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From Overjet to Overhead: Malocclusion and Increased Overjet as a Potential Upstream Risk Multiplier for Sports-Related Dentofacial Trauma

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Abstract

Background: A greater overjet combined with poor lip control has long been recognized as a significant morphological indicator of anterior traumatic dental injury (TDI), with sports being a primary environment for such injuries. Typically, the risks associated with orthodontics and the prevalence of TDI among athletes are examined separately.

Objective: This review aims to evaluate how far orthodontic morphology influences the chain of athlete-related TDI burdens and whether preventative measures can lessen these effects.

Methods: A carefully structured narrative review with a systematic appraisal approach was conducted using databases such as PubMed, Scopus, Web of Science, SPORTDiscus, and Cochrane. The analysis utilized RoB 2, Newcastle-Ottawa, and AMSTAR-2 frameworks, along with GRADE for the sourced evidence.

Results: An overjet measurement exceeding 3-3.5 mm approximately doubles the risk of incisor trauma, while inadequate lip coverage increases that risk by about 2.6 times. TDI adversely affects oral health-related quality of life (OHRQoL), self-esteem, and social confidence, with lifetime restorative treatment incurring various direct and indirect costs.

Conclusions: The use of mouthguards can lower the incidence of orofacial injuries, and early correction of Class II malocclusion can reduce incisal trauma, with relatively low to moderate certainty. Orthodontic morphology represents a potentially alterable upstream factor that amplifies a significant biopsychosocial burden in athletes.

Keywords

traumatic dental injury; overjet; malocclusion; oral-health-related quality of life; sports injury prevention; mouthguards; health economics; orthodontics

1. Introduction

In sports, injuries to the front teeth are quite common, and the overall impact of these injuries around the world is significant. Data suggests that around one billion people have faced a traumatic dental injury (TDI) at some stage in their lives [1]. Research on the causes of TDI consistently identifies sports and leisure activities as major contributors, alongside other factors like falls, collisions, and traffic incidents [2]. Studies focused on specific sports populations reveal a notable occurrence of dental trauma, along with a lack of proper protective gear among players [3]. For readers interested in physical culture and sports medicine, this highlights that dentofacial injuries fall under the injury prevention category: TDI is a frequent, sport-related issue that is mostly preventable, yet it often doesn't receive the same level of preventive focus that is usually given to musculoskeletal injuries.

Injuries to the front teeth are not minor or temporary. The maxillary central incisors, which are the most likely to be impacted during an injury, can suffer from various types of damage, including enamel-dentin fractures, crown-root fractures, luxation, and even complete avulsion [4]. The consequences of such injuries often extend beyond the initial incident. They may lead to pulpal necrosis requiring endodontic care, crown discoloration, ankylosis, inflammatory root resorption, and ultimately the loss of the tooth, which would necessitate lifelong prosthetic solutions [5]. An adolescent who injures an incisor often faces decades of dental upkeep, adopting the "dental patient for life" path, which includes dealing with acute pain, aesthetic issues, and a significant increase in medical appointments. Thus, the challenges posed by a single damaged incisor are both biological and personal in nature.

In this context, orthodontics offers a perspective that the sports injury research has mostly missed. An increased overjet, defined as the upper front teeth protruding more than about 3 mm, paired with insufficient lip coverage that does not protect the visible tooth crowns, has long been recognized as a predictor of anterior traumatic dental injuries (TDI) [6]. Recent previews further link larger overjet and poor lip coverage to a higher risk of incisor trauma [7]. Notably, lip coverage is likely as important as the size of the overjet because effective lips can help absorb and distribute the force of an impact, even with protruded incisors, while ineffective lips allow the exposed crowns to take on the full force. Importantly, this physical trait is present before any impact occurs; it is a characteristic that may influence the likelihood of injury beforehand and can be adjusted through orthodontic treatment, unlike the impact itself.

Traditionally, overjet has been viewed mainly as a cosmetic or bite issue. However, seen through the lens of injury epidemiology, it emerges as a measurable and adjustable risk factor that can, theoretically, be assigned a cost.

Orthodontic literature relates to this topic, yet they are usually examined separately. The first indicates that a greater overjet and poor lip seal can predict anterior TDI. The second reveals that TDI negatively affects oral health-related quality of life (OHRQoL), self-esteem, and social confidence, leading to significant direct and indirect lifetime expenses. This review's unique contribution is merging these aspects into one athlete-centric biopsychosocial-economic pathway where orthodontic structure acts as the initial risk factor and the psychological and financial issues are the resulting impacts. Within this framework, two preventative measures function at different stages: mouthguards address the impact-to-injury phase, while early orthodontic overjet reduction addresses the initial exposure.

Only orofacial and orodental injury endpoints are included, and the evidence related to mouthguards is used solely for its relevance to orofacial injuries.

To facilitate this synthesis, we present three research questions:

RQ1: How much do higher overjet and lip incompetence contribute to the risk of anterior TDI in sports, and does this link remain significant when controlling for other factors?

RQ2: What level of biopsychosocial (OHRQoL, self-esteem, social confidence) and economic (direct + indirect, lifetime) impact does athlete TDI have?

RQ3: Can primary structural prevention (early reduction of overjet) and situational prevention (using mouthguards) each alleviate part of that impact, and what should be their order of priority?

The framework is structured around three specific, testable hypotheses aligned with the research questions - RQ1→H1, RQ2→H2, RQ3→H3 - with each hypothesis clearly accompanied by a possible counter-evidence. H1 addresses the inherent morphological status; H2 examines the increased burden on athletes; H3 evaluates the cost-effectiveness of preventive measures.

2. Methodology

2.1 Design and rationale

The goal of this review is to unite four distinct bodies of evidence that have been previously gathered for different inquiries: the link between greater overjet and the risk of traumatic dental injury (TDI) [6,7,8]; the impact of TDI on oral-health-related quality of life (OHRQoL) [9,10,11,12]; the costs associated with TDI both directly and indirectly [13,14,15]; and the effectiveness of prevention strategies [16,17,18]. These pieces of evidence are combined into a specific biopsychosocial-economic framework tailored for athletes.

2.2 Information sources

A total of five databases were utilized in a structured yet narrative way: PubMed, Scopus, Web of Science, SPORTDiscus, and the Cochrane Library. These databases were chosen to cover the biomedical, sports-science, and systematic-review literature that relates to the pathway. Additionally, reference lists of key syntheses were manually searched [1,6,7,16,18]. The retrieval process was organized based on three overlapping concept blocks - (overjet / lip incompetence / malocclusion) × (traumatic dental injury / dentofacial trauma) × (OHRQoL / cost / prevention / mouthguard / sport) - without guaranteeing a specific, reproducible outcome.

2.3 Synthesis approach

The findings were presented both in narrative form and organized tables. It was essential to analyze the two prevention methods based on their functions: mouthguards acted as a situational, secondary measure that intervenes between impact and injury [16,17], while the early reduction of overjet was treated as a structural, primary measure that eliminates the initial exposure [18]. This latter aspect was strictly connected to reducing trauma risk and was clearly separated from any cosmetic purposes.

3. Results

The results are shown in a clear explanatory ladder, starting with the biomechanical foundation of the exposure (3.1), moving to its link with injury through epidemiological data (3.2), then

covering the biopsychosocial (3.3) and economic (3.4) impacts of injuries, and ultimately discussing the prevention strategies that can help lessen these effects (3.5). This entire process is illustrated in Figure 1.

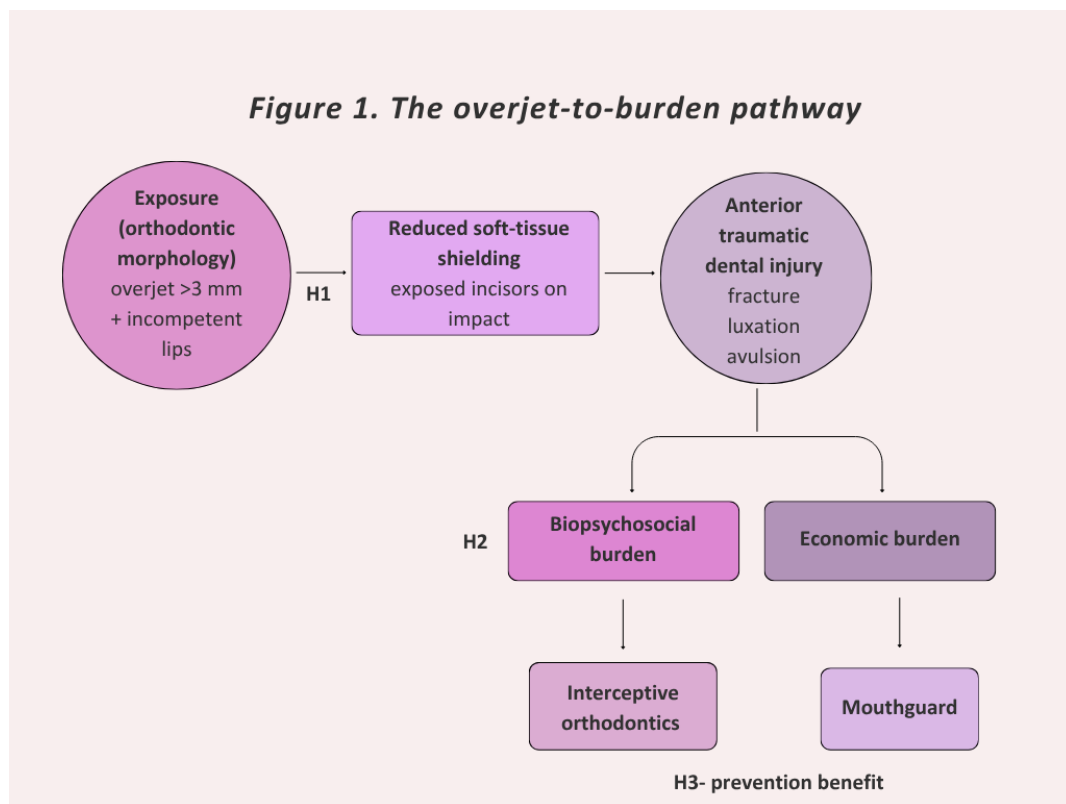


Figure 1. The overjet to burden pathway highlighting three hypotheses.

3.1 Mechanistic basis

To fully understand the impact of traumatic dental injuries (TDI) on athletes, it's essential to consider factors beyond just the moment of impact. Specifically, the dentofacial structure plays a crucial role in how a force impacts the front teeth. Two key aspects influence this: the degree of overjet and how well the labial soft tissue covers the maxillary incisors. It is argued that a larger overjet, along with inadequate lip coverage, may create a biomechanical risk factor for anterior TDI.

Overjet indicates the horizontal overlap between the incisal edges of the maxillary and mandibular central incisors and is measured in millimeters aligned with the occlusal plane. In typical cases, the overjet is small (approximately 2-3 mm), and values exceeding around 3 mm are generally classified as "increased" in trauma epidemiology. Larger differences raise more significant clinical concerns. The Index of Orthodontic Treatment Need (IOTN), created by Brook and Shaw [19], offers a standardized way to grade this variable. Higher overjet measurements lead to more severe categories of treatment need - establishing a framework that turns overjet into a measurable, ordinal exposure instead of a subjective perception.

The International Association of Dental Traumatology categorizes injuries into different groups [4]. This classification distinguishes between hard-tissue and pulpal injuries-including enamel infraction, fractures of enamel and enamel-dentine, complicated crown fractures that involve the pulp, and crown-root or root fractures-and periodontal/luxation injuries, which include tooth concussion, subluxation, extrusive, lateral and intrusive luxation, and complete avulsion.

In a situation where the lips are functional and there is a normal overjet, the upper lip extends over and past the biting edges of the teeth. This means that if a person experiences a frontal impact-such as from falling, bumping into someone, or getting hit by a ball-soft tissue helps absorb the initial force. However, an increased overjet disrupts this protective setup in two main ways. Firstly, when the incisors protrude, they advance forward beyond where the lips could normally protect them, moving outside the arc safeguarded by the nearby facial structures. Consequently, the tooth crowns become the most prominent part of the facial profile and are more likely to take the first hit. Secondly, if the lips are incompetent-meaning they don't align at rest and cannot cover the biting edges comfortably-then this protective layer of soft tissue is almost nonexistent. As a result, impact energy strikes the exposed tooth crowns more directly and intensely. This leads to less energy being absorbed and an increased concentration of stress on the incisors, making it more likely that the force will surpass the limits that cause enamel or dentine fractures, or periodontal issues that can result in luxation or avulsion.

When competent lips cover protruding incisors, these teeth benefit from significant soft-tissue protection and are less exposed. In contrast, if the same protruding incisors are accompanied by lip incompetence, that protective layer is lost, increasing their exposure. Thus, lip competence plays a role as an effect modifier in the overjet-trauma relationship. The highest-risk profile occurs when there is both an increased overjet and incompetent lips, which this review identifies as the modifiable upstream factor.

The process does not stop at the moment of a fracture, luxation, or avulsion. The initial injury sets off a series of consequences: immediate discomfort and functional issues; subsequent pulpal and endodontic complications (such as pulp necrosis, need for root-canal treatment, pulp-canal obstruction, inflammatory or replacement root resorption, and, following luxation or avulsion, ankylosis); and gradual aesthetic and functional decline, leading to discolored, frequently restored, or eventually lost anterior teeth. As sports often lead to such anterior injuries, this general link between morphology and injury is clearly relevant to athletes [4].

3.2 The upstream risk association

Sports are one of the most common activities leading to fractures or loss of anterior teeth. The significance of this issue is underscored by the vast numbers involved: global estimates suggest that around one billion people have experienced traumatic dental injury (TDI) at some point in their lives, indicating a prevalence of about 15% among those with permanent teeth [1]. Research points to sports and play as key situations where such injuries take place, along with other factors like falls, collisions, and violence [2].

The key quantitative reference is the systematic review conducted by Nguyen and his team, which compiled the observational data linking overjet size to anterior TDI [6]. The main finding, often referenced, is both qualitative and strong: children whose overjet exceeds 3 mm have roughly double the risk of incisor trauma compared to those with an overjet of 3 mm or less. First, as the overjet increases, so does the risk, showing a clear dose-response relationship that's hard to dismiss as mere artifact. Second, when lip coverage is inadequate, the risk rises even more, aligning with the mechanistic explanation (§3.1) stating that without the lip's soft tissue protection, protruding incisors are left vulnerable to injury.

In a systematic review and meta-analysis focused on TDI in Arab children's permanent teeth, Hashim and colleagues found that an overjet exceeding 3.5 mm correlated with TDI, presenting a pooled odds ratio of 1.78 (95% CI 1.17-2.70). In contrast, insufficient lip coverage showed a notably higher pooled odds ratio of 2.57 (95% CI 1.82-3.62) [7]. Additionally, this meta-analysis identified male sex as an independent factor linked to TDI, with a pooled odds ratio of 2.06 (95% CI 1.72-2.47) [7]. Since the analysis focuses solely on a pediatric Arab demographic, its pooled estimates have limitations when applied to adult and elite athletes. The findings are insightful: according to this data, lip incompetence emerges as the most significant morphological predictor, arguably overshadowing the effect of overjet size and supporting the idea that soft-tissue protection, rather than just protrusion, is the key factor. Furthermore, this synthesis contextualized the estimates within a high prevalence background, indicating a pooled TDI rate of about 26% (95% CI 10-43%), which reflects a specific population level rather than a general one, while the broad interval suggests significant variability across studies. Taken together, [6] and [7] present a consistent and biologically rational/moderate association: overjet roughly doubles the odds, while lip incompetence exceeds that figure.

Costa and colleagues evaluated observational studies related to the link between dentofacial features and dental trauma. They warned that the noticeable overjet effect could be influenced by residual confounding. They cautioned that the basic association may diminish toward zero when other competing factors are accurately modeled [8]. The potential confounders include those that also correlate with overjet: age, sex, socioeconomic status, risk-taking behavior, and - most importantly for discussions around sports injuries - exposure to physical activity.

3.3 The biopsychosocial burden

While the mechanistic and epidemiological aspects indicate that a greater overjet and lip incompetence increase the chances of anterior dental injuries, understanding the full significance of these injuries extends beyond just the physical damage. The first step in this causal chain lies within the biopsychosocial realm: traumatic dental injury (TDI) negatively impacts oral-health-related quality of life (OHRQoL), diminishes self-worth, and limits social confidence. The maxillary incisors, located at the center of the face, play roles in activities such as speech, eating, and smiling; therefore, any fracture, discoloration, movement, or loss of these teeth leads to functional, emotional, and social repercussions that last long after the initial incident.

Research consistently shows that TDI affects OHRQoL across various environments and tools (Table 1). [9], in an investigation of the quality-of-life effects following childhood dento-alveolar injuries, reveals declines in functional ability, emotional wellbeing, and social interactions, not just in terms of pain. Recent primary studies back this trend within diverse groups: [10] shows a hospital-based cohort of children and adolescents with TDI reporting significant declines in OHRQoL using validated questionnaires, while [11] observes similar effects in a school-based (non-clinical) group of 8-12-year-olds in Goa, India, employing the Adolescent Oro-Dental Trauma Impact Index. The similarity in outcomes between clinic and community samples suggests that the observed decline isn't merely due to seeking treatment: children with untreated or visibly damaged front teeth experience lower OHRQoL regardless of whether they went to a hospital. Importantly, functional limitations were significantly affected, and many of these effects decreased over months; about two-thirds of children noted fewer impacts at the six-month mark - implying that the OHRQoL drop, while considerable, often improved as recovery continued [9].

These assertions are based on confirmed measurements. To assess paediatric oral health-related quality of life (OHRQoL), the Child Perceptions Questionnaire [21], which is a multi-domain

tool known for its validity and reliability regarding the effects of oral health on children, is usually used. For adults, the Oral Health Impact Profile [22], particularly its short version, is the standard measure. This distinction between instruments is significant for two main reasons. Firstly, comparisons across studies are qualitative rather than quantitative. Different studies utilize various tools-like child-specific questionnaires, trauma-focused indices, and adult profiles-with diverse structures and scoring systems. As a result, declines in quality can be described in a directional sense, but they cannot be aggregated. Secondly, the strong emphasis on paediatric tools defines the limits of the existing evidence; while the adult profile [22] offers a way to apply these findings to adults and elite athletes, this pathway has yet to be extensively explored.

Additionally, the literature on malocclusion reveals a clear impact on self-image and social consequences. A review[12] on the effects of severe malocclusion highlights the psychosocial challenges related to self-esteem, social engagement, and confidence. It shows that a noticeable dentofacial issue-regardless of trauma-results in a significant psychological burden. Further, [23] specifies the process involved: bullying and teasing among schoolchildren are associated with dental appearance, particularly regarding pronounced or increased overjet incisors, which are known to trigger victimisation linked to appearance. This connection is important for the current discussion for two reasons. It suggests that an increased overjet might lead to psychosocial difficulties even before any actual impact occurs, and it highlights the route through which an added anterior traumatic dental injury (TDI) could worsen distress. In summary, the focal point of interest in this review bears a psychosocial significance at different stages of the cause-and-effect relationship-acting as a visible feature that invites judgment related to appearance[23] and as a damaged, restored, or absent tooth that diminishes OHRQoL [9,11].

This convergence leads to the second hypothesis of this review. H2 - known as the "Biopsychosocial Amplifier" hypothesis - suggests that for athletes, the decline in OHRQoL and self-image after TDI is intensified beyond just the physical injury. An identity that revolves around looks, public presence, and performance could increase the psychosocial impact of an injury compared to a similar non-athlete. The appearance-sensitivity mechanism shown in[23] along with the malocclusion self-image challenges noted in [12] support the idea of this amplification. Additionally, the OHRQoL reductions from [9], [10], and [11] provide a baseline for this effect. However, it's important to note that this hypothesis is one that generates further questions rather than one that is confirmed; there are few to no direct comparisons of athletes and non-athletes that account for TDI severity, and no mentioned study focuses on an athlete-specific increase. H2 thus proposes - but has not proven - that athletes experience greater declines in OHRQoL and self-image than matched non-athletes with the same injury severity; it would be disproven if those declines were found to be statistically the same.

There are two important calibration issues to consider for this subsection. First, the evidence available on OHRQoL is mainly related to children: [9], [10], and [11] focus on younger populations, and the validated child tool [21] reflects this aspect. Extending these findings to adult and especially elite athletes is speculative - it points to an area for future research rather than a definitive conclusion. Second, due to variations in instruments and age groups, the overall issue is best described as a consistent degradation of OHRQoL and self-image linked to appearance across different samples, rather than as a singular measure.

Located on the ladder, the biopsychosocial burden represents downstream branch 1 of the pathway. This element influences the economic branch (3.4) via care-seeking behaviors, re-treatment needs, and the demand for appearance-related restoration. Additionally, it provides

some of the justification for prevention efforts (3.5). According to the H2 argument, this burden is also the one most likely to be underestimated when data from paediatric and general populations are applied to athletes, the focus of this review.

Source	Population	Instrument / measure	Finding (direction)
Porritt et al. 2011 [9]	Children with dento-alveolar trauma	Longitudinal study of OHRQoL impacts	↓ OHRQoL across functional, emotional and social domains; functional limitations among the most affected, with many impacts diminishing over follow-up
Pamei et al. 2026 [10]	Children and adolescents with TDI (hospital-based)	Validated OHRQoL questionnaires	↓ OHRQoL (measurable decrements)
Cardozo et al. 2025 [11]	8-12-year-old school children, Goa, India (non-clinical)	Adolescent Oro-Dental Trauma Impact Index	↓ OHRQoL (comparable to clinical samples)
Leck et al. 2022 [12]	People living with severe malocclusion	Review of psychosocial consequences	↓ self-esteem, social interaction and confidence (independent of trauma)
Seehra et al. 2011 [23]	Schoolchildren	Review linking dental appearance to bullying	Prominent / increased-overjet incisors → appearance-related teasing/bullying (psychosocial harm)

Table 1. Biopsychosocial impact of traumatic dental injury / malocclusion.

3.4 The economic burden

The economic aspect represents the second downstream branch of the pathway. Anterior TDI typically is not just a one-time expense; it marks the beginning of ongoing restorative care, making someone a "dental patient for life. " When a young person suffers a fractured, luxated, or avulsed permanent incisor, they face a continual need for care involving pulpal and endodontic procedures, various restorations, crowns, and ultimately, replacement with prosthetics or implants, which will also require renewal throughout adulthood. Consequently, the cost associated with TDI includes three distinct elements: direct treatment costs (which cover the care itself), indirect costs (like the time spent by patients and caregivers, travel expenses, and lost work productivity), and the ongoing maintenance burden from revising or replacing initial restorations throughout life.

To support these components, three sources are identified, ensuring each remains separate rather than combined (Table 2). [13] presented the direct costs of treating children and teenagers with permanent incisor injuries at a dental hospital in the UK, providing a sterling-based

estimate from the mid-2000s in a hospital context. [14] conducted a one-year prospective study on the costs associated with managing dental trauma in children, including both direct treatment and clinical chair-time over a specific follow-up period within a pediatric group. [15] stands out as the most comprehensive study for this discussion: it involved a two-year prospective cost-of-illness research in Sweden, detailing both direct and indirect costs (encompassing the time and losses for patients and parents) and confirming that the indirect costs significantly contribute to the overall total.

The most vital interpretive guideline for this evidence is that these figures should not be considered interchangeable and cannot be combined into a single headline number. They vary in currency (pounds sterling compared to Swedish kronor), year (ranging from 2001 to 2020, without any inflation adjustments or purchasing-power parity harmonizations), context (a UK dental hospital versus prospective national cohorts), time frame (individual incidents, one-year windows, and two-year windows - none covering a full lifetime), and what they measure (only direct costs, direct costs plus chair-time, or direct and indirect costs combined). Presenting a singular transferable “cost of a knocked-out tooth” would misrepresent this diversity; the accurate summary consists of a collection of estimates specific to each context, each associated with its unique year, currency, and cost type caveat. Collectively, these establish a cohesive qualitative conclusion instead of a shared quantitative figure. Any specific value reported must come directly from its original source, complete with currency, year, and context; these values are not combined, adjusted, or converted here.

Viewed with this caution in mind, the three studies lend support to a strong directional claim, even without a uniform number. First, the direct cost of treating a single injured incisor is significant [13,14]. Second, this direct cost fails to capture the full burden, as indirect time and caregiver expenses greatly contribute to it [15]. Third - and here none of the three studies can provide a complete view since they all assess short durations - the injury's key economic aspect is time-related: the maintenance obligation recurs throughout the remaining life of a person injured in childhood or adolescence, increasing in severity as luxation and avulsion lead to endodontics, crowns, and necessary replacements.

This imbalance forms the economic basis for the third hypothesis mentioned in the review. The ongoing, increasing, and somewhat indirect lifetime expenses associated with a single anterior TDI contrast sharply with the relatively low, one-time or occasional costs of the two prevention strategies examined in section 3.5. The "Prevention Dividend" hypothesis, or H3, suggests that due to this imbalance, the total lifetime costs and quality-of-life reductions stemming from TDI in high-risk athlete morphotypes surpass the investment in targeted prevention, making such prevention a sensible economic choice. It is important to clarify the nature of this hypothesis: H3 presents a directional economic argument rather than a formal cost-effectiveness outcome. Here, there is no incremental cost-effectiveness ratio, net-monetary-benefit figure, or QALY (Quality-Adjusted Life Year) model formed; the variables involved are the diverse, specific ranges described earlier and the limited athlete-specific cost data required to support the claim. A decision-analytic model that shows a favorable ratio for high-risk morphotypes would support H3, while evidence that targeted prevention is less economically viable would refute it.

Within this framework, the economic aspect transforms physical and psychosocial injuries into a lasting financial obligation, characterized by its tendency to recur throughout an individual's life- a factor that is not adequately reflected in the available short-term studies. This discrepancy does not justify inflating the estimate; rather, it underscores the necessity to present the economic argument and the resulting prevention dividend as directional and to prioritize cost, athlete-specific research.

Source	Setting / country	Year / currency	Cost type	Note (setting-specific; no pooled / headline figure)
Wong et al. 2004 [13]	Dental hospital, United Kingdom	2004; pounds sterling (£)	Direct (hospital treatment of permanent-incisor injuries)	Single-centre, hospital setting; direct cost only; not inflation-adjusted
Bani-Hani et al. 2020 [14]	Prospective study, children (paediatric)	2020; currency per source	Direct treatment + clinical chair-time	One-year window (not lifetime); paediatric sample
Glendor et al. 2001 [15]	Cost-of-illness study, Sweden	2001; Swedish kronor (SEK)	Direct + indirect (patient/parent time and related losses)	Two-year prospective horizon; indirect component is a material fraction of total

Table 2. Economic burden of dental trauma.

3.5 Prevention levers

If an increase in overjet with inadequate lip coverage serves as a changeable upstream factor contributing to an expensive downstream issue, the key question is where the process can be disrupted. There are two types of interventions, each targeting different points in the causal chain. Mouthguards function as a situational, secondary measure: while they don't change the shape of the host, they create a cushion that absorbs energy during the process of injury. On the other hand, early orthodontic overjet reduction acts as a structural, primary measure: it tackles the problem directly by moving the protruded incisors back before any injury can occur. These two approaches complement each other instead of replacing one another, and each is supported by a unique body of evidence along with specific practical limitations.

3.5.1 Situational prevention: mouthguards

The most robust quantitative evidence supporting mouthguards comes from a systematic review conducted by Knapik et al. [16]. By examining various sports groups, this review revealed that athletes who did not utilize mouthguards faced a significantly increased risk of orofacial injuries, with a relative risk of about 2.33 (95% CI 1.59-3.44) for not using one compared to those who did. Essentially, neglecting to wear a mouthguard is linked to an increased risk of orofacial injuries by roughly two to three times, indicating a protective effect that is both reliable and clinically significant for the anterior teeth that overjet leaves unprotected. This finding regarding orofacial injuries is the sole advantage of mouthguards mentioned here. Research specific to particular sports further supports the orofacial injury claim while highlighting its limitations: Vucic et al. [17] noted a high rate of dentofacial injuries in field hockey players, who typically held negative views towards mouthguard usage, demonstrating that proven effectiveness does not automatically lead to increased adoption.

This gap in adoption represents a critical real-world barrier to situational prevention. What is effective when worn is not equivalent to effectiveness in practice, where factors like compliance, fit, and upkeep can vary greatly. A study by Özkal Eminoğlu et al. [24] compared the use, hygiene, and maintenance of mouthguards among combat and team-sport athletes, revealing significant variations in the types of devices used and the consistency of their use - indicating that routine and properly maintained wear cannot be taken for granted and differs based on the sport. A mouthguard can only offer protection if it is worn correctly, fitted properly, and well-maintained; thus, the overall public health value of this intervention is more limited by behavioral adherence than by its biomechanical effectiveness.

3.5.2 Structural prevention: interceptive orthodontics

The second lever focuses on reducing exposure right at the source. A Cochrane review conducted by Batista et al. [18] supplies essential proof that implementing an early, two-phase Class II treatment for children significantly lowers the chances of new incisal trauma compared to postponing treatment to a single later phase. When it comes to functional appliances, early intervention decreased the likelihood of new incisal trauma with an odds ratio of 0.56 (95% CI 0.33-0.95), indicating an incidence of approximately 19% for early treatment versus about 30% for delayed treatment. In terms of headgear, the odds ratio stood at 0.45 (95% CI 0.25-0.80). The reliability of this evidence surrounding trauma reduction was deemed moderate for the functional appliance figure and low for the headgear figure (overall, the certainty was low to moderate). Importantly, this assertion specifically pertains to reducing trauma associated with overjet: the review justifies early intervention based on the notable decline in incisal injuries rather than any advantages related to aesthetics, skeletal growth, or self-esteem, for which early two-phase treatment provided no benefits compared to later interventions. Thus, the argument for interceptive orthodontics presented here is strictly about preventing injuries and nothing else - a clear distinction from the cosmetic reasons that typically drive Class II corrections.

3.5.3 Honest weighting

Mouthguards are widely available, cost-effective, and can be used right away in any sport with risk, yet their effectiveness is limited by how consistently they are used [17,28]. On the other hand, interceptive orthodontics is more specific and involves structural changes - it eliminates risks instead of merely providing protection - but it is more expensive, takes longer to implement, is only relevant during certain developmental phases, and is warranted for high-risk morphotypes solely based on trauma considerations [18]. Furthermore, both methods face the same ultimate challenge: compliance. For a mouthguard to offer protection, it needs to be worn, and for the overjet to be corrected, a two-phase orthodontic treatment must be embraced and successfully completed; in both instances, the difference between efficacy and effectiveness hinges on adherence rather than the method itself.

Collectively, these two bodies of research form the foundation for the prevention-dividend argument (H3). Each method evidently alleviates some of the orofacial or incisal trauma burden - mouthguards lessen injuries during impacts [16], while interceptive treatment reduces the occurrence of new incisal trauma, albeit with low-to-moderate certainty [18]. The ideal approach for high-risk athletes - characterized by an increased overjet and insufficient lip coverage in contact sports, stick sports, or ball sports - involves a combination: using a properly fitted mouthguard during gameplay, along with targeted, trauma-justified interceptive measures for selected children.

4. Discussion

This review brought together two traditionally distinct areas of orthodontic research: the association of increased overjet with inadequate lip coverage as a recognized indicator of anterior traumatic dental injury (TDI), and the impact of TDI on loss of oral-health-related quality-of-life (OHRQoL) and associated lifetime costs. The result is an athlete-focused biopsychosocial-economic model rather than a new effect estimate. Here, overjet is shifted from a mere cosmetic concern to an identifiable, adjustable risk factor for injury that incurs costs later on. The framework is structured around three specific, testable hypotheses aligned with the research questions - RQ1→H1, RQ2→H2, RQ3→H3 - with each hypothesis clearly accompanied by a possible counter-evidence. H1 addresses the inherent morphological status; H2 examines the increased burden on athletes; H3 evaluates the cost-effectiveness of preventive measures. This intentional approach to framing each hypothesis with its own condition for falsification turns a narrative about burden into a testable, intervention-focused claim, highlighting the different levels of evidence related to each hypothesis. Currently, H2 and H3 serve as possible avenues for further investigation and are proposed as hypotheses to be validated rather than absolute conclusions; H1, however, is based on a significant, though confounded, quantitative foundation.

4.1 H1 - The "Upstream Multiplier" hypothesis

H1 asserts that the shape of orthodontic features-specifically, an increased overjet and lips that do not cover teeth properly-serves as a real and changeable factor influencing athlete TDI, rather than just a result of exposure to physical activity or risky behaviors. The standard systematic review [6] found that the risk of anterior trauma is nearly doubled for individuals with an overjet greater than 3 mm, with this risk increasing steadily along with the overjet size. More recent meta-analytic findings support this view: [7] presented an odds ratio of 1.78 (95% CI 1.17-2.70) for overjet measurements over 3.5 mm and a 2.57 odds ratio (95% CI 1.82-3.62) for inadequate lip coverage, which identifies lip incompetence as the most significant single anatomical risk factor; being male was also linked independently (odds ratio 2.06, 95% CI 1.72-2.47).

The main challenge to H1 is its complexity. [8] points out that studies observing dentofacial trauma can be affected by lingering confounding factors such as age, sex, socioeconomic status, sports participation, and hours of exposure, meaning that a simple association doesn't necessarily imply a causal relationship.

Falsification/Test: H1 would be considered invalid if the effect of overjet/ lip-incompetence decreases towards neutrality after applying multivariable adjustments for age, sex, sport type, and exposure hours in a suitably powered, exposure-controlled group (preferably athletes).

4.2 H2 - The "Biopsychosocial Amplifier" hypothesis

H2 posits that athletes experience the effects of TDI far beyond just the physical damage; their identity tied to appearance, along with the visibility of sports, amplifies losses in OHRQoL and self-image when compared to non-athletes with similar injuries. This issue is well-documented in both general and pediatric populations. Trauma affecting the teeth and jaw in children negatively impacts OHRQoL across various aspects-functional, emotional, and social [9]. Research conducted in hospitals [10] and schools [11] shows significant declines using established OHRQoL assessment tools. Studies on dentofacial form support the social implications of dental appearance, noting links between malocclusion [12] and instances of

teasing or bullying [27]. This suggests that appearance-related distress could be more intense among those whose physical looks are closely connected to their athletic identity.

What is lacking is a comparison that would prove this amplification. There are virtually no direct comparisons of OHRQoL between athletes and non-athletes, matched by injury severity; the existing data tends to be general, primarily focused on children, and evaluated with varying tools, allowing for qualitative insights but not collective analyses. Hence, the assertion of amplification is an inference-fair and supported by mechanisms, yet unverified. It should be viewed as a hypothesis rather than a confirmed athlete-specific conclusion; the truthful stance is that athletes might face more significant declines, a hypothesis that still requires validation. Furthermore, it's worth considering an alternative scenario: the boost from athletic confidence and team backing could potentially lessen the psychosocial toll of noticeable dental injuries, suggesting that the decline might be equal to or less than that of non-athletes. Since the existing data cannot clarify whether there are amplification or buffering effects, the nature of any unique impact on athletes remains an open question for research.

Falsification/Test: H2 is disproved if matched athletes, with equivalent TDI severity, report OHRQoL and self-image declines that are statistically similar to those of matched non-athletes.

4.3 H3 - The "Prevention Dividend" hypothesis.

H3 argues that the overall lifetime expenses and the loss of quality of life due to athlete TDI are greater than the costs associated with targeted prevention in high-risk morphotypes, making prevention a sensible economic choice. Two main approaches mitigate this burden. The first, situational - mouthguards - helps to decrease the risk of orofacial injuries: [16] found that those who do not use mouthguards face approximately 2.33 times (95% CI 1.59-3.44) the risk of orofacial injuries compared to users (focusing on orofacial injuries only; concussions are not included). The second approach, structural - interceptive/early Class II correction - minimizes new incisal trauma: [18] reported odds ratios of 0.56 (95% CI 0.33-0.95) for functional appliances and 0.45 (95% CI 0.25-0.80) for headgear, with this effect specifically linked to reducing trauma risk rather than cosmetic benefits, as the same review noted no other lasting advantage of early interventions. In contrast, there are significant and ongoing lifetime costs: direct costs for hospital treatment [13], prospective one-year management costs [14], and combined direct-plus-indirect (time and caregiver) illness costs [15].

The imbalance - relatively inexpensive and effective prevention versus expensive, lifelong restorative care ("dental patient for life") - leans favorably towards prevention, especially for more severe injuries, where luxation and avulsion can lead a young patient to years of endodontics, crown replacements, and eventual implant treatment. However, this does not translate into a definitive cost-effectiveness outcome: there are no incremental cost-effectiveness ratios (ICER) or quality-adjusted-life-year (QALY) models presented here, the effect sizes of the two approaches are not directly comparable, and real-world barriers to implementation [17,28] could diminish the potential benefits.

Falsification/Test: H3 becomes invalid if a decision-analytic model for high-risk morphotypes shows a negative net monetary benefit or an ICER that exceeds a standard willingness-to-pay threshold. This means that if targeted prevention is found to be economically unfavorable, it is considered falsified.

4.4 Prevention prioritization and practice message

Prioritization ought to depend on morphotype and sport instead of being uniform. The focus should be on athletes with high overjet and poor lip closure, particularly those involved in contact, collision, or stick/ball sports, where there is a combination of increased host risk and significant impact exposure. A well-fitted mouthguard is a sensible suggestion for everyone

participating in contact sports since it is widely applicable, cost-effective, and situational. For selected high-risk children, early reduction of overjet should be assessed based on trauma risk, clearly distinct from any cosmetic considerations. The structural approach should be applied only when a child's morphology categorizes them as high-risk, with both approaches being complementary instead of mutually exclusive. Practically, this would involve a straightforward two-step screening process during sport participation: first, identify the high-risk morphotype (overjet exceeding approximately 3 mm with incompetent lip coverage) and assess the sport's impact exposure, and next, implement the universal, low-effort strategy (a fitted mouthguard) for all those in contact sports, while the targeted, more intensive intervention (interceptive overjet reduction) is reserved for the few whose morphology and age warrant it. The emphasis is on proportionate prevention rather than a one-size-fits-all orthodontic approach.

4.5 Research agenda

The main deliverables arise directly from the untested aspects of the pathway. To begin, it is essential to establish confounder-adjusted, exposure-controlled overjet→TDI groups among athletes to evaluate H1 [7,8]. Next, studies comparing the OHRQoL and self-image of matched athletes and non-athletes are necessary, focusing on TDI severity and employing standardized tools, to assess H2 [9]. Additionally, data on athlete-specific direct and indirect costs, along with a formal decision-analytic model incorporating QALYs and an ICER for high-risk morphotypes, must be gathered to examine H3 [15,18].

5. Limitations

A number of factors limit the reliability of conclusions regarding the associations between overjet/lip-incompetence and TDI. Key issues include significant confounding due to the high variability ($I^2 = 93\%$) of observational data, which diminishes the effect when considering variables like age, sex, type of sport, and hours of exposure [8]. The relationship is not established as causal, necessitating tools tailored for observational studies for evaluation, rather than relying on controlled trials [20]. Furthermore, economic data presents inconsistencies related to region, currency, and year, with costs presented in ranges that lack adjustment for inflation and purchasing power. The "Prevention Dividend" serves only as a directional suggestion for cost-effectiveness, not a conclusive assessment. Additionally, the important effect-size meta-analysis [7] focuses exclusively on Arab children, making it difficult to apply these results to adult or elite athletes, which should be considered carefully.

Information specific to athletes remains scant, with the data drawn primarily from general and pediatric populations, leading to insufficient cost data. Variability in definitions and measurements of terms like overjet and lip coverage further complicates interpretations. OHRQoL measurements vary widely across age groups, restricting qualitative comparisons. Notably, concussions are excluded from consideration, focusing only on orofacial outcomes, as mouthguard effectiveness is referred solely in relation to orofacial injuries [16]. Lastly, although this synthesis resembles systematic reviews, it is not recognized as a PRISMA systematic review, lacking an independent database search, data re-pooling, and a pre-registered protocol.

6. Conclusion

A significant overjet combined with insufficient lip coverage presents a biologically plausible and consistently linked factor that could modify the extensive biopsychosocial challenges faced by athletes experiencing anterior dental trauma injury (TDI). This paper introduces a connected

sequence that results from this relationship: overjet → trauma → OHRQoL and psychosocial impact → lifetime expenses → prevention, all framed together through an athlete-centered perspective for the first time. The evidence supporting this includes a recognized systematic review and a recent meta-analysis focused on risk association [6,7], well-documented declines in OHRQoL following trauma [9], a mixture of important direct and indirect costs [13,14,15], and two prevention strategies with notable effects on orofacial and incisal trauma [16,18].

The assertions made are presented with careful consideration. The basic risk association might lessen with multivariable adjustments [8]; the idea of athlete amplification (H2) serves as a starting point for hypotheses, while the prevention dividend (H3) indicates direction rather than presenting a strict ICER; economic data vary by currency, year, and context, and are provided only as ranges; concussion is intentionally excluded. Therefore, both situational mouthguards (for orofacial safety) and early interventions for overjet reduction (structurally aimed at reducing trauma risk rather than for aesthetic purposes) can alleviate part of this burden and should be prioritized according to the athlete's morphotype and sport. For audiences interested in physical culture, the key takeaway is to view overjet as more than just an aesthetic element; instead, it should be recognized as a measurable and modifiable exposure linked to injury rates, and strategies for prevention should be developed and funded accordingly. The immediate focus must be on acquiring adjusted evidence specific to athletes and creating a decision-analytic cost-effectiveness model, which together could validate or challenge the hypotheses H1 and H3. A broader insight extends beyond dentistry: to prevent sports injuries effectively, one must identify and address the underlying host factor—highlighting the point of leverage rather than merely tracking the outcomes.

Declarations

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