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Head Injuries in Contact Sports – Literature Review

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Abstract

Head injuries in athletes are an increasingly common issue, not only in professional sports but also due to the growing number of amateurs participating in contact sports. These sports include not only martial arts such as boxing, judo, or MMA but also team sports, including some of the most popular ones like soccer, rugby, American football, and hockey.

The aim of this paper is to review the available literature on the frequency and mechanisms of head and neck injuries in various sports, as well as to propose possible methods for preventing these injuries and rehabilitation after they occur. The article discusses both acute and chronic injuries, as well as long-term health consequences. It highlights the need for further research in the field of biomechanics, athlete monitoring, and the development of effective health protection strategies for athletes.

The article was prepared by analyzing multiple databases, including PubMed, Google Scholar, and Elsevier.

Conclusions: There is also a lack of conclusive evidence on the mechanisms behind these injuries, which makes it difficult to develop programs to reduce the frequency of neurological injuries. Many years of systematic research and athlete monitoring, with detailed documentation of all injuries, are needed. Additionally, further biomechanical analyses are required to understand the forces acting on athletes and how well protective equipment performs. Only after obtaining such results it will be possible to prepare better strategies to protect the health and life of athletes in these disciplines

Keywords: head injuries, contact sport, prevention, concussion, traumatic encephalopathy.

Types of Head Injuries in Contact Sports

1. Acute Head Injuries

Head injuries in contact sports can be divided into acute and chronic. Among acute injuries, the most common are concussion and intracranial hemorrhage. Epidural and subdural hematoma are one of the most frequent types of bleeding associated with head injuries in contact sports. Other head injuries include skull fractures, which may lead to neurological deficits. [31-36]

2. Chronic Head Injuries

A chronic head injury resulting from multiple brain injuries is chronic traumatic encephalopathy (CTE). This disease, particularly associated with boxing, leads to disturbances in thinking, mood, and, over time, may result in dementia. [37]

Mechanisms of Injury

1. Concussion

Concussion in contact sports most often results from direct blows to the head or sudden rotation of the head, which may occur due to a hit from an opponent, a takedown, or a change in direction. This phenomenon leads to the displacement of the brain within the skull, resulting in a temporary disruption of brain function due to neuron damage and communication disturbances. The most common symptoms of a concussion are: headache and dizziness, nausea and vomiting, vision disturbances, memory problems, balance and coordination issues, speech difficulties, concentration and attention problems, loss of consciousness, and drowsiness. [2,31,38-40]

2. Intracranial Hematoma

Intracranial hematoma occurs as a result of damage to blood vessels within the skull, leading to a hemorrhage. Two types of hematomas are distinguished: epidural and subdural. An epidural hematoma results from the rupture of the meningeal artery and most often occurs in conjunction with skull fractures, while a subdural hematoma results from the sudden

movement of the brain, which disrupts the continuity of bridging veins. Symptoms of intracranial hematoma may include severe headache, confusion, dizziness, nausea, vomiting, and loss of consciousness. As the condition worsens, it can lead to neurological deficits such as weakness, difficulty speaking, seizures, and changes in behavior or mental status. [2,32,33]

3. Vertebral or carotid dissection

Traumatic damage to the carotid or vertebral artery in combat sports is a serious condition that can lead to neurological symptoms such as dizziness, loss of balance, paralysis, speech problems, or difficulty swallowing. The mechanisms of injury mainly include sudden twisting, jerking of the head, strikes, and falls, which can cause damage to blood vessels and ischemia of key structures in the nervous system. [41-43]

Data and Injury Frequency Analysis

The definition and reporting frequency of concussions in combat sports are subject to significant methodological differences. Depending on the combat sport being described, concussions may be reported in various ways, making the data difficult to interpret. For example, in boxing, a concussion may be directly diagnosed and reported by the ringside physician, or it may be inferred from a knockout, technical knockout, or the referee stopping the fight due to a head injury. This results in significant discrepancies in the diagnosis and reporting of concussion cases related to boxing. In professional boxing, the literature reports that concussions account for between 15.9% and 69.7% of all injuries [19,20,44]. Among amateur boxers, studies have shown that concussions account for between 6.5% and 51.6% of all injuries [17,18,43-45].

In other combat sports, concussions are much less frequently reported in medical analyses. In adult karate tournaments, concussions account for between 0.9% and 5.4% of all injuries [9,46,47,48]. In studies of younger karate competitors, or in studies where the age was not specified or included various age groups, concussions accounted for 1.2% to 8.8% of all injuries [12,49,50]. In adult taekwondo competitions, the percentage of concussions ranges from 4.3% to 7.5% [51,52]. However, in younger taekwondo competitors, concussions account for between 8.6% and 24.4% of all injuries [4,22]. In kickboxing, a high percentage of concussions has been reported, both in amateur and professional competitions (65.2% and

17.5%, respectively) [53,54]. In other studies examining concussion rates in mixed martial arts, concussions accounted for 1.1% to 2.5% of all injuries [16,55,56].

Concussion rates per 100 participants are shown in the table below. Most of the studies used to determine these concussion rates relied on prospective data, but they only reported prospective data on concussions occurring during competitions. To date, no prospective data has been collected regarding concussions occurring during training or sparring sessions, and studies that report such retrospective data are hindered by issues related to recall. This is an area where further research is needed in combat sports.

The frequency of head and neck injuries in contact sports varies depending on the sport. The most common injury in these sports is concussion. The table below presents the concussion rate per 100 participants in combat sports, divided by age groups:

Sport	**Reference**	**Participants, setting injury occurred Injury**	**Rate per 100 participants**
Taekwon do	Beis et al [1]	Adults, competition	0.2
	Oler et al [2]	Children, competition	0.3
	Oler et al [2]	Adults, competition	0.4
	Pieter et al [3]	Children, competition	0.5
	Beis et al [1]	Children, competition	0.6

	Pieter et al [3]	Adults, competition	0.8
	Pieter and Zemper [4]	Children, competition	0.9
	Pieter and Zemper [5]	Adults, competition	1.2
	Koh et al [6]	Adults, competition	1.4
	Pieter et al [7]	Adults, competition	5.2
	Koh and Cassidy [8]	Children, competition	9.8
Karate	Stricevic et al [9]	Adults, competition	0.4
	Destombe et al [10]	Non specified, Non specified	0.5
	Zetaruk et al [11]	Adults, competition	0.9
	Critchley et al [12]	Various, competition	0.9
	McLatchie et al [13]	Non specified, Non specified	2.8

Martial Arts	Birrer [14]	Various, Non specified	0.3
	Buschbacher and Shay [15]	Non specified, Non specified	1.7
	Birrer and Birrer [16]	Non specified, competition	3.5
Boxing	Welch et al [17]	Adults (amateur), competition	14.0
	Porter and O'Brien [18]	Various (amateur), various	20.4
	McCown, 1958 [19]	Adults (professional), competition	21.0
	Jordan and Campbell [20]	Adults (professional), competition	41.5
	Zazryn et al 2006 [21]	Adults (both), various	44.7

The analysis of the table leads to several interesting conclusions regarding injury rates in combat sports. Boxing has the highest injury rates, with figures ranging from 14 to 44.7 injuries per 100 participants for adult competitors (both amateurs and professionals). This indicates a significantly higher risk of injury in boxing compared to other sports.

There is noticeable variability in the injury rates within the same sports. For instance, in taekwondo, the injury rate among children ranges from 0.3 to 9.8, which may result from differences in competition intensity, punching techniques, participant protection, and also from varying data collection methods.

Differences between professionals and amateurs: In professional boxing, the injury rate is higher than in amateur boxing (for example, 21 in professional boxing compared to 14 in amateur boxing). This may be due to the higher intensity of professional competitions and the better technical skills, which could lead to stronger punches.

Long-Term Consequences of HeadInjuries

Repeated head injuries can lead to serious long-term health problems. These include Chronic Traumatic Encephalopathy (CTE), a neurodegenerative disease associated with the accumulation of tau protein in the brain, leading to degeneration of the brain [57,58]. Symptoms of CTE may include personality changes, aggression, depression, and cognitive decline. CTE develops over many years, often appearing only after the end of an athlete's career, making diagnosis difficult.

Other neurological problems associated with frequent head impacts, such as chronic headaches, dizziness, memory problems, and concentration issues, are common among athletes who have suffered multiple concussions. Additionally, balance problems can lead to increasing the risk of further injuries.

Prevention of Head Injuries

Prevention of head and neck injuries is crucial in combat sports. This includes:

1. **Use of protective equipment** – helmets, neck guards, mouthguards.
2. **Training in defensive techniques** – avoiding blows, improving balance and coordination, refining striking techniques.
3. **Reducing the number and intensity of training sessions** – monitoring training load.
4. **Education** – raising awareness about the risks of head and neck injuries and symptoms that may indicate a concussion.

Suggested prevention measure	Studies conducted	Level of evidence
Education and training		
Education of athletes, coaches, referees about injuries	Pieter et al[4], Oler et al [2]	±
Better training and advice on appropriate technique	Pieter et al [3], Pieter et al [22], Koh i Cassidy [8]	±
Coaching and officiating		
Minimum standards of referee and coach certifications	Birrer [14], Oler et al [2], Critchley et al [12]	±
Minimum referee experience requirements	McLatchie et al [23]	±
Equipment		

Allowing of foot padding and other protective equipment	Beis et al [1], McLatchie et al [24]	±
Use of headgear	McLatchie i Morris [24], Schmidt-Olsen et al [25]	±
Use of mouth guards	Tuominen [26]	±
Glove weight standardization	Unterharnscheidt [27], Schmidt-Olsen et al [25]	±
Alterations to flooring of ring/sport surfaces	Unterharnscheidt [27]	-
Sport policies and regulations		
Reduction in head blows through rule & scoring changes	Birrer [14], Oler et al [2], Tuominen [26], Pieter et al [28], Burke et al [29], Macan et al [30]	±

The above table shows that despite numerous strategies proposed to reduce the frequency of head injuries, the evidence for their effectiveness is inconclusive, and no studies have been conducted regarding changes to the ring surface.

Summary

Head and neck injuries are a significant health problem in combat sports, both among professionals and amateurs. These injuries, such as concussions, intracranial hematomas, and cervical spine damage, can lead to serious health consequences. These injuries have been described in the literature for a long time, but their frequency varies in the studies cited. There is also a lack of conclusive evidence on the mechanisms behind these injuries, which makes it difficult to develop programs to reduce the frequency of neurological injuries. Many years of systematic research and athlete monitoring, with detailed documentation of all injuries, are needed. Additionally, further biomechanical analyses are required to understand the forces acting on athletes and how well protective equipment performs. Only after obtaining such results it will be possible to prepare better strategies to protect the health and life of athletes in these disciplines.

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