ORIGINAL ARTICLE

Analysis correlation of the remaining tooth number and muscle mass in women 45 to 69 years old: a cross-sectional design

Delyta Piramida[1]
Zahreni Hamzah[2*]
Dwi Prijatmoko[3]

[1]Undergraduate student, Faculty of Dentistry,Universitas Jember, Jember,Indonesia
[2]Department Dentistry-Biomedical Science, Pathology of Oral and Maxillofacial,Jember,Indonesia
[3]Department Orthodontic, Jember,Indonesia

*Correspondence:
zahreni.fkg@unej.ac.id

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ABSTRACT

Introduction: Tooth loss is a prevalent condition among older adults. Maintaining at least 20 teeth in the oral cavity is crucial for optimal masticatory function, which in turn is important for adequate nutrient intake, including protein necessary for muscle mass synthesis. This study aimed to analyze the correlation between the number of remaining teeth and muscle mass in women aged 45-69 years, a demographic that typically begins to experience a decrease in muscle mass. **Methods**: The research used an analytical observational method with a cross-sectional design. Subjects were selected using purposive sampling techniques based on specific inclusion and exclusion criteria, resulting in a sample size of 60 participants. The independent variable was the number of remaining teeth, while the dependent variable was muscle mass. The number of remaining teeth was assessed using a disposable dental kit. Muscle mass was measured with a Tanita BC-541 digital body composition scale, and height was measured using a microtoise. All participants provided informed consent, and data were recorded on a measurement result sheet. The data were then tabulated and analyzed descriptively and using the Spearman correlation test, with a significance threshold set at 0.000 (p-value <0.05). **Results**: The correlation coefficient was found to be 0.672, indicating a significantly positive correlation between the number of remaining teeth and muscle mass in women aged 45-69 years. **Conclusion**: A lower number of remaining teeth is associated with lower muscle mass in women aged 45-69 years.

KEYWORDS

Elderly, tooth loss, muscle mass

INTRODUCTION

One of the most common oral health problems in older adults is tooth loss.[1–7] The smaller number of teeth remaining in the oral cavity leads to decreased chewing function.[8–13] Tooth loss makes it difficult for older adults to chew hard food, so that often large-particle food is swallowed immediately, even though it is not smooth enough.[14–17] Therefore, older adults often experience indigestion and change their food choices to softer, easier-to-chew foods.[5,14,18,19] As a result, they consume more simple carbohydrates than proteins.[20–23] Protein plays an important role in muscle health, and low protein intake can increase the risk of muscle mass loss.[22–24] Therefore, adequate protein intake is important to maintain muscle mass and prevent muscle mass loss.[24,25]

Jaw movement is indispensable in the masticatory system.[8,26–29] Well-occluded teeth improve chewing function, which involves cutting, tearing, and

grinding food into small pieces to form a ready-to-swallow bolus.[26,27,30–32] The elderly with tooth loss will experience shifting of the teeth towards the missing tooth. Consequently, the teeth lose contact with neighboring or opposing teeth, resulting in an unbalanced occlusion and decreased chewing function.[33–36] A person is expected to have at least 20 teeth remaining so that nutritional intake is adequate.[37–41] As more teeth are lost, the occlusal area of the teeth decreases, leading to a decrease in the chewing surface area and masticatory effectiveness.[26,36,42–44] Generally, foods that contain protein, fiber, minerals, and vitamins, such as meat, fruits, and certain vegetables, tend to be have a hard and difficult texture for chewing.[6,23,31,45] Hard foods require high chewing pressure and frequency to break down the food into small particles faster.[26,47] Therefore, a person who has a small number of remaining teeth tends to change their protein diet from animal protein to softer plant protein, even though the protein content is lower.[22,48,49] Insufficient protein intake can affect muscle protein synthesis.[45,50,51] When protein intake is sufficient, muscle protein synthesis will be stimulated, muscle mass will be built, and muscle protein breakdown will be suppressed. Conversely, if protein intake is insufficient, it can lead to a decline in muscle mass.[51–53]

A physiological decline in muscle mass will begin to occur at the age of 30 years, with a 30-50% decline occurring at the age of 40-80 years and a rapid decline at 50 years of age.[51,54–56] Several studies have shown that, on average, men have a greater amount of muscle mass and a shorter survival time than women. This makes muscle loss potentially a bigger health problem among women than men.[57] The muscle mass decrease does not only occur in skeletal muscle mass but also occurs in the masticatory muscles, so that chewing strength decreases.[58–60] The correlation between the number of remaining teeth and nutritional intake.[22,61–64] and the relationship between nutrient intake and muscle mass[65–67], especially skeletal muscle, has been widely studied. However, the direct relationship between the number of remaining teeth and muscle mass is still not fully understood, so the author is interested in conducting this research.

At present, research on the relationship between the number of remaining teeth in the oral cavity and masticatory muscle mass is still ongoing.[66–69] The results of the present study are expected to be useful for older adults who want to maintain the number of remaining teeth. Hence, if the intake of nutrients consumed is optimal, muscle mass can be maintained. This study aims to analyze the correlation between the number of remaining teeth and muscle mass in women aged 45-69 years.

METHODS

The study was conducted in Kepatihan, Kaliwates sub-district, Jember district, Indonesia, from September 27, 2023, to November 30, 2023. Kaliwates sub-district is one of 31 sub-districts in Jember with the 5th highest permanent tooth extraction rate.[70] The study was conducted analytically observational with a cross-sectional design. Using the Lameshow formula, the minimum number of research subjects was determined. It was found that the research subjects were 60 women aged 45-69 years. Purposive sampling techniques were used to select research subjects, based on inclusion and exclusion criteria. This resulted in the selection of 60 female research subjects, aged 45-69 years,, who entered the pre-elderly range of 45-59 years, and the elderly age range of 60-69 years.

The inclusion criteria included those who were physically and mentally healthy, were able to perform daily activities as indicated by the Basic Activities of Daily Living (BADL), were able to communicate verbally well, and were at the research site at the time the study was conducted. The exclusion criteria included those who were wearing dentures, had uncontrolled systemic diseases that affected the amount of tooth loss, were taking long-term medications that reduced salivary secretion, and were unwilling to participate in the study until completion.

Validity and reliability tests were not conducted in this study, as we used standardized questionnaires in various studies. Each research subject in the study has completed and signed the informed consent form.

The calculation of the number of remaining teeth was carried out by conducting an intraoral examination, including the 3rd molar tooth counted as the number of remaining teeth; the remaining tooth roots were considered missing teeth. The measurement of muscle mass involved the determination of the total weight content of the research subject's muscles, including skeletal muscle mass, smooth muscle, and heart muscle. in percentage (%). This was done using the Bioelectrical Impedance Analysis (BIA) method with Tanita BC-541 digital body composition scales. To determine the characteristics of the research subjects, the data were analyzed descriptively using Microsoft Excel 2013 , and the Spearman correlation test on IBM SPSS version 26 software with a 95% confidence interval was used to determine the relationship between two variables that were not normally distributed and had a non-linear relationship.

RESULTS

The study was conducted on women aged 45-69 years, totaling 60 people. Based on the above results, the research subjects were divided into two groups: pre-elderly, aged 45 to 59 years, and elderly, aged 60 to 69 years, as shown in Table 1.

Table 1. The Characteristics of Age, Height, and Weight of the Subjects

Characteristics of the Research	Age 45-59 years (n=30)		Age 60-69 years (n=30)	
	$\bar{x} \pm SE$	Min – Max	$\bar{x} \pm SE$	Min – Max
Age (Year)	55.80 ± 0.74	45 – 59	64.37 ± 0.60	60 – 69
Height (cm)	152.23 ± 0.95	143 – 164	150.83 ± 0.52	144 – 155
Body weight (kg)	58.11 ± 1.91	43.40 – 86.20	62.76 ± 1.47	46.50 – 76.20

n = number of research subjects; x = average (mean); SE = standard error

Table 1 shows that in the age group of 45-59 years, most research subjects were 59 years old, 158 cm tall, and had an average body weight of 58 kg. In the age group of 60-69 years, most research subjects were 69 years old, 153 cm tall, and had a body weight of 72 kg. This trend observed in the data regarding age, height, and weight indicates that older adults have a lower height than the pre-elderly and a higher weight than the pre-elderly. The measurement of the research subjects was conducted, and the results are summarized in Table 2.

Table 2. Data on the number of remaining teeth, muscle mass, and BMI of the study subjects

Research Results	Age 45-59 years (n=30)		Age 60-69 years (n=30)	
	$\bar{x} \pm SE$	Min – Max	$\bar{x} \pm SE$	Min – Max
Number of remaining teeth	16.33 ± 1.42	1 – 28	12.17 ± 0.97	1 – 24
Muscle mass (%)	59.44 ± 1.45	46.80 – 75.40	55.40 ± 0.48	50.83 – 61.22
BMI (kg/m^2)	25.11 ± 0.81	18.47 – 33.74	27.58 ± 0.63	20.66 – 32.87

n = number of research subjects; x = average (mean); SE = standard error

Table 2 shows that the average number of remaining teeth in the 60-69 age group is lower than that the 45-59 age group. Additionally, the average percentage of muscle mass in the 60-69 age group is lower than that in the 45-59 age group. Meanwhile, the average BMI in the 60 to 69-year-old group is higher than that in the 45-59-year-old group.

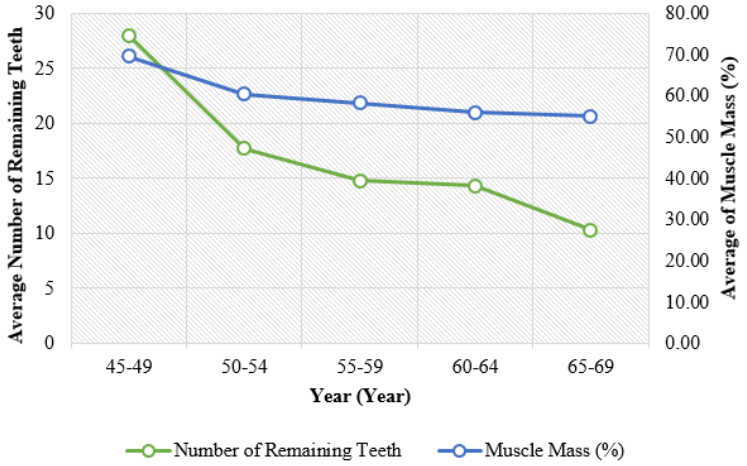

Figure 1. Graph of age versus number of remaining teeth and muscle mass (%)

Figure 1 shows a negative correlation between age and both the average number of teeth and muscle mass. Increasing age shows a decreasing graph, meaning that as age increases, the number of remaining teeth and muscle mass decreases. Both experienced a relatively large decrease at the age of 45-59 years.

Table 3. Spearman correlation test results of correlation analysis between the number of remaining teeth and muscle mass in women aged 45 - 69 years old

			Number of Remaining Teeth	Muscle Mass
Spearman's rho	Number of Remaining Teeth	*Correlation Coefficient*	1000	0.672
		Sig. (2-tailed)	.	0.000
		N	60	60
	Muscle Mass	*Correlation Coefficient*	0.672	1000
		Sig. (2-tailed)	0.000	.
		N	60	60

The results of the Spearman correlation test above show that the p-value of the variable number of remaining teeth on muscle mass (0.000) has a value smaller than 0.05, meaning that the muscle mass variable has a significant relationship with the variable number of teeth (p-value <0.05). The correlation coefficient of 0.672 between the variable numbers of remaining teeth and muscle mass indicates that these variables have a strong unidirectional (positive) correlation.

DISCUSSION

According to the results above, the average number of remaining teeth in the 60-69 age group was less than the 45-59 age group (Table 2). A lower number of remaining teeth indicates that tooth loss increases with age (Figure 1). Data by the Centers for Disease Control and Prevention (CDC) states that approximately 13% of Americans aged 65-74 years have no teeth, and this number will double for those over 75 years old.[45] Based on research by Hassel, AJ. (2018), someone aged 71-75 years has an average of 18 remaining teeth, while someone aged 53-57 years has an average of 25 remaining teeth.

In this study, the average number of remaining teeth was lower than that reported by Hassel, A.J. in 2018.[87] The study's findings reveal that, on average, individuals retain 20 teeth in their oral cavity across different age groups. The 2012 World Health Organization (WHO) standard states that masticatory function,

speech function, and aesthetics are considered normal if individuals aged 65 years and older have a minimum of 20 functioning teeth.[88] Research indicated that those with fewer than 20 teeth will have a greater risk of malnutrition.[37–40,89] Therefore, it is hoped that older adults will be able to improve oral health and prevent tooth loss by conducting early dental examinations and treatments to maintain a minimum of 20 remaining teeth to maintain optimal masticatory function and body homeostasis.

Based on the results above, the average percentage of muscle mass in the 60-69 age group was lower than the 45-59 age group (Table 2), with the largest decrease occurring in the 45-59 age group (Figure 1). This result follows the theory by Hayes (2020) and Lonnie (2019), which states that physiologically, muscle mass experiences a rapid decline at 50 years old.[51,54] The muscle mass speed decline that occurs at the age of 18 to more than 65 years is 0.37% per year in women and 0.47% per year in men, while at the age of 75 years or more, the speed of muscle mass decline is 0.64 to 0.70% per year in women and 0.80 to 0.98% per year in men.[90] Loss of muscle mass occurs along with a decrease in the size of muscle cells, fibers, and tissue. The number of muscle fibers decreases due to the decrease in the cell's productive capacity to produce muscle protein.[57,80] In addition, a decrease in muscle mass can also be caused by disease, nutritional intake, and decreased physical activity.[51,79,91,92]

Physiologically, changes in body composition in aging are characterized by a decrease in muscle and body mass and an increase in fat mass [57,73–76], together with changes in the tissue structure of the oral cavity, especially tooth loss.[77,78] The progressive and comprehensive decrease in muscle mass, especially skeletal muscle, in older adults is often referred to as sarcopenia.[79–81] Patients with sarcopenia have a high risk of falls, fractures, disability, and impaired mobility, which will give an impact on reduced quality of life and death.[52,80,82,83] The increased risk and cumulative effects of caries and periodontal disease can cause changes in the structure of the oral cavity tissue, especially tooth loss. [45,77,84] Tooth loss may have a significant impact on various aspects, including masticatory function, aesthetics, speech, social relationships, and quality of life, which will ultimately lead to malnutrition.[6,85,86]

In addition to measuring the remaining number of teeth in the oral cavity and muscle mass, BMI measurements were also taken, with the results in the elderly group being higher than the pre-elderly group (Table 2). In this study, the average BMI of the research subjects was included in the overweight category. Being overweight in older adults is a multifactorial condition caused by an imbalance between energy expenditure and energy intake, physical activity, environment, and lifestyle behavior.[44,93,94] When energy expenditure is lower than energy intake the body stores more fat, which can lead to overweight and obesity.[94–96] As the elderly age, their physical activity tend to decrease, potentially leading to an increase in BMI.[97,98] Compared to adults, older adults are more likely to experience functional limitations associated with a disease, which can start a cycle of stress and lead to lifestyle patterns that cause obesity.[57]

According to the Spearman correlation test (Table 3), there is a positive correlation between the number of remaining teeth and muscle mass, meaning that a lower number of remaining teeth was associated with lower muscle mass in women aged 45-69 years. That relationship is in line with several studies. According to O'Conor et al.'s 2020 research, tooth loss can significantly impair the ability to chew and swallow, thus, this condition. can lead to a decrease in appetite, which in turn disrupts nutrient intake. Nutritional disorders due to changes in food choices cause a person to choose soft, easy-to-chew foods, which are often low in fiber, protein, and iron. [45]

Based on research by Bomfim et al. in 2018, tooth loss that causes chewing difficulties has a significant effect on animal protein and total protein intake. Older adults with tooth loss prefer not to consume animal protein (meat) because the texture is hard, so it is more difficult to chew.[22] Then, based on several studies,

someone who has 21 or more remaining natural teeth is positively associated with food intake such as fruit, vegetables, and nuts and produces higher food quality scores compared to individuals who have lost more teeth.[36,61,99] Decreased masticatory function in older adults with tooth loss is caused by the shortening of the jaw arch, which can reduce masticatory activity. Furthermore, anatomical changes in the masticatory muscles will occur in response to the decreased tissue and function. [26]

In terms of quantity, a person with few remaining teeth is associated with a protein intake below 0.8 g/kg/day[92], whereas the daily protein requirement for older adults to remain physically fit and avoid loss of muscle mass needs to be increased from 0.8 g/kg/day to 1-1.2 g/kg/day. [22] Protein has a role as an energy source for the production of muscle protein because the absorbed amino acids stimulate the synthesis of muscle protein.[79] According to research conducted by Alexandrov et al. in 2018, the intake of total protein and animal protein, particularly on meat, fish, and egg protein, are important for maintaining and building muscle mass. However, animal protein is most likely more effective in maintaining muscle mass due to its higher-quality protein content. [65]

Then, according to research by Yaegashi in 2021, the intake of animal protein is more effective in maintaining muscle mass than vegetable protein. It is more effective because animal protein contains essential amino acids, is easier to digest, and has a higher leucine content compared to vegetable protein.[100] Leucine plays a crucial role in stimulating the synthesis of muscle protein.[101,102] Muscle protein synthesis is the metabolic process of combining amino acids into bound muscle protein.[103] When the process exceeds the breakdown of muscle protein, muscle mass will increase, and vice versa.[103] The amino acids from protein breakdown, especially essential amino acids, have a role in providing signals to induce muscle protein synthesis by regulating cell growth and metabolism so that muscle mass formation occurs. When protein intake in older adults is insufficient, it can contribute to increased muscle mass loss.[52,104]

Therefore, it is hoped that local health services can increase the knowledge of older adults about oral health and the importance of nutritional intake. In addition, there needs to be awareness among nutritionists and other health professionals to refer patients with tooth loss to dentists early on to optimize dental health, so that older adults can maintain their nutritional intake and health. This study was carried out with a cross-sectional design so it has limitations in establishing a causal relationship between the remaining tooth number and muscle mass. Longitudinal studies would be needed to determine causality. Apart from the age range and gender specificity, this study focused on women between the ages of 45 and 69, so it may not apply to men or women outside that age range.

CONCLUSION

The number of remaining teeth in the oral cavity has a significantly positive correlation with muscle mass among women aged 45 to 69 years. As the number of teeth decreases, there is a corresponding decrease in muscle mass among women between the ages of 45 and 69 years. Implication of this findings can provide input for public health initiatives aimed at health promotion and prevention strategies that emphasize the importance of maintaining dental health among the elderly. This highlights the importance of the number of remaining teeth in supporting muscle mass. Future research should explore this relationship further, considering gender differences and the position of tooth loss, to ensure that findings can be widely generalized.

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