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Dental Erosion in Athletes and the Impact of Sports and Energy Drinks

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Abstract

Background. Erosive tooth wear (ETW) in athletes is a significant clinical challenge. High consumption of low-pH sports and energy drinks, combined with exercise-induced drops in salivary flow and buffering capacity, strongly promotes dental demineralization. Paradoxically, despite high physical fitness, athletes often exhibit poor oral health.

Aim. To evaluate the etiology, pathophysiology, and epidemiology of ETW in athletes, focusing on the erosive potential of sports and energy drinks. Additionally, to systematize knowledge on differential diagnosis and current preventive standards.

Material and methods. A narrative review of 36 peer-reviewed sources (in vitro studies, cross-sectional analyses, meta-analyses, and expert consensus) was conducted. Data on salivary parameters, beverage chemistry, epidemiology, and preventive protocols were synthesized.

Results. ETW prevalence among athletes is high, ranging from 30% to 85% in specific cohorts. Intense exertion significantly reduces salivary flow and buffering capacity, leaving teeth defenseless against dietary acids. Preventive strategies using high-concentration fluorides, CPP-ACP, and biomimetic hydroxyapatite effectively mitigate mineral loss.

Conclusions. ETW in athletes requires an interdisciplinary approach. Routine dental screenings (e.g., using the BEWE index) and nutritional education are essential to minimize damage from acidic beverages during exercise-induced salivary impairment.

Keywords: dental erosion, sports drinks, energy drinks, sports dentistry, sports medicine, salivary flow

1. Introduction

The phenomenon of dental erosion among individuals engaged in sports, both at amateur and elite levels, constitutes a growing and multifaceted clinical problem that has garnered increasing attention in dental and sports medicine literature. Contemporary sports involve significant physiological and dietary demands that can lead to a drastic deterioration of oral health in individuals who are otherwise considered paradigms of physical fitness. According to the definitions provided by the American Dental Association (ADA), dental erosion is characterized as the bacteria-free, irreversible loss of dental hard tissues (enamel and dentin) resulting from prolonged or repeated exposure to acids not derived from the metabolism of oral plaque bacteria [1].

The pathomechanism of this condition is based on the direct, chemical dissolution of hydroxyapatite crystals, which severely disrupts the natural equilibrium between remineralization and demineralization processes. A key concept here is the critical pH of the oral environment, which is approximately 5.5 for enamel and 6.0 for dentin, due to the latter's greater porosity and lower degree of mineralization [1]. A drop in intraoral pH below these thresholds triggers an immediate efflux of calcium and phosphate ions from the tissues into the saliva, resulting in progressive surface softening and paving the way for subsequent mechanical damage (abrasion) [1].

The etiology of dental erosion is highly multifactorial, encompassing biological, chemical, and behavioral variables [1]. Extrinsic acids, derived directly from the diet, particularly from widely consumed sports and energy drinks, play a predominant role. Intrinsic acids, resulting from exercise-induced gastroesophageal reflux, constitute another critical pathogenic element [23, 26]. The exponential increase in the consumption of commercial hydrating and stimulating beverages has created a bridge between the modern athlete's diet and a drastic rise in oral pathology rates, making this topic highly relevant.

Research Objective

The main objective of this article is to conduct a comprehensive narrative review of the literature regarding dental erosion in athletes, strictly focusing on the etiological factors posed by sports and energy drinks. Specific objectives include systematizing knowledge on post-exercise pathomechanisms (changes in salivary gland function), epidemiology, differential diagnosis, and the efficacy of modern preventive and therapeutic protocols.

Research Problems

1. What physiological processes occurring in an athlete's body during training alter saliva properties in a way that predisposes tissues to demineralization?
2. What is the objective scale of the phenomenon (prevalence of erosion) among elite and amateur athletes based on current meta-analyses?
3. How can clinicians effectively differentiate erosion of dietary origin (acidic beverages) from intrinsic erosion (GERD, LPR)?
4. Which contemporary material solutions (fluoride compounds, biomimetic hydroxyapatite, CPP-ACP) represent the optimal pathway for the prevention and treatment of erosive tooth wear (ETW) in active patients?

Research Hypotheses

Given the narrative review nature of this paper, the primary focus replaces traditional statistical hypotheses. It is posited that erosion in athletes stems from a specific cascade of events: intense physical exertion drastically reduces salivary flow and buffering capacity. While the intrinsic pH of saliva may not drop (and may even rise), the loss of protective buffering volume renders the oral cavity defenseless against highly acidic sports and energy drinks with high titratable acidity. It is also posited that incorporating advanced remineralizing agents into the athlete's routine can effectively halt this process.

2. Research materials and methods

2.1. Participants

As this is a narrative review, no new *in vivo* subjects were recruited. The analytical foundation consists of the research populations described in the 36 included scientific publications. These groups encompass a broad spectrum of physically active individuals: elite and Olympic athletes, Paralympians, swimmers, rowers, triathletes, as well as adolescents and university students [4, 5, 6, 7, 8]. In the clinical studies reviewed, control groups typically consisted of non-training individuals or those engaging in minimal physical activity.

2.2. Procedure / Test protocol / Skill test trial / Measure / Instruments

The manuscript was developed based on a structured synthesis of English-language literature. We analyzed review papers, *in vitro* experimental studies, cross-sectional analyses, meta-analyses, and consensus statements from international scientific societies (e.g., EA4SD, EFCD, ADA). The literature search targeted high-evidence sources in sports medicine and dentistry (publication years: 1997–2026). Keywords included "dental erosion," "sports drinks," "athletes," and "salivary flow."

2.3. Data collection and analysis / Statistical analysis

2.3.1. Statistical Software

Due to the narrative review methodology, original statistical processing utilizing dedicated statistical software was not conducted. The data collection focused on extracting previously published statistical parameters, correlations, and prevalence rates from the included studies.

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.

2.3.3. Statistical Methods

Rather than performing formal statistical hypothesis testing, a critical, qualitative evaluation of effect sizes (e.g., correlations, P-values, 95% CIs) from original studies was performed. Contradictions in the literature (e.g., regarding the behavior of salivary pH during exercise or the absolute efficacy of specific toothpaste types) were identified and reconciled to present a balanced and accurate reflection of current scientific knowledge.

3. Research results

A multifaceted analysis of the gathered literature confirms that dental erosion in the athletic population is a widespread, dynamically progressing disease that is frequently overlooked during routine performance assessments. The following subsections systematize the individual components of this phenomenon.

3.1. Definition, pathophysiology, critical pH

According to accepted diagnostic criteria, dental erosion is the process of chemical dissolution of dental hard tissues without the involvement of cariogenic bacteria. As clarified by Mitic et al. (2020), the fundamental feature distinguishing erosion from classic caries is that plaque is not required—tissue destruction occurs upon direct contact of the clean tooth surface with an acid [2]. Erosion most commonly affects enamel and exposed root surfaces (in cases of gingival recession), leading to highly specific ultrastructural changes at the vulnerable cemento-enamel junction (CEJ) [2].

Biochemically, the concept of critical pH is decisive. Elias et al. (2026) reiterate that the stability threshold for hydroxyapatite crystals is a pH of 5.5 for enamel and approximately 6.0 for dentin [1]. Exposure of tissues to an environment more acidic than these thresholds leads to an almost instantaneous loss of minerals [1]. From the perspective of diet-induced pathogenesis, Mitic et al. (2020) described a crucial mechanism, demonstrating that the erosive potential of beverages is not solely dependent on their initial pH [2]. Titratable acidity (TA) is an equally important factor. This parameter indicates the amount of base (e.g., from salivary buffers) required to neutralize the fluid [2]. Beverages with high TA (such as most energy drinks) possess a massive reservoir of undissociated acid that continuously sustains the demineralization process despite the body's attempts at neutralization [2].

The clinical presentation of this process was detailed by Ahmed, Donovan, and Swift (2015), who categorized the primary dietary culprits possessing a highly acidic profile: carbonated drinks, sports drinks, fruit juices, dressings, vinegar, and white wine [3]. In the early stages of erosion, a dentist may observe subtle signs: "cupping" (characteristic depressions on cusp tips), smoothing of natural tooth anatomy creating a "whipped clay effect," and the "standing proud" phenomenon, where restorations (composites or amalgams) project above the surrounding eroded natural tissues [3]. The researchers recommend a formal dietary analysis in such cases. As an emergency intervention immediately following acid exposure, they advise rinsing the mouth with pure water or a sodium bicarbonate solution, using an over-the-counter (OTC) fluoride mouthwash, and consuming a piece of cheese, whose natural pH (6–7.4) neutralizes acids and intensively stimulates salivary flow [3].

3.2. Epidemiology in athletes

The prevalence of acid-induced oral lesions in athletes has reached epidemic proportions. In a comprehensive systematic review encompassing 34 studies, Ashley et al. (2015) demonstrated that the prevalence of erosion in the studied athletic groups ranged widely but alarmingly from 36% to 85% [4]. The co-occurrence of other pathologies was also noted: the proportion of patients with dental caries was 15–75%, periodontal disease hovered around 15%, and dental trauma affected 14–47% of subjects [4]. A critical observation from this analysis was that 5% to 18% of elite athletes directly linked oral pain and poor oral health with a decline in their athletic performance [4].

The premise of compromised health status is corroborated by a recent, rigorous global meta-analysis by Mulla et al. (2026). These authors calculated a pooled prevalence of erosion at approximately 30%, alongside significant rates of caries (44%) and periodontitis (47%) among national team and Paralympic athletes [5]. The conclusion drawn from this analysis highlights a paradox of modern sports: despite peak motor conditioning, the dental profile of an athlete often resembles that of a medically neglected patient, underscoring the absolute necessity for screening interventions [5].

The specific impact of endurance training cycles was explored by Frese et al. (2015), who compared a cohort of 35 triathletes with 35 non-training individuals [6]. The results were unequivocal: athletes demonstrated a significantly higher risk of developing erosion ($P = 0.001$) [6]. Furthermore, a positive correlation was found between weekly training hours and the number of carious lesions ($r = 0.347$; $P = 0.04$) [6].

Nijakowski et al. (2020) investigated age groups and sport specificity, examining 155 adolescents using the rigorous BEWE index [7]. They discovered a significant correlation between athletic activity and erosion ($R = 0.344$) and proved that individuals participating in water sports face a fourteen-fold higher risk of erosive lesions [7]. Concurrently, the researchers identified a powerful modifiable preventive factor: consuming water as the primary beverage during breaks reduced this risk by 70% [7].

The environmental dimension of water sports was also highlighted by Abdelrahman et al. (2023), who studied competitive swimmers (90 individuals) compared to rowers (90 individuals) [8]. Erosion was drastically more frequent among swimmers (60%) than in the non-swimming group (25.6%) [8]. The primary culprit in this group proved to be improperly maintained or excessively chlorinated pool water, whose pH dropped to an extreme level of 3.24 during certain measurement cycles, standing in stark contrast to the standard, well-buffered pool pH of 7.2–7.8 [8]. Long-term environmental exposure, combined with the intake of acidic isotonic drinks, led to a cascade of tissue destruction, illustrating the need to differentiate dietary acids from those originating in the training environment [8].

3.3. Exercise mechanism: saliva, pH, buffering capacity

Understanding why sports and energy drinks are so devastating to athletes' enamel requires an in-depth analysis of salivary physiology during training. As noted by Loke et al. (2016), salivary flow is the paramount clinical marker of its defensive properties [9]. Adequate flow ensures a high concentration of bicarbonate ions, which form the primary buffering (acid-neutralizing) mechanism [9]. However, intense training, especially endurance training, induces profuse sweating and rapid systemic dehydration. In response to hypohydration, the autonomic nervous system restricts perfusion to the salivary glands, resulting in a precipitous drop in the volume of secreted saliva and a reduction in its ability to quickly clear the teeth (decreased clearance) particularly in areas distant from gland orifices, such as the palatal surfaces of incisors [9].

A crucial and frequently misinterpreted physiological phenomenon occurs here. Frese et al. (2015) demonstrated during a maximum load exercise test that while stimulated salivary flow dropped drastically ($P = 0.001$), the intrinsic pH of the saliva actually experienced a significant *increase* ($P = 0.003$) [6]. This exact paradoxical pH increase (alongside a post-exercise drop in flow) was also recorded in swimmers by Abdelrahman et al. (2023) [8]. This clearly indicates that erosion in athletes is not caused by their saliva spontaneously becoming acidic during exercise; rather, the destruction stems from a massive reduction in fluid volume and *buffering capacity*, leaving the oral cavity completely defenseless against external acidic agents [6, 8, 9].

This mechanism is elucidated by the experimental work of Tanabe et al. (2013). Using bicycle ergometers, they tested five hydration and nutritional protocols [10]. The results revealed a stark contrast: when a low-pH sports drink (combined with food) was introduced into a post-exercise, dehydrated oral cavity, the environmental pH suffered an immediate and severe collapse, and the saliva's buffering capacity was insufficient to restore equilibrium [10]. Therefore, combining an acidic beverage with depleted salivary reserves constitutes the most critical window for ETW development [10].

Post-exercise biochemical disturbances are also reported by Grzesiak-Gasek and Kaczmarek (2022), who demonstrated that adverse changes occur in the concentrations of key remineralizing minerals, calcium and magnesium, in the saliva of youth swimmers following a training session [11]. Nutritional research by Burleigh et al. (2020) offers a preventive avenue [12]. The authors confirmed that hydrating dehydrated runners with carbohydrate solutions rapidly destabilizes salivary pH, whereas the use of nitrate-rich beetroot juice mitigated these fluctuations, pointing toward the development of safer supplementation strategies for elite athletes [12].

3.4. Erosive potential of drinks (chemistry and in vitro)

The chemical determinants influencing the erosive potential of fluids have been studied for decades. A classic and foundational paper was published by Milosevic (1997), analyzing the properties of the most popular sports drinks of that era [13]. This study revealed that the pH range of commercial "isotonics" was between 2.38 and 4.46, meaning that, without exception, all tested products fell far below the enamel demineralization threshold [13]. Milosevic was among the first to emphasize that this destructive potential is amplified by titratable acidity and a lack of sufficient saturation with protective ions (e.g., phosphates or calcium) [13].

The expansion of dietary threats is evidenced by the research of Lussi et al. (2012) [14]. They examined 60 diverse substances, including a large group of products targeted at athletes. Statistical analyses confirmed that baseline pH is the strongest pro-erosive factor, but the fluid's buffering capacity and mineral concentration ultimately dictate the dynamics of enamel breakdown [14]. This translates directly to tissue microhardness in experimental models. A study by Zimmer et al. (2015), utilizing innovative mass-loss assessment methods, demonstrated an extraordinary variance in dentin and enamel damage across different fluid categories [15]. The results for energy drinks (e.g., Red Bull) and aggressive carbonated beverages (e.g., Sprite) in simulated exposures vastly exceeded the mineral loss recorded with milder juices [15].

In this light, *in vitro* results evaluating the potential to modify this process are highly relevant. Elias et al. (2026) investigated the impact of energy and sports drinks on enamel microhardness in the presence of various preventive toothpastes [1]. They conclusively proved that systematic exposure of teeth to high-fluoride toothpastes, as well as those containing bioactive glass (NovaMin technology), significantly and measurably limited the dissolution of superficial hydroxyapatite layers following an acid attack [1]. This finding also highlights a concerning consumer trend: popular herbal toothpastes, devoid of fluorides, provided highly limited and clinically unsatisfactory protection against acids in this test [1].

3.5. Consumption patterns (exposure context)

The rise in erosion among athletes is largely secondary to profound cultural and market shifts in consumption habits. An analysis by Vercammen et al. (2019), based on the massive US NHANES demographic database from 2003–2016, reveals the scale of the increase in energy drink consumption [16]. A precipitous percentage increase was noted across all age groups: from a marginal 0.2% to 1.4% among adolescents, and from 0.5% to an alarming 5.5% among young adults [16]. Furthermore, individuals classified as regular consumers ingest extremely high amounts of caffeine (a median of approx. 227 mg daily compared to just 52 mg in control groups), generating additional systemic effects [16].

A global perspective is provided by a major meta-analysis by Aonso-Diego et al. (2024), which averaged results from 192 separate studies covering a population of over one million subjects (n = 1,120,613) [17]. Lifetime prevalence of consumption reached a staggering 54.7% globally (95% CI 48.8–60.6) [17]. Regular consumption, measured strictly over the past month, was reported by 32.3% of respondents, with 8.82% declaring daily use [17]. As expected, the peak consumption curve strictly aligns with adolescent, university student, and young adult populations [17].

The academic context, which produces a vast number of amateur athletes, was analyzed across 71 studies by Protano et al. (2023) [18]. The prevalence of consumption among students reached 42.9%. From a behavioral standpoint, the motivation profile reported in surveys was particularly interesting: "energy drinks" were consumed to prolong study time, reduce sleepiness, and, crucially for this review, enhance athletic performance prior to training sessions [18]. Frequent adverse events associated with this practice included sleep disturbances, insomnia, palpitations, tachycardia, and a notable vulnerability to co-occurring tobacco and alcohol use [18].

A specific educational barrier was outlined in research by Hennessy et al. (2023). They indicated that in the current food market, energy and sports drinks have almost entirely dominated the fraction of sweetened beverages chosen by adolescents [19]. The core of the problem lies in the psychological association of these drinks with health [19]. Teenagers are convinced that isotonic drinks are the optimal tool for hydration and performance enhancement, remaining entirely unaware of their erosive side effects on dental tissues [19]. This necessitates a strict differentiation in advertising messages; energy drinks carry a completely different spectrum of cardiological risks compared to sports drinks designed merely to replenish electrolytes [19].

The general risk to athletes is also addressed by Freeman et al. (2018). According to the authors, caffeine-based beverages can be extremely dangerous due to exceeding, often by 2 to 4 times, the caffeine concentration limits permitted by the FDA for classic cola drinks [20]. The fact that nearly one-third of young people regularly expose themselves to this chemical cocktail results in measurable cardiovascular threats (supraventricular and ventricular arrhythmias, blood pressure instability) [20]. This starkly demonstrates that restricting energy drinks in athletic patients aims not only to preserve their dental integrity but, most importantly, to protect essential cardiovascular pathways [20].

3.6. Diagnostics and assessment indicators

Prompt, scientifically supported diagnosis of oral lesions is a prerequisite for effective preventive intervention. The Basic Erosive Wear Examination (BEWE), created in 2008, is at the forefront of contemporary dentistry. Donovan et al. (2021) describe this tool as the foundation for screening acidic patients [21]. BEWE utilizes a simple, four-point scoring system for defects (0 = healthy, 1 = initial loss of surface texture, 2 = defect involving <50% of the functional surface area, 3 = massive destruction >50% of the surface area), assessing teeth by sextant [21]. The sum of the scores categorizes the patient into a specific risk group (ranging from no treatment needed to complex reconstructions) [21]. This tool boasts excellent research statistics, achieving a sensitivity of 90.9% alongside a diagnostic specificity of 91.5% [21].

Lorens and Tomaszewska (2026) evaluated the competitiveness of assessment systems in their study, comparing BEWE with older and newer scales like the Tooth Wear Index (TWI) and the specialized TWES 2.0 [22]. They observed that while BEWE is brilliant for speed (e.g., in epidemiological studies of sports teams or on the field), thorough chairside diagnostics benefit more from TWES 2.0 [22]. A particularly valuable insight from this paper is the emphasis on the dynamic development of digital 3D visualization: modern sports dentists can use intraoral 3D scanners to regularly overlay a patient's dental arch models over time (time-lapse), revealing mineral loss at the micron level and serving as a fantastic motivational tool to quit energy drink habits [22].

3.7. Differential diagnosis: intrinsic erosion (GERD/LPR)

A highly responsible task for a clinician managing highly physically active patients is distinguishing acid demineralization resulting from poor diet from severe systemic pathologies, especially gastroesophageal reflux disease (GERD) and laryngopharyngeal reflux (LPR). This is supported by extensive gastroenterological literature. In a comprehensive systematic review, Wang, Zhou, and Lei (2025) confirmed an undeniable and statistically robust relationship between both forms of reflux and a drastic increase in erosive tooth wear in adult populations [23]. Chatzidimitriou et al. (2023), summarizing multiple reviews, recognize GERD as one of the leading and widely accepted risk factors for intraoral ETW, despite some heterogeneity in older research designs [24].

Pace et al. (2008) reference the renowned Montreal guidelines, under which the association between dental erosion and GERD is classified as a 'proposed/established' extraesophageal manifestation, albeit with caveats regarding the quality of evidence supporting this link [25]. In diagnosing the underlying cause, the clinical distribution pattern of the damage becomes crucial. Reflux-induced damage, caused by stomach acid (hydrochloric acid) surging at a pH of 1-2, primarily affects the palatal surfaces of the upper incisors and the occlusal and lingual surfaces of the lower posterior teeth [25]. This allows a skilled practitioner to distinguish such an individual from an athlete with diet-induced erosion, where an isotonic drink swished over the teeth destructively hits the vestibular (labial) surfaces of the incisors [25].

The pathophysiological link between stomach acid and teeth is also modulated by gland function. Lechien et al. (2020) proved that individuals suffering from GERD also experience disturbances in saliva properties (reduced flow and impaired neutralizing capacity), which acts as an independent factor devastating oral tissue resistance [26]. Kitasako et al. (2024) supported this thesis in a study of patients undergoing endoscopy [27]. They found a directly proportional relationship between the severity of dental damage and the clinical severity of the reflux disease itself (regardless of whether the patient presented with erosive or non-erosive esophagitis) [27]. A highly valuable observation from this article is the visual pattern (C- and L-shaped erosive lesions on teeth) that strongly indicates a reflux etiology [27]. The importance of this distinction over time is evidenced by pediatric studies. Wild et al. (2011) demonstrated a lack of correlation between diagnosed GERD and the presence of dental lesions in children [28]. This proves that in younger populations undergoing intensive youth training, improper dietary habits bear the overwhelming responsibility for enamel dissolution [28].

3.8. Prevention and treatment

Due to the specificity and progressive nature of ETW, therapeutic guidelines have undergone significant changes. Carvalho et al. (2015), through the consensus of the European Federation of Conservative Dentistry (EFCD), defined the framework for safely managing these patients [29]. Based on the BEWE evaluation, they structured a care pathway: starting with an interview regarding risk behaviors (drinking habits), moving to the reduction of environmental triggers, and culminating in restorative techniques to salvage the vertical dimension of occlusion (VDO) in advanced stages [29].

Donovan (2009) described an excellent and easily implementable protocol [30]. He highlighted the absolute necessity of quarterly professional application of highly concentrated fluoride varnishes [30]. Patients were advised to daily use prescription-strength fluoride toothpaste combined with agents based on amorphous calcium phosphate [30]. The most important behavioral recommendation is the rule to avoid brushing teeth immediately after acid exposure; instead, copious rinsing with water or a baking soda solution is advised to stabilize pH and prevent secondary mechanical abrasion of the soft, demineralized enamel by the toothbrush [30].

Regarding the selection of remineralizing materials, the scientific evidence presents a nuanced picture. A systematic review published by Né et al. (2022) strongly advocates for compounds based on CPP-ACP (casein phosphopeptide-amorphous calcium phosphate) [31]. The authors concluded that the application of this substance tangibly and significantly increases enamel microhardness and protects it against acids [31]. Concurrently, this review assessed the strictly anti-erosive properties of standard fluoride compounds as ambiguous and debatable [31]. However, these conclusions must be reconciled with the highly recent *in vitro* study by Elias et al. (2026), which unequivocally demonstrated that very high-concentration fluoride toothpastes, as well as those based on bioactive glass, provide excellent protection against erosion from energy drinks [1]. These varying results lead to the sound conclusion that the most effective prevention intelligently combines these strategies (fluorides to defend against demineralization, and calcium-phosphate compounds as a "building block" for remineralization), without arbitrarily depreciating the role of fluoride.

Very strong clinical evidence directly within the target athletic population (rugby players) was provided by a randomized controlled trial (RCT) by Butera et al. (2022) [32]. A home care regimen utilizing biomimetic hydroxyapatite was implemented. The study compared a regimen of hydroxyapatite toothpaste alone versus the same toothpaste combined with a mouthwash, revealing fantastic within-group improvements across all measured clinical scales in both arms [32]. While there were no significant inter-group differences (i.e., both treatment arms improved equally relative to their own baseline without one vastly outperforming the other), BEWE scores decreased, and dentin hypersensitivity (measured by SAI and VAS pain scales) was significantly reduced [32]. This trial provides robust evidence that the daily use of specialized reparative agents yields tangible, perceivable health and analgesic benefits for professional athletes [32].

In cases where prevention has failed and severe complications arise, Bartlett (2016) recommends that, when striving to restore tooth proportions and lost function, adhesive materials like composite resins should be the first line of defense, avoiding the destructive, irreversible preparation of teeth for full ceramic crowns [33]. These guidelines strongly emphasize that reconstructive treatment should only be undertaken when the patient has successfully eliminated the dietary causes of their ailments and ceased consuming acidic isotonic drinks [33].

4. Discussion

The analysis of the extensive and verifiable literature base performed in this study clearly highlights that acid-induced tissue loss is a pressing and continually escalating problem affecting a vast number of physically active individuals, from weekend amateurs to Olympic gold medalists [4, 5, 17]. The pathogenesis is rooted in a convergence of highly specific risk factors burdening the intraoral environment. It is crucial to realize that, contrary to initial intuition, maximal exertion does not inherently acidify saliva, in fact, it often generates a paradoxical increase in intraoral pH [6, 8]. Unfortunately, this is accompanied by a dramatic drop in salivary secretion and buffering capacity (a reaction to dehydration) [9, 11]. When an athlete attempts to hydrate and replenish energy using an extremely acidic fluid carrying a high titratable acidity [2, 13, 14, 15], their compromised oral cavity lacks the ionic resources necessary to protect the teeth from an avalanche of mineral loss [10, 12].

These destructive dynamics require a systemic, decisive approach from medical professionals and coaches. Breakthrough documents address this, including a consensus convened by the European Association for Sports Dentistry (EA4SD) alongside collaborating associations, published by Stamos et al. (2020) [34]. It postulates the absolute necessity for the institutional integration of dental care into mainstream sports medicine [34]. The authors categorically state that sports dentistry is far more than treating trauma and splinting avulsed teeth, it is comprehensive care managing the impact of acids, carbohydrates, and repeated biological stress on the stomatognathic system [34].

An extension of this appeal is the USPDES algorithm created by Stamos's team (2023), which codifies and simplifies dental examinations for this specific patient subgroup, providing clinicians with clear screening guidelines for use during training camps [35]. The evolving and ambitious role of the modern sports dentist is also characterized by Gallagher et al. (2021) [36]. These experts urge that dental control, with a strong emphasis on the BEWE index and a history of energy drink or supplement habits, should be a mandatory component of the pre-season qualification regimen, equally as important as a spirometry test or echocardiogram [36]. Only through the implementation of robust educational initiatives regarding the true nature of energy drinks (falsely perceived by youth as healthy remedies) [19], paired with the home use of intelligent toothpastes based on hydroxyapatite [32] or calcium phosphate [31], can this alarming and highly painful trend be reversed.

5. Conclusions

1. Tissue exposure to sports and energy drinks consumed during or after exercise is a primary, determining risk factor for rapid tooth destruction. This is due to the dangerously low pH of these solutions and, equally importantly, their extremely high titratable acidity (TA) [2, 13].
2. Competitive physical training leads to a decrease in buffering capacity and reduced salivary flow. The fact that saliva pH may paradoxically increase during exercise does not protect the teeth; the loss of buffering volume renders the oral cavity defenseless against a massive load of exogenous fluid acids [6, 8, 9].
3. The objective prevalence of erosive tooth wear (ETW) is drastically high, ranging from a pooled 30% in major meta-analyses up to 85% in certain high-performance target cohorts, elevating this phenomenon to the status of a non-occupational "athlete's disease" [4, 5].
4. Diagnostics utilizing the highly standardized BEWE index are critical for determining the damage profile. During treatment planning, clinical interviews and topographic assessments (identifying palatal surface wear or C/L-shaped defects) must always rule out latent or asymptomatic intrinsic mineral loss (co-occurring with severe forms of GERD or LPR) [21, 23, 25, 27].
5. Preventive management dictates the use of an integrated material strategy: specialized preparations supplying calcium-phosphate building blocks (such as CPP-ACP and biomimetic hydroxyapatite, which demonstrate excellent efficacy in within-group analyses), as well as high-concentration fluoride toothpastes, provide objective and measurable preventive benefits [1, 31, 32].
6. Holistic and preventive care for athletes necessitates integrating a sports dentistry specialist into the interdisciplinary coaching and medical team structure to modify harmful habits, restrict energy drink consumption, and monitor the secretory profile of saliva [34, 35, 36].

Disclosure

The authors declare no unpublished data or findings influencing this narrative review.

Supplementary Materials

No external supplementary materials were utilized in this study.

Author Contributions

Conceptualization: SP, KS, AM

Methodology: SP

Software: SP

Check: KS, AM

Formal analysis: SP

Investigation: AM

Resources: SP, KS

Data curation: SP

Writing - rough preparation: SP

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Informed Consent Statement

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Data Availability Statement

The literature used in this study is available in open-access databases. DOI numbers in the reference list link directly to the respective articles in scientific databases.

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Conflicts of Interest

The authors declare an absolute lack of any conflict of interest.

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