ORIGINAL ARTICLE

Relationship between Age, Body Mass Index, and Number of Missing Teeth with Clinical Attachment Loss in Patients with Metabolic Syndrome

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ABSTRACT

Introduction: Metabolic syndrome (MetS) consists of obesity, hypertension, impaired glucose tolerance, and dyslipidaemia. Physiological alterations resulting from MetS could impact oral health, especially the periodontium. This study aimed to determine the relationship between age, body mass index (BMI), and number of missing teeth, and clinical attachment loss in patients with MetS. **Methods:** This cross-sectional study included 62 patients with MetS and periodontitis who visited the Dental and Oral Hospital Universitas Sumatera Utara. Age was obtained through anamnesis, BMI was calculated by measuring the patient's height and weight, and oral and dental examinations were performed by measuring the number of missing teeth and clinical attachment loss to determine periodontal destruction. **Results:** The mean age of the patients was 48.34 (11.72) years. Based on the Spearman correlation test, age ($p = 0.001$) and the number of missing teeth ($p = 0.006$) were significantly correlated with clinical attachment loss, but BMI ($p = 0.998$) was not, in patients with MetS. **Conclusion:** Age and number of missing teeth are factors associated with periodontal damage in periodontitis patients with metabolic syndrome, where the increasing age and number of missing teeth are the more severe periodontal damage in periodontitis patients with metabolic syndrome. Age and tooth loss may be useful as an indicator of periodontal status in individuals with MetS.
Keywords:

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Keywords: Age, body mass index, clinical attachment loss, metabolic syndrome, missing teeth

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INTRODUCTION

Periodontal disease is a chronic inflammatory disease caused by complex interactions between specific pathogenic microorganisms in subgingival plaque and progressive host-mediated destruction of tooth-supporting structures (1). Periodontal disease is the sixth most common chronic condition as the main cause of tooth loss. Periodontitis is a chronic inflammatory disease caused by multiple factors resulting from complex dynamic interactions between specific pathogenic bacteria, deleterious host immune responses, and environmental factors (2). Beyond local etiological factors, growing evidence has established a significant association between periodontal disease and various systemic conditions, including metabolic syndrome (MetS), diabetes mellitus, and cardiovascular diseases (2).

Metabolic syndrome (MetS) is defined as a constellation of comorbid conditions that includes obesity, hypertension, and disordered carbohydrate and lipid metabolism. Metabolic syndrome (MetS) is defined by a set of clinical criteria, which include obesity as a mandatory component, accompanied by at least two of the following: elevated blood pressure, impaired glucose metabolism, or increased non-HDL cholesterol, a marker of atherogenic dyslipidemia (3).

Metabolic diseases typically arise from excessive

consumption of calories and nutrients, leading to a state of inflammation known as a 'pro-inflammatory' state. Other chronic inflammatory conditions may also contribute to the development of these disorders. This hypothesis posits that an elevated level of inflammatory substances, such as tumor necrosis factor-alpha (TNF-α), leads to insulin resistance. This, in turn, triggers further inflammation by increasing the concentration of free fatty acids derived from the breakdown of fats, which interferes with the ability of insulin to reduce inflammation. The presence of inflammation in the body can cause an increase in oxidative stress, which has the potential to negatively affect various key biological activities. Therefore, insulin resistance may act as a common link among all its components (4,5).

Risk factors that influence periodontitis include age, sex, educational level, socioeconomic conditions, and obesity, among others. The increasing severity of periodontal disease and alveolar bone loss with age is related to the length of time that periodontal tissues have been exposed to bacterial plaque and is thought to reflect an individual's cumulative oral history (6). The most common definition of obesity is based on body mass index (BMI), which is the ratio of body weight (in kilograms) to height (in meters) squared (7). Obesity is associated with adipocyte hyperplasia and hypertrophy, leading to chronic low-grade systemic inflammation. Inflammatory cytokines secreted by adipose tissue have been shown to increase bone resorption. Elevated levels of TNF-α initiate a link between obesity and inflammation including periodontitis (8).

Periodontitis can be diagnosed by clinical examination, and attachment loss is one of the most important signs. Attachment loss is the movement of the junctional epithelium apical to the cemento-enamel border. Gingival recession is associated with attachment loss in 31 to 50-year-old patients with chronic periodontitis, in whom systemic conditions also increase in the body (9). Research by Robo et al. showed that a high prevalence of periodontitis at a young age indicates a poor prognosis in old age (9). The current study aimed to determine the relationship between age, BMI, the number of missing teeth, and clinical attachment loss in patients with MetS. Although the relationship between MetS and periodontitis has been explored, most studies have examined one or two metabolic or clinical parameters in isolation. Moreover, research focusing on Indonesian populations, particularly from North Sumatra, remains limited despite unique ethnic, dietary, and health behavior characteristics that may influence outcomes. This study will provide new insights into the association between metabolic health and oral health, by investigating this combination of clinical and metabolic variables in a relatively understudied population, this research contributes new insights into the systemic-oral health interface.

MATERIALS AND METHODS

A cross-sectional study was performed, including 62 patients who visited the Dental and Oral Hospital Universitas Sumatera Utara, Medan, Indonesia. Inclusion criteria were: periodontitis patients with MetS, aged ≥17 years, who had not had periodontal treatment for at least 6 months. Patients with systemic diseases other than MetS, those taking blood thinners, and patients with bad habits such as smoking, bruxism, and others, were excluded from this study. All the included patients who agreed to participate signed an informed consent form. Demographic data were collected through interviews. Data retrieved from patients included age, height, and weight. Height was measured using a measuring tape, whereas weight was measured using a weighing scale. BMI was calculated as the ratio of the patients' body weight (kg) to the square of their height (m2) (10).

A person was considered to have MetS if at least three of the following components were present: obesity of the abdomen region, hypertension, high blood glucose levels, microalbuminuria and hyperglycemia. Abdominal obesity was measured with a measuring tape positioned parallel to the floor and wrapped around the centre of the body between the ribs and hip bones. The number at the point where the measuring tape met was the size of the stomach circumference (11,12). Hypertension was determined by blood pressure measurements performed with a digital sphygmomanometer, and blood sugar levels were measured using a glucometer to determine whether the patient had hyperglycemia. Calibration was performed before taking the measurements.

Periodontal examinations in this study were performed by trained Periodontal Specialists at the Dental and Oral Hospital, Universitas Sumatera Utara. To ensure consistency and accuracy of clinical data, all examiners underwent a calibration process prior to the commencement of the study. The examinations were repeated until an acceptable level of inter-examiner reliability was achieved for all parameters (Kappa>0.8). The periodontal examination included oral hygiene index (OHI), pocket depth (PD), gingival recession (GR), and attachment loss (AL). The study performed full-mouthed measurements where AL and PD were measured using a periodontal probe. All the measurements were performed on six surfaces per tooth: mesiobuccal, midbuccal, distobuccal, mesiolingual/palatal, midlingua/palatal, and distolingual/palatal. The PD was assessed from the base of pocket to the gingival margin. The AL was assed from cementoenamel junction to base of pocket. For teeth where the gum had receded, attachment loss was calculated by adding the PD to the distance between the cemento-enamel junction and the gingival margin (the gingival recession). When the gingival margin was aligned with the cemento-enamel junction, the attachment loss equalled the PD. However, in cases of gingival enlargement, attachment

loss was determined as PD minus the distance from the gingival margin to the cemento-enamel junction (13-15). Examination of the number of missing teeth was carried out by counting the number of teeth that were missing/had been removed from the patient's oral cavity at the time of the examination. The remaining tooth roots were not included as missing teeth. The oral hygiene index measurement is the sum of the calculus index and the debris index.

Data analysis was performed using the Kolmogorov-Smirnov test for data normality and additionally using the Spearman correlation test for bivariate analysis with a significance level of 5%.

Ethical Clearance

This research project was approved by the Health Research Ethics Committee of the Universitas Sumatera Utara No. 1069/KEPK/USU/2023.

RESULTS

The mean age of the study participants was M = 48.34, SD = 11.72 years, and the mean of BMI was M = 29.97, SD = 3.50 kg/m2 as shown in Table I, indicating that the participants were, on average, in the obese category. The average number of missing teeth was M = 5.44, SD = 3.8, while the mean oral hygiene index was M = 2.92, SD = 1.31.

Table I. Description of Patients with Metabolic Syndrome

Variables (n=62)	Mean±SD
Age	48.34±11.72
Body Mass Index	29.97±3.500
Number of Teeth Missing	5.44±3.814
Pocket Depth	2.74 ± 0.576
Recession	0.79±0.764
Clinical Attachment Loss	3.47±1.176
Oral Hygiene Index	2.92±1.306

Based on the Spearman test in Table II, a significant relationship between age and attachment loss (p = 0.001) was observed with a positive correlation coefficient (r = 0.415). The number of missing teeth is also significantly related to attachment loss (p = 0.006) with a positive correlation coefficient (r = 0.344). However, there was no significant relationship between BMI and attachment loss (p = 0.998).

Based on the Spearman test results shown in Table III, there was no significant relationship between oral hygiene and age (p = 0.917), BMI (p = 0.353), or number of missing teeth (p = 0.989).

Table II. Relationship between Age, Body Mass Index, Number of Missing Teeth, and Clinical Attachment Loss in Patients with Metabolic Syndrome

Variables (n=62)	Clinical Attachment Loss	
	Coefficient Correlation	p
Age	0.415	0.001*
Body Mass Index	0.000	0.998
Number of Teeth Missing	0.344	0.006*

Spearman test; * Significant p<0.050

Table III. Relationship between Age, Body Mass Index, and Number of Missing Teeth, and Oral Hygiene Index in Patients with Metabolic Syndrome

Variables (n=62)	Oral Hygiene Index	
	Coefficient Correlation	p
Age	0.014	0.917
Body Mass Index	-0.120	0.353
Number of Teeth Missing	0.002	0.989

Spearman test; * Significant p<0.050

DISCUSSION

The data in Table I shows that the mean age of the study participants was M = 48.34, SD = 11.72 years. Similar results were found by Campos et al., who showed that most patients with MetS are of the age of >45–55 years (16). The body's metabolism naturally slows, leading to a decrease in the body's ability to process sugar and fat efficiently, resulting in a gradual increase in body fat and decrease in muscle mass. This alteration in body composition may facilitate the onset of insulin resistance and dyslipidemia, which are significant elements of the MetS (17).

Overweight and obesity are associated with increased body fat levels. Therefore, someone who is overweight has a higher risk of experiencing abdominal obesity, which is one of the components of MetS (18). In this study, the average BMI of patients with MetS was M = 29.97, SD = 3.50 kg/m2, which means the patients were in the obese category. A higher BMI, particularly due to increased visceral fat, is strongly associated with insulin resistance. In obese individuals, there is an elevation in the levels of hormones, cytokines, pro-inflammatory markers, and other chemicals associated with the onset of insulin resistance. People with MetS often exhibit elevated glucose levels, indicating a predisposition to insulin resistance and diabetes.

In this study, the average number of missing teeth in the study participants was M = 5.44, SD = 3.8. Alterations in dietary intake influence the elements of MetS, including lipid and glucose metabolism as well as blood pressure; hence, a reduction in the number of teeth is regarded as

a risk factor for the onset of MetS. Flink et al. showed that hyposalivation is more common in younger persons and is connected with confirmed disease and a high BMI, whereas it is associated with treatment after the age of 50 years old. It is also connected with gender and having fewer remaining teeth (19). Elevated levels of inflammatory markers in individuals with MetS may lead to increased periodontal tissue destruction, including the gingiva and periodontal ligament, contributing to the periodontal pocket formation (20). The average PD of the participants of this study was 2.74 ± 0.576 mm.

The average attachment loss of the participants in this study was 3.47 ± 1.176 mm. Gingival recession and clinical attachment loss are periodontal parameters that are irreversible; therefore, if gingival recession and clinical attachment loss occur, they cannot change towards a better score even if oral hygiene is improved and glycaemic status is controlled to reduce periodontal tissue inflammation, except when therapy is provided for repairing gingival recession and periodontal tissue damage (21).

The average oral hygiene index of the participants in this study was M = 2.92, SD = 1.31. This value shows that the oral hygiene index was at a medium level. Insulin resistance is one of the main factors causing MetS, resulting in a decrease in cell sensitivity to insulin, which causes an increase in insulin levels, resulting in hyperglycemia. Hyperglycaemia provides a favourable environment for oral bacteria to thrive which leads to the formation of dental plaque. In connection with the increased formation of debris and calculus, the oral hygiene index also increases, indicating poor oral hygiene (22,23).

This study found a significant relationship between age and attachment loss ($p = 0.001$), with a correlation coefficient of $r = 0.415$. This means that the older a person gets, the higher the risk of developing gingival attachment loss (41.5 %). A reduction in the number of teeth can cause a decrease in the chewing function. This causes individuals with reduced chewing ability to avoid chewy foods and prefer soft foods, resulting in a decrease in the intake of dietary fibre and vitamins, as well as an increase in carbohydrate intake (24). In this study indicated no significant relationship between the oral hygiene index and age ($p = 0.917$). Chronic exposure to periodontitis causes increased periodontal tissue damage. However, age-related susceptibility assumes that age increases the risk of periodontitis due to dysregulation of the immune system or immunosenescence, so that not only age but also the condition of the patient's immunity and knowledge of the condition of the oral cavity influence periodontal damage (25,26).

The correlation between BMI and periodontitis is associated with detrimental dietary habits in patients, such that micronutrients are not met, and the patients also have excess blood sugar and fat levels (27). Jha, et al. showed that there is a relationship between BMI and oral hygiene because nutritional status is a factor that plays a role in oral health, and good oral health conditions are strongly supported by good nutritional health (28). However, in the current study, no significant relationship was found between the oral hygiene index and BMI ($p = 0.353$). The frequency of regular brushing and the correct way to brush one's teeth also influence the condition of oral hygiene; BMI is not the only factor that influences the condition of oral hygiene.

In the present study, a lack of association was found between number of missing teeth and the oral hygiene index ($p = 0.989$). Similar findings were shown in a study by Ur Rehman et al., where no significant relationship was found between the oral hygiene index and decayed, missing, and filled teeth (29). Teeth play an important role in function and aesthetics in carrying out daily life activities. Teeth loss is one of the main problems encountered when patients visit a dentist. Loss of teeth is not a result of aging but is more often caused by trauma or dental and oral diseases.

This study has several limitations, including the fact that it only measures blood pressure, fasting sugar levels, abdominal circumference, and BMI to determine MetS. These criteria, although widely accepted, do not include laboratory measurements of antioxidant, triglyceride, and high-density lipoprotein (HDL) cholesterol levels. The absence of these additional parameters limits the depth of understanding of an individual's oxidative stress and lipid profile, which is critical for understanding the complete metabolic state.

Despite these limitations, this study has several strengths and important contributions. One significant strength is its focus on a relatively under-researched area: the relationship between age, BMI, and number of missing teeth, and clinical attachment loss in patients with MetS. This study provides valuable evidence from an underrepresented population in North Sumatra, Indonesia, contributing to a more geographically diverse understanding of the MetS-periodontitis relationship. This study provides new insights into how these variables collectively influence periodontal health in individuals with MetS. The knowledge gained from this research is critical for improving clinical practice and public health guidelines. Understanding the complex relationship between metabolic syndrome and periodontal health can inform better preventive and therapeutic strategies.

CONCLUSION

Age and number of missing teeth are factors associated with periodontal damage in periodontitis patients with metabolic syndrome, where the increasing age and number of missing teeth are the more severe periodontal

damage in periodontitis patients with metabolic syndrome. Age and tooth loss may be useful as an indicator of periodontal status in individuals with MetS.

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Conflict of Interest

The authors declare no conflicts of interest.

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