

Research Article

Development of a Masticatory Indicator Using a Checklist of Chewable Food Items for the Community-Dwelling Elderly

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The purpose of the present study was to develop a new assessment scale to evaluate masticatory ability among community-dwelling elderly individuals. The study comprised 761 independent elderly subjects residing in the community. We pooled 25 food items with various textures. Based upon the pass rate and nonresponse rate, we extracted 9 food items to be included in the masticatory ability assessment for the community-dwelling elderly (MACE). The reliability of this assessment was determined using Cronbach's alpha coefficients. We then examined the concurrent validity of the MACE by comparing it with an existing method termed "mastication score." Additionally, the convergent validity was examined by comparing the correlation coefficients of MACE, general oral health assessment index (GOHAI), and the number of teeth. Cronbach's alpha coefficient of MACE was 0.89 ($P < 0.001$), indicating satisfactory reliability. MACE was significantly correlated with the mastication score ($P < 0.001$), GOHAI ($P < 0.001$), and the number of teeth ($P < 0.001$). These results suggest that MACE is a useful tool with sufficient reliability and validity to identify declines in masticatory ability among community-dwelling elderly individuals.

1. Introduction

It is very important for middle-aged and elderly individuals in particular to maintain a healthy diet. Furthermore, for community-dwelling elderly persons, dietary insufficiency is adversely associated with overall health status [1, 2]. The digestive process begins with mastication, which is influenced by oral health status [3, 4]. Some cross-sectional studies report that chewing function is related to nutritional status, food selection, body composition (sarcopenia), and physical balance [5, 6]. In particular, poor mastication may contribute to restricted fruit and vegetable intake [7, 8].

The National Health and Nutrition Examination Survey of Japan indicated that 26.6% of Japanese people aged 60–69 years and 40.8% of Japanese people above 70 years of age had difficulty chewing [9]. Interestingly, Bradbury et al. reported

that the combined approach of improved masticatory ability and provision of suitable nutritional guidance was effective in increasing fruit and vegetable intake among the elderly [10]. Improvement of masticatory status has been stated as a part of the Food and Nutrition Education (Shokuiku) by the Cabinet of Japan [11]. However, few assessments on the masticatory status of community-dwelling elderly individuals have been reported. In many epidemiological studies among community-dwelling elderly persons, subjective evaluation has frequently been used. Thus, the development of a more quantitative means of assessment will be needed for the community-dwelling elderly. The development of a simple and valid method to evaluate masticatory ability among community-dwelling elderly will allow us to provide better quality nutritional counseling based on oral health information.

Previously, evaluation of masticatory function has been performed using valid questionnaires for complete denture wearers at dental clinics [12, 13]. These surveys provided satisfactorily reliable and valid results for denture wearers. However, there are few assessment tools for evaluating masticatory function for community-dwelling persons, including nondenture wearers. Thus, the purpose of the present study was to develop a new masticatory indicator for independent elderly individuals residing in the community, by using a checklist of chewable food items.

2. Subjects and Methods

2.1. Subjects. The present survey was conducted in the northern area of Miyazaki prefecture, Japan. The initial target population was 962 independent community-dwelling individuals aged 65–84 years. All potential subjects were contacted to explain the objectives of present study, and informed consent was subsequently obtained from 761 elderly persons (response rate: 78.1%; 342 men, 419 women; Average age: 71.2 ± 9.6). This study was approved by the Institutional Review Board of the National Institute of Public Health (NIPH-IBRA number 10050).

2.2. Study Design and Measurements. The study design was a cross-sectional survey. Survey items were grouped as follows: (i) demographic variables, (ii) oral health-related quality of life, (iii) clinical assessment of masticatory ability, (iv) the number of teeth, and (v) chewable food items.

Oral health-related quality of life was evaluated using the Japanese version of the general oral health assessment index (GOHAI) [14]. Furthermore, clinical assessment of masticatory ability was conducted using the mastication score reported by Koshino et al. [12]. The number of teeth present was determined by oral examination.

2.3. Survey on Chewable Food Items. At first, we pooled 25 food items based on previous food-intake questionnaires [12, 13, 15], which evaluated masticatory ability in complete denture wearers (Table 1). We used a self-administered questionnaire to examine chewable food items using a 3-point Likert scale as follows: “0”: very difficult, “1”: slightly difficult, and “2”: easy. We also examined the rates of nonresponse and subjects who checked “easily masticated” (pass rate) for each food item in order to exclude unsuitable food items and maintain the divergent validity. Based on previous studies on scale development, the criteria of exclusion were as follows: nonresponse rate, more than 5%, and pass rate, more than 90% [16, 17].

2.4. Analysis. Firstly, we excluded chewable food items according to the above exclusion criteria in order to set up the tentative masticatory checklist, which was termed the masticatory ability assessment for the community-dwelling elderly (MACE). Secondly, we examined the validity and reliability of MACE using statistical analysis. To verify the concurrent validity of MACE, we calculated the Spearman's correlation coefficients (r_s) between the score of MACE and

TABLE 1: The pass rate and nonresponse rate for 25 chewable food items.

Food item	Nonresponder (%)	Subjects passed (%)
Banana	0.9	97.3
Boiled cabbage	0.5	90.9
Boiled carrots	0.9	96.4
Boiled taro	1.0	97.8
Boiled onion	2.7	95.0
Strawberry	2.3	97.7
Ham	5.0	98.7
Boiled fish paste patty	1.8	93.6
Boiled seaweed	3.2	90.0
Konjac food	0.5	92.3
Fried chicken	2.3	80.0
Roast chicken	10.0	75.4
Apple	1.0	85.5
Pickled eggplant	1.2	85.9
Raw cabbage	1.2	86.9
Roast pork	9.1	80.9
Pickled radish	0.9	80.0
Cubic rice cracker	4.1	78.6
Peanuts	2.7	70.0
Sliced raw cuttlefish	8.2	70.9
Raw carrots	2.3	63.2
Vinegared octopus	16.4	68.2
Dried cuttlefish	8.2	49.5
Dried sweet potato	4.5	59.5
Hard baked rice cracker	3.2	62.7

the mastication score. We also examined the correlation between MACE and GOHAI, or the number of the present teeth, in order to verify the convergent validity. The reliability of MACE was examined using Cronbach's alpha coefficients. These serial statistical analyses were performed using SPSS version 19.0.

3. Results

Table 1 shows the pass rate and the nonresponse rate for each item of the 25 food items. Following application of the exclusion criteria, 9 food items were included in the checklist for masticatory ability as MACE (Table 2).

Figure 1 shows the score distribution of the MACE. Approximately 45% of the subjects had a perfect score with satisfactory mastication. The mean and standard deviation of the score was 14.2 ± 4.6 , and the first, second, and third quartiles were 12.0, 16.0, and 18.0, respectively.

Table 3 shows the correlations between the MACE and some variables such as mastication score, GOHAI, and the number of teeth. The MACE score was significantly correlated with mastication score ($r_s = 0.90$, $P < 0.001$). Furthermore, the MACE score had significant coefficients

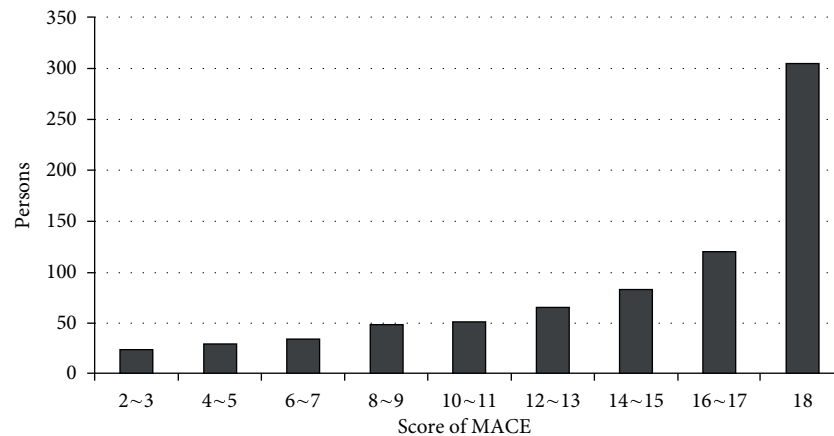


FIGURE 1: Distribution of the score calculated by MACE.

TABLE 2: The checklist related to masticatory ability*.

Food item	Chewing status		
	Easy	Slightly difficult	Very difficult
Fried chicken	2	1	0
Apple	2	1	0
Raw cabbage	2	1	0
Pickled radish	2	1	0
Cubic rice cracker	2	1	0
Peanuts	2	1	0
Raw carrot	2	1	0
Dried sweet potato	2	1	0
Hard baked rice cracker	2	1	0

*Cronbach's alpha coefficient = 0.89 ($P < 0.001$).

TABLE 3: Spearman's correlation coefficients comparing MACE with GOHAI, the number of teeth, and mastication score.

	r_s	P value
Versus the MACE score		
GOHAI	0.48	<0.001
Number of teeth	0.40	<0.001
Mastication score	0.90	<0.001

with GOHAI ($r_s = 0.48$, $P < 0.001$) and the number of teeth ($r_s = 0.40$, $P < 0.001$). Furthermore, the Cronbach's alpha coefficient of the MACE was 0.89.

4. Discussion

The present findings indicated that the MACE, which was the new checklist using chewable food items, had sufficient validity and reliability to evaluate masticatory ability for community-dwelling individuals. In addition, the MACE was economical and simple assessment, and it could be easily applied to nutritional counseling sessions.

Mastication is essential to the maintenance of a healthy diet, and, thus, low masticatory ability is sometimes a major barrier to diet improvement. Some reports suggest

that well-designed diet counseling can greatly increase fruit and vegetable intake [18, 19]. Moreover, Bradbury et al. [10] reported the benefits of combined dental treatment to improve masticatory ability and nutritional counseling. Thus, understanding the present masticatory function among community-dwelling individuals would be very useful to inform and provide appropriate nutritional counseling. The checklist developed in the present study is simplified, and, therefore, specialized knowledge and skills are not necessary for its application.

The status of masticatory function is mutually related to various organs and functions such as the number of teeth, the strength of bite force, and tongue movement. Thus, the evaluation of masticatory status has been reported as subjective in some epidemiological studies. However, frequently, a gap between subjective evaluation and objective assessment on masticatory ability has been frequently reported [20, 21]. A quantitative assessment of masticatory ability will help to improve nutritional counseling for those with chewing difficulties. Previous assessments of masticatory function using food intake questionnaires mostly focused on dental patients have been reported [12, 13, 15]. However, many of these surveys included a variety of soft food items that would only allow detection of a major decline in masticatory ability. Among healthy community-dwelling elderly individuals, there were few persons with severe impairment of oral function. Food items with a high pass rate frequently had a soft texture; thus these items were not included in MACE to improve the discriminatory ability of the checklist.

Satisfactory performance of masticatory function is considered to be related to better oral health-related quality of life [22]. The present results support previous finding indicating that mastication plays a major role in the overall health status of community-dwelling individuals of middle or older ages. Thus, routine assessment of masticatory ability at nutritional counseling sessions may increase fruit and vegetable intake [19].

In the future, it will be needed that MACE is applied to the community-dwelling individuals in different regions in order to examine its cross-validity. Furthermore, the cut-off score of MACE will be expected in order to improve its

convenience. Most of the present subjects have lived in a rural area for a long time and may differ from community-dwelling individuals residing in cities. Moreover, some of the food items selected may not be popular among people of other nationalities who are unfamiliar with the traditional Japanese food. Therefore, for the worldwide application, the MACE may require revision considering universal foods for the future.

5. Conclusion

In conclusion, the present findings suggest that our newly developed MACE checklist comprising 9 food items is very useful as a brief, preliminary assessment tool to determine masticatory status in community-dwelling individuals.

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Conflict of Interests

The authors state that they have no conflict of interests to declare.

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