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The Impact of High-Intensity Training on TMJ and Occlusal Disorders: A Literature Review

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ABSTRACT

To enhance their performance, athletes often clench their jaws forcefully. In the short term, this intense physical strain is beneficial for biomechanics, but it is extremely harmful to dental health. In order to underline the significance of preventive strategies for temporomandibular and occlusal problems, this literature review attempts to gather existing research on the effects of high-intensity exercise on the stomatognathic system. Severe jaw clenching is a Remote Voluntary Contraction (RVC) that causes Concurrent Activation Potentiation (CAP). This phenomenon increases descending neural drive, which significantly increases the neuromuscular performance and peak force of both upper and lower limbs. Nevertheless, the temporomandibular joint (TMJ) is chronically overloaded by the very high maximum voluntary bite forces (MVBF) generated during this diurnal parafunctional habit. The sustained intracapsular pressure surpasses the shock-absorbing capability of the fibrocartilaginous disc and initiates lubrication disturbances and degenerative joint changes. Masticatory muscles contract persistently. It leads to severe local ischemia, metabolic fatigue, and myofascial pain. Clinicians observe these strong biomechanical vectors as accelerated macroscopic tooth wear, enamel microfractures, and non-carious cervical lesions (NCCLs). The adaptive capacity of the stomatognathic system is exceeded by exercise-induced awake bruxism, which therefore becomes a primary etiologic factor of severe dental and temporomandibular joint pathologies. Effective conservative treatment involves targeted physiotherapy to relieve myofascial tension, cognitive-behavioral interventions to control clenching, and the mandatory use of custom bite-aligning mouthguards. Custom-fitted splints will protect teeth, reduce pressure on the temporomandibular joint, and allow athletes to safely maintain the ergogenic neuromuscular benefits of jaw clenching.

Keywords: Temporomandibular Joint Disorders, Awake Bruxism, Resistance Training, Tooth Wear, Bite Force, Occlusal Splints, Concurrent Activation Potentiation

1. INTRODUCTION

Temporomandibular disorders (TMD) consist of various clinical conditions involving the masticatory muscles, the temporomandibular joint (TMJ), and their associated tissues. These disorders often occur as orofacial pain, joint sounds, and restriction of jaw movement, significantly impacting their proper function (Abe et al., 2022; Makino et al., 2014). Among the many etiological factors, bruxism is a repetitive jaw muscle activity characterized by clenching or grinding of the teeth and is considered a primary factor in the development and exacerbation of TMD symptoms (Wetselaar et al., 2019; Zieliński et al., 2024).

In parallel to TMD, the masticatory muscles contracting in an abnormal way lead to occlusal disorders. These problems encompass pathological alterations in the dental occlusion and hard tissues, including severe tooth wear, non-carious cervical lesions, cracked tooth syndrome, and changes in the vertical dimension of occlusion (Friedman Rubin et al., 2019; Ribeiro et al., 2024).

Growing public interest in healthy lifestyles has led to increased physical activity, making the fitness industry one of the fastest-growing sectors today (Vuckovic and Duric, 2024; Xiao et al., 2025). Gym enthusiasts, however, are often overly eager to lift excessively heavy weights. They overload their bodies, including the TMJ, often without realizing the long-term damage they may cause (Mansour Ibrahim Alrowdan et al., 2023). This lack of awareness is deeply concerning, especially since 40.5% of weightlifters report exercise-related injuries and 86.7% of trainers grind their teeth during workouts (compared to 46.7% of non-exercisers). Consequently, 46.7% of heavy lifters experience noticeable tooth wear, whereas only 20% of the non-exercising group do (Lee et al., 2024).

This literature review aims to aggregate and assess the latest research regarding the impact of high-intensity exercise on the stomatognathic system. The main goal is to get the fitness community to pay attention and underscore the importance of taking steps to prevent temporomandibular and occlusal disorders.

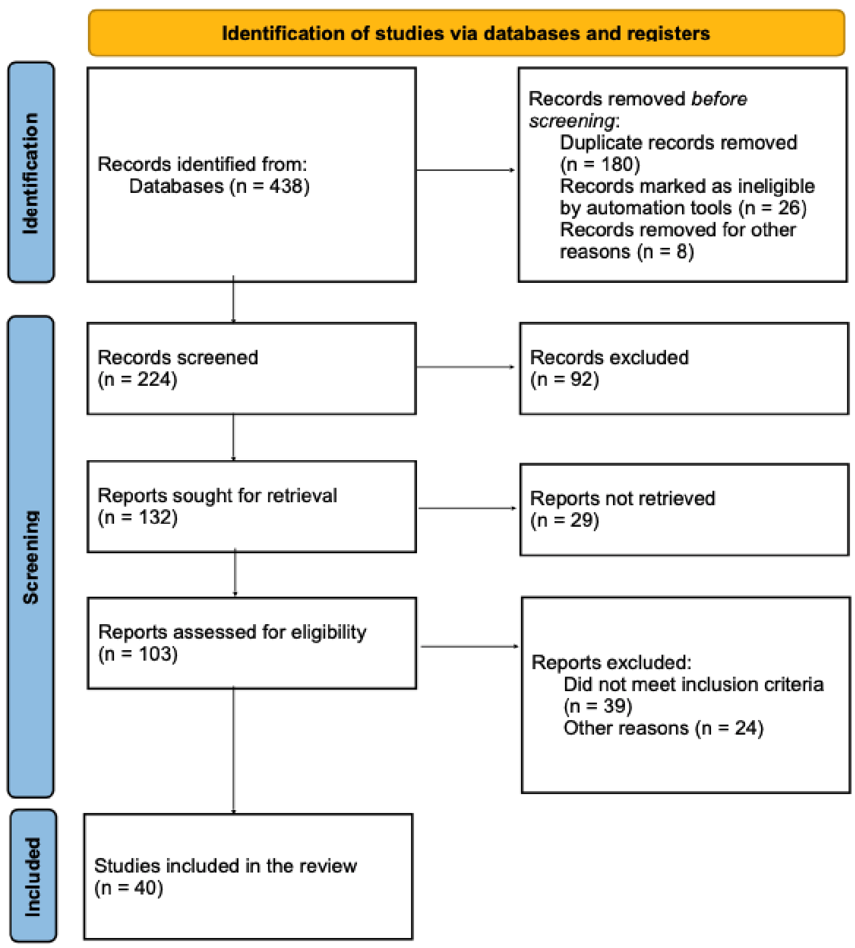

Figure 1. PRISMA 2020 flow diagram of study selection.

2. REVIEW METHODS

This study was conducted as a literature review of the available literature on the impact of high-intensity training on temporomandibular joint (TMJ) and occlusal disorders. The writers focused on studies published between 2005 and 2025. Relevant publications were identified by searching the PubMed/MEDLINE and Google Scholar databases. The search included the following keywords: “exercise-induced stomatognathic diseases”, “maximal voluntary bite force”, “high-intensity training”, “temporomandibular joint biomechanics”, “awake bruxism”, and related terms.

The authors identified further articles by analyzing the reference lists of selected papers. The review included observational studies, cross-sectional cohort studies, systematic reviews, and meta-analyses. Particular attention was given to studies involving athletes and fitness practitioners engaging in different forms of intense physical exertion, including heavy resistance training, weightlifting, and high-intensity functional training. Basic inclusion criteria were defined to improve the consistency of the selection process. Finally, authors included studies based on the following criteria: 1) adult participants performing recreational or competitive physical activity of high intensity, 2) forceful jaw clenching or resistance training as a main contextual factor, and 3) reporting outcomes relevant to stomatognathic health such as TMJ overloading, tooth wear, or non-carious cervical lesions. Authors excluded studies if they did not report temporomandibular or dental outcomes, were non-human models exclusively, were not written in English, or did not report sufficient methodological description. We selected 40 publications for the final analysis. Figure 1 shows the exact PRISMA flow diagram of this process.

3. RESULTS AND DISCUSSION

Neurophysiology and Biomechanics: Ergogenic Effects of Jaw Clenching

Athletes in both recreational and competitive groups often use biomechanical techniques for improving their performance during high-intensity training (Allen et al., 2018; Ebben et al., 2008). Forceful voluntary jaw clenching is a common phenomenon during maximal physical effort, such as heavy resistance training or vertical jumping (Ebben et al., 2008). From a neurophysiological and kinesiological perspective, this action is classified as a Remote Voluntary Contraction (RVC) (Allen et al., 2018). An RVC is the voluntary activation of a muscle group, in this case, the masticatory system, which is physically and mechanically separate from the primary kinetic chain involved in the primary athletic movement. In physiology, prolonged RVC induces Concurrent Activation Potentiation (CAP) (Allen et al., 2018; Ebben et al., 2008). CAP is an acute neurophysiological condition that enhances descending neural drive, thereby greatly increasing the neuromuscular performance of prime movers in the upper and lower extremities (Ebben et al., 2008).

The basic mechanism of this potentiation is strong somatosensory afferentation. The athlete’s forceful occlusion of the dentition strongly stimulates the high-threshold mechanoreceptors in the periodontal ligaments and the muscle spindles within the masseter, temporalis, and wider masticatory musculature (Miró et al., 2023). These focused afferent sensory signals project supraspinally and elicit strong excitation of the primary motor cortex (M1) and the reticular formation (Hirabayashi et al., 2021; Miró et al., 2023).

This physiological phenomenon, theoretically called “motor overflow”, means that the high cortical excitation controlling the stomatognathic system overflows to modify descending central nervous system pathways (Hirabayashi et al., 2021; Miró et al., 2023). As a result, increased efferent neural drive reduces presynaptic inhibition, increasing the excitability of anterior horn cells and the motor neuron pool substantially in the spinal cord (Hirabayashi et al., 2021).

This increased spinal motor neuron excitability can be objectively measured through spinal function assessments. Potentiation is demonstrated by amplification of the Hoffmann reflex (H-reflex) and augmentation of F-wave variables during jaw clenching. The amount of this neurophysiological facilitation is dose-dependent. There is evidence that clenching strengths of 50%-100% of maximum voluntary contraction (MVC) are necessary to sufficiently modulate spinal reflex pathways and increase anterior horn cell excitability to levels that can influence athletic performance (Hirabayashi et al., 2021).

Biomechanically, such a short-term enhancement of the nervous system produces immediate and substantial gains in movement performance. Studies have shown that athletes with a powerful jaw clench exhibit greater peak force and a more rapid rate of force development (RFD) during explosive actions such as countermovement jumps and force tests (Allen et al., 2018; Ebben et al., 2008). While this is good in the short term, excessive jaw clenching can put excessive stress on the temporomandibular joint and teeth. This results in high rates of tooth wear and temporomandibular disorders (TMD) in weightlifters.

Maximum Voluntary Bite Force (MVBF) as a Biomechanical Vector and Diagnostic Indicator

Maximum voluntary bite force (MVBF) is an indicator of the maximal force produced by the mandibular elevator muscles and is mainly dependent on the muscular, skeletal, and mechanoreceptor systems. Biomechanically, the MVBF increases posteriorly in the dental arch. The Constrained Lever Model (CLM) indicates that adductor muscle forces must be transmitted laterally to prevent tensile loading of the temporomandibular joint (TMJ) during heavy posterior biting (Edmonds and Glowacka, 2020). Craniofacial morphology affects the magnitude of MVBF. Individuals with acute gonial angles, vertical rami, and reduced facial heights have a greater mechanical advantage and greater MVBF (Patil et al., 2024; Varga et al., 2011).

In the context of heavy physical work or intense sports, general physical training of specific muscle groups can increase overall muscle strength. This indirectly increases bite force above baseline levels related to an individual's body mass index (BMI) in terms of force generation and exertion (Varga et al., 2011). Maximal voluntary clenching results in maximal contraction of the jaw elevator muscles. This physical activity correlates with the occurrence of tooth fracture, damage to existing dental restorations, and local discomfort. The production of these extreme vectors is highly correlated with the electromyographic (EMG) activity of the masseter and temporalis muscles. This diagnostic test shows a directly proportional, linear relationship during maximal and submaximal (2/3) clenching, yet its linearity deteriorates and decreases during low-exertion (1/3) occlusal loads (Bogdanov et al., 2023). MVBF is known for being a well-established diagnostic indicator for assessing functional integrity and pathological deviations of the stomatognathic system (Patil et al., 2024).

In clinical research and practice, various recording devices, ranging from early mechanical gnathodynamometers to modern electromechanical sensors, are used to precisely measure this important parameter. These precision devices allow practitioners to diagnose baseline malocclusions and to quantitatively evaluate the functional efficacy and success of extensive dental interventions, such as complex prosthodontic rehabilitations and orthodontic treatments (Verma et al., 2017). Furthermore, Clinicians frequently compare the bite force between sides of the jaw as a diagnostic marker of bite force asymmetry. Unilateral bite force testing measures the load on one side of the jaw and may help to identify localized stomatognathic differences and unilateral impairments.

Total bite stability and chewing adequacy are determined by bilateral measurements (Patil et al., 2024). Physiological and pathological force degradation are also important clinical indicators. Physiological force degradation is observed universally in senility and in older age groups. Here, the maximum bite force gradually decreases due to the natural process of aging, tooth loss, decreased bone density, and masticatory muscle degeneration (Patil et al., 2024; Takaki et al., 2014).

On the other hand, pathological force degradation is strongly associated with temporomandibular disorders (TMD). From clinical indices, it has been shown that muscle tenderness in TMD, especially when measured by high Palpation Index scores, is significantly associated with a decrease in maximum bite force. This confirms that localized muscle pain is a biological limiter, which prevents subjects from exerting their maximal biomechanical potential (Bonjardim et al., 2005; Pereira et al., 2007). However, the literature is contradictory, and there was no statistically significant difference in maximal bite force between completely healthy adults and adults with specific structural signs of TMD, suggesting that force degradation in the jaw is highly multifactorial and strongly dependent on the presence of acute muscle tenderness (Pereira-Cenci et al., 2007).

Biomechanics and Pathophysiology of Temporomandibular Joint Disorders

Biomechanics of the Healthy Temporomandibular Joint

The temporomandibular joint (TMJ) is a highly mobile, bicondylar joint with a unique articulation. The mandibular condyle articulates in the temporal articular fossa, separated by a dense, biconcave fibrocartilaginous articular disc, rather than hyaline cartilage (Ingawalé and Goswami, 2009). Morphologically, the disc is composed of a thinner intermediate zone (1.0 to 1.2 mm) and thicker anterior and posterior bands (about 2.4 and 2.9 mm, respectively) (Commisso et al., 2014). The disc divides the joint cavity into the superior and inferior compartments, which are filled with synovial fluid that lubricates and nourishes the joint structures. The TMJ has three degrees of freedom that allow special hinge and gliding movements, including rotation, and anterior, posterior, and mediolateral translation. Coordinated movement of the condyle and disc is important for physiological function. The fibrocartilaginous disc spreads joint stresses over a large area, prevents focal contact stress concentrations, and prevents bone-on-bone friction between the condylar head and the articular fossa (Ingawalé and Goswami, 2009).

Overload and Articular Disc Degradation

The etiology of temporomandibular joint disorders is multifactorial, with psychosocial, neuromuscular, biological, and biomechanical factors. The main biomechanical contributors are occlusal overloading and parafunctional habits such as bruxism (Chisnoiu et al., 2015). Finite element analysis is a useful tool for studying load distribution in the TMJ and its cartilaginous structures (Commisso et al., 2014; Ingawalé and Goswami, 2009). Quasilinear viscoelastic and biphasic (poroelastic) models have been used by researchers to simulate the behavior of the fibrocartilaginous articular disc under abnormal loading, specifically sustained clenching (awake bruxism) encountered during resistance training (Commisso et al., 2014; Tanaka and Koolstra, 2008). These simulations indicate that sustained, tonic contractions of jaw-closing muscles are highly harmful for the joint space (Commisso et al., 2014). The interstitial fluid shock-absorbing properties normally carry most of the load on cartilaginous structures (Tanaka and Koolstra, 2008).

However, the excessive intracapsular pressure and the persistent compression due to persistent awake bruxism overwhelm the shock-absorbing ability of the disc, thus leading to tissue damage and deterioration of the TMJ articular structure (Commisso et al., 2014; Friedman Rubin et al., 2019). Such pathological mechanical stress causes intra-articular lubrication disturbance, resulting in frictional sticking of the disc, which is a major etiological factor of anterior disc displacement (Friedman Rubin et al., 2019). Osteoarthritis is a degenerative disease characterized by breakdown of its structure, subchondral remodeling of the bone, irreversible damage to the cartilage, and inflammation of the synovial membrane. It can occur when a joint is subjected to chronic mechanical loading beyond its adaptive capacity (Ingawalé and Goswami, 2009; Pascu et al., 2025).

Myofascial Pathology

Weightlifting and high-intensity resistance training impose rigorous demands on their technique. Neglecting them induces significant myofascial pathology in the stomatognathic system. Athletes use the masseter, temporalis, digastric, and pterygoid muscles during high-intensity training. They contract them synchronously, forcefully, and sustainably for stabilization of the mandible (Mansour Ibrahim Alrowdan et al., 2023). These muscle contractions serve not only for stabilization but also as a direct neurophysiological feedback mechanism. Athletes perceive it as a physical effort. Masseter activity increases significantly as exercise intensity does (Huang et al., 2014). This tonic action results in a profound overuse of the masticatory muscles in the long run and, in chronic cases, in a mechanical restriction of the maximum voluntary range of mouth opening due to the hypertrophy of the facial muscles (Friedman Rubin et al., 2019). Reduction of local tissue perfusion is called ischemia. It occurs when muscles contract persistently. As a result, muscle fibers accumulate harmful toxins and metabolic by-products. These substances directly lead to acute muscle fatigue and pain (Ben et al., 2025).

Further electromyographic (EMG) evaluations of bodybuilders show that this intense muscular recruitment during resistance training significantly alters the electrical activity of the masseter and temporalis muscles; thus, this acute neuromuscular fatigue diminishes maximum voluntary occlusal bite force (MVOBF) and overall masticatory efficiency (Júnior et al., 2021). These physiological changes often induce localized myalgia, masticatory muscle spasms, and more generalized myofascial pain syndromes in fitness practitioners. In addition, this localized muscle dysfunction spreads anatomically. Excessive tension and overuse of the masticatory muscles and unbalanced agonist-antagonist relationships in the cervical spine are highly correlated with a high prevalence of tension-type headaches, frequent cranial pain, and radiated pain in the craniomandibular and cervical regions (Friedman Rubin et al., 2019; Mansour Ibrahim Alrowdan et al., 2023; Ben et al., 2025).

The Clinical Consequences: Predominant Dental and Occlusal Pathologies with Associated Periodontal Manifestations

Repeated high-intensity resistance training with teeth clenching is a very harmful habit. This activity induces a broad spectrum of morphological and functional discrepancies in the stomatognathic system (Ribeiro et al., 2024). The etiology of temporomandibular disorders (TMD) is multidimensional, but occlusal overload and parafunctions are considered the main biomechanical aggravating factors, especially exercise-induced bruxism (Chisnoiu et al., 2015). Oral parafunctional habits (OPFHs), such as diurnal clenching during high physical exertion, can easily surpass the individual's resistance threshold and adaptive capacity, resulting in direct biomechanical damage to the dentition, the temporomandibular joint (TMJ), and the masticatory muscles. Certainly, clinical studies have shown that people who clench during the day are at much higher risk of developing severe jaw pain and fatigue of the chewing muscles (Abe et al., 2022).

Excessive forces applied to the teeth are a major risk factor for irreversible hard tissue damage. Clinicians can observe this biomechanical overload mainly as accelerated tooth wear. The severity of these lesions is positively correlated with the duration of the athletic career (Lee et al., 2024). Macroscopic tooth wear was found in 61.40% of the high-intensity functional training practitioners (Ribeiro et al., 2024). Pathological changes associated with exercise-induced bruxism always include visible oral signs such as macroscopic dental attrition, irregular lingual borders, and marked buccal occlusal lines (Crincoli et al., 2022). Apart from surface wear, continuous mechanical forces due to clenching result in microfractures in the enamel. That may develop into visible macroscopic tooth fractures and make exposed dentin and root surfaces vulnerable to carious lesions (de Sales et al., 2025; Lee et al., 2024).

Regarding purely mechanical damage, there is the chemical problem that many athletes face. Consuming acidic sports drinks often accompanies regular, intensive physical training. High intake of these drinks decreases salivary pH, which promotes the dissolution of calcium ions, leading to severe dental erosion of enamel and dentin (Crincoli et al., 2022). Also, the structural integrity of the occlusal scheme is important to the health of the athletic stomatognathic system. Existing occlusal disharmonies, such as untreated edentulous gaps, reduced vertical dimension of occlusion (VDO), and premature occlusal contacts, significantly influence the severity and progression of TMD (Pascu et al., 2025).

Specific morphologic malocclusions, especially Angle Class II and III relationships, deep overbites and crossbites, have been strongly associated with a higher prevalence of TMJ symptoms such as disc displacement, joint clicking, and mandibular deviation (Pascu et al., 2025). When these malpositions and occlusal interferences are combined with the extreme occlusal loading created during weightlifting, they produce severe orthopedic joint instability and predispose the individual to long-term secondary muscular and joint pain (Chisnoiu et al., 2015; Pascu et al., 2025).

This abnormal occlusal loading has also been heavily implicated in the pathogenesis of non-carious cervical lesions (NCCLs). Resistance trainees who train extensively have 16% more tooth “abfractions” than recreational trainees (2%) (Friedman Rubin et al., 2019), while over 35% of practitioners of high-intensity functional training present with general NCCLs (Abe et al., 2022). Extreme masticatory tension contributes not only to the loss of cervical hard tissue but also to harmful stress on existing cervical restorations, often leading to their mechanical failure (Lee et al., 2024).

The dental and occlusal hard tissues are the primary site of this parafunction during sports, while the secondary site of manifestation is the periodontium and the adjacent oral soft tissues. This biomechanical load often leads to adaptive alveolar bone atrophy, with an incidence of about 19% among high-intensity trainees (Ribeiro et al., 2024). In addition, practitioners frequently demonstrate marked frictional keratosis, such as linea alba (82.45% of subjects), and marked scalloped indentations along the lateral borders of the tongue and the labial mucosa, which are soft-tissue signs of severe, chronic clenching (Ribeiro et al., 2024).

The Craniocervical-Mandibular Chain and Posture

There is a deep biomechanical interdependency between the stomatognathic system and the craniocervical motor system, where the coordinated mandibular and head-neck movements are necessary for the normal physiological function of the jaws (Makino et al., 2014). In the gym, athletes are likely to clench their teeth to achieve mandibular fixation during intense physical activity, including extensive resistance training and weightlifting (Mansour Ibrahim Alrowdan et al., 2023). The intense stomatognathic activity is thought to increase muscular performance and motor excitability through remote facilitation effects in the spinal cord (Hirabayashi et al., 2021). It is closely related to dynamic balance and postural control by complex neurophysiological links between the trigeminal nerve and the spinal cord (Fadillioglu et al., 2023; Friedman Rubin et al., 2019). However, high-intensity exercise induces simultaneous and forceful contraction of the digastric and adjacent posterior cervical muscles, which may cause the condylar point to shift backward and downward in the sagittal plane (Mansour Ibrahim Alrowdan et al., 2023). This extreme physical stress has an important effect on a bidirectional association between forward head posture, which is often assumed during heavy squats and deadlifts, and altered mandibular resting posture.

Table 1. Benefits vs. Risks of Jaw Clenching in High-Intensity Training

Impact Area	**Key findings**
Athletic Performance	Jaw clenching temporarily boosts muscle strength and power in the limbs (CAP)
TMJ & Muscles	Chronic clenching causes joint overload, disc degeneration, and severe jaw muscle pain and fatigue.
Teeth & Gums	Leads to rapid tooth wear, enamel cracks, and lesions at the gumline. Acidic sports drinks worsen this via chemical erosion.
Posture	Forward head posture during heavy lifting alters jaw position, creating a harmful loop of neck strain and joint compression.

In this bidirectional dynamic, the forward head posture significantly alters the resting position of the mandible, exacerbating cervical strain and TMJ compression. Heavy jaw clenching concomitantly further alters head deflection and cervical muscle reflex activity (Fadillioglu et al., 2023; Friedman Rubin et al., 2019). This may lead to agonist-antagonist muscular imbalances around the cervical spine due to heavy, repetitive resistance training, which may cause harmful postural abnormalities (e.g., uneven shoulder levels), impaired cervical mobility, and limited mouth opening due to facial muscular hypertrophy (Friedman Rubin et al., 2019). These behavioral risk factors, such as abnormal head posture and intense exercise-induced parafunctional behaviors (e.g., bruxism) (Chisnoiu et al., 2015; Makino et al., 2014), place significant stress on the masticatory system. The prolonged craniocervical overloading, the impaired reflex coordination, and the poor postural ergonomics may finally lead to the development of chronic myofascial pain and craniomandibular joint dysfunction in weightlifters (Fadillioglu et al., 2023; Mansour Ibrahim Alrowdan et al., 2023). This proves the obvious pathogenetic connection between the beginning of temporomandibular disorders (TMDs) and unsupervised, high-intensity postural strain (Friedman Rubin et al., 2019; Makino et al., 2014). Table 1 summarizes the main benefits and risks of jaw clenching during high-intensity training.

Preventive Measures and Conservative Management

Temporomandibular joint and occlusal disorders require a multimodal approach. Heavy resistance exercises such as deadlifts, bench presses, and squats are often maladaptive parafunctional activities, such as involuntary teeth clenching. As a result, athletes are at a substantially increased risk of enamel microfractures, accelerated tooth wear, and restricted maximum mouth opening (Lee et al., 2024). To counteract these structural and functional deficits, the basis of non-invasive management includes a combination of physiotherapy, occlusal splint therapy, and cognitive-behavioral interventions (González-Sánchez et al., 2023; Ben et al., 2025).

Physiotherapy involves propulsion, vertical distraction, and joint mobilizations in the medial-lateral plane. The main goal is to reduce myofascial tension. Often, these manual modalities are combined with superficial thermotherapy. Local vasodilation and relaxation of the masticatory muscles are achieved by using heat, moist or dry, preferably at a temperature of 40°C–42°C for 20 minutes, resulting in functional improvements in mouth opening. At the same time, conservative management must include appropriate stretching protocols that aim to restore joint lubrication and stimulate the synthesis of glycosaminoglycan between collagen fibers. Specific opening stretches are performed by having the patient open their mouth to the maximum spontaneous limit and applying gentle downward pressure on the lower incisors with two fingers for 15 seconds (Ben et al., 2025).

Moreover, craniomandibular dysfunctions are closely linked to craniocervical and postural changes, forming a unique “tonic-postural system”. Clinical evidence indicates that a combination of gnathological treatment (custom occlusal splints) and physiotherapy has been effective in treating persistent symptoms beyond the jaw, including chronic low back pain (Baldini et al., 2012). The application of these occlusal appliances, such as 3D-printed repositioning splints, unloads the temporomandibular articulation effectively (Ainoosah et al., 2024; Jin, 2024). This unloading reduces the maximal contractile force of the masticatory musculature, which can be considered an evidence-based standard for mitigating training-induced stomatognathic dysfunctions (González-Sánchez et al., 2023).

Bite-Aligning Mouthguards: Tissue Protection and Ergogenic Benefits

Bite-aligning mouthguards have an important role during high-intensity resistance training. The main purpose of these oral appliances is a prophylactic one designed to decrease the risk of acute orofacial trauma (Lee et al., 2024). They also protect the periodontium against catastrophic mechanical stress during heavy exertion (Miró et al., 2021). While cheap, self-adapted "boil-and-bite" mouthguards are available, custom-made mouthguards need clinical impressions or intraoral scans to obtain an optimal, individualized fit (Allen et al., 2018). This precise calibration results in better stabilization of the temporomandibular joint and in an improved overall occlusal function (Allen et al., 2018; Miró et al., 2023).

A perfectly balanced occlusion is essential. In fact, studies show that an artificially imbalanced occlusion immediately and significantly impairs lower limb athletic performance. In particular, asymptomatic females with an imbalanced dental occlusion (through a 1mm resin interference) showed a 9% reduction in quadriceps eccentric peak torque and a 7% reduction in hamstring eccentric peak torque (Grosdent et al., 2014). A perfectly balanced splint will prevent neural inhibitions during extreme eccentric contractions. Moreover, in athletes with existing TMJ dysfunctions, a custom-fit, instrumentally balanced splint has been shown to significantly improve concentric quadriceps force and total work in isokinetic testing compared to lifting with unassisted teeth contact (Baldini et al., 2012).

In addition to baseline functional restoration, athletes may benefit from the ergogenic advantages of jaw clenching due to (described earlier) concurrent activation potentiation (CAP) through the use of these customized devices (Ebben et al., 2008; Miró et al., 2021). The remote voluntary contraction (RVC) of the masticatory musculature against a calibrated splint enhances upper and lower body muscular force production and rate of force development. On the other hand, when athletes are in a "non-jaw" condition, in which they jump with an open mouth or breathe through pursed lips to avoid the clenching of teeth, this potentiation does not occur (Allen et al., 2018; Ebben et al., 2008).

Multimodal Physiotherapy and Cognitive-Behavioral Interventions

Conservative management of temporomandibular disorders (TMDs) caused by athletic parafunctional habits requires a multimodal physiotherapeutic and cognitive-behavioral approach. Active recognition and control of clenching habits during exertion are vital parts of this regimen and involve educating athletes to avoid chronic TMJ overloading (Lee et al., 2024; Makino et al., 2014). In particular, psychological interventions and Cognitive-Behavioral Therapy (CBT) are intended to increase the patient's awareness of diurnal parafunctional activities (Makino et al., 2014).

Combined with this awareness comes training in relaxation techniques, such as progressive muscle relaxation and specific breathing exercises, to directly relieve tension in the jaw and surrounding muscles. Patients are asked to take a deep breath through the mouth, consciously relaxing the masticatory musculature. During this practice, they must consciously avoid clenching their teeth. In addition, to prevent the onset of myofascial pain after demanding physical activity, athletes should incorporate jaw rehabilitation exercises post-training. The therapeutic techniques consist of slow and controlled jaw movements in front of the mirror to ensure symmetrical tracking and with the bite on a cotton roll to prevent hypertranslation of the TMJ beyond physiological limits (Makino et al., 2014). Table 2 lists the core preventive and therapeutic solutions for athletes.

Table 2. Core Preventive and Therapeutic Solutions

Solution	**Core Benefit & Action**
Custom Mouthguards	Protects teeth and the TMJ while preserving the strength benefits of clenching. Athletes should avoid cheap "boil-and-bite" guards.
Physiotherapy	Uses joint mobilization, stretching, and heat therapy (40°C - 42°C) to relieve muscle tension and restore function.
Behavioral Awareness	Teaches relaxation and breathing techniques to help athletes consciously stop involuntary clenching during exercise.
"Non-Jaw" Training	Lifting with an open mouth or pursed lips protects the jaw, but sacrifices the temporary strength boost associated with clenching.

4. CONCLUSION

In conclusion, although the systemic health benefits of high-intensity resistance training are undeniable, the accompanying habit of forceful jaw clenching, often performed unconsciously to enhance strength through neurophysiological motor overflow, poses alarming and often irreversible risks to the stomatognathic system. The primary clinical aim of this review is to raise awareness in the fitness community by translating complex biomechanical pathologies into actionable, preventative guidelines. Those who attend the gym have to consciously change their training behavior and follow evidence-based protective measures to prevent temporomandibular joint (TMJ) and occlusal injuries.

Most importantly, athletes must learn how to avoid maladaptive parafunctional habits, such as teeth grinding, which occurs involuntarily and constantly during heavy compound movements such as deadlifts, bench presses, and squats. Therefore, fitness lovers should incorporate some cognitive and physical interventions into their fitness routines to proactively safeguard their stomatognathic health. The clinical management is grounded in cognitive-behavioral awareness. Patients are requested to identify and attempt to manage daytime clenching during their exercise sessions. The single most important preventative measure that a serious weightlifter can take to maximize both safety and performance is to wear custom occlusal splints. These devices are necessary, since they unload the temporomandibular force articulation in an efficient way, protect the periodontium from catastrophic mechanical stress, and prevent neural inhibition during heavy eccentric contractions, all clinically calibrated. The custom guards allow the gym-goer to safely harness the neurophysiological benefits of jaw clenching with a perfectly balanced occlusal relationship without incurring permanent structural damage to their stomatognathic system.

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Data and materials availability
All data associated with this study will be available based on the reasonable request to corresponding author.

REFERENCES

1. Abe S, Kawano F, Matsuka Y, Masuda T, Okawa T, Tanaka E. Relationship between Oral Parafunctional and Postural Habits and the Symptoms of Temporomandibular Disorders: A Survey-Based Cross-Sectional Cohort Study Using Propensity Score Matching Analysis. J Clin Med 2022;11(21):6396. doi: 10.3390/jcm11216396
2. Ainoosah S, Farghal AE, Alzemei MS, Saini RS, Gurumurthy V, Quadri SA, Okshah A, Mosaddad SA, Heboyan A. Comparative analysis of different types of occlusal splints for

the management of sleep bruxism: a systematic review. BMC Oral Health 2024;24:29. doi:10.1186/s12903-023-03782-6

3. Allen CR, Fu YC, Cazas-Moreno V, Valliant MW, Gdovin JR, Williams CC, Garner JC. Effects of Jaw Clenching and Jaw Alignment Mouthpiece Use on Force Production During Vertical Jump and Isometric Clean Pull. J Strength Cond Res 2018;32(1):237–43. doi:10.1519/JSC.0000000000002172
4. Baldini A, Beraldi A, Nota A, Danelon F, Ballanti F, Longoni S. Gnathological postural treatment in a professional basketball player: a case report and an overview of the role of dental occlusion on performance. Ann Stomatol (Roma) 2012;3(2):51–8.
5. Ben El Hammi N, Amessegher F, Moudni S, Jouhadi EM. Physiotherapy Approaches for Temporomandibular Disorders: A Multimodal Conservative Management Strategy. Cureus 2025;17(7):e88885. doi: 10.7759/cureus.88885.
6. Bogdanov V. Type of correlation between bite force and EMG activity of the temporalis and masseter muscles during maximal and submaximal clenching. Folia Med (Plovdiv) 2023;65(6):975–85. doi:10.3897/folmed.65.e107180
7. Bonjardim LR, Gavião MBD, Pereira LJ, Castelo PM. Bite force determination in adolescents with and without temporomandibular dysfunction. J Oral Rehabil 2005. doi: 10.1111/j.1365-2842.2005.01465.x
8. Chisnoiu AM, Picos AM, Popa S, Chisnoiu PD, Lascu L, Picos A, Chisnoiu R. Factors involved in the etiology of temporomandibular disorders - a literature review. Clujul Med 2015;88(4):473–8. doi:10.15386/cjmed-485
9. Commisso MS, Martínez-Reina J, Mayo J. A study of the temporomandibular joint during bruxism. Int J Oral Sci 2014; 6(2):116–23. doi:10.1038/ijos.2014.4
10. Crincoli V, De Biase C, Cazzolla AP, Campobasso A, Dioguardi M, Piancino MG, Mattia L, Ribatti D, Comite M. Effects of Contact Sports on Temporomandibular Disorders: An Observational Study. Dent J 2022;10(10):180. doi: 10.3390/dj10100180
11. de Sales ADN, Almeida R de AC, Barbosa ATL, Raposo JC dos S, Correia Júnior JL, Gusmão B de A, Freitas Dias R, de Godoy F. Prevalence of Bruxism in Athletes: A Systematic Review and Meta-Analysis. J Oral Rehabil 2025;52(9):1518–43. doi:10.1111/joor.14039
12. Ebben WP, Flanagan EP, Jensen RL. Jaw clenching results in concurrent activation potentiation during the countermovement jump. J Strength Cond Res 2008;22(6):1850–4. doi:10.1519/JSC.0b013e3181875117
13. Edmonds HM, Glowacka H. The ontogeny of maximum bite force in humans. J Anat 2020;237(3):529–42. doi:10.1111/joa.13218
14. Fadillioglu C, Kanus L, Möhler F, Ringhof S, Hellmann D, Stein T. Effects of jaw clenching on dynamic reactive balance task performance after 1-week of jaw clenching training. Front Neurol 2023;14:1140712. doi:10.3389/fneur.2023.1140712
15. Friedman Rubin P, Eli I, Greenbaum T, Shapira K, Emodi-Perelman A, Winocur E. Potential orofacial hazards of resistance training: A controlled comparative study. CRANIO® 2019;37(1):45–52. doi:10.1080/08869634.2017.1370566
16. González-Sánchez B, García Monterey P, Ramírez-Durán MDV, Garrido-Ardila EM, Rodríguez-Mansilla J, Jiménez-Palomares M. Temporomandibular Joint Dysfunctions: A Systematic Review of Treatment Approaches. J Clin Med 2023; 12(12):4156. doi:10.3390/jcm12124156
17. Grosdent S, O'Thanh R, Domken O, Lamy M, Croisier JL. Dental occlusion influences knee muscular performances in asymptomatic females. J Strength Cond Res 2014;28(2):492–8. doi:10.1519/JSC.0b013e3182a7665a
18. Hirabayashi R, Edama M, Saito A, Yamada Y, Nawa R, Onishi H. Effects of Clenching Strength on Exercise Performance: Verification Using Spinal Function Assessments. Sports Health 2021;14(3):404–14. doi:10.1177/19417381211014836
19. Huang DH, Chou SW, Chen YL, Chiou WK. Frowning and Jaw Clenching Muscle Activity Reflects the Perception of Effort During Incremental Workload Cycling. J Sports Sci Med 2014;13(4):921–8.
20. Ingawalé S, Goswami T. Temporomandibular joint: disorders, treatments, and biomechanics. Ann Biomed Eng 2009;37(5): 976–96. doi:10.1007/s10439-009-9659-4
21. Jin X. Clinical effect of digitalized designed and 3D-printed repositioning splints in the treatment of anterior displacement of temporomandibular joint disc. BMC Musculoskelet Disord 2024;25:348. doi:10.1186/s12891-024-07477-z
22. Júnior M, Goiato M, De Caxias F, Turcio K, Da Silva E, Deusdete Ms, Santos Dm. Masticatory efficiency, bite force and electrical activity of the masseter and temporalis muscles in bodybuilders. J Clin Exp Dent 2021;e920–6. doi: 10.4317/jced.58368
23. Lee SM, Lee EC, Gong J, Jang CE, Hwang YS. Investigation of the Effects of Teeth Clenching Due to Weight Training on Oral Health. J Dent Hyg Sci 2024;24(3):152–9. doi:10.17135/jdhs.2024.24.3.152
24. Makino I, Arai YCP, Aono S, Hayashi K, Morimoto A, Nishihara M, Ikemoto T, Inoue S, Mizutani M, Matsubara T, Ushida T. The effects of exercise therapy for the improvement of jaw movement and psychological intervention to reduce parafunctional activities on chronic pain in the craniocervical

region. Pain Pract Off J World Inst Pain 2014;14(5):413–8. doi: 10.1111/papr.12075
25. Mansour Ibrahim Alrowdan A, Mohsin SF, Ali Shah S, Alkhalifah TS. Frequency and Severity of Temporomandibular Disorders Among Weightlifters at Fitness Centers in a Subset Population of Saudi Arabia: A Cross-Sectional Observational Study. Cureus 2023;15(11): e49113. doi:10.7759/cureus.49113
26. Miró A, Buscà B, Aguilera-Castells J, Arboix-Alió J. Acute Effects of Wearing Bite-Aligning Mouthguards on Muscular Strength, Power, Agility and Quickness in a Trained Population: A Systematic Review. Int J Environ Res Public Health 2021;18(13):6933. doi:10.3390/ijerph18136933
27. Miró A, Buscà B, Arboix-Alió J, Huertas P, Aguilera-Castells J. Acute effects of jaw clenching while wearing a customized bite-aligning mouthguard on muscle activity and force production during maximal upper body isometric strength. J Exerc Sci Fit 2023;21(1):157–64. doi:10.1016/j.jesf.2022.12.004
28. Pascu L, Haiduc RS, Almășan O, Leucuța DC. Occlusion and Temporomandibular Disorders: A Scoping Review. Medicina (Mex) 2025;61(5):791. doi:10.3390/medicina61050791
29. Patil R, Khubchandani M, Kanani H, Yeluri R, Dangore-Khasbage S. Unravelling the Complexities of Bite Force Determinants in Paediatric Patients: A Literature Review. Cureus 2024;16(5):e60630. doi:10.7759/cureus.60630
30. Pereira LJ, Pastore MG, Bonjardim LR, Castelo PM, Gavião MBD. Molar bite force and its correlation with signs of temporomandibular dysfunction in mixed and permanent dentition. J Oral Rehabil 2007. doi:10.1111/j.1365-2842.2006.01697.x
31. Pereira-Cenci T, Pereira LJ, Cenci MS, Bonachela WC, Del Bel Cury AA. Maximal bite force and its association with temporomandibular disorders. Braz Dent J 2007;18:65–8. doi: 10.1590/S0103-64402007000100014
32. Ribeiro IFB, Lieuthier KM, Ferreira GDS, Passos VF, Peixoto RF, Nogueira SMA, Ongaro PJ, Fiamengui LMSP. Clinical signs of bruxism in CrossFit® practitioners: observational study. Dent Press J Orthod 2024;29(5):e242476. doi: 10.1590/2177-6709.29.5.e242476.oar
33. Takaki P, Vieira M, Bommarito S. Maximum Bite Force Analysis in Different Age Groups. Int Arch Otorhinolaryngol 2014;18(3):272–6. doi:10.1055/s-0034-1374647
34. Tanaka E, Koolstra JH. Biomechanics of the temporomandibular joint. J Dent Res 2008;87(11):989–91. doi: 10.1177/154405910808701101
35. Varga S, Spalj S, Lapter Varga M, Anic Milosevic S, Mestrovic S, Slaj M. Maximum voluntary molar bite force in subjects with normal occlusion. Eur J Orthod 2011;33(4):427–33. doi: 10.1093/ejo/cjq097
36. Verma TP, Kumathalli KI, Jain V, Kumar R. Bite Force Recording Devices - A Review. J Clin Diagn Res 2017;11(9):ZE01–5. doi:10.7860/JCDR/2017/27379.10450
37. Vuckovic V, Duric S. Motivational variations in fitness: a population study of exercise modalities, gender and relationship status. Front Psychol 2024;15:1377947. doi: 10.3389/fpsyg.2024.1377947
38. Wetselaar P, Vermaire E (J. H), Lobbezoo F, Schuller AA. The prevalence of awake bruxism and sleep bruxism in the Dutch adult population. J Oral Rehabil 2019;46(7):617–23. doi: 10.1111/joor.12787
39. Xiao X, Huang D, Li G. The impact of fitness social media use on exercise behavior: the chained mediating role of intrinsic motivation and exercise intention. Front Psychol 2025;16: 1635912. doi:10.3389/fpsyg.2025.1635912
40. Zieliński G, Pająk A, Wójcicki M. Global Prevalence of Sleep Bruxism and Awake Bruxism in Pediatric and Adult Populations: A Systematic Review and Meta-Analysis. J Clin Med 2024;13(14):4259. doi:10.3390/jcm13144259