**QUALITY IN SPORT**
*eISSN 2450-3118 · Open Access · Peer-reviewed*
apcz.umk.pl/QS Nicolaus Copernicus University in Toruń

**PAWLAK, Stanisław, SIATKOWSKA, Karolina, and MOROZ, Agata. Oral Health and Sports Performance: An Interdisciplinary Perspective. Quality in Sport. 2026;76:75357. https://doi.org/10.12775/QS.2026.76.75357**

**ARTICLE TIMELINE**
**Received: 17.08.2026. Revised: 30.08.2026. Accepted: 12.09.2026. Published: 23.09.2026.**

The journal has been awarded 20 points in the parametric evaluation by the Polish Ministry of Higher Education and Science (Annex to the announcement of 05.01.2024, No. 32553). Unique Journal 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. Przypisane dyscypliny naukowe: Ekonomia i finanse (Dziedzina nauk społecznych); Nauki o zarządzaniu i jakości (Dziedzina nauk społecznych). 

# Oral Health and Sports Performance: An Interdisciplinary Perspective

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**Abstract**

**Background.** While oral health's link to systemic homeostasis is well-documented, its impact on objective athletic performance is a newer, developing research area. Despite growing awareness, athletes' oral health remains frequently marginalized in routine diagnostics.

**Aim.** This review assesses associations between compromised oral health (particularly chronic periodontitis and advanced caries) and objective athletic performance parameters (e.g., VO2max, generated power), discussing the underlying biological mechanisms.

**Material and methods.** A narrative review of recent literature (up to February 2026) was conducted, incorporating epidemiological, clinical, and cohort studies, systematic reviews, and RCTs in dentistry and sports medicine.

**Results.** Evidence highlights a high prevalence of oral diseases (periodontitis, enamel erosion, caries) in athletes. Clinical tests show an inverse relationship between periodontitis indicators and both VO2max and power generation. Proposed mechanisms include chronic systemic inflammation, endotoxemia, impaired nutrition, oral microbiome dysbiosis affecting the nitric oxide (NO) pathway, psychological burden, and sensomotor disorders. Disrupting the oral microbiome impairs post-exercise vascular responses. However, current sports-specific literature is limited by a dominance of cross-sectional studies.

**Conclusions.** Oral health is a crucial, yet overlooked factor in optimal physical performance. Integrating dental protocols (e.g., USPDES) into routine sports medicine screening is justified. Future research requires multicenter longitudinal designs using validated physiological indicators to establish causality, supported by evidence of periodontal therapy's cardiovascular benefits.

**Keywords:** sports performance, oral health, periodontitis, VO2max, sports medicine, sports dentistry, systemic inflammation, nitric oxide

## 1. Introduction

The development of modern sports medicine and the pursuit of maximizing achievements at the highest competitive level determine the necessity of a holistic approach to the athlete's health. While care for the musculoskeletal system, cardiorespiratory system, and dietary optimization constitutes an established standard, the oral cavity and its potential impact on the systemic capacity to undertake extreme physical exertion remains a relatively rarely explored research niche. Recent scientific reports demonstrate consistent associations between poor oral health—including chronic periodontitis, advanced caries, or malocclusions—and objectively measured performance parameters, such as maximum oxygen uptake (VO2max), peak power, speed, agility, as well as a subjective decline in training adaptation capacity reported by the athletes themselves [1]. This phenomenon prompts a redefinition of the oral cavity: from an isolated anatomical area to an integral element of the organism that may project onto homeostasis and the adaptive response of the body subjected to oxidative and mechanical stress.

Both in the population of elite athletes and among recreational sports participants, oral pathologies show a notable prevalence, which often contrasts with the general, above-average health status of this target group. The concept of sports performance itself shows strong diversification depending on the specificity of the discipline practiced. In endurance sports, a key determinant of success is the optimization of the oxygen uptake (VO2max) and exercise economy, while in explosive sports, the priority is strength, speed parameters, and the ability to recruit motor units and generate maximum power. The mechanisms through which local inflammatory conditions within the periodontium (periodontitis) may affect these fundamental physiological aspects are beginning to emerge as a gap in the preventive procedures of modern sports teams. Despite emerging clinical correlations, a significant portion of current sports-specific publications relies on a cross-sectional study methodology, which poses a challenge in establishing definitive causality. This requires a thorough synthesis of current data to identify areas requiring further, in-depth research intervention, particularly drawing upon novel interventional data regarding endothelial function and the oral microbiome.

**Research Objective.** The main objective of this study is a comprehensive summary and critical analysis of current scientific evidence (covering the state of knowledge up to February 2026) regarding the impact of oral diseases on objective sports performance parameters and the

evaluation of potential biological, immunological, and physiological mechanisms mediating this relationship.

**Research Problems.** The following research problems were formulated: 1) What is the prevalence of oral diseases (including caries and periodontal diseases) in the group of elite athletes against the background of general health standards? 2) How do measurable indicators of periodontal inflammation and dental pathologies associate with the results of performance tests assessing VO2max and anaerobic power? 3) What pathomechanisms are proposed for the functioning of the so-called oral-systemic axis under conditions of chronic exercise loads typical for competitive sports?

**Research Hypotheses.** Two main research hypotheses were formulated for the purpose of this review. Hypothesis 1 (H1): There is a statistically significant, negative relationship between the severity of oral pathologies (measured, inter alia, by the PSI index $\geq 3$) and objective parameters of aerobic (VO2max) and anaerobic (relative power) capacity in athletes. Hypothesis 2 (H2): A key endogenous mediator of reduced sports performance in the presence of oral diseases is odontogenic, chronic low-grade systemic inflammation and subsequent endothelial dysfunction.

## 2. Research materials and methods

### 2.1. Participants

The target population analyzed in the review includes highly trained elite athletes representing diverse disciplines (both endurance and strength-speed), as well as control populations (including groups of younger adults who are not competitive athletes). The subject of the evaluation was the results of studies correlating periodontal status and caries indices with the results of objective exercise trials and physiological tests.

### 2.2. Procedure / Test protocol / Measure

To achieve the objectives of the study, a structured narrative literature review method was applied. A search was conducted in leading biomedical databases (including PubMed, Scopus, Web of Science Core Collection), covering the time frame from 2013 to February 2026. The selection of keywords included terms: "sports dentistry", "athletic performance", "periodontitis", "VO2max", "systemic inflammation in athletes", "oral microbiome", and "nitric oxide". The final analysis included original clinical trials (including exploratory ones), multicenter population studies (such as the Study of Health in Pomerania, SHIP, and the National Health and Nutrition Examination Survey, NHANES), consensus documents of

international sports dentistry societies (e.g., EA4SD, ASD), systematic reviews, and meta-analyses of randomized controlled trials (RCTs). The focus was on reports verifying measurable performance parameters (e.g., peak oxygen uptake, time to exhaustion, generated power on an ergometer) and cardiovascular metrics (e.g., blood pressure, endothelial function) in comparison with standard dental indices (PSI, PBI, probing pocket depth, endodontic treatment need indices).

### 2.3. Data collection and analysis

The collected literature data were subjected to a critical synthesis. In the analytical process, importance was attached to the assessment of the methodological rigor of individual reports, distinguishing the strength of evidence derived from single cross-sectional studies from those with a broader, population-based character or interventional design. The extracted data were classified into three overarching thematic categories: 1) epidemiology and prevalence, 2) physiology and performance tests, 3) pathogenesis and mechanistic pathways. Arguments and reports questioning or showing no statistical correlation were also compiled to maintain objectivity in the scientific discourse.

#### 2.3.1. Statistical Software

Because this study was designed as a narrative literature review rather than a quantitative meta-analysis, no statistical software (such as SPSS, R, or STATA) was utilized. The research did not involve analyzing raw numerical data or conducting primary mathematical hypothesis testing. Instead, the extraction, categorization, and synthesis of data from the included articles were performed using a qualitative approach. The analysis focused on comparing clinical findings, identifying common themes, and describing biological mechanisms across different independent studies. Additionally, standard reference management software was used to systematically organize the collected literature and format the citations.

#### 2.3.2. AI

Artificial intelligence (AI) tools were utilized for two specific, clearly delimited purposes in this study. First, AI-assisted text analysis was applied to the extracted literature to support the identification of recurring thematic patterns and to help organize the reviewed evidence into coherent conceptual categories (e.g., etiology, pathophysiology, epidemiology, diagnostics, and prevention). Second, AI was used to refine the academic English of the manuscript, ensuring clarity, terminological consistency, and adherence to scientific writing standards.

It is important to emphasize that all AI tools were used strictly as assistive instruments under continuous human supervision. The selection of sources, critical appraisal of the included studies, interpretation of results, and formulation of all conclusions were performed exclusively by the human authors, who are responsible for the scientific content of this review. The AI tools served primarily to enhance efficiency in literature organization, thematic synthesis, and linguistic refinement, and did not replace expert human judgment at any stage of the analytical or interpretive process. The authors have reviewed, verified, and approved all content in its final form and take full responsibility for the integrity and accuracy of the work.

## 3. Research results

### 3.1. Epidemiology of oral diseases in athletes

The foundation for the discussion on the oral health status of competitive athletes was established by a systematic review conducted by Ashley et al. [2]. This analysis indicated a suboptimal standard of hygiene and dental health among elite athletes at the international level. The authors demonstrated that the prevalence of active caries fluctuated in this group from 15% to 75%, while enamel erosion, linked to diet and hydration during exercise, affected from 36% to 85% of the subjects. Furthermore, early and advanced stages of periodontal diseases were diagnosed in approximately 15% of athletes.

Recent publications from 2025 and 2026 further support this trend, providing quantitative updates that suggest the issue persists alongside the intensity of sports commercialization and the standardization of carbohydrate supplementation. A comprehensive systematic review and meta-analysis by Mulla et al. [3], which incorporated data from 34 studies, confirmed these patterns on a global scale. The meta-analysis estimated the global prevalence of dental caries among elite and Paralympic athletes at 44%, periodontitis at 47%, enamel erosion at 30%, and dental trauma at 15%. These figures align closely with a cross-sectional study conducted by Júdice et al. [4] on a diverse cohort of 114 elite athletes, which documented that over 50% of them presented with at least two overlapping oral pathologies. An interesting aspect of this research was that the high prevalence of these conditions did not correlate with an objectively measured reduction in oral health-related quality of life (OHRQoL indicators). This suggests a deficit in athletes' self-awareness; athletes exhibit a limited perception of dental issues and may underestimate symptoms until an acute pain incident occurs.

The reports by Maraş et al. [5] provide further data on the risk profile in athletes. It was shown that young athletes, in direct comparison to their non-training peers (control group), exhibited a higher need for endodontic treatment, higher rates of caries activity, and a more frequent occurrence of inflammation in periodontal tissues. The specific demands of endurance training also contribute heavily to these risks. Frese et al. [6] demonstrated in a controlled study that endurance athletes exhibit a significantly higher risk of dental erosion and caries compared to matched controls. This elevated risk correlated positively with the weekly training volume and was mechanistically linked to a notable post-exercise decrease in salivary flow, which reduces the oral cavity's natural buffering capacity. This indicates that hypercaloric diets, high PRAL (Potential Renal Acid Load) indices, and exercise-induced hyposalivation collectively compromise the oral environment.

### 3.2. Clinical evidence on the relationship with objective performance parameters (VO2max, power)

Shifting the analysis to the plane of exercise physiology, the evidence base reveals measurable correlations. According to the systematic review developed by Bramantoro et al. [7], 10 out of 11 clinical studies analyzed at that time supported the existence of a direct relationship between oral health and structured physical fitness parameters, such as cardiorespiratory fitness, motor skills, agility, as well as static and dynamic balance tests.

Research verifying this relationship using objective ergospirometric measurements, utilizing the physiological indicator VO2max (maximum oxygen uptake), represents valuable scientific insight. An exploratory clinical study conducted by Merle et al. [8] on a selected group of young elite athletes provided important observations. The applied methodology showed that athletes with clinical signs of periodontitis, classified based on the Periodontal Screening Index (PSI $\geq$ 3), were characterized by a lower oxygen uptake compared to the group with healthy periodontium (mean VO2max values: 55.9 vs. 59.3 mL/min/kg; $p = 0.03$). This result signifies a loss of approximately 5-6% of aerobic potential. Moreover, this study indicated that a lower Papillary Bleeding Index (PBI) showed a positive correlation with a higher maximum relative power generated during tests on a cycle ergometer.

The hypothesis regarding the negative impact of periodontal pathologies on aerobic capacity is supported by data from population-based studies. Two extensive studies from the SHIP (Study of Health in Pomerania) cycle, analyzed by Holtfreter et al. [9], provided reliable

epidemiological data. It was established that the mean probing pocket depth (PPD) demonstrates a consistent, inversely proportional correlation with the peak oxygen uptake (peakVO2) and total exercise time during standardized exercise trials. This was considered evidence supporting the biological plausibility of the investigated mechanism.

In order to present a balanced state of knowledge, it is also necessary to discuss evidence that does not align with these findings. An extensive study by Thai et al. [10], based on the analysis of data from the American NHANES registry (covering a cohort of younger adults between 1999 and 2004), failed to demonstrate a statistically significant association between periodontal infections and cardiorespiratory fitness. However, in this study, fitness was assessed based on estimation and declared training level, rather than direct gasometric measurements. These discrepancies likely stem from substantial methodological differences, the heterogeneity of the studied population (non-competitive individuals vs. sports elite), and different diagnostic definitions. They serve as a necessary counterpoint, indicating that the described correlation is a multifactorial system.

### 3.3. Biological mechanisms connecting the oral cavity and the musculoskeletal system in the context of sports performance

Integrated theoretical models, structured in recent scientific reviews [1, 11], categorize the mechanisms of the impact of oral diseases on exercise capacity into several distinct neurophysiological, immunological, and biochemical pathways. They are examined across five main axes (the oral-systemic axis paradigm):

- **Systemic Inflammation and Endothelial Dysfunction:** Recognized as a primary proposed pathomechanism. Chronic periodontal disease involves ulceration of the gingival pocket epithelium, which creates a portal for the translocation of pathogenic bacteria, their antigens, and lipopolysaccharides (LPS) into the systemic bloodstream. This condition induces a generalized immune response in the form of a cytokine cascade, resulting in elevated levels of circulating inflammatory biomarkers, such as C-reactive protein (CRP), interleukin-6 (IL-6), and tumor necrosis factor (TNF-alpha). As elucidated by Higashi and Taguchi [12], periodontal disease-induced inflammation and oxidative stress lead directly to vascular endothelial dysfunction by impairing local nitric oxide production. Similarly, the scientific statement of the American Heart Association [13] outlines how this systemic inflammation causes progressive

endothelial impairment and reduces vasodilation. In the context of sports physiology, endothelial dysfunction limits the efficiency of delivering oxygen and energy substrates to working skeletal muscles, affecting aerobic capacity and VO2max. Furthermore, existing evidence indicates a correlation between odontogenic inflammation and higher release of the creatine kinase enzyme in competitive soccer players [14], suggesting delayed regeneration of micro-injuries.

- **The Nitrate-Nitrite-Nitric Oxide (NO) Pathway:** A highly notable mechanism under current investigation linking the oral microbiome directly to exercise tolerance. A significant portion of nitric oxide—a gas essential for blood pressure regulation, vasodilation, and muscle work economy—is produced through the enterosalivary circuit. As detailed by Jones et al. [15], dietary nitrates are reduced to nitrites specifically by commensal symbiotic bacteria residing in the oral cavity before being converted to NO in the circulation and skeletal muscle. Athletes, due to forced mouth breathing dictated by high ventilation volumes, may undergo drying of the mucous membranes and a reduction in saliva secretion. Such changes generate an oral dysbiosis that can inhibit this crucial NO production pathway. Bryan et al. [16] emphasize that oral dysbiosis, whether caused by active dental disease or the excessive use of antiseptic mouthwashes, suppresses NO bioavailability. Crucially, experimental evidence provided by Cutler et al. [17] in a randomized, double-blind crossover study demonstrated that the use of antibacterial mouthwashes abolished post-exercise hypotension and impaired skeletal muscle oxygenation by disrupting the nitrate-reducing activity of oral bacteria. This provides strong causal evidence that a healthy oral microbiome is necessary for optimal vascular responses during and after exercise.

- **Nutrition, Mastication, and Metabolic Conditioning:** The biomechanical aspect. Chronic toothache, extensive tooth loss, or untreated deep caries impair the mastication (chewing) process. Inadequately ground food reduces the absorption area in the gastrointestinal tract, which can result in impaired assimilation of micro- and macronutrients. In the regimen of competitive sports, a reduced supply of carbohydrates and proteins can lead to a slowed rate of muscle and liver glycogen resynthesis and delayed rebuilding of muscle fibers, potentially contributing to overtraining and a decrease in power parameters over a training microcycle [1, 5].

- **Psychological Load and Sleep Deficit:** Pain ailments of dental origin absorb the athlete's nervous system. Toothache can lead to elevated cortisol levels and disrupt sleep architecture (particularly the NREM phases associated with tissue regeneration). Sleep impairment is a known factor in the decline of cognitive and physical abilities.

- **Impaired Sensomotor and Postural Control:** The receptors of the stomatognathic system are connected to the trigeminal nerve and brainstem nuclei responsible for posture control. Malocclusions, temporomandibular joint asymmetries, and tooth missing forcing asymmetrical chewing, may project onto the tension of the myofascial lines of the neck. This can cause disturbances in body posture statics, reduce neuromuscular coordination, affect balance [7], and distract the athlete while executing complex movement patterns.

## 4. Discussion

The juxtaposition of the research results analyzed in this paper highlights a gap in traditional training and medical care systems for athletes. Scientific evidence gathered over the last decade has prompted international scientific societies to formulate clinical recommendations. A step in this direction is the validation of the role of a specialized sports dentist in the staffs of first teams [18]. In the consensus document developed jointly by the European Association for Sports Dentistry (EA4SD), the Academy for Sports Dentistry (ASD), and the European College of Sports and Exercise Physicians (ECOSEP) [14], it was recommended to integrate dental diagnosis into the framework of examinations allowing for participation in competitive sports.

The mechanism for implementing this knowledge into practice involves the introduction of standardized diagnostic tools. An example is the USPDES (Universal Protocol for Dental Examination in Sports), which provides a framework for conducting routine baseline screening during the pre-season period [19]. These procedures involve the assessment of malocclusions and temporomandibular joint overloads, an examination of periodontal indices (CPITN/PSI), mapping of carious lesions, and a dietary interview. Focus is placed on analyzing the frequency and volume of consumed carbohydrate supplements (energy gels, hypertonic sports drinks), which, accompanied by exercise-induced dehydration and a drop in the buffering pH of saliva, significantly contribute to the erosion of tooth enamel as observed in endurance athletes.

Despite the consistency of much of the cited evidence regarding the occurrence of a correlation between oral pathologies and a reduction in physiological adaptive capabilities, a significant limitation of contemporary sports-specific literature remains the deficit of high-quality longitudinal studies [2]. A secondary evaluation of publication quality shows that the vast majority of available works in sports dentistry are cross-sectional and observational in nature. Such a research model limits the ability to formulate definitive conclusions about the existence of a cause-and-effect relationship [1].

However, interventional evidence from the broader field of periodontology offers a compelling proof of concept that addresses this limitation. A recent systematic review and meta-analysis of randomized controlled trials by Gandhi et al. [20] demonstrated that periodontal therapy significantly reduces systolic blood pressure (-4.64 mmHg), diastolic blood pressure (-1.84 mmHg), and systemic CRP levels (-0.58 mg/L). This robust quantitative data is supported by both classic and recent interventional studies, including work by Tonetti et al. [21] and Lyu et al. [22], which confirm that the treatment of periodontitis effectively reverses endothelial dysfunction and restores vascular health. Furthermore, comprehensive reviews by Orlandi et al. [23] indicate that treating periodontitis positively impacts broader systemic health markers and quality of life. These interventional findings strongly suggest that the eradication of oral inflammatory foci could translate into tangible cardiovascular and performance benefits for athletes. Therefore, there is a clear mandate for future randomized controlled trials (RCTs) within the athletic population to assess the dynamics of changes in parameters such as VO2max or the lactate threshold (LT) before and after the implementation of comprehensive periodontal treatment.

## 5. Conclusions

Based on the collected and analyzed literature evidence, the following conclusions are drawn:

- The oral health status is closely associated with the human body's systemic capacity to adapt to physical loads. Neglect in this area, manifesting as advanced carious disease and periodontitis, statistically correlates with a decrease in objective performance measures (VO2max, maximum relative power).

- Low-grade systemic inflammation, having a potential etiology in odontogenic infections, constitutes a primary proposed pathomechanistic pathway. Induced endotoxemia impairs endothelial function, reducing optimal blood perfusion in muscle tissue and potentially exacerbating catabolic phenomena after exercise. Furthermore, oral dysbiosis directly impairs the nitrate-reducing pathway, negating post-exercise vascular responses.

- Guidelines from international scientific societies recommend that dental examinations based on universal protocols (e.g., USPDES) be integrated into sports screening, alongside cardiovascular and orthopedic assessments.

- A research gap is identified: while cross-sectional data predominate in sports medicine, interventional evidence from general periodontology shows that treating oral disease improves endothelial function. There is an urgent need to conduct multicenter, prospective longitudinal studies involving elite athletes to more accurately determine and quantify the performance benefit derived from the resolution of inflammatory foci in the oral cavity.

**Disclosure**

The authors report no additional information affecting the reliability of the conducted research and the drawn conclusions.

**Supplementary Materials**

The work does not contain supplementary materials.

**Author Contributions**

Conceptualization: SP, KS, AM

Methodology: SP

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Check: KS, AM

Formal analysis: SP

Investigation: AM

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Data curation: SP

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Writing - review and editing: AM

Visualization: SP, KS

Supervision: AM

Project administration: SP

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

**Funding**

The conducted research analyses and the preparation of this article received no external funding or grant support.

**Institutional Review Board Statement**

Not applicable, as the submitted article is a review paper (literature review).

**Informed Consent Statement**

Not applicable.

**Data Availability Statement**

The source data utilized are derived from official, peer-reviewed, published, and publicly accessible scientific literature databases.

**Acknowledgements**

The authors wish to express their gratitude to the research teams and international societies co-creating the consensus and guidelines (in particular EA4SD) for providing the substantive framework necessary for the development of sports dentistry.

**Conflicts of Interest**

All authors declare no conflicts of interest (financial, professional, or personal) that could influence the objectivity of the presented content.

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