

Masticatory Ability and Nutritional Status in Elderly Population

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Abstract

Age-related changes in oral health may lead to impaired masticatory function. This phenomenon may affect food selection and nutrient intake and lead to malnutrition. Previous studies showed different relationships between masticatory performance and nutritional status. However, similar studies are still limited in Indonesia, especially among the elderly population.

To analyze the relationship between masticatory ability and nutritional status using the Mini Nutritional Assessment-Short Form (MNA-SF) among the elderly and the relationship between masticatory ability and nutritional status among the elderly based on the loss of teeth (Eichner Index), denture wearing, and other sociodemographic factors (gender, educational level, and economic status).

A cross-sectional study was conducted from 100 patients (age ≥ 60 years) at the Kramat Jati Sub-district Health Center. Subject data was obtained, oral examinations were performed, subject heights and weights were measured, and subjects were interviewed regarding their masticatory abilities and nutritional statuses.

There was a significant relationship between masticatory ability and nutritional status ($p = 0.009$). Significant relationships were also found between two variables: female gender ($p = 0.040$) and not wearing dentures ($p = 0.014$).

This study shows a relationship between masticatory ability and nutritional status among the elderly population.

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Introduction

The global elderly population in the world has increased significantly in recent years and is expected to increase in the future.¹ Although developed countries have an older population profile, the number of elderly adults has increased most rapidly in developing countries such as Indonesia.² The increase in the number of elderly people reflects the success of the government in implementing programs related to health services. Therefore, life expectancy in Indonesia has increased over the past few decades.² In addition to being an indicator of success, this demographic transition

is also a challenge for various public health, social, economic, and environmental aspects of state development. This challenge is related to a decrease in overall public health and productivity as the population ages.²

As elderly adults age, they experience a decrease in bodily function, including oral health. Loss of teeth, dental caries, periodontitis, xerostomia, and precancerous lesions or cancer of the mouth are some of the major problems that occur in the elderly.^{3,4} The function of mastication decreases with age.⁵

The reduced number of natural teeth or functional units, xerostomia, and decreased muscle activity due to aging are some of the factors contribute to impaired mastication.⁶ The stomatognathic system is the digestive pathway that is often associated with nutrition. If the stomatognathic system is disrupted, nutritional status may be affected. Disorders of dental and oral health, including masticatory disorders, are often associated with dietary patterns and changes in

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nutritional intake. Decreased masticatory ability affects the desire to bite, chew, and swallow food. This causes the elderly to have a tendency to avoid eating foods that are difficult to chew.^{5,7} This restriction and change in diet may cause the elderly to be vulnerable to malnutrition because of insufficient nutritional intake.^{8,9}

There have been several studies that examined the relationship between dental and oral health or oral function with the nutritional status of elderly adults, but most have been conducted abroad. Some of the results of previous studies stated that the condition of the teeth and mastication abilities have a significant relationship with the nutritional status of the elderly. A decrease in mastication associated with loss of dentition was associated with poor nutritional status or abnormalities in the body mass index (BMI).^{8,10-13} However, there were also other studies stating that there is no relationship between masticatory ability and nutritional status among the elderly.¹⁴ In Indonesia, research on the relationship between masticatory ability and nutritional status among the elderly population is still relatively scarce. Furthermore, these studies are generally not accompanied by the collection of data on factors including tooth loss, use of dentures, and sociodemographic characteristics. The results of previous studies are also varied; therefore, further research is needed regarding the relationship between masticatory ability and the nutritional status of the elderly, especially in Indonesia.¹⁰⁻¹³

In this study, we assessed mastication ability and nutritional status through interviews with patients. Assessment of masticatory ability performed using a questionnaire entitled "Masticatory Ability Measurement Tool for Dentists," which was tested by Hanin et al. in 2012.¹⁵ In previous studies, the assessment of nutritional status mostly refers to the patient's BMI. There have not been many studies in Indonesia that evaluate the nutritional status of the elderly using the *Mini Nutritional Assessment-Short Form* (MNA-SF) questionnaire, even though it is a multidimensional tool with high sensitivity, specificity, and reliability.¹⁶ The result of this study is expected to be able to better understand the relationship between masticatory ability and nutritional status. These results will be beneficial for health workers, especially dentists and prosthodontists, and the community.

Materials and methods

This cross-sectional study was approved by the Human Research Ethics Committee of the Faculty of Dentistry at the Universitas Indonesia (No. 59/Ethical Approval/FKGUI/VII/2018). This research was conducted at the Kramat Jati Sub-district Health Center between August and October 2018. The subjects included 100 people ≥ 60 years of age. The inclusion criteria were subjects who were able to communicate well and willing to participate in this study. Subjects were selected by *consecutive sampling*.

Data retrieval was performed based on procedures designed to maintain the quality of data in this study. Subjects' data and oral examination were obtained, height and weight were measured, and interviews regarding masticatory ability and nutritional status were conducted. Height was measured using *stature meters* and body weight was measured using analog scales. Oral cavity examination was performed to determine the loss of teeth and the use of dentures. The examination of tooth loss was carried out based on the Eichner Index classification. This classification system includes six groups based on the presence of tooth contact in four support zones (two in the molar region and two in the premolar region): A (four support zones), B1 (three support zones), B2 (two support zones), B3 (one support zone), B4 (there is anterior contact but no support zone), and C (no occlusal contact in the remaining teeth). Masticatory ability was assessed the "Masticatory Ability Measurement Tool for Dentists" questionnaire previously used by Hanin et al. This questionnaire was previously tested for validity and reliability. The questionnaire consists of eight questions with a scoring range of 0-2 and the scores for each question were added together. A total score < 12 indicates poor mastication abilities while a score ≥ 12 indicates good mastication ability.¹⁵ Nutritional status was evaluated using the MNA-SF which had six questions that included anthropometric measurements. The maximum total score for this questionnaire is 14. A score of 12 to 14 indicates normal nutrition, 8 to 11 indicates that the subject is at risk of malnutrition, and 0-7 indicates malnutrition.¹⁷

Sociodemographic data were obtained from the patient's personal data. For the analysis, the education level of the subject was

classified into the following categories: not graduating from elementary school, elementary, junior high, high school, and college. The economic status of the subject was obtained based on the subject expenditures and was calculated using the *adult-equivalence scale* formula. This formula is the total household consumption divided by the number of adults and children in the household.¹⁸ These data were analyzed using the Kruskal–Wallis and Chi-square tests using SPSS version 22 statistical software.

Results

Based on the data in Table 1, most of the subjects were women (75%) and the majority of the population had completed high school (40%). The economic statuses of the subjects were divided into the following five quintiles: quintile 1 (< Rp594.603), quintile 2 (Rp594.603 - Rp910.273), quintile 3 ((Rp910.273 - Rp1.229.949), quintile 4 (Rp1.229.949 - Rp2.032.444), and quintile 5 (> Rp2.032.444). The subjects were evenly distributed across economic statuses.

Based on the Eichner Index, use of dentures, and masticatory ability group, the largest proportion of subjects were classified as Class C by the Eichner Index (24%), group of people who did not use dentures (77%), and had poor masticatory ability (58%). Based on the results of the MNA-SF and BMI, the largest proportions of subjects had normal nutritional status (67%) and were obese (31%).

A significant correlation between masticatory ability and the nutritional status of the elderly because ($p = 0.009$) was showed in table 2. The percentage of subjects with poor masticatory ability in the malnutrition group (100%) and in the risk of malnutrition group (73.3%) was statistically significantly greater than subjects with good masticatory ability in those two groups (0% and 26.7%, respectively).

Table 3 shows no significant correlation between the masticatory ability and the nutritional status of the elderly within each of the Eichner Index groups.

Variable	n = 100	Percentage (%)
Gender		
Women	75	75
Men	25	25
Level of education		
Not graduating from elementary school	6	6
Elementary school	21	21
Junior high school	17	17
High school	40	40
College	16	16
Economic status		
Quintile 1 (poorest)	21	21
Quintile 2	18	18
Quintile 3	21	21
Quintile 4	20	20
Quintile 5 (richest)	20	20
Eichner Index		
A	22	22
B1	12	12
B2	17	17
B3	19	19
B4	6	6
C	24	24
Use of dentures		
Do not use dentures	77	77
Wear dentures	23	23
Masticatory ability		
Poor (Score < 12)	58	58
Good (score ≥ 12)	42	42
Nutrition status		
Malnutrition	3	3
At risk of malnutrition	30	30
Normal nutritional status	67	67
Body mass index (BMI)		
Underweight	19	19
Normal	27	27
Overweight	23	23
Obese	31	31

Table 1. Distribution of Subjects by Gender, Education Level, Economic Status, Dental Loss (Eichner Index), Use of Dentures, Masticatory Ability, Nutrition Status, and Body Mass Index.

	Nutritional Status						P-value
	Malnutrition		Risk of malnutrition		Normal nutritional status		
	n	%	n	%	n	%	
Masticatory Ability							0.009*
Poor	3	100.0	22	73.3	33	49.3	
Good	0	0.0	8	26.7	34	50.7	
Total	3	100.0	30	100.0	67	100.0	

Table 2. Relationship between Masticatory Ability and Nutritional Status.

^a Analysis using *Kruskal–Wallis test*.

* $p < 0.05$ = significant.

Table 4 shows the relationship between masticatory ability and nutritional status based on the use of dentures. A significant relationship was only found in the group of subjects who did not use dentures. Among the malnutrition group and the at risk of malnutrition group, more subjects who did not use dentures with poor masticatory abilities were identified. As many as 27 out of 77 (35%) of subjects who did not use dentures experienced poor nutrition (malnutrition or risk of malnutrition). A lower percentage (26%) of subjects in the group that uses dentures were at risk of malnutrition.

	Nutritional Status						P-value
	Malnutrition		At risk of malnutrition		Normal Nutrition Status		
	n	%	n	%	n	%	
Eichner A Index							1.000 ^c
Poor masticatory ability	0	0.0	0	0.0	2	11.8	
Good masticatory ability	0	0.0	5	100.0	15	88.2	
Total (Eichner A Index)	0	0.0	5	100.0	17	100.0	
Eichner B1 Index							0.091 ^c
Poor masticatory ability	0	0.0	2	50.0	0	0.0	
Good masticatory ability	0	0.0	2	50.0	8	100.0	
Total (Eichner B1 Index)	0	0.0	4	100.0	8	100.0	
Eichner B2 Index							0.515 ^c
Poor masticatory ability	0	0.0	3	100.0	9	64.3	
Good masticatory ability	0	0.0	0	0.0	5	35.7	
Total (Eichner B2 Index)	0	0.0	3	100.0	14	100.0	
Eichner B3 Index							0.881 ^a
Poor masticatory ability	1	100.0	8	88.9	8	88.9	
Good masticatory ability	0	0.0	1	11.1	1	11.1	
Total (Eichner B3 Index)	1	100.0	9	100.0	9	100.0	
Eichner B4 Index							1.000 ^c
Poor masticatory ability	1	100.0	0	0.0	3	60.0	
Good masticatory ability	0	0.0	0	0.0	2	40.0	
Total (Eichner B4 Index)	1	100.0	0	0.0	5	100.0	
Eichner C Index							0.131 ^a
Poor masticatory ability	1	100.0	9	100.0	11	78.6	
Good masticatory ability	0	0.0	0	0.0	3	21.4	
Total (Eichner C Index)	1	100.0	9	100.0	14	100.0	

Table 3. Relationship between Masticatory Ability and Nutritional Status based on Dental Loss (Eichner Index).

^a Analysis using *Kruskal-Wallis test*.

^c Analysis using *Chi-Square test (Fisher's Exact Test)*.

* p < 0.05 = significant.

In this study, an analysis was also conducted to determine the relationship between masticatory ability and the nutritional status of the elderly based on sociodemographic factors such as gender, education level, and economic status. The relationship of masticatory ability to nutritional status based on gender factors is shown in Table 5. Based on this analysis, the relationship between masticatory ability and nutritional status was only found among the

female subjects. Among the female subjects, there was a greater number with poor masticatory ability in the malnutrition group and the at risk of malnutrition group compared to those with good masticatory ability in these groups.

	Nutritional Status						P
	Malnutrition		At risk of malnutrition		Normal Nutrition Status		
	n	%	n	%	n	%	
Does not use dentures							0.014 ^{a*}
Poor masticatory ability	3	100.0	18	75.0	25	50.0	
Good masticatory ability	0	0.0	6	25.0	25	50.0	
Total (Not using dentures)	3	100.0	24	100.0	50	100.0	
Wears dentures							0.640 ^c
Poor masticatory ability	0	0.0	4	66.7	8	47.1	
Good masticatory ability	0	0.0	2	33.3	9	52.9	
Total (Using dentures)	0	0.0	6	100.0	17	100.0	

Table 4. Relationship between Masticatory Ability and Nutritional Status based on Dentures.

^a Analysis using *Kruskal-Wallis test*.

^c Analysis using *Chi-Square test (Fisher's Exact Test)*.

* p < 0.05 = significant.

	Nutritional Status						P
	Malnutrition		At risk of malnutrition		Normal Nutrition Status		
	n	%	n	%	n	%	
Women							0.040 ^{a*}
Poor masticatory ability	2	100.0	17	73.9	26	52.0	
Good masticatory ability	0	0.0	6	26.1	24	48.0	
Total (female)	2	100.0	23	100.0	50	100.0	
Man							0.109 ^a
Poor masticatory ability	1	100.0	5	71.4	7	41.2	
Good masticatory ability	0	0.0	2	28.5	10	58.8	
Total (male)	1	100.0	7	100.0	17	100.0	

Table 5. Relationship between Masticatory Ability and Nutritional Status based on Gender.

^a Analysis using the *Kruskal-Wallis test*.

* p < 0.05 = significant.

There was no significant association between masticatory ability and nutritional status in any of the educational level groups (Table 6).

There were no significant relationships between masticatory ability and nutritional status among any of the economic status groups, (Table 7).

	Nutritional Status						P-value
	Malnutrition		At risk of malnutrition		Normal Nutrition Status		
	n	%	n	%	n	%	
Not graduating from elementary school or elementary school							0.596 ^a
Poor masticatory ability	0	0.0	11	84.6	13	92.9	
Good masticatory ability	0	0.0	1	15.4	2	7.1	
Total (Not graduated from elementary or elementary school)	0	0.0	13	100.0	14	100.0	
Middle school or high school							0.050 ^a
Poor masticatory ability	2	100.0	11	64.7	16	42.1	
Good masticatory ability	0	0.0	6	35.3	22	57.9	
Total (Middle or high school)	2	100.0	17	100.0	38	100.0	
College							0.313 ^b
Poor masticatory ability	1	100.0	0	0.0	4	26.7	
Good masticatory ability	0	0.0	0	0.0	11	73.3	
Total (College)	1	100.0	0	100.0	15	100.0	

Table 6. Relationship between Masticatory Ability and Nutritional Status based on Education Level.

^a Analysis using *Kruska-Wallis* test.

^b Analysis using the *Chi-Square* test (*Fisher's Exact Test*).

* p < 0.05 = significant.

	Nutritional Status						P-value
	Malnutrition		At risk of malnutrition		Normal Nutrition Status		
	n	%	n	%	n	%	
Quintile 1							0.300 ^a
Poor masticatory ability	1	100.0	5	83.3	9	64.3	
Good masticatory ability	0	0.0	1	16.7	5	35.7	
Total (Quintile 1)	1	100.0	6	100.0	14	100.0	
Quintile 2							0.114 ^a
Poor masticatory ability	2	100.0	6	85.7	5	55.6	
Good masticatory ability	0	0.0	1	14.3	4	44.4	
Total (Quintile 2)	2	100.0	7	100.0	9	100.0	
Quintile 3							0.656 ^c
Poor masticatory ability	0	0.0	5	71.4	8	57.1	
Good masticatory ability	0	0.0	2	28.6	6	42.9	
Total (Quintile 3)	0	0.0	7	100.0	14	100.0	
Quintile 4							0.642 ^c
Poor masticatory ability	0	0.0	4	66.7	7	50.0	
Good masticatory ability	0	0.0	2	33.3	7	50.0	
Total (Quintile 4)	0	0.0	6	100.0	14	100.0	
Quintile 5							0.549 ^c
Poor masticatory ability	0	0.0	2	50.0	4	25.0	
Good masticatory ability	0	0.0	2	50.0	12	75.0	
Total (Quintile 5)	0	0.0	4	100.0	16	100.0	

Table 7. Relationship between Masticatory Ability and Nutritional Status based on Economic Status.

^a Analysis using the *Kruska-Wallis* test.

^c Analysis using *Chi-Square* test (*Pearson Chi-Square*).

* p < 0.05 = significant.

Discussion

The results showed that most of the elderly subjects were female (75%). These characteristics are in accordance with the general characteristics of the Indonesian elderly

population based on data from the Central Statistics Agency.² The majority of subjects studied had a high school education level which does not align with the general characteristics of the elderly population in Indonesia. The majority of elderly people in Indonesia have an elementary school education level or lower (not graduating from elementary school and never going to school).² The subjects in this study may have been less representative of the total population because data collection was only performed in one area. Based on data from the 2017 Central Bureau of Statistics for East Jakarta City, the majority of residents ≥ 15 years of age had high school as their highest level of education (28.25%).¹⁹ In this study, the distribution of subjects based on economic status was quite even.

More than half of the elderly people (58%) who were the subjects of the study had poor masticatory ability (score <12). This finding illustrates the decline in the function masticatory function that occurs due to age-related changes in the oral cavity.⁵ Based on the assessment of nutritional status using the MNA-SF, 3% of subjects were malnourished and 30% were at risk of malnutrition while the rest were normal. The proportion of subjects who were malnourished or at risk of malnutrition in this study was lower than the proportions indicated in a study by Yuniendra et al.²⁰ This can be explained by the fact that the majority of elderly subjects participating in this study who are independent, still active and maintain good health. In addition, most subjects in this study do not have mobility disorders and generally have good health. Food intake of the average subject is also maintained because they are aware of their diet and have a family to take care of them. The BMI, which is obtained from measurements of height and weight, is also one of the elements of the MNA-SF. The categories of BMI used in this research are based on adjusted categories for Indonesian population.⁴ The percentage of obese subjects is in accordance with the theory stating that the prevalence of obesity has increased among elderly adults, especially in women. According to studies by Fogelholm et al. and Villareal et al., increasing body mass in the elderly population may be caused by changes in body composition and metabolism. Body fat mass is highest between the ages of 60 and 70 years; this increase in body fat is often

accompanied by a decrease in the intensity and duration of physical activity.²¹

This study analyzed the relationship between masticatory ability and nutritional status. The results showed that statistically there was a significant relationship between the masticatory ability and the nutritional status of the elderly. It supports the results of studies by Okada et al. and Samnieng et al. which stated that there was a relationship between masticatory ability and nutritional status of the elderly.^{8,10} The greater proportion subjects with of poor mastication abilities among the malnourished subjects and those at risk of malnutrition align with the results of a study by Samnieng et al. stating that malnutrition is associated with low masticatory ability.¹⁰

Various studies showed the ability of mastication to influence nutritional status is believed to be related to nutrition. Based on *systematic reviews* by Tada A. et al., 22 of the 28 *cross-sectional* studies in the elderly showed that food consumption and intake of certain nutritious substances were higher among subjects with good masticatory ability and good dentition. The associated foods included fruits, vegetables, and nuts which contain lots of vitamins, calcium, and fiber.²² In contrast, subjects with low mastication ability tend to consume less of these foods.⁵ In addition, individuals with masticatory disorders tend to choose foods with a softer or softer texture and these foods are processed longer to obtain the texture. Processing can reduce the nutrient content in these foods.⁹ The existence of restrictions and changes in the selection of these foods can cause the nutritional needs of the elderly to not be fulfilled properly and increase the risk of poor nutritional.⁸ However, nutritional intake was not seen during this study. Nutritional intake should be observed in future studies to better determine the relationship between masticatory ability and the nutritional status of the elderly.

In this study, we also observed a relationship between masticatory ability and nutritional status based on tooth loss. Using the Eichner Index, we can see the number of occlusal support zones present. The largest proportion of subjects had no occlusal contacts at all or were included in the Eichner Index C class (24%). In this study, there was no significant relationship between mastication ability and

nutritional status within each Eichner Index category. This finding suggests that tooth loss does not affect the relationship to nutritional status. The results of this study support the studies by Felicita et al. and Shakina et al.^{23,24} However, this results differs from the results obtained by McKenna et al.²⁵ Differences in the results of the study can be caused by the difference of method used in reviewing the occlusal contacts where the study was not seen from the Eichner Index classification, but only from the numbers.

In this study, data on the use of dentures only included whether the subject did or did not use dentures. Furthermore, since a small proportion of subjects used dentures (23%), we could not carry out the analysis based specifically on the type of denture. This low percentage in line with the low rate of denture use among elderly adults in Indonesia (14.5%).²⁶ In this study, there was a significant relationship between masticatory ability and status among the group of subjects who did not use dentures. This is in line with the results of a study by Tsai et al which stated that groups of subjects who did not use dentures tended to have the lowest masticatory ability compared to subjects using dentures and were more at risk of having poor nutrition. This finding may be due to the fact that subjects who do not use dentures consume a smaller amount of fruits and vegetables, which may affect the body's nutritional status.²⁷ This result is also in line with the study by Kikutani et al.²⁸ However, no significant association was found in the group that uses dentures in this study. This finding may be because a lower number of subjects used dentures in this study. In addition, the type of dentures was not recorded in this study. Based on a *cohort* study carried out in Taiwan, the type of dentures used is also one of the factors that influence the relationship between masticatory ability and nutritional status. Fixed dentures may help improve the subject's masticatory ability which improves their overall nutritional status.²⁷

In this study, we also analyzed sociodemographic factors (gender, education level, and economic status). In Indonesia, no study included these factors when examining the relationship between oral health and masticatory ability with nutritional status among the elderly. A significant relationship between masticatory ability and nutritional status was only found

among female subjects. This finding is in line with the results of studies by Laurin et al. and Tada A. et al.²² The variation between measurements of nutritional status and the proportion and distribution of unbalanced subjects may also influence the differences in these relationships.

To analyze the data, we merged the educational levels into three categories. We found no significant relationship between masticatory ability and nutritional status based on the education category. This study contradicts a previous report which states that education levels can promote the maintenance of good oral health and nutritional status.^{29,30} The low level of education is associated with low knowledge of good oral hygiene habits and poor nutritional intake, which can affect nutritional status.³¹ The absence of a significant relationship at the level of education may also be influenced by differences in educational parameters.²⁹ In addition, differences in the educational background of the Indonesian population compared to other countries can also influence this finding. In a study conducted by Felicita et al. in Indonesia, there was no relationship between the level of education and one's nutritional status.²³

Based on the subjects' economic statuses, there was no significant relationship between masticatory ability and nutritional status. This finding contradicts several previous studies.^{29,30} Monteiro et al., Popkin et al. and Mayén et al. stated that subjects with low economic status often do not have adequate knowledge of good nutrition nor the ability to afford healthy foods, so they tend to have poor nutritional statuses.³² The difference in the results of this study may be due to differences in the categorization of economic status between this study and previous related studies. This research was only conducted in one area where the economic status of the subjects was more homogeneous; therefore, the range of economic statuses obtained by our calculation does not represent the economic conditions of the entire Indonesian population.

In this study, there are several limitations. The research design cannot distinguish between cause and effect variables because the data collection was performed at one timepoint. The research was also carried out in a limited geographical area, which made the

subject cohort less representative of the general population. The imbalance in the number of subjects based on gender and other variables (tooth loss based on the Eichner Index, use of dentures, and other sociodemographic factors) may also influence the results of statistical analyses. The BMI assessment, which is one of the MNA-SF elements, is objective because measurements are carried out quantitatively; however, in this study, weight measurements were carried out with analog scales. These scales have a lower level of accuracy compared to *digital* scales so that they could have affected the accuracy of the assessment. Further research using a longitudinal study design may be necessary to identify the causative variables in this study. In addition, other related factors such as nutritional intake and type of dentures used need to be considered in analyses. A larger sample size and a wider geographical sampling area would be necessary to ensure that the study cohort is more representative of the general population. More objective assessments are also necessary to minimize information bias; for example, bodyweight should be measured with digital weight scales to gain a more accurate BMI measurement.

Conclusions

Based on this study, it can be concluded that there was a relationship between masticatory ability and nutritional status. There was a relationship between masticatory ability and nutritional status among female subjects and subjects who did not use dentures. There was no relationship between masticatory ability and nutritional status within each Eichner Index category, education level, nor each economic status quintile.

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Declaration of Interest

The authors report no conflict of interest.

References

1. United Nations Department of Economic and Social Affairs, Population Division. World Population Aging 2015 (ST / ESA / SER.A / 390); 2015.
2. Central Bureau of Statistics. Elderly Population Statistics 2017. Elderly Population Statistics. Jakarta; 2017.
3. Holm-Pedersen P, Walls AW, Ship JA. Textbook of Geriatric Dentistry. United Kingdom: John Wiley & Sons; 2015.
4. Basic Health Research. Jakarta: Ministry of Health Republic of Indonesia; 2013.
5. Kimura Y, Ogawa H, Yoshihara A, et al. Evaluation of Chewing Ability and Its Relationship with Activities of Daily Living, Depression, Cognitive Status and Food Intake in the Community-dwelling Elderly. *Geriatr Gerontol Int* 2013;13(3):718-25.
6. Peyron MA, Woda A, Bourdiol P, Hennequin M. Age-related Changes in Mastication. *J Oral Rehabil* 2017;44(4):299-312.
7. Naka O, Anastassiadou V, Pissiotis A. Association between Functional Tooth Units and Chewing Ability in Older Adults: A Systematic Review. *Gerodontology* 2014;31(3):166-77.
8. Okada K, Enoki H, Izawa S, Iguchi A, Kuzuya M. Association between Masticatory Performance and Anthropometric Measurements and Nutritional Status in The Elderly. *Geriatr Gerontol Int* 2010;10(1):56-63.
9. Marcenes W, Steele JG, Sheiham A, Walls AWG. The Relationship between Dental Status, Food Selection, Nutrient Intake, Nutritional Status, and Body Mass Index in Older People. *Cad Saude Publica* 2003;19(3):809-16.
10. Samnieng P, Ueno M, Shinada K, et al. Oral health status and chewing ability related to mini-nutritional assessment Results in an older adult population in Thailand. *J Nutr Gerontol Geriatr* 2011;30(3):291-304.
11. Ikebe K, Matsuda K-I, Morii K, Nokubi T, Ettinger R. The relationship between oral function and body mass index among independently living older Japanese people. *Int J Prosthodont* 2006;19(6):539-46.
12. Sheiham A, Steele JG, Marcenes W, Finch S, Walls AWG. The Relationship between Oral Health Status and Body Mass Index among Older People: A National Survey of Older People in Great Britain. *Br Dent J* 2002;192(12):703-6.
13. Torres LH do N, da Silva DD, Neri AL, et al. Association between Underweight and Overweight / Obesity with Oral Health among Independently Living Brazilian Elderly. *Nutrition* 2013;29(1):152-7.
14. Flores-Orozco EI, Tiznado-Orozco GE, Osuna-González OD, et al. Lack of Relationship between Masticatory Performance and Nutritional Status in Adults with Natural Dentition. *Arch Oral Biol* 2016;71:117-21.
15. Hanin I. Relationship of Masticatory Ability with the Quality of Life of Pre-elderly and Elderly Women [Thesis]; 2012.
16. Secher M, Soto ME, Villars H, Van Kan GA, Vellas B. The Mini Nutritional Assessment (MNA) after 20 years of research and clinical practice. *Rev Clin Gerontol* 2008;17(4):293-310.
17. NN Institute. MNA® Elderly - MNA® Forms. Available at: http://www.mna-elderly.com/mna_forms.html. Accessed: July, 2019.
18. Maharani DA. Inequity in Dental Care Utilization in the Indonesian Population with a Self-Assessed Need for Dental Treatment. *Tohoku J Exp Med* 2009;218(3):229-39.
19. East Jakarta in Figures. East Jakarta Administration City Central Bureau of Statistics; 2017.
20. Yuniendra GG, Rahardjo A, Adiatman M, Maharani DA, Thuy PAV. Relationship between Oral Health Status and Masticatory Performance with Nutritional Status in the Elderly. *IOP Conf Series: Journal of Physics: Conf Series* 2018;1073(4):1-7.
21. Villareal DT, Apovian CM, Kushner RF, Klein S. Obesity in older adults: Technical review and Position Statement of the American Society for Nutrition and NAASO, The Obesity Society. *Am J Clin Nutr* 2005;82(5):923-34.
22. Tada A, Miura H. Systematic Review of the Association of Physics with Food and Nutrition Intake in the Independent Elderly. *Arch Gerontol Geriatr* 2014;59(3):497-505.
23. Felicita M, Koesmaningati H, Dewi RS. Relation between Tooth Loss and Denture Wearing relations toward Nutritional Status. *J Int Dent Med Res* 2016;9:317-22.
24. Indrasari M, Shakina T, Masulili C. Association between Masticatory Performance and Body Mass Index (BMI). *J Int Dent Med Res* 2016;9:293-9.
25. McKenna G, Allen PF, Flynn A, et al. Impact of Tooth Replacement Strategies on the Nutritional Status of Partially-Dentate Elders. *Gerodontology* 2012;29(2):883-90.
26. Basic Health Research (RISKESDAS) 2007-2008. Jakarta: Ministry of Health Republic of Indonesia; 2008.
27. Tsai AC, Chang TL. Association of Dental Prosthetic Condition with Food Consumption and Risk of Malnutrition and Follow-up 4-year Mortality Risk in Elderly Taiwanese. *J Nutr Heal Aging* 2011;15(4):265-70.
28. Kikutani T, Yoshida M, Enoki H, et al. Relationship between Nutrition Status and Dental Occlusion in Community-dwelling Frail Elderly People. *Geriatr Gerontol Int* 2013;13(1):50-4.
29. Saeidlou SN, Merdol TK, Mikaili P, Bekta Y. Assessment of the Nutritional Status and Affecting Factors of Elderly People Living at Six Nursing Home in Urmia, Iran. Part I. *Int J Acad* 2011;3(1):173-81.
30. Stoffel LMB, Muniz FWMG, Colussi PRG, Rösing CK, Colussi EL. Nutritional Assessment and Associated Factors in the Elderly: A Population-based Cross-sectional Study. *Nutrition* 2018;55-56:104-10.
31. Devaux M, Sassi F, Church J, Cecchini M, Borgonovi F. Exploring the Relationship Between Education and Obesity. *OECD Journal: Economic Studies* 2011;1:121-59.
32. Mayén AL, Marques-Vidal P, Paccaud F, Bovet P, Stringhini S. Socioeconomic Determinants of Dietary Patterns in Low and Middle-Income Countries: a Systematic Review. *Am J Clin Nutr* 2014;100(6):1520-31.