

Balancing body and health: The impact of obesity on oral health condition

Karolina Trytek-Miś¹, Patrycja Ochman-Pasierbek², Kinga Cogieł², Magdalena Jaskółka³

¹DENTIST, EURODENT DENTAL CENTER, TARNOW, POLAND

²POSTGRADUATE MEDICAL INTERNSHIP, DR. B. HAGER MULTI-SPECIALIST DISTRICT HOSPITAL IN TARNOWSKIE GORY, TARNOWSKIE GORY, POLAND

³POSTGRADUATE MEDICAL INTERNSHIP, INDEPENDENT PUBLIC HEALTH CARE CENTER OF THE MUNICIPAL HOSPITAL COMPLEX, CHORZOW, POLAND

ABSTRACT

Aim: This paper explores the relationship between obesity and oral diseases. Early detection and prevention of risk factors are essential for indispensable for promoting long-term health and elevating the quality of life in affected patients.

Materials and Methods: A search of PubMed and Google Scholar on November 10, 2024, retrieving 48 articles from 2016–2024. After screening criteria, 45 articles were included. All authors verified the final content.

Conclusions: Evidence suggests a notable association between obesity and oral health issues, including periodontitis, peri-implantitis, and other gum diseases. Certain research point to the possibility that patients who undergo bariatric surgery could also experience worsening dental health. Inadequate oral hygiene and excessive sugar consumption, along with obesity, contribute to the worsening of dental problems in both children and adults. Further studies are required to better elucidate the underlying mechanisms of this association, which remains insufficiently explained in literature.

KEY WORDS: obesity, tooth condition, periodontitis, oral health, bariatric surgery

Wiad Lek. 2025;78(6):1168–1175. doi: 10.36740/WLek/204813 DOI

INTRODUCTION

It is well known that an unhealthy lifestyle is the cause of many civilization diseases. Along with hypertension and diabetes, obesity is one of the primary lifestyle-related conditions. Obesity is becoming more common around the world and is increasingly recognized as one of the primary health dangers. It is an escalating global health issue with significant effects not only on general health but also on oral health. Defined as excessive fat storage in adipose tissue, obesity involves larger and more numerous adipocytes. It's classified by BMI: 30 and more for obesity and 25–29.99 for overweight. Recent studies suggests a correlation between oral health and obesity/overweight. This paper explores the relationship between obesity and oral diseases. Early detection and prevention of risk factors are essential for indispensable for promoting long-term health and elevating the quality of life in affected patients.

AIM

This paper discusses the impact of obesity and its connections with the most prevalent oral conditions.

MATERIAL AND METHODS

The materials used in this work were selected through open-access databases such as PubMed and Google Scholar. The literature search was performed November 10, 2024, using the query string “(obesity) AND (oral health) AND (periodontitis) AND (tooth condition)” to retrieve relevant articles. The search criteria covered the years 2016 to 2024, yielding a total of 48 articles. In order to expand the search, we reviewed the reference lists of retrieved publications to capture additional relevant studies, some pre-2016 studies were included as exceptions. The inclusion criteria were the publication type (original research, review, systematic review, case

report, observational studies) and published in English. Following a detailed evaluation, 45 articles met the inclusion criteria and were ultimately included. The final version of the review was read, verified, and revised by all authors. Any unclear parts were discussed as a group and adjusted to ensure accuracy.

REVIEW AND DISCUSSION

If it comes to obesity, it is defined as accumulation of abnormal or excessive fat in the adipose tissue [1] in which the number and size of adipocytes are enlarged [2]. The indicator describing obesity is BMI (Body Mass Index), which is determined using the formula: body weight (in kilograms) divided by height (in meters)² [2,3,4,5]. Obesity is classified as having a body mass index (BMI) of 30 kg/m² or more, while overweight is classified as having a BMI between 25 and 29.99 kg/m² [2]. Recent studies suggest a correlation between oral health and BMI, as both are impacted by shared risk factors, such as diet, genetics, lifestyle choices and socioeconomic conditions [6]. Obesity is caused by an unhealthy diet high in sugars, which promotes the accumulation of excess plaque, leading to the development of various oral health problems, such as gingivitis, periodontitis, and dental caries [7].

According to the World Health Organization, in 2022, one out of every eight people globally was affected by obesity. Additionally, the WHO states that 43% of adults aged 18 and older (43% of men and 44% of women) were overweight in 2022 marking an increase from 1990, when 25% of adults in this age group were overweight. Each year, around 3.4 million people die due to obesity and overweight [3, 6].

ASSOCIATIONS BETWEEN OBESITY AND PERIODONTAL DISEASES

The association between obesity and periodontitis is a frequently discussed topic in the literature. In research conducted by Leena Alsalihi et al., it was found that periodontitis was highly prevalent (97%) among obese patients [8]. Periodontitis is an inflammatory disorder of the tissues that support the teeth, caused by certain groups of microorganisms. This leads to progressive destruction of the gingival tissue, periodontal ligament, cementum and alveolar bone. [9,10]. The chronic inflammatory condition caused by periodontitis can result in various systemic issues, including, for example, cardiovascular disease, osteoarthritis, and type 2 diabetes [9, 11, 12]. Obesity, as defined in the introduction, is an excess of fat in the adipose tissue. The adipose tissue located around the visceral organs

(visceral adiposity) secretes specific proteins known as adipokines. These proteins are classified to two groups: pro-inflammatory mediators: leptin, resistin, visfatin and anti-inflammatory mediators: adiponectin and omentin-1 [9]. Obesity results in higher production of pro-inflammatory adipokines and reduced synthesis of anti-inflammatory adipokines [2, 13], leading to an imbalance between them and, consequently, a state of low-grade inflammation [2, 14, 15].

Checa-Ros et al. described, that there is an inverse relationship between the level of adiponectin and periodontitis [9]. Adiponectin is a strong inhibitor of osteoclasts, so its low levels lead to the exacerbation of periodontitis [16, 17]. What is more, reduced salivary omentin-1 levels were observed in patients with chronic periodontitis, correlating with elevated periodontal parameters, whereas increased salivary omentin-1 levels following non-surgical periodontal therapy were associated with improvements in periodontal health. [9]. As far as pro-inflammatory adipokines are concerned, leptin impairs the regenerative ability of periodontal ligament cells and additionally activates the secretion of proinflammatory cytokines, such as Tumor Necrosis Factor Alpha (TNF- α) and IL-6 which are recognized as mediators of tissue damage [9]. Resistin affects the metabolism of soft and hard tissues in the periodontium by decreasing alkaline phosphatase activity and markers associated with bone tissue and matrix development [9]. Visfatin could enhance periodontal inflammation and bone degradation through the production of matrix metalloproteinase-1 (MMP-1) and chemokine ligand 2 (CCL2). [9, 18]. Obesity is associated with an increase in waist circumference. Recker EN et al. identified a positive correlation between waist circumference and the severity of periodontitis in their study [19]. Ling Liu and Lin Yu Xia et al. also found a similar relationship, stating that with each 1-unit increase in waist circumference, the incidence of periodontitis rises by 1% [20]. On the other hand, Leena Alsalihi et al. noted a positive correlation between waist circumference and periodontitis in men, but no such correlation was found between waist circumference and periodontitis in women [8]. If additional studies confirm the connection between waist circumference and the severity of periodontitis, waist circumference could become an important indicator for monitoring the progression of periodontitis [21].

The study by L. Martens et al. states that, among children and adolescents, there is a positive correlation between obesity/overweight and various periodontal issues, including increased plaque and calculus accumulation, gingivitis, probing pocket depth (>4 mm), and a higher presence of bacterial oral microbiota.

What is more, age (17–21 years) and gender (male) were factors that positively impacted the risk of periodontal disease in obese/overweight children [1].

PREGNANCY, OBESITY AND PERIODONTITIS

The prevalence of obesity and excessive weight gain are frequently observed issues in the context of pregnancy. Elevated hormones can compromise connective tissue remodeling, which may raise inflammation and bacterial growth in periodontal tissues, heightening the risk of periodontal diseases in pregnancy [22–24]. Over the past few years, research has focused on confirming or rejecting a potential association between obesity in pregnancy and periodontitis. In their 2018 publication, Gomes-Filho et al. demonstrated that the association was found to be statistically non-significant. Periodontitis prevalence was observed at 17.24% using the Gomes-Filho, et al. criteria and at 66.92% according to the Center For Disease Prevention and Control and American Academy of Periodontology (CDC/AAP) criteria [25]. However, an extensive systematic review and meta-analysis by Foratori-Junior, et al. did not substantiate these findings in 2022. The study found a positive link between obesity/overweight and periodontitis, showing that, an average 61.04% of overweight or obese women also presenting with periodontitis [23]. Additional studies have also established a relationship between excess weight and periodontitis in pregnancy, showing a more pronounced connection in overweight pregnant women who suffer from both tooth loss and periodontitis [22].

GINGIVAL INFLAMMATION AND OBESITY

Gingivitis refers to an inflammatory condition that develops from the patient's immune response interacting with the biofilm of dental plaque. This inflammatory process can be reversed with a reduction in plaque presence [26, 27]. Both periodontitis and gingivitis arise from the same mechanism of inflammation, however gingivitis does not lead to periodontitis in every case [26, 28]. Evidence supporting the thesis that elevated BMI leads to a greater incidence of gingivitis includes studies indicating increased salivary cytokine concentrations in obese patients compared to those with overweight or normal statuses [29]. Such cytokines contribute to chronic systemic inflammation, which potentially weakens the immune system and predisposes individuals to infections [26,30]. It is noteworthy to mention that the systematic review and meta-analysis by da Silva et al. indicated that obesity is associated with an increased level of gingivitis among patients

diagnosed with periodontitis against to those without obesity [26].

ORAL MICROBIOTA IN OBESE PATIENTS

Porphyromonas gingivalis, *Treponema denticola* and *Tannerella forsythia* are a group of microorganisms located in the subgingival biofilm that induce the long-term inflammatory condition known as periodontitis [2]. Al-Rawi and Al-Marzooq observed that obese individuals had notably higher levels of *Tannerella forsythia*, *Fusobacterium spp.*, and *Porphyromonas gingivalis* compared to those who were not obese, but further studies are required to clarify whether obesity leads to the overgrowth of these or other pathogenic microorganisms, contributing to periodontal damage [2, 31]. Tam et al. also recorded a variation in the composition of the oral microbiota between obese and nonobese individuals [2, 32].

The study by Fanny Le Sage et al. described how lipopolysaccharide (LPS) from *Porphyromonas gingivalis* influences the release of inflammatory adipokines. Their findings indicate that *P. gingivalis* LPS can modify the inflammatory condition of adipocytes by interfering with their adipokine secretion, leading to a decrease in adiponectin release, which is recognized as an anti-inflammatory factor inversely correlated with body fat mass [33].

OBESITY, SALIVA COMPOSITION AND ORAL HEALTH

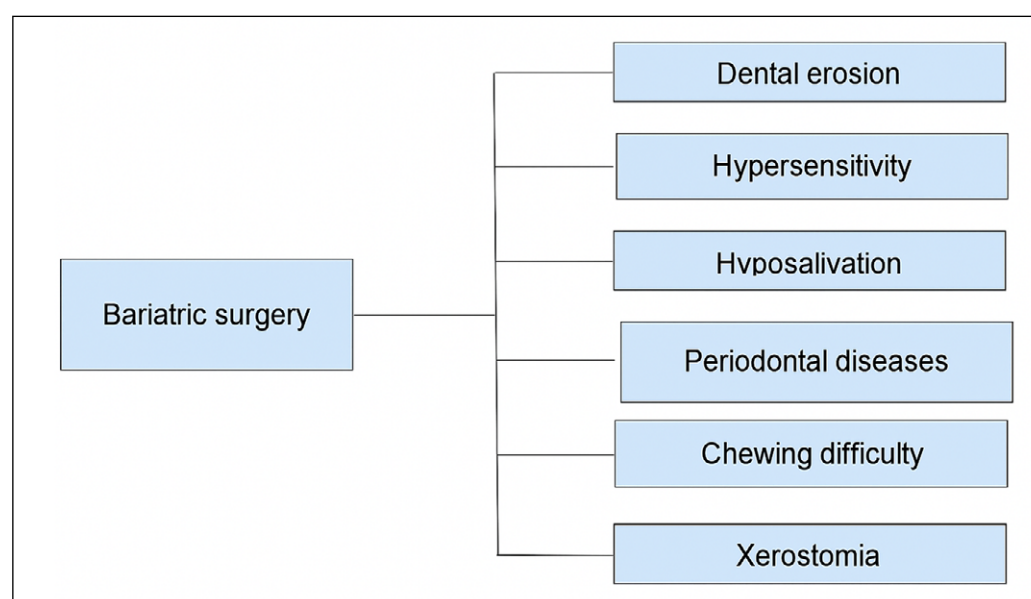
It is widely known that saliva could be a potential source of biomarkers that may have associations with oral diseases. The markers analyzed in recent years have been assembled in Table 1. Recker et al. reported a positive association between body fat percentage and levels of Granzyme B and negative association between levels of sCD40L and BMI, but none of those correlations showed statistical significance after multiple comparison correction [19]. Some studies report elevated levels of interleukins in obese patients [29,30]. Al-Ameri et al. performed a study that examined Thy-1 (CD90) levels across four patient groups (obese, obese with periodontitis, healthy, and those with periodontitis). They found that periodontitis leads to higher salivary Thy-1 levels, independent of obesity [34].

BARIATRIC SURGERY

As the most effective approach to treating morbid obesity, bariatric surgery not only benefits individuals with related conditions, including hypertension,

Table 1. Biological salivary markers of periodontitis and/or obesity

Study	Biomarkers	Correlation with obesity
Recker et al. [19]	• sCD40L • Granzyme B • Interleukin-1 receptor antagonist (IL-1ra) • Alpha-fetoprotein (AFP)	• Positive association between body fat percentage and levels of Granzyme B • Negative association between levels of sCD40L and BMI
Doğan et al. [29]	• IL-6 • IL-10	• IL-6 levels in saliva were elevated in obese patients • Positive association between BMI and IL-6 levels • Negative association between IL-10 levels in the gastrointestinal tract and saliva
Vohra et al. [30]	• IL-6 • IL-1β	• Significant differences in periodontal clinical measures and salivary IL-1β and IL-6 were found between class I of obese and classes II and III (between class II and III values were found to be similar)
Al-Ameri et al. [34]	• Thy-1 (CD90)	• Periodontal inflammation increases salivary Thy-1 levels, independent of obesity status.

**Fig. 1.** Oral conditions that can potentially be affected by bariatric surgery [35-37]

diabetes, and sleep apnea but also enhances patients' quality of life [35-37]. According to certain studies, undergoing bariatric surgery could potentially lead to a decline in dental health [37-39]. Figure 1 shows oral conditions that can potentially be affected by bariatric surgery. Alterations in the rate of salivary flow may constitute one of the mechanisms influencing oral cavity health. A decline in salivary flow is linked to an increased proliferation of microorganisms. In a cohort study conducted by Hashizume, et al. on 27 morbidly obese patients, documented a rise in mutans streptococci levels in the saliva of these patients six months post-bariatric surgery, as compared to the pre-operative baseline [36]. Moreover, de S Porcelli, et al., observed that bariatric surgery increases the risk of tooth erosion in patients [39]. It is worth noting that not all studies confirm the effect of bariatric

surgery on dental health. Ferraz, et al., in an extensive systematic review and meta-analysis, determined that for patients undergoing bariatric surgery, the rates of missing teeth and caries remain unaffected [35]. This shows how important additional studies are for reaching unified conclusions.

PERI-IMPLANTITIS

Lost teeth are increasingly replaced with dental implants. Due to the increase in life expectancy, the percentage of elderly patients who decide to have implants is growing. This implies an increase in the number of side effects of such a procedure [40]. Despite the effectiveness and high safety index, the incidence of complications such as peri-implantitis and crestal bone loss is escalating [12, 40, 41]. According

to medical literature, this complication may affect up to 50% of implanted dental implants [41]. Peri-implantitis is a destructive inflammation around a tooth implant caused by numerous bacteria. It damages both soft and hard tissues surrounding the implants, causing bone loss [40, 41]. Untreated peri-implantitis may cause implant loss and even lead to permanent damage to the jaw bone [40]. Unfortunately, due to the lack of targeted and effective treatment, reducing the risk factors of peri-implantitis in patients is very important during treatment [12, 40, 41]. Many risk factors contribute to the development of the disease [12]. The authors mention, among others: smoking, drugs, old age, depression, and environmental factors [41]. Obesity, metabolic syndrome and diabetes are among the main modifiable factors that increase the risk of developing peri-implantitis. Inflammation and oxidative stress are mediators of metabolic disorders in the body, these mediators increase the incidence of peri-implantitis [40]. The relationship between obesity and an increased risk of developing inflammation around the implant is confirmed by Vorha's study. This study shows that people with normal body weight are less susceptible to developing inflammation around the implant than people with obesity. In the future, the number of patients with metabolic disorders will increase, which may elevate the risk of complications related to dental implants [41]. Appropriate treatment of obesity and other metabolic disorders and quitting smoking are the main factors that should be taken into account when planning dental implantation and treatment of peri-implantitis [40].

ASSOCIATIONS AMONG OBESITY AND TOOTH LOSS

Tooth loss may be due to periodontal disease caused by chronic inflammation. Obesity contributes to the development of such chronic inflammation and the increase in markers such as C-reactive protein (CRP) [42, 43]. According to the authors, it has been shown that obesity is a modifiable risk factor for tooth loss and there is a connection between obesity and an increased number of lost teeth [42, 43]. When talking about general obesity, it should be noted that central obesity itself also influences the development of systemic inflammatory diseases. Therefore, it will also predispose to the development of caries, periodontal diseases and ultimately lead to tooth loss. Studies have shown that patients with central obesity also have an increased risk of tooth loss. The impact of both central and general obesity is important and should become a key element in oral health prevention [42].

OBESITY AND ORAL HEALTH IN PAEDIATRIC PATIENTS

Childhood obesity has reached epidemic proportions worldwide, with its prevalence continuing to rise [1]. According to data published by the World Health Organization (WHO) in 2022, 160 million children and adolescents aged 5-19 suffered from obesity [3]. Some cross-sectional studies indicate that overweight and obese children and adolescents experience more dental caries in permanent teeth, greater plaque accumulation, and increased gingival inflammation. Additionally, they have lower saliva flow rates and reduced buffering capacity compared to children of normal weight [44]. Often first observed in adults but typically beginning earlier in life in children. Among children and adolescents, plaque-induced gingivitis is the most commonly encountered periodontal disease. The prevalence of gingivitis in children can be as high as, or even exceed, that of dental caries, yet it has not received the same level of attention regarding its long-term effects on overall health [1].

Meta-analyses, which incorporated both descriptive and quantitative data, have revealed a positive association between obesity and the prevalence of periodontal diseases. Several theories have been proposed to explain the biological interactions between obesity and periodontal diseases. These include alterations in pro-inflammatory and immune responses, insulin resistance, changes in lipid profiles, modifications of the immune system, heightened activation of macrophages, impaired microvascular function, physiological responses to psychosocial stress, and the release of pro-inflammatory molecules from adipose tissue, such as TNF- α , IL-6, and C-reactive protein. Despite these insights, the precise molecular and cellular mechanisms underlying these associations remain unclear, and further research is needed to deepen our understanding of these processes. Such research could provide valuable insights into potential targets for prevention and treatment [1].

Studies have not demonstrated a clinically significant association between oral health factors, overweight/obesity, and stress variables [44, 45]. However, a significant association exists between obesity and periodontal disease in children. Pediatric dentists should be mindful of potential periodontal changes related to obesity, recognizing them as a possible health risk [1].

Given the significance of overweight and obesity as major public health concerns, both medical and dental professionals should assess health-related behaviors and the connections between oral and overall health. Additionally, they should promote interdisciplinary communication to identify and address early signs of dental and periodontal diseases in children and adolescents [4].

CONCLUSIONS

The aim of this review was to collect and evaluate existing data on the relationship between obesity and oral health. As a result, it was found that there is a significant association between obesity and the development of various oral health diseases, such as gum diseases, periodontitis, peri-implantitis. A diet high in sugar, com-

bined with poor oral hygiene and obesity, promotes the occurrence of dental issues both in adults and children. Nevertheless, additional studies are needed to better understand the mechanisms of this relationship. Future studies should also consider the development of more effective preventive strategies that could help prevent oral diseases in obese individuals.

REFERENCES

1. Martens L, De Smet S, Yusof MY, Rajasekharan S. Association between overweight/obesity and periodontal disease in children and adolescents: a systematic review and meta-analysis. *Eur Arch Paediatr Dent*. 2017 Apr;18(2):69-82. doi: 10.1007/s40368-017-0272-1 DOI
2. Jepsen S, Suvan J, Deschner J. The association of periodontal diseases with metabolic syndrome and obesity. *Periodontol 2000*. 2020 Jun;83(1):125-153. doi: 10.1111/prd.12326 DOI
3. Obesity and overweight. WHO [online] <https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight> [Access: 10 December 2024].
4. Kesim S, Çiçek B, Aral CA, Öztürk A, Mazicioğlu MM, Kurtoglu S. Oral Health, Obesity Status and Nutritional Habits in Turkish Children and Adolescents: An Epidemiological Study. *Balkan Med J*. 2016 Mar;33(2):164-72. doi: 10.5152/balkanmedj.2016.16699 DOI
5. Gerber FA, Sahrman P, Schmidlin OA, Heumann C, Beer JH, Schmidlin PR. Influence of obesity on the outcome of non-surgical periodontal therapy - a systematic review. *BMC Oral Health*. 2016 Sep 2;16(1):90. doi: 10.1186/s12903-016-0272-2 DOI
6. Issrani R, Reddy J, Bader AK, Albalawi RFH, Alserhani EDM, Alruwaili DSR, Alanazi GRA, Alruwaili NSR, Sghaireen MG, Rao K. Exploring an Association between Body Mass Index and Oral Health-A Scoping Review. *Diagnostics (Basel)*. 2023 Feb 27;13(5):902. doi: 10.3390/diagnostics13050902 DOI
7. Deszczyńska K, Górka R, Haładyj A. Clinical condition of the oral cavity in overweight and obese patients. *Dent Med Probl*. 2021 Apr-Jun;58(2):147-154. doi: 10.17219/dmp/127873 DOI
8. Alsalihi L, Bain C, Milosevic A, Hassan A, Janahi A, Sivaramakrishnan G. Prevalence of periodontitis in obese patients in Bahrain: a cross-sectional study. *BMC Oral Health*. 2021 Jul 24;21(1):376. doi: 10.1186/s12903-021-01720-y DOI
9. Checa-Ros A, Hsueh WC, Merck B, González-Torres H, Bermúdez V, D'Marco L. Obesity and Oral Health: The Link Between Adipokines and Periodontitis. *touchREV Endocrinol*. 2024 Apr;20(1):25-31. doi: 10.17925/EE.2024.20.1.7 DOI
10. Gasner NS, Schure RS. Periodontal Disease. 2023 Apr 10. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. PMID: 32119477
11. Carvalho R, Botelho J, Machado V, Mascarenhas P, Alcoforado G, Mendes JJ, Chambrone L. Predictors of tooth loss during long-term periodontal maintenance: An updated systematic review. *J Clin Periodontol*. 2021 Aug;48(8):1019-1036. doi: 10.1111/jcpe.13488 DOI
12. Darby I. Risk factors for periodontitis & peri-implantitis. *Periodontol 2000*. 2022 Oct;90(1):9-12. doi: 10.1111/prd.12447 DOI
13. Zhu J, Guo B, Gan X, Zhang L, He Y, Liu B, Chen X, Zhang S, Yu H. Association of circulating leptin and adiponectin with periodontitis: a systematic review and meta-analysis. *BMC Oral Health*. 2017 Jun 29;17(1):104. doi: 10.1186/s12903-017-0395-0 DOI
14. Adamczak M, Wiecek A. The adipose tissue as an endocrine organ. *Semin Nephrol*. 2013 Jan;33(1):2-13. doi: 10.1016/j.semnephrol.2012.12.008 DOI
15. Krysiak R, Handzlik-Orlik G, Okopien B. The role of adipokines in connective tissue diseases. *Eur J Nutr*. 2012 Aug;51(5):513-28. doi: 10.1007/s00394-012-0370-0 DOI
16. Kubić-Filiks B, Szymańska J. Problemy stomatologiczne u pacjentów z otyłością [Dental problems in obese patients]. *Pediatr Med Rodz*. 2018;14:386-391 [Polish]. doi: 10.15557/PiMR.2018.0049 DOI
17. Ryba B, Pytko-Polonczyk J. Molecular aspects of periodontitis in obese patients - Review of literature. *Czasopismo Stomatologiczne*. 2013;66:246-255. doi: 10.5604/00114553.1035089 DOI
18. Nokhbehsaim M, Eick S, Nogueira AV, Hoffmann P, Herms S, Fröhlich H, Jepsen S, Jäger A, Cirelli JA, Deschner J. Stimulation of MMP-1 and CCL2 by NAMPT in PDL cells. *Mediators Inflamm*. 2013;2013:437123. doi: 10.1155/2013/437123. DOI
19. Recker EN, Brogden KA, Avila-Ortiz G, Fischer CL, Pagan-Rivera K, Dawson DV, Smith KM, Elangovan S. Novel biomarkers of periodontitis and/or obesity in saliva-An exploratory analysis. *Arch Oral Biol*. 2015 Oct;60(10):1503-9. doi: 10.1016/j.archoralbio.2015.07.006 DOI
20. Liu L, Xia LY, Gao YJ, Dong XH, Gong RG, Xu J. Association between Obesity and Periodontitis in US Adults: NHANES 2011-2014. *Obes Facts*. 2024;17(1):47-58. doi: 10.1159/000534751 DOI
21. Xu L, Liu Y, Zhao C, Wang J, Zhou H. Association between weight-adjusted waist index and periodontitis: A population-based study. *PLoS One*. 2024 Jun 6;19(6):e0305010. doi: 10.1371/journal.pone.0305010 DOI

22. Batista JET, Figueiredo ACMG, Souza ES, et al. Excessive weight in pregnant women increases the chance of diagnosing periodontitis combined with tooth loss. *J Periodontol*. 2024 Nov;95(11):1097-1108. doi: 10.1002/JPER.23-0745 DOI
23. Foratori-Junior GA, Pereira PR, Gasparoto IA, de Carvalho Sales-Peres SH, Storniolo de Souza JM, Khan S. Is overweight associated with periodontitis in pregnant women? Systematic review and meta-analysis. *Jpn Dent Sci Rev*. 2022 Nov;58:41-51. doi: 10.1016/j.jdsr.2022.01.001 DOI
24. Silva de Araujo Figueiredo C, Gonçalves Carvalho Rosalem C, Costa Cantanhede AL, Abreu Fonseca Thomaz ÉB, Fontoura Nogueira da Cruz MC. Systemic alterations and their oral manifestations in pregnant women. *J Obstet Gynaecol Res*. 2017 Jan;43(1):16-22. doi: 10.1111/jog.13150 DOI
25. Gomes-Filho IS, Batista JET, Trindade SC, et al. Obesity and periodontitis are not associated in pregnant women. *J Periodontal Res*. 2020 Jan;55(1):77-84. doi: 10.1111/jre.12690 DOI
26. da Silva FG, Pola NM, Casarin M, Silva CFE, Muniz FWMG. Association between clinical measures of gingival inflammation and obesity in adults: systematic review and meta-analyses. *Clin Oral Investig*. 2021 Jul;25(7):4281-4298. doi: 10.1007/s00784-021-03961-1 DOI
27. Chapple ILC, Mealey BL, Van Dyke TE, et al. Periodontal health and gingival diseases and conditions on an intact and a reduced periodontium: Consensus report of workgroup 1 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions. *J Clin Periodontol*. 2018 Jun;45 Suppl 20:S68-S77
28. Chapple IL, Van der Weijden F, Doerfer C, et al. Primary prevention of periodontitis: managing gingivitis. *J Clin Periodontol*. 2015 Apr;42 Suppl 16:S71-6. doi: 10.1111/jcpe.12366 DOI
29. Doğan GE, Toraman A, Şebin SÖ, Doğan Ç, Güngör A, Aksoy H, Asutay H. Salivary IL-6 and IL-10 levels in subjects with obesity and gingivitis. *Am J Dent*. 2016 Oct;29(5):261-265
30. Vohra F, Akram Z, Bukhari IA, Sheikh SA, Riny A, Javed F. Comparison of Periodontal Inflammatory Parameters and Whole Salivary Cytokine Profile Among Saudi Patients with Different Obesity Levels. *Int J Periodontics Restorative Dent*. 2018 Nov/Dec;38(6):e119-e126. doi: 10.11607/prd.3411 DOI
31. Al-Rawi N, Al-Marzooq F. The Relation between Periodontopathogenic Bacterial Levels and Resistin in the Saliva of Obese Type 2 Diabetic Patients. *J Diabetes Res*. 2017;2017:2643079. doi: 10.1155/2017/2643079 DOI
32. Tam J, Hoffmann T, Fischer S, Bornstein S, Gräßler J, Noack B. Obesity alters composition and diversity of the oral microbiota in patients with type 2 diabetes mellitus independently of glycemic control. *PLoS One*. 2018 Oct 1;13(10):e0204724. doi: 10.1371/journal.pone.0204724 DOI
33. Le Sage F, Meilhac O, Gonthier MP. Porphyromonas gingivalis lipopolysaccharide induces pro-inflammatory adipokine secretion and oxidative stress by regulating Toll-like receptor-mediated signaling pathways and redox enzymes in adipocytes. *Mol Cell Endocrinol*. 2017 May 5;446:102-110. doi: 10.1016/j.mce.2017.02.022 DOI
34. Al-Ameri HW, Shetty S, Rahman B, Gopalakrishnan ARK, Ismail AA, Acharya AB. Evaluation of salivary Thy-1 in health, periodontitis, and obesity. *Oral Dis*. 2024 May;30(4):2670-2677. doi: 10.1111/odi.14652 DOI
35. Ferraz AX, Gonçalves FM, Ferreira-Neto PD, et al. Impact of bariatric surgery on oral health: a systematic review and meta-analysis. *Clin Oral Investig*. 2023 May;27(5):1869-1884. doi: 10.1007/s00784-023-04959-7 DOI
36. Hashizume LN, Bastos LF, Cardozo DD, et al. Impact of Bariatric Surgery on the Saliva of Patients with Morbid Obesity. *Obes Surg*. 2015 Aug;25(8):1550-5. doi: 10.1007/s11695-015-1741-4 DOI
37. Quintella MCM, Farias TMCP, SoutoMaior JR, Casado BGDS, Leão RS, Moraes SLD. Relationship between bariatric surgery and dental erosion: a systematic review. *Surg Obes Relat Dis*. 2020 Sep;16(9):1283-1290. doi: 10.1016/j.soard.2020.04.044 DOI
38. de Moura-Grec PG, Yamashita JM, Marsicano JA, et al. Impact of bariatric surgery on oral health conditions: 6-months cohort study. *Int Dent J*. 2014 Jun;64(3):144-9. doi: 10.1111/idj.12090 DOI
39. de S Porcelli IC, Roma CC, Nunes MCP, Maciel SM, Pascotto RC Effects of Bariatric Surgery on The oral Health of Patients. *Int J Dent Oral Health* 2016;2(2). doi http://dx.doi.org/10.16966/2378-7090.181
40. Gasmi Benahmed A, Gasmi A, Tippairote T, Mujawdiya PK, Avdeev O, Shanaida Y, Björklund G. Metabolic Conditions and Peri-Implantitis. *Antibiotics (Basel)*. 2022 Dec 29;12(1):65. doi: 10.3390/antibiotics12010065 DOI
41. de Oliveira PGFP, Bonfante EA, Bergamo ETP, et al. Obesity/Metabolic Syndrome and Diabetes Mellitus on Peri-implantitis. *Trends Endocrinol Metab*. 2020 Aug;31(8):596-610. doi: 10.1016/j.tem.2020.05.005 DOI
42. Kang J, Smith S, Pavitt S, Wu J. Association between central obesity and tooth loss in the non-obese people: Results from the continuous National Health and Nutrition Examination Survey (NHANES) 1999-2012. *J Clin Periodontol*. 2019 Apr;46(4):430-437. doi: 10.1111/jcpe.13091 DOI
43. Meisel P, Holtfreter B, Völzke H, Kocher T. Sex Differences of Tooth Loss and Obesity on Systemic Markers of Inflammation. *J Dent Res*. 2014 Aug;93(8):774-9. doi: 10.1177/0022034514535604 DOI
44. Panagiotou E, Agouropoulos A, Vadiakas G, Pervanidou P, Chouliaras G, Kanaka-Gantenbein C. Oral health of overweight and obese children and adolescents: a comparative study with a multivariate analysis of risk indicators. *Eur Arch Paediatr Dent*. 2021 Oct;22(5):861-868. doi: 10.1007/s40368-021-00643-0 DOI

45. Schmidt J, Strecker P, Kreuz M, et al. Stress-related hormones in association with periodontal condition in adolescents-results of the epidemiologic LIFE Child study. Clin Oral Investig. 2019 Apr;23(4):1793-1802. doi: 10.1007/s00784-018-2599-3 

CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Patrycja Ochman-Pasierbek

Postgraduate Medical Internship,

Dr. B. Hager Multi-Specialist District Hospital in Tarnowskie Góry,

Tarnowskie Góry, Poland

e-mail: patrycja.ochman09@gmail.com

ORCID AND CONTRIBUTIONSHIP

Karolina Trytek-Miś: 0009-0008-1317-6538    

Patrycja Ochman-Pasierbek: 0009-0008-0125-2564    

Kinga Cogiel: 0009-0000-6456-2887  

Magdalena Jaskółka: 0009-0004-1522-3976  

 – Work concept and design,  – Data collection and analysis,  – Responsibility for statistical analysis,  – Writing the article,  – Critical review,  – Final approval of the article

RECEIVED: 10.02.2025

ACCEPTED: 02.06.2025

