checklist for oral frailty (19). It is composed of 8 questions and is scored from 0 to 11. Tanaka et al. reported that scores over 4 had a significantly increased risk of oral frailty and functional disability, suggesting OFI-8 to be a useful indicator of individuals at frailty risk. Using a self-completed checklist and no additional devices, the OFI-8 can easily be applied in community settings for social implementation research.

In our cohort, participants who met the criteria for oral frailty had significantly lower baseline scores for the CAMCAM checklist, KCL, SNAQ, and Chew 20. Avoiding hard foods is a sign of deteriorated oral function (2, 24). Our findings indicated that the participants with OF had difficulty chewing textured foods, and so the variety of suitable choices and appetite were diminished. From the CAMCAM checklist Q1 (Eat textured diet) and Q2 (Like textured food), participants with OF tended to avoid textured food and might have realized some limitations in food intake. From Q4 (Think about nutritional balance) and Q5 (Eat sufficient protein), those subjects might also tend to deviate from nutritional balance and not consume sufficient protein. Deteriorated oral function is a risk factor for malnutrition and systemic frailty (1, 3). We identified several individuals who were at risk of oral frailty using the OFI-8 checklist but showed improvement by the 6-month CAMCAM program. Considering past reports (25), our findings carry the clinical implications that early detection by simply answering a checklist and mild intervention as in the CAMCAM program in community settings may prevent oral frailty and subsequent problems in community-dwelling older individuals.

### Validation of CAMCAM checklist

Composed of questions related to chewing and meals, the CAMCAM checklist was developed to examine the changes in awareness and attitude towards eating behavior. It included food preferences, awareness of chewing, nutrition, and joy of mealtime. The total checklist score and those of Q1 and Q2 (Eat or Like textured food) were moderately correlated with other self-reported indices, including frailty (KCL), appetite (SNAQ), and chewing ability (Chew 20). The KCL is a versatile evaluation sheet of systemic frailty that is composed of 25 questions, 2 of which are on oral health. Avoiding hard or textured foods deviates nutritional balance (2), decreases appetite (26), and increases the risk of systemic frailty. Thus, the CAMCAM checklist had moderate correlations with the KCL and SNAQ. The Chew 20 simply asks about what the

respondent can chew and eat to evaluate chewing ability, with higher scores indicating a greater variety of food available to the individual (22). The CAMCAM checklist correlation with the Chew 20 showed it could partially evaluate chewing ability as well.

Q5 and Q6 of the CAMCAM checklist were correlated with the KCL and SNAQ. Frailty has physical, social, and psychological aspects. Eating alone is a risk factor for depression and frailty (27-29). As the proper intake of protein is essential to prevent physical frailty, the correlation of Q5 and the KCL was reasonable. Q6 (Enjoy mealtime) had a moderate relationship with the KCL, supporting earlier literature (26). The above findings suggest that the CAMCAM checklist can be useful as an index of the attitude and behavior towards chewing and meals, including their texture, in addition to balance and joy.

### ***Changes in characteristics of oral frailty and eating behavior***

By completing the CAMCAM program, OFI-8 and KCL scores were seen to significantly improve in the OF group, which indicated potential effectiveness as an oral frailty preventive program. Although the participants were not actively encouraged to perform physical or oral exercises in the present study, our findings suggested the improvement of oral frailty via this mild intervention program. In particular, the proportions of participants who answered positively for Q1 (Difficulty chewing), Q5 (Going out), and Q8 (Dental visits) in the OFI-8 increased significantly in the OF group; it appeared that OF participants were more inclined to chew hard food by awareness of their chewing behavior through the textured lunch, went out more frequently by listening to talks about frailty prevention, and tried to visit a dental clinic more regularly. The participants had likely already heard that oral health, chewing properly, and well-balanced meals were important for their health before participating in the CAMCAM program. However, listening to such points while chewing on textured food in a public setting may have conveyed this information more effectively. Indeed, text mining analysis of Impression and Prospects confirmed that many participants had a favorable impression of the textured lunch box and perceived the importance of chewing and oral health.

The average OFI-8 score increased in the Robust group contrarily to our expectations. In particular, the proportion of participants who answered “yes” for Q2 (Coughing) and Q3 (Dentures) in the OFI-8 rose significantly. This may have reflected a realization of oral frailty symptoms during the learning period of the program, although starting denture use can increase chewing ability (30). These findings implied that additional personal instruction could be particularly beneficial in such participants after the program.

The total score of the CAMCAM checklist did not change remarkably after the program in either the Robust or OF group, although sub-item scores changed significantly. More participants cited increased awareness of chewing food for Q5 in the Robust group, with the same tendency in the OF group,

which suggested promoted awareness towards chewing.

Lastly, the proportion of answers for Q6 (Enjoy mealtime) in the CAMCAM checklist did not change significantly after the program. One of the purposes of the program was to stimulate enjoyment in having meals with others to combat social isolation as a risk factor for frailty (31). In the CAMCAM program, participants easily gathered at community places close to their home for lunch and a chat while learning about their health. However, roughly 75% of the participants in both subject groups had already answered that they enjoyed mealtime often or always at baseline. There might have been a ceiling effect for this question, such that responses could not significantly change in proportion afterwards. A larger number of participants is needed to clarify this point.

### ***Limitations***

This study had several limitations. First, it was performed as a single-arm pre-post comparison study. Our previous investigation was designed as a randomized control study to test the efficacy of the program (12). The CAMCAM program was then developed to be easily adopted in community activities for the purpose of social implementation. The program was conducted in 2 prefectures in Japan. As implementation research, the study design appeared suitable for health promotion and will be further expanded. Since 22 participants (8.1%) dropped out of the study, larger sample sizes will also help adjust for possible selection bias. The CAMCAM program was aimed for adoption in community-based activities. The present study showed that the feasibility of the program starting from recruitment to retention of the participants was sufficient since the program was successfully conducted at 4 venues. Due to the limited study design of this investigation, however, a well-executed randomized controlled trial is warranted in the future.

Second, we only used subjective questionnaires for pre-post evaluation. The objective evaluation of oral and physical function provides useful information, but also requires equipment and skilled staff. Thus, we developed the present CAMCAM checklist to monitor the attitudes towards eating behavior and used the OFI-8 and KCL for oral frailty and frailty checks, respectively. The main purpose of the program was to modify awareness and attitudes rather than teach functional exercises. Future studies are being planned to develop a system for evaluating the continued effectiveness of the CAMCAM program in different areas.

### ***Conclusion***

In this pilot study, we tested if implementation of the novel CAMCAM program could improve awareness and attitude towards oral health, mastication, and diet, as well as improve oral frailty, in community-dwelling older adults. We identified that older adults with a risk of oral frailty also had problems with chewing and meals. The CAMCAM program could improve oral frailty and views towards chewing, oral health, and meals, especially in individuals with oral frailty.

## Our findings suggest that the CAMCAM program should be expanded as a community-based frailty prevention program.

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