The Comparison of the Salivary Flow Rate and the DMF-T Index in Obese and Normal-Weight Individuals

Ignatius Setiawan[1,2]*, Yuana Putri[3], Ayu Damayanti[3], Dewi Marhaeni Diah Herawati[4], Irna Sufiawati[5], Sunardhi Widyaputra[6]

1. Doctor of Dental Medicine, Master of Management, Department of Public Health, Faculty of Dentistry, Maranatha Christian University, Bandung, Indonesia.
2. Postgraduate Program, Faculty of Medicine, Universitas Padjadjaran, Bandung, Indonesia.
3. Undergraduate Program, Faculty of Dentistry, Maranatha Christian University, Bandung, Indonesia.
4. PhD, Doctor of Dental Medicine, Master of Health Science, Department of Public Health, Faculty of Medicine, Universitas Padjadjaran, Bandung, Indonesia.
5. PhD, Doctor of Dental Medicine, Oral Medicine Specialist, Department of Oral Medicine, Faculty of Dentistry, Universitas Padjadjaran, Bandung, Indonesia.
6. Professor, PhD, Doctor of Dental Medicine, Master of Science, Department of Oral Biology, Faculty of Dentistry, Universitas Padjadjaran, Bandung, Indonesia.

Abstract

The decrease of salivary flow in obese person is related to the abnormal condition of their adipose tissue. Individuals with low salivary flow rates may experience oral health problems such as dental caries. The objective of this study was to compare the salivary flow rate and the DMF-T index in obese and normal-weight individuals.

This study is a comparative analytic study with a case-control design. Sixty participants were taken using the quota sampling method. Research data were analyzed using Wilcoxon and Mann-Whitney statistical tests.

The average salivary flow rate in obese individuals was 0.20 ml/min while in normal-weight individuals it was 0.26 ml/min. The DMF-T index in obese individuals was 7.23 while in normal-weight individuals it was 4.10. Statistical test results showed that there were significant differences in salivary flow rate and DMF-T index between obese and normal-weight individuals with p-value <0.05.

The decrease in salivary flow rate also can be related to periodontal disease. The Maintenance of a healthy periodontal condition should be considered in obese individuals.

Clinical article (J Int Dent Med Res 2020; 13(4): 1488-1493)

Keywords: DMF-T index, Obesity, Salivary Flow Rate.

Received date: 03 September 2020 **Accept date:** 22 October 2020

Introduction

The epidemy of overweight and obesity is a major challenge for the prevention of chronic non-communicable diseases worldwide. The problem of obesity and overweight not only occurs in developed countries but also increases in prevalence in developing countries.[1] Obesity is defined as abnormal or excessive fat accumulation that can damage health. The fundamental cause of obesity and overweight is an energy imbalance between calories consumed and calories expended.[2,3]

***Corresponding author:**
Ignatius Setiawan
Permukiman Singgasana Pradana, Jl. Singgasana Raya no. 123
Bandung, Jawa Barat, Indonesia 40238
E-mail ignatius.setiawan@dent.maranatha.edu

Accumulation of excess fat can occur if we excessively consume fat-producing foods, one of which is carbohydrates or sugar.[4] Sugar or glucose is classified as a simple carbohydrate composed of carbon, hydrogen, and oxygen. Sugar contains a lot of energy but only a few vitamins and minerals. Since sugar is a simple carbohydrate, it is easily absorbed by the intestine to be used as energy.[5]

Excessive glucose will be stored in the liver and muscle cells in the form of glycogen. When the body needs glucose, the liver will release it into the bloodstream and is carried throughout the body such as into the brain, the nervous system, the heart, and other organs. When glucose enters the cell, the enzymes break it down into small pieces which in turn produce energy, carbon dioxide, and water. Excess carbohydrates are converted into fat and then stored in fat tissue.[6] Several studies on the causes of obesity have shown an association between obesity and high consumption of sweet foods and drinks which have also been proven to be risk factors that cause dental caries.[7] Carbohydrates provide energy to the body, particularly through glucose, a simple sugar that is a component of starch and an ingredient in many staple foods. Carbohydrates are classified into three subtypes: monosaccharides, disaccharides, and polysaccharides. Our body stores excess glucose as glycogen (a polymer of glucose) which become liberated in times of fasting. Glucose is also derivable from products of fat and protein break-down through the process of gluconeogenesis.[8]

Dental caries is considered a common public health problem throughout the world because of its high prevalence and significant social impacts.[9] Many factors cause caries, one of which is cariogenic food. Carbohydrates are highly cariogenic ingredients. Processed sugars such as glucose and particularly sucrose are very effective in causing a drastic decrease in pH of saliva until as low as or below 5.5, which in turn will facilitate demineralization.[10] The dental caries of each individual can be determined through a method named the DMF-T (T (Decay Missing Filled Teeth) index. The DMF-T index can provide information about teeth that have caries, teeth that have been cursed, and teeth that have been lost due to caries.[11]

In previous studies body mass index was found to be associated with a decrease in salivary flow rate.[12–14] A study conducted by Modeer et al also showed that childhood obesity is associated with decreased salivary flow rate.[14] Normal, high, low or very low parameters of salivary flow are expressed in units of ml/min. The normal rate of salivary flow without stimulation is 0.25 - 0.35 ml/min, the low salivary flow rate is 0.1 - 0.25 ml/min and the very low salivary flow rate is less than 0.1 ml/min.[15] Individuals with the low salivary flow can experience oral health problems such as periodontitis, caries, xerostomia, mucosal inflammation, burning mouth, taste disturbance, tooth demineralization, mastication difficulties, speech disorders, and poor denture retention. Low Salivary flow can also affect food intake patterns and nutritional status, which in turn negatively affect the quality of life.[12] The salivary flow rate, both stimulated and non-stimulated, can be influenced by the source of stimulus, smoking habit, glandular size, vomiting reflex, olfactory reflex, food, hydration, body position, previous stimulation, circadian rhythm, drugs, age, psychological effects, functional stimulation, and weight.[15] Saliva functions in maintaining neutral pH in the oral cavity and producing calcium and phosphate ions that are needed for the teeth remineralization. Saliva also protects teeth and oral mucosa from local microbial by producing many enzymes, sIgA, lactoferrin, and histatin.[16]

Evaluation of the nutritional status of body weight can be done through several standard methods, namely body mass index (BMI), waist circumference, waist and hip circumference ratio, and fat percentage. Body fat percentage, one indicator in nutritional anthropometric measurements, illustrates the comparison of fat and non-fat mass in a person's body. Body fat measurements are used to monitor body fat reserves and see a person's level of obesity.[17] The Bioelectrical Impedance Analysis (BIA) method is a method that can be used to measure a person's body fat percentage. BIA method is a method that measures body composition based on electrical conductivity by running electrical signals in human body fluids so that muscle mass, body fat mass, the water content in the body and even individual bone mass can be determined.[18,19]

Based on the above explanation, obese individuals can experience dental caries and a disruption in the salivary flow rate. This study aims to compare the salivary flow rate and the DMF-T index in obese and normal-weight individuals.

Materials and methods

This study is a comparative analytical study with case-control study design. This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the Health Research Ethics Committee, Maranatha Christian University – Immanuel Hospital Bandung, Indonesia No. 012/KEP/III/2019. Written informed consent was obtained from all participants / patients.

The sample size in this study was calculated using the sample calculation formula for comparative analysis research. Sixty participants were taken using the quota sampling method. Each of them was a patient who got dental treatment at Maranatha Dental Hospital. The participants were divided into two groups. The first group was the case group, consisting of obese individuals with several criteria as follow: the patient was between 20 and 35 years old, the Body Mass Index score was ≥30 and the body fat percentage was ≥25% for men and ≥33% for women. The second group was the control group, consisting of normal-weight individuals with several criteria as follow: the patient was between 20 and 35 years old, the Body Mass Index score was 18,5 - 22,99 and the body fat percentage was 8 – 15% for men and 13 – 23% for women.[17] There were also several exclusion criteria for both groups. First, individuals with mental disorders and diseases with a high risk of infection. Second, individuals with conditions that might interfere with the assessment of body mass index scores and body fat percentage, including pregnancy and athletic profession. Third, individuals with conditions that might affect salivary flow rate, including diabetes mellitus and drugs that affect salivary flow rate.

The BMI and body fat percentage of each participant were measured to put them into the appropriate groups. Research participants were advised not to smoke, chew gum or consume other foods and drinks one hour before data collection. First participants were advised to rinse their mouth several times and relax for 5 minutes. They were also given instructions to minimize movements, especially mouth movements before and during salivary collection. When the participants wanted to swallow the saliva, they were instructed to lean their head forward over the measuring tube and open the mouth slightly so that the saliva could flow into the measuring tube. The participants were required to carry out each procedure in the same manner until the collection procedure ended. Saliva was collected using Navazesh and Kumar method. The collection procedure lasted for 5 minutes. Afterwards the total volume of saliva collected from every participants were measured and recorded.[20]

The DMF-T component consists of D (decay), M (missing), and F (Filling). D stands for a tooth that is affected by caries, M stands for a tooth that is lost or extracted due to caries and F stands for a tooth that is affected by caries and has been filled. All teeth are examined except for the third molars. In condition that one tooth has decay at more than one tooth surface, it is only counted as one decay. Likewise, for the severity of tooth decay, it will be considered as the same decay. The DMF-T score is the number of permanent teeth that have decayed, been missed and been filled due to caries.[21]

Results

Participants in this study were 40 women (66.7%) and 20 men (33.3%). The largest age group is aged 20-25 years (46 people/76.7%). The characteristic of Participants based on age is shown in Table 1.

Age (Years)	n	%
20-25	46	76,7%
26-30	10	16,7%
31-35	4	6,7%
Total	60	100%

Table 1. The Characteristic of Participants based on age.

The Male participants had an average body fat percentage (%BF) of 22.38% which is categorized as obesity but their average BMI score of 24 is categorized as normal. The female participants showed a similar picture, where their average body fat percentage (%BF) of 32.23% is categorized as obesity but their average BMI score of 23 is categorized as normal.

The results showed that 85.71% of obese individuals had a low salivary flow rate, 14.29% had a normal salivary flow rate and none had a high salivary flow rate. In the control group, 28.57% of normal-weight individuals had a low salivary flow rate, 66.66% had a normal salivary flow rate and 4.77% had a high salivary flow rate, as in the table (Table 2).

Salivary Flow Rate	Obese Individuals	Normal-weight Individuals	p-value	Conclusion
Low	85,7%	28,57%		
Normal	14,28%	66,67%	0,0002	Significant
High	0%	4,76%		

Table 2. The Comparison of Salivary Flow Rate in Obese and Normal-weight Individuals.

Descriptively, the result showed that the salivary flow rate of obese individuals, the average of which was 0.20 ml/min, was low compared to that of normal-weight individuals, who have an average salivary flow rate of 0.26

ml/min. Based on the results of the comparative analysis using Wilcoxon's, a p-value of 0.0002 was obtained, which indicates that there is a significant difference between the salivary flow rate of obese and that of normal-weight individuals in RSGM Maranatha.

Cross tabulation of DMF-T scores and body fat percentage (% BF) in normal-weight and obese individuals can be seen in Table 3. Based on the table, it appears that 50% of obese individuals had DMF-T index in the very high category and no one has DMF-T index in a very low category. On the other hand only 15% of normal-weight individuals had a very high DMF-T index. The average DMF-T index score in normal-weight individuals was 4.10 while the average DMF-T index score in obese individuals was 7.23.

DMF-T Index	Obes Individuals	Normal-weight Individuals	p-value	Conclusion
Very High	50%	13,33%		
High	33,3%	23,33%		
Middle	13,3%	30%	0,0000	Significant
Low	3,3	23,33%		
Very Low	0%	10%		

Table 3. The Comparison of DMF-T Index in Obese and Normal-weight Individuals.

The differences of DMF-T index score in obese and normal-weight individuals were tested by non-parametric statistical tests using the Mann-Whitney's. Through calculations obtained p-value = 0,000 (<0.05) which means that there are significant differences of the DMF-T score between normal-weight and obese individuals.

Discussion

The results showed that the salivary flow rate of obese individuals was below the normal salivary flow rate, which is 0.25-0.35 ml / min. This situation can be caused by the changes of adipose tissue in obese individuals such as changes in size, distribution, composition and function. Adipose tissue experiences hypertrophy, ectopic fat deposition, hypoxia, and chronic stress in this obesity state. The expansion of adipose tissue significantly influences the physiological response and can interfere with tissue function.[22] Enlargement of the parotid gland caused by increased adipocyte storage is found in overweight individuals.[14] Adipocytes are endocrine organs with a dual metabolic role in regulating physiological bodies. Adipocytes in lean individuals increase homeostasis, while enlarged adipocytes in obese individuals activate macrophages and increase inflammation.[22,23] Activated macrophages will secrete pro-inflammatory mediators, resulting in an imbalance between the decrease of anti-inflammatory adipokine secretion and the increase of pro-inflammatory adipokine secretion.[24,25] The presence of these inflammatory cells causes the function of the salivary glands to be disrupted, resulting in decreased salivary flow.[14]

Obese individuals have been reported to exhibit a significant enlargement of parotid glands probably by an enhanced storage of adipocytes in the parotid parenchyma whereas the submandibular glands seem to remain unaffected.[26] Based on that, pro-inflammatory cytokines derived from adipocytes as well as macrophages, accumulated in adipose tissue may negatively affect the function of salivary glands due to chronic low-grade inflammation in the gland. Moreover, we have reported enhanced levels of pro-inflammatory cytokines tumor necrosis factor–α, inter- leukin-1, and interleukin-8 in crevicular fluid in obese adolescents compared with normal-weight subjects indicating a hyper-inflammatory reaction in the periodontal tissue as well.[14]

These changes in adipose tissue are mainly hypertrophy. They are accompanied by macrophage infiltration. These macrophages may participate in the inflammatory process, where macrophages secrete maximum pro-inflammatory mediators which also cause an imbalance between pro-inflammatory adipokines and anti-inflammatory adipokines. The presence of these high inflammatory cells causes the inflammatory process to occur more frequently, so it can cause damage to the salivary gland parenchymal tissue, where the gland contains secretory cells and ducts. This causes the salivary glands to function abnormally and it is followed by an accumulation of adipose in the parenchymal tissue, which causes the acini ducts to shrink, and disturbances such as decreased salivary flow can occur.[23,24]

Besides being influenced by body weight, salivary flow rate can also be influenced by several factors. Different physical activities in each individual can affect salivary flow rate. Physical activity can affect sympathetic stimulation, which can lead to reduced or blocked salivary flow. Psycho-emotional conditions can also affect salivary flow rate. Depression or stress conditions can reduce salivary flow, while thinking about or looking at food can be a stimulus to increase salivary flow. Bad habits such as smoking and alcohol consumption in short term or long term can also affect the condition of the oral cavity including salivary flow rate. Another very important factor that can affect salivary flow rate is the degree of hydration. If the body lacks water content or body hydration is decreased, the salivary glands will adapt by reducing salivary secretion to maintain the amount of water in the body, and vice versa. if the degree of hydration increases, which means hyper-hydration, salivary flow rate also increases.[14,15] In this study physical activity factors, emotional conditions, habits, and degrees of hydration have not been studied.

The decrease in salivary flow rate can be related to the incidence of dental caries.[7] Descriptively it is seen that the DMF-T index of obese individuals tends to be higher compared to that of normal-weight individuals. In addition to its association with a decrease in salivary flow rate, the increase in caries index in obese individuals can be related to food intake patterns. Research conducted by Te Morenga et al. shows that the increase in fat accumulation, which causes obesity, can occur if we consume fat-producing foods excessively, one of which is carbohydrates or sugar.[4] Carbohydrates or sugars that enter the oral cavity can also be easily metabolized by certain bacteria involved in the formation of dental biofilms. The bacteria will produce acid as by products, so the pH of the oral cavity will decrease to below 5 within 2-5 minutes, while the time needed by the oral cavity to neutralize the acid is 60 minutes. If sweet food continues to be consumed then the state of the oral cavity will continue to be in acidic conditions, and this will lead to the process of demineralizing tooth structure and can eventually cause caries.[21,27]

The use of herbal medicines can be an option to treat decreased salivary flow in obese individuals. There is a study which suggested that consuming secang (Caesalpinia sappan Linn) drink may increase the salivary flow rate, salivary pH, and related to the body mass index.[28] Another study showed that after consumption of tualang honey, there was also a significant increased in salivary flow.[29]

There is a limitation of our study because saliva collection procedures were taken place at various time points on the day and therefore to some extent influence the results due to circadian rhythm of salivary flow. However, the mean value of salivary flow rate in each group showed a similar pattern. Based on that fact the lower flow rate of whole saliva secretion among the obese subjects reflects presumably an effect by adiposity rather than difference in sampling time of saliva collection.

Conclusions

The salivary flow rates in obese individuals are lower whereas the DMF-T index are higher compared to those of normal-weight individuals. There is a significant difference in salivary flow rate and DMF-T index between obese and normal-weight individuals.

Acknowledgements

All authors have made substantive contribution to this study and/or manuscript, and all have reviewed the final paper prior to its submission.
We thank Faculty of Dentistry Maranatha Christian University and Maranatha Dental Hospital for the technical support during the research.

Declaration of Interest

The authors declare no conflict of interest. This research received no specific grant from any funding agency, commercial or not-for-profit sectors.

References

1. Sandjaja, Sudikno. Prevalensi Gizi Lebih dan Obesitas Penduduk Dewasa di Indonesia. Gizi Indonesia. 2005;28(2):1–7.
2. DS Akram, AV Astrup, T Atinmo, JL Boissin, GA Bray, KK Carroll, et al. The Problem of Overweight and Obesity. In: Obesity : Preventing and Managing The Global Epidemic. Geneva: World Health Organization; 2004:5–15.
3. Camacho S, Ruppel A. Is The Calorie Concept A Real Solution to The Obesity Epidemic? Global Health Action. 2017;10(1):1–12.
4. Morenga LT, Mallard S, Mann J. Dietary Sugars and Body Weight: Systematic Review and Meta-Analyses of Randomised Controlled Trials and Cohort Studies. British Medical Journal. 2012;346(7492):1–25.
5. Bovi APD, Michele LD, Laino G, Vajro P. Obesity and Obesity Related Diseases, Sugar Consumption and Bad Oral Health: A Fatal Epidemic Mixtures The Pediatric and Odontologist Point of View. Translational Medicine @UniSa. 2017;16(2):11–6.

6. Burhan FZ, Sirajuddin S, Indriasari R. Pola Konsumsi terhadap Kejadian Obesitas Sentral pada Pegawai Pemerintahan di Kantor Bupati Kabupaten Jeneponto. Jurnal Media Kesehatan Masyarakat Indonesia. 2013;9(1):1–14.
7. Cury JA, Rebelo MAB, Cury AADB, Derbyshire M, Tabchoury CPM. Biochemical Composition and Cariogenicity of Dental Plaque Formed in the Presence of Sucrose or Glucose and Fructose. Caries Research. 2000;34(6):491–7.
8. OpenStax CNX. Carbohydrates. In: General Biology. California: LibreTexts; 2020:89–101.
9. Dixit LP, Shakya A, Shrestha M, Shrestha A. Dental Caries Prevalence, Oral Health Knowledge and Practice among Indigenous Chepang School Children of Nepal. BMC Oral Health. 2013;13(20):1–5.
10. Ramayanti S, Purnakarya I. Peran Makanan terhadap Kejadian Karies Gigi. Jurnal Kesehatan Masyarakat. 2013;7(2):89–93.
11. Hatkehlouei MB, Tari H, Goudarzian AH, Hali H. Decayed, Missing, and Filled Teeth (DMFT) Index among First- grade Elementary Students in Mazandaran Province, Northern Iran. International Journal of Pediatrics. 2017;5(6):5069–77.
12. Fajrin FN, Agus Z, Kasuma N. Hubungan Body Mass Index dengan Laju Aliran Saliva (Studi pada Mahasiswa Fakultas Kedokteran Gigi Universitas Andalas). Majalah Kedokteran Gigi Indonesia. 2015;1(2):156–62.
13. Setiawan I, Lathifah GG, Fikri SN, Herawati DMD, Sufiawati I, Widyaputra S. The Correlation between Body Mass Index with DMF-T index and CPI Modified. Proceeding Book The 4th Bali Dental Science and Exhibition Balidence. 2019:843–9.
14. Modéer T, Blomberg CC, Wondimu B, Julihn A, Marcus C. Association Between Obesity, Flow Rate of Whole Saliva, and Dental Caries in Adolescents. Obesity Journal. 2010;18(12):2367–73.
15. Kasuma N. Saliva. In: Fisiologi dan Patologi Saliva. Padang: Andalas Univerity Press; 2015:1–26.
16. Wimardhani YS, Kusuma YW, Sasanti H, Subita GP, Sarsito AS, Pradono SA, et al. Salivary Profile of Recovering Drug Users in Indonesia. Journal of International Dental And Medical Research. 2016;6(1):50–4.
17. Fahmida U, Dillon DHS. Anthropometry Assessment. In: Handbook Nutritional Assessment. 2nd ed. Jakarta: SEAMEO RECFON UI; 2011:92–122.
18. Gibson RS. Laboratory Assessment of Body Composition. In: Principles of Nutritional Assessment. 2nd ed. New York: Oxford University Press; 2005:353–72.
19. Soegih R, Wiramihardja KK, editors. Penilaian Status Pasien Obesitas. In: Obesitas : Permasalahan dan Terapi Praktis. Jakarta: Sagung Seto; 2009:29–38.
20. Navazesh M, Kumar SKS. Measuring Salivary flow Challenges and Opportunities. Journal American Dental Association. 2008;139:35–40.
21. Kidd EAM. Fluoride Supplementation. In: Essentials of Dental Caries. 3rd ed. New York: Oxford University Press Inc; 2005:109–25.
22. Fasshauer M, Blüher M. Adipokines in Health and Disease. Trends in Pharmacological Sciences. 2015;3(7):461–70.
23. Kershaw EE, Flier JS. Adipose Tissue as an Endocrine Organ. The Journal of Clinical Endocrinology & Metabolism. 2004;89(6):2548–56.
24. Greenberg AS, Obin MS. Obesity and the Role of Adipose Tissue in Inflammation and Metabolism. The American Journal of Clinical Nutrition. 2006;83(2):461–5.
25. Wardhana IMW, Wangko S. Interaksi antara Makrofag dan Jaringan Adiposa dan Obesitas. Jurnal Biomedik. 2011;3(2):111–8.
26. Bozzato A, Burger P, Zenk J, Uter W, Iro H. Salivary Gland Biometry in female Patients with Eating Disorders. European Archives of Oto-Rhino-Laryngology. 2008;265(9):1096–102.
27. Alswat K, Mohamed W, Wahab M, Aboelil A. The Association Between Body Mass Index and Dental Caries. J Clin Med Research. 2016;8(2):147–52.
28. Yohana W, Tjahajawati S, Sufiawati I, Kartika IS, Izdaulfikri MI. Increasing Salivary Flow Rate and Salivary Ph after Consuming Secang Drink (Caesalpinia Sappan L.) Related to Body Mass Index. Journal of International Dental And Medical Research. 2020;13(2):659–62.
29. Ghazali N, Mohammad N, Ramli H, Yazid F, Ibrahim AZ. Level of Salivary Flow Rate, pH Level, Buffering Capacity and After Consumption of Malaysian Tualang Honey: A Preliminary Study. Journal of International Dental and Medical Research. 2019;12(3):1084–9.