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Oral Health Pathologies in Elite Athletes and Their Implications for Sports Performance - A Narrative Review

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Abstract

Background

Despite their exceptional fitness and access to specialised medical care, elite athletes consistently show oral health worse than would be expected for individuals of their age and condition. This counter-intuitive observation - sometimes called the "elite-athlete oral health paradox" - has prompted growing interest in how sport-specific factors shape oral disease and how oral health, in turn, affects training, recovery, and competitive performance.

Aim

The aim of this review was to summarise the most common dental conditions seen in elite athletes, examine the sport-specific factors behind their high prevalence, outline how oral health influences

athletic performance, and translate these observations into practical recommendations for prevention and clinical management.

Materials and Methods

A narrative review of the current literature was conducted, focusing on the epidemiology of oral disease in elite athletes, sport-specific aetiological factors, performance-related consequences, and preventive strategies.

Results

Untreated caries, dental erosion, gingivitis, periodontitis, dental trauma, and temporomandibular disorders all occur at rates equal to or higher than in the non-athletic population. Frequent carbohydrate intake, low-pH sports drinks and gels, mouth breathing, exercise-induced reductions in salivary flow, and post-exercise immunosuppression appear to be the principal contributors. Around one in three elite athletes report that oral health interferes with training, sleep quality, or performance, with mechanisms including pain, impaired nutrition, disrupted recovery, low-grade systemic inflammation, and lost training time.

Conclusions

Oral health in elite athletes deserves to be treated as a performance factor, not a cosmetic one. Pre-participation dental screening, targeted education, dietary adjustments, fluoride and remineralisation strategies, custom-fitted mouthguards, and the routine integration of dentists into sports medicine teams are low-cost, evidence-based measures capable of preventing and reducing many of the issues currently seen in this population.

Keywords

sports dentistry; elite athletes; oral health; athletic performance; dental erosion; dental caries; periodontitis; inflammation; mouthguards; dental trauma; nutrition; dental screening

1. Introduction

Sports dentistry is a relatively young but rapidly expanding branch of dental medicine focused on the prevention, diagnosis, and management of oral and dental conditions in physically active populations (1). Its initial scope was largely confined to the prevention and management of orofacial trauma in contact sports (2). Over the past two decades, the discipline has expanded substantially to encompass the full spectrum of oral health issues affecting athletes - from dental caries and periodontal disease to dental erosion, temporomandibular disorders, and the bidirectional interaction between oral health and overall systemic well-being (3,4).

Elite athletes form an unusual group in dental research. Their excellent cardiorespiratory fitness, low body fat, and access to specialised medical care would seem to predict an equally favourable oral health profile. However, multiple studies have demonstrated that their dental status is paradoxically worse than would be expected for individuals of their age and physical condition (4,5). The seminal dental survey conducted at the London 2012 Olympic Games by Needleman and colleagues reported substantially higher rates of oral problems than expected in healthy young adults of comparable socioeconomic status (6). Similar issues have been found among Olympic competitors at Beijing 2008 (7), Dutch elite athletes eligible for the Rio 2016 Olympic and Paralympic Games (8), and across various sport-specific studies, including professional footballers (9), rugby players (10), swimmers (11), triathletes and endurance runners (12).

Beyond aesthetics and personal comfort, oral health in athletes has implications that reach into training, recovery, and competitive performance. Approximately one-third of elite athletes report that the condition of their teeth and mouth negatively affects training, sleep, or competitive performance (13,14). Proposed mechanisms include direct dental and orofacial pain, low-grade systemic inflammation, impaired nutritional intake, disrupted sleep, and time loss due to acute dental emergencies during major competitions. Consequently, integration of dental care into multidisciplinary sports medicine teams is increasingly recognised as best practice by international sporting bodies, including the International Olympic Committee (15).

This review summarises the most common dental conditions seen in elite athletes, examines the sport-specific factors behind their high prevalence, and considers how oral health can affect training and

performance. The closing section turns these observations into practical recommendations for prevention and clinical management in multidisciplinary sports medicine.

2. Materials and Methods

This study is based on a narrative review of literature examining the prevalence of oral disease in elite athletes, the sport-specific factors that contribute to it, its influence on athletic performance, and current strategies for prevention and clinical management. Studies included original research articles, systematic reviews, meta-analyses, surveys, and cross-sectional studies. Relevant sources were identified using major scientific databases, including PubMed, Scopus, and Google Scholar. Following the screening process, 65 publications were selected based on clinical relevance, methodological quality, and citation impact.

3. Epidemiology of Oral Health in Elite Athletes

One of the first real looks at the oral health of Olympic athletes came out of the Beijing 2008 Games. At the Polyclinic in the Olympic Village, doctors treated competitors from all over the world and, for the first time, had a chance to see in real time what kind of dental care top athletes actually needed. The records collected by the Dental Care Department of the Polyclinic showed that permanent fillings, root-canal treatments with finished filling, and hygiene cases were the 3 most prevalent procedures - 25.51%, 13.13%, 11.45%, respectively. An additional service that gained popularity among athletes was the manufacturing of custom-made mouthguards - 122 of 516 athletes who attended the clinic received new appliances (7). These findings reinforced observations from earlier Olympic and Commonwealth Games, suggesting that the burden of oral disease among international-level athletes is remarkably consistent.

Although the Beijing data laid important groundwork, it was the London 2012 Olympic Games that produced what has since become one of the most widely cited and influential datasets in sports dentistry. The study examined 302 athletes representing 25 sports and more than 50 countries. The results were striking. 55% had untreated caries, 45% exhibited dental erosion, 76% had gingivitis, and 15% showed signs of periodontitis. Beyond the clinical findings, 28% of athletes reported that their oral health affected their quality of life, 18% described an impact on training, and 7% felt it directly compromised their athletic performance (6).

Interesting research conducted by Gay-Escoda et al. during the 2003-2006 seasons at FC Barcelona strengthens previous findings. A study of 30 professional football players found that, on average, each athlete had nearly three teeth that had previously been treated for caries and two teeth with active, untreated carious lesions. These numbers may seem surprising, especially considering footballers' wages and the size of the medical support staff behind them.

Comparisons with the general population are complicated by differences in age, sex, and socioeconomic status. However, several controlled studies suggest that elite athletes have at least equivalent, and often worse, rates of caries, gingivitis, and erosion when matched to non-athletic peers (16). This observation, sometimes referred to as the "elite-athlete oral health paradox," remains the central motivation for sport-specific dental research and forms the research foundation of the present review.

4. Common Dental Conditions in Elite Athletes and Sport-Specific Aetiological Factors

4.1. Dental caries

Dental caries is a multifactorial disease in which cariogenic bacteria (most notably Streptococcus mutans and Lactobacillus species) interact with fermentable carbohydrates, producing acids that damage the hard tissues of the tooth - enamel and dentine (17,18). Its occurrence depends on the dynamic balance between pathological factors (acidogenic bacteria, sugar exposure) and protective factors (effective oral hygiene, optimal salivary flow, fluoride availability). When this balance is repeatedly disturbed, demineralisation outpaces remineralisation and carious lesions emerge (19).

Despite being effectively preventable, it is still one of the most dominant dental findings in athlete populations, with reported rates ranging from approximately 15% to 75%, depending on the study, with endurance sport athletes consistently scoring at the upper end of this range (6,10). Several factors contribute to this elevated risk.

Most importantly, athletes typically consume large quantities of fermentable carbohydrates throughout the day in the form of sports drinks, energy gels, and confectionery snacks (20). It is not only the total amount but the frequency of carbohydrate intake that matters. Repeated and prolonged drops in oral pH cause hard tissue demineralisation and create a continuous substrate for cariogenic bacteria (21).

Adding to this dietary challenge, there is a physiological one. Salivary flow, which provides essential buffering, supplies calcium and phosphate ions for remineralisation, and partially cleans teeth from

food and drink residues (22). During sustained exercise it is reduced due to increased water loss and may remain suppressed for extended recovery periods, particularly when athletes are dehydrated (23). As a result, the mouth's natural defenses are weakened exactly when sugar exposure is the highest.

Finally, the demanding training schedules of elite athletes can lead to inconsistent oral hygiene routines. The demanding training and travel schedules often result in daily flossing and twice-daily brushing being adhered to less reliably than recommended (9).

Together, these factors create a particularly high-risk environment for caries development. Frequent sugar intake, reduced salivary flow, and inconsistent hygiene rarely occur in isolation in elite sport. They reinforce each other and operate continuously throughout an athlete's career. As a result, dental caries in this group is widely spread and frequently overlooked by both athletes and their medical teams.

4.2. Dental erosion

Dental erosion is the irreversible chemical dissolution of dental hard tissues caused by acids of non-bacterial origin (24). Unlike dental caries, in which acids are produced locally by cariogenic biofilms, erosive demineralisation results from direct contact between the tooth surface and an acidic fluid (25). Importantly, the location of erosive damage is largely dictated by the source of the acid.

Extrinsic acids, derived primarily from the diet, attack the surfaces that come into direct contact with the fluid as it enters and circulates through the mouth. The damage typically appears on the labial surfaces of the upper incisors and on the occlusal surfaces of the posterior teeth, where acidic liquid tends to linger during drinking and swallowing. Over time, the affected areas develop smooth, shallow depressions, the enamel becomes progressively thinner, and the teeth lose their natural contour and mechanical strength (26).

Intrinsic acids, in contrast, originate from the stomach and enter the oral cavity due to conditions such as gastro-oesophageal reflux disease (GERD), recurrent vomiting, or eating disorders like bulimia nervosa. Because gastric acid enters the mouth from behind and pools against the inner parts of the dentition, the resulting damage shows a noticeably different topography. The most affected areas are the palatal surfaces of the upper anterior teeth and the occlusal surfaces of the lower molars (27). This pattern is so distinctive that it has its own clinical name - perimylolysis. This characteristic picture

serves as a diagnostic clue that allows clinicians to suspect undiagnosed reflux disease or eating disorders.

In elite athletes, several factors account for the high prevalence of dental erosion. First, sports drinks, energy drinks, and gels typically have a pH between 2.4 and 4.5, well below the critical pH of 5.5 at which enamel begins to demineralise (28). Frequent consumption of these products during prolonged training sessions is often accompanied by oral dryness caused by mouth breathing. As a result, the natural salivary buffer is diminished precisely when the acid intake is at its highest (23). In a survey carried out by Mathew and colleagues among 304 university athletes, frequent sports-drink consumption was significantly associated with occlusal and labial erosion lesions, consistent with the extrinsic-acid mechanism described above (29).

Second, in competitive swimmers, chronic exposure to chlorinated pool water with a suboptimally maintained pH level can directly demineralise enamel surfaces. The paper by Centerwall et al. demonstrated severe enamel erosion in swimmers training in low-pH pools, and subsequent studies have confirmed this finding (11,30,31). In that case, the source of damage lies not in the athlete's behaviour but in the training environment itself. Therefore, effective prevention depends on water-chemistry control and facility management rather than on the athlete's individual hygiene habits (30).

Taken together, dental erosion in elite athletes results from a combination of dietary, physiological, and environmental factors that are often an integral part of competitive sport itself.

4.3. Periodontal disease and gingivitis

The pathogenesis of gingival and periodontal inflammation is multifactorial. Frequent carbohydrate exposure and mouth breathing during exercise promote plaque accumulation. Prolonged high-intensity training has been associated with temporary post-exercise immunosuppression lasting approximately 3–24 hours after exercise, depending on the intensity and duration of the workout. It is most evident when the activity is continuous, lasts longer than 1.5 hours, and is performed at moderate to high intensity (55–75% VO_2max) (32). Combined, these two factors create conditions that predispose to periodontal disease.

The state of periodontal health is commonly screened using the Basic Periodontal Examination (BPE), a simple yet standardised tool that allows clinicians to identify the level of periodontal involvement and the need for further investigation (Table 1.). Two large-scale studies in elite athletes have provided

particularly informative BPE-based data. In the London 2012 Olympic Games study, gingivitis (BPE codes 1-2) was identified in over 76% of participants, while signs of periodontitis (BPE codes 3-4) were observed in more than 15% (6). These findings were further supported by a study conducted across elite athletes attending UK training centres, in which 348 of 352 examined competitors (almost the entire group) presented with BPE codes between 1 and 4, and 76 of them (approximately 22%) scored within the periodontitis range (codes 3-4) (10).

Table 1. Clinical interpretation of BPE codes (33)

Code	Description
0	No pockets >3.5 mm, no calculus/overhangs, no bleeding after probing (black band completely visible)
1	No pockets >3.5 mm, no calculus/overhangs, but bleeding after probing (black band completely visible)
2	No pockets >3.5 mm, but supra- or subgingival calculus/overhangs (black band completely visible)
3	Probing depth 3.5-5.5 mm (black band partially visible, indicating pocket of 4-5 mm)
4	Probing depth >5.5 mm (black band entirely within the pocket, indicating pocket of 6 mm or more)
*	Furcation involvement

These findings show that periodontal disease is far more common in young elite athletes than would be expected - especially considering that it is usually regarded as a slowly developing, age-related condition.

4.4. Dental trauma

Sport is the leading cause of dental trauma in adolescents and young adults (34). Contact and collision sports, such as rugby, ice hockey, American football, basketball, wrestling, and field hockey, carry the highest risk, but trauma also occurs in non-contact disciplines including cycling and equestrian sports (35–38). The most commonly affected teeth are the maxillary central incisors, followed by the maxillary lateral incisors. The injury usually affects a single tooth, but certain traumas result in multiple tooth injuries (39). Types of trauma vary substantially depending on the circumstances of the injury - crown fractures, luxations, and avulsions, alveolar bone fractures, and condylar injuries.

However, many of these injuries are preventable through proper protective equipment. The intra-oral mouthguard is the single best-documented preventive intervention in sports dentistry and has been shown to reduce both the incidence and the severity of sport-related dental trauma. A study carried out by Labella et al. among American college basketball players showed impressive results. Across a total of 62,273 exposures without mouthguards and 8,663 with custom-fitted mouthguards, the dental injury rate fell from 0.67 to 0.12 per 1,000 - about an 82% reduction (40). Comparable findings emerge from a meta-analysis by Knapik et al., who pooled data from multiple controlled studies and reported that the risk of orofacial injury was approximately 1.6 to 1.9 times higher in athletes not wearing a mouthguard (41).

Despite this strong evidence base and the relative simplicity of the intervention, a substantial proportion of athletes still do not wear mouthguards. In a survey of 127 athletes from rugby, field hockey, kickboxing, handball, taekwondo, and other contact sports in Barcelona, only 62.4% reported regular mouthguard use, with younger athletes and those without a prior history of dental trauma rating their use as least important (42). The long-term consequences of sport-related dental trauma further reinforce the case for prevention. Even minor injuries carry a substantial risk of late complications, including pulp necrosis, internal or external root resorption or aesthetic compromise that may persist for decades (39). In a young athlete, a single avulsed or severely luxated incisor can initiate a lifelong sequence of restorative interventions with cumulative costs that far exceed the price of a custom-fitted mouthguard.

4.5. Temporomandibular disorders and bruxism

Temporomandibular disorders (TMDs) are a group of conditions affecting the temporomandibular joint (TMJ), the masticatory muscles, and the associated orofacial structures. They are typically characterised by pain in the preauricular region, masticatory muscle tenderness, joint sounds such as clicking or crepitation, restricted or asymmetric mandibular movement, and, in some cases, headache or orofacial pain (43).

Bruxism is defined as a repetitive masticatory muscle activity characterised by clenching or grinding of the teeth and/or by bracing or thrusting of the mandible (44). Two distinct phenotypes are recognised - sleep bruxism, occurring during sleep, and awake bruxism, occurring during wakefulness. Importantly, bruxism is currently classified as a behaviour rather than a disorder.

Several mechanisms have been proposed to account for the elevated burden of TMD and bruxism in athletes. Direct trauma during contact sports, repetitive clenching during high-intensity strength training, psychological stress associated with competition, and disturbed sleep patterns linked to travel and tournament schedules are the most probable risk factors.

Prevalence estimates differ between studies. Across the available literature, signs of temporomandibular dysfunction have been reported in anywhere from 11.7% to 100% of athletes, compared with only 11.1% to 14.3% of non-athletic controls (45). This wide range reflects methodological differences - the sports studied (all of them contact sports), the level at which the athletes competed, and the diagnostic criteria applied. Direct numerical comparisons across studies should therefore be interpreted with caution.

Despite this variability, a consistent pattern emerges from the available evidence. Elite sport exposes participants to a combination of physical and psychological stressors - as a result, competitive athletes show a greater tendency to develop temporomandibular dysfunction and to present with more pronounced symptoms than non-athletic controls.

5. Mechanisms Linking Oral Health to Athletic Performance

Poor oral health affects the athlete on several levels simultaneously. Most of the proposed mechanisms can be grouped into five categories - pain and discomfort, compromised nutrition, disrupted sleep and recovery, systemic inflammation, and time lost from training and competition.

5.1. Pain and discomfort

The most straightforward issue is symptomatic pain coming from caries, periodontal diseases or dental trauma. It interferes with athletes' concentration, disturbs sleep quality, and affects their regeneration. In the London 2012 Olympic Games study, over 40% of athletes were bothered by their oral health, with 28% reporting an impact on quality of life and 18% on training and performance (6). Pain signals activate the sympathetic nervous system through spinal reflexes, and the response is proportional to the intensity and duration of the pain. This leads to higher peripheral vascular resistance, faster heart rate, and increased stroke volume (46). In an elite athlete, this combination of impairments translates directly into reduced training quality, slower recovery, and ultimately diminished competitive performance.

5.2. Nutritional impairment

Acute dental pain and orofacial trauma can interfere with chewing and narrow the range of foods an athlete is willing to eat. Avoidance of tough or fibrous foods (meat being a particularly common example) and a tendency to reduce overall intake have both been documented in patients with impaired masticatory function (47). For athletes already operating at the margins of energy availability, such dietary restrictions can compromise macro- and micronutrient intake at critical moments in training or competition.

5.3. Sleep and recovery

Sleep is a key determinant of athletic recovery, and even small reductions in its duration or quality can impair endurance performance, lower muscle glycogen, and increase perceived effort during submaximal exercise (48). Dental pain, bruxism, TMD, and obstructive symptoms originating in the oropharynx can all disrupt sleep architecture in this population. A recent review concluded that there is consistent evidence supporting an association between TMDs and poor sleep quality, with several

investigations reporting poor sleep in 43-60% of TMD patients compared with 28-41% of non-TMD controls (49). Pain and sleep disturbance form a vicious cycle - dental pain produces nocturnal arousals that fragment sleep, while the sleep loss lowers pain thresholds, amplifying the dental discomfort (50).

5.4. Systemic inflammation

Periodontitis is a recognised contributor to chronic low-grade systemic inflammation, with elevated circulating concentrations of C-reactive protein (CRP), interleukin-6 (IL-6), and tumor necrosis factor alpha (TNF-α) (51,52). Such inflammation may interfere with the finely regulated acute inflammatory response that is essential for post-exercise muscle repair and adaptation (53), and chronic low-grade systemic inflammation has been specifically implicated in the blunted anabolic response to resistance training observed in older adults (54). In a self-report study of male elite footballers, Solleveld et al. found that poorer oral health was associated with higher odds of muscle cramps and recurrent muscle and tendon injuries related to elevated levels of IL-6 and other cytokines (55). Furthermore, chronic inflammation driven by TNF-α and interleukin-6 is strongly linked to insulin resistance (56). Insulin acts as a crucial anabolic hormone that facilitates glucose transport into muscle cells and its storage as glycogen (57). Its impaired action directly slows down post-workout recovery and limits training adaptation. Taken together, periodontitis affects athletes' performance in many different ways simultaneously.

5.5. Time loss

Acute dental emergencies represent an under-appreciated cause of training and competition disruption. Data from Olympic Polyclinics consistently rank dental complaints among the leading reasons for athlete consultations. At the Beijing 2008 Olympic Games, dental care was the second most frequently used service in the Olympic Village Polyclinic after physiotherapy. Over 1600 cases were recorded over the 40-day duration of the event, with peak demand for dental services beginning three days before the opening ceremony (7). A single emergency endodontic or extraction appointment during a major competition can compromise hours or even days of training, recovery, or warm-up time. This becomes especially relevant in the pre-competition period.

6. Prevention and Management

Effective prevention in elite athletes works on several levels at once - from individual habits, through team practices, to federation-level policy.

6.1. Education

Athletes, coaches, and support staff are often unaware of the oral consequences of sports nutrition products and training regimens (58). Brief, targeted education on the cariogenic and erosive potential of sports drinks, on appropriate timing of carbohydrate intake, and on basic oral hygiene practices should therefore form a routine part of the athlete's training plan (59). Such measures are inexpensive, easy to implement, and considerably more cost-effective than the management of established disease.

6.2. Nutritional modification

Sports nutrition strategies should minimise the duration of low-pH exposure and lengthen intervals between carbohydrate intake. Practical measures include using straws to bypass anterior teeth, consuming carbohydrates as part of meals rather than sipping them constantly during training, opting for less acidic formulations of drinks and gels, and alternating the carbohydrate intake with plain water (60). Additionally, incorporating calcium-rich foods and using buffered preparations may further reduce the cariogenic and erosive potential (61).

6.3. Fluoride and remineralisation strategies

For athletes at elevated risk of caries or erosion, additional preventive measures should be considered. High-fluoride toothpastes (1450 ppm fluoride for routine use, or 5000 ppm in selected high-risk cases), professional fluoride varnish applications applied every three to six months, and CPP-ACP-containing products promote remineralisation of demineralised enamel and reduce caries incidence (59,62). Salivary stimulation through sugar-free chewing gum can also help restore oral pH and enhance buffering capacity following acidic intake, and is a particularly useful adjunct in athletes who train with reduced salivary flow (63).

6.4. Mouthguards

Mouthguards are widely regarded as the gold standard for orofacial injury prevention in contact sports. Among the available designs, custom-fabricated laboratory-made mouthguards consistently outperform stock and "boil-and-bite" alternatives in retention, comfort, and protection (41). For safety reasons, the appliance should have adequate retention, fit comfortably, and should not interfere with speech or breathing during play (64). Although their cost is substantially higher than that of standard devices, the improvements in comfort and protective effectiveness generally justify the additional expense, particularly in athletes exposed to frequent impacts and high-risk contact situations.

6.5. Pre-participation dental screening

A comprehensive dental examination should form part of pre-season medical screening for elite squads, with particular attention to caries, periodontal status, erosive lesions, and erupting third molars (8). Spotting problems early means treatment can be planned calmly, well outside major competition periods - so athletes are not benched by a dental emergency in the middle of a big event. Annual or twice-yearly dental reviews should become as routine for athletes as physiotherapy assessments or cardiovascular screening, allowing problems to be identified and addressed before they escalate.

6.6. Multidisciplinary integration

Finally, oral health forms part of the overall medical care of athletes. Dentists belong on the sports medicine team alongside physicians, physiotherapists, dietitians, and psychologists - not called in only when something goes wrong (65). This way, dental issues can be factored into nutrition plans, return-to-play decisions, and pre-competition preparation.

7. Conclusions

The evidence reviewed here highlights a striking paradox - despite their exceptional physical condition and easy access to specialist medical care, elite athletes show surprisingly high rates of oral disease. Caries, gingivitis, erosion, dental trauma, and temporomandibular disorders all appear at rates equal to or higher than in non-athletic peers. The causes are built into elite sport itself. Frequent intake of carbohydrates, regular consumption of low-pH sports drinks and gels, mouth breathing during

prolonged exercise, reduced salivary flow, and post-exercise immunosuppression together create an oral environment that favours disease over health.

The effects do not stop at the teeth. Roughly one in three elite athletes report that the state of their dentition interferes with training, sleep, or competitive performance. Pain, impaired nutrition, disrupted recovery, low-grade systemic inflammation, and lost training time all add up, and together they touch nearly every part of athletic preparation. In that sense, oral health is not just a cosmetic issue but an adjustable performance parameter.

Implementing these findings into practice does not require advanced technology or large budgets. Several simple, low-cost measures can make a real difference - basic education for athletes, dietary adjustments, fluoride and remineralisation strategies, pre-participation dental screening, custom-fitted mouthguards, and the routine inclusion of dentists in sports medicine teams. All of them are well supported by evidence and have the potential to prevent much of the disease seen in this population. Custom mouthguards alone prevent over 80% of dental injuries when worn consistently - proof that simple measures can deliver remarkable results.

More research is still needed. Future studies should look at how much athletes actually gain in performance, recovery, and injury prevention when their oral health is properly managed. The link between gum disease, inflammation, and recovery deserves particular attention. Even without these data, there is already enough reason to take oral health seriously. And this is not only an issue for elite competitors - recreational athletes and people who never compete at all benefit from the same basic habits. Proper oral care supports general health regardless of how much one trains.

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