

Preclinical Oral Health Status in Athletes, Effects on Performance and Means of Prophylaxis A Literature Review

Pateishvili A.¹, Lomidze T.¹, Puturidze S.¹, Margvelashvili V.¹, Margvelashvili A.¹, Manana Kalandadze.¹

Abstract

Background:

Athletes of any level are at a higher risk of trauma compared to the general population. Orofacial injuries can be extremely impactful to physical and mental health, can negatively affect performance and are a financial burden. Thus, it is important to outline risk factors that can contribute to oral health status decline and evaluate means of prophylaxis.

Methods: 66 articles were reviewed, out of the originally selected 101, databases of Pubmed.gov, Scopus and Elsevier were utilized.

Aim: This article aims to summarize the importance of oral health in athletes, as well as describe the means of prophylaxis and discuss the effects on performance this might have

Results: The research focused on evaluating athletes and their susceptibility to trauma and poor oral health, as well as on level of educational facilities, coaching, management staff, and on-site medical staffs' knowledge. At least 24 articles reviewed have outlined unsatisfactory oral health status among the athletes, low levels of adherence to FDI sports dentistry guidelines, low availability of information on oral health care to athletes. Athletes exhibited unsatisfactory oral health conditions, which may affect their performance.

Conclusion: Athletes are said to have comparably bad oral health, numerous articles included have found rather high prevalence of not only dental trauma but tooth decay and gingival disease as well. Increased use of mouthguards and protective headgear is said to be enough to remedy this problem, as other studies show the problem is more complex and needs further research (TCM-GMJ March 2023; 8 (1):P43-P49)

Keywords: Sports dentistry; Athlete; Oral, Health.

Introduction

The biggest governing body in all of dentistry, the FDI World Dental Federation, has identified that athletes require particular attention to oral healthcare, therefore, during their Poznan 2017 meeting, a new branch of dentistry, Sports dentistry, has been created(1). This branch caters especially to people in sport, those that have special needs coming from their occupation, which asks for demanding physical activity, along with multiple other risk factors.

Athletes, especially those competing in contact sports, have a higher-than-average probability of dentognathic trauma, regardless of the level they're competing at(2–9) . Additionally, they have other factors contributing to poor oral health, such as

poor diet (starvation or high-carb), insufficient food supplementation, and high consumption of sugary sports drinks, clenching during physical exertion (10–13) . This problem is worsened by the fact that the institutions, staff, and management, and athletes themselves are not properly informed about the course of action in case orofacial trauma occurs, how to avoid it from happening, or how to practice general oral healthcare behaviors (9,14–17). Such lack of information is reflected in poor oral hygiene habits and infrequent use of personal protective equipment. These habits are rooted in early childhood (9,17–19)

Traumatic Dental Injuries (TDI) take up almost a third of all oral pathologies and most of them are sports-related. Types of TDI include: concussion, subluxation, extrusion, lateral luxation, intrusive luxation, avulsion, broken and fractured teeth (20). TDIs are not limited to teeth, they also include alveolar, mandibular and maxillary fractures, as well as soft tissues, mostly the lips and cheeks. Prior dental work such as fixed orthodontic devices can

From the ¹Faculty of Medicine, Iv.Javakishvili Tbilisi State University, Tbilisi, Georgia.

Received March 29, 2023; accepted April 15, 2023.

Address requests to: Alexandre Pateishvili

E-mail: Alexandre.pateishvili257@med.tsu.edu.ge

Copyright © 2023 Translational and Clinical Medicine-Georgian Medical Journal

be detrimental to these cases, appliances such as braces can lacerate buccal surfaces and lips, as well as, transfer traumatic forces to teeth that would have been otherwise unaffected (21).

Contact sports athletes are at a higher risk of TDIs but they are often observed in other sports modalities as well (22). Amateurs and weekend warriors – people that engage in particular sports only on weekends are at risk as well, even though their training time is comparably short (7). Children and adolescents are also at a similarly high risk of injury (4,7,9,22–24) Obviously, when movement, strength, and athleticism are involved, injuries are bound to happen. Young individuals more often test their limits, thus the risk of injuries increase.(25–27) Amateurs are also at high risk, as they exert themselves often inconsistently(7) . To prevent or minimize injuries protective gears such as mouthguards (custom, factory or boil&bite types) and different types of protective headgear are introduced. This is exactly what the FDI capitalized on in their policy statement on sports dentistry.(1) Widespread use of mouthguards, shock absorbing materials, custom face masks and shields along with headgear are the best protection against TDIs to date (1). It has been outlined in numerous articles that mouthguard use can have a major effect on reduction of TDIs (7,18,19,28–34).

Thus, it has become imperative to properly communicate the necessity of protection and use of protective gears with athletes and coaches (21)The use of such gear is rather low, especially in sports where they are not mandatory. Athletes cite trouble with breathing, speaking and general discomfort, as a reason for low adoption rate of mouthguards (30–32,35–37). Mouthguards are differentiated into standard or boil&bite types and Custom made. Standard and boil&bite mouthguards offer good protection and only a moderate amount of comfort, since using standard human measurements are rarely comfortable for most, but, custom made mouthguards not only increase the wearers' comfort, but they offer superior protection with reduced overall thickness as well, by strategically thickening in important areas (18,30,33,38).

There can be benefits often overlooked, provided by protective headgear. Mouthguards which can be designed as occlusal splints can be beneficial and actually aid in athletic performance by aligning the occlusion in a more favorable way (39,40).

Here we present the literature review highlighting the risk factors and oral diseases with higher prevalence recorded in sports professionals. We identify the measures that can be taken to ensure the maintenance

of proper dental hygiene and oral health status. Athletes' motivation to do so, and factors that may be holding these people back.

Methods

Searches were conducted through Pubmed.gov and Scopus and Elsevier's databases. Keywords used were "sports dentistry", "athlete oral status", "dental protective gear", "dental trauma in sports", then snowball method was applied. Initially 104 articles published between 2010 to 2021 were selected. Articles that were not in direct correlation with the subject, or had unfavorable research criteria applied, such as extremely small groups of people included in the study were eliminated, thus we were left with 66 articles.

Results and discussion

The 66 research articles analyzed have shown that athletes are at higher risk of TDIs. Risk factors not only include higher trauma incidence, but low awareness regarding protective gear and prophylactic actions.

A study carried out by Needleman et al. at the 2012 London Olympics games evaluated the oral health of athletes taking part.(41) The Cross-sectional study was conducted at the dental clinic within the Polyclinic in the athletes' village. Data gathered from 278 participants showed a high prevalence of poor oral health: caries, dental erosion, and periodontal disease being the main culprits, with 55%, 45% and 76% athletes affected, respectively. Almost half of the participants had not received a dental checkup, or a hygienist appointment in the past year. Thus, around 40% of the athletes were disturbed enough by their oral health to visit the on-site clinic, 28% have reported an impact on their quality of life and 18% on their performance during sports events.

A similar situation was observed during the 2019 Pan American games in Lima. The study covered 6680 athletes, from 41 countries. During these games, 1.14% of the total number of athletes needed dental emergencies in the on-site clinic. 90.8% of the patients attending the clinic were presented with pre-existing conditions. Periodontal disease (34%) and dental caries (29%) were the most prevalent diseases. Notably, the biggest percentage of patients admitted to the clinic were competing in limited contact sports (such as athletics)(29%), followed by Soccer (8%) and Taekwondo (8%).

Effect on performance

Several studies and reviews have pointed out, that poor oral health and proper occlusion also affect sports performance and training(39,41–46).

A study conducted in the UK, by Gallagher et al. 2018 (42) focused on 352 athletes from 11 different sports showed that 49% of the participants were found to have

dental caries, 41.4% revealed erosive tooth wear, 77% had dental calculus and/or bleeding upon probing, and a further 21.6% had periodontal pockets with depth of at least 4mm. 32% of these athletes have reported an oral-health related impact on their sports performance, such as oral pain (29.9%), difficulty participating in normal training and competition (9%), and reduction in training volume. Other discomforts affecting daily life reported were: difficulty with eating, relaxing and smiling.

Needleman et. al 2013 (41) have concluded that 278 people visited the on-site dental clinic during the 2012 London Olympic games. Out of these elite athletes, 28 % of patients complained that their dental health has deteriorated so much so that it was impacting their quality of life. More importantly, 18% of patients mentioned that their dental problems affect their performance in sports as well.

A similar trend is seen in special Olympics athletes as well(47–50).

With a total of 1,286 participants from the Special Olympics in Nigeria(47), 6.6% had dental injury, 12.2% complained of dental pain and 21.1% had untreated dental caries.

664 athletes took part in the Special Olympics in New York city(48). Of the examined athletes, 9% reported oral pain, 8% needed urgent care, 28% had untreated caries, 60% had filled teeth, and 32% had signs of periodontal disease. 8% of the participants needed urgent care with pulpal involvement caused either by dental trauma or caries.

The research conducted during the Latin Special Olympics in Puerto Rico(51) examined 445 athletes. Dental caries (51%) was recorded for more than half of the examined athletes. Missing teeth (35%) were noted in more than one-third of the athletes. Almost half of the participants had signs of periodontal disease (48%) and almost half needed preventive mouth guards (44%).

Several studies were conducted about oral health awareness, that included the athletes, coaching and managerial staff.

Mouthguard use significantly decreases the risk of orofacial injury, especially in high contact, impact sports (7,19,23,25,31,32,52,53). Mouthguard use is seen as one of the most effective way of decreasing TDI prevalence in high risk populations, such as, athletes of high impact, contact and non-contact sports, military, endurance etc.

(56)A study from Saudi Arabia, involving 191 school sports teachers revealed that even though 88% of those interviewed encountered orofacial trauma among children, such as teeth (33.5%) and lips (25.2%), during sports activities, 27.7% were still against the use of mouthguards. 72.8% of the injured had poor knowledge of immediate intervention and first aid. Dissuading factors (mouthguard thickness, willingness to comply etc.)

Several studies have shown that due to discomfort, diminished performance and trouble breathing many athletes don't want to wear non-mandatory protective gear, such as the mouthguard and other types of headgear (7,9,18,19,31,32,35). Most of these complaints are addressed to the use of standard or, so called, boil & bite mouthguards compared to the customized ones.

A study by Gomez-Gimeno et al. 2019 (36) looked at water polo players, where mouthguard use is non-compulsory and therefore only 8% of players use it. The reasons listed for not using mouthguards were discomfort in speech, breathing, swallowing and overall athletic performance. In the scope of this study, two custom ethyl-acetate, 4mm mouthguards were fabricated per person, one having a conventional 6mm palatal expansion and the other a shortened one, shortened only by 2mm. Each mouthguard was worn for two weeks, for each training session and match. In conclusion, players were considerably more satisfied with shortened palatal expansion, without affecting the degree of protection (36).

The findings from a cross-sectional study conducted by Liew et al. 2014, in two different rugby tournaments showed that mouthguard use was 31.1% among 456 participants. Here, custom mouthguards were only 1.8%, stock mouthguards - 7.7% and boil & bite types - 21.1%. Of those who have started using mouthguards, only 28% continued using them. The rate of discontinuation of stock and boil & bite mouthguards was 57.1% and 80.2% respectively (35).

Tanaka et al. 2015 came up to similar conclusion, in a study of 500 rugby players, many users, especially of standard mouthguards, complain of discomfort in regards of protective appliance use and have low use rates. A leading cause of discontinuation of mouthguard use was problems breathing. Overall, the group using custom-made mouthguards reported a much lower number of complaints and a much higher mouthguard use frequency, 52% versus 34%, respectively (31).

A study by Hasegawa et al. 2014 focused on the effect of clenching in regards of decreasing acceleration forces on the cerebral tissues. They have concluded that increased masticatory muscle involvement can decrease these forces (54), but while decreasing concussion risks, clenching coupled with impacts can increase the risk of dentoalveolar trauma if no precautions are taken and this can be remedied by the use of mouthguards.

A finite element analysis by Tribst et al. addresses these concerns, and concludes that in a laboratory setting, in all 3 classes of occlusion, mouthguard use significantly decreased stresses on the condyles, as well as, on the articular disks (55).

A group of researchers led by Tribst have compared the effectiveness of custom and stock mouthguards, with no mouthguard use at all(38). They have concluded that even though maximum intercuspation offers more protection during a traumatic event compared to no occlusion, mouthguards outweigh them both(38).

Mouthguards decrease stress transmission for up to 85%, even while decreasing its thickness from the standard 4mm to 3mm and increasing the wearers comfort even greater (30,33).

Mouthguards do not completely eliminate the risk of orofacial trauma, but they decrease it, even if the force was not directly applied to the masticatory system (53).

Prevention starts from the school age, so a study of school sports teachers showed that almost a third of the teachers were against the use of mouthguards in children

and more than 70% of them had poor knowledge of first aid. This knowledge is not only important to be instilled in athletes from a young age, but also imperative for the coaching staff to be able to administer first aid since they will be the first on scene in case of a traumatic event. TDIs such as avulsions are especially dangerous, since, without swift action, children may lose their teeth (26). Avulsions are a luxative injury, where teeth can become completely dislodged from the alveola, this is especially prevalent in school aged children owing to their anatomy and weaker alveolar bone structure

By increasing the mouthguard wearers comfort, we can increase their willingness to comply (35).

Fabricating a properly fitting mouthguard for a first time user is important, since an uncomfortable first mouthguard might lead to a discontinuation of its use, and coincidentally, first time mouthguards happen to be cheaper, boil and bite types (7,9,18,32,35).

Thus it is important to have proper awareness and accessibility for athletes to receive professional care, to maximize their comfort and not to get discouraged by cheap, ill-fitting protective gears.

Occlusal splints can increase oral health, but can also be used as a potential tool to optimize some aspects of training efficacy (39). Although this is not a practice that has been widely implemented and needs further practical testing

Athletes might consider the use of mouthguards, not only for their protective role but also for the potential ergogenic effects in specific actions, mainly those for which lower limb muscular power are required (56).

Mouthguards not only do not hinder gas exchange during training, but these results provide support for cyclists to correct jaw posture that may improve their exercise performance. (57)

Besides protection, mouthguards might provide to help with balance and agility, even though the jaw-repositioning technique used in the design of these OTC mouth guards did not affect performance. It is important to note that negative effects were not observed indicating that mouth guard use did not impede performance (28).

Compared with a custom mouthguard, a neuromuscular dentistry-based mouthguard appears to enhance peak power

output, performance and repeated maximal efforts. When required to wear a mouthguard, athletes may benefit from wearing a neuromuscular dentistry-designed mouthguard compared with a CFM (58).

Why mouthguards should be used

External forces applied to the dento-alveolar apparatus are only partly responsible for trauma cases, alongside with the internal forces, produced by masticatory muscles during clenching. This behavior might take place during high-strain activities, during training or in some cases to decrease trauma to other body parts (to the head for example).

There is some skepticism regarding mouthguard use, some might say that it may not be effective in different types of occlusions and is only designed to protect Class I occlusion. Also, mouthguards, while effective at preventing dentoalveolar trauma, will not protect the condyles or the TMJ itself.(55) Some types of sports drinks and food can be harmful to oral health. (13,59,60) But there are alternatives that may prove beneficial (61-64).

Conclusion

In conclusion, athletes are said to have comparably bad oral health, numerous articles included in this review have also found rather high prevalence of not only dental trauma but tooth decay and gingival disease as well. It has been speculated that increased use of mouthguards and protective headgear is enough to remedy this problem, as other studies show the problem is more complex. Athletes are at a higher risk of dental and gingival disease because of their diets and oral care habits, as well as trauma.

Their oral health can be improved by a complex approach and proper prophylaxis – facilities need to improve, oral health knowledge should be improved and rooted into the minds of young athletes, also oral protective appliances should be customized to fit each person and made as comfortable as possible, without sacrificing protection, to increase the likelihood of an athlete wearing it.

Table 1.

Untreated Caries	Oral Pain	Gingival Disease Signs	Urgent Care	Total No of Participants	Reference
21.1%	12.2%	48.1%	n/a	1286	Folakemi et al. 2010
51%	13%	48%	20%	367	Rosana Hanke-Herrero et al. 2010
28%	9%	32%	8%	664	Fernandez, J.B. et al. 2012

Table 2.

Study Population	Total No of Participants	Reference
Elite athletes, different modalities	352	Gallagher J. et al 2018
Competitive / non-competitive swimmers	54 / 69	D Ercole et al 2016
Athletes with intellectual disabilities	627	Fernandez C. et al 2015

Table 3.

Type of article	2021	2020	2019
Systematic review	2	1	9
Research paper	4	0	1
Literature review	0	3	5
Cross sectional study	1	4	2

References

- FDI policy statement on Sports dentistry: Adopted by the FDI General Assembly, September 2016, Poznan, Poland. *International Dental Journal*. 2017;67(1).
- Sarao SK, Rattai J, Levin L. Dental Trauma Among Hockey Players: Preventive Measures, Compliance and Injury Types. *J Can Dent Assoc*. 2021;87:18.
- Tripodi D, Cosi A, Fulco D, D'Ercole S. The impact of sport training on oral health in athletes. *Dentistry Journal*. 2021;9(5).
- Oliveira Werlich M, Honnef LR, Silva Bett JV, Domingos FL, Paultetto P, Dulcinea Mendes de Souza B, et al. Prevalence of dentofacial injuries in contact sports players: A systematic review and meta-analysis. *Dental Traumatology*. 2020;36(5):477–88.
- Kragt L, Moen MH, van den Hoogenband CR, Wolvius EB. Oral health among Dutch elite athletes prior to Rio 2016. *Physician and Sportsmedicine*. 2019;47(2).
- Bartosiak-Drosio B, Modzelewska-Chiniewicz P, Boguszewska-Gutenbaum H, Olczak-Kowalczyk D, Gozdowski D. Traumatic dental injuries in permanent teeth of children and adolescents: A study based on own material | Uszkodzenia urazowe zębów stałych u dzieci i młodzieży – Badanie na podstawie materiału własnego. *Dental and Medical Problems*. 2016;53(3):373–81.
- Dursun E, Ilarslan YD, Ozgul O, Donmez G. Prevalence of dental trauma and mouthguard awareness among weekend warrior soccer players. *Journal of Oral Science*. 2015;57(3):191–4.
- Solleveld H, Goedhart A, Bossche L vanden. Associations between poor oral health and reinjuries in male elite soccer players: A cross-sectional self-report study. *BMC Sports Science, Medicine and Rehabilitation*. 2015;7(1).
- Tiwari V, Saxena V, Tiwari U, Singh A, Jain M, Goud S. Dental trauma and mouthguard awareness and use among contact and noncontact athletes in central India. *Journal of Oral Science*. 2014;56(4):239–43.
- Sato T, Fukuzawa Y, Kawakami S, Suzuki M, Tanaka Y, Terayama H, et al. The onset of dental erosion caused by food and drinks and the preventive effect of alkaline ionized water. *Nutrients*. 2021;13(10).
- Murtaza N, Burke LM, Vlahovich N, Charlesson B, O'neill HM, Ross ML, et al. Analysis of the effects of dietary pattern on the oral microbiome of elite endurance athletes. *Nutrients*. 2019;11(3).
- Bryant S, McLaughlin K, Morgaine K, Drummond B. Elite athletes and oral health. *International Journal of Sports Medicine*. 2011;32(9).
- Taşkinsel E, Özel E, Öztürk E. Effects of sports beverages and polishing systems on color stability of different resin composites. *Journal of Conservative Dentistry*. 2014;17(4):325–9.
- Gallagher J, Ashley P, Needleman I. Implementation of a behavioural change intervention to enhance oral health behaviours in elite athletes: A feasibility study. *BMJ Open Sport and Exercise Medicine*. 2020;6(1).
- Gallagher J, Ashley P, Petrie A, Needleman I. Oral health-related behaviours reported by elite and professional athletes. *British Dental Journal*. 2019;227(4).
- Iglesias-Porqueras N, Zamora-Olave C, Willaert E, Martinez-Gomis J. Attitudes and opinions towards the prevention of orofacial injuries among water polo coaches in Catalonia: A cross-sectional study. *Dental Traumatology*. 2021;37(4):623–30.
- Biagi R, Cardarelli F, Butti AC, Salvato A. Sports-related dental injuries: Knowledge of first aid and mouthguard use in a sample of Italian children and youngsters. *European Journal of Paediatric Dentistry*. 2010;11(1):66–70.
- Slwkanich L, Ouanounou A. Mouthguards in dentistry: Current recommendations for dentists. *Dental Traumatology*. 2021;37(5):661–71.
- Tuna EB, Ozel E. Factors affecting sports-related orofacial injuries and the importance of mouthguards. *Sports Medicine*. 2014;44(6):777–83.
- Petti S, Glendor U, Andersson L. World traumatic dental injury prevalence and incidence, a meta-analysis—One billion living people have had traumatic dental injuries. Vol. 34, *Dental Traumatology*. 2018.
- Solleveld H, Flutter J, Goedhart A, VandenBossche L. Are oral health and fixed orthodontic appliances associated with sports injuries and postural stability in elite junior male soccer players? *BMC Sports Science, Medicine and Rehabilitation*. 2018;10(1).
- Spinas E, Marni A, Giannetti L. Traumatic dental injuries resulting from sports activities; immediate treatment and five years follow-up: An observational study. *Open Dentistry Journal*. 2018;12:1–10.
- Ozbay G, Bakkal M, Abbasoglu Z, Demirel S, Kargul B, Welbury R. Incidence and prevention of traumatic injuries in paediatric handball players in Istanbul, Turkey. *European Archives of Paediatric Dentistry*. 2013;14(1):41–5.
- Bruggesser S, Kühl S, Solakoglu Ö, Filippi A. The prevalence of orofacial injuries in judo: A cross-sectional study. *Dental Traumatology*. 2020;36(4):411–6.
- Tsuchiya S, Tsuchiya M, Momma H, Sekiguchi T, Kuroki K, Kanazawa K, et al. Factors associated with sports-related dental injuries among young athletes: A cross-sectional study in Miyagi prefecture. *BMC Oral Health*. 2017;17(1).
- Eroje ABI, Tikare S, Alqahtani NA, Braimoh OB, Sundarraj RK, Muteq MA, et al. Orofacial trauma awareness among sports teachers in Southern Saudi Arabia. *Nigerian Journal of Clinical Practice*. 2020;23(3).
- Hecova H, Tziggounakis V, Merglova V, Netolicky J. A retrospective study of 889 injured permanent teeth. *Dental Traumatology*. 2010;26(6):466–75.
- Golem DL, Arent SM. Effects of over-the-counter jaw-repositioning mouth guards on dynamic balance, flexibility, agility, strength, and power in college-aged male athletes. *Journal of Strength and Conditioning Research*. 2015;29(2):500–12.
- D'Ercole S, Martinelli D, Tripodi D. Influence of sport mouthguards on the ecological factors of the children oral cavity. *BMC Oral Health*. 2014;14(1).
- Tunc ES, Ozdemir TE, Arici S. Postfabrication thickness of single- and double-layered pressure-formed mouthguards. *Dental Traumatology*. 2013;29(5):378–82.
- Tanaka Y, Maeda Y, Yang TC, Ando T, Tauchi Y, Miyanaga H. Prevention of orofacial injury via the use of mouthguards among young male rugby players. *International Journal of Sports Medicine*. 2015;36(3):254–61.
- Lee JW, Heo CK, Kim SJ, Kim GT, Lee DW. Mouthguard use in Korean taekwondo athletes—awareness and attitude. *Journal of Advanced Prosthodontics*. 2013;5(2):147–52.
- Gialain IO, Coto NP, Driemeier L, Noritomi PY, Dias RBE. A three-dimensional finite element analysis of the sports mouthguard. *Dental Traumatology*. 2016;32(5):409–15.
- Ahmed I, Fine P. “Injury prevention versus performance”: Has the time come to mandate the use of mouthguards in all contact sports? *BMJ Open Sport and Exercise Medicine*. 2021;7(1).
- Liew AKC, Abdullah D, Wan Noorina WA, Khoo S. Factors associated with mouthguard use and discontinuation among rugby players in Malaysia. *Dental Traumatology*. 2014;30(6):461–7.
- Gómez-Gimeno À, Zamora-Olave C, Cordobés-Navarro M, Willaert E, Martínez-Gomis J. Satisfaction with shortening the palatal extension of a mouthguard for water polo players: A randomized crossover study. *Dental Traumatology*. 2019;35(2).
- Ohlendorf D, Romdhane M, Lehmann C, Lehmann S, Kopp S, Maurer-Grubinger C, et al. Effect of a sports mouthguard on the functional range of motion of the spine and the upper body posture in taekwondo. *BMC Sports Science, Medicine and Rehabilitation*. 2021;13(1).
- Tribst JPM, de Oliveira Dal Piva AM, Borges ALS, Bottino MA. Influence of custom-made and stock mouthguard thickness on biomechanical response to a simulated impact. *Dental Traumatology*. 2018;34(6):429–37.
- Cesarelli L, Cesaretti G, Ylaitè B, Iovane A, Bianco A, Messina G. Occlusal splints and exercise performance: a systematic review of current evidence. *International Journal of Environmental Research and Public Health*. 2021;18(19).
- Dias A, Redinha L, Vaz JR, Cordeiro N, Silva L, Pezarat-Correia P. Effects of occlusal splints on shoulder strength and activation. *Annals of Medicine*. 2019;51(sup1).
- Broad EM, Rye LA. Do current sports nutrition guidelines conflict with good oral health? *General Dentistry*. 2015;63(6).
- Gallagher J, Ashley P, Petrie A, Needleman I. Oral health and performance impacts in elite and professional athletes. *Community Dentistry and Oral Epidemiology*. 2018;46(6):563–8.
- Militi A, Ciccì M, Sambataro S, Bocchieri S, Cervino G, de Stefano R, et al. Dental occlusion and sport performance. *Minerva Stomatologica*. 2020;69(2):112–8.
- Opazo-García C, Moya-Salazar J, Chicoma-Flores K, Contreras-Pulache H. Oral health problems in high-performance athletes at 2019 Pan American Games in Lima: a descriptive study. *BDJ Open*. 2021;7(1).
- Needleman I, Ashley P, Fine P, Haddad F, Loosemore M, Medici A de, et al. Oral health and elite sport performance. *British Journal of Sports Medicine*. 2015;49(1).
- Needleman I, Ashley P, Petrie A, Fortune F, Turner W, Jones J, et al. Oral health and impact on performance of athletes participating in the London 2012 olympic games: A cross-sectional study. *British Journal of Sports Medicine*. 2013;47(16):1054–8.
- Ashley P, di Iorio A, Cole E, Tanday A, Needleman I. Oral health of elite athletes and association with performance: A systematic review. Vol. 49, *British Journal of Sports Medicine*. 2015.
- Oredugba FA, Perlman SP. Oral health condition and treatment needs of Special Olympics athletes in Nigeria. *Special Care in Dentistry*. 2010;30(5):211–7.
- Fernandez JB, Lim IJ, Dougherty N, Lasasso J, Atar M, Daronch M. Oral health findings in athletes with intellectual disabilities at the NYC Special Olympics. *Special Care in Dentistry*. 2012;32(5):205–9.
- Fernandez C, Declerck D, Dedecker M, Marks L. Treatment needs and impact of oral health screening of athletes with intellectual disability in Belgium. *BMC Oral Health*. 2015;15(1).
- Marks L, Wong A, Perlman S, Shellard A, Fernandez C. Global oral health status of athletes with intellectual disabilities. *Clinical Oral Investigations*. 2018;22(4).
- Hanke-Herrero R, López Del Valle LM, Sánchez C, Waldman HB, Perlman SP. Latin-American Special Olympics athletes: Evaluation of oral health status, 2010. *Special Care in Dentistry*. 2013;33(5):209–12.
- Alves DCB, dos Anjos VDL, Giovannini JFBG, Lima RPE, Mendonça SMS. Dentistry in sport: Knowledge and habits of soccer and basketball athletes re-

- garding oral health. *Revista Brasileira de Medicina do Esporte*. 2017;23(5).
54. Sigurdsson A. Evidence-based review of prevention of dental injuries. *Pediatric Dentistry*. 2013;35(2):184–90.
 55. Gialain IO, Kobayashi-Velasco S, Caldeira CL, Cavalcanti MGP. Dental trauma prevention with mouthguard in a nose fracturing blow to the face: Case report. *Dental Traumatology*. 2017;33(5):410–3.
 56. Gould TE, Piland SG, Caswell SV, Ranalli D, Mills S, Ferrara MS, et al. National athletic trainers' association position statement: Preventing and managing sport-related dental and oral injuries. *Journal of Athletic Training*. 2016;51(10):821–39.
 57. Hasegawa K, Takeda T, Nakajima K, Ozawa T, Ishigami K, Narimatsu K, et al. Does clenching reduce indirect head acceleration during rugby contact? *Dental Traumatology*. 2014;30(4):259–64.
 58. Tribst JPM, Dal Piva AMDO, Bottino MA, Kleverlaan CJ, Koolstra JH. Mouthguard use and TMJ injury prevention with different occlusions: A three-dimensional finite element analysis. *Dental Traumatology*. 2020;36(6):662–9.
 59. Miró A, Buscà B, Aguilera-Castells J, Arboix-Alió J. Acute effects of wearing bite-aligning mouthguards on muscular strength, power, agility and quickness in a trained population: A systematic review. *International Journal of Environmental Research and Public Health*. 2021;18(13).
 60. PIERO M, SIMONE U, JONATHAN M, MARIA S, GIULIO G, FRANCESCO T, et al. Influence of a custom-made maxillary mouthguard on gas exchange parameters during incremental exercise in amateur road cyclists. *Journal of Strength and Conditioning Research*. 2015;29(3):672–7.
 61. Arent SM, McKenna J, Golem DL. Effects of a neuromuscular dentistry-designed mouthguard on muscular endurance and anaerobic power. *Comparative Exercise Physiology*. 2010;7(2):73–9.
 62. Lutovac M, Popova OV, Macanovic G, Kristina R, Lutovac B, Ketin S, et al. Testing the effect of aggressive beverage on the damage of enamel structure. *Open Access Macedonian Journal of Medical Sciences*. 2017;5(7):987–93.
 63. van Rosendal SP, Strobel NA, Osborne MA, Fassett RG, Coombes JS. Performance benefits of rehydration with intravenous fluid and oral glycerol. *Medicine and Science in Sports and Exercise*. 2012;44(9).
 64. Jacob J, Amalraj A, Divya C, Janadri S, Manjunatha PM, Gopi S. Oral toxicity study of sports nutritional powder in Wistar rats: A 90 day repeated dose study. *Toxicology Reports*. 2018;5.
 65. O'Connell SM, Woodman RJ, Brown IL, Vincent DJ, Binder HJ, Ramakrishna BS, et al. Comparison of a sports-hydration drink containing high amylose starch with usual hydration practice in Australian rules footballers during intense summer training. *J Int Soc Sports Nutr*. 2018;15(1).
 66. Schleh MW, Dumke CL. Comparison of Sports Drink Versus Oral Rehydration Solution During Exercise in the Heat. *Wilderness and Environmental Medicine*. 2018;29(2).