Australian Government
Australian Sports Commission

AIS

INQUIRY INTO CONCUSSIONS AND REPEATED HEAD TRAUMA IN CONTACT SPORTS

Submission from the Australian Sports Commission to the Senate Community Affairs Committee

GLOSSARY OF TERMS

ACCHO – Aboriginal Community Controlled Health Organisations

ACSEP – Australian College of Sports and Exercise Physicians

AIS – Australian Institute of Sport

AMA – Australian Medical Association

AMS – Athlete Management System

ASC – Australian Sport Commission

CBHPS23 – Concussion and Brain Health Position Statement 2023

CDC – US Centres for Disease Control and Prevention

CTE-NC – Chronic Traumatic Encephalopathy Neuropathological Change

NHMRC – National Health and Medical Research Council

NSO – National Sporting Organisation

NSOD – National sporting organisation for people with a disability

RACGP – Royal Australian College of General Practitioners

RHT – Repeated Head Trauma

SMA – Sports Medicine Australia

OPENING STATEMENT

The Australian Sports Commission (ASC) is the Australian Government agency responsible for supporting and investing in sport at all levels. The ASC's strategic vision is to ensure sport has a place for everyone and delivers results that make Australia proud. The ASC also plays a critical leadership role in guiding sporting organisations and the sport sector in relation to a range of issues impacting sport. The ASC is not a regulatory authority and has no power to enforce compliance or regulations. The Australian Institute of Sport (AIS) is the high-performance arm of the ASC. The AIS functions as a resource for sport organisations, providing expertise and education as required. The AIS seeks to guide, but not instruct sports on a range of policy positions, including sport-related concussion (referred to as concussion from here on).

In 2019, the AIS, in collaboration with the Australian Medical Association (AMA), the Australasian College of Sport & Exercise Positions (ACSEP) and Sports Medicine Australia (SMA) produced the Concussion in Sport Australia position statement. The 2019 position statement was supported by over 50 sport and medical bodies, including the Royal Australian College of General Practitioners (RACGP). The 2019 position statement has recently been updated and is now available online as the ***Concussion and Brain Health Position Statement 2023 (CBHPS23)***.

There are many new scientific publications on concussion and long-term brain health each year. For instance, the National Library of Medicine's PubMed database had 1,840 concussion related publications in 2021 and a further 1,600 in 2022. The ASC, through the AIS, is committed to ensure all Australians involved in sport, at all levels of the participation pyramid, including athletes, coaches, parents, medical practitioners, and others, can access latest evidence-based resources on concussion.

A growing number of scientific publications have indicated that chronic traumatic encephalopathy neuropathologic change (CTE-NC) is a condition with distinct histopathological features and an association with RHT. CTE-NC has been reported in athletes from a number of different contact and collision sports.[1-4] CTE-NC has unclear clinical diagnostic criteria (i.e. Traumatic Encephalopathy Syndrome or TES). There is evidence that some individuals who are exposed to RHT during their sporting career are susceptible to cognitive deficits later in life.[1, 5-7] It should be noted that there is currently a lack of high-quality evidence indicating the degree of association between RHT, concussion and CTE-NC. The currently available, albeit limited, population data suggests that CTE-NC is uncommon relative to the number of individuals who sustain concussion.[8] While many questions on CTE-NC remain unanswered, the AIS recognises the importance of long-term brain health in those who participate in sport. Both the ***2019 Concussion in Sport Australia*** position statement and the recently updated ***CBHPS23*** operates on a principle of an 'abundance of caution'. Where there is any suspicion of concussion, an athlete should be removed from the field of play and should not be allowed to return, until cleared to do so by a medical practitioner ['if in doubt, sit them out'].

The best way to protect athletes against acute and long-term effects of concussion is to ensure that every concussion is treated seriously and that concussed athletes are removed from the field of play and are not returned prematurely. *The recommended process for return to sport, outlined in **CBHPS23**, means that an adult is highly unlikely to return to sport in less than 12 days.*

There is good evidence that children and adolescents, aged 18 years and under, take longer to recover from concussion when compared to adults.[9] In this age group, *the AIS recommends that the athlete should not be returned to play until they have concluded a 14-day period of being symptom-free.* **To be clear, that is not 14 days from the time of concussion. It is 14 days from when the athlete becomes symptom-free.** This recommendation allows for the huge individual case variability in duration of symptoms. It ensures that the most vulnerable athletes have demonstrated a clear capacity to perform all normal activities of daily living, including non-contact exercise, without symptoms, before they return to the field of play.

The AIS is pleased to have the opportunity to contribute this submission to the Senate Inquiry on matters of medicine and science, raised by References Committee. Matters of organisational liability and access to workers compensation (terms of reference d and h) are not addressed by this submission.

a. the guidelines and practices contact sports, associations and clubs follow in cases of player concussions and repeated head trauma, including practices undermining recovery periods and potential risk disclosure;

Any athlete in any sport may suffer a concussion. Those participating in snow sport, equestrian, motor sport, contact, collision and combat sports are at increased risk of repeated head trauma (RHT). It is important to note that a blow to the trunk, with forces transmitted to the head, can cause head trauma, with or without concussion.

Both the 2019 Concussion in Sport Australia position statement and the updated ***CBHPS23*** makes it clear that an athlete should be removed from sport where there is any suspicion of concussion *('**if in doubt, sit them out**'). The athlete should not return to sport until cleared to do so by a medical practitioner.*

CBHPS23 outlines a graduated return to sport process which means that ***it is highly unlikely that an individual will return to sport in less than 12 days from the time of concussion.*** In many cases the duration for a return to sport **will be longer than 12 days**. For individuals aged 18 and under, ***there must be a period of 14 days where the athlete is symptom-free*** (i.e., not 14 days from the time of concussion), before return to contact activities can be considered. This means that if an athlete has symptoms that continue for 14 days, they will not be eligible for return to sport for 28 days. This cautionary approach is based on the evidence that children aged 18 years and under, take longer to recover from concussion.[9]

The degree of caution exercised in return to sport is modified if there is a history of RHT. That is, if there is a history of previous concussion, particularly where there has been recurrent concussion within a short period of time, the duration of time for a return to sport will be increased. The length of that increase will be at the discretion of the doctor assessing the athlete.

Where an athlete has had multiple concussions, the medical practitioner will counsel the athlete regarding the dangers of RHT, the potential long-term effects of RHT and the need for the athlete to think carefully about their continued involvement in high-risk sports, including contact and collision sports.

The AIS applies the above approach to concussion management to all athletes under the care of AIS medical practitioners. The 2019 ***Concussion in Sport Australia*** position statement was endorsed by over 50 sport and medical bodies, including the Royal Australian College of General Practitioners (RACGP). Many sporting organisations across the participation pyramid including high-performance sports utilise the AIS position statement to inform their own approach to concussion. Other sports, particularly professional sports, and those with significant resource capacity, will have their own policies in relation to concussion.

The AIS does not participate in any practices which undermine the recovery periods following concussion. The return to sport processes in the ***CBHPS23*** are framed with the specific intention of reducing the likelihood of concussion recurrence.

b. the long-term impacts of concussions and repeated head trauma, including but not limited to mental, physical, social and professional impacts;

Data on concussion and long-term brain health including *Chronic Traumatic Encephalopathy Neuropathological Change* (CTE-NC) in Australia is lacking. It is difficult to determine accurate incidence, frequency and prevalence of concussion due to the absence of an Australia-wide injury surveillance system, inconsistent reporting methods, and a lack of recognition of the signs and symptoms of concussion. The ASC and the Australian Institute of Health and Welfare are leading the development of a National Sport Injury Database to better capture nationwide sport injury data including concussion in sport. Many individuals with concussion do not seek medical guidance and do not present to hospitals for assessment.[10] Under-reporting of concussions and failing to seek medical advice range from 17% to 82% across different sports.[11-15] That large numbers of concussions are going undetected and therefore unmanaged, is concerning. A survey during the 2020 NRL preseason reported that 17% of players have indicated that they decline to report a likely concussion to medical staff during the 2018 and 2019 seasons despite 85% of surveyed players receiving concussion education through their club over the previous two seasons.[11] The reasons players have indicated that they decline to report concussions are primarily due to 'not wanting to be ruled out of the game or training session' or 'not wanting to let down the coaches or teammates'.[11]
These results are consistent with other survey data reviewing the knowledge and attitudes of athletes about concussion.[12,15,16]

Concussion is common in children and adolescents.[17-19] By the age of 10 years, one in five children will experience a concussion but only 25% of those concussions result from sport participation.[19] The US Centre for Disease Control and Prevention (CDC) estimates that 1.6 to 3.8 million concussions occur in sports and recreational activities annually.[20] Extrapolating from this North American data, it is reasonable to estimate at least 100,000 concussions occur in Australia each year. The majority of concussions occur in community sport. Many concussions are never documented and never come to the attention of medical health professionals.[10] The majority of concussions follow an uneventful course of recovery over days or weeks. There is usually no requirement for medical intervention.

Concussion is a common experience amongst those individuals who have played a contact or collision sport for five years or more in their adult lives. For the majority of these individuals, concussion is experienced on a small number of occasions during their sporting lives, and they report no long-term consequences from concussion.

There is evidence that some individuals who suffer RHT are susceptible to long-term degenerative brain disease. There is an association between a history of multiple concussions and cognitive deficits later in life.[1, 5-7, 21] CTE-NC is a neurodegenerative pathology associated with RHT. There are a growing number of cases of individuals who are posthumously diagnosed with CTE-NC, following a sporting career involving RHT.[1, 2, 4-7] However, there is currently a lack of high-quality evidence indicating the ***degree of association*** between RHT and concussion with CTE-NC, a condition with unclear clinical diagnostic criteria (i.e. Traumatic Encephalopathy Syndrome or TES). CTE-NC cannot yet be diagnosed during life.[5] It is a post-mortem diagnosis, based on histopathological examination of brain tissue.

> *"Retired athletes appeared to have increased self-reported cognitive difficulties, but the paucity of high-quality, prospective studies limited the conclusions that could be drawn regarding a cause-and-effect relationship between concussion and long-term health outcomes".* [6]

> *"A challenge of evaluating the long-term consequences of repetitive head impacts is that the outcomes are chronic, but the exposures are acute and, in this setting, remote. Each impact is of short duration, can be ambiguous, and rarely quantified".* [5]

Most research data on CTE-NC is obtained from sport brain bank studies. Those who donate their brain for these studies almost universally have pre-existing clinical symptoms of degenerative brain disease. The brain donations are made in good faith but the skewed representation in donors makes it difficult to apply the findings to the general population.[3] The clinical data obtained from sport brain bank studies also relies on retrospective interviews with athletes and athlete-relatives for information such as playing time, RHT exposure, symptom patterns, mental health issues and substance abuse. Recall bias is highly likely to affect the reliability of such information, as is the case with research into other forms of degenerative brain disease.[22]

> *"Closely related to exposure assessment, a major difficulty for case-control studies generally is recall bias. Because the exposures tend to occur much earlier than the diagnosed outcome, the individual is asked to remember potential exposures over a long period; this is exacerbated for neurological diseases because the outcomes in question also tend to affect memory. However, those individuals with symptoms may overreport exposures because of the desire to determine a cause for their condition".*[23]

This mode of retrospective clinical analysis is insufficient for creating robust clinical diagnostic criteria for CTE-NC in living patients.[24] The design of CTE-NC case series studies is compromised by referral and recall biases and cannot answer epidemiological questions.[3, 24, 25] CTE-NC is not an inevitable consequence of RHT.[8, 26] There are questions that need to be explored regarding modifying factors that may predispose an individual to long-term effects from RHT. Such modifying factors may include substance (e.g. alcohol, recreational drugs) abuse, genetic predisposition, personality factors, genetic predisposition, education exposure, family history of mental health and neurological problems.[22] More longitudinal research is required to understand the frequency, incidence, prevalence of CTE-NC in athletic populations and to identify factors that may predispose individuals to long-term consequences from RHT and concussion.

The weaknesses with current CTE-NC research need to be addressed with appropriately structured, prospective research projects which attempt to control for confounding variables (e.g. mental health, drug and alcohol use, genetic predisposition, education), and which include control groups that have ***not*** been exposed to RHT. In collaboration with the University of Newcastle, University of Sydney and the University of Canberra, the AIS is involved in a longitudinal prospective cohort study (i.e., the 'Former Elite Level Athlete Brain Health Research Program') to investigate many variables that affect brain health and aging, and the extent to which modifiable risk factors may contribute to the risk of poor health outcomes. This research program includes elite level former rugby league and rugby union players, and is one of the few prospective studies in the world which includes comparison groups consisting of age and education matched healthy community-based control participants without a history of neurotrauma or contact sport participation. The recruitment of another research cohort comprising former Australian able-bodied Olympians from non-contact sports is currently underway.

The best way to avoid both short-term and long-term effects from concussion is to treat each concussion seriously. Any individual with suspected concussion should be removed from the sporting environment and not be permitted to return to sport until cleared to do so by a qualified medical practitioner. Individuals with concussion should follow a graduated program for return to sport. They should not return to sport until they have fully recovered from the effects of the previous concussion.

The updated ***CBHPS23*** outlines a ***graduated return to sport process*** which means that ***almost no one will return to sport in less than 12 days from the time of concussion***. ***For individuals aged 18 and under, there must be a 14-day period where the athlete is symptom-free, before return to contact activities can be considered***. This means that if an athlete has symptoms that continue for 14 days, they will *not be eligible* for return to contact or collision activities for 28 days. This cautionary approach is based on the evidence that children aged 18 years and under, take longer to recover from concussion.[9] Both the ***2019 Concussion in Sport Australia*** position statement and the recently updated ***CBHPS23*** operates on a principle of an 'abundance of caution'. Where there is any suspicion of concussion, an athlete should be removed from the field of play and should not be allowed to return, until cleared to do so by a medical practitioner ['if in doubt, sit them out'].

Reporting on concussion stories in the media is often conducted in a sensationalist manner that is not evidence-based. Individual cases of CTE-NC are frequently promoted in both mass and social media with a degree of certainty that is not supported by scientific evidence. This type of misinformation and disinformation can compromise efforts to improve understanding of CTE-NC and may in fact have negative consequences for the health of retired athletes.

> *"Unfortunately, the uncertainties around the clinical syndrome and the pathological definition of CTE are not acknowledged adequately in much of the current research literature or related media reporting, which at times has resembled science by press conference. Too often an inaccurate impression is portrayed that CTE is clinically defined, its prevalence is high, and pathology evaluation is a simple positive or negative decision. This distorted reporting on CTE might have dire consequences. Specifically, individuals with potentially treatable conditions, such as depression or post-traumatic stress disorder, might make decisions on their future on the basis of a misplaced belief that their symptoms inevitably herald an untreatable, degenerative brain disease culminating in dementia".*[27]

While it is essential that athletes, sport organisations and the general public are aware of the risks of concussion, it is not helpful for concern related to concussion to be exaggerated or catastrophised in a manner that is not supported by scientific evidence. Recent media reporting of specific individual cases has attempted to attribute suicide to CTE-NC and a history of concussion/RHT. Suicide is rarely caused by a single circumstance or event. The CDC presents a range of individual, relationship, psychological, community and societal risk factors that may predispose a person to suicide. [28] The media reporting of suicide makes no attempt to consider the multiple other factors that may have contributed to the tragic circumstances in the death by suicide of a specific retired athlete. Recent reviews of the applicable literature that apply established methods for rating quality of research evidence indicate scant support for the proposition of a relationship between CTE-NC and suicide.[29-31]

Sport is an excellent platform for individuals, families and communities to be more physically active. A large proportion of the population is insufficiently active. Physical inactivity is a major risk factor for chronic conditions as well as contributor for overweight and obesity. There is incontrovertible evidence that regular physical activity contributes to the primary and secondary prevention of chronic diseases, improves health and wellbeing, reduces risk of premature death, and improves productivity.[32-34] It is estimated that overweight and obesity cost the Australian community $11.8 billion in 2018 and may cost $87.7 billion by 2032 if no action is taken.[35]

Risk of injury is inherent in many sports. Sports injuries (including concussion) and fear of sports injuries may be barriers for sport participation.[36] Improving the safety of sport and reducing the incidence of RHT is vitally important. It is equally important to report balanced and evidence-based information on matters of concussion and the long-term issues related to CTE-NC. Unbalanced and alarmist reporting in the media has the potential to discourage participation in team sports, at a time when large portion of Australians are insufficiently active. A school in Sydney recently ceased their AFL program out of fear that students would suffer negative consequences for their long-term brain health.[37] Causing excessive alarm and anxiety in relation to the long-term effects of concussion could also result in parents withdrawing their children from sporting activities, which can undermine efforts to increase physical activity to improve the health and wellbeing of all Australians. Such an outcome could result in overall worse health outcomes for the Australian population.

c. the long and short-term support available to players affected by concussion and repeated head trauma;

The AIS provides 24-hour medical cover, seven days per week, on the AIS Canberra campus to those who are using AIS facilities for training purposes. The same level of medical cover is provided at the AIS European Training Centre, during busy training periods in the European summer. Any athletes suffering a concussion on AIS premises are treated according to the recommendations of the updated ***CBHPS23***. It is the responsibility of sporting organisations to provide acute medical care at locations other than AIS facilities. Sport organisations provide long-term medical care. It is uncommon for AIS medical staff to be asked to provide any medical input for individuals who have long-term issues arising from RHT and/or concussion.

The AIS provides subsidised access to a ***web-based cognitive assessment tool*** for National Institute Network partners, National Sporting Organisations (NSO) and National Sporting Organisations for People with Disability (NSOD) partners. This facilitates a high degree of standardisation and consistency in assessing cognitive function in athletes affected by concussion.

The AIS does not govern or instruct sporting bodies in relation to the recognition and management of concussion. Many sport organisations in Australia however do align their policies with the position statements of the AIS. The majority of Olympic, Paralympic and Commonwealth Games sports are not considered high risk for concussion. Several sports falling under this umbrella however (e.g. basketball, netball, rugby sevens, water polo, winter sports) do experience concussion as a common presenting complaint.

There is an association between concussion and mood disorders in athletes.[38] The ***AIS Mental Health Referral Network (MHRN)*** is a group of expert psychologists, psychiatrists and neuropsychologists across the country who understand the complexity of life in a high-performance setting. The MHRN provides rapid access to professional mental health support to high performance athletes, alumni, coaches, and support staff within the Australian high performance sports system.

e. the role of sports associations and clubs in the debate around concussion and repeated head trauma, including in financing research;

All sporting organisations have a duty of care to ensure that their sport is conducted in the safest manner possible. Risk of injury, including concussion, is inherent in many sports, including but not limited to snow sports, cycling, equestrian, contact, collision and combat sports. It is not possible to remove all risk from sport. Prevention of RHT in sport is challenging. The main pathways to reduce RHT incidents are via changes to rules/regulations within sport and by modification to training methods to decrease the likelihood of head trauma. Changes to rules and regulations within a particular sport should be based upon analysis of head trauma risk within the sport and evidence supporting the hypothesis that the rule/regulation changes will decrease risk of head trauma. The risk of injury in a particular sport needs to be monitored. Amendments made to rules and regulations can then be made, where there is evidence that such changes are likely to make the sport safer, without unreasonably compromising the inherent nature of the sport.

In considering provision of funding for research into concussion, sport organisations often find themselves in a '*damned if they do and damned if they don't*' situation. Funding of concussion research is inherently controversial. While failure to fund scientific research can lead to allegations of disinterest or failure of duty of care, provision of research funding can be interpreted as undermining the essential neutrality of scientific investigation and thus unduly influencing the evidence base.[39]

There are often concerns expressed in the media about sport organisations providing research funding to external organisations for investigating concussion and other health issues in sport. Critics have accused sports bodies as conducting a 'big tobacco' style manipulation of research outcomes. Interestingly, some of the critics who are levelling these claims against sporting bodies have been recipients of research funding from sport organisations in the past.

In Australia, funding of medical research is available via the ***National Medical Health and Research Council (NHMRC) grant system***, and/or the ***Medical Research Futures Fund (MRFF)*** with transparent peer review processes to determine how funding is allocated. NHMRC and MRFF are currently funding long term studies of mild traumatic brain injury and concussion. Funding via NHMRC and MRFF is based on the track record of the researcher and the strength of the proposed study.

Appropriately structured research projects are expensive. This is particularly true of long-term prospective studies – the types of studies that are required to gain definitive information about concussion and brain health. The ASC believes that sporting bodies should be able to contribute to funding health research in sport, as long as the funding structure is such that the sports bodies do not have input into, or influence over, the manner in which the research is conducted or the way the results are presented. Most sport organisations in Australia are resource poor and do not have the capacity to fund research. The larger professional sports do have some capacity to contribute to research funding, but that contribution will often attract criticism from researchers that are not recipients of that funding. A multimodal funding model (from government bodies, sport organisations, universities) is appropriate, as long as appropriate ethical safeguards are in place.

The AIS is involved in concussion and long-term brain health research, funded by the Federal Government. The AIS has also been successful in obtaining a grant from the International Olympic Committee to fund concussion research. One of the significant limitations of research conducted to date has been the lack of studies comparing findings between retired athletes who have *not* been exposed to repeated head trauma and those who have. In 2021, the AIS commenced a study, in collaboration with the University of Newcastle, the University of Sydney and the University of Canberra, to assess the brain health of retired athletes, comparing findings between those that have suffered concussion and those who have *not* suffered concussion.

Sport rules and regulations regarding return to sport after concussion have changed significantly over the past two decades. 20 years ago, over 50% of athletes suffering concussion in some sports returned to play on the same day, or to not be removed from play following a concussion. In 2023, it is very unusual for elite athletes who have been concussed to return to sport in under 6 days. Several sport organisations, including the AIS, have introduced return to sport protocols which make it *highly unlikely* that an individual would return to sport in less than 12 days from the time of concussion.

The current cases of CTE-NC that have been reported in the media relate to individuals that played contact sport in an era where same-day return to play, or to not be removed from play following a concussion was common and where cumulative cases of concussion did not result in longer periods of stand down. It is difficult to predict the effect that having more prolonged periods of stand down (e.g. 12 days) will have on the incidence of recurrent concussion and CTE-NC. It is likely that it will take years, if not decades to assess the efficacy of the more conservative return to sport guidelines. There are calls for the stand down period to be further increased to 28 days. There is no evidence base to support one stand down period over another, apart from a general principle that it is better to have a greater duration of time between exposures to head trauma risk.

f. the lack of a consistent definition of what constitutes 'concussion';

Concussion is defined as "a traumatic brain injury induced by biomechanical forces" because it can occur through a collision with another person or object where biomechanical forces to the head, or anywhere on the body transmit an impulsive force to the head/brain, resulting in transient neurological impairment. Concussion can also occur with relatively minor 'knocks' to the head or body.

The ASC/AIS is not aware of inconsistencies in the definition of 'concussion'. The essential components included in definitions used by most reputable bodies include:

- A rapid onset, transient disturbance of neurological function, secondary to a trauma to the head, or trauma to the body where forces are transmitted to the head
- Evolution of symptoms in the minutes, hours and days after the acute trauma
- Spontaneous recovery over days or weeks
- The clinical signs and symptoms cannot be explained by drug, alcohol, or medication use, other injuries (such as cervical injuries, peripheral vestibular dysfunction) or other comorbidities (e.g. psychological factors or coexisting medical conditions)
- A broad range of symptoms (unique in each case) in the acute and subacute phases including, but not limited to:
  - loss of consciousness
  - seizure
  - balance disturbance
  - confusion
  - blurred vision
  - headache
  - 'don't feel right'
  - 'pressure in the head'
  - difficulty concentrating
  - neck pain
  - difficulty remembering
  - nausea or vomiting
  - fatigue or low energy
  - dizziness
  - drowsiness
  - sensitivity to light
  - emotional lability
  - sensitivity to noise
  - irritability
  - feeling slowed down
  - sadness
  - feeling like 'in a fog'
  - nervous or anxious
  - sleep disturbance

While the precise wording may vary between organisations, the above is aligned with definitions used by most reputable medical bodies, including:

- *US Centre for Disease Control and Prevention*
- *Brain Foundation*
- *AIS*
- *AMA*
- *ACSEP*
- *SMA*
- *Concussion legacy foundation*
- *Ontario Neurotrauma Foundation*
- *American Association of Neurological Surgeons*
- *UK Department for Digital, Culture, Media and Sport*

It should be noted that concussion is often an evolving injury, therefore, signs and symptoms can change or be delayed reflecting the underlying physiological injury status of the brain. Currently there is no specific diagnostic test that confirms the presence or otherwise of a concussion. Concussion remains a clinical diagnosis, which is identified based on a person's history, symptoms and signs on physical examination by a qualified medical practitioner.

g. the prevalence, monitoring and reporting of concussion and long-term impacts of concussion and repeated head trauma, including in First Nations communities;

The risk of concussion and RHT vary across sports. Precise data on the incidence, frequency, and prevalence of concussion and RHT in Australians, including First Nations Communities, and long-term impacts of concussion is unavailable. This is further compounded by a lack of recognition of the signs and symptoms of concussion, under-reporting and failing to seek medical advice. For example, under-reporting of concussions and failing to seek medical advice range from 17% to 82% across different sports.[11-15] That large numbers of concussions are going undetected and therefore unmanaged, is concerning. A survey during the 2020 NRL preseason reported that 17% of players did not report a likely concussion to medical staff during the 2018 and 2019 seasons despite 85% of surveyed players receiving concussion education through their club over the previous two seasons.[11] Players indicated that they did not report a concussion because of 'not wanting to be ruled out of the game or training session' (58%) or 'not wanting to let down the coaches or teammates' (23%).[11] These results are consistent with other survey data reviewing the knowledge and attitudes of athletes about concussion.[12,15,16]

A study of hospitalisations in Victoria found that the highest rates of concussion requiring hospitalisation occurred in motorsports, equestrian activities, Australian football, rugby and roller sports.[40] A 2020 study systematically reviewed 42 studies reporting concussion in Australian football. Concussion rates per 1,000 player hours at the elite level was 2.2 to 17.6 and at the recreational level was 0.4 to 14.8 per 1,000 player hours.[41] Data from both studies cannot be separated to understand the concussion rates in First Nations Communities.

To overcome the limitations of the current data sources, the ASC and the Australian Institute of Health and Welfare are leading the development of a National Sport Injury Database to better capture nationwide sport injury data including concussion in sport. A National Sport Injury Database will also allow better understanding of concussion rates in First Nations Communities.

Every concussion occurring on AIS premises and the medical care received is recorded within the Athlete Management System (AMS). Prior concussion history is an important consideration in return-to-sport decision making.

The ASC/AIS is aware of and concerned about an increased number of case reports of former Australian contact, collision and combat sport athletes who are diagnosed posthumously with CTE-NC.[2-4] There are still many unknowns about CTE-NC. CTE-NC is not an inevitable consequence of RHT.[8, 26] There is no evidence to indicate the prevalence of CTE-NC in specific athletic cohorts. There is evidence that the likelihood of developing CTE-NC increases with the number of exposures to head trauma.[5] Potential modifying factors include substance abuse, education level, genetic predisposition and history of mental illness. The impact of modifying factors upon individual susceptibility to development of CTE-NC, remains unknown.

A large scale study of 636 cases of community-based cohort of ageing and neurodegeneration from the Sydney Brain Bank collection, CTE-NC was identified in five cases (prevalence 0.8%). Three of the five cases with CTE-NC had a history of traumatic brain injury and two cases had no known history of neurotrauma (including repetitive head impacts from sports).[42] Low prevalence of CTE-NC is further corroborated from similar sample of 532 cases from the United States and 323 cases from Europe, where CTE-NC was 0.6%[43] and 0%.[44] This low prevalence of CTE-NC in the general community highlights the need for further well-structured longitudinal studies exploring the strength of the link between RHT, concussion, and CTE-NC.

CTE-NC continues to be reported in the format of case histories or case series. There have been no studies of CTE-NC which attempt to control for modifying variables. The vast majority of the cases of CTE-NC in retired athletes have been detected via posthumous brain bank reports. The studies of CTE-NC by brain banks have significant methodological limitations, as acknowledged by the researchers themselves. In Australia, as elsewhere in the world, almost all individuals who have donated their brains to sports brain banks have done so after developing clinical features of degenerative brain disease. This highly skews the results of these studies. ***Professor Ann McKee*** is the Director of the Boston University CTE Center. Professor McKee has published more articles than any other researcher on CTE. Professor McKee was interviewed by the Journal of the American Medical Association (JAMA) following publication of one of her team's biggest studies,[3] and had this to say:

> *"There's lots of limitations to this study. This is a brain donation study. It is a highly skewed population. These brains were donated by family members who in almost in almost all instances were concerned about their loved one. So, all of the players in this study were symptomatic, even though we only asked that they be exposed to football. It's also a cross-sectional analysis, that is, we only get to look at these individuals at one point in time, that is at the time of their death. This is not representative of American football players as a whole, as a general population, because most of the football players in our study played football at a very high level, that is, college or above and so the results cannot be applied to the general population....It is a problem for football but we don't know the extent of the problem."*

Speaking to the ***New York Times in 2016***, Professor McKee stated;

> *"We can't say from this sample whether the rate of C.T.E. in pro players is 1 percent or what; we have no idea."*

It is clear from Professor McKee's comments that even the most experienced CTE-NC researchers in the world acknowledge that while the information currently available regarding long term effects of concussion are concerning, there is still much yet to be done to understand the strength of the association between RHT and CTE-NC.

In June 2021, Aboriginal and Torres Strait Islander people represented 3.8% of the total Australian population.[45] In both the NRL and AFL, 12% of listed players are Aboriginal and Torres Strait Islander people. Despite this over-representation of First Nation Communities in these football codes, there are no studies comparing rates of concussion between Indigenous and non-Indigenous players. The occurrence of traumatic brain injuries (TBI, including concussions) in Australia are limited to data gathered through hospitalisations. Aboriginal and Torres Strait Islander peoples are 1.7 times more likely to sustain a TBI than the general population, although not all of this TBI is related to sport.[46]

It is important to note that there is no evidence that SCAT5 is a culturally appropriate tool for Aboriginal or Torres Strait Islander peoples and those with culturally and linguistically diverse backgrounds, especially for those individuals whose first language is not English.

Health care facilities often fail to provide culturally appropriate care for Aboriginal and Torres Strait Islander peoples. There can be mistrust of authority, previous negative experiences involving poor communication, discrimination and racism.[47] Lack of culturally appropriate services outside of Aboriginal Community Controlled Health Organisations (ACCHO) may result in health assessments where there is a failure to elicit appropriate information, incorrect assumptions potentially made, and diagnoses are missed.[46] This means that current data regarding concussion related injuries of First Nations Communities may be heavily under reported. Between 2011-2016, concussion was the most common outcome of intracranial injury in both Indigenous and non-Indigenous people, however indigenous people had a larger proportion of concussion injuries (70% (3,468 cases) vs 52%, (47,466 cases)].[48] There is need for community codesigned models of research into the epidemiology of concussion in First Nations Communities, as well as an assessment of Aboriginal and Torres Strait Islander peoples' knowledge and attitudes relating to concussion.[49, 50]

i. alternative approaches to concussions and repeated head trauma in contact sport, and awareness raising about its risks;

Prevention of head trauma in sport is challenging. The main pathways to reduce RHT incidents are via changes to rules/ regulations within sport and by modification to training methods to decrease the likelihood of head trauma. Changes to rules and regulations within a particular sport should be based upon analysis of head trauma risk within the sport and evidence supporting the hypothesis that the changes to rules/regulations will in fact decrease the risk of RHT.

Sport rules and regulations informing return to sport after concussion have changed significantly over the past two decades. In the 80's, 90's and early 2000s, it was common for athletes to return to play on the same day of the concussion, or to not be removed from play following a concussion. For the past decade, regulations regarding stand down times following concussion have evolved in most sports. In 2023, it is very unusual for elite athletes who have been concussed to return to sport in under 6 days. Several sport organisations, including the AIS, have introduced return to sport protocols which make it *highly unlikely* that an individual would return to sport in less than 12 days from the time of concussion. The current case reports of individuals suffering CTE-NC relate to repeated head trauma exposure in a historical environment, where returning to sport on the same day was common, or to not be removed from play following a concussion. The effects of the more conservative return to sport guidelines who have been introduced by most contact and collision sports may not be seen for several years or even decades.

One of the principles for reducing short and long-term effects from concussion is to ensure that athletes that suffer concussion are promptly identified and removed from the sporting environment. Assisting with this aim, are strategies which aim to have "more eyes" on players (both in and behind play) and thereby increase the likelihood of recognition of potential concussions. Some of the professional football codes have introduced sideline officials whose sole task is to observe play for any head trauma which warrants sideline assessment. In 2018, Rugby Australia introduced the mandatory use of ***Blue Cards*** in all club, school and domestic representative rugby. When a player exhibits signs and symptoms of concussion or suspected concussion, the referee will show the player a Blue Card. The Blue Card is a visual cue for team's support sport staff and triggers an off-field medical process to begin. The AIS applauds this initiative. Referees and match officials are one of the 'constants' in the sporting arena. Having these individuals trained to recognise overt signs of potential concussion, to collaborate with team support staff, and empowered to issue a Blue Card is highly likely to contribute to the early recognition of concussion, particularly at the community level. Other sport codes could consider introducing a Blue Card system.

There is a significant amount of research being conducted in Australia and elsewhere in the world into concussion and its short and long-term effects. While research is ongoing, scientific publications are often not available to the general public or are in a format which is not easy to understand for the general public. In 2019 the AIS launched its ***Concussion in Sport Australia website***, which currently houses the updated ***CBHPS23***. This website provides free, evidence-based and up to date information and practical resources for all Australians who have an interest in concussion in sport. There are resources specifically targeting teachers, parents, coaches, athletes, non-medical support staff and medical practitioners.

j. international experiences in modifying sports for children; and

There has been discussion in the medical literature regarding the possibility that heading the ball in soccer may contribute to concussion, and cause long-term detrimental effects on brain health.[7, 51-53] It has been suggested that estimates of the cumulative number of heading impacts over a playing career should be used as the main exposure metric in epidemiological studies of soccer players.[54] In the US, headers have been banned for children up to 11 years of age. The soccer leagues of England, Scotland and Ireland have also decided in 2020 that there will be no headers-training under 11 years of age and only limited training from 12-16 years of age. In competitions in the UK, however, heading is not banned because only few headers are played in matches in this age group.[55] A follow-up study in the US, comparing rates of concussion in soccer players aged 10-13 years found no evidence that banning heading reduced incidence of concussion.[56] Whether banning soccer heading by children will lead to any change in health outcomes remains to be seen. The efficacy of banning heading in children's soccer (where heading is uncommon) is contested. The decision to ban or restrict heading in the US and the UK appears to be based on an approach of 'an abundance of caution' rather than any strong evidence that such restriction will impact short or long-term effects of concussion.

Body checking in ice hockey occurs when a defensive player crashes into the opponent who's handling the puck, leading with the hip or shoulder, and resulting in a violent collision. Children's ice hockey has a high rate of concussion in Canada, in leagues that permit body checking.[57] Disallowing body checking in non-elite ice hockey for children aged 13-14 years resulted in a 40% reduction in the rate of concussion.[58]

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