

# National Athletic Trainers' Association Position Statement: Reducing Intentional Head-First Contact Behavior in American Football Players

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**Objective:** To provide evidence-based recommendations for reducing the prevalence of head-first contact behavior in American football players with the aim of reducing the risk of head and neck injuries.

**Background:** In American football, using the head as the point of contact is a persistent, well-documented, and direct cause of catastrophic head and cervical spine injury. Equally concerning is that repeated head-impact exposures are likely to result from head-first contact behavior and may be associated

with long-term neurocognitive conditions such as dementia, depression, and chronic traumatic encephalopathy.

**Conclusions:** The National Athletic Trainers' Association proposes 14 recommendations to help the certified athletic trainer, allied health care provider, coach, player, parent, and broader community implement strategies for reducing the prevalence of head-first contact in American football.

**Key Words:** catastrophic injury, sport injury, helmet, concussion, chronic traumatic encephalopathy

## Key Points

- Head-first contact behavior during tackling and blocking in American football persists and is associated with an increased risk of head and neck injury.
- We developed 14 recommendations based on the scientific literature and expert consensus to help address the behavior of initiating contact with the head in American football.
- High-level, empirical evidence to support strategies for reducing head-first contact behavior is lacking, highlighting the continuing need to conduct rigorous research (eg, randomized controlled trials).
- Lower-level evidence, combined with education and rule changes, shows promise for reducing injuries stemming from head-first contact.

In 2004, the National Athletic Trainers' Association (NATA) position statement "Head-Down Contact and Spearing in Tackle Football" presented recommendations to decrease the incidence of cervical spine and head injury risk in football participants using head-down tackling techniques.<sup>1</sup> *Head-down tackling* uses the top or crown of

the helmet to initiate contact, and *spearing* is the deliberate and intentional use of a head-down contact technique.<sup>2</sup> The original 24 recommendations were aimed at reducing the risky behaviors that can lead to cervical spine fractures and dislocations, as well as traumatic brain injuries.<sup>3</sup> At that time, head-down tackling remained a persistent behavior in



football players despite a decades-old rule prohibiting spear tackling. Even with new rules and contemporary educational programs on tackling intended to protect the head, head-first contact behavior remains commonplace in tackle football today and, therefore, necessitates a renewed focus. For the purposes of this position statement, *head-first contact behavior* refers to players initiating contact with their heads, regardless of where that impact is initiated (top or front of helmet) or what they are doing when exhibiting that head-first contact technique (tackling, blocking, or carrying the ball).

Research<sup>4–12</sup> has revealed that head impacts in American football, at all levels of play, are frequent and of varying severity. Technologies permitting in vivo head-impact measurements indicated that players can experience a high frequency of head impacts each season, with crown-related impacts resulting in the highest accelerations (ie, impact force).<sup>4,7</sup> These impacts pose particular risk for both head and neck injuries, as evidenced in 2011 with the initial in vivo biomechanical data of a head-first tackle that resulted in a cervical spine fracture and concussion.<sup>13</sup> These data highlight an increasing concern that head impacts can cause not only cervical spine injuries but also acute<sup>3</sup> and chronic<sup>14–17</sup> brain injuries. Since 2004, investigators<sup>3,18–20</sup> have continued to document the prevalence and incidence of head and neck injuries in epidemiologic studies. For example, data from the 2011–2012 and 2013–2014 athletic seasons showed that US high school football players had the highest sport-related concussion rate.<sup>18</sup> Most impacts that result in concussion among high school football players occur at the front of the helmet; the largest proportion of those involving loss of consciousness occur at the top of the head.<sup>21</sup> Not only is using the head as the point of contact in American football a direct cause of catastrophic head and spine injuries, but accumulated head-impact exposures are thought to contribute to the risk for long-term neurocognitive conditions such as dementia, depression, and chronic traumatic encephalopathy,<sup>22–25</sup> emphasizing the importance of reducing head impacts in football, regardless of the force or association with acute injury.

Therefore, it is essential to update the 2004 position statement and address the persistent behavior of head-first contact in American football players. Our purpose was to present recommendations that encompassed (1) education and administration, (2) skill development and behavior modification, (3) rules and regulations, and (4) technology and scientific research as they relate to decreasing head impacts in football.

## RECOMMENDATIONS

Through its members, the NATA has provided foundational leadership, research, and education for the prevention, management, and care of athletic injuries. Highlighting these key principles is the NATA position statement on preventing sudden death in sports.<sup>26</sup> Thus, the NATA continues to seek collaborations and interprofessional initiatives to improve the safety of sport at all levels by reducing injuries and illnesses. Football players must learn, execute, and maintain head-protective behaviors. However, we should not expect players to independently and spontaneously learn these complex behaviors<sup>27,28</sup> or transfer them to the unpredictable context and emotions of

competition.<sup>29</sup> The responsibility for implementing these recommendations should not fall solely on an athletic trainer (AT). Rather, where appropriate, the AT may be part of a multidisciplinary team that can help implement these best practices cohesively within the organizational structure. All stakeholders should commit to working together to use strategies that enhance football player health and safety by reducing head-first impacts and limiting both intentional and unintentional head contact.

The NATA advocates that the following recommendations be carefully considered as part of an overall prevention strategy to reduce the prevalence of head-first contact in tackle football. The recommendations are rated using the letters *A*, *B*, or *C* in association with the Strength of Recommendation Taxonomy (SORT) developed by the American Academy of Family Physicians.<sup>30,31</sup> Although some methods for reducing head-first contact in football have been outlined,<sup>32,33</sup> few data from controlled trials' research designs have supported the effectiveness of such measures. Nevertheless, the epidemiologic and case study literature, in addition to models from other sports and expert consensus, inform the recommendations that lack high-level evidence.

## Education and Administration

1. Develop and require consistent, contemporary education for players on the dangers of head-first contact in football as it pertains to the risk for head and neck injury.<sup>34</sup> *Strength of Recommendation (SOR): C*
2. Develop and require documented education for coaches at all levels of play, including youth, on the dangers of teaching, instructing, or allowing head-first contact in football as it pertains to the risk for head and neck injury.<sup>34</sup> *SOR: C*
3. Develop and require education for officials at all levels of play on the mechanisms and dangers of head-first contact in football and how they pertain to officiating scrimmages and games.<sup>1,34</sup> *SOR: C*
4. Organizational bodies that involve minors should communicate with parents and legal guardians on a regular basis to describe the strategies used to reduce head-first contact behavior and its potentially risky outcomes. *SOR: C*
5. Encourage coaches, strength and conditioning specialists, administrators, ATs, team physicians, and athletics or league directors to meet regularly and work together to discuss, implement, and review strategies (including the recommendations in this document) that reduce head-first contact behavior by football players.<sup>1,26,34</sup> *SOR: C*

## Skill Development and Behavior Modification

6. Introduce evidence-based, progressive techniques for avoiding head-first contact behavior<sup>33,35–38</sup> during ball carrying, tackling, and blocking before the first exposure to tackle football (ie, first-time participants, preseason). *SOR: B*
7. Teach until mastery is achieved and reinforce the maintenance of appropriate tackling and blocking skills that explicitly deter head-first contact behavior<sup>3,33,35,38</sup> in football at all levels of play. *SOR: B*

## Rules and Regulations

8. Because full-contact practice sessions (ie, live tackling, taking the opponent to the ground) increase the opportunities for head-first behavior, regulate the time devoted to such sessions each week<sup>39,40</sup> to ensure sufficient focus on age-appropriate instruction, maintenance, and mastery of proper tackling and blocking skills. *SOR: B*
9. Adapt the practice structure by eliminating or modifying football drills that do not reinforce proper and safe tackling and blocking behaviors or techniques.<sup>41–43</sup> *SOR: B*
10. Consistently enforce the penalties or fines (or both) for head-first contact behavior, spearing, or targeting at all levels of play for all player positions.<sup>3,44</sup> *SOR: C*

## Technology and Scientific Research

11. Recognize that helmet and after-market companies that produce helmet add-on products may overstate injury-prevention benefits,<sup>45,46</sup> leading to risk-taking behavior.<sup>47,48,49</sup> *SOR: B*
12. Consider using validated head-impact monitoring systems or video capture<sup>50,51</sup> (or both) as a complementary tool for identifying and correcting head-first contact behavior. *SOR: B*
13. Educate athletes on the influence of protective equipment and techniques related to avoiding head contact.<sup>46</sup> *SOR: C*
14. Engage all stakeholders in the generation of high-level scientific research to test and validate strategies, techniques, or technologies proposed to support the reduction of head-impact exposure in football. *SOR: C*

## BACKGROUND AND LITERATURE REVIEW

### Education and Administration (Recommendations 1–5)

The need for consensus among stakeholders on the education and administration of head-safe principles is obvious and stems from the 1970s, when the risk of spear tackling was first identified.<sup>44</sup> Players were then instructed to “see what you hit” and encouraged to tackle with the “head up.” Thus, the “heads-up tackling” phrase was used in promotional efforts, such as locker room posters. The National Operating Committee on Standards for Athletic Equipment (NOCSAE) included such phrases on helmet shells as a required component of certification. Tracking the direct effectiveness of these educational efforts remains difficult because they coincided with rule changes that made intentional spear tackling illegal. However, after the rule was implemented, the incidence of catastrophic head and neck injuries declined by approximately 50%.<sup>44</sup>

Despite widely accepted knowledge about the axial-load mechanism and risks of head-down tackling,<sup>3</sup> the behavior has not been eliminated, as verified through observational<sup>52,53</sup> and instrumented<sup>4,9,54–56</sup> research. For example, between 2010 and 2019 in high school and collegiate football, a total of 287 catastrophic head and neck injuries were reported, with 40 of these events resulting in fatalities.<sup>57</sup> Although no football injury rates during this timeframe have been published, Boden et al<sup>58</sup> determined

**Table 1. Categories of Educational Programs on Head-Contact and Playing Behaviors in Rugby**

Strategies
General education
Safety workshops and practical trainings for stakeholders
Online educational material specific to head, neck, and spine injuries
Athlete education and information
Supportive environment and community information
Medical care and protocols
First aid in rugby
Medical programs and protocols

that the rate of brain-related injury deaths from 1990 to 2010 was 0.26 per 100 000 athletes (number of fatalities = 62) and 4 deaths resulted from cervical fractures. All deaths were attributed to severe head impact. Justifiably, much effort continues to be directed at educational strategies for participants and other stakeholders to raise awareness and discourage head-first and head-down tackling behaviors. No authors have directly evaluated the effect of player or coach education on head-first contact, but expert consensus is that contemporary education for players and documented education for coaches should be current practices for both governing bodies and institutions.<sup>12</sup>

Even though they were not necessarily aligned with the historical understanding pertaining to spine injury prevention and the focus of the original position statement, USA Football<sup>59</sup> and the US Centers for Disease Control and Prevention<sup>60</sup> developed educational campaigns promoting heads-up tackling to improve awareness and encourage proper tackling and contact training to avoid concussion. Yet, despite this common-sense approach, little to no direct scientific evidence has supported a role of heads-up educational programs in reducing cervical spine and head injuries. However, early researchers who studied the USA Football model proposed that implementation of such a program might reduce head impacts over a season in youth athletes<sup>61</sup> and reduce concussions among high school athletes.<sup>36</sup> Missing from the discussion, analysis, and implementation of educational programs were game officials, who have a significant influence on the field of play. Thus, based on consensus and expert opinion, American football officials should also be part of these educational efforts.<sup>1,34</sup>

American football is not alone in its efforts to reduce the incidence of head and spine injuries. Recommendations 2 and 3 highlight the similarities with rugby in the requisite skill of tackling and associated injuries.<sup>62</sup> Although players sustained multiple impacts during play,<sup>63–65</sup> most of these occurred on the side and back of the head,<sup>63,65</sup> suggesting that intentional head-first contact behaviors were not used in rugby; this was in contrast to American football, in which front and top impacts were most frequent.<sup>4,7,66</sup> Nevertheless, extensive educational efforts using various themes (Table 1) to control the head<sup>62</sup> and spine<sup>67,68</sup> injury risk in rugby demonstrated moderate success. For example, the RugbySmart program in New Zealand<sup>69</sup> required coaches and referees to attend annual workshops to view video and internet resources related to head safety. Educational guidelines focused on physical conditioning, tackling and scrummaging techniques, and injury-management strategies. The RugbySmart program decreased



scrum-related spine injuries and overall injury claims.<sup>70</sup> BokSmart, a similarly designed educational program for rugby in South Africa, reduced the prevalence of catastrophic head and neck injuries between 14% and 24%.<sup>71</sup> A national injury-prevention program for rugby in France, when combined with rule changes to the scrum event, decreased spine injuries from 1.8/100 000 to 1.0/100 000 players, yet spine injuries among players categorized as backs increased.<sup>67</sup> However, when Fraas and Burchiel<sup>72</sup> reviewed 10 reports on rugby educational programs and catastrophic head and neck injuries or concussions, they concluded that little good-quality evidence supported the effectiveness of these programs. Of the articles included, none provided SORT level 1 (good-quality) evidence, and only 2 studies offered level 2 (limited-quality [patient-oriented]) evidence.<sup>72</sup> Although initiatives in rugby can serve as a model for football, further prospective research is needed to establish the long-term efficacy of educational programs in these and other sports involving collisions (eg, ice hockey).

Additionally, for these educational efforts to be effective, coordination of key stakeholders (eg, coaches, strength and conditioning specialists, administrators, ATs, team physicians, officials) is essential to ensure that evidence-based strategies<sup>1,26,34</sup> are part of local football safety efforts. Experts agreed that organizations involving minors should also communicate these evidence-based strategies on a regular basis to parents and guardians, given their role in the child's decision making and participation.<sup>1,34</sup>

### Skill Development and Behavior Modification (Recommendations 6, 7)

Tackling and blocking are foundational skills that involve contact or collision, often with subsequent body-to-ground contact. Thus, it is likely unrealistic to prevent all head impacts in American football players, and no threshold has been identified for a safe number of head impacts. Nevertheless, teaching tackling and blocking techniques that help players adopt skills to avoid or significantly limit head impacts provides a conservative platform for the recommendations in this category, especially for young players and those beginning football participation. Because reducing the prevalence of impacts derived from head-first contact behavior is this statement's logical goal, teaching skills with the intent of reducing head impacts is essential.

However, rigorous research models for reducing head-initiated behavior in sports are challenging to design and carry out. This explains the dearth of prospective randomized controlled trials (RCTs) in American football; to date, most studies have been cohort based and non-randomized in design, which can carry a high risk of bias<sup>73</sup> (Table 2). For example, a laboratory-based investigation<sup>37</sup> demonstrated that football players could adapt techniques to avoid or lessen the magnitude of head impacts after a single training session, but because this work was not conducted in an active football environment, its external validity was limited. Field-based research on a team-level (nonrandomized) intervention using the "Heads Up Football Program" (USA Football) showed a 3.4 impacts/practice reduction in head-impact exposure,<sup>61</sup> and head impacts decreased by approximately 30% after midseason implementation of a tackling training intervention.<sup>35</sup> Other

field-based studies resulted in reductions in concussions, both when combined with practice contact restrictions<sup>32</sup> and without.<sup>36</sup> Despite these findings, some research on USA Football's "Heads Up" program indicated it was inconsistently implemented<sup>74</sup> and may be less accessible to communities of lower socioeconomic status.<sup>75</sup> Furthermore, USA Football recently revised the "Heads Up" tackling training system to include "rugby-style" tackling, which emphasizes shoulder contact, but to our knowledge, the newer protocol's effectiveness has not yet been assessed.

The concept of incorporating rugby-style tackling techniques in American football<sup>76</sup> has grown in popularity based on the presumption that it develops safer skills and reduces the chance of using the head as the point of contact. During a properly executed rugby tackle, the defender's head is not the focal point of contact, nor is it intentionally placed in front of the ball carrier.<sup>77</sup> The National Football League (NFL) promotes a modification of rugby-style tackling instruction for American football in the "Hawk Tackling" method<sup>76</sup> associated with the Seattle Seahawks and the team's head coach. Instructional videos remain prevalent online, although no scientific literature to date supports the efficacy of the tackling technique to reduce head-first contact behavior.

Randomized controlled trials have been conducted to determine the effectiveness of a progressive helmetless-tackling training (HuTT) program in reducing head-impact exposures.<sup>33,38</sup> The HuTT technique also models rugby in that the skill progression and behavioral development require athletes to complete training without a helmet. Doing so makes use of inherent reflexes<sup>78,79</sup> that remove the unprotected head as a point of contact. This is a manifestation of risk compensation theory,<sup>80-82</sup> whereby protective measures, such as a helmet, can sometimes result in unintended consequences or increase risky behavior. For instance, spear-tackling behavior originated and persisted because of the advent of helmets with hard outer shells, which gave players a false sense of security.<sup>83</sup> This conduct may be countered by time spent in helmetless training. Early results at the collegiate level showed a 30% reduction in head-impact exposure throughout the season when training drills were implemented twice per week in the preseason and once per week in the regular season.<sup>33</sup> At the high school level, more frequent training sessions primarily reduced head impacts during games at midseason time points.<sup>38</sup> Although more examination is warranted, this training method holds promise as an intervention for reducing head-impact behavior and cumulative exposure. Details on these interventions published in the research thus far can be found in Table 2.

### Rules and Regulations (Recommendations 8–10)

Historically, the first measures taken to influence player behavior were updating policies and rules. The landmark 1976 rule change to eliminate intentional spear tackling or using the head as a weapon is one such example. Even though this change decreased catastrophic head and spine injuries, nearly 80% of high-magnitude head impacts resulted from leading with the head.<sup>66</sup> This indicates a continuing need to emphasize policies and develop innovative health and safety interventions to further reduce

**Table 2. Characteristics of Intervention Studies for Reducing Head-Impact Exposure in American Football Players Continued on Next Page**

Research Study	Study Design	Strength of Recommendation Taxonomy		Sample, n	Intervention	Relevant Findings
		Study Quality <sup>30</sup>	2			
Kerr et al (2015), "Comprehensive Coach Education Reduces Head Impact Exposure in American Youth Football" <sup>60</sup>	Cohort	2	70 (HU = 38, NHU = 32)	Educational: preseason, HU teams received didactic and demonstration instruction in tackling techniques, drill development, and ↓ player contact. Top-down instruction provided by "master trainers" to PSCs and then team coaches and players.	<ul style="list-style-type: none"><li>• ↑ Impacts in NHU (62%, n = 4637) vs HU (38%, n = 2841) group</li><li>• 6 concussions, all in NHU, but no difference between HU and NHU</li><li>• Age 8 to 11 y: ↑ practice impacts/individual in NHU (9.1 ± 3.3) vs HU (5.5 ± 3.2; difference = 3.6; 95% CI = 2.9, 4.3)</li><li>• Age 12 to 15 y: ↑ practice impacts/individual in NHU (8.7 ± 2.9) vs HU (5.7 ± 2.5; difference = 3.0; 95% CI = 2.3, 3.7)</li><li>• At 10g, 20g thresholds: no difference between game impacts/individual</li><li>• 10g threshold: ↓ practice impacts/individual in HU (5.6 ± 2.9) vs NHU (8.9 ± 3.1; difference = 3.4; 95% CI = 0.9, 3.9); difference varied at 20g threshold but remained significant (difference = 1.0; 95% CI = 0.7, 1.3)</li></ul>	
Schussler et al (2018), "The Effect of Tackling Training on Head Accelerations in Youth American Football" <sup>37</sup>	Controlled laboratory	3	24 (age = 11.5 ± 0.6 y)	Behavioral: 1-d training on tackling technique using tackling dummy. Subgroup completed additional 2 d of training and 48-h retention test.	<ul style="list-style-type: none"><li>• ↓ Peak linear head accelerations &gt;10g and peak rotational head accelerations &gt;1885°/s<sup>2</sup> in dummy tackling after 1- and 3-d training regimens; tackling form score changed between pretest and posttest (<i>P</i> = .004).</li><li>• Risk of SRC = 1.5× (95% CI = 1.1, 2.1) or 32% ↓ for HU vs NHU (4.1 vs 6.0/100 players)</li><li>• Entire cohort: game (61) vs practice (56) rate ratio difference not significant (1.1; 95% CI = 0.73, 1.5)</li><li>• ↑ Practice SRCs in NHU vs HU (RR = 1.9; 95% CI = 1.1, 3.2)</li></ul>	
Shanley et al (2019), "Heads Up Football Training Decreases Concussion Rates in High School Football Players" <sup>36</sup>	Prospective cohort	2	2514 (HU = 1818, NHU = 696)	Behavioral: preseason, ≥1 coach/team received HU training from USA Football. Coaching technique, player instruction monitored randomly ×3 during season to ensure program compliance.	<ul style="list-style-type: none"><li>• End of season 1: intervention → 28% ↓ in head-impacts/AE (9.99 ± 6.10); control unchanged (13.84 ± 7.27. <i>P</i> = .009)</li><li>• Intervention: 30% ↓ impacts/AE (9.99 ± 6.10) vs control (14.32 ± 8.45, <i>P</i> = .045)</li><li>• WoH: 26%–33% ↓ game ImpAEs at 2 identical time points across seasons; also ↓ game ImpAEs vs control at wk 4 (season 1 <i>P</i> = .0001, season 2 <i>P</i> = .0005) and 7 in both seasons (<i>P</i> = .0001) and ↓ ImpAEs in wk 7 during training vs control in-season 1 (<i>P</i> = .015)</li></ul>	
Swartz et al (2015), "Early Results of a Helmetless-Tackling Intervention to Decrease Head Impacts in Football Players" <sup>33</sup>	RCT	2	50 (intervention = 25, control = 25)	Behavioral: progressive tackling instruction, drills (HuTT) without shoulder pads and helmet 2×/wk preseason, 1×/wk in-season	<ul style="list-style-type: none"><li>• End of season 1: intervention → 28% ↓ in head-impacts/AE (9.99 ± 6.10); control unchanged (13.84 ± 7.27. <i>P</i> = .009)</li><li>• Intervention: 30% ↓ impacts/AE (9.99 ± 6.10) vs control (14.32 ± 8.45, <i>P</i> = .045)</li><li>• WoH: 26%–33% ↓ game ImpAEs at 2 identical time points across seasons; also ↓ game ImpAEs vs control at wk 4 (season 1 <i>P</i> = .0001, season 2 <i>P</i> = .0005) and 7 in both seasons (<i>P</i> = .0001) and ↓ ImpAEs in wk 7 during training vs control in-season 1 (<i>P</i> = .015)</li></ul>	
Swartz et al (2019), "A Helmetless-Tackling Intervention in American Football for Decreasing Head Impact Exposure: A Randomized Controlled Trial" <sup>38</sup>	RCT	1	180 enrolled, 115 completed study (WoH = 59, control = 56)	Behavioral: progressive tackling, blocking instruction and drills without shoulder pads and helmet; 4×/wk preseason, 2×/wk in-season over 2 y	<ul style="list-style-type: none"><li>• End of season 1: intervention → 28% ↓ in head-impacts/AE (9.99 ± 6.10); control unchanged (13.84 ± 7.27. <i>P</i> = .009)</li><li>• Intervention: 30% ↓ impacts/AE (9.99 ± 6.10) vs control (14.32 ± 8.45, <i>P</i> = .045)</li><li>• WoH: 26%–33% ↓ game ImpAEs at 2 identical time points across seasons; also ↓ game ImpAEs vs control at wk 4 (season 1 <i>P</i> = .0001, season 2 <i>P</i> = .0005) and 7 in both seasons (<i>P</i> = .0001) and ↓ ImpAEs in wk 7 during training vs control in-season 1 (<i>P</i> = .015)</li></ul>	

Table 2. Continued From Previous Page

Research Study	Study Design	Strength of Recommendation		Sample, n	Intervention	Relevant Findings
		Study Quality <sup>30</sup>	Taxonomy			
Kerr et al (2016), "Comparison of Indiana High School Football Injury Rates by Inclusion of the USA Football 'Heads Up Football' Player Safety Coach" <sup>97</sup>	Cohort	2		390 (PSC = 204, EDU = 186)	Educational: players supervised by PSC certified in concussion program modules ("Heads-Up"), heat and hydration, cardiac arrest, and proper tackling, blocking, and equipment fit	<ul style="list-style-type: none"> <li>• 17 SRCs = 11.4% of all injuries</li> <li>• Educational = 88.2% (n = 15/17) vs PSC group (11.8%, n = 2/17)</li> <li>• SRCs in practice: IRR ↓ in PSC group (0.09 vs 0.73/1000 AEs; IRR = 0.12; 95% CI = 0.01, 0.94)</li> <li>• SRCs in games: IRR not different in PSC group vs EDU (0.60 vs 4.39/1000 AEs; IRR = 0.14; 95% CI = 0.02, 1.11)</li> <li>• 30% ↓ total frequency of practice impacts session in practice 1 mo postintervention</li> <li>• No difference in cumulative rotational velocity (g): preintervention = 4047.46 ± 1838.71, postintervention = 3789.98 ± 2170.24 (P = .6378)</li> <li>• Average cumulative linear acceleration (g) ↓: preintervention = 272.19 ± 112.78, postintervention = 186.10 ± 80.98 (P = .0037)</li> </ul>
Champagne et al (2019), "Data-Informed Intervention Improves Football Technique and Reduces Head Impacts" <sup>35</sup>	Experimental	2		70 (baseline and postintervention measurements), 19 wore helmet accelerometers	Behavioral: players completed prepractice tackling and blocking drills simulating game-like situations 2×/wk	

Abbreviations: AE, athlete-exposure; EDU, education-only group; HU, "Heads-Up" participants; HuTT, helmetless-tackling training; ImpAE, impacts per athlete-exposure; IRR, injury rate ratio; NHU, non-"Heads-Up" participants; PSC, player safety coach; RCT, randomized controlled trial; RR, rate ratio; SRC, sport-related concussion; WOH, without-helmet group.

head-first contact behavior, whether via tackling, blocking, or carrying the ball.

Limiting contact practices and modifying practice structures may be beneficial in reducing the magnitude and frequency of head impacts. In 2011, the NFL Players' Association collective bargaining agreement restricted full-contact practices by limiting the total to 14 per year, with 11 allowable in the first 11 weeks of the season (1 per week). The agreement influenced the 2016 National Collegiate Athletic Association (NCAA) policy change that limited full-contact practices to 1 per week with players dressed in full equipment or shells (helmet and shoulder pads only). The Ivy League schools went so far as to ban tackling from practice altogether.<sup>84</sup>

Youth football participants can experience an average of 100 to 200 head impacts in a season,<sup>10,11,85</sup> whereas high school players may sustain more than 400 impacts.<sup>86,87</sup> The increase in head-impact frequency with age contradicts the typical improvement in skill that correlates with increased experience. To mitigate head-impact exposure, some states and leagues have limited the number of allowable full-contact practice days per week or, as in youth football, prohibited tackling in practice. Pop Warner practice guidelines eliminate drills in which players are more than 2.7 m (3 yd) apart,<sup>88</sup> though these efforts have been driven primarily by the risk for concussion. When full-contact high school football practices were reduced from 3 to 2 per week, head-impact instrumentation captured a 42% overall reduction in head-impact exposure, with a greater decrease during practices than during games.<sup>40</sup> However, too few concussions occurred to evaluate a change in that risk. Similar findings were noted among youth athletes when contact practices were restricted.<sup>89</sup> In addition, eliminating certain drills known to encourage head-first contact behavior (eg, the Oklahoma Drill) or limiting full-contact practice sessions decreased the risk of sustaining a catastrophic spine injury or concussion.<sup>40</sup> Yet adopting changes that restrict practice in a full-contact environment prompts questions about how these measures might inhibit skill development or reduce a team's competitive edge. In other words, because the game requires full contact, how much of the introduction, rehearsal, and mastery of these skills can be suppressed before the participant's safety is affected? This conundrum has been studied in ice hockey regarding the risk of injury due to body checking,<sup>90</sup> a collision-specific skill that is similar to tackling or blocking in football. Compared with youth hockey players who lacked body-checking experience, those who had 2 years of such experience displayed a 33% decrease in overall severe injuries (more than 7 days of time loss) but no differences in concussion rates or severity.<sup>91</sup> Nevertheless, the authors pointed out that this finding needs to be considered in the context of the 70% reduction in severe injuries among Pee Wee players in leagues that prohibited body checking.<sup>90</sup> In other words, the benefits and consequences of rule changes for tackling must be assessed in totality to determine the best overall preventive model for decreasing head-impact exposure in American football players. To our knowledge, this work has not yet been done.

At higher levels of play, leagues have changed rules for game play, particularly kickoffs, which had the highest incidence of concussions and severe injuries.<sup>92,93</sup> Notable

changes by the NFL were the ban on wedge-formation blocking by the receiving team (2004, 2018), moving the line of scrimmage from the 30- to the 35-yard line and minimizing the running start of the kicking team to 4.57 m (5 yd [2011]), restricting contact to within 13.72 m (15 yd) of the kickoff spot (2018), and eventually eliminating the running start by the kicking team (2018). The NCAA followed suit with wedge and line-of-scrimmage changes and added a fair-catch option for the receiving team (2018). These rule changes resulted in a reduction in concussions of 8.88/1000 plays during kickoffs at the collegiate level.<sup>93-95</sup> Updates to the National Federation of State High School Associations (NFHS) rules include infractions for *blind-side blocking* (ie, contact with an opponent other than the runner who does not see the block coming) and banning *pop-up kicks* (a form of onside kick in which the ball is kicked so that it pops it up in the air; 2018). The receiving player's upward gaze and concentration during the pop-up kick leaves him vulnerable to injury. Pop Warner Youth Football was the first league to ban kick-offs for its youngest divisions (2016).

In addition, the NCAA and NFHS have elevated the consequences for head-down tackling in situations deemed to be targeting. Specifically, targeting and making forcible contact with the crown of the helmet (NCAA Rule 9-1-3) or the head or neck area of a defenseless player (NCAA Rule 9-1-4) both result in immediate disqualification from competition.<sup>2</sup> The NCAA describes *targeting* as an infraction stemming from a player "taking aim at an opponent for the purposes of attacking with forcible contact going beyond that which is required to make a legal tackle or a legal block."<sup>2</sup> The NFHS uses similar language and punitive results.<sup>96</sup>

Ultimately, although policies aimed at reducing full-contact time or practices have merit for lowering the general head-impact risk,<sup>8,89</sup> they fall short in addressing head-first contact behavior. Use of the "Heads-Up" coaching strategy and limiting contact in practice decreased both head-impact exposures and concussions in youth football.<sup>97</sup> However, further study is needed to understand when introducing tackling and blocking is appropriate. For example, researchers<sup>98</sup> attempted to address a similar question about the injury risk from body checking among youth ice hockey teams, considering rule and policy changes, and this work could serve as a model for American football.

Rule and policy changes may create controversies due to social pressures in the sport (eg, football highlights often center on "big hits"). These changes may put pressure on coaches and players to modify training techniques, develop new skills while eliminating high-risk maneuvers, and limit the amount of contact exposure and potentially the opportunities for skill rehearsal. Greater still is the pressure on game officials. Consistent and vigorous enforcement of rules for protecting players' safety, especially the use of the head and helmet when making contact, is subjective at best and may influence the outcome of a game. Despite these concerns and pressures, rule changes have been demonstrated to improve athlete safety. As more evidence becomes available, they should be implemented to enhance the health and safety of athletes.



## Technology and Scientific Research (Recommendations 11–14)

Helmets remain the best—and yet still incomplete—solution for mitigating forces generated by single or multiple direct head impacts. As a result, attention has focused on designing better protective headgear and the emergence of independent quality assessments to validate these enhancements (eg, Virginia Tech's Summation of Tests for the Analysis of Risk [STAR] rating,<sup>99</sup> National Football League helmet testing<sup>100</sup>). At its outset, the STAR system identified a single helmet as qualifying for 5 stars (the highest rating); more recently, 16 helmets spread over 5 brand labels have received top ratings.<sup>101</sup> Given these independent appraisals, which exceed the minimum certifying standards set forth by NOCSAE, manufacturers have developed helmets that are better able to mitigate head-impact forces. Despite persistent concussion rates,<sup>102</sup> the football helmet has likely never been better able to absorb deleterious contact forces and protect the head from acute trauma (eg, skull fracture, hemorrhage), its original intention.<sup>103</sup>

Helmets are not designed to reduce head-first contact behavior, so ATs and other key stakeholders should remain vigilant in their efforts to do so. This vigilance may include ATs educating other stakeholders about recent evidence, as unintended behavioral changes and subsequent injury outcomes follow a pattern associated with the use of protective equipment.<sup>80,104,105</sup> Risk compensation theory explains similar consequences for behavioral changes in other sport or physical activities (eg, helmet use in alpine skiing and cycling) and activities of daily living (eg, seatbelt use and motor vehicle crashes).<sup>80</sup> History informs us that as helmets evolved, from a leather cover to a solid outer shell in the 1950s to 1960s and the inclusion of a face mask and various iterations of interior padding or air bladders in the 1970s to 1980s,<sup>103</sup> a documented change in player behavior took place. Alarming and at a time coinciding with helmet innovation,<sup>44</sup> head and neck injuries in American football at all levels of play resulted in 204 deaths between 1965 and 1974, with 36 deaths in the 1968 football season alone<sup>3</sup> and 99 permanent cervical cord injuries in a 4-year span from 1971 to 1975.<sup>83</sup>

To mitigate the unintended consequence of head-first contact behavior associated with helmet usage, head-impact monitoring systems may be useful. These instruments are commercially available as research-grade equipment (most expensive) and more consumer-friendly models (least expensive). The devices are primarily intended to detect head accelerations resulting from impacts during sport participation. Head-impact biomechanical data are computed as linear acceleration ( $g$ ), rotational velocity ( $\text{rad/s}$ ), rotational acceleration ( $\text{rad/s}^2$ ), Head Injury Criterion, Gadd Severity Index (GSI), or other measures of interest. Some also triangulate the head-impact location. These data may be minimally useful as a means of biofeedback or, more importantly, as trackable outputs in the study of behavioral interventions. With recent advances in technology (eg, smaller equipment at lower costs), a growing market of head-impact monitors is available. These monitoring systems may be beneficial for obtaining real-time head-impact data, but their clinical utility has been questioned.<sup>50,106</sup> The science surrounding head-impact biomechanics continues to evolve and, thus,

the data provided by these systems are likely affected by external (eg, sport) and internal (eg, age, behavioral) factors. Devising a product that performs perfectly in the field is not tenable, even when the product demonstrates good performance in controlled laboratory environments. The literature is divided on this topic: some researchers<sup>107</sup> noted system inaccuracies, whereas others<sup>108</sup> supported these tools as useful in furthering our knowledge of concussion and head-impact biomechanics. Notwithstanding the known limitations of these devices, accelerometer-based head-impact monitoring is useful for characterizing the head kinematics and kinetics associated with concussion<sup>50</sup> and the play-related circumstances believed to increase the concussion risk (eg, anticipating collisions,<sup>109</sup> special teams plays<sup>110</sup>). Although these systems may provide additional information for identifying and correcting drills or practice strategies that result in leading with the head, it is important to point out that impact-monitoring systems and video capture are not appropriate clinical tools for diagnosing a concussion,<sup>56,106,111</sup> nor should they be used in place of an on-site health care professional for football.

Several commercially available products attempt to address the safety-related needs of players, and many are advertised as after-market add-ons to football helmets for impact-force mitigation. Such products often take the form of more soft or conforming exterior padding and come with little to no independent scientific evidence to support their efficacy in reducing impact forces during play. The current evidence describes no benefit. For example, investigators<sup>45</sup> assessed the ability of the Guardian Cap helmet cover to reduce linear acceleration and the GSI score. Using 2 styles of helmets and the NOCSAE drop-testing method, they found that the Guardian Cap failed to improve the helmets' ability to mitigate impact forces at all but 2 rear helmet locations. Football helmets must meet an industry standardization process. Though several processes exist, NOCSAE certification is required of all helmets worn in professional and amateur football. No standards or certifications are required for after-market helmet add-ons. Because of this limited product oversight, stakeholders are encouraged to use due diligence before investing in marketed products. In most cases, after-market helmet add-ons will compromise the NOCSAE certification obtained by protective equipment manufacturers.<sup>112</sup>

Finally, an overarching primary injury-prevention recommendation is to continue rigorous epidemiologic monitoring and experimental research where possible to provide evidence-informed strategies related to head-safe behaviors. It is paramount that American football stakeholders use observational and empirical data to evaluate, propose, and direct head-safe behaviors. Ideally, head and cervical spine trauma in football players should be more fully understood before rules and policies are proposed to further mitigate the injury risk. Athletic trainers who already work closely with coaches and strength specialists can reinforce the importance of teaching appropriate skills and monitoring practice structures in a way that reduces head-first contact behavior.<sup>26</sup> Athletic trainers should be primary stakeholders on committees that assess and direct policy. For example, identifying and then eliminating or modifying



specific drills or practice maneuvers that increase the concussion risk is one such approach.<sup>113</sup> The benefit of this approach is eliminating injuries, allowing for greater participation by all involved athletes.

## CONCLUSIONS

The recommendations outlined in this position statement and discussed in the existing literature are aimed at decreasing the prevalence of head-first contact behavior and the associated risk for serious head and cervical spine injury, in addition to reducing the accumulation of head impacts over time. Although these recommendations provide a host of potentially effective strategies for reducing head impacts in football, it is concerning that the scientific-medical community has little to no high-level (SOR A) evidence for a mechanism that entails a potentially catastrophic outcome. Critically needed are rigorous studies (ie, RCTs) and validation of existing and future strategies intended to address head-first contact behavior in American football players. It is worth noting that participation in any sport comes with an inherent risk of injury, and our profession should take collective action to reduce the injury risks for athletes participating in all sports. The potential risks of participation should be mitigated by options that enable young athletes to develop skills and sustain physically active lifestyles. With respect to American football, we must continue to identify strategies that decrease football-related head, neck, and spine injuries and the associated behaviors that increase the injury incidence, given the very high level of interest in participating in the sport.

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## Addendum

Swartz EE, Register-Mihalik JK, Broglio SP, et al. National Athletic Trainers' Association Position Statement: Reducing Intentional Head-First Contact Behavior in American Football Players. *J Athl Train*. 2022;57(2):113–124. doi: <https://doi.org/10.4085/1062-6050-0062.21>

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