Review

INTERNATIONAL JOURNAL OF CURRENT ADVANCED RESEARCH
ISSN: O: 2319-6475, ISSN: P: 2319-6505
Available Online at www.journalijcar.org
Volume 15; Issue 03; March 2026; Page No.634-640
DOI: http://dx.doi.org/10.24327/ijcar.2026.0640.0105

Subject Area : Dentistry- Orthodontics and dentofacial orthopedics

OCCLUSAL DISHARMONY AND MULTIORGAN HEALTH: ILLUMINATING THE HIDDEN PATHOLOGICAL NEXUS

Puneeth Kumar R, H Jyothi Kiran, Pradeep S, Alok U A

JSS Dental College and Hospital , india - 570015

ARTICLE INFO

Received 16th February, 2025
Received in revised form 25th February, 2025
Accepted 19th March, 2026
Published online 28th March, 2026

Key words:

Malocclusion, Oral, Respiratory, Cardiovascular,Neurological,Musculoskeletal, Renal, Erectile dysfunction

ABSTRACT

In physiological research, malocclusion is a dental condition that is frequently overlooked. It is described as any abnormality in the relationship between the dental arches, whether or not there is an aberration in the teeth developmental issue, that affects speaking, swallowing, mastication, and other processes. Although the fundamental mechanisms are unclear, mounting evidence suggests that malocclusion may be linked to dysfunction of nearby and distant organs. The framework linking malocclusion to oral (mastication, speech) and distant organ diseases, including ocular, auditory, nasal, cerebral, respiratory, musculoskeletal, cardiovascular, blood-related, renal, and sexual physiologies, still has not been united. Thus, this perspective presents a prioritised research goal to examine the causality and offers the integrated framework linking malocclusion with multiorgan pathology.

INTRODUCTION

Malocclusion is currently an extensively documented oral health condition that affects people of all ages, from young children and adolescents to old population worldwide. This dental condition is characterised by an abnormal malocclusion, which is an abnormal deviation from the average orientation of the mandibular and maxillary arches(1). Malocclusions are more challenging to identify and classify because of their vast broad spectrum of abnormalities. Malocclusion can be divided into two categories based on its severity and pattern: (1) occlusal problem, which may make it difficult for the jaw to function, and (2) teeth-alignment disorder, which is associated with abnormal facial features and physical abnormalities (2). Angle's traditional classification divides occlusion into four distinct classes: normal occlusion, "Class I (Neutro-occlusion), Class II (Disto-occlusion), and Class III (Mesio-occlusion)"(3). Malocclusion is the third most common oral health issue, according to the World Health Organization (WHO). It has a major impact on a patient's speech, appearance, confidence, and other everyday activities including chewing and swallowing. Extended occlusal issues linked to mixed and permanent dentitions may be mediated by malocclusion (4). Evidence suggests that malocclusion may also be a risk factor for other distant or surrounding organ systems, which could be severe and persistent. Malocclusion and multi-organ pathologic relationships were therefore discussed in the next section.

*Corresponding author: **Puneeth Kumar R**

JSS Dental College and Hospital , india - 570015

The relationship between the physiology of other organs and malocclusion

The connection between malocclusion and various organ systems proves complex. Many individuals with malocclusion progress to periodontitis, particularly in adulthood amid gingival inflammation and suboptimal oral hygiene.Other key challenges from dental misalignments include impaired swallowing and speech(5). Severe malocclusion triggers substantial psychological strain in children, whereas adolescents and adults—regardless of severity—may experience depression, anxiety, interpersonal difficulties, obsessive tendencies, and stress-linked disorders. Orthodontic correction typically resolves these mental health effects(6).

Malocclusion-related facial deformities disrupt tongue muscles linked to the trigeminal and oculomotor nerves. Severe Class III malocclusion often impairs patient's vision, while all malocclusion classes show ocular motility issues and midline shifts, sometimes with convergence problems(7).Malocclusion can also erode cartilage and bone in temporomandibular joints (TMJ), leading to osteoarthritis(8). Orthodontic interventions fail to reverse this joint damage.Patients with malocclusion exhibit lower heart rates, exacerbated by ongoing psychological stress, which heightens cardiovascular disease risk(9). These cardiovascular changes persist despite occlusal correction.

Drawing from existing evidence, we propose a model of potential pathological interactions between malocclusion and

various organ systems to improve understanding and prevention of associated comorbidities that risk causing irreversible harm to the body (Figure-1).

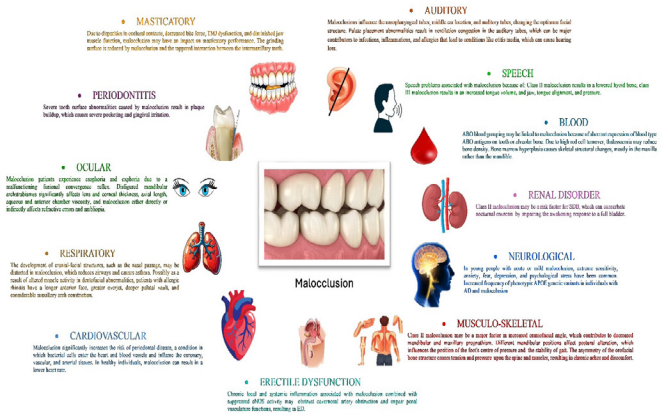

Figure-1: Pathologic relationship between malocclusion and multiple organs. SDB: Sleep-disordered breathing, AD: Alzheimer's disease, eNOS: endothelial nitric oxide

Oral

Malocclusions significantly impact an individual's physiological and psychological well-being. Orthodontic treatments and malocclusions directly and indirectly influence quality of life (QoL)(10). This has led to the term "Oral Health-Related Quality of Life" (OHRQoL), which is notably diminished in children and young people affected by malocclusions(10). These conditions impair mastication, speech, swallowing, oral hygiene, and breathing, but they most prominently cause facial disfigurements that drive patients toward cosmetic surgeries or orthodontic interventions(1).

Speaking difficulties may arise from tongue position changes in children with anterior open-bite and posterior cross-bite. Malocclusions are less likely to cause speech difficulties in men.

Malfunction or misalignment reduces OHRQoL by interfering with regular mastication. Patients with malocclusion have malfunctioning TMJs, unequal occlusal contacts, and decreased bite force(12). The masticatory performance is significantly impacted by these symptoms. The grinding surface area was reduced by weakened jaw muscle function brought on by dental misalignment and tapering intermaxillary tooth contact. As a result, malocclusion impairs effective chewing patterns, deteriorates masticatory function, and results in an uneven threshold for swallowing.

Periodontitis

Periodontitis is caused by plaque buildup in the roots of the teeth, which harbours pathogenic bacteria and causes gum inflammation and tooth alveolar bone loss. Bacterial plaque deposition is encouraged by any irregularity or misalignment in the positioning of the teeth and jaw, whichisacrucialcomponentinthedevelopmentof periodontitis. Because misaligned teeth can easily trap food particles, malocclusion is a sign of periodontitis(13). Due to tissue weakening and pocket formation, food deposition and plaque formation contribute to the development of gum inflammation. According to reports, Class II occlusion has the lowest risk of periodontitis, while Class I occlusion has the highest risk(14). The buccal attachments may be compromised by anterior and posterior crowding and spacing, anterior cross-bite, and deep overbites, which can lead to plaque deposition, severe pocketing, and gingival irritation. In cases of severe crowding and plaque formation, post-orthodontic treatment is crucial because even orthodontic therapies do not ensure periodontal health(15).

RESPIRATORY

Respiratory diseases, particularly asthma, are more common in younger malocclusion patients due to the distorted development of craniofacial features, such as the nasal septum.

Malocclusion, which keeps microorganisms in the saliva for a long time, exacerbates mouth breathing, the most prevalent symptom of asthma. Other oral conditions such caries, tooth erosion, and candidiasis, which are brought on by pathogenic microbiota deposited in the buccopharyngeal area, have been noted in asthmatic patients (16).Anteroposterior disproportion in the dentition may be caused by class II malocclusion, and these vertical orofacial abnormalities change the upper nasal passage's progressive formation by narrowing it. Patients who have trouble breathing through a tiny nasopharyngeal tube may develop the habit of mouth breathing, which further displaces the mandibular condyle and TMJ and further deforms the malocclusion (17).

AUDITORY

The auditory tubes, middle ear location, and nasopharyngeal tubes are all affected by malocclusion, which completely or partially modifies the optimal facial structure. Numerous diseases and conditions pertaining to smooth auditory functioning may result from these abnormalities (18). The ventilation, drainage, and protection of the auditory canal depend on the auditory tube, also known as the eustachian tube. The auditory tube's opening and closing are controlled by the soft palate and related muscles.Palatal positioning deviations restrict auditory tube ventilation, which can be a major source of ear infections, inflammation, and allergies (19), resulting in serious disorders such as otitis media and hearing loss. This is brought on by a disruption in the air pressure inside the eustachian tube, which results in microbial infection and tubal dysfunction in the middle and inner ears. Microbial invasion into the cochlear region also infects the eustachian tube, which is linked to the nose route(20).However, cochlear placements show gradual improvements following occlusal position treatment, which results in the resolution of auditory discrepancies (21).

NEUROLOGICAL ABNORMALITIES

Cognitive

In both acute and chronic situations, trigeminal input modifies the cognitive brain's functioning and is essential for the development of neurological illnesses(22). Mastication, speech, and other motor skills are just a few of the brain functions and actions that are impacted by the repression of the trigeminal nerve system caused by malocclusion and facial deformities. Trigeminal nerve impairment results in pupil size and occlusal abnormalities. Malocclusion problems are made worse by the trigeminal system's

unilateral and uneven gene expression (23). Patients with significant malocclusion have also been found to have growth deficits, mandibular retrognathia, hypodontia, psychiatric esses,behaviouralsyndromes,andlipandtonguedisarrangement.

Alzheimer's disease (AD)

Malocclusion may be linked to the development of AD through the production of allele-inducing AD, according to new research. It has been noted that Ɛ3 and Ɛ4 allelic phenotypes of APOE genes are linked to malocclusion and other occlusal problems. Compared to the other APOE gene alleles, these genes have a higher phenotypic frequency in individuals with AD (24). In the elderly population, dental conditions including periodontitis and tooth loss are risk factors for AD. The buccal masticatory insufficiency linked to malocclusion impacts oral digestion, which eventually results in nutrient loss. Poor dental health and habits exacerbate cognitive impairment in elderly adults. Delirium may result from brain damage and degeneration in malocclusion patients with worse OHRQoL, which may also lead to disorientation and cerebral haemorrhage (25).

Dementia

The ongoing oral degenerative ageing process can lead to problems of several organ systems, therefore oral health in the elderly is a major concern. Elderly people are more likely to experience cognitive diseases like dementia and delirium in relation to dental health, which suggests that oral hygiene requires special attention. After controlling for diabetes, biological sex, visual disorder, depression, osteoporosis medication, and collagen disease, the number of teeth, age, and clinical dementia rating were all independently linked to periodontal inflamed surface area (PISA) in a home visit survey of individuals with cognitive decline. It has been proposed that odontitis increases the risk of dementia, potentially by allowing P. gingivalis and lipopolysaccharides to enter the brain through increased blood-brain barrier permeability(26, 27).

Neurological-Sleep

In addition to growth, learning, and development, sleep is crucial for overall wellbeing (28). Dentocranial abnormalities, such as severe malocclusion, may be the main cause of sleep-disordered breathing (SDB) (29). Research has demonstrated that children with severe malocclusion (maxillary inclination) experienced daytime sleepiness and sensations of great fatigue far more frequently than those with neutral occlusion(30).

Psychological

Malocclusion in adolescents and young adults can lead to severe psychological stress. In addition to anomalies in facial appearance, reduced trigeminal nerve growth is responsible for mental diseases such as"Attention Deficit Hyperactivity disorder (ADHD), Depression, and Anxiety"(31). Individuals with ADHD who also have orofacial abnormalities, such as malocclusion, are rather common. Psycho-neurological issues have been shown to occur later in adulthood in adolescents with different classifications of malocclusion (32).When considered collectively, mental and physical disorders including ADHD, anxiety, and migraines are directly linked to oral health and malocclusion.

OCULAR

Mandibular lateral deviation links malocclusion to ocular vision issues via the trigeminal nerve, which controls facial and ocular muscles (33). Occlusal anomalies disrupt motor control, affecting visual coordination, balance, peripheral vision, eye symmetry, and sensory function, leading to asymmetric convergence (phorias). Class II/III malocclusion patients, especially Class III, show higher rates of ocular motility disorders (34).Malocclusion impacts vision across ages but hits youth hardest. Ongoing diagnosis during orthodontic therapy is essential to prevent irreversible vision loss.

CARDIOVASCULAR DISORDERS

Malocclusion has been demonstrated to be related with several systemic illnesses. The circulatory and cardiovascular systems may be greatly impacted by this dental malformation (35), most likely as a result of oral microbes, inflammatory chemicals, and hormones brought on by stress (36). PD (periodontal disease) has been found to be a risk factor for cardiovascular diseases (CVDs), including high blood pressure, atherosclerosis, and high cholesterol, which increases a patient's chance of heart attack or stroke (37). Inflammation in the arteries, veins, and coronary tissue may result from bacterial cell infiltration into the heart and blood vessels (38). Accordingly, PD with deep periodontal pockets (≥6 mm) was substantially linked to high CVD risk [systemic coronary risk assessment (SCORE > 5%)], according to a Spanish study on 4224 working individuals (39). Salivary matrix metalloproteinase-8 and -9, as well as MPO, have been found to be substantially positive with periodontal disease (PD) and its association with CHD, according to the "PAROKRANK (Periodontitis and Its Relation to Coronary Artery Disease)study" (40).

These findings suggest that malocclusion has a significant impact on heart health; therefore, coordinated monitoring and treatment of oral and cardiovascular health is critical to patients' full recovery. It is anticipated that orthodontic treatment techniques will reduce stress and HRV indicators in addition to addressing oral functional and aesthetic concerns.

BLOOD DISORDERS

Blood group A showed a considerably greater prevalence of Class II (34.2%) and 3 (19%) malocclusions in a cross-sectional study of Saudi individuals (41). Blood group AB had the highest incidence of impacted teeth (48.8%). The population's geographic and racial variety may be the cause of these discrepancies.

Thalassaemia major causes deformation in orofacial structures due to gingivitis, maxillary protrusion, and poor OHRQoL, which frequently results in Class II malocclusion in individuals (42, 43). According to research by Jeelani et al., around 59% of children with thalassaemia had high-severity Angel's Class II malocclusion (44). Overall, these findings show that blood-related diseases and malocclusion are interconnected.

MUSCULOSKELETAL

Osteoarthritis of the temporomandibular joint is one of the musculoskeletal conditions that can result in clicking sounds and limited mouth opening, as well as discomfort, altered jaw mobility, and pain in the masticatory muscles and all related neuromuscular structures (45). Increased TMJ disc displacement (short ramus, posterior facial height, backward

position, and rotated mandible) and degenerative diseases have been linked to class II malocclusion and hyper-divergent growth patterns (46). This suggests that malocclusion may interfere with the TMJ's ability to support weight, which could lead to the development of TMD.

Osteoporosis

The skeletal system is affected by osteoporosis, a disorder that weakens bones and increases a person's risk of fracture (47, 48). Malocclusion may affect male head density and total bone mineral density (BMD) in teenagers, according to studies (49). Malocclusion may develop from skeletal and dental abnormalities caused by aberrant cranial bone growth brought on by vitamin insufficiency. In particular, a lack of vitamin D3 may affect maxillary growth by raising the likelihood of crowding, cross-bite, and a narrower upper arch (50). Class II and Class III malocclusions have frequently shown dehiscence, which may be related to increased loss of coronal alveolar bone thickness and vertical alveolar bone (51).

Postural

Research has shown a connection between malocclusion and variations in cervical vertebral morphology, highlighting the critical relationship between craniofacial dimensions and head posture. Class II malocclusion, which is strongly linked to increased cervical curvature and forward head tilt, has been linked to both cervical and general body posture (52). Increased craniocervical angle and decreased mandibular and maxillary prognathism appear to be significantly influenced by class II malocclusion (53). This led to the conclusion that class II malocclusion may be caused by greater head extension relative to the cervical spine.

Additionally, there is evidence that various mandibular postures impact postural changes that affect gait stability and the location of the foot's centre of pressure (54). Orthodontic plate placement was shown to restore postural balance in patients with craniocervical-mandibular problems using a stabilometric platform (55).

The asymmetry of the orofacial bone structure puts pressure and strain on the muscles and spine, resulting in persistent aches and pains.Poor posture also affects the alignment of the vertebral column as people age, which can result in serious medical disorders as herniated discs, muscular spasms, disc degeneration, and disc dislocation (56). Therefore, people with malocclusion require an early diagnosis and treatment.

RENAL

A risk factor for sleep-disordered breathing (SDB) is the Class II malocclusion, which is a skeletal anteroposterior discrepancy between the maxilla and mandible accompanied by a vertical discrepancy (57). A growing body of research suggests that SDB is one of the fundamental causes of nocturnal enuresis (NE), as it lowers arousal response and impairs arousal response to a full bladder (58). NE, also known as bedwetting effect, affects roughly 10% of children worldwide and is the second most prevalent health problem among school-age children, after allergies and asthma. By changing urodynamics and triggering hormones that regulate salt, SDB causes an excess of urine to be produced at night. By activating hormones that regulate salt and changing urodynamics, SDB causes excessive urine output at night. These data suggest the indirect link of malocclusion and renal dysfunctions. In a cross-sectional investigation, the most prevalent malocclusion Class II was observed, where spacing and extrusion were prevalent types of pathologic tooth transfer, predominantly impacted by interdental clinical attachment loss and tooth loss due to periodontitis (59).

ERECTILE DYSFUNCTION (ED)

ED is the inability to achieve or maintain a penile erection, which can negatively impact sexual health, activity, psychological well-being, relationships, and quality of life in men (60). Although the aetiology of ED can be complex (vascular, hormonal, drug-induced, psychological, or mixed), vascular is the most prevalent. Among oral conditions, periodontal disease (PD) is a significant risk factor for systemic illnesses brought on by periodontal pathogens and systemic inflammation brought on by periodontal infections that result in endothelial dysfunction (61). Any irregularity or misalignment of the jaw and teeth in a malocclusion increases the risk of periodontal disease (PD) by encouraging the buildup of bacterial plaque (29). In a recent investigation on 400 community-dwelling men, poor occlusal support status was independently and significantly linked with ED (62). In another study including 305 guys, 22.9% men had ED, and 4.3% had chronic PD. When compared to males without ED, those with mild and moderate to severe ED had a considerably higher prevalence of chronic PD.

Moreover, dental disorders as anterior tooth damage or malocclusion negatively affect social acceptance and personal behaviour, which results in sadness and low self-esteem. It may result in ED and, as a result, an unsatisfactory sexual life (63). This suggests that ED may be brought on by the psychological condition linked to malocclusion. Studies have already shown a connection between increased ED prevalence and severity and anxiety and sadness (64, 65). This implies that the psychological disorder associated with malocclusion may be the cause of ED.

Potential as well as challenges for the future

In order to identify preventative and therapeutic measures for the unique systemic consequences of malocclusion, including oral and non-oral disorders, it is necessary to unravel emerging studies. A large, prospective, multidisciplinary cohorts that combine robust systemic outcomes with high-quality orthodontic phenotyping continue to be the top research priority for bridging the gap between dental and systemic health. This will necessitate multidisciplinary, mechanistically orientated research grounded in both experimental and clinical observation.

CONCLUSION

Malocclusion can have a detrimental effect on quality of life by causing multiple organ diseases. The malocclusion can cause a number of illnesses related to the oral, visual, auditory, nasal, cerebral, respiratory, cardiovascular, renal, metabolic, and sexual physiologies in addition to lowering self-esteem and psychological problems. Therefore, a new approach to comprehensive intervention techniques to enhance quality of life and reduce considerable mortality and morbidity will be provided by a knowledge of the complex relationships between various conditions.

References

1. Balachandran P, Janakiram C. Prevalence of malocclusion among 8-15 years old children, India - A systematic review and meta-analysis. J Oral Biol Craniofac Res [Internet]. 2021;11(2):192–9. Available from: http://dx.doi.org/10.1016/j.jobcr.2021.01.011
2. Abe M, Mitani A, Yao A, Hoshi K, Yanagimoto S. Systemic disorders closely associated with malocclusion in late adolescence: A review and perspective. Int J Environ Res Public Health [Internet]. 2022;19(6):3401. Available from: http://dx.doi.org/10.3390/ijerph19063401
3. Angle, E.H. (1899) Classification of malocclusion. Dental Cosmos, volume: 41, Issue: 3, March, 1899, pp. 248-264.
4. Lombardo G, Vena F, Negri P, Pagano S, Barilotti C, Paglia L, et al. Worldwide prevalence of malocclusion in the different stages of dentition: A systematic review and meta-analysis. Eur J Paediatr Dent [Internet]. 2020;21(2):115–22. Available from: http://dx.doi.org/10.23804/ejpd.2020.21.02.05
5. Javali MA, Betsy J, Al Thobaiti RSS, Alshahrani RA, AlQahtani HAH. Relationship between malocclusion and periodontal disease in patients seeking orthodontic treatment in southwestern Saudi Arabia. Saudi J Med Med Sci [Internet]. 2020;8(2):133–9. Available from: http://dx.doi.org/10.4103/sjmms.sjmms_135_19
6. Görgülü S, Sağdıç D, Akin E, Karaçay S, Bulakbası N. Tongue movements in patients with skeletal Class III malocclusions evaluated with real-time balanced turbo field echo cine magnetic resonance imaging. Am J Orthod Dentofacial Orthop [Internet]. 2011;139(5):e405-14. Available from: http://dx.doi.org/10.1016/j.ajodo.2009.07.022
7. Ekuni D, Furuta M, Irie K, Azuma T, Tomofuji T, Murakami T, et al. Relationship between impacts attributed to malocclusion and psychological stress in young Japanese adults. Eur J Orthod [Internet]. 2011;33(5):558–63. Available from: http://dx.doi.org/10.1093/ejo/cjq121
8. Bollero P, Ricchiuti MR, Laganà G, DI Fusco G, Lione R, Cozza P. Correlations between dental malocclusions, ocular motility, and convergence disorders: a cross-sectional study in growing subjects. Oral Implantol (Rome) [Internet]. 2017;10(3):289–94. Available from: http://dx.doi.org/10.11138/orl/2017.10.3.289
9. Matías EMC, Mecham DK, Black CS, Graf JW, Steel SD, Wilhelm SK, et al. Malocclusion model of temporomandibular joint osteoarthritis in mice with and without receptor for advanced glycation end products. Arch Oral Biol [Internet]. 2016;69:47–62. Available from: http://dx.doi.org/10.1016/j.archoralbio.2016.05.007
10. Drury RL, Simonetti SA. Heart rate variability in dental science. Front Med (Lausanne) [Internet]. 2019;6:13. Available from: http://dx.doi.org/10.3389/fmed.2019.00013
11. Chaturvedi TP, Singh D, Sharma VK, Priyadarshani P, Turkiya S. Effect of orthodontic retraction force on thick and thin gingival biotypes in different grades of gingival recession and alveolar bone quality: A finite element analysis. J Orthod Sci [Internet]. 2023;12(1):22. Available from: http://dx.doi.org/10.4103/jos.jos_96_22
12. Elyaskhil M, Shafai NAA, Mokhtar N. Effect of malocclusion severity on oral health related quality of life in Malay adolescents. Health Qual Life Outcomes [Internet]. 2021;19(1):71. Available from: http://dx.doi.org/10.1186/s12955-021-01710-2
13. Assaf D do C, Knorst JK, Busanello-Stella AR, Ferrazzo VA, Berwig LC, Ardenghi TM, et al. Association between malocclusion, tongue position and speech distortion in mixed-dentition schoolchildren: an epidemiological study. J Appl Oral Sci [Internet]. 2021;29:e20201005. Available from: http://dx.doi.org/10.1590/1678-7757-2020-1005
14. Verma SK, Tandon P, Agrawal DK, Prabhat KC. A cephalometric evaluation of tongue from the rest position to centric occlusion in the subjects with class II division 1 malocclusion and class I normal occlusion. J Orthod Sci [Internet]. 2012;1(2):34–9. Available from: http://dx.doi.org/10.4103/2278-0203.99758
15. Iwasaki T, Suga H, Yanagisawa-Minami A, Sato H, Sato-Hashiguchi M, Shirazawa Y, et al. Relationships among tongue volume, hyoid position, airway volume and maxillofacial form in paediatric patients with Class-I, Class-II and Class-III malocclusions. Orthod Craniofac Res [Internet]. 2019;22(1):9–15. Available from: http://dx.doi.org/10.1111/ocr.12251
16. Koizumi K, Shintani T, Yoshimi Y, Higaki M, Kunimatsu R, Yoshioka Y, et al. Impact of maximum tongue pressure in patients with jaw deformities who underwent orthognathic surgery. Diagnostics (Basel) [Internet]. 2022;12(2):404. Available from: http://dx.doi.org/10.3390/diagnostics12020404
17. Sheiham A, Steele J. Does the condition of the mouth and teeth affect the ability to eat certain foods, nutrient and dietary intake and nutritional status amongst older people? Public Health Nutr [Internet]. 2001;4(3):797–803. Available from: http://dx.doi.org/10.1079/phn2000116
18. Gu M, Yang Y, Shan Z. The Association between Mastication, Malocclusion, and Craniofacial Morphology. Int J Dent Oral Sci. 2018;6–11.
19. Castañeda-Zetina J, Chuc-Gamboa MG, Aguilar-Pérez FJ, Pinzón-Te AL, Zúñiga-Herrera ID, Esparza-Villalpando V. Malocclusions in pediatric patients with asthma: A case-control study. Healthcare (Basel) [Internet]. 2022;10(8):1374. Available from: http://dx.doi.org/10.3390/healthcare10081374
20. Rathi S, Gilani R, Kamble R, Bhandwalkar S. Temporomandibular joint disorder and airway in class II malocclusion: A review. Cureus [Internet]. 2022;14(10):e30515. Available from: http://dx.doi.org/10.7759/cureus.30515
21. Lin S-W, Jheng C-H, Wang C-L, Hsu C-W, Lu M-C, Koo M. Risk of dental malocclusion in children with upper respiratory tract disorders: A case-control study of a nationwide, population-based health claim database. Int J Pediatr Otorhinolaryngol [Internet]. 2021;143(110663):110663. Available from: http://dx.

doi.org/10.1016/j.ijporl.2021.110663

22. Torii K, Nippon Dental University. Ear Symptoms and Malocclusion. Otolaryngol Head Neck Surg [Internet]. 2019;5(2):1–2. Available from: http://dx.doi.org/10.24966/ohns-010x/100029
23. Spineli EA, Studart LPC, Heimer MV, Katz CRT. Maloclusões e disfunção da tuba auditiva em crianças: uma revisão integrativa. Rev CEFAC [Internet]. 2016;18(4):960–4. Available from: http://dx.doi.org/10.1590/1982-021620161844116
24. Koskela A, Neittaanmäki A, Rönnberg K, Palotie A, Ripatti S, Palotie T. The relation of severe malocclusion to patients' mental and behavioral disorders, growth, and speech problems. Eur J Orthod [Internet]. 2021;43(2):159–64. Available from: http://dx.doi.org/10.1093/ejo/cjaa028
25. Popovac A, Mladenović I, Krunić J, Trifković B, Todorović A, Milašin J, et al. Apolipoprotein ε4 allele and dental occlusion deficiency as risk factors for Alzheimer's disease. J Alzheimers Dis [Internet]. 2020;74(3):797–802. Available from: http://dx.doi.org/10.3233/JAD-191283
26. Tsuneishi M, Yamamoto T, Yamaguchi T, Kodama T, Sato T. Association between number of teeth and Alzheimer's disease using the National Database of Health Insurance Claims and Specific Health Checkups of Japan. PLoS One [Internet]. 2021;16(4):e0251056. Available from: http://dx.doi.org/10.1371/journal.pone.0251056
27. Fujinami Y, Hifumi T, Ono Y, Saito M, Okazaki T, Shinohara N, et al. Malocclusion of molar teeth is associated with activities of daily living loss and delirium in elderly critically ill older patients. J Clin Med [Internet]. 2021;10(10):2157. Available from: http://dx.doi.org/10.3390/jcm10102157
28. Iwasaki M, Kimura Y, Ogawa H, Yamaga T, Ansai T, Wada T, et al. Periodontitis, periodontal inflammation, and mild cognitive impairment: A 5-year cohort study. J Periodontal Res [Internet]. 2019;54(3):233–40. Available from: http://dx.doi.org/10.1111/jre.12623
29. Edahiro A, Okamura T, Motohashi Y, Takahashi C, Meguro A, Sugiyama M, et al. Severity of dementia is associated with increased periodontal inflamed surface area: Home visit survey of people with cognitive decline living in the community. Int J Environ Res Public Health [Internet]. 2021;18(22):11961. Available from: http://dx.doi.org/10.3390/ijerph182211961
30. Nakamura T, Zou K, Shibuya Y, Michikawa M. Oral dysfunctions and cognitive impairment/dementia. J Neurosci Res [Internet]. 2021;99(2):518–28. Available from: http://dx.doi.org/10.1002/jnr.24745
31. Roy A, Ferraz Dos Santos B, Rompré P, Nishio C. Dental malocclusion among children with attention deficit hyperactivity disorder. Am J Orthod Dentofacial Orthop [Internet]. 2020;158(5):694–9. Available from: http://dx.doi.org/10.1016/j.ajodo.2019.10.016
32. Dutra SR, Pretti H, Martins MT, Bendo CB, Vale MP. Impact of malocclusion on the quality of life of children aged 8 to 10 years. Dental Press J Orthod [Internet]. 2018;23(2):46–53. Available from: http://dx.doi.org/10.1590/2177-6709.23.2.046-053.oar
33. Sabuncuoglu O. Understanding the relationships between breastfeeding, malocclusion, ADHD, sleep disordered breathing and traumatic dental injuries. Med Hypotheses. 2013;80:315–20.
34. Poluha RL, Canales GD la T, Bonjardim LR, Conti PCR. Oral behaviors, bruxism, malocclusion and painful temporomandibular joint clicking: is there an association? Braz Oral Res [Internet]. 2021;35:e090. Available from: http://dx.doi.org/10.1590/1807-3107bor-2021.vol35.0090
35. Caruso S, Gatto R, Capogreco M, Nota A. Association of visual defects and occlusal molar class in children. Biomed Res Int [Internet]. 2018;2018:1–4. Available from: http://dx.doi.org/10.1155/2018/7296289
36. Liu Y, Chen T, Huang J, Li W, Chen Y, Huo L. Refractive error characteristics and influence on ocular parameters in patients with unilateral congenital ptosis. BMC Ophthalmol [Internet]. 2022;22(1):291. Available from: http://dx.doi.org/10.1186/s12886-022-02511-x
37. Giuca MR, Pasini M, Giuca G, Mannella EC, Gandini P. Clinical association between dental malocclusion and strabismus in adolescents: a retrospective dental cast analysis. Minerva Stomatol [Internet]. 2019;68(1):11–6. Available from: http://dx.doi.org/10.23736/S0026-4970.18.04156-0
38. Ribeiro-Lages MB, Martins ML, Magno MB, Masterson Ferreira D, Tavares-Silva CM, Fonseca-Gonçalves A, et al. Is there association between dental malocclusion and bruxism? A systematic review and meta-analysis. J Oral Rehabil [Internet]. 2020;47(10):1304–18. Available from: http://dx.doi.org/10.1111/joor.12971
39. Michalak M, Wysokińska-Miszczuk J, Wilczak M, Paulo M, Bożyk A, Borowicz J. Correlation between eye and ear symptoms and lack of teeth, bruxism and other parafunctions in a population of 1006 patients in 2003-2008. Arch Med Sci [Internet]. 2012;8(1):104–10. Available from: http://dx.doi.org/10.5114/aoms.2012.27289
40. Grippaudo C, Valerio P, Romeo C, Fiasca F, Quinzi V. Bite and sight: Is there a correlation? Clinical association between dental malocclusion and visual disturbances in pediatric patients. Appl Sci (Basel) [Internet]. 2020;10(17):5913. Available from: http://dx.doi.org/10.3390/app10175913
41. Abe M, Mitani A, Yao A, Zhang C-D, Hoshi K, Yanagimoto S. Close association between awareness of teeth-alignment disorder and systemic disorders in late adolescence. Healthcare (Basel) [Internet]. 2021;9(4):370. Available from: http://dx.doi.org/10.3390/healthcare9040370
42. Sanz M, Marco Del Castillo A, Jepsen S, Gonzalez-Juanatey JR, D'Aiuto F, Bouchard P, et al. Periodontitis and cardiovascular diseases: Consensus report. J Clin Periodontol [Internet]. 2020;47(3):268–88. Available from: http://dx.doi.org/10.1111/jcpe.13189
43. Rathnayake N, Gustafsson A, Norhammar A, Kjellström B, Klinge B, Rydén L, et al. Salivary matrix

metalloproteinase-8 and -9 and myeloperoxidase in relation to coronary heart and periodontal diseases: A subgroup report from the PAROKRANK study (periodontitis and its relation to coronary artery disease). PLoS One [Internet]. 2015;10(7):e0126370. Available from: http://dx.doi.org/10.1371/journal.pone.0126370

44. Zorlu M, Camcı H. The relationship between different levels of facial attractiveness and malocclusion perception: an eye tracking and survey study. Prog Orthod [Internet]. 2023;24(1):29. Available from: http://dx.doi.org/10.1186/s40510-023-00483-2
45. Bulczak G, Gugushvili A. Physical attractiveness and cardiometabolic risk. Am J Hum Biol [Internet]. 2023;35(8):e23895. Available from: http://dx.doi.org/10.1002/ajhb.23895
46. Borráz-León JI, Cerda-Molina AL, Mayagoitia-Novales L. Stress and cortisol responses in men: differences according to facial symmetry. Stress [Internet]. 2017;20(6):573–9. Available from: http://dx.doi.org/10.1080/10253890.2017.1378341
47. Tsai S-Y, Hsu J-Y, Lin C-H, Kuo Y-C, Chen C-H, Chen H-Y, et al. Association of stress hormones and the risk of cardiovascular diseases systematic review and meta-analysis. Int J Cardiol Cardiovasc Risk Prev [Internet]. 2024;23(200305):200305. Available from: http://dx.doi.org/10.1016/j.ijcrp.2024.200305
48. AlSahman L, AlBagieh H, AlSahman R. Is there a relationship between salivary cortisol and temporomandibular disorder: A systematic review. Diagnostics (Basel) [Internet]. 2024;14(13):1435. Available from: http://dx.doi.org/10.3390/diagnostics14131435
49. malocclusion among Saudi adults: A cross-sectional study. Clin Cosmet Investig Dent [Internet]. 2024;16:371–9. Available from: http://dx.doi.org/10.2147/CCIDE.S480646
50. Namdar P, Shiva A, Etezadi T, Yazdani Charati J, Karami H, Iri S. Prevalence of malocclusion in patients with thalassemia major: A cross-sectional study. Iran J Orthod [Internet]. 2021;15(2). Available from: http://dx.doi.org/10.5812/ijo.117155
51. Gaudio A, Morabito N, Catalano A, Rapisarda R, Xourafa A, Lasco A. Pathogenesis of thalassemia major-associated osteoporosis: A review with insights from clinical experience. J Clin Res Pediatr Endocrinol [Internet]. 2019;11(2):110–7. Available from: http://dx.doi.org/10.4274/jcrpe.galenos.2018.2018.0074
52. Hattab F. Thalassemia major and related maxillofacial complications: Clinical and radiographic overview with reference to dental care. Int J Exp Dent Sci. 2017;6:1–10.
53. Jeelani W, Sher U, Ahmed M. Nature and severity of dental malocclusion in children suffering from transfusion-dependent (-thalassemia major). Dent Press J Orthod. 2020;25:26-e47.
54. Lopes CMI, Lira SS, da Silva Oliveira JC, Alves E Luna AC, de Melo Valença PA, de Menezes VA. Occlusal disorders in patients with sickle cell disease: Critical literature review. J Clin Pediatr Dent [Internet]. 2021;45(2):117–22. Available from: http://dx.doi.org/10.17796/1053-4625-45.2.8
55. Taher M, Aminondin S 'aisyah, Nasir NA, Jasmadi NA, Nizam NIN, Shahrul IS, et al. Sickle cell disease: understanding pathophysiology, clinical features and advances in gene therapy approaches. Front Pharmacol [Internet]. 2025;16(1630994):1630994. Available from: http://dx.doi.org/10.3389/fphar.2025.1630994
56. Matsuo T, Kakita S, Honda H, Mori S, Araki K, Mitsunari K, et al. Relationship between tooth loss due to chronic periodontitis and lower urinary tract symptoms. Medicina (Kaunas) [Internet]. 2024;60(11):1829. Available from: http://dx.doi.org/10.3390/medicina60111829
57. Alexopoulos EI, Malakasioti G, Varlami V, Miligkos M, Gourgoulianis K, Kaditis AG. Nocturnal enuresis is associated with moderate-to-severe obstructive sleep apnea in children with snoring. Pediatr Res [Internet]. 2014;76(6):555–9. Available from: http://dx.doi.org/10.1038/pr.2014.137
58. Zadik Y, Bechor R, Galor S, Justo D, Heruti RJ. Erectile dysfunction might be associated with chronic periodontal disease: Two ends of the cardiovascular spectrum. J Sex Med [Internet]. 2009;6(4):1111–6. Available from: http://dx.doi.org/10.1111/j.1743-6109.2008.01141.x
59. Xiao Y, Xie T, Peng J, Zhou X, Long J, Yang M, et al. Factors associated with anxiety and depression in patients with erectile dysfunction: a cross-sectional study. BMC Psychol [Internet]. 2023;11(1):36. Available from: http://dx.doi.org/10.1186/s40359-023-01074-w
60. Keller JJ, Chung S-D, Lin H-C. A nationwide population-based study on the association between chronic periodontitis and erectile dysfunction. J Clin Periodontol [Internet]. 2012;39(6):507–12. Available from: http://dx.doi.org/10.1111/j.1600-051X.2012.01879.x
61. Bui FQ, Almeida-da-Silva CLC, Huynh B, Trinh A, Liu J, Woodward J, et al. Association between periodontal pathogens and systemic disease. Biomed J [Internet]. 2019;42(1):27–35. Available from: http://dx.doi.org/10.1016/j.bj.2018.12.001
62. Özkent MS, Hamarat MB, Taşkapu HH, Kılınç MT, Göger YE, Sönmez MG. Is erectile dysfunction related to self-esteem and depression? A prospective case-control study. Andrologia [Internet]. 2021;53(1):e13910. Available from: http://dx.doi.org/10.1111/and.13910
63. Zemishlany Z, Weizman A. The impact of mental illness on sexual dysfunction. Adv Psychosom Med [Internet]. 2008;29:89–106. Available from: http://dx.doi.org/10.1159/000126626
64. Eltas A, Oguz F, Uslu MO, Akdemir E. The effect of periodontal treatment in improving erectile dysfunction: a randomized controlled trial. J Clin Periodontol [Internet]. 2013;40(2):148–54. Available from: http://dx.doi.org/10.1111/jcpe.12039
65. Saito J, Kumano H, Ghazizadeh M, Shimokawa C, Tanemura H. Relationships between erectile dysfunction, depression, anxiety, and quality of life in young Japanese men: A cross-sectional study. J Psychosexual Health [Internet]. 2023;5(2):77–83. Available from: http://dx.doi.org/10.1177/26318318231181687