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Quality in Sport. 2026;52:69458. eISSN 2450-3118.

<https://doi.org/10.12775/QS.2026.52.69458>



Quality in Sport. eISSN 2450-3118.

Journal Home Page

<https://apcz.umk.pl/QS/index>

NOSOWICZ, Konstancja, RÓŻAK, Patrycja, DRAGUŁA, Michał, MUSIELIŃSKA, Marcelina, MALICKA, Patrycja and WÓJCIK, Joanna. The Impact of Sports Participation on Oral Health: A Comprehensive Review. Quality in Sport. 2026;52:69458. eISSN 2450-3118. <https://doi.org/10.12775/QS.2026.52.69458>

The journal has been awarded 20 points in the parametric evaluation by the Ministry of Higher Education and Science of Poland. This is according to the Annex to the announcement of the Minister of Higher Education and Science dated 05.01.2024, No. 32553. The journal has a Unique Identifier: 201398. Scientific disciplines assigned: Economics and Finance (Field of Social Sciences); Management and Quality Sciences (Field of Social Sciences).

Punkty Ministerialne z 2019 - aktualny rok 20 punktów. Załącznik do komunikatu Ministra Szkolnictwa Wyższego i Nauki z dnia 05.01.2024 Lp. 32553. Posiada Unikatowy Identyfikator Czasopisma: 201398. Przynależność dyscypliny naukowej: Ekonomia i finanse (Dziedzina nauk społecznych); Nauki o zarządzaniu i jakości (Dziedzina nauk społecznych). © The Authors 2026.

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The authors declare that there is no conflict of interest regarding the publication of this paper.
Received: 02.03.2026. Revised: 05.03.2026. Accepted: 05.05.2026. Published: 15.03.2026.

The Impact of Sports Participation on Oral Health: A Comprehensive Review

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Abstract

Purpose:

To critically analyze the bidirectional relationship between sports participation and oral health, evaluating the physiological, nutritional, and mechanical challenges that athletic activities impose on the stomatognathic system and their subsequent systemic impact on athletic performance.

Materials and Methods:

A comprehensive literature review was conducted by synthesizing data strictly from 25 peer-reviewed studies published between 2005 and 2026. The analysis was systematically structured around four primary domains: (1) the deleterious effects of sports nutrition on dental hard tissues; (2) the systemic impact of oral inflammation (particularly periodontal disease) on muscle recovery; (3) the prevalence of sports-related traumatic dental injuries (TDIs) and the prophylactic efficacy of various mouthguards; and (4) the incidence of biomechanical stress disorders, including bruxism and temporomandibular disorders (TMD), induced by physical exertion.

Results:

The aggregated data reveal a disproportionately high prevalence of oral diseases among athletes. Adherence to standard sports nutrition guidelines often directly conflicts with oral health maintenance, leading to a caries prevalence of up to 84% and dental erosion rates as high as 59%. Unmanaged periodontal inflammation significantly reduces training capacity and delays muscle recovery by generating systemic inflammation. While custom-made mouthguards are proven to prevent catastrophic TDIs without compromising respiratory parameters such as gas exchange or VO₂ max, compliance remains alarmingly low. Furthermore, high-intensity sports strongly correlate with awake bruxism and severe tooth wear, with observational data showing that over 60% of athletes in specific disciplines experience exertion-induced clenching.

Conclusions:

Athletic participation imposes severe and unique challenges on oral health, driven by a combination of erosive sports diets, dehydration, high-velocity mechanical trauma, and profound biomechanical stress. Because poor oral health demonstrably impairs athletic output, the integration of specialized sports dentistry into the standard medical care of athletes is urgently required. Implementing routine clinical screenings, individualized preventive protocols, and the mandatory provision of custom-made mouthguards is essential to safeguarding both the athlete's dentition and their competitive career.

Keywords:

sports dentistry; oral health; athletic performance; dental erosion; traumatic dental injuries; mouthguards; bruxism.

Introduction

Historically, the oral health of athletes has been a marginalized component of sports medicine, frequently overshadowed by cardiovascular, orthopedic, and psychological evaluations. However, recent consensus statements from international medical committees and comprehensive epidemiological screenings have catalyzed a paradigm shift, recognizing sports dentistry as a critical pillar of athlete welfare [6, 15]. The turning point in this discipline occurred during the London 2012 Olympic Games, where massive screening initiatives exposed an alarming prevalence of oral pathologies among the world's most elite competitors [12].

These findings shattered the assumption that elite physical conditioning inherently equates to excellent oral health.

The relationship between athletic participation and oral health is fundamentally bidirectional and multifactorial. First, the athletic lifestyle inherently exposes individuals to significant cariogenic and erosive risk factors. The continuous consumption of low-pH, carbohydrate-dense sports drinks and energy supplements, combined with exercise-induced hyposalivation (dry mouth), creates a hostile oral environment that accelerates enamel demineralization [1, 4, 11]. Secondly, participation in contact and high-intensity sports drastically increases the risk of traumatic orofacial injuries and biomechanical overloading of the masticatory system, leading to temporomandibular joint dysfunction and bruxism [7, 22, 24]. Conversely, poor oral health exerts a negative systemic influence on the athlete. Localized oral infections, such as gingivitis and periodontitis, initiate systemic inflammatory responses that can delay muscle recovery, induce chronic pain, and ultimately impair athletic performance [5, 15].

This review systematically examines the available evidence regarding the physiological, nutritional, and mechanical challenges that sports participation imposes on the stomatognathic system, utilizing standardized clinical indices and performance metrics documented in the current literature.

Materials and Methods

This comprehensive literature review was conducted by synthesizing data retrieved from major scientific databases, including PubMed, Scopus, and Web of Science. A total of 25 peer-reviewed articles, published between 2005 and 2026, were selected for the final analysis. The inclusion criteria focused on studies evaluating the bidirectional relationship between athletic participation and oral health. The selected literature was systematically categorized and analyzed across four primary domains: (1) the impact of sports nutrition on dental hard tissues; (2) the systemic effects of oral inflammation on athletic performance and recovery; (3) the prevalence of sports-related traumatic dental injuries (TDIs) and the efficacy of prophylactic mouthguards; and (4) the incidence of biomechanical stress disorders, including bruxism and temporomandibular disorders (TMD) induced by physical exertion.

Sports Diet, Enamel Demineralization, and Dental Caries

To sustain optimal energy levels during prolonged physical exertion, sports nutrition guidelines heavily advocate for the frequent intake of easily fermentable carbohydrates, energy gels, and isotonic solutions. However, as Broad and Rye (2015) explicitly state, these nutritional strategies are often in direct conflict with established dental health guidelines [11].

Sports drinks and isotonic fluids are formulated with high titratable acidity and low pH levels, which give them a potent erosive capacity on dental enamel [2, 4]. The mechanical habit of retaining or "swishing" these acidic fluids in the mouth before swallowing—a practice common among athletes attempting to alleviate oral dryness—prolongs acid clearance time and drastically exacerbates the demineralization process [4]. Nutritional habits are directly linked to these outcomes, acting as a primary catalyst for dental hard tissue degradation [3].

The epidemiological scope of these diet-induced pathologies is vast. Comprehensive reviews indicate that the prevalence of dental caries in athletic populations ranges from 20% to an astonishing 84%, while dental erosion affects between 42% and 59% of athletes [1, 16]. A highly specific cross-sectional study by Antunes et al. (2017) evaluated 108 amateur runners and found a 19.4% prevalence of dental erosion [21]. Statistical analysis in this cohort revealed that enamel erosion was significantly associated ($P < 0.05$) with the frequency of weekly training, the duration of competitions, and the co-occurrence of gastroesophageal reflux disease (GERD), which is frequently triggered by intense physical exertion [21]. Interestingly, in this specific amateur cohort, the isolated consumption of isotonic drinks was not the sole determinant of erosion, highlighting the multifactorial nature of the disease where dehydration, reduced salivary buffering capacity, and gastric acids act synergistically [21].

To counteract these nutritional side effects, dental professionals strongly recommend immediate water rinsing post-consumption of acidic sports products, strict avoidance of tooth brushing while the enamel is in an acid-softened state, and the rigorous application of topical fluorides (varnishes and toothpastes) to promote remineralization [4, 11].

Oral Inflammation and Systemic Impacts on Performance

The hypothesis that oral inflammation directly diminishes athletic performance is supported by robust clinical data. The landmark study by Needleman et al. (2013) evaluated 278 athletes at the London 2012 Olympic Games [12]. The clinical examinations revealed a staggering disease burden: 55% of the athletes presented with clinical dental caries (with 41% exhibiting irreversible lesions extending into the dentin), 76% suffered from gingivitis, and 15% were diagnosed with periodontitis [12]. Most critically, 18% of the athletes self-reported through standardized questionnaires that their poor oral health, and the accompanying psychosocial discomfort and pain, had a direct, quantifiable negative impact on their training routines and competitive performance [12].

These findings have been consistently validated across diverse sports disciplines using standardized epidemiological tools, such as the International Caries Detection and Assessment System (ICDAS), the Basic Erosive Wear Examination (BEWE), and the Basic Periodontal Examination (BPE) [13, 14].

The pathophysiological mechanism linking oral disease to decreased athletic performance is primarily rooted in systemic inflammation. A recent systematic review and meta-analysis by Ferreira et al. (2024) established that periodontal disease acts as a chronic reservoir for pro-inflammatory cytokines (such as interleukins and C-reactive protein) [5]. The dissemination of these inflammatory markers into the systemic circulation exacerbates oxidative stress, thereby delaying the regeneration of skeletal muscle fibers following exercise-induced microtrauma [5]. Furthermore, acute odontogenic pain leads to sleep disruption, increased psychological stress, and reduced cognitive focus, all of which are detrimental at the elite sporting level [15]. Consequently, researchers advocate for mandatory, pre-season comprehensive oral health screenings as an indispensable component of athlete medical evaluations [6].

Table 1: Key Epidemiological and Clinical Findings Regarding Oral Health in Athletes

Study Authors & Year	Study Population / Design	Primary Clinical and Statistical Findings
Needleman et al. (2013) [12]	278 Olympic Athletes (London 2012); Cross-sectional	55% caries prevalence; 76% gingivitis. 18% of athletes reported a direct negative impact on their sporting performance and training.

Study Authors & Year	Study Population / Design	Primary Clinical and Statistical Findings
Antunes et al. (2017) [21]	108 Amateur Runners; Cross-sectional	19.4% prevalence of dental erosion. Significant correlation found with training frequency, competition time, and gastroesophageal reflux (GERD).
Schulze & Busse (2024)[1]	Elite Athletes; Comprehensive Review	Global prevalence ranges established: Dental caries (20–84%), dental erosion (42–59%), and periodontal disease (15–41%).
Ribeiro et al. (2024) [25]	CrossFit® Practitioners; Observational	61.4% exhibited awake bruxism during exertion; 82.4% presented with linea alba (bite marks on buccal mucosa); high rates of abfractions.
Freiwald et al. (2021) [24]	Competitive Athletes; Literature Review	Temporomandibular dysfunction (TMD) prevalence varied drastically between 11.7% and 100%, highly dependent on the sport's nature.

Traumatic Dental Injuries (TDIs) and Mouthguard Efficacy

Orofacial trauma represents a severe occupational hazard in athletic environments, particularly within contact disciplines such as martial arts, rugby, basketball, and hockey [7, 22]. Young et al. (2015) categorize the most frequently encountered injuries as tooth crown fractures (involving enamel and dentin), tooth luxations, total avulsions (complete displacement of the tooth from its socket), and temporomandibular joint dislocations [22].

Effective management of these injuries requires immediate and precise intervention, such as the rapid replantation of an avulsed tooth within critical timeframes. However, a 2025 systematic review of case reports by Silva-Sousa et al. highlighted a persistent and dangerous lack of standardization in on-field emergency protocols [23]. The authors noted that sports medicine personnel frequently fail to adhere to the gold-standard guidelines established by the International Association of Dental Traumatology (IADT), resulting in poorer long-term prognoses for traumatized dentition [23].

Mouthguards are universally recognized as the primary prophylactic defense against TDIs. The literature classifies them into three distinct categories: stock (ready-made), boil-and-bite (mouth-formed), and custom-made sports mouthguards (CSMs), which are vacuum-formed or digitally milled by dental professionals [18, 25]. The European Association for Sports Dentistry (EA4SD) position statement emphatically recommends CSMs, citing their unparalleled adaptability, optimal energy-absorption capabilities, and superior retention, which negate the need for the athlete to consciously clench their jaw to hold the device in place [17].

A persistent barrier to mouthguard compliance has been the athletes' subjective perception that these devices impair respiratory function and athletic output. However, a rigorous systematic review by Ferreira et al. (2019) conclusively dismantled this myth [8]. Analyzing physiological data, the review proved that properly fitted CSMs do not induce negative alterations in ventilatory flows, gas exchange, or maximal oxygen uptake (VO₂ max) during incremental exercise [8]. Furthermore, cutting-edge advancements have introduced "instrumented mouthguards" embedded with micro-sensors [9]. As validated by Liu et al. (2020), these advanced devices not only protect the dentition but precisely measure head impact kinematics and assess brain deformation, serving as vital diagnostic tools in concussion management protocols [9].

Biomechanical Overload: Bruxism and Temporomandibular Disorders

Beyond acute trauma and chemical erosion, athletes are subjected to immense biomechanical and psychological stress. The intense competitive environment, combined with the extreme muscular exertion required in heavy athletics, triggers parafunctional habits, notably bruxism and temporomandibular disorders (TMD) [24]. Systematic meta-analyses confirm that the prevalence of bruxism is statistically significantly higher in athletic populations compared to non-athletic control groups [19].

This phenomenon is exceptionally pronounced in strength and conditioning sports. An observational study by Ribeiro et al. (2024) focusing on CrossFit® practitioners documented that 61.4% of the participants engaged in "awake bruxism"—the involuntary, forceful clenching of teeth during heavy lifting and maximal physical effort [25]. The clinical intraoral manifestations of this stress were severe: 82.4% of the cohort exhibited *linea alba* (calloused

bite lines on the inner cheeks), alongside widespread non-carious cervical lesions (abfractions) and severe mechanical attrition of the enamel [25].

Similarly, an exhaustive literature review by Freiwald et al. (2021) investigating the correlation between competitive sports and TMD found prevalence rates ranging from 11.7% up to 100% in specific high-stress sporting cohorts [24]. The repetitive micro-trauma to the temporomandibular joint complex, exacerbated by psychological competition anxiety, leads to myofascial pain, joint clicking, and restricted mouth opening [20, 24]. To mitigate these biomechanical destructive forces, the literature strongly advises the fabrication of specialized occlusal splints or custom mouthguards, which serve to evenly distribute occlusal loading and protect the periodontium during intense physical exertion [17, 25]. Gender-based analyses also indicate slight variations in the manifestation of these stress-induced oral conditions, suggesting a need for highly individualized diagnostic approaches [10].

Table 2: Evidence-Based Comparison of Mouthguard Classifications [8, 17]

Mouthguard Category	Fabrication Method	Fit & Retention Characteristics	Impact on Athletic Performance & Physiology
Stock (Ready-Made)	Mass-produced in standard sizes; purchased over-the-counter.	Extremely poor. Requires constant occlusal pressure (biting down) to remain in the mouth.	High interference. Significantly impairs speech, causes discomfort, and restricts oral airflow.
Boil-and-Bite	Thermoplastic material softened in boiling water and molded by the athlete's bite.	Moderate. Often results in uneven thickness, particularly thinning over critical protective areas (incisors).	Variable. Can be excessively bulky, causing moderate interference with deep ventilation.

Mouthguard Category	Fabrication Method	Fit & Retention Characteristics	Impact on Athletic Performance & Physiology
Custom-Made (CSM)	Fabricated in a dental laboratory using precise analog impressions or digital intraoral scans.	Excellent. Relies on anatomical friction fit; remains securely in place without conscious effort.	Minimal to none. Scientifically proven to have zero negative impact on gas exchange or VO ₂ max.

Discussion

The aggregated literature reveals a persistent paradox within sports medicine: despite possessing elite cardiovascular and muscular conditioning, athletes consistently demonstrate a severely compromised oral health profile [1, 12, 16]. This review highlights that the etiology of this phenomenon is highly complex, rooted in a collision of intensive sports nutrition, physiological stress, and a historical lack of integrated dental care within athletic medical teams.

A primary theme across the analyzed studies is the inherent conflict between contemporary sports nutrition guidelines and dental health maintenance [11]. Dietitians frequently prescribe a continuous intake of highly acidic, carbohydrate-dense isotonic solutions to maintain glycogen stores and hydration. However, as demonstrated by Antunes et al. (2017) and Coombes (2005), these practices, particularly when coupled with exercise-induced hyposalivation, create an aggressively erosive oral environment [4, 21]. The challenge for modern sports dentistry is not to prohibit these essential nutritional aids, but to implement pragmatic harm-reduction strategies. Evidence suggests that simple interventions, such as immediate water rinsing post-consumption and the prophylactic application of fluoride varnishes, can significantly mitigate enamel demineralization without compromising the athlete's energy requirements [11].

Furthermore, the systemic implications of poor oral health can no longer be ignored by sports medicine physicians. The robust correlation between periodontal disease and elevated systemic inflammation directly threatens an athlete's recovery capacity and peak performance [5]. The data from the London 2012 Olympics, where 18% of elite competitors reported that oral pain and discomfort negatively impacted their training, underscores the urgent need for a paradigm shift [12]. Treating oral health as a separate, non-essential entity from overall physical conditioning is a clinical oversight that leaves athletes vulnerable to preventable performance decrements [15].

In the realm of traumatology, the literature points to a significant gap between evidence-based guidelines and on-field practices. While custom-made sports mouthguards (CSMs) are definitively proven to offer superior protection

against traumatic dental injuries (TDIs) without inhibiting ventilatory parameters or VO₂ max [8, 17], athlete compliance remains remarkably low. This resistance is largely driven by outdated perceptions and negative experiences with poorly fitting, over-the-counter "boil-and-bite" models. The emergence of instrumented mouthguards, capable of measuring head impact kinematics for concussion protocols, presents a unique opportunity [9]. By integrating neurological monitoring with dental protection, sports organizations may simultaneously improve mouthguard compliance and athlete safety.

To address these multifaceted challenges, the literature strongly advocates for a multidisciplinary approach [6]. The current fragmentation of care—where dental trauma is poorly managed on the field due to a lack of standardization [23]—must be resolved through better education. Integrating specialized sports dentists into the primary medical staff, mandating pre-season oral health screenings alongside standard cardiac and orthopedic evaluations, and fabricating CSMs as mandatory athletic equipment are critical steps forward [6, 17]. Future research should focus on longitudinal interventions that measure the direct impact of these integrated oral health protocols on long-term athletic performance and injury reduction.

Directions for Future Research

While the current body of literature robustly establishes the prevalence of oral pathologies among athletes, several critical gaps remain that must be addressed by future investigations. Much of the existing data, particularly regarding dental erosion and caries, is derived from cross-sectional and observational studies [12, 21]. Future research must prioritize prospective, longitudinal cohort studies to establish definitive causal relationships between prolonged sports nutrition habits, exercise-induced hyposalivation, and the degradation of dental hard tissues over an athlete's entire career.

Secondly, there is a distinct need for interventional randomized controlled trials (RCTs) concerning oral inflammation. While systematic reviews and meta-analyses have established that periodontal disease exacerbates systemic inflammation and impairs muscle recovery [5], future clinical trials should quantify the direct effects of periodontal treatment on measurable athletic performance metrics. Research should focus on tracking changes in ventilatory thresholds, VO₂ max, and specific pro-inflammatory biomarkers (e.g., C-reactive protein) before and after comprehensive periodontal therapy.

In the realm of sports traumatology, the emergence of instrumented mouthguards presents a highly promising avenue for future technological research [9]. Subsequent studies should expand the application of these micro-sensor-embedded devices beyond American football into a wider variety of contact sports (such as rugby and martial arts). Research should aim to correlate real-time head impact kinematics and brain deformation data with both the incidence of traumatic dental injuries (TDIs) and concussion protocols. Furthermore, rigorous research is required to evaluate the effectiveness of standardized, globally integrated on-field emergency protocols to eliminate the current heterogeneity in TDI management [23].

Finally, future investigations must incorporate sport-specific and gender-specific variables into their methodologies. As recent analyses suggest, the manifestation of biomechanical stress, temporomandibular disorders (TMD), and bruxism may differ significantly between male and female athletes, as well as between endurance runners and high-intensity strength athletes [10, 24, 25]. Developing highly targeted, discipline-specific oral health risk profiles will be essential for creating individualized, evidence-based preventive protocols in sports dentistry.

Conclusions

Based on the extensive synthesis of the current literature, it is unequivocally clear that athletic participation imposes severe and unique challenges on oral health. The paradoxical "unhealthy elite athlete" phenomenon is driven by a combination of erosive sports diets, dehydration, high-velocity mechanical trauma, and profound biomechanical stress. The data demonstrate that sports drinks and carbohydrate loading lead to massive rates of enamel erosion and caries, while untreated periodontal disease generates systemic inflammation that demonstrably impairs muscle recovery and athletic output. Despite the proven efficacy of custom-made mouthguards in preventing catastrophic dental injuries without hindering respiratory performance, adherence to protective protocols remains alarmingly low.

To bridge the gap between athletic excellence and oral health, sports dentistry must be fully integrated into the multidisciplinary teams managing athletes. Standardized pre-season oral health screenings, aggressive preventive education regarding the timing of sports nutrition consumption, and the mandatory provision of custom-made mouthguards are evidence-based imperatives. Only through such comprehensive strategies can the medical community safeguard the longevity of both the athlete's dentition and their competitive career.

Disclosure

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All authors have read and agreed with the published version of the manuscript.

Funding Statement:

Not applicable.

Institutional Review Board Statement:

Not applicable.

Informed Consent Statement:

Not applicable.

Data Availability Statement:

The authors confirm that the data supporting this study are available in the article's references.

Conflict of Interest:

Authors declare no conflict of interest.

Declaration on the use of AI:

In preparing this work, the authors used Gemini for the purpose of improving language and readability, text formatting, and verification of bibliographic styles. After using this tool/service, the authors have reviewed and edited the content as needed and accept full responsibility for the substantive content of the publication.

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