Sriwijaya Journal of Dentistry

Sriwijaya Journal of Dentistry (SJD)
Volume 4 Issue 1 2023 : 34-41
https://jurnalkedokteranunsri.id/index.php/SJD/index

The Difference of Masticatory Performance between Body Mass Index Categories on Students of Universitas Sriwijaya

Shanty Chairani[1], R Irwin Setiadi[2], Rani Purba[3]

[1]Department of Oral Biology, Dentistry Study Program, Faculty of Medicine, Universitas Sriwijaya, Palembang, Indonesia

[2]Student of Dentistry Study Program, Faculty of Medicine, Universitas Sriwijaya, Palembang, Indonesia

[3]Department of Prosthdontics, Dentistry Study Program, Faculty of Medicine, Universitas Sriwijaya, Palembang, Indonesia

*Correspondence author email: shanty.c@fk.unsri.ac.id

Abstract

Introduction: Mastication is a complex rhythmical activity that requires coordination of the neuro-musculature to prepare the food for swallowing. Masticatory performance can be influenced by some factors, such as bite force. Underweight and overweight/obese persons had reported having low bite force. The purpose of this study was to compare the masticatory performance between underweight, normal weight, and overweight/obese adults. **Methods:** In this cross-sectional study, 60 students of Universitas Sriwijaya were included (age: 21-25 years). Subjects were grouped according to their BMI: group I (underweight), group II (normal weight), and group III (overweight/obese). Masticatory performance was evaluated with the sieves method. During the masticatory performance test, subjects were asked to chew 3-gram peanuts for 20 masticatory strokes, which was done three times. Peanut particles that had been chewed were filtered with a sieve. The volume of peanut particles passed through the sieve was divided by the volume of total particles and multiplied by 100 percent, which the result was noted as a masticatory performance score. The One-way ANOVA test was employed to identify differences between groups. P values ≤0.05 were considered statistically significant. **Results:** The underweight group showed the smallest masticatory performance score, followed by the overweight/obese group, while the normal weight group showed the highest score. There was a significant difference in masticatory performance score between the underweight and normal weight group ($p<0,05$), while the rest were not showed a significant difference ($p>0,05$). **Conclusion:** The underweight and overweight/obesity groups had a lower masticatory performance compared to the normal weight group.

Keywords: masticatory performance; normal weight; overweight/obesity; underweight

Introduction

Mastication is the first step in the process of digestion and serves to prepare the food for swallowing. It is a complex rhythmical activity that requires coordination of the neuro-musculature.[1] Masticatory performance can be measured by evaluating the sieve of comminuted food and determine the degree of food breakdown.[2] Poor masticatory performance lead to altered food digestion due to swallowing coarse food particles. Individuals with

impaired masticatory performance may adapt their food choices.[3] This condition further leads to deficient nutrient intake or increases the likelihood of gastrointestinal diseases.

Some factors can affect masticatory performance such as age, hormone, diet culture, and bite force.[4,5,6] Bite force is influenced by the body mass index (BMI).[6,7] Previous studies reported that the underweight group exhibited a low bite force.[8] Bite force is higher as the age increases, reaching the peak at the age of 21-30 years, then decreasing significantly after the age of 50 years old.[9] Rosa et al reported that a person who exhibited higher bite force showed a higher masticatory performance.[10] Positive correlations between masticatory performance and maximum bite force had also reported.[11] This study aimed to compare the masticatory performance between underweight, normal weight, and overweight/obese individual.

Material and methods

This observational study with a cross-sectional design was approved by The Health Research Review Committee of Mohammad Hoesin Central Hospital and Faculty of Medicine, Sriwijaya University, Indonesia (protocol number-153/keprsmhfkunsri/2018).

Sampling design

The present study involved 60 students of Sriwijaya University aged 21-25 years old. The sample selection was established to form three groups. Groups were defined by the body mass index (BMI). Body mass index is defined as an individual's body weight divided by the square of his or her height (the standard unit of measure is kg/m2). Body weight and height were measured by a portable anthropometric scale (GEA Medica, Indonesia). A total of 60 subjects were divided evenly into three groups consisting of 20 people each. Subjects with BMI <18,50 Kg/m^2 were categorized into group I (underweight), BMI of 18,50-24,99 Kg/m^2 in group II (normal weight), and BMI >24,99 in group III (overweight/obesity).[6,7]

The subject was selected if exhibited at least 20 teeth, 8 or more functional tooth units, and class I Angle's malocclusion. An individual who exhibited malocclusion with severe crowding or crossbite, under orthodontic treatment or using dental prostheses, hypersensitivity to peanuts, and a history of systemic disorders that can affect the stomatognatic system (eg. trigeminal neuralgia) was excluded from this research. All subjects were explained about the research procedure and purposes, and then asked to sign the informed consent.

Evaluation of masticatory performance

Masticatory performance was assessed by the sieves method. The subjects were instructed to brush their teeth without using toothpaste to ensure the cleanliness of the oral cavity with a toothbrush (Pepsodent®, Indonesia). Then subjects were instructed to chew 3 grams of peanuts (Dua Kelinci®, Indonesia) in 20 chewing strokes. The chewed food was collected in a disposable plastic cup. The subjects were asked to rinse their mouth with 20 ml of mineral water and the rinse obtained was also added to the same plastic cup. This procedure was done three times until a total of 9 grams of peanuts were chewed. The chewed food was then stirred with a glass rod and filtered using a 10-mesh sieve (Sembada™, Indonesia). The volume of food particles that passed the sieve is known as filtrate and the volume of remaining particles on the sieve is residue. Both filtrate and residue were then transferred to different centrifugal tubes and centrifuged using a laboratory centrifuge (Hitachi®, Japan) for 3 minutes at 1500 rpm. The volume of filtrate and residue in each tube was recorded. The percentage of masticatory performance was calculated by dividing the volume of the filtrate by the volume of total particles and multiplying by 100%.

Statistical Analysis

The data were analyzed with a One-way ANOVA test to compare the masticatory performance among groups, followed by a post-hoc Bonferroni test in which *P*-value less than 0,05 was considered significant.

Results

Sixty students of Sriwijaya University were involved in this study with mean age 21,73 years old. The anthropometric measurement data of each group were shown in table 1.

Table 1. **Anthropometric characteristics of the participating subjects**

Study groups	n	Means

		Height (m)	Weight (Kg)	BMI
Group I	20	165,24	47,43	17,33
Group II	20	162,43	57,25	21,59
Group III	20	163,91	82,08	30,14

The mean BMI in group I was 17,33 Kg/m^2, group II was 21,59 Kg/m^2, and group III was 30,14 Kg/m^2. Test of normality and homogeneity of data was done using Kolmogorov-Smirnov and Levene test. All data were normal and homogenous, thus parametric tests were used for analysis. Table 2 demonstrated the result of the masticatory performance test of each group.

Table 2.**Mean score of masticatory performance of study groups**

Study groups	n	Mean±SD Masticatory performance (%)	*P*-value
Group I	20	27,93±9,64	
Group II	20	39,05±9,84	0,00
Group III	20	31,27±10,90	

One-way ANOVA test

It was observed that group II presented the highest masticatory performance (39,05%) among the study groups, followed by group III (31,27%) and group I (27,93%), respectively. There was a statistically significant difference between groups as determined by One-way ANOVA ($p<0,05$). Data analysis then proceeded to the post-hoc test (Table 3).

Table 3. **Comparison of mean score of masticatory performance for each group**

	Group I	Group II	Group III
Group I	-	0,00*	0,90
Group II	0,00*	-	0,05
Group III	0,90	0,05	-

Post-hocBonferroni analysis. Data shown in the table are the *P*-value. *: significant ($p<0,05$)

A significant difference in masticatory performance was seen between group I and group II ($p<0,05$). While between group I and group III, and also between group II and III, there were no significant differences ($p>0,05$).

Discussion

The present study demonstrated that underweight adolescence recorded the lowest mean of masticatory performance. This result was in accordance with a former study in which underweight and overweight/obese groups showed lower masticatory performance than the normal weight group, reported by Soares et al.[7] A person with underweight exhibits a lack of nutrient intake, thus affecting salivary glands and muscles.[8] Lack of nutrient intake disturbs the development of salivary glands, therefore leading to a lower salivary flow rate. Calvarho et al reported that the stimulated flow rate in underweight subjects was lower than in normal subjects.[12] Lack of nutrient intake also results in muscle atrophy, causing a decrease in the strength and functional abilities of masticatory muscles, thus bite force generated is decreased.[8] Verbecque et al reported that underweight children had lower muscular power than normal weight children.[13] Low salivary flow rate and reduction of bite force produced poor masticatory performance in underweight persons.

The normal weight group showed the highest mean of masticatory performance. This result was in line with the previous research which stated that the normal weight group had the highest masticatory performance.[14] The optimum masticatory performance is supported by the salivary flow and bite force to form an adequate bolus to be swallowed.[15]

The present study indicated that the overweight/obese group had lower masticatory performance than the normal weight group, but not significant. This result was coherent with the research by Santosa et al, who reported that the masticatory performance of overweight/obese groups, when compared with the normal weight group, was lower, evidenced by larger bite-size, performing fewer masticatory sequences and rapid mastication.[16] Individuals with overweight/obese exhibited low bite force caused by fat infiltration and changes in the distribution of muscle fiber types. Individuals with high intermuscular fat deposits showed a decline in muscle strength.[17] Individuals with overweight/obese have less type I muscle fibers and more type II muscle fibers, thus leading to muscle easily getting fatigued while doing activities with high frequency, continuity, and long duration of contraction

intensity.[18] Valenzuela et al reported that individuals with obesity exhibited poor muscle quality.[19]

The mean of masticatory performance of the overweight/obese group was higher than the underweight group, which could be due to BMI limitation in distinguishing body fat profile and muscle mass.[20] Aroujo et al described that the masticatory performance of overweight/obese groups was higher than the normal group.[6] A person can have a high BMI because of high muscle mass and low body fat but is misclassified as overweight/obese.[21] An increase in muscle mass was associated with an increase in the strength generated by the muscles, thus leading to better masticatory performance.[21,22] Body mass index has also been reported that have positive a correlation with oral function, such as tongue pressure and lip-seal strength.[23]

Other contributing factors that can influence the masticatory performance are chewing side preferences and mental stress which were not examined in this study. Rovira-Lastra reported that there is a positive association between the preferred chewing side and masticatory performance.[24] Research conducted by Roohfaza et al showed that stressed individuals have low masticatory performance.[25] Stress leads to decreasing salivary flow rate due to sympathetic nervous system activation. Reduced salivary flow leads to difficulties in processing adequate food boluses to swallow.[26]

This study reported that the highest masticatory performance was recorded in the normal weight group followed by the overweight/obese and underweight groups, respectively. The poor masticatory performance will lead to difficulty in digesting the food as the particle size is still in the coarse form.[3] Larger particle size will reduce the performance of the enzyme in the digestive process, which makes the absorption of nutrition low.[27] People with poor masticatory performance tend to change their food choices. They will avoid foods that are hard to chew, like high-fiber vegetables and fruits.[3] All those conditions will cause an imbalance in nutritional intake, leading to digestive disorders like constipation.[3]

Conclusions

It can be concluded that individual who is underweight or overweight/obesity presented a lower masticatory performance compared to individual with normal weight. They need to adopt a healthier lifestyle so they can regain the normal weight, and thus will have a good masticatory performance.

References

1. Rasmi GS. Textbook of dental anatomy, physiology, and occlusion. New Delhi: Jaypee Brothers Medical Publishers. 2014. p. 299.
2. Stjernfeldt, PE, Wårdh I, Trulsson M, Irving IF, Bostrom AM. Methods for objectively assessing clinical masticatory performance: protocol for a systematic review. Syst Rev. 2017; 6(20):1-6.
3. Deogade SC, Naitam D, Patil SM. Influence of impaired masticatory function on the nutrition of completely edentulous patients. J Med Pharm Sci. 2015:55-61.
4. Pamungkas PB, Chairani S, Purba R. Performance of mastication in menopausal women in Palembang. Jurnal Kesehatan Gigi. 2019:6(2):113-7.
5. Tada A, Miura H. Association of mastication and factors affecting masticatory function with obesity in adults: a systematic review. BMC Oral Health. 2018;18:76.
6. Tureli MC, Barbosa TS, Gaviao MB. Associations of masticatory performance with body and dental variables in children. Pediatr Dent. 2010;32(4):283-8.
7. Araujo DS, Marquezin MCS, Barbosa TS, Gavião MBD, Castelo PM, Evaluation of masticatory parameters in overweight and obese children, European Journal of Orthodontics. 2016;389(4):393–7.
8. Soares ME, Ramos ML, Alencar BM, Marques LS, Pereira LJ, Ramos J. Factors associated with masticatory performance among preschool children. Clin Oral Investig. 2017;21(1):159-166.
9. Sun KT, Chen SC, Li YF, Chiang HH, Tsai HH, Li CY, Tu MG. Bite-force difference among obese adolescents in central Taiwan. J Formos Med Assoc. 2016;115(6):404-10.
10. Misch CE. Dental implant prothetics. 2nd Ed. Missouri: Elsevier. 2015. p.96.
11. Rosa RB, Bataglion C, Siéssere S, Palinkas M, Junior WM, de Freitas O, de Rossi M, et al. Bite force and masticatory efficiency in individuals with different oral rehabilitations. J Stomato. 2012;2:21-6.
12. Kosaka T, Kida M, Ono T. Factors influencing the changes in masticatory performance: the suita study. JDR Clin Trans Res. 2018;3(4): 405–12.
13. Carvalho PM, Castelo PM, Carpenter GH, Gavião MBD. Masticatory function, taste, and salivary flow in young healthy adults. Journal of Oral Science. 2016;58(3):391-9.
14. Verbecque E, Coetzee D, Smits-Engelsman B. Underweight children are agile but lack power. BMC Pediatr. 2022;22(490):1-9.
15. Isabel CA, Moyses MR, van der Bilt A, Gameiro GH, Ribeiro JC, Pereira LJ. The relationship between masticatory and swallowing behaviors and body weight. Physiol Behav. 2015;151(1):314-9.
16. Santosa REA, Leandroa CG, de Françac KEX, Barbosab DAM, Aragãoa RS, Pinheiro IL. Mastication in overweight and obese children: A comparative cross-sectional study. J Pediatr (Rio J). 2022; S0021-7557(22)00096-1.
17. White AK, Venn B, Lu LW, Rush E,Gallo LM, Yong JLC, Farell M. A comparison of chewing rate between overweight and normal BMI individual. Physiol Behav. 2015;145(1):8-13.
18. Hayashida I, Tanimoto Y, Takahashi Y, Kusabiraki T, Tamaki J. Correlation between muscle strength and muscle mass, and their association with walking speed, in community-dwelling elderly Japanese individuals.Plos One. 2013;9(11):e111810.

19. Qaisar R, Bhaskaran S, Remmen VH. Muscle fiber type diversification during exercise and regeneration. Free Radic Biol Med. 2016;98:56-67.
20. Valenzuela PL, Maffiuletti NA, Tringali G, Col AD, Sartorio A. Obesity-associated poor muscle quality: prevalence and association with age, sex, and body mass index. BMC Musculoskeletal Disorders. 2020;21(200):1-8.
21. Addison O, Marcus RL, LaStayo PC, Ryan AS. Intermuscular fat: A review of the consequences and causes. Int J Endocrinol. 2014;2014:11.
22. Buss J. Limitations of body mass index to assess body fat. Workplace Health Saf. 2014;62(6):264.
23. Nishi T, Ohta M, Takano T, Ogami K, Ueda T, Sakurai K. Oral function is associated with the body and muscle mass indices of middle-aged dental patients. Clin Exp Dent Res. 2022;8(1):217–24.
24. Rovira-Lastra B, Flores-Orozco EI, Salsench J, Peraire M, Martinez-Gomis J. Is the side with the best masticatory performance selected for chewing?. Arch Oral Biol. 2014;59(12):1316-20.
25. Roohafza H, Afshar H, Keshteli AH, Shirani MJ, Afghari P, Vali A, Adibi P. Masticatory ability with depression, anxiety, and stress: Does there exist any association? Dent Res J. 2016;13(3): 211–6.
26. Sherwood L. Human physiology from cells to systems. 9th Ed. Boston: Cengage Learning. 2014. p. 574-5.
27. Pedersen AML, Sørensen CE, Proctor GB, Carpenter GH. Salivary functions in mastication, taste and textural perception, swallowing and initial digestion. Oral Dis. 2018;24(8):1399–7
28. Bornhorst GM, Feruja MJ, Singh RP. A proposed food breakdown classification system to predict food behavior during gastric digestion. J Food Sci. 2015;80(5):924-34.