UNIVERSITY OF WINCHESTER

# Inside the peloton: An exploration into the culture of competitive road cycling with reference to masculinity, risk and injury, with a principle focus on concussion

Jack Hardwicke

ORCID NUMBER: 0000-0002-1152-0920

Doctor of Philosophy

May 2022

This thesis has been completed as a requirement
for a postgraduate research degree at the University of Winchester.

**DECLARATION AND COPYRIGHT STATEMENT**

**Declaration**

No portion of the work referred to in the Thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

I confirm that this Thesis is entirely my own work.

I confirm that no work previously submitted for credit or published in the public domain has been reused verbatim. Any previously submitted work has been revised, developed and recontextualised relevant to the thesis.

I confirm that Study 1 in the thesis (103-114) has been published in advance of its submission and appropriately referenced in the text.

I confirm that no third-party proof-reading or editing has been used in this thesis.

**Copyright**

Copyright © Jack Hardwicke 2022 Inside the peloton: An exploration into the culture of competitive road cycling with reference to masculinity, risk and injury, with a principle focus on concussion, University of Winchester, PhD Thesis, p. 1-229, ORCID 0000-0002-1152-0920

This copy has been supplied on the understanding that it is copyright material and that no quotation from the thesis may be published without proper acknowledgement. Copies (by any process) either in full, or of extracts, may be made only in accordance with instructions given by the author. Details may be obtained from the RKE Centre, University of Winchester.

This page must form part of any such copies made. Further copies (by any process) of copies made in accordance with such instructions may not be made without the permission (in writing) of the author.

No profit may be made from selling, copying or licensing the author's work without further agreement.

**Acknowledgements**

I am indebted to many for their help throughout my PhD. Firstly, I would like to thank my supervisor, Prof Eric Anderson. Since meeting him, by chance, my life has been improved in so many ways. Eric is the most awesome, caring and supportive mentor you could have. His light-hearted and down to earth approach to life, combined with serious academic intellect and passion, is inspiring. He has challenged my thinking and improved my character in all aspects of life.

I would also like to thank my second supervisor, Dr. John Batten, for stepping in halfway through the PhD to join my supervisory team and provide his expertise and support throughout the project. Further, his mentorship from the very beginning of the project was invaluable before he formally joined the team.

The third and final member of the supervisory team has been central to this thesis and the wider research area. Dr Howard Hurst came on board after several informal discussions around our mutual interests in concussion in competitive cycling. Working with him on this thesis, and associated research, has been a pleasure. I hope to continue our working partnership and passion for improving the management of concussion in cycling. I'd also like to thank Dr Tim Gamble for his early insights and support on this thesis. He was my second supervisor before an institution move but has continued to be a supportive figure throughout which I am most grateful for.

Furthermore, I would like to thank all the other PhD students and academics that I have been put in touch with via Eric. These include both scholars interested in Brain Injuries in sport and masculinity scholars. I have received such fantastic support, training and mentorship from all that has shaped my work and values within academia. Conversations and comments from them have helped shape this PhD as well as fostered my interest in critical interdisciplinary research. These include: Keith Parry, John Batten, Matt Smith, Gary Turner, Joseph Reed, James Alder, Jo Batey, Adam White, Howard Hurst, Rory Magrath, Rachael Bullingham and Mark McCormack.

A huge thanks also goes to my family who have been so supportive throughout my time in education. I couldn't ask for better parents and without their help and support, undertaking this PhD would not have been possible.

**University of Winchester**

## Abstract

Inside the peloton: An exploration into the culture of competitive road cycling with reference to masculinity, risk and injury, with a principle focus on concussion

Jack Hardwicke
ORCID 0000-0002-1152-0920

Doctor of Philosophy

May 2022

In recent years, concerns pertaining to sports-related concussion have become more visible within the mainstream media and entered the cultural consciousness of western societies. Research has shown that brain trauma can lead to a range of neurological, physiological, psychological, and social issues. Yet, despite these concerns dating back to the 1920's, limited progress has been made in the prevention and reduction of these injuries in many sporting contexts. Importantly, much of this increasing concern and research has been focused on team sport contexts such as football and rugby. Competitive road cycling has been largely overlooked in the concussion crisis until very recently, and academic research has somewhat neglected this area. Further, cultural aspects of competitive cycling, such as masculinity, have also been overlooked, particularly in how these aspects relate to injury management.

As such, this interdisciplinary thesis was concerned with exploring the culture of competitive road cycling with reference to masculinity, risk and injury with a principle focus on concussion. The thesis adopts a four-study approach to achieve this, with the aim to provide a comprehensive insight into concussion in competitive road cycling. Study 1 comprised of a qualitative content analysis of social media data to gain an insight to the social and cultural engagement with concussion within the competitive road cycling community. Study 2 adopted a quantitative approach, drawing on a self-report survey of 118 UK cyclists to capture concussion knowledge and attitudes. Study 3 also used a quantitative approach to investigate road cyclist's relationship with masculinity. Finally, Study 4 involved semi-structured interviews with 8 athletes to gain an understanding of their perspectives on the sport, risk and concussion.

The findings suggest that competitive cyclists hold problematic attitudes towards concussion management, which I argue the culture of the sport is highly influential in constructing these attitudes. Whilst findings suggest sound knowledge of concussion amongst competitive cyclists, significant misperceptions were found as well as gaps in knowledge. The thesis concludes that serious cultural change and official action is needed to bring competitive road cycling in line with the current zeitgeist and concussion crisis.

**Keywords**: Sports-related concussion; Competitive cycling; Attitudes; Sporting cultures; Masculinities

**List of Contents**

# Chapter 1: Introduction

**Concussion in sport**

Concussion is a serious problem facing contemporary sporting practices around the world. The repercussions of the injury extend beyond most common sporting injuries, with its potential for life-debilitating impacts, an insidious onset of long-term symptoms and, at the extreme, the injury can be fatal in numerous ways.

The last two decades have seen a significant increase in academic interest and cultural awareness of the effects of concussion in sport. Research is continually contributing to a growing understanding of concussion and the life-changing impacts it can have. As well as research, increasingly we are seeing stories from athletes that have experienced concussion, shedding a light on the nature of this injury.

The injury itself is endemic in competitive sport, particularly contact sports, and it effects many people internationally. The Centre for Disease Control state approximately 1.4 million individuals are treated annually for sports-related concussions in the US alone (CDC, 2019). This is a significant figure, and one that does not include the incidences that go unreported and undiagnosed; something widely acknowledged as problematic in sport (Meier et al., 2015; Torres et al., 2013; Williamson and Goodman, 2006). Comparable data in the UK is not currently available, but these figures give an insight to the scale of the problem, with some scholars now observing this as a health 'crisis' within sport (Nowinski, 2012; Malcom, 2019).

The problem of sports-related concussion provides an interesting and complex intersection of politics, academic disciplines, and cultural investment. Sport holds a hegemonic position in western societies, with frequent cultural exaltation for the many benefits it is deemed to provide society and its participants. The increasing discourses around sports-related concussion challenges this narrative and is questioning the position of some of western societies most well-established sports (Malcom, 2019).

As such, sports-related concussion is a politically charged and culturally contentious issue. For many contact sports, the increasing research around the risks of head trauma serve a direct threat to the future sustainability of these sports (Anderson & White, 2018). Concussion is a medical condition, however, the proliferation and high value attached to sports which induce high rates of the injury make it a social problem. The literature on sports-related concussion is varied, with many different agendas and perspectives on the issue coming to the fore (De Marco & Barth, 2014). It is important to understand these as they impact the research being produced.

The injury draws research interest from a range of disciplines: Neurology, Psychology, Sociology, Social Policy, Physiotherapy and Medicine research amongst others. As a result, there is a wide-ranging understanding of the injury and different perspectives on the approach to address the problem, or indeed that there is no problem that needs addressing. The intersection of these factors must be appreciated when working in the sports-related concussion field. The social and political discourse around the research area influences the literature and often the validity of many studies.

A key example of this is the on-going context in the American National Football League (NFL). The increasing research into the damaging effects of concussion and high frequency of the injury in the NFL serves as a direct threat to the sport. This has significant implications due to the cultural position of the sport in America and the financial investments. The book 'League of Denial: The NFL, Concussions, and the Battle for Truth' written by ESPN reporters Mark Fainaru-Wada and Steve Fainaru (2013) provides a good insight to the intersection of academic research, the media, public culture and sporting governing bodies in the context of the long-term threat concussion poses. This was specifically in the NFL, but we are increasingly seeing the same discourse spread to other sports.

There are numerous 'camps' within the field, from those that wish to rewrite the rules of sport to prevent concussion entirely, to those that deny there is indeed an issue, to those that are somewhat 'on the fence' and seek strategies to reduce concussion incidence through micro interventions. This is by no means an exhausted list but represents the multiple discourses and approaches in the field. Each approach can be seen to correlate with the political, cultural, and financial position of the person or organisation writing on the subject. This is a phenomenon that is essential to understand and appreciate, as well as act reflexively on, when researching the area.

This thesis is grounded in a social approach to the area, working from an inter-disciplinary paradigm situated in the social sciences. Appreciating the historical structures and position of sport, and how this is reproduced today, the research approach of this thesis is to not lose sight of the fact concussive injuries have the real potential to alter a person's life, permanently, and that where this occurs in sport is a socially produced problem.

## Concussion in Road Cycling

Competitive road cycling is a complex and unique sport, and one that is not considered mainstream in popular culture. It is also a non-contact sport and, as a result, it has been overlooked in the wider concerns around concussion in sport. Much of the rhetoric and cultural discussion around concussion in sport has been situated in contact sports, notably rugby and American football.

Although competitive road cycling is a non-contact sport, it is an extremely dangerous sport where crashes and injuries are frequent (Silberman, 2013; De Bernardo, Barrios, Vera, Laíz, & Hadala, 2012; Barrios et al, 2015; Decock et al, 2016). Yet, the attention given to it with concerns around concussion is extremely limited.

It is only in recent years competitive road cycling has come into the conversation, with much of the work being in the form of 'call to actions' directed at the governing bodies within the sport (see Elliot et al, 2019; Greve & Modabber, 2012; Heron et al., 2019). There is extremely little rigorous primary research into the topic. The lack of attention is not warranted, and this thesis argues road cyclists are at a serious risk of concussion and the sports structure and framework is not apt to manage this.

There are numerous case studies and examples of where concussion has impacted athletes lives in cycling. One particularly prominent case is that of Kelly Caitlin. On the 7th March 2019, Caitlin, at just 23-years-old, took her own life in the confines of her university apartment. Caitlin was a successful American road and track cyclist with multiple international achievements in the sport. Her death has been attributed to the mismanagement of concussions sustained in crashes while training and competing, despite her reporting multiple concussive symptoms over a three-month period to official medical staff.

The story highlights multiple issues in competitive cycling regarding policy, education, and concussion awareness. This thesis is situated in competitive road cycling, but other cycling disciplines are explored as well as some implications for cycling in general. These research parameters are explained in more detail in chapter four. At the time of writing, competitive cycling governing bodies have extremely limited concussion policy in place, and no universally agreed in-competition assessment protocols, or return to competition procedures. In fact, at the time of writing, British Cycling has not a single policy in place that is transparent or publicly available (Scullion and Heron, 2022).

The need for greater research into this field is evidenced by this lack of policy, the lack of literature and the continuing real-life examples of where mismanagement of concussion in cycling has had fatal consequences. As such, this thesis is working in an extremely limited field, still in its infancy, but is crucial for raising the profile of the issue and guiding the collective knowledge and body of research.

**Research aims and thesis structure**

The aim of this research is to improve the understanding of concussion in competitive road cycling and provide evidence-based suggestions for change. To date, extremely few primary studies exist researching concussion in competitive road cycling with the notable studies being Hurst et al. (2018), Rice et al. (2020) and O'Reilly et al. (2020). All of which implemented self-report survey methodology and have a broad scope into cycling in all its pursuits, or competitive cycling in all its disciplines. The rest of the literature is made up of retrospective epidemiological studies without a specific focus on concussion or commentary articles on policy and protocol (See; Heron et al. 2019, 2020a, 2020b; Elliot et al. 2019).

Evidently, the field is in its infancy and almost exclusively the domain of those from a sports science or sports medicine background, with the narrative being situated within medical domains. With my work, I hope to bring a new perspective and critical analysis from a social science perspective. The literature thus far frames concussion in its physical form, which is analysed within a medical domain. I seek to reframe the narratives, showing appreciation to the wider social forces at play as well as bringing the research focus to the individual athletes' experiences, which are often dehumanised as statistics and figures in the literature.

To begin this exploration, chapters two and three present the literature on concussion and its outcomes. The injury is examined in a broad context, with definition, pathophysiology, biomechanics, and diagnosis all discussed. The implications of the injury are then discussed in detail, from the individual medical perspective of those that suffer the injury to the wider social implications of concussion in society.

Chapter four presents a detailed review of the specific literature on concussion in competitive cycling. The thesis is concerned with road cycling, but due to the limited field, research from other disciplines is drawn upon where relevant to the discussions. The review covers epidemiological research in the sport, injury surveillance in competitive road cycling, concussion incidence in road cycling, pathology and biomechanics of a bicycle crash and a policy analysis.

Chapter five explores the intersection of gender and society in understanding the process that occur within sport, with a focus on sports-related injury. The scholarship on men and masculinities is outlined and discussed within the context of sport, leading to a specific focus on masculinity in competitive road cycling. The gendered historical and cultural context of road cycling is discussed in its influence on injury management within the contemporary sport.

Chapter six introduces models of understanding risk management in sport. I have already discussed that road cycling is a sport that carries a high risk of injury, this chapter picks apart exactly what the risk of injury is per hours of exposure in a competitive setting. Models of risk management and acceptable levels of risk are then presented within a discussion of the organisational management of risk. Social characteristics that impact how individuals interact with risk are then explored drawing upon literature in psychology, which is then discussed in how these manifests in sport and athlete behaviour. The chapter concludes with the argument that, in the face of the paucity of research on concussion in competitive road cycling, governing bodies must move towards working on the precautionary principle to manage risk (Barnnet and O'Hagan, 1997).

Chapter seven concludes the literature review section of this thesis with a discussion of theorising sports-related concussion. I work from a macro through to micro examination of the theoretical understandings of sports-related concussion. First, I present my argument that concussion in sport is a social problem, with social consequences and, ultimately, it requires a social approach to address it effectively. I then bring the discussion to the individual level, examining how a change here can improve concussion management and how athletes interact with the injury. I present social norms theory (Perkins & Berkowitz, 1986) and theory of planned behaviour (Ajzen, 1991) to make sense of the sporting environment and why athletes may not report concussion, or mask symptoms to continue in competition. I then utilise Inclusive Masculinity Theory (Anderson, 2009) to make sense of wider social changes and how this may impact athlete's injury management behaviours.

Chapter eight explores the methodological approach taken for this project and the philosophical underpinnings. Rationale for a mixed-method approach is presented alongside a discussion of ontology and epistemology as applied to the thesis. A practical discussion around researcher reflexivity and positionality is also provided.

Chapter nine presents Study 1 of this mixed-methods project. Here, I look at the social and cultural engagement with concussion in competitive road cycling over time. I utilised a content analysis of the competitive cycling communities' engagement with sports-related concussion on Twitter. Results demonstrate the net increase in attention given to the issue since its first discussion in 2008. Themes which emerged from the content analysis are presented along with the demographics which engaged with the area on Twitter. Implications of this work and practical applications are then discussed.

Chapter ten outlines Study 2. I administered a self-report survey to 118 UK competitive road cyclists to assess concussion knowledge, attitudes, and reporting behaviours. The results of the study suggest that UK competitive cyclists have moderate concussion knowledge and good concussion

symptom recognition, but significant issues with attitudes were revealed with large groups indicating they would continue in competition following a concussion or withhold reporting the injury. Results also showed that youth were less concerned about concussion than older participants and higher ability groups were associated with more dangerous attitudes. The findings application for informing targeted educational interventions and behaviour change in cycling conclude the study.

Chapter eleven presents an analysis of masculinity amongst the participants in the original survey, outlining Study 3. Through a self-disclosed Likert scale, the study revealed competitive cyclists in this study identified as 'Exclusively masculine' at higher rates than the general population, across age groups, and the implications of this are presented.

Chapter twelve outlines Study 4, the final study of this mixed-method project. I used semi-structured interviews with 8 participants recruited from the original sample of 118 in study two. The interviews focused on attitudes, experiences, and motivations in competitive cycling with themes around injury, risk, and concussion in competitive cycling. Transcripts were analysed working within the thematic analysis framework outlined by Braun and Clarke (2006), and recently updated as reflexive thematic analysis (See; Braun, Clarke, Hayfield & Terry, 2018; Braun & Clarke, 2019).

The results suggest a disassociation of concussion being an issue in cycling, something also revealed in study one. It was found that the participants in this study normalised the risks and accepted the risk of injury as a 'price worth paying' to access the perceived benefits of participation. The behavioural norm of competing when injured and 'getting back on the bike' after a crash was present amongst all participants, with peers and the media being cited as reasons for this attitude to exist.

Some of the participants had experienced concussion, and the interviews revealed the lived experience with the injury and interactions with the healthcare system to manage and recover from the injury. This study represents the first qualitative research into athlete experiences and attitudes in the context of concussion in competitive road cycling. As such, the implications are presented and recommendations for the future directions of the field.

Chapter thirteen brings the thesis to its conclusion. Presenting previous academic research, and the findings of this thesis, I argue that competitive road cycling has a problem with concussion that is under-researched and requires action. I offer a critical commentary on the field, and recommendations for the future direction of research efforts and policy action. As well as this, I outline the areas this thesis revealed as areas that I wish to further research to improve the collective understanding of the culture of competitive road cycling regarding injury management.

## Chapter summary

This chapter has provided an overview of the research context and the structure of the thesis to achieve my research aims. Importantly, this is an identified area in need of further research. The lack of previous research and literature has made this thesis's scope broader as this research hopes to provide a comprehensive overview of concussion in competitive cycling, considering cultural factors in the sport to provide a more holistic understanding of the research area. To begin this exploration, the following two chapters provide a detailed account of the core research issue; sports-related concussion.

# Chapter 2: An overview of concussion

## Introduction

This chapter provides a grounding to the wider research area in which this thesis is positioned. Terminology and definition are both important for research quality, medical and cultural understandings, and policy implementation in sports-related concussion. As such, this is explored with the most up to date literature at time of writing. Concussion is then examined in its physical form, with the biomechanics and pathophysiology of the injury presented. The chapter concludes with the difficulties the injury presents within sporting domains.

## Brief historical review of concussion

Awareness and medical considerations of concussion have a long history. Medical literature dating back to the 5th Century discussed the condition (Casper, 2018). The 10th century saw physician, Muhammad ibn Zakarīya Rāzi, make the first distinction of concussion as a separate condition to muscular-skeletal head injuries (McCory & Berkovic, 2001). Ancient Greeks worked with the condition, with concussion being mentioned in the Hippocratic Corpus, a collection of medical papers, which described the condition through a "commotion of the brain" leading to the loss of speech, hearing and sight (Masferrer et al*.,* 2000).

The early medical work on concussion was grounded in the understanding that the injury was characterised by a loss of function and not physical damage. Concussion was instead described by its clinical features (Sivak et al*.,* 2005). With advancements in technology, notably the invention of the microscope, research turned to the physical and structural mechanisms in the brain and the relationship of these to head injury (McCory & Berkovic, 2001).

In the early 19th century, French anatomist, Guillaume Dupuytren, established for the first time a difference between concussion and loss of consciousness associated with brain contusion (Dagi, 1997). This formed the understanding that concussions are not characterised by structural injury and that macroscopic damage is not a feature of concussion (Masferrer et al., 2000). Over the 19th and early 20th century, attention turned to the aftereffects of a head trauma, with posttraumatic amnesia becoming a predictor of head injury severity (Masferrer et al., 2000).

In the 21st century, we now understand concussion being characterised as a functional injury seen through cognitive impairment (Nowlinski, 2012). The structural damage that does occur is on the

microscopic level, being extremely acute and subtle, often not being detected by traditional methods of brain scans (Lumba-Brown et al., 2018).

## A consideration for terminology

A concussion is a form of mild traumatic brain injury (mTBI) (McCrory et al., 2017). The term itself is based on the Latin word concutere, meaning to 'shake violently' (Cantu & Hyman, 2012). It is only in sport that we see the high frequency of the injury being referred to as 'Concussion', with other disciplines that study concussion referring to it as mild traumatic brain injury. The term, concussion, may be deliberate, as its connotation diminishes the linguistic sense of trauma that a brain injury incurs.

Whatever the aetiology of the term, defining its medical parameters is made more difficult as it is a fluid concept situated between several disciplines. For example, within sports medicine and general medicine, the term is constantly being defined and redefined by various organisations (Meehan, 2017). Because of this, much concussion research findings are not comparable over time and cannot therefore be transferred from study to study. This led to a stymie within the field (Baron, Baron and Reardon, 2013).

To overcome this stymie, experts in the field, primarily from the discipline of sports medicine, have worked to create the International Consensus on Concussion in Sport in order to enhance the consistency of concussion research. This is a multi-disciplined and dynamic consensus on concussion in sport which changes in line with the research field.

First held in Vienna in 2001, the Consensus on Concussion meeting was last held in 2016. At the 2008 Third International Conference on Concussion in Sport, the push for a separation of the term's concussion and mTBI was debated. Researchers acknowledged that the two terms represent separate injury constructs and should not be used interchangeable in the research field (Baron et al., 2013; Wills & Leatham, 2001).

The Consensus on Concussion in Sport recognised the need for a universally agreed upon definition of concussion to avoid inconsistency in research, as much of the literature prior to 2008 used concussion and mTBI interchangeably. This remains an issue within the literature, with a body of research recognising the impact of the different terms on athlete perception and appreciation of the severity of the injury (Weber & Edwards, 2010; Kelly & Erdal, 2016; Sussman et al*.,* 2019).

Indeed, research by McKinlay et al. (2010) revealed that fifty-nine per cent of participants that had reported they had experienced a concussion stated that they had never had a brain injury. This work highlights the detachment present between concussion and traumatic brain injury, which has serious implication on the identification and diagnosis of concussion, as well as individuals' perceptions of their injury and thus the management behaviours they adopt (Whittaker et al., 2007).

More recently, Garavito et al. (2019) showed that high-school and college athletes were more willing to expose themselves to risk than non-athletes when hypothetical scenarios involved colloquial references to traumatic brain injury such as 'getting your bell rung'. Also, athletes were more likely to expose themselves to risk when the term concussion was used as opposed to brain injury. This references the injury management behaviour often seen in sport, with the narrative of downplaying injury (Baron et al., 2013). It also further supports the assertion that the term concussion is connotated with less severity than traumatic brain injury.

Despite the noted issues, within this thesis the terms will be used interchangeably. When the discussion is original thought in the research context of sport, concussion will be the choice of terminology. This is to ensure consistency throughout the writing, align with the terminology used within the research phases and to contribute to the literature with the understanding that a concussion *is* a form of Traumatic Brain Injury and thus the severity of the injury is acknowledged regardless of the terminology used.

However, when citing research, the terms used in said research will be used to ensure consistency and validity in acknowledgement of the impact terminology has on the perceptions of the injury in athletes (Weber & Edwards, 2010; Kelly & Erdal, 2016; Sussman et al., 2019). Also, when the injury is being discussed outside of sport, the term traumatic brain injury may be adopted to be consistent with the literature and research that is being engaged with.

## Defining Concussion

Following the 2016 Berlin conference, the 2017 Concussion in Sport Group (CISG) outlined sports related concussions as: 'Sport related concussion [(SRC)] is a traumatic brain injury induced by biomechanical forces. Several common features that may be utilised in clinically defining the nature of a concussive head injury include:

> ► SRC may be caused either by a direct blow to the head, face, neck or elsewhere on the body with an impulsive force transmitted to the head.

► SRC typically results in the rapid onset of short-lived impairment of neurological function that resolves spontaneously. However, in some cases, signs and symptoms evolve over a number of minutes to hours.

► SRC may result in neuropathological changes, but the acute clinical signs and symptoms largely reflect a functional disturbance rather than a structural injury and, as such, no abnormality is seen on standard structural neuroimaging studies.

► SRC results in a range of clinical signs and symptoms that may or may not involve loss of consciousness. Resolution of the clinical and cognitive features typically follows a sequential course.

However, in some cases symptoms may be prolonged. The clinical signs and symptoms cannot be explained by drug, alcohol, or medication use, other injuries (such as cervical injuries, peripheral vestibular dysfunction, etc) or other comorbidities (e.g., psychological factors or coexisting medical conditions) (McCrory et al., 2017: 839).

The consensus statement (McCrory et al., 2017) is a progressive step forwards for medical professionals and researchers to develop a universal and consistent approach to the research and management of concussion. However, the text is jargon heavy and adopts medical terminology which reduces its effective application to the public and even sport stakeholders, including athletes, parents, coaches, and officials (Meehan, 2017).

To combat this, Meehan defines a concussion as 'trauma-induced brain dysfunction' (2017: 4). A concussion is a display of the brain not operating as normal due to a trauma, and many define concussion on this principle. A concussion is characterised by functional neurological impairment as opposed to a physical structural injury, Nowinski (2012) suggests, 'A concussion is actually not defined by a physical injury, but by a loss of brain function that is induced by trauma… a brain malfunction or as an alteration in mental status'. Concussive injuries are a subset of traumatic brain injuries, and, although commonly classified as mild, they can have highly impactful negative outcomes to the brain.

## The biomechanics of concussion

A concussion concerns the shaking of the brain within the skull because of an external load, leading to several biological processes that can result in deleterious damage to the brain. The external load can be directly to the head or neck, but this is not the only cause. Contrary to popular belief, impacts

to other areas of the body can cause the biological responses leading to a concussion (Cantu & Hyman, 2012).

The biomechanics of concussion can be defined through:

-The forces experienced during impact;

- Head and neck movements, stiffness of the tissue that composes the head/neck complex;

-Deformation of structures at the macroscopic and microscopic level, and the biological responses to the various loading conditions imposed on the head (Graham et al*.,* 2014).

The biological responses to this external load on the brain are twofold. First, there can be structural damage seen through torn vessels and axons. Gorgorapatis et al*.* (2019) work revealed the biological response to a physical trauma can cause structural changes in the brain in the form of protein 'tau' tangles that are associated with the onset of dementia. Research on animals also indicates the structural impacts of external loads on the brain. Bashir et al. (2020) found a single Closed Head Impact Model of Engineered Rotational Acceleration (CHIMERA) induced on mice caused increased levels of plasma tau and acute microstructural vascular abnormalities.

The second biological response is seen through the functional changes in the brain following a physical trauma. This includes changes in blood flow in the brain, altered neurological status and impaired cognitive function (Meany & Smith, 2011).

## Pathophysiology of concussion

The brain located in the top of the skull in the cavity of the cranium from the roof of the mouth upwards and is contained within cerebral fluid (Meeham, 2017). It is connected to the spinal cord via the brain stem located at the rear under-side of the brain. Made up of soft tissue with a high concentration of water, the brain's texture is often described as gelatine like (Meaney & Smith, 2011).

The brain is highly complex with countless components. Billions of nerve cells, or neurons, work together using electrical signals communicated through their axons to operate the human body. In a process known as action potential (Bear, Connors & Paradiso, 2016), these electrical signals travel along the axons from the dendrites to the terminal ends. It is at this point there is a chemical exchange of sodium and potassium between the extracellular space and the intracellular space which creates positive electrical activity inside the cells (Khurana & Kaye, 2012; Meehan, 2017).

If there are too many potassium ions inside the intracellular space, or too much sodium in the extracellular space, the brain must reduce the electrical charge inside the cell. Accordingly, either potassium or sodium is exchanged (Bear et al., 2016). The biomechanical infrastructure in place to manage this consists of an ion leak channel that allows excess ions to move across the cell membrane. As well as this, the sodium potassium pump maintains stable chemical balance by returning sodium to the extracellular space and potassium to the intracellular space, when necessary. For this process to work, energy is required to fuel the sodium potassium pump, this energy is sourced from adenosine triphosphate (ATP) (Meehan, 2017).

When a concussion occurs, there are two biomechanical processes. The initial instance of a concussive impact on the brain results in the diffuse axonal injury. This is a physiological injury in which the axon of a neuron is sheared due to the rotational forces that result from physical trauma (Johnson et al., 2013). The second phase from this is known as the neurometabolic cascade of concussion. Because of the damage, the brain experiences an energy crisis leading to chemical imbalances within the intracellular space.

When the brain experiences rotational forces of this nature, such as that experienced in a bicycle crash, the damage to the neurons causes many of the cellular structures in the brain to deform (Meehan, 2017). In this crisis, the ion leak channels open causing a rush of sodium in the intracellular space. At this point the cell cannot function correctly whilst flooded with excess sodium and it must be removed (Meehan, 2017). The sodium potassium pumps are responsible for this removal, but they are at capacity to deal with this irregular quantity of sodium inside the cell requiring removal. To do this, they require more energy to deal with the workload, but due to the reduced blood flow following a concussion there is limited resources to draw upon in the brain to aid this process (Meehan, 2017).

**Cause of concussion**

The cause of concussion is often a direct biomechanical force to the head or neck; however, impacts to other areas of the body can also result in in concussive injuries (Cantu & Hyman, 2012). For example, a cyclist can crash without directly hitting their head on the floor and still experience the damaging impacts of rotational forces to the brain (Nowinski, 2012). Indeed, Hurst et al. (2018a; 2018b; 2020) demonstrates that Mountain bike and BMX cyclists may be at risk of sub-concussive trauma without a crash being a necessity. Riders were reported to experience repeated head accelerations of 82g or higher, just from the demands of the terrain.

In quantifiable terms, there is no agreed upon point of force in which it can be objectively observed a concussion will occur. Some argue external loads within the range of 70g and 90g are the point at which concussion occurs (Guskiewicz & Mihalik, 2011). Zhang et al. (2004) proposed that an external load of 82g or higher would result in over a 50% per cent, or greater, chance of sustaining a degree of irreversible brain injury. Experiencing a force of more than 90g does not confirm a concussive injury; similarly, whereas impacts below 70g may result in concussion (McCaffrey et al., 2007). There is no universal classification, and these parameters are a contested and constantly changing dispute, as we learn more about the condition.

What is agreed upon for a concussion to occur, is that there must be a biomechanical loading of the brain. When the head experiences a physical trauma, it accelerates away from the direction of force. This leads to the acceleration and deceleration of the brain, the point at which many agree concussion occurs. Meehan (2017) highlights that matters are more complex than this; that it is not just this process of acceleration and deceleration of the brain inside the cranium that results in concussion, the rotational forces present in head trauma are equally as impactful.

Research on animals supports this thesis. In monkeys it was found that rotational forces, rather than linear acceleration from impact, were the primary causes of concussion (Ommaya & Hirsch, 1971; Ommaya & Gennarelli, 1974). This would suggest the rotational forces that cause sheer strain on the brain are the biomechanical cause of concussion (Speed, 1989). This force does not have to be direct to the head, and physical impacts to other regions of the body can lead to concussions (Meaney & Smith, 2011). For example, a bicycle crash often occurs at high speed so the impact on any part of the body can result in the acceleration/deceleration rotational forces on the brain. In sport, we see both linear and rotational forces because of physical trauma.

## Difficulties diagnosing sports-related concussion

Concussion is a significant issue in sport. In the US alone, the Centre for Disease Control estimate between 1.6-3.8 million sports related concussions occur annually (Langlois et al., 2006), comparable data is not currently available for the UK.

Among the age group 15-24, sport is a leading cause of brain injury, behind only motor incidents (Cantu & Hyman, 2012). The available data on concussion rates only represent a rough estimate of the true numbers. Many do not seek medical help for concussions, so these are not diagnosed and thus not accounted for in the data (Daneshvar et al., 2011). It is estimated that over half of all sports-related concussions go unreported (Harmon et al., 2013). A true representative picture of the rates

of concussion in sport is not available. With a large proportion going unaccounted, many suggest that concussion is mostly an invisible injury (Carroll & Rosner, 2012).

Making matters yet more difficult, unlike many injuries seen in sport, there is no simple test to confirm a concussion (Covassin et al., 2009). McCrory and colleagues (2013: 561), at the 4th International Conference on Concussion in Sport, comment that concussion, '…is among the most complex injuries in sports medicine to diagnose, assess and manage.'.

A significant contributing factor to the ambiguity of diagnosing a concussion is the wide array of symptoms that may be present, and often can subside in the short-term (Daneshvar et al., 2011). Unfortunately, many symptoms of concussion cross over with other injures or even signs of fatigue (Wilkins et al., 2004), leading to some coaches, sport clinicians and team managers to ignore signs of concussion, attributing them to other injuries (Nowinski, 2012).

The diagnosis of concussion is currently still dependent on assessing functionality in an athlete or through self-reporting of symptoms. The technology to reveal the immediate micro-structural damage from concussions is not available (Cantu & Hymer, 2012; Malcolm, 2017). Further, typical Magnetic Resonance Imaging (MRI) scans will not detect concussions. These scans reveal macro-structural damage to the brain, whereas damage from concussion is acute and subtle, so MRI scans will not give any insight to the injury (Lumba-Brown et al., 2018) and should not be used for diagnosis (McCrory et al., 2017).

However, there is a body of work revealing the potential importance of Functional Magnetic Resonance Imaging (fMRI) in diagnosing concussions. These scans reveal functional abnormalities, rather than structural, within the brain (Meier et al., 2020). But this work is in its infancy, not accessible to all athletes and research is post-injury, not being used as a form of immediate assessment and diagnosis.

The reliance on athletes being symptomatic to diagnose concussion is problematic. Previously noted, the crossover of concussion symptoms with other injuries or conditions complicates the understanding of concussion and can lead to its dismissal (Nowinski, 2012). Further, symptoms of concussion in athletes can be easily mistaken for other medical impairments or body states such as Veisalgia (a hang-over) shares many similarities with concussion symptoms and is problematic in sports associated with heavy drinking (Anderson, McCormack & Lee, 2012) and fatigue in athletes from physical exertion also share similar symptoms with concussion.

Cultural frameworks that exist within sport further problematise the diagnosis of concussion through athlete symptom reporting. Research estimates up to 50 per cent of all athletes fail to report

concussive symptoms (Baron et al., 2013). This can be for a range of reasons including; 'players either want to keep playing for fear of losing their position on the team to a backup player, do not want to be perceived as weak, or both' (Baron et al., 2013:15).

Indeed, the phenomenon of 'sandbagging' has been seen in athletes (Baron et al., 2013:15). This involves athletes consciously underperforming on baseline cognitive tests pre-season to 'beat' the test in season and avoid being taken out of competition following a concussion (Baron et al., 2013:15). Further, research estimates that up to 33 per cent of athletes are not even aware of the symptoms of concussion (Baron et al., 2013). As such, it can be difficult for athletes, coaches, sports clinicians, and parents to understand and recognise a concussive injury (Meehan, 2011).

**Returning to competition**

If an athlete is diagnosed with a concussion, the next phase is recovery and return to competition. With the nature of the injury, this is not straight forward, and the understanding of return-to-competition guidelines is constantly shifting in line with the changing and evolving scientific knowledge around concussion.

A source of the ambiguity surrounding return-to-competition is that there is no agreed 'grading' system for the severity of a concussion (McCory et al., 2017). The complexity of initial recognition of concussion in competition complicates the context of when, and how, the injury occurred and the extent of the damage. Health practitioners work in the after care of an athlete post-injury or competition and it is here that severity of injury is attempted to be identified.

The most recognised work to aid the categorisation of a concussion, and thus its management, comes from the 'Evidence-based Cantu Grading System for Concussion' (Cantu, 2001: 246). Here, the system categorises concussive injury into mild, moderate, or severe. Cantu's system (2001) draws on the proposed grading severity of a concussion to have a clear relationship with the amount of rest given before an athlete returns to competition.

The work proposed has been adapted and revised in line with the evolving scientific knowledge regarding concussive injury, but the core ethos of it provides a useful addition to return to competition guidelines. However, there is a recognition that the effective recovery and return to competition for athletes requires highly individualized management plans (McCory et al., 2009).

There is in increasing recognition of the many factors that contribute to different experiences of concussion and thus different needs for effective recovery. These include an athletes history of

concussions (Covassin et al., 2013), an athletes age (Murdaugh et al., 2019; Wilmoth et al., 2019), the sex of an athlete is recently receiving a lot more attention as we understand the different experiences of concussion between sexes (Desei et al., 2019 ) and the physiological impact of the injury (Kamins et al., 2017).

The current state of the literature supports a gradual reintroduction into competition after an athlete has stopped being symptomatic following a concussion and has had a minimum of 24-48 hours of physical and cognitive rest (McCrory et al., 2017). However, this is changing with the increases in our knowledge around concussion and is regularly contested. Kamins and colleagues (2017) observe that physiological dysfunction from concussion may often outlast clinical measures of symptoms and recovery, so the reliance on clinical symptoms of athletes may not be an appropriate marker for return to competition decisions.

There is also increasing evidence of the complexity of rest in the management of concussion. The literature reflects how rest can both benefit and prevent effective concussion recovery depending on situational factors (Broglio, 2018). Complete rest has often been at the forefront of concussion recovery rhetoric (Giza et al., 2018) but this is starting to subside with active rest receiving more attention in the field as an effective management of concussion recovery (Broglio, 2018). It has been noted in the literature that adherence to doctors, often outdated and not sport-specific, recommendations for rest following concussion may lead to athletes experiencing symptoms for longer periods (Root et al., 2020).

Buckley and colleagues (2016:30) write on this:

> Cognitive and physical rest may be harmful in several ways: it may lead to longer symptom durations, decreased physical conditioning and subsequently longer physical recovery times, increased severity and number of symptoms, and long-lasting psychological effects. Similarly, in its comparison to many chronic issues (such as pain, fatigue, and balance disorders), activity avoidance and rest in individuals with concussion should be carefully prescribed. Further, cognitive rest specifically should be thoughtfully considered by Speech-language pathologists when beginning therapy with individuals who have sustained a concussion.

## Chapter summary

This chapter has provided an overview of concussion in line with the most current literature. The medical aspects of the injury have been discussed, showing recognition to increasing research

interest in the injury. The injury is complex, and there is still much to learn about the specific mechanics of concussion. The impacts of the complexity of the injury have been contextualised within the domain of sport, and the specific issues that come with this.

Crucially, concussion refers to a traumatic brain injury which is often overlooked within sporting domains. It can be seen through acute, subacute, and chronic symptoms which pose a serious risk to an individual's long-term health. The next chapter examines these, giving context to the severity of the injury.

# Chapter 3: Outcomes of concussion

**Introduction**

The medical explanations of concussion, and some of the issues the injury presents in sport, was discussed in chapter two. In this chapter, I examine the outcomes of concussion. Medically, I present the acute, subacute, and chronic outcomes that concussion can have on an individual. I then examine the social implications of the injury, demonstrating the breadth of damage concussion causes on society.

**Acute and subacute symptoms of concussion**

Previously in the literature it was widely accepted that the loss of consciousness (LOC) was the primary indicator of when a concussion had taken place (McCrory et al., 2013; Meehan, 2017; Nowinski, 2012; Omalu, 2008). This is no longer the case and research now suggests' only 5-10 per cent of concussive injuries in sport lead to the loss of consciousness (Ellemburg et al., 2009; Meehan, 2017). There is now a wide array of symptoms that are used in the identification of concussion.

When an individual experiences the external load causing the biological responses in the brain, there is a timeline of the possible resultant symptoms that are displayed in a concussed individual. Concussion poses both short-term and long-term threats to an individual's health. McCrory and colleagues (2017) propose a framework of acute symptoms that may be present in the short-term to inform the diagnosis of a concussion:

> The suspected diagnosis of SRC can include one or more of the following clinical domains:
>
> a. Symptoms: somatic (e.g., headache), cognitive (e.g. feeling like in a fog) and/or emotional symptoms (e.g. lability).
>
> b. Physical signs (e.g. loss of consciousness, amnesia, neurological deficit).
>
> c. Balance impairment (e.g. gait unsteadiness).
>
> d. Behavioural changes (e.g. irritability).
>
> e. Cognitive impairment (e.g. slowed reaction times).
>
> f. Sleep/wake disturbance (e.g. somnolence, drowsiness).

> If symptoms or signs in any one or more of the clinical domains are present, an SRC should be suspected and the appropriate management strategy instituted. It is important to note, however, that these symptoms and signs also happen to be non-specific to concussion, so their presence simply prompts the inclusion of concussion in a differential diagnosis for further evaluation, but the symptom is not itself diagnostic of concussion (McCrory et al., 2017: 840).

These clinical domains presented by McCrory and colleagues offer a clear break down of the acute and subacute symptoms an individual may display because of a concussive injury. These domains, or frameworks similar, are widely used within sport for in-competition assessments for concussion (Brett et al., 2018).

**Second Impact Syndrome**

Perhaps the most dangerous potential immediate consequence of multiple concussions is Second Impact Syndrome, a condition that captured the interest of the media and sporting governing bodies (Saunders, 1984; Malcolm, 2017; McCrory, 2001). Formally known as 'malignant cerebral edema' (Bruce et al., 1981), Second Impact Syndrome is when a second concussion is sustained before the brain has restored normal function following the first concussion (Bey & Ostick, 2009).

When an initial concussion is sustained the brain must work to restore physiological regulation and cerebral blood flow. The brain is already overworked following a concussion and cannot meet the demands required to restore normal function. It enters a protective state to reduce swelling and is extremely vulnerable while dealing with the chemical imbalance induced by the physical trauma (Bey & Ostick, 2009).

If a further concussion is sustained that interrupts this process, the resultant damage can manifest in the form of Second Impact Syndrome. The sequelae of Second Impact Syndrome is as follows; the brain cannot regulate the edema (swelling) and resultant intracranial pressure (Bey & Ostick, 2009). The intracranial pressure increases to the point the brain shuts down and death soon follows. Concerningly, in a sport context, death is almost certain. There is evidence that increases in intracranial pressure can be managed by the brain but such levels cannot be reduced without surgical interventions that would not be available in the time scales required for instances that occur on a sports field (Saunders, 1984; Bey & Ostick, 2009).

The condition is relatively rare, with research suggesting there are fewer than twenty documented cases in the literature (Dessy et al., 2015). Documented cases most frequently occur in adolescents

(Bey & Ostick, 2009; Cantu, 2016; McCrory, Davis & Makdissi, 2012), but there have been cases in young adults (McCrory & Berkovic, 2000). Regardless of frequency, one death through a preventable injury taking place within sport is too many, so the condition must be taken seriously.

In France, three deaths occurred in under-21's rugby players within the space of five months, all related to the game. Within the UK, Benjamin Robinson was the first recorded case of Second Impact Syndrome, where he was fatally injured following multiple concussions in a school rugby game (Pollock, 2014). The harrowing nature of Benjamin's death has had a ripple effect on cultural awareness surrounding the risks of concussion and Second Impact Syndrome. Benjamin's father, Peter Robinson, is a leading advocate in the UK raising awareness of the risks involved in contact sports.

The spectacle of this injury, particularly in youth athletes, captures large media attention and public pressure on the governing bodies to act. The response from sporting organisations is to focus on 'safety' through the implementation of 'recognise and remove' protocols to prevent Second Impact Syndrome (McCrory, 2001). This rhetoric first seen in rugby, but increasingly in a range of sports, of 'recognise and remove' and 'if in doubt, sit them out' are now commonplace in western sporting culture (McCrory et al., 2013).

Whilst this is important, this approach serves as a distractor to the actual problem; the rates and occurrence of concussion in sport in the first place. The aim should be to prevent a concussion ever occurring, but we see governing bodies in sport placing the emphasis on protocols after a concussion is already sustained, and thus the damage is done. This offers a response to the increasing media and public pressure to act, implementing greater concussion training for stakeholders and 'official' concussion removal protocols makes it seem action is being taken. These serve as methods to protect the sport and avoid the clear solution to prevent concussions occurring. In the case of rugby, of course this would mean removing contact; something the governing bodies will avoid at all costs.

Further, as highlighted previously in this chapter, dominant cultural frameworks often still privilege sport over health and many athletes, coaches and sports clinicians continue to ignore removal guidelines that are in place (Malcom, 2017). This is a problem very prevalent in cycling (Hurst et al. 2018).

### Concussion as a risk-factor for further injury

The injury rate of many sports and cultural frameworks that exist complicate the recognition, diagnosis and recovery from concussion, leading to athletes being a high-risk cohort for suffering the

impacts of concussion. Aside from the medical complications of a concussive injury itself, the injury puts athletes at risk for further injuries also.

Research indicates that once an individual has sustained a concussion, they are between 1.5-6 times more likely to sustain a further concussion when compared to an individual not previously sustaining one (Zemper, 2003; Guskiewicz et al., 2003). This can be due to the decreased cognitive function (Carlozzi et al., 2019) as well as gait and balance problems (McLeod & Hale, 2015) leading to the athlete being at sub-optimal performance, increasing risk of the point at which concussions occur in the sport.

The cognitive impairment and effect on motor skills following a concussion is now well understood in the literature (Collie et al., 2006; Buckley et al., 2016; Nowak et al., 2020). This can be a key factor in exposing an athlete to further injuries. Indeed, Nordström and colleagues (2014) found in a sample of footballers, athletes that had suffered a concussion were at up to a fifty per cent greater risk of suffering further musculoskeletal injuries because of the compromised performance associated with an athlete following a concussive injury.

Further, Brooks et al. (2016) conducted research across a range of sports in collegiate athletes. Here, researchers sought to establish the link between the deficits in neurocognition following a concussion which can impair neuromuscular control potentially causing an increased risk for musculoskeletal injury in athletes. Using conditional logistic regression to analyse results, Brooks et al. (2016) research found that concussed athletes were at a higher risk of acute musculoskeletal injury to the lower extremity than the non-concussed control group. It is thus suggested that a concussion presents a range of complications to athletes, but also places athletes at a higher risk for musculoskeletal injury.

## Post Concussive Syndrome

The acute and subacute symptoms demonstrate some of the immediate and short-term impacts of concussion. But concussive injuries pose several longer-term conditions too. One of these is Post-Concussive Syndrome (PCS). The condition has been linked to a reduction in glucose utilization in the brain and fMRI changes that occur within a week of the concussive injury (Baron et al., 2013). There is no definitive diagnostic test to confirm PCS, which complicates the condition. The most frequently reported symptoms of PCS are persistent headaches, difficulty with concentration, memory problems, dizziness, irritability, fatigue, sensitivity to noise, anxiety, and depression (Ryan & Warden, 2003).

These symptoms can persist for several weeks becoming subacute and then chronic in nature. The International Classification of Disease (10th Revision) suggests that the signs of symptoms within four weeks of a concussive injury is representative of PCS (Khurana & Kaye, 2012). Typically, the symptoms of concussion ease within weeks with some cases continuing for months (Hall, Hall & Chapman, 2005). Despite this, research suggests that 7-15 per cent of individuals that have suffered a concussion are symptomatic for over a year (Hall et al., 2005).

Post Concussive Syndrome affects between 38-80 per cent of individuals that suffer a mild head trauma resulting in individuals being symptomatic for extended periods of time (Hall et al., 2005; Baron et al., 2013). The nature of this injury makes it a significant problem in sport, where there is a widespread culture of returning to play in the shortest time possible. This culture leaves sport clinicians in a difficult position of balancing appropriate recovery times with the pressure from athletes, teams, and sponsors to return to play (Stuart et al., 2017). There is no agreed upon framework for the management of PCS, or on recovery time, as this is influenced by multiple individual factors such as age, sex and history of concussive injuries (Leddy et al., 2012; Guskiewicz et al., 2003; Iverson, 2019).

The impact of Post Concussive Syndrome can be fatal when not diagnosed and treated appropriately. The condition leaves individuals in a debilitated state for prolonged periods of time which causes a host of mental health problems. This can be seen through two levels. Firstly, the structural damage sustained from a concussion can alter the brains function making an individual more prone to mental health conditions, notably depression (Rice et al*.,* 2018). Secondly, for athletes, not being able to compete or function at their usual capacity for such long periods of time can be detrimental to their mental health. We see many deaths through suicide in athletes that have suffered with post concussive syndrome (CLF,2019).

**Chronic Traumatic Encephalopathy (CTE)**

Much of the increased concern regarding sports-related concussion has been a result of research findings regarding Chronic Traumatic Encephalopathy (CTE). Indeed, the 2015 award-winning film 'Concussion' was based around the discovery of CTE in deceased NFL player Mike Webster and the resultant struggle of bringing this research to policy action when taking findings to the governing bodies of the sport (Omalu et al., 2005).

The disease was revealed as a concern in contact sports in 2005, with Dr Omalu and colleagues publishing research findings "Chronic Traumatic Encephalopathy in a National Football League

Player" in the journal *Neurosurgery* (Omalu et al., 2005). This was the first work where this condition was documented in the context of team sports and American Football (Nowinksi, 2012).

Omalu is credited as the key figure in the discovery of the disease CTE, however the disease can be seen throughout sports-medicine literature prior to 2005. Initially seen in boxers, with the condition being referred to as 'punch-drunk' (Martland, 1928). CTE has also been referred to as dementia pugilistica (Millspaugh, 1937; Corsellis et al., 1973) and gridiron dementia (Omalu, 2008). The neurologist, MacDonald Critchley (1949), first used the term CTE in his work, "Punch-drunk syndromes: The chronic traumatic encephalopathy of boxers". Ten years after publication he then referred to the condition as Chronic *progressive* Traumatic Encephalopathy (Critchley, 1957).

Will Hobson wrote a damming article in the Washington Post about Omalu (WP, 2020). He accused Omalu of basing a career on distorted science, and that he should not be championed as the key figure to discover CTE, nor did he coin the term for the disease. The previous work by neurologists into CTE was in a different socio-context to Omalu which has influenced his work and the reaction to it from the scientific community. Omalu contributed to the literature through identifying the disease in the NFL, with the aim of publicising it. This had far greater cultural impacts than previous research into CTE and thus greater media attention, resulting in Omalu today being credited as the key figure in the discovery of CTE. Further, Omalu is religious and has depicted a religious discourse around his discovery, and divine duty to publish it, which has been met with fierce criticism in the scientific community. However, due to the subsequent autopsies of deceased American Football players by Omalu and colleagues (Omalu et al., 2005; Omalu et al., 2006), the disease is now consistently referred to as CTE, with a now significant research field on the condition.

CTE is a progressive neurodegenerative disease found in individuals that have suffered brain trauma (Maroon et al., 2015; Stewart et al., 2015). The sequelae of the condition following repeated head trauma is seen through the '…gradual onset of neuropsychological, psychiatric and behavioural disturbance followed by progressive cognitive decline' (Stewart et al. 2015: 11). In layman's term, CTE can be characterised as a form of Parkinson's disease and Alzheimer's, but the onset occurs much earlier in an individual's life (Omalu, 2008) and the individual has a history of sub-concussive repetitive head trauma (Maroon et al., 2015).

The focus on sub-concussive head trauma is crucial to the understanding of CTE and vulnerability to it. There have been cases of CTE in athletes that went without a diagnosis of concussion (CLF, 2019) leading to research focusing on the sub-concussive impacts experienced by athletes. Bailes et al. (2013) note the phenomenon of sub-concussive impacts as an emerging concern, with evidence highlighting their 'potential to contribute to the development of subacute and chronic sequelae such

as depression, post concussive syndrome, post traumatic stress disorder, mild cognitive impairment, CTE, and dementia pugilistica (p.1241).

The issue here, being that opposed to its counterpart, concussion, sub-concussive hits often go unidentified and thus time away from play is not enforced. In the case of American Football, Adnan and colleagues' (2019) research discovered athletes in the NCAA Division III experienced nearly 20,000 hits across competition and practice in one season. The research used accelerometers that measured rotational and linear accelerations, recording all impacts of 10g or higher. Of the 20,000 hits, the median force was 25g with over half exceeding this (Adnan et al., 2019). To put this into perspective, Formula 1 drivers can experience up to 6g traveling at speeds in excess of 100mph (Seedhouse, 2012).

Further, of the 20,000 recorded hits, only two resulted in a diagnosed concussion (Adnan et al., 2019). The sheer frequency of exposure to these external loads and sub-concussive impacts to the brain many athletes experience in various sports (See; Hurst, 2018a; Hurst, 2018b; Andnan, 2019; Crisco et al, 2010; Pearce, 2016) has led research to examine the accumulative effect of such head trauma (Govender & Nel, 2019) and its link to CTE.

One of the defining features of CTE, as opposed to other neurodegenerative diseases, is that its onset can be seen mid-life, often at the stage an athlete retires from sport (Gavett, Stern & McKee, 2011; Khurana & Kaye, 2012). Not dissimilar to other diseases, CTE has an initial onset followed by the progressive degeneration of the brain (Khurana & Kaye, 2012). In a review of neuropathologically-confirmed CTE in athletes, Mckee and colleagues (2009) found the mean age of onset to be 42.8 years (SD=12.7), with ages ranges from 25 to 76 years. On average, onset occurred 8 years following retirement from sport, yet one-third of athletes were reportedly symptomatic at the time of retirement (McKee et al., 2009). The average duration of CTE in boxers is twenty years, but just six in American Football (McKee et al., 2009).

Noticeable behavioural changes are strongly associated with the onset of CTE such as mood-swings, intense irritability, impulse control problems and aggressive violence (D'Ascanio et al., 2018). Supporting this, reports from peers and those of close relation suggest individuals suffering from CTE become more irritable, angry, apathetic and have an increased temper (Omalu et al., 2010).

Early indicators of CTE include memory impairment, executive dysfunction, depression, apathy, irritability, suicidality, impulse control problems, disinhibition, substance abuse, addictions, aggression, and increased violence (Baugh et al., 2012). In the late phases of the condition, 'movement (e.g., parkinsonism), speech, and ocular abnormalities may emerge in the context of

declining cognition and worsening comportment' (Gavett et al., 2011: 3). A small number of cases also see the development of dementia, but this often does not have the biological time to develop due to the high frequency of death through suicide and accidental death associated with individuals suffering with CTE (McKee et al., 2009; Omalu et al., 2010).

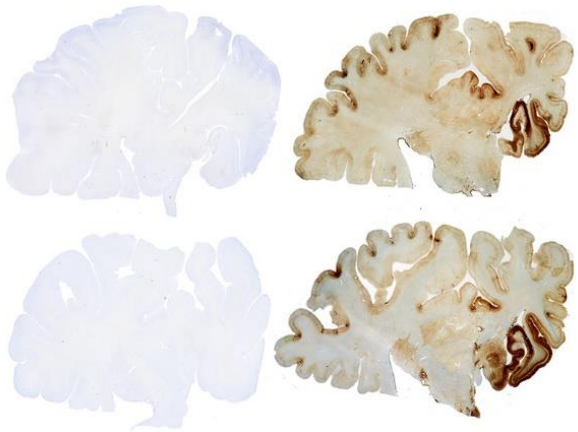


**Figure 1**: Healthy control brain (Left) compared to one diagnosed with CTE (Right)

(Concussion Legacy Foundation, 2019)

The neuropathology of the disease is like Alzheimer's, but several factors separate the condition (Gavett et al., 2011). Baugh and colleagues (2012) describe CTE as 'neuropathologically characterized by aggregation and accumulation of hyperphosphorylated tau and TDP-43'. A key feature of CTE being the profusion of neurofibrillary tangles, neurophil threads and glial tangles (McKee et al., 2015). These are mainly comprised of a tau protein (Omalu et al., 2005; Gavett, Stern & McKee, 2011) which have also been seen in dementia patients that suffered head trauma (Alosco, 2019).

The formation of CTE is unique, with the neurofibrillary tangles being positioned in different locations of the brain and in irregular patterns, differing from that of Alzheimer's (Gavett, 2011). Further, for a clinical diagnosis of Alzheimer's, beta-amyloid must be present, whereas this protein is only seen in around 43 per cent of CTE cases (McKee et al., 2014).

Although all cases of neuropathologically diagnosed CTE have been linked to repeated head trauma (McKee et al., 2015), the precise neurobiological process that leads to the Neurofibrillary Tangle Formation (NFT) are not known (Gavett et al., 2011). When the brain is subject to an external load, the acceleration, deceleration and rotational forces cause the brain to lengthen and deform causing structural tears on the microscopic level of the brain (McKee et al., 2015). This process predominately affects the long fibres in the brain, notably axons and blood vessels and is most

damaging when the direction of axons changes (Cloots et al., 2011). This initial retardation of the brain after impact can result in diffuse axonal injuries that are then aggravated by further head trauma potentially leading to the NFT seen in CTE cases (Gavett et al., 2011).

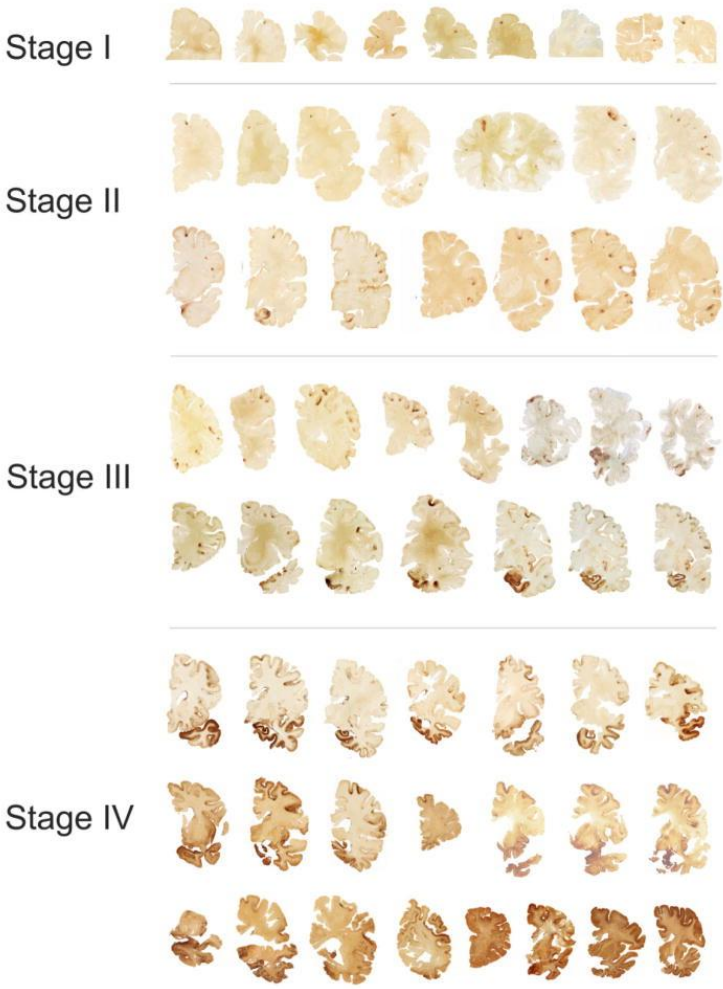



**Figure 2**: Four stages of CTE depicted (McKee et al., 2015)

**"Stages of Chronic Traumatic Encephalopathy (CTE)**

**In stage I CTE,** p-tau pathology is found in discrete foci in the cerebral cortex, most commonly in the superior or lateral frontal cortices, typically around small vessels at the depths of sulci.
**In stage II CTE,** there are multiple foci of p-tau at the depths of the cerebral sulci and there is localized spread of neurofibrillary pathology from these epicentres to the superficial layers of adjacent cortex. The medial temporal lobe is spared neurofibrillary p-tau pathology.
**In stage III CTE,** p-tau pathology is widespread; the frontal, insular, temporal and parietal cortices show widespread neurofibrillary degeneration with greatest severity in the frontal and temporal lobes, concentrated at the depths of the sulci. Also in stage III CTE, the amygdala, hippocampus and entorhinal cortex show substantial neurofibrillary pathology that is found in earlier CTE stages.
**In stage IV CTE,** there is widespread severe p-tau pathology affecting most regions of the cerebral cortex and the medial temporal lobe, sparing calcarine cortex in all but the most severe cases. All images, CP-13 immunostained 50 µ tissue sections"

(Mckee et al., 2015:18)

Cases of CTE are increasingly being found across contact sports and in military settings, with recent work looking into victims of domestic abuse being a high-risk population for CTE, yet the post-mortem analysis to confirm this is not yet present (Monohan, 2017, 2018). A systematic review by Maroon et al. (2015) revealed a cohort of 153 unique pathologically confirmed cases of CTE. In this cohort, 69 cases were former boxers, 63 from amateur or professional football players, five former hockey players, six military veterans, three former wrestlers and seven miscellaneous cases (Maroon et al., 2015). With one exception, all cases were males (Maroon et al., 2015).

The age of death was available in 150 of the cases reviewed, in which ages ranged from 17-98 years old (Maroon et al., 2015). The majority of CTE cases with available data died from natural causes (Maroon et al., 2015), however suicide (11.7 per cent) and accidental deaths (17.5 per cent) were much higher in the CTE population compared to the general population which sees rates of 1.5 per cent and 4.8 per cent, respectively (Hoyert & Xu, 2012). Omalu and colleagues (2010) research suggests these higher percentages of suicide and accidental death rates in CTE populations could be a result of CTE-related symptoms such as lack of impulse control and mood disorders.

The true prevalence of CTE and deaths caused by CTE are unknown. Pathologically confirmed cases of CTE are only obtained through post-mortem examination (Stewart et al., 2016), meaning it is difficult to determine the presence of the disease in living individuals in high-risk CTE populations.

There is increasing work to identify CTE in living patients (Cherry et al., 2017; Omalu, 2017), with recent progress in the early detection of CTE using fluid biomarkers and advanced neuroimaging techniques (Dallmeier et al., 2019). This work remains in its infancy, with no tangible use yet but provides a marker for the future direction of the field. The only established diagnosis of CTE is the posthumous examination of the brain, something being carried out internationally giving the picture for the rates and characteristics of CTE.

The largest institutions conducting this research is the Boston Brain Bank, hosted by Boston University, which hosts the largest brain tissue repository in the world, with the specific focus on traumatic brain injury and CTE (BU, 2019). The research here, led by Professor Anne McKee, has rapidly been revealing the threat CTE poses. In 2009, there were only 51 cases of pathologically studied cases of CTE published in medical literature (McKee et al., 2009). In 2018, this number has risen to over 320 (BU, 2019).

In a culturally impactful publication in the Journal of the American Medical Association, Mez and colleagues (2017) sampled 202 deceased American football players from a brain donation program. This revealed concerningly high rates; CTE was pathologically diagnosed in 177 players across all

levels (87 per cent) including 110 of the 111 former NFL players (99 per cent). On this research, and further research conducted in collaboration with the Boston Brain Bank, Professor Anne McKee comments, 'The fact that we were able to gather so many instances of a disease that was previously considered quite rare, in eight years, speaks volumes,' (BU, 2017).

The brains sampled that form the base of this knowledge around CTE mainly come from ex-NFL players which of course impacts the generalisability of results. Schwab and Hazrati (2019) also comment on the inherently biased nature of the post-mortem data used in this research. This is seen in the selection bias present in the brains included in the data. Families that are close to an individual and experience first-hand the signs of early CTE are more likely to donate the brain after death for analysis (Hurley, 2017; Stern et al., 2011).

However, Binney and Bachynski (2018) published a paper in the journal of *Neurology* that accounted for the selection bias, using statistical modelling to give an insight into the true prevalence rates of CTE in the NFL. Results show that, at a minimum, the rates of CTE across all the athletes in the NFL are 9.6 per cent, with the threshold for selection bias in the Mez et al. study (2017) being set at the very upper threshold. It is unlikely the selection bias was so extreme, accounting for this and lowering the threshold, statistical analysis produced very plausible rates of anywhere between 20-50 per cent of NFL players being affected by the disease. Binney and Bachynski have publicly acknowledged that further research is needed and have made their methods and findings public and open for development and updating. But the suggested rates are extremely concerning and have serious implications on the future lifespan of the game.

The efforts in the scientific community to get deceased athletes' brains in the NFL for post-mortem assessment makes it appear the disease is only of concern in American football. However, more cases are coming forth from other sports and there is no reason not to suspect that any sport that involves regular head trauma is putting athletes at risk of CTE.

### Neurological diseases associated with concussive and sub-concussive trauma

Increasingly, research is suggesting further links to concussion and sub-concussive traumas to a host of neurological diseases. In the literature we see some suggestions that the medical implications of head trauma and traumatic encephalopathy can be viewed as a spectrum disorder in which characteristics of a range of neurodegenerative disorders are seen (Washington et al., 2016). Thus, head trauma is not linked to the development of one specific neurological disease, as such, but

exposes an individual to multiple neurological deficits that fit the pathological markers of a range of neurodegenerative diseases.

One such disease is dementia, which is seen to be elevated in athlete populations that suffer regular head trauma (Ling et al., 2015; Mez at al., 2017). Research has shown the pathological markers of dementia in humans and animals with a history of traumatic brain injury (TBI), these can be seen through tau and amyloid-β pathology, chronic neuroinflammation, vascular damage, and white matter degeneration (Maroon et al., 2015; Smith et al., 2013; Faden et al., 2015). The incidences of these markers being present suggests a link between head trauma and the development of dementia.

Fann and colleagues (2018) conducted a nationwide population-based cohort observational study in Denmark observing links between history of TBI and the presence of dementia. The research found individuals that had suffered a TBI had an increased risk of developing dementia, with the risk increasing with individuals suffering multiple TBI's (Fann et al., 2018). Further, the younger a person was when sustaining a TBI, the greater the risk for dementia in later life (Fann et al., 2018).

Research from Dr. Willie Stewart and the Football's InfluencE on Lifelong health and Dementia risk (FIELD) project, hosted by the Glasgow Brain Injury Research Group, has shown elevated levels of Dementia and Alzheimer's in former football players. Dementia is a clinical syndrome that can result from a host of neurological diseases, Alzheimer's disease being one of the most common types. In this research, both were used as a factor in the research of the two cohorts.

The FIELD research project is a large-scale retrospective cohort study of the incidence rates of neurological diseases amongst former professional football players. Researchers have found mortality from neurodegenerative disease was higher in former professional football players compared to the demographically matched population control cohort (Mackay et al., 2019). Further, dementia-related medicines were more frequently prescribed to the former players than control group (Mackay et al., 2019).

This work shows an elevated risk for dementia in former professional football players. However, there are limitations to this work which undermine the validity of the findings. The FIELD team used the general population as the control group. Here, we see a larger percentage of men play years of concussive sports and do not make it to the professional ranks. A study comparing former football players against a control that have never played contact sports would provide a more valid insight to the predisposed risk of head trauma in football and the development of dementia.

Research is also increasingly showing the pathological markers of a range of other neurological diseases in individuals with a history of head trauma. A meta-analysis from Jafari and colleagues (2013) demonstrated a significantly increased risk of developing Parkinson's disease in individuals with a history of traumatic brain injury. After statistical modelling and staged reviews to ensure the validity of studies included, the researchers used 22 studies (19 case-control studies, 2 nested case-control studies, and 1 cohort study) in the meta-analysis. Here, the researchers found a statistically significant correlation between a history of head trauma and the development of Parkinson's which stayed consistent against changing control groups and setting the publication bias at the very lower limit (Jafari et al., 2013).

We are also seeing an elevated risk of developing diseases impacting the brain and spinal cord such as Motor Neurone Disease (Wright et al., 2017) and Multiple Sclerosis (MS) in those that have a history of head trauma, particularly when sustaining frequent trauma in adolescence. Montgomery et al (2017) conducted a population study of Swedish patients with diagnosed MS. All MS diagnoses between 1964 and 2012 were included giving a sample of 7,292 patients which the researchers matched individually with 10 people without MS by a range of controls, giving a total population sample of 80,212. The analysis showed significant statistical correlations of head trauma in adolescence with an associated raised risk of MS in later life, they cited the potential reason as the initiation of an autoimmune process in the central nervous system instigated by head trauma (Montgomery et al., 2017). The associated risk increased with patients that suffered repeated head trauma (Montgomery et al., 2017).

## Social implications of concussion

Understanding the long-term outcomes of concussion is difficult as the field is relatively new. Hence, lifetime studies of individuals suffering concussions are either retrospective or run over smaller time scales. Also, cause and causation are a subject of dispute with other variables causing ill health having to be accounted for (McCroy et al., 2013). Yet, there is a growing body of longitudinal research that highlights the long-term implications of concussion both on an individual's health and on the impact this injury has on society.

### *Long-term implications of concussion on the individual*

Concussion is associated with a range of long-term health implications. In a systematic review of 32 studies, including 2,013,197 individuals, 13,866 dementia events and 8,166 Alzheimer's disease events, Li et al. (2017) found 'a 63 per cent increase in any dementia risk and 51 per cent increase in

AD [Alzheimer's disease], comparing individuals with head injury to those without head injury' (2017:10). In the analysis, the severity of a head injury did not correlate with an increased risk of Dementia or Alzheimer's, with no relation found between loss of consciousness with either disease (Li et al., 2017). However, a positive association between head injury with no loss of consciousness and Alzheimer's was found (Li et al., 2017). Thus, suggesting that the severity of any given head injury may not be a reliable predictor for future neurocognitive deficits in individuals.

There is a body of work concerned with the long-term neurological impacts of contact sports on the developing brains of youth athletes, with long-term cognitive, neuro-psychiatric, and neurologic disturbances being the main concern (Alosoco & Stern, 2019). Stamm et al. (2015) found that in former NFL players, those that started contact football before the age of 12 performed significantly worse on all measures (Wisconsin Card Sort Test, Neuropsychological Assessment Battery List Learning test, and Wide Range Achievement Test, 4th edition) than the sample that played contact football after the age of 12. This is related to the neurodevelopment of young brains and experiencing concussions during this period can significantly increase the risk of cognitive impairment in later life. All of which impact an individual's ability to operate as normal within society.

*Long-term social implications of concussion*

The known impacts of concussion on individual health also have several social implications. Sariaslan et al. (2016) explored the impact of concussion on life chances. To do this, a Swedish birth cohort of over one million individuals under the age of 26 was used. Of the 104,290 individuals reported to have suffered a concussion in the past, Sariaslan et al. (2016) found that concussion had a significant negative impact on an individual's life chances when compared with a control group without suffering concussions. This was consistent with all measures: premature mortality, receipt of disability pension, low educational achievement, receipt of state welfare payments and psychiatric inpatient admissions or outpatient visits (Sariaslan et al., 2016).

Further supporting this work, a systematic review and meta-analysis by Stubbs et al. (2019) investigated traumatic brain injury (TBI) in homeless and marginally housed populations in six high-income countries. The research found that around half of homeless people had a TBI in their lifetime and that one quarter had experienced a moderate or severe head injury; the study classified these as being unconscious for at least thirty minutes or injury being identified on an MRI scan (Stubbs et al., 2019).

In relative comparison, only around twenty-two per cent of the general population has experienced a TBI, and only three per cent experiencing a moderate or severe brain injury (Corrigon et al., 2018). In the review, TBI was consistently associated with 'poorer self-reported physical and mental health, higher suicidality and suicide risk, memory concerns, and increased health service use and criminal justice system involvement' (Stubbs et al. 2019:1). TBI was seen to be a possible factor contributing to an individual becoming homeless, as well as creating a barrier to individuals to get out of it (Stubbs et al., 2019).

A comprehensive review in The Lancet by Williams et al. (2018) suggested that TBI's can lead to the neurological impairments that alter brain function increasing the risk of violent offending. The review showed that at least fifty per cent of the prison population in the UK and US had suffered a TBI. Again, the discrepancy here is clear when compared to the general population, standing at only twenty-two per cent (Corrigon et al., 2018). Lead author, Professor Huw Williams, concluded the work with, 'Addressing traumatic brain injury offers a means to not only improve the lives of those who offend, but also to reduce crime' (Williams et al., 2018:11).

Additional research by Williams et al. (2010) revealed a correlation between the frequency of self-reported TBI and number of criminal convictions, drug use and mental health problems in a sample of adolescent male youth offenders. Again, concluding from the research that, 'Addressing TBI within adolescent offenders with neurorehabilitative input may be important for improving well-being and reducing re-offending' (Williams et al. 2018:1). This research was supported by independent research conducted by the National Prisoner Healthcare Network, funded by NHS Scotland, which found similar rates of TBI in offending populations (NPHN, 2016).

There is further evidence for this phenomenon. A meta-analysis of thirty-three papers by Durand et al. (2017) found prevalence rates of TBI in prison populations to range from 9.7 per cent and 100 per cent, with an average of 46 per cent. A direct causal link between TBI and criminality could not be established because of the lack of data in the papers used in analysis. Another meta-analysis from McKinlay & Albicini (2016) found varying rates of TBI history in adolescent and adult prison populations; youth and adolescent rates of TBI were between 18-82 per cent, and the adult population 31-94 per cent. The authors found that a history of TBI was associated with, 'increased rates of violent behaviour, increased drug and alcohol use, deficits in cognitive functioning and increased mental health problems' (McKinlay & Albicini, 2016:12).

## Chapter conclusion

In this chapter I have discussed the implications of the injury, both medically and socially. The state of the literature on concussion outcomes has been presented with the most current understanding at the time of writing being used to discuss the injury.

Research shows a positive association of concussive and sub concussive injuries with neurogenerative diseases, Post Concussive Syndrome, Second Impact Syndrome, Chronic Traumatic Encephalopathy and cognitive impairment. The context of the research cited in this chapter begs the question; why is western society continuing to place such high value on sports that induce such hideous trauma and long-term implications on mental well-being?

As such, concussion is a medical condition but also a social problem. This is explored in greater detail in chapter seven where the socio-context of sport is critically examined which places precedence on sport over health. Indeed, we are at a point in time that contact sports must adapt and evolve to align with the science, or they face extinction (Anderson & White, 2018).

# Chapter 4: Injury and concussion in competitive road cycling

**Introduction**

This chapter presents the literature on injury in competitive road cycling, with a specific focus on the literature on concussion. First, the parameters regarding cycling in this thesis will be clarified, which will apply throughout. The thesis is concerned with competitive road cycling, categorised through participation in cycling as a sport and involvement in racing. Competitive road cycling involves multiple forms of competition such as road races, criteriums and time trialling. Although not the primary focus, research from other disciplines in competitive cycling will also be drawn on throughout the thesis, where appropriate, such as mountain biking, and these will be explicitly stated.

There are two other large domains in cycling: recreational and transport. Neither are of concern to this thesis but may be discussed in some areas. Recreational cycling refers to any pursuit in cycling outside of organised, competitive formats, such as cycling in a park or cycling for fitness purposes. Transport includes those that use cycling for commuting purposes, which may also include competitive cyclists. Both these domains are not the research focus for this thesis, however some of the research findings may apply to them.

This chapter examines injury within competitive road cycling, with some reference to other disciplines. First, I present an overview of the participation rates in competitive road cycling and then provide context for the epidemiological research in the sport and the injury surveillance in competitive road cycling. I then draw on a specific discussion of concussion in terms of the literature, biomechanics, incidences, and policy.

**Participation rates in competitive road cycling**

The overall narrative around traditional competitive sports is that participation rates are in decline. Drawing on data from the United States, Hyman (2006) outlines data showing participation rates continually declining from 1998 to 2004. Key figures from this include participation dips in soccer (13 percent), baseball (21 percent) and ice hockey (30 percent) (Hyman, 2006:197).

Looking at participation rates in the UK, we see the same trend. To capture this, Sport England's Active People data demonstrates this decline of traditionally masculine sports, in England, with a decade data set collected from 2005 to 2015. The survey, cross-sectional in design, had nine 'waves' of data collection, each with a substantial sample size obtained through a random stratified sample technique (Rowe, 2009).

Results show a consistently increasing participation rate in fitness and conditioning, recreational cycling, and gym use (Sport England, 2016). Conversely, we see a decrease in organised, traditionally male sports. Participation in rugby union saw a decrease of 0.46 percent to 4.42 percent, while football decreased from 4.97 percent to 4.40 (Sport England, 2016).

Gaining an insight to participation in competitive road cycling is more difficult, and little data exists outside of governing body figures. Globally, road cycling is a popular activity that covers multiple domains: transport, recreation, and competition. Because of this, it is difficult to obtain data specifically on competitive cyclists and, indeed, defining what constitutes a 'competitive cyclist'. There has been a large growth in road cycling riding for fitness purposes in England (Sport England, 2016, 2018). Although there is an element of competition amongst this demographic, and many regularly train, this is not the cohort of study for this thesis.

The competitive cyclists of focus for this thesis participate under the regulation of the UCI (international governing body) and/or British Cycling (national governing body). In terms of the professional sport, there has been consistent growth in the number of registered professional teams, male and female, since 2010 (UCI Annual Report, 2019). This is, of course, relative growth, and competitive road cycling remains a niche sport within the wider culture.

Competitive road cycling in the UK has also been growing, reflecting the relative growth in the international professional sport. The biggest increase in participation has been from 2012, following the success of team GB in the 2012 London Olympics, and the first British Winner of the Tour de France, Bradley Wiggins (Grous, 2012). The elite level of the sport receives a high percentage of funding; indeed, it received the second highest sum of funding for the Tokyo 2020 Olympics with approximately £29.6 million being put into the GB cycling team (Lange, 2019).

British Cycling is the governing body for most competitive and organised cycling events in Great Britain. In 2017, nearly half a million people in the UK participated in a British Cycling organised event, a 62 percent increase from the year before (British Cycling, 2017). These events include races of all disciplines, sportives and guided leisure rides. In 2019, British Cycling had 150,000 members

representing a three-fold increase since 2012, and the highest ever membership base (British Cycling, 2019).

Taking the 2019 membership figures of British Cycling (this is required to receive a license to race) of 150,000, this represents 0.2 percent of the population based on the UK population of 66.65 million in 2019 (ONS, 2019). This gives a rough figure of 1 in 500 people being a British Cycling member. Recognising that there are other organisations that organise competitive cycling, but these organisations are small in membership to significantly impact this figure.

To put this in context, we can compare cycling to one of the UK's most popular sports, football, which sees a rate of 1 in 30 participation based on the 2019 population figure (Lange, 2019). While the participant figures are not as much as mainstream sports; the various forms of cycling still occupy a large percentage of athletic endeavours by people in the United Kingdom. It is therefore important that cycling sports be included in research focused on concussion, particularly with a focus on this amateur demographic.

**Epidemiological research in competitive road cycling**

Injury in competitive road cycling is common (Barrios et al., 2015). Epidemiological research in competitive cycling classifies injuries into three categories: bicycle contact, overuse, and traumatic injuries (Silberman, 2013). Bicycle contact injuries involve any injuries sustained from the contact points on a bicycle, such as Plantar Neuropathy from the foot to pedal connection, 'saddle sores' in the perineal region from saddle contact, or Ulnar neuropathy/carpal tunnel syndrome which affects the hand from handlebar contact (Silberman, 2013). Overuse injuries are sustained through the repetitive biomechanics of riding a bike, most often seen through lateral knee pain in the form of Iliotibial band syndrome (Farrell et al., 2003).

These two injury constructs are not of concern to the scope of this thesis. Traumatic injuries are the focus of this work, which represent injuries sustained from anything in the external environment that causes a crash, such as the road surface (potholes), contact with road traffic (cars, pedestrians or other cyclists) or human error. In the literature, these injuries are most often seen through fractures and result in the most time off to recover (Silberman, 2013).

Given the frequency of injury, across all constructs, in competitive road cycling (see; De Bernardo et al., 2012; Barrios et al., 2015), there is limited epidemiological literature in road cycling focusing on traumatic injury (Silberman, 2013), with the focus predominantly on recreational injuries (Davidson, 2005), or overuse injuries in sport science fields.

There are also no consistent methodological approaches in the literature, making the cross comparison of studies in road cycling difficult (Silberman, 2013). Indeed, professional road cycling does not have a robust injury surveillance system in place, making insight to injury rates and trends extremely difficult (Heron et al., 2020).

A recent international consensus statement of injury reporting in professional road cycling was published to address this (See; Heron et al., 2020). Here, medical experts clarified injury definitions and concluded 'Injury rates should be reported as per 1,000 hours of cycling training, both in and outdoors, and per 1,000 hours of competition as well as per 1,000 hours of non-cycling training.' (Heron et al., 2020:1). Although holding some utility for the field moving forward, the statement holds little utility without the support of the UCI to implement an injury surveillance system and also does not account for the, largely unknown, injury rates outside of the professional level of the sport.

Drawing on research that is available, we see high rates of traumatic injury in competitive road cycling. Decock and colleagues (2016) found in a sample of amateur competitive cyclists, in Flanders between 2002 and 2012, that 1 in 6 athletes had a crash resulting in traumatic injury during races. The most common cause of crashing was collisions with other riders (Decock et al., 2016).

De Bernardo and colleagues (2012) conducted a four-year study of fifty-one professional cyclists. Here, forty-three of the cyclists' experienced 103 injuries over the period and only eight were injury free. Overall injury rates were 0.50 per racer/year and 0.007 per 1000 km of training and competition. They conclude that competitive cyclists are exposed to a high injury risk and that more research is needed to greater understand incidence rates of injury in the sport (De Bernardo et al., 2012).

Looking at the Tour de France, one of cycling's most iconic races that spans over 21 days, Haeberle and colleagues (2018) found, between 2010 to 2017, an average of 17 cyclists had to withdraw annually after suffering a traumatic injury. This was just for one event in a season and does not account for the many that continue to race with serious injury, which is common practice in road cycling. For example, Geraint Thomas in the 2013 tour continued the race with a broken pelvis, so would not have been included in this data (BBC, 2013). Greve and Modabber (2012) note that by stage 9 of the 2011 Tour de France, there were fourteen fractures, sixteen rider retirements and one athlete in intensive care.

The paucity of research into traumatic injury in competitive road cycling, and diversity in methodology, makes cross-comparison of studies, longitudinal insights and identifying a valid picture of injury aetiology somewhat challenging. Much of the work, such as Haeberle et al. (2018), do not

capture the true rates of injury as they rely on public data retrospectively compiled to produce the injury rates. Working with the data that is available, however, it is warranted to follow the assumption that road cycling is a high velocity and dangerous sport that carries high rates of traumatic injury.

## Injury Surveillance in competitive road cycling

Injury surveillance in sport refers to 'the ongoing collection of data describing the occurrence of, and factors associated with, injury.' (Finch, 1998: 157). This process is essential for epidemiological information, directions of injury prevention and providing insight to monitoring long-term changes in the frequency and mechanisms of injury (Junge et al., 2008). Diversity across sports is problematic, here, with varied injury definitions and the limited consistency across studies complicating the overall understanding of sports epidemiology (Pollock, 2014).

These issues are particularly pertinent in competitive road cycling, where there is no centralised injury management system, both on an international level and within the UK (Haeberle et al., 2018). This is reflected through much of the epidemiological research into competitive cycling working on secondary-sourced data, retrospectively collected data from third parties or from hospital admissions data.

The international body for competitive cycling, the UCI, has no central management system of injury in any sanctioned events. Injury monitoring and management operates in isolation based on resources available to teams and athletes. Under the UCI medical regulations, revised and active from March 2019, it states in article 13.3.020: 'The Team doctor shall keep a medical file for each rider' (UCI, 2019). It is the team doctor's responsibility to hold this file and when a rider moves team, the file moves with them.

This significantly reduces the ability for research to effectively implement injury surveillance studies over time. Subsequently, understanding epidemiological trends and injury prevention in road cycling is a difficult pursuit (Silberman, 2013). As previously noted, much epidemiological research in road cycling relies on either collecting primary data or working with hospital admissions. This complicates the insight into injury trends and results in large-scale under reporting of injury in the sport (Branion-Calles et al., 2017).

It is for these reasons Finch (1997) notes the importance of standardisation in sports injury, answering questions such as:

> 'What is a sport? When should an activity be considered to be recreational rather than sport? Who is a sports participant? How should sports participation be measured? What is a meaningful measure of exposure to injury risk? What is a sports injury? How should sports injury severity be measured? How severe must an injury be before it should be considered to be a sports injury for surveillance purposes?' (Finch, 1997:157).

Without such agreed definitions, a clear and rigorous study of sports injury cannot be undertaken, something the research field in competitive cycling has evident issues with.

**An overview of the current state of the literature on concussion**

I have outlined the paucity of epidemiological research on traumatic injuries in competitive road cycling, this become sparser when looking at concussion in road cycling. Much of the work into injury in road cycling focuses on overuse injuries, coming from a performance angle rather than a health perspective. It is only in recent years we note competitive road cycling come under consideration for having issues with concussion, with much of the work being in the form of 'call to actions' directed at the governing bodies within the sport (see; Greve et al., 2012; Elliot et al., 2019; Heron, 2020).

A systematic review from Elliot and colleagues (2019) sought to assess the state of the literature on sports-related concussion in road cycling. Working with MEDLINE, EMBASE, PsycINFO and Web of Science journal databases, key search terms only returned ninety-four studies. Of these, sixty-five were excluded for not being specific to road cycling, and the review of the remaining twenty-nine studies led to only two studies being included for full review (Elliots et al., 2019).

The first paper identified was Gordon and colleagues (2013), that presented just a single case of a fourteen-year-old that suffered a concussion whilst mountain biking. This was not road cycling specific but was included due to the use of a concussion assessment tool. The utility of this paper was highlighting the use of the Sport Concussion Assessment Tool (SCAT), as well as the importance of a stepwise return-to-play protocol. The boy's mother used the SCAT to then refer him back to a specialised clinic, and a graded re-entry to school aided his recovery. This is an extremely limited study with minimal application to competitive road cycling other than the utility of protocols when dealing with concussion in the sport.

The second paper was from Greve and Modabber (2012) titled 'An epidemic of traumatic brain injury in professional cycling: a call to action.'. This was a commentary piece on the 2011 professional cycling season which saw multiple traumatic brain injuries, and several fatalities from brain injury, but no original research was undertaken for the paper. The utility, here, was the

authors call on cycling governing bodies to address this problem, and work on an evidence-based criterion for the return to sport of brain-injured cyclists. Further calls for action can be seen in more recent literature (Heron et al., 2018; Heron et al., 2020). Again, Greve and Modabber's (2012) paper has many limitations and little application without any primary and rigorous research.

The literature is extremely limited and suffers a lack of published evidence to advise on concussion assessment, frequency, and management in road cycling (Elliots et al., 2019). Of importance is the need for the development of cycling-specific concussion protocols and policy. Further, the research paradigms of the literature must be noted. All published studies in the area are from researchers within sports medicine fields which influences the methodology and angle of approach to the research area. Also, many of the authors in the field have significant conflicting interests, either being directly employed by sporting governing bodies or having close relations. Thus, the presentation of data and narratives in these research papers must be examined in light of these interests.

**Aetiology and mechanics of concussion in competitive road cycling**

Being involved in a crash is the leading cause of concussive injuries in competitive road cycling. Little is known about the exact biomechanics the head experiences during a bicycle crash, as there is no published data on it. However, road cycling takes place at extremely high speeds over testing terrains and in large groups, making crashes frequent and of high velocity (Greve & Modabber, 2012). The nature of a bicycle crash is extremely conducive for concussive injury.

Rice and colleagues (2020) found high rates of cosmetic damage to helmets following crashes in a sample of 780 competitive cyclists in the US, suggesting the head frequently contacts the floor in cycling crashes. Although not in the competitive domain, Lagina and colleagues (2019) examined data from the 2002–2012 National Trauma Data Bank in the US finding 76,032 cyclists with head/neck injuries in this period. The high rates further support the involvement of the head/neck region in bicycle crashes.

In chapter two, I outlined the ranges of G force associated with head trauma. Hurst and colleagues (2018a, 2018b, 2020) demonstrate that mountain bike and BMX cyclists may be at risk of sub-concussive trauma without a crash being necessary. Riders were reported to experience repeated head accelerations of 82g or higher, just from the demands of the terrain, suggesting these riders would experience some level of brain trauma (Hurst et al. 2018)

Specifically, in road cycling, the G force riders experience during a crash has not been researched. However, Hurst and colleagues (2018) did find for mountain bike crashes, athletes experienced force of over 100g when crashing, so it is plausible to suggest road cyclists suffer similar force when involved in crashes.

Further, road cycling rule structures dictates limited time out from competition and athletes having to continue in races, or face disqualification (Silberman, 2013). In these scenarios, we see a cycling specific mechanism of concussive injury through the continuation of competition following a concussive injury.

The immediate effect on cognitive function from a concussive injury is now widely understood in the literature (Nowak et al., 2020; Cardoso et al., 2019). Here, when a cyclist continues to race following a crash in an already demanding environment, the deficits in cognitive function puts them at greater risk of crashing again, or causing a crash through a mistake (Silberman, 2013). We do not yet understand the implications on recovery of continuing to physically push the body immediately following a concussion, however we do know that the cerebral swelling following a head impact makes the brain extremely vulnerable if another impact is sustained, with the risk of second impact syndrome (outlined in chapter three).

In summary, not enough is known about the aetiology of concussion in cycling, and further concentrated research is required. However, we do know that the biomechanics of a bicycle crash often involves the upper extremity of the body and head/neck region, suggesting cyclists are suspectable to concussive injuries.

**Pathology of concussion following a bicycle crash**

The aetiology of concussion in competitive road cycling discussed above presents the different challenges cycling has to other sports. An extension of this is the different pathophysiology of brain injury in cycling, which is not yet understood. Namely, competitive road cycling involves high velocity head impacts, often in isolation, but can occur frequently. Whereas concerns in boxing, rugby and American football are around the repeated lower velocity impacts. As such, the pathologies, levels of risk and rates of development of neurological diseases need to be understood in the context of the different sports.

We are only recently beginning to understand the effects of head trauma, as outlined in chapter three. The Concussion Legacy Foundation and Boston Brain Bank in the US is leading the way in understanding the pathology of head trauma in athletes. Here, a multidisciplinary team is doing

excellent work to greater understand CTE and mild traumatic brain injury, in terms of diagnostic tests for CTE in living persons, genetic risk factors, environmental risk factors, the importance of age at first exposure and treatments for CTE.

There is still much to learn and, although increasing, the number of brains tested is not enough to compare against the general population to understand the specific pathophysiology of head trauma in sport. Given this, cross comparison within sporting head trauma is not possible yet, either. Indeed, most brains that have been studied come from contact sports which reflects the raising awareness within these sports to the devastating effects of repeated head trauma. Unfortunately, due to cycling being behind in this, there is limited understanding on the specific pathology of head impacts in this sport. Silberman comments on this:

> The risk of diffuse cerebral swelling after head injury, a rare occurrence seen more often in boxers and children, is unknown in cycling. The pathophysiology and risk of chronic traumatic encephalopathy, a neurodegenerative tauopathy, diagnosed in post-mortem cases in other contact collision sports such as hockey and football, also are unknown as they relate to closed head injuries in cycling. (2013:340)

The only confirmed case of CTE in cycling, across all disciplines, comes from Dave Mirra, a BMX rider. Mirra took his own life aged 41 with a post-mortem brain examination being undertaken at a Canadian brain bank confirming CTE (Hazrati, 2016). Dr Lili-Naz Hazrati, the lead neuropathologist, commented: 'The tau protein deposits found in Mirra's brain were indistinguishable from the kind that have been found in the brains of former football and hockey players with CTE'' leading to a crucial comment 'The key is brain injury. Regardless of how you get it, through BMX or hockey, you are at risk for this' (Hazrati, 2016).

Moore and colleagues (2020) conducted a retrospective chart review of twenty-eight patients aged eighteen or older who sustained a concussion while bicycling and were referred to the Canadian Concussion Centre for management of post-concussive syndrome. The findings here provide some insight to the specific pathology of concussion in road cycling. The researchers found the most prevalent symptoms were headache (71.4 per cent), fatigue (53.6 per cent), memory problems (50.0 per cent), sleep disturbance (50.0 per cent), anxiety (46.4 per cent) and sensitivity to light/noise (46.4 per cent) (Moore et al*.,* 2020).

Most significantly, they found duration of post-concussive syndrome was greater in the cycling cohort (23.7 months) compared to a contact sport comparison group (16.1 months) (Moore et al.,

2020). Further, by the time of the last follow up, 82.1 per cent of the cycling patients had failed to recover completely (Moore et al., 2020).

Although there is no formal literature on the area, accounts of professional cyclists coming forward about their experiences with concussion are often centred around suffering with post-concussive syndrome, suggesting the mechanics of brain trauma from a cycling crash may be more conducive to this condition than in contact sports. Further, the long-term implications of this in cyclists is not yet known.

**Concussion incidence in competitive road cycling**

I have outlined the paucity of research into concussion in competitive road cycling. Related to the content already discussed in this chapter is the difficulty in deducing the true rates of concussion in the sport. A primary reason for this is the lack of a centralised injury management system (Heron et al., 2020), but the nature of concussion would make accounting difficult regardless because of the difficulties of diagnosis (McCrory et al., 2013) and under reporting (Harmon et al., 2013) we see in sport.

In light of this, self-reported cases in the literature can offer some insight to concussion incidence. Work from Rice and colleagues (2020) explored recreational and competitive cyclists in the US revealing the rates, and nature, of crashes in this demographic, with a specific focus around head injury. The work distributed an online survey to 780 US cyclists with questions focused on injuries sustained from cycling crashes. Of this sample, 403 (51.7%) reported crashes in the previous two years. Of these, 77 reported significant head injury described through experiencing 17 of the 22 symptoms on the SCAT3 symptom checklist. This was a relatively small sample and restricted to one area, within one cultural context. Yet, it still presents high levels of crashes and head injuries considering this number is likely to be higher in the sample, with the under-reporting of formally diagnosed concussions.

Hurst and colleagues (2019) conducted a preliminary study into knowledge and attitudes of concussion in competitive cyclists and cycling stakeholders (coaches, medical personnel, team managers). In a sample of 1990, 526 (26.6 per cent) reported having a cycling-related concussion formally diagnosed and 629 (31.7 per cent) reporting having a suspected cycling-related concussion without formal diagnosis (Hurst et al., 2019). This study looked at a range of individuals involved in cycling in various capacities, and across disciplines, so does not provide a direct insight to

competitive road cycling, but it does support the assumption that rates of concussion are significant in cycling.

A research issue with concussion in road cycling is that epidemiological studies rarely account for concussion. This also overlooks the multi-injury nature of cycling crashes. For example, the most common fracture seen in road cycling is to the clavicle (Silberman, 2013), it is very plausible to suggest falling on this region of the body with enough velocity to break a bone would also result in a concussion. However, only the broken clavicle would be recorded in any data sets. Pictured in figure 3 is an example of the selection criteria for epidemiological studies into road cycling, the lack of concussion as a categorised injury can be seen which is often reflected in the field. In this example, we do see the authors use 'Cranial trauma' as an injury type, but this gives little insight to the occurrence of concussion or the late effects of such an injury.



TABLE 1
Epidemiology, Demographics, and Return-to-Competition Time by Injury Type[a]

| Injury Type | n | Mean Age, y | Return-to-Competition Time, d | Surgical Treatment, % | Return-to-Competition Time by Group, d | | |
|---|---|---|---|---|---|---|---|
| | | | | | Surgery Group | Nonsurgery Group | *P* |
| Fracture | 67 | 30.4 | 60.3 | 43 | 77.1 | 44.4 | .065 |
| Clavicle | 21 | 30.2 | 49.0 | 48 | 37.6 | 75.5 | .007 |
| Wrist | 6 | 28.4 | 48.7 | 50 | 45.7 | N/A | |
| Hand | 5 | 29.3 | 45.0 | 40 | 68.5 | N/A | |
| Femur | 5 | 31.4 | 129.4 | 100 | 129.4 | N/A | |
| Rib | 5 | 32.9 | 79.8 | 40 | 134.5 | 43.3 | .1485 |
| Humerus | 5 | 31.2 | 41.0 | 0 | N/A | 46.0 | |
| Spine | 4 | 30.2 | 152.7 | 100 | 152.7 | N/A | |
| Scapula | 3 | 28.4 | 39.0 | 0 | N/A | 39.0 | |
| Elbow | 2 | 30.9 | 31.5 | 50 | 26.0 | 37.0 | |
| Tibia | 2 | 30.8 | 127.5 | 100 | 127.5 | N/A | |
| Forearm | 1 | 25.7 | 15.0 | 0 | N/A | 15.0 | |
| Patella | 1 | 37.2 | N/A | 100 | N/A | N/A | |
| Pelvis | 1 | 27.5 | 44.0 | 0 | N/A | 44.0 | |
| Multiple | 6 | 30.9 | 62.7 | 0 | N/A | 57.3 | |
| Laceration/contusion | 17 | 30.9 | 25.6 | | | | |
| Muscle sprain/strain | 7 | 30.6 | 64.8 | | | | |
| Overuse | 6 | 27.0 | 64.0 | | | | |
| Cranial trauma | 3 | 30.6 | 29.3 | | | | |
| Multiple | 8 | 32.2 | 88.6 | | | | |
| Other | 17 | 29.7 | 34.1 | | | | |
| Unknown | 13 | 29.7 | 40.4 | | | | |
| Total | 138 | 30.3 | 52.4 | | | | |

[a]N/A, not available.

**Figure 3**: Epidemiology, Demographics, and Return-to-Competition Time by Injury Type in the Tour de France from 2010 to 2017 (Haeberle, 2018)

Most recently, Rooney and colleagues (2020) undertook a systematic review of injury and illness in road cycling. Working with MEDLINE, Embase, PsycINFO, Web of Science and Cochrane Library data bases, 52 tittles were screened and 12 selected for full review. Researchers found head injuries (including concussions) to account for 5-15% of injuries in road cycling. Further, the upper extremity of the body was more affected by injury than the lower, with amateurs appearing to be at an elevated risk of injury than professionals (Rooney et al., 2020). Authors concluded the injury

percentages are inconclusive due to inconsistent methods of injury reporting across the reviewed studies and called for the need for an international consensus on injury reporting in road cycling.

Ultimately, there is not enough research to give an insight to the rates of concussion, or risk of concussion per hour of exposure or kilometre raced, in competitive road cycling. This is a phenomenon that needs addressing through more rigorous primary research and the implementation of a centralised injury management system in the sport (Rooney et al., 2020).

**Concussion knowledge and attitudes in competitive cycling**

Understanding the levels of knowledge and attitudes of concussion in sports is of increasing research interest. Several key studies have demonstrated the positive influence increased concussion education has on athletes' attitudes and reporting behaviours (See; Miyashita et al*.,* 2013; Provvidenza et al*.*, 2013; Register-Mihalik et al*.*, 2013; Register-Mihalik et al*.*, 2020). Schmidt and colleagues (2020) showed in a collegiate athlete sample, in the US, that concussion reporting behaviours and attitudes greatly increased following a year-long educational intervention programme. Further, Rice and Curtis (2019) showed that specific adult-learning concussion educational interventions improved parental knowledge around concussion.

Within the concussion in competitive cycling literature, there are only two studies, at the time of writing, that have examined levels of concussion knowledge and attitudes. The first paper comes from Hurst and colleagues (2019), they utilised the Rosenbaum Concussion Knowledge and Attitudes Survey (RoCKAS) to assess the state of concussion knowledge and attitudes in competitive cycling, across disciplines.

An international sample of 1990 individuals, involved in cycling in a range of capacities, completed an online RoCKAS survey providing the research sample. Results compared to other sports and public knowledge of concussion (see; Broglio et al. 2010; Weber and Edwards 2012; Register-Mihalik et al. 2013) showed the cycling community in this study held similar levels of concussion knowledge (Hurst et al*.,* 2019). However, it is not enough to draw conclusions on the levels of concussion awareness in competitive road cycling from this one study, but, at current, there is limited literature to draw on.

Providing an insight to the lack of formal education and resources in competitive cycling, the study found 66.4 per cent of the 1990 responded "No" when asked if participants had ever received education about the risks associated with concussion (Hurst et al*.*, 2019). A key finding from the paper was that the knowledge levels were undermined by attitudes regarding concussion

management when in competition. Participants were seen to favour performance over health in their survey responses (Hurst et al., 2019).

The main application of the paper from Hurst and colleagues (2019) is the need for targeted educational interventions to address concussion in competitive cycling. The findings highlight a significant issue that the sport faces in dealing with sports-related concussion, which is the ingrained cultural frameworks to compete through injury. This becomes particularly problematic in the context of concussion. Specific educational programmes aimed to address these behaviours could improve reporting rates of the injury, and attitudes around withdrawing from competition. The paper also aligns the wider literature calling for the development of cycling-specific concussion monitoring and return to sport protocols (Hurst et al., 2019).

The second paper comes from O'Reilly and colleagues (2020). This paper was more limited in its application than the study by Hurst et al. (2019) as the sample was only drawn from individuals in New Zealand, but a large sample of 672 was achieved. The same methodology was used, with a self-report survey administered online. The findings support that of Hurst et al. (2019), with concussion knowledge being found to be high, but issues with attitudes and behaviour translation when in competition being problematic (O'Reilly et al., 2020). It was also found that knowledge of helmets not preventing a concussion were low in the sample (O'Reilly et al., 2020).

In summary, both Hurst et al. (2019) and O'Reilly et al. (2020) allude to the same issues that face competitive cycling. Concussion knowledge appears to be sound, but this knowledge is undermined when in competition and dangerous attitudes exist in these athletes. At current, there is no research into why these attitudes exist, how they manifest and recommendations for effective cultural change.

**Concussion policy in competitive road cycling**

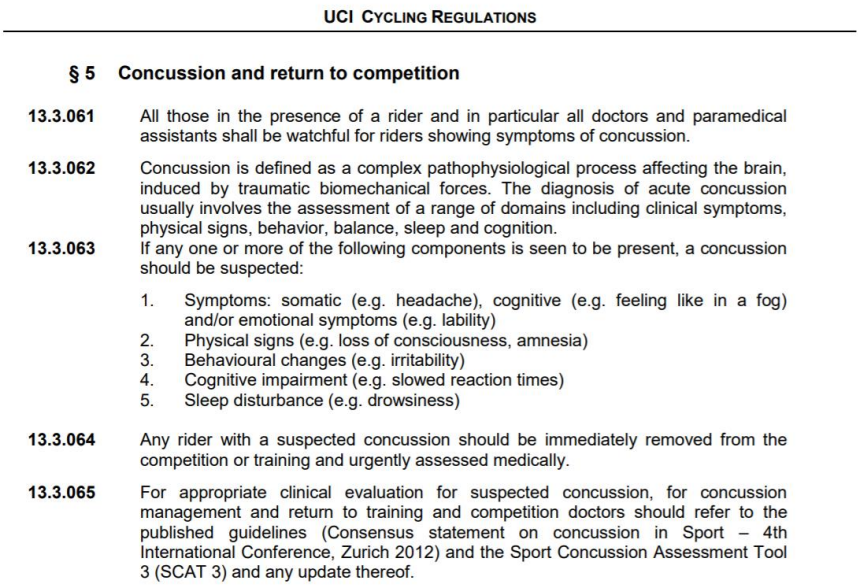
Here I will examine the policy in place from governing bodies in the sport to manage concussion. Interestingly, this is a small section of the thesis as there is extremely limited policy in place to discuss.

Starting in the UK context, British Cycling is the governing body for competitive cycling and sanctions all competitive events. There is no literature on the policy in place to deal with concussion in British Cycling. Indeed, there is also no publicly available policy so an analysis cannot be undertaken. A recent scoping review from Scullion and Heron (2022) on concussion guidelines in amateur sports in

the UK found British Cycling to be one of only two governing bodies to not have published SRC guidelines available to the public.

The international governing body, the UCI, also has limited policy. Seen in figure 4 is the most recent policy, active from March 2019. In a large document covering all medical issues in competitive cycling, concussion takes up less than half a page. The policy is also limited in its application. Firstly, article 13.3.064 'Any rider with a suspected concussion should be immediately removed from the competition or training and urgently assessed medically' (UCI, 2019). This is not enforced and very rarely adhered to, and without formalised mandatory training on concussion for any personnel in cycling, then identification of suspected concussion is not possible. Further, Heron and colleagues (2018) note that the suggestion for medical assessment without there being an internationally agreed assessment protocol for concussion in road cycling is counterproductive.

Secondly, the UCI advises the use of Sport Concussion Assessment Tools (SCAT 3 and SCAT 5) for in-competition assessment. These tools have been created within team field sports and have no practical application to road cycling without significant modification (Heron et al., 2018). Also, there is no cycling-specific return to competition policy, the UCI refers to the Zurich consensus statement on concussion in sport which has little application to road cycling.



UCI CYCLING REGULATIONS

**§ 5 Concussion and return to competition**

**13.3.061** All those in the presence of a rider and in particular all doctors and paramedical assistants shall be watchful for riders showing symptoms of concussion.

**13.3.062** Concussion is defined as a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces. The diagnosis of acute concussion usually involves the assessment of a range of domains including clinical symptoms, physical signs, behavior, balance, sleep and cognition.

**13.3.063** If any one or more of the following components is seen to be present, a concussion should be suspected:

1. Symptoms: somatic (e.g. headache), cognitive (e.g. feeling like in a fog) and/or emotional symptoms (e.g. lability)
2. Physical signs (e.g. loss of consciousness, amnesia)
3. Behavioural changes (e.g. irritability)
4. Cognitive impairment (e.g. slowed reaction times)
5. Sleep disturbance (e.g. drowsiness)

**13.3.064** Any rider with a suspected concussion should be immediately removed from the competition or training and urgently assessed medically.

**13.3.065** For appropriate clinical evaluation for suspected concussion, for concussion management and return to training and competition doctors should refer to the published guidelines (Consensus statement on concussion in Sport – 4th International Conference, Zurich 2012) and the Sport Concussion Assessment Tool 3 (SCAT 3) and any update thereof.

**Figure 4**: UCI Concussion and Return to competition policy (UCI, 2019)

The most recent Berlin Consensus Statement on Concussion in Sport states that:

> Adequate facilities should be provided for the appropriate medical assessment both on and off the field for all injured athletes. In some sports, this may require rule changes to allow an

> appropriate off-field medical assessment to occur without affecting the flow of the game or unduly penalising the injured player's team. (McCrory et al., 2017).

This is not being adhered to in cycling (Heron et al., 2018), with cyclists facing severe disadvantages if taken out of competition for a concussion assessment (Silberman, 2013). For example, there is no provision for athletes to be taken out of a race for assessment without then being disadvantaged as they have to attempt to re-join the race from a large time deficit without support. There also appears to be a lack of clarity and unity amongst cycling governing bodies on concussion policy, with little collaboration between the UCI and national governing bodies, leaving it to either individual teams or national bodies to develop their own in-house concussion management policies. Therefore, we see numerous calls to actions from cycling medicine experts and stakeholders for the UCI to act (See; Heron et al., 2018; Elliot et al., 2019; Greve et al., 2012; Heron, 2020). At the time of writing, this action is yet to be seen.

**Helmet use and concussion**

The literature shows that helmet use is associated with a reduction in structural head injuries (Hoye, 2018). Research shows us the use of cycling helmets can produce an estimated 50 percent reduction in risks associated with head injury and up to a 90 percent reduction in the risk of death from cycling (Olivier et al., 2017; Bil et al., 2018).

However, while research has shown the effectiveness of helmets in reducing structural head injuries, there is no research confirming that helmets reduce brain injuries. Helmets protect against fractures and structural injury, but concussions occur from the rapid deceleration of the brain striking against the skull, of which helmets do not prevent (Sone et al., 2017).

Research publications have highlighted that helmets offer no protection against concussion, and the resultant long-term implications in other sports (Gammons, 2013; Honarmandi et al., 2014). A meta-analysis of concussion prevention strategies by Schneider and colleagues (2017) concluded that protective equipment and helmets were the least effective intervention, and the level of protection was sub-optimal. Yet, Hardwicke et al. (2022) recently reported high rates of self-reported belief that bicycle helmets protect against concussion amongst competitive cyclists.

Helmets do not have a role in the consideration of concussion in cycling. In chapter six I discuss in more detail the position of helmets in a risk management framework for concussion in cycling, as well as the role of risk compensation we see in helmet using bicycle users.

## Chapter conclusion

This chapter has outlined multiple aspects of injury and concussion in competitive cycling. I have set the parameters for this thesis, and its specific examination of competitive road cycling. The chapter has outlined the injurious nature of the sport, and limited scope in the literature in understanding traumatic injuries, with much of the focus being on performance-based injuries. I have discussed the limited injury surveillance in competitive cycling, which limits the overall understanding of injury incidence, mechanisms, and trends in the sport.

The most up to date literature on concussion in competitive cycling has been explored and it is clear this is a developing area. We have much to learn in terms of concussion incidence, the pathology of concussion in cycling, and effective policies for the sport. Drawing on recent research, I demonstrate that levels of knowledge of concussion may not be of great concern, rather, the attitudes that seem to exist within the sport regarding injury management and perspectives on concussion appear the most problematic and in need of further research.

In summary, competitive road cycling is a sport that carries a high risk of injury, with traumatic injuries being under-researched in the literature. When considering concussion in the sport, the literature and understanding becomes sparser. The content I have discussed in this chapter legitimates the scope of this thesis and positions my work in the wider research field. There is much still to learn in the field, and much more to be done by the governing bodies to start to address this problem.

# Chapter 5: Masculinity and Sport

## Introduction

The intersection of gender and society is important in understanding processes that occur within sport, including sports-related injury. The context of this thesis, and the research data, is concerned with the influence of masculinities, and thus this chapter will be focused on the scholarship examining men and masculinities. The chapter will discuss masculinity, the typology of masculinities and the changing understandings of masculinities. The role sport plays in reproducing masculinities and shaping gender roles will then be discussed, leading us to the specific focus on masculinities in competitive road cycling.

## Defining masculinity

The discussion of a theoretical concept often starts with clear definition. However, the essence of masculinities cannot be defined in a universal and succinct sentence. Rather, masculinity is a complex construct in which the theoretical grounding must first be understood to begin to understand definitions of the term.

An important factor in understanding discussions of masculinities is to recognise its position within academia. Many academic disciplines work with the concept, and there is no 'home' discipline for its study (Anderson & Magrath, 2019). When disciplines work with the concept of masculinity, it is often done so in disciplinary isolation; academic disciplines will approach masculinity within their academic silos and not deviate from these (Anderson & Magrath, 2019). Therefore, a wide-ranging understanding of masculinity is produced, as well as a plethora of definitions. An interdisciplinary approach to the study of masculinities is of much benefit to the collective understanding, but it complicates the development of a universally agreed definition.

When defining the concept, we see some scholars do so through drawing on the commonalities in definitions across disciplines (Anderson & Magrath, 2019). Perhaps most pertinently is the mutual agreement, and understanding, that masculinity does not encapsulate a singular entity that men embody. It does not refer to one coded set of behaviours and biological markers; rather, masculinity represents a host term encapsulating multiple aspects, social and biological, that contribute to our understanding of a gender. Gender is also not a fixed concept and changes with socio-cultural context. Thus, we must understand that there is no singular definition or understanding of

'masculinity' – as it is not a singular fixed entity or concept. Rather, there exist many masculinities that predominantly men, but not exclusively, interact with to express their gender.

A key theoretical question that is often integrated into understandings of masculinity is whether it represents a set of socially coded behaviours that have been gendered in society, and thus any individual can interact and reproduce the behaviours. Or, whether it refers explicitly to the gender of boys and men as a homogeneous group (Halberstam, 1998; Paechter, 2006). In masculinity scholarship, the term is often used to describe the experience of boys and men (Connell, 1995; Mac an Ghaill, 1994; Plummer, 1999). Here, it would suggest that masculinity refers to the study of behaviours attributed to the biological bodies of males (Anderson & Magrath, 2019).

This is, however, problematic. Following this assumption, explanations fall short in that woman can embody aspects of masculinity, which can be seen both physically and socially. The work of Jack Halberstam (1998) challenges this view of masculinity, introducing the concept of 'female masculinity'. Through the study of arenas in which woman express masculine gendered behaviours, originally with lesbians in the nineteenth century and subsequently in 'drag king culture', Halberstam demonstrates that masculinity is not solely a concern of boys and men, and this view would limit the collective understanding of how masculinities can manifest in the social world.

Further, this view does not explain intersex individuals (Davis, 2015), transgender individuals whose gender identities do not match their biological bodies (Stryker & Bettcher, 2016), or those that do not identify as a man or woman. Logically speaking, the gender binary separating humans into two sexes does not account for the diversity we see in human bodies and gender identities (Fausto-Sterling, 2000). Thus, biologically grounded approaches fall short of comprehensively understanding gender performances and, specifically, what masculinity is.

I have briefly discussed the complexities of defining the concept. A central debate, here, being whether masculinities represent a set of coded behaviours anyone can access, or that they are intrinsically linked to the experience of male bodies. To an extent, the answer to this depends on the angle of study. This thesis is exploring the experiences of a male population, and the study of masculinities embodied by men. Professor Anderson (2019) offers clarity on how to approach this research area; he appreciates that masculinities are not just a question of men's experience, and they can exist in any individual. However, when studying masculinities specifically within men, the use of men and masculinities provides the context of the group in discussion.

In summary, masculinity refers to a set of characteristics that are predominantly seen within boys and men, but not exclusively. These can be seen through ascribed and achieved characteristics

(Anderson, 2005). Ascribed characteristics refer to features that one is born with, biological aspects of a body. Achieved characteristics are behaviours and practices one learns and interacts with in the social world. Both are subject to social coding and thus are not fixed, changing with time and social-cultural context. The crux, then, is that masculinities are a socially constructed and coded set of biological and social attributes, which are predominantly seen to be associated with boys and men. The extent to which masculinities are biologically or socially influenced is subject to debate and is not a question of concern for this thesis.

**The Industrial Revolution and the historical construction of masculinity**

The latter half of the nineteenth century marks a significant epoch for how we conceive and understand society today. Britain, and other western societies, went through a rapid process of structural and organisational change in line with technological advancements and innovations in machinery (Cancian, 1987). An agrarian society was to undergo a process of great change: with the advances in machinery, farmland work became far more efficient and less dependent on workers resulting in widespread redundancies in this industry.

Concurrently, there were rising opportunities in cities such as London, Manchester, and Newcastle, where the technological advancements seen in factories meant that there was a requirement for large workforces. Here, we see a mass migration of the agrarian workforce to the new urban environments in pursuit of employment in response to a changing economy. Indeed, Cancian (1987) estimates that over fifty percent of the population transitioned from rural living to the new urban industry in the nineteenth century. Consequently, western society underwent a 'transition process from a completely agrarian (feudal) society to a society based on market exchange' (Wittenburg, 2005:21). In this new system, in addition to produce, labour became a product.

This mass urbanisation of western society influenced cultural processes and transformed many aspects of social life, including the family structure. Prior to this epoch, families would live and work as a unit in a farm environment, all contributing to its function, forming a central focus point of the family structure. In this structure, there were less defined gender roles. Scholars suggest there was an overlap of duties for men and women so there were no defined gender roles within the family and, as a result, the wider society (Goldstone, 1996). With the urbanisation of society, there was a restructuring of associated gender roles in both work and household spheres. Women became responsible for the domestic sphere, and men became the sole income providers (White & Vagi,

1990). Here, Canican (1987) observes the introduction of distinct gender roles that formed within this changing cultural context.

This new division of gender responsibilities in the nuclear family unit resulted in a collective concern over the absence of a male figure in the household to regulate the development of young boys (Anderson & White, 2018). This job was now the responsibility of women, with children of both genders receiving their primary socialisation from women for the first time. Rotundo comments on this, within the domestic environment 'Motherhood was advancing, fatherhood was in retreat ... women were teaching boys how to be men' (1993:31).

This presented a problem to late nineteenth and early twentieth century society due to the increasing visibility of homosexuality in the novel urban environments (Anderson & White, 2018). For the first time, with the increased population density, there were high concentrations of homosexuals in cities, whereas previously, in agrarian life, homosexuals would be dispersed, producing a feeling of isolation and relative deprivation in sexuality. Here, gay identity and communities had collective power and flourished, with a homosexual population being established in cities such as London and Manchester (Spencer, 1995). At the time, the increasing visibility of homosexuality because of increased population density was not the collectively agreed understanding of the phenomenon. Rather, homosexuality was seen to be a result of feminine gender socialisation which was delivered by mothers, since fathers were absent working in the factories and taking the role of the breadwinners.

For an explanation of this, that is in line with the thinking at the time, I turn to Sigmund Freud (1905), a prominent theorist in this era and founder of Psychology as an academic discipline. His work "Three Essays on the Theory of Sexuality" sought to explain homosexuality and the apparent rise seen in these new societies. Crucially, Freud's theories were grounded in the understanding that sexuality and gender were not innate, both being socially constructed. He suggests that childhood experiences were central to the understanding of how men became heterosexual or homosexual, which the latter he referred to as inversion. For Freud, homosexuality was the result of a disruption to the gendering process caused by the absence of a father figure and over-domineering mothers. He writes '…the presence of both parents plays an important part. The absence of a strong father in childhood not infrequently favours the occurrence of inversion' (1905:146).

As such, in this social zeitgeist, the meaning of what it was to be a man in the twentieth century was predicated on being the opposite of a woman (Anderson & White, 2018). As homosexuals were associated with behaviours coded as feminine, being heterosexual was conceived as not being

perceived as homosexual (Anderson & White, 2018). Kimmel (1994) demonstrates that the heterosexual identity expanded based on an aversion to any behaviours coded as feminine.

There was a collective social concern about this new societal structure producing young homosexual boys, and solutions to this problem were sought after to undo the perceived damage of gender inversion that mothers were causing. Alongside this, there was increasing demand for boys to be brought up to be disciplined, docile and stoic to risk their bodies in the dangerous factory environments (Anderson, 2010). Anglo-American society perceived itself to have a serious problem with masculinity. Competitive, organized, and violent sport was thus introduced to address this social unrest (Anderson & White, 2018).

## Sport and masculinity

The position of sport in society is discussed in greater detail in the chapter seven. Here, I will examine the historical and contemporary position of sport in the reproduction of orthodox masculine characters and its regulatory power over boys and men.

## Competitive sport in The Industrial Age as a political project

In the collective societal concern of the 19th century, sport was restructured as a political project, with a function and answer to the perceived rise of homosexuality and feminising of young boys due to the absence of father figures (Anderson & White, 2018). Sport, and its coaches, were now responsible for addressing this issue by producing heterosexual, masculine boys (Anderson & White, 2018). As a by-product, sport also served to maintain men's hierarchical position over women in society and reinforced the view that male bodies were superior to women's (Connell, 1995).

In this time, sport had three key functions that would benefit the novel urbanised society. The first of these was the development of attributes in men that would benefit the new factory-based industry (Cancian, 1987). The bourgeoisie needed three qualities from their workers for the successful continuation of their production; they required brave men to not be put off by the dangerous factory environments; they needed to be disciplined, docile and accept orders, and they needed to be fast and efficient in performing physical tasks (Eitzen, 2001). For these factories to maximise profit, workers needed to accept risk and work through pain, injury, and fatigue (Anderson, 2009). As Bailey puts it, sport offered an excellent instrument to preserve 'the fitness of the nation's physical stock' (2014:126).

Sharing characteristics with the first, the second function was to produce a strong and obedient workforce using a military discourse. The military required men that were brave, stoic, and disciplined. They also needed men that would face almost certain death or would need to take another man's life at the sound of an order (Anderson & White, 2018). Sport offered an excellent arena for this, with its 'mock battle' (Sheard and Dunning, 1973:7) approach to competition. Commenting on this epoch, prolific sport sociologist Jay Coakley (2016:1) writes:

> Youth sports were believed to create in young men the energy, nationalism, and competitive spirit that would sustain personal health, fuel industrial expansion, and create American military power. Programs in selected team sports were used to Americanize immigrant children, convert unruly boys in crowded tenements into efficient and compliant workers, foster good health though outdoor activities, prepare boys to be fit and willing soldiers, and masculinize middle-class boys who were perceived to lack the assertive and competitive character to become political and economic leaders, because they had been socialized in female-dominated households. Fuelled by anecdotal evidence, the personal testimonies of athletes, stories circulated through popular culture, and the pronouncements of physical educators and coaches, the belief that sport participation produced positive development among youth became a taken-for-granted cultural truth in most Western societies.

The third function is situated within the increased social concern surrounding the feminisation of young men (Anderson, 2005). With the primary socialisation of young men becoming the responsibility of women, and the rising public awareness of homosexuality, many at the time perceived this to be an issue in the gendering of children (White & Vagi, 1990). Previously discussed, Freud's (1905) work aligned this issue with the absence of a father figure. Due to this absence on account of the long working hours that came with industrial life, the working classes needed another source of male influence (Anderson, 2009).

The masculinising potential of sport to address this issue was recognised and utilised. Sport offered a mechanism to develop the archetype of men that was required for the social environment to be of benefit, both socially and economically. Anderson notes, 'It was in this atmosphere that sport became associated with the political project to reverse the feminising and homosexualising trends of boys growing up without father figures' (2014:30). With sport being an exclusively male domain (Dunning & Sheard, 1978), it provided an environment in which boys could be socialised by older and more physically superior males (Anderson, 2012). Boys could now have contact and learn from each other and, crucially, from older more masculine boys who held the most legitimate power (Spring, 1974).

Key to this gendered socialisation was gender segregation within sport (Hargreaves, 1990). Mothers were perceived to be the cause of inversion (Freud, 1905), combined with women being physiologically inferior to men. For masculinity to maintain its position as the dominant model in the culture, men needed to be naturally superior to women (Connell, 1995). Here, we see sport offer a perfect pedestal for men to display physical authority through competitive aggression and physical violence (Cooky, Messner & Musto, 2015). Sports fields have historically been a vehicle to justify the superiority of men over women. However, more critically examining this gendering process in sport, Anderson (2012) shows recognition of this only being possible if women continue to be excluded from or segregated in sport, not allowing the opportunity to demonstrate physical ability, and thus reinforcing stark distinctions in physical ability. Connell suggests, 'men's greatest sporting prowess has become symbolic proof of superiority and right to rule' (1995: 54).

The ability of sport to develop masculine, economically efficient men, whilst reinforcing a patriarchal society, awarded it great social power and influence in the twentieth century. It served as a legitimate instrument to stratify genders to the benefit of heterosexual masculine men, and to the detriment of both homosexual men and women. This increasingly capitalist and oppressive social structure developed a gender hierarchy, and it is in this context that we see Raewyn Connell's theorising of Hegemonic Masculinity (1995), which is discussed later in this chapter.

**Competitive road cycling and masculinity**

The construction and reproduction of masculinities is omnipresent in sport (Hargreaves, 1986). Much of the literature on this is predicated on organised team sports such as Rugby, Football, and Basketball. Much of these sports, particularly contact sports, are prominent vehicles in the development of highly gendered, and socially esteemed, notions of masculine characters (Anderson & White, 2018). Road cycling is a non-contact endurance sport, and is structured very differently to other team sports, with no clear opposition and more intricacies in the rules of the sport. Importantly, the sport takes place within a very masculine and dangerous environment.

We must turn again to the industrial era to make sense of the culture we see in competitive road cycling. Initially, bicycle use was a male dominated domain, and the domain of privileged ruling class males (Mackintosh & Norcliffe, 2007). However, the invention of the Rover Safety bicycle shifted the cultural perception of cycling in the Industrial Era as, for the first time, bikes were adopted and used by both men and women (Mackintosh, 2005), as well as the increasing technology allowing mass production and more accessible pricing.

The increased strain for men to express their masculinity in opposition to the rising urban effeminacy was previously outlined (Chauncey, 1994; Kimmel, 1996; Ditz, 2004). Here, the shift of cycling from a male leisure pursuit to an accessible mode of transport, adopted by both men and women, threatened men's position on the use of bicycles in fear of the increasing feminised coding of bicycles (Mackintosh & Norcliffe, 2007).

The bicycle required masculinising for men to still enjoy their use. The first stage of this was the conspicuous use of high wheel bicycle models (Penny Farthings) by men, as opposed to the 'Safety bicycle' model increasingly being used by women and children as a mode of transport and leisure pursuit (Norcliffe, 2006). The high wheel bicycle was extremely dangerous, and crashes were frequent. Indeed, the most common injury was riders being thrown over the handlebars from a height and landing headfirst - termed 'headers', these injuries were often fatal (Norcliffe 2001). Norcliffe (2006) notes the choice of men to use this bike model over the safer Rover bicycle, and accepting the risks, was an overt expression of 'cavalier masculinity', allowing men to detach themselves from the increasingly feminised connotations of the safety bicycle.

The second technique used to masculinise the bicycle was the introduction of cycling as a sport, bringing in a competitive aspect to further separate cycling from the transport domain that was becoming increasingly popular with women. It is here we see the birth of the sport recognised today. Important to note here is that, at this time, it was exclusively in the domain of the bourgeoisie, and early competitive cycling culture was surrounded by elitist and social hierarchical attributes (Mackintosh & Norcliffe, 2007). However, a sub-group was formed that did not have the social prestige to join this elite, but instead used displays of masculinity as a tool to gain access. Termed 'scorchers', they consisted of fearless young male riders that took 'substantial risks to demonstrate their prowess'(Mackintosh & Norcliffe, 2007:161), it is suggested this sub-group were perhaps the early orchestrators of the 'badass' masculinity seen in sport, and particularly in cycling (Mackintosh & Norcliffe, 2007).

Crucial to the understanding of road cycling masculinity in the contemporary sport, is this focus on high risk and acceptance of injury. In this early conception of cycling as a competitive pursuit, Chauncey (1994:114) writes:

> 'Crashes were quite frequent, their consequent wounds were badges of an aggressive masculinity that exemplified the era's resulting 'cult of muscularity', which identified firm muscles and 'manly' fitness as necessary attributes of bourgeois masculinity.'

Therefore, we see that the orthodox masculine culture within competitive cycling, and particularly surrounding narratives of pain and suffering, also originates from a reaction to rising social concerns around homosexuality, and the feminisation of boys, in an epoch entirely different to that in which we live today. Times have changed, and athletes are changing in their interactions and gender performances, as earlier discussed (Anderson, 2014).

Yet, some harmful constants remain despite the changes in socio-political contexts. Competitive road cycling remains a highly dangerous sport, with frequent crashes and high injury rates (See; Silberman, 2013; De Bernardo et al., 2012; Greve & Modabber, 2012; Barrios et al., 2015; Decock et al., 2016). Although there is sparse formal literature on the topic, cycling remains an environment in which orthodox masculinity traits are encouraged and reproduced.

One study used a sample of 32 collegiate male cyclists drawn from a cycling related conference in the U.S. Utilising the Bem Sex-Role Inventory, Powell and colleagues (2005) found that the sample more strongly identified as masculine than the general population. This was an extremely limited study both in sample size, selection and the instrument used but is one of the only available studies on this area in the literature.

Due to the lack of formal literature, I turn to an interesting discussion from one of road cycling's only openly transgender figures. Phillipa York, who competed as Robert Millar, is one of Britain's most successful cyclists. Talking to the Guardian on the macho culture within professional cycling, she discusses how 'the [macho] culture in professional cycling is preventing riders from coming out as gay.' (Kelner, 2018). She depicts how, within the competitive cycling culture, being homosexual is still coded as a weakness and a detriment to an athlete's masculinity. She comments how athletes in cycling must hide any weaknesses because of the brutality of not only the demands of the sport, but the culture of roadside fans.

This is, perhaps, reflected by the fact there are no openly gay athletes in the World Tour cycling ranks, despite it being highly statistically likely that some athletes are gay in this cohort. This is, however, unproven, and it may be the case that there are few homosexual professional cyclists as they are simply not interested or overly represented in the sport.

Anderson and colleagues (2005, 2016) provide two hypotheses to account for this possible phenomenon: the homophobia hypothesis and the non-participation hypothesis. The homophobia hypothesis posits that gay men may not disclose their sexuality in fear of homophobia within the sporting culture. This hypothesis seemingly aligns with the comments from Phillipa York previously discussed, that professional cyclists fear disclosing their sexuality (Kelner, 2018). However, increasing

academic research is revealing the widespread acceptance of gay teammates across sports and declining homophobic environments (See; Adams, 2011; Adams & Kavanagh, 2017; Magrath, 2019; White, Magrath & Morales, 2020). Yet, this academic inquiry has not reached competitive cycling, so the attitudes and environment are not known.

The non-participation hypothesis posits that gay men are not proportionally represented in many sports because they chose not to participate in them. Here, common narratives predict that the percentage of gay men in the general population must be matched within sporting populations. Anderson and colleagues (2016) outline this approach as reductionist and offer a more balanced perspective. Research shows that in net grouping, gay men's bodies are slightly different to straight men (Anderson et al. 2016), being more feminized than straight males (Bailey 2003). Because of this, on net average, gay men may not be drawn to typically masculinised domains found in competitive sports such as Rugby, Football or American football. Rather, we see an over-representation of gay men in theatre, music, dance, and feminized sports that explain the statistical deficit in competitive team sports (Anderson et al. 2016).

Competitive road cycling offers an interesting sport to observe both these hypothesises. The environment of the sport values orthodox masculine values, with research showing the demonstration of this through harmful injury management behaviours (O'Reilly et al., 2020; Hardwicke & Hurst, 2020) and competitive road cyclists identifying more closely with masculinity than the general population (Powell et al., 2005). Yet, the anatomy required to excel in the sport requires thin bodies that would typically be feminine coded. Further, cultural practices of shaving legs and lycra clothing required in the sport adds to the feminine coded behaviours.

With lack of research, only speculation into this aspect of competitive cycling culture can be posited. Emerging research on the topic is showing masculinity may play a role in understanding the undesirable injury management behaviours found in the sport (Powell et al., 2005; Hardwicke, Forthcoming). Further research is needed to greater understand masculinities in competitive road cyclists, and how this many impact attitudes towards sexuality amongst athletes.

### Intersection of masculinity and injury in sport

Subscription to orthodox masculine norms, and a conformity to archaic norms of bodily sacrifice exist in sport. Indeed, Anderson (2009) suggests orthodox notions of masculinity are institutionally codified within sport. Important, here, is the ongoing centrality of injury in sport. There exists a

dissonance between what research is increasingly showing about masculinities and athletes, and the way contemporary sport is still structured and the values it propagates.

In wider society, violence among men is declining and young men are now less interested in the previously dominant violent scriptures of masculinity (Anderson, 2014). Pinker (2012) revealed that, across several measures, violent behaviour of men in society is in decline. Men today are less willing or interested in engaging in violent acts. Yet, these now outdated, harmful and redundant discourses around masculinity and warrior narratives are still endemic to much competitive sport in the western world. Indeed, commenting on this, Anderson notes that unless competitive sport recognises and responds to this dissonance, it faces extinction (Anderson & White, 2018).

Turning to collision and combat sports, we often see the core principles of violence, pain and injury being packaged as 'character building' traits that instil essential values to individuals that engage with such sports (Gatz, Messner & Ball-Rokeach, 2002). This is not dissimilar to sport's function in the Industrial Era to instil orthodox masculine values. On this phenomenon, Coakley (2002: 15-16) comments:

> I often am amazed by the pervasiveness of beliefs and assumptions about the character-producing and behaviour-shaping potential of sport participation. Dreams of using sports to promote or redirect the development of young people, especially those who have been defined as problems and threats to society.

Much research exists that dispels this thesis of the ability of sport to develop character (Miracle & Rees, 1994; Krause & Priest, 1993; Doty, 2006). The acceptance of pain is widespread in sport (Anderson, 2012). Hughes and Coakley comment that 'accepting risks and playing through pain' (1991:309) forms a central place in sporting ethics. Further, Sabo suggests athletes must adhere to the pain principle within sport, defining it as a 'patriarchal cultural belief that pain is inevitable and that the endurance of pain enhances one's character and moral worth' (2004:64). Acceptance of pain therefore becomes a predictor for 'self-worth, social acceptance, and status gains' (Sabo, 2004:64), and is prolific in sporting environments.

In reference to pain, specifically, it is important to note the multiple constructs of pain in sport. It can be examined through physical pain from injury, emotional pain through the requirements of sport and exhaustive pain through the physical exertion of the body (Leder, 1990). Athletes are required to endure all constructs of pain and compete with significant risks (Curry, 1993; Young et al., 1994). Roderick comments, 'athletes learn to disregard the risk of physical harm to normalize pain and injury as part of their sporting experience' (2006:18-19). The acceptance of pain is a

widespread, accepted and promoted social norm in sporting culture (Curry, 1993; Young et al., 1994; Waddington, 2000). Athletes are expected to sacrifice their bodies for athletic success (Sabo, 2004). Even amongst adolescent athletes who learn that 'males should ... [be] tolerant of pain' (Pringle & Markula, 2005:482).

Looking at exhaustive pain, utilising ethnographic studies, Howe (2004) found some athletes to conceive pain as positive, a notion supported by work from Nixon that revealed athletes 'learn to enjoy pain' (1993). Further, it is not only essential for athletes to accept pain but in many sports athletes are required to inflict pain. This references the military discourses seen around competitive sports, where athletes utilise their bodies as weapons to inflict and cause pain to opposition players (Messner, 1990).

It is here we see the intersection of masculinity, injury, and pain in sport. Sport, and its propagators, are continuing to socialise young people to privilege sport over their health (Anderson & White, 2018). This had a function in the context of war and industry in the twentieth century but is no longer a requirement for twenty-first century society.

## Hegemonic Masculinity Theory

I have discussed the cultural processes of the Industrial Revolution, and competitive sport, in western societies that led to the construction of a certain archetype of men, and masculine attributes. This forms one of the most researched and discussed archetypes in scholarship, being conceptualised as hegemonic masculinity (Connell, 1995). To theorise this form of masculinity, I turn to Connells's (1995) Hegemonic Masculinity Theory, which has dominated masculinity scholarship for decades.

Hegemonic masculinity is deemed the dominant form of masculinity seen in society at a certain point in time. In her work, Connell notes how this is not fixed and 'At any given time, one form of masculinity rather than others is culturally exalted' (2005:77). As such, this form of masculinity shifts in line with socio-cultural processes. Central to this theoretical understanding of masculinity is that only one archetype exists as the socially dominant form of masculinity at one time. Connell defines hegemonic masculinity as 'the configuration of gender practices which embodies the currently accepted answer to the problem of legitimacy of patriarchy, which guarantees (or is taken to guarantee) the dominant position of men and the subordination of women' (2005:77).

This archetype of a man embodying hegemonic masculinity refers to attributes such as being physically able, having a muscular body-type, being heterosexual, emotionally-stoic, psychologically

disciplined and being economically efficient. Importantly, the theory posits that a core principle of hegemonic masculinity is heterosexuality, access to this form of masculinity is predicated on not being homosexual and a detachment from any feminine coded behaviours (Jewkes et al., 2015). One such coded behaviour being physical tactility, affection and touching amongst males.

Connell's (1995) work appreciates that masculinity is not fixed, and the archetype of what depicts the dominant form of masculinity is subject to change. However, this theorising is problematic and fails to account for several processes we see in society.

The close tie of hegemonic masculinity to patriarchy discredits this theoretical understanding of men. Patriarchy exists as an unmeasurable concept, with no tangible utility. This is because, as a concept, in Connell's theorising, patriarchy exists as a system in which all men benefit, with a close tie to power and dominance in men (Moller, 2007). We understand the impact of gender to be more complex than this in society, and a gendered hierarchy based on men and women, as the concept of patriarchy posits, does not account for this complexity (Anderson & McGrath, 2018). Neither does it account for the intra-male experiences of subordination.

This complicates the understanding of hegemonic masculinity's role in reproducing a structure that cannot be clearly conceptualised. Connell's work acknowledges that not all men align with the top tier of masculinity, and some men are lower on the scale of male privilege. However, Connell's work still suggests all men benefit from patriarchy as, within this system, all women are subject to subordination. She states, 'the majority of men gain from its hegemony, since they benefit from the patriarchal dividend, the advantage of men in general gain from the overall subordination of women' (2005:79). This approach is reductionist, and too simplistic to understand the complex intra-male experiences of masculinities, and how this impacts wider gender dynamics and societal processes.

Hegemonic Masculinity Theory had utility in theorising masculinities in the industrial era, and twentieth century, but cannot explain the changing dynamics of masculinities we now see in western society.

**Orthodox Masculinity**

In understanding this theoretical grounding of hegemonic masculinity and its problems, it is here we see Professor Anderson (2005) introduce the concept of orthodox masculinity to describe this archetype of men. Anderson (2005) introduces this term to detach the concept from that of hegemonic masculine theory, as the two are often conflated within masculine scholarship.

Here, he shows recognition that orthodox ascriptions of masculinities exist in society but positioning them in a gendered hierarchy grounded in patriarchal concepts does not account for the real experiences of men in society, or the gender relations that exist. For this reason, I refer to these typologies of masculinity as orthodox throughout this chapter.

**Inclusive Masculinity Theory**

Previous masculinity scholarship does not account for this shift in masculinities and attitudinal changes. Professor Anderson's Inclusive Masculinity Theory (2009) explains this shift through the examination of the interaction of homosexuality with society, and the declining presence of homophobia. Here, Anderson and colleagues working with the theory (Anderson, 2009; 2014; McCormack, 2011; 2012; Roberts, 2013) work within frameworks that recognize the shift in the male gender structures. This shift is explained through Inclusive Masculinity theory's underlying concept of homohysteria (McCormack and Anderson, 2018).

Homohysteria refers to the fear of the social ostracization of being perceived as homosexual by peers. The concept has faced some critique in the academy, with Negy (2014) commenting that the concept is much like homophobia and the further breakdown of exploring prejudice is not a constructive endeavour. However, McCormack and Anderson (2014) show recognition of this critique and assert that there are conceivable differences between the two concepts, justifying the position and utility of the concept of homohysteria.

Homophobia is understood as the prejudice and discrimination against a sexual orientation, a hostility towards homosexuals and homosexuality (Herek, 2004). Homohysteria, however, is the fear of being socially perceived as homosexual, something that extends beyond homosexual men and affects all men, regardless of sexual orientation. With this understanding, an individual may be homophobic but not homohysteric. On this, Anderson comments that a theoretical grounding in just homophobia cannot 'capture the complications of how people feel about homosexuals [and homosexuality]' (2009:85).

For a culture to be considered homohysteric, Anderson (2009) and later McCormack (Anderson & McCormack, 2014) propose that three parameters must exist. These are the acceptance of homosexuality as a legitimate sexual orientation, a cultural antipathy towards homosexuality and a conflation that femininity is a predictor of homosexuality. Each variable can fluctuate in line with different socio-cultural contexts, impacting male gender performances and sexual identities.

Applying this theory within a culture where cultural awareness of homosexuality is high, but antipathy towards homosexuals is low, such as in the UK, then we see how a culture of inclusivity is

proliferated (Anderson, 2009; 2014; McCormack, 2012). As homosexuality is not a socially ostracized practice, boys can more freely engage with behaviours previously coded as synonymous with homosexuality. These include behaviours such as cuddling, being more emotionally open and bromances (Robinson et al., 2017). Here, we see the erosion of the previous power of homophobia to regulate boys' behaviours and interactions with each other.

In contemporary Western societies, boys and men are not assigned one orthodox conception of masculinity at the top of a hegemonic hierarchy, as previously theorised. Instead, there exists a spectrum in which a plethora of masculinities are equally esteemed and reflect the diversity seen across men's gender performances. This affords boys more diversity in routes to gain social esteem and acceptance, and this is no longer the exclusive domain of orthodox masculine boys. We see a shift; adherence to traditional gendered behaviours is no longer the predictor of masculine hierarchy. On this, McCormack (2012) demonstrates through his ethnographic research in British high schools that charisma, authenticity, emotional supportiveness, and social fluidity are now far greater received amongst adolescent boys. Here, we see adolescent boys now have far greater diversity in routes to obtain social esteem amongst their peers, particularly within school settings.

I will now outline the behavioural and attitudinal changes we see in society, and how IMT provides a framework to understand these.

## The softening of masculinities

My experience of growing up as a boy in the UK was different to that of my father's, whose experience was different to his father's. Similarly, a boy who grew up in India would have had a different experience compared to mine. This is because social structures and processes change, as does the understanding and practice of masculinities depending on time and culture (Beynon, 2001). Some of the theoretical groundings of masculinity scholarship have been discussed, this will now be brought into the contemporary context.

This thesis is focused on sport, but here I will draw on wider domains which demonstrate the softening of masculinity that is now reflected through much data-driven, empirical research (McCormack & Anderson, 2018). Firstly, men's position on physical affection has greatly shifted, which challenges Hegemonic Masculine Theory's discourse around men's gender performances being predicated on heterosexuality. The boundaries of heterosexuality have opened allowing a plethora of previously stigmatised behaviours to be embodied by men, without fear of social stigma. Research now shows men more readily exercise physical tactility in friendships, such as cuddling

(Anderson & McCormack, 2015), kissing on the lips (Drummond et al., 2014) and hugging (Robinson et al., 2017).

We also see in contemporary western societies that men now have access to many previously feminine coded behaviours. For example, men are solving problems through talking rather than fighting, being open about emotions and being affectionate outside of just heterosexual relations e.g. 'bromances' (Anderson, 2009; 2014). Pinker (2011) shows us overall violence in men has decreased.

A survey conducted with a sample of 1692 UK residents, in 2016 by YouGov, reflects this trend of the declining identity with masculinity in young men. Figure 5 depicts this generational shift in attitudes. Using a Likert scale ranging from 0-6, with 0 representing completely masculine and 6 completely feminine, participants responded to what they most closely identified with. Most notably here, we see only 2 percent of 18-24-year-old men identify as 'completely masculine', compared to 56 percent of men over 65 identifying as such. Even when considering the second tier of masculine identification we see a vast gap, with only 18 percent of 18-24-year olds at level 0 or 1 of the scale against 74 percent of over 65s.

In a triangulation of this YouGov data, I draw upon more recent research from Anderson and Fidler (2018). The researchers conducted in-depth interviews with twenty-seven heterosexual British men aged between 65 and 91. Findings demonstrated this generational gap in attitudes, with participants expressing negative views towards the softer masculinities that are increasingly visible today. Here, Anderson and Fidler (2018) conclude that these attitudes reflect the cultural homophobia and homohysteria the participants experienced growing up in the twentieth century. The increasing research showing the acceptance and embrace of softer masculinities in today's youth in UK and US societies (See; Carrillo & Hoffman, 2017; McCormack, 2011; McCormack & Anderson, 2014) highlights this shift in the dominant cultural attitudes of the twentieth century.

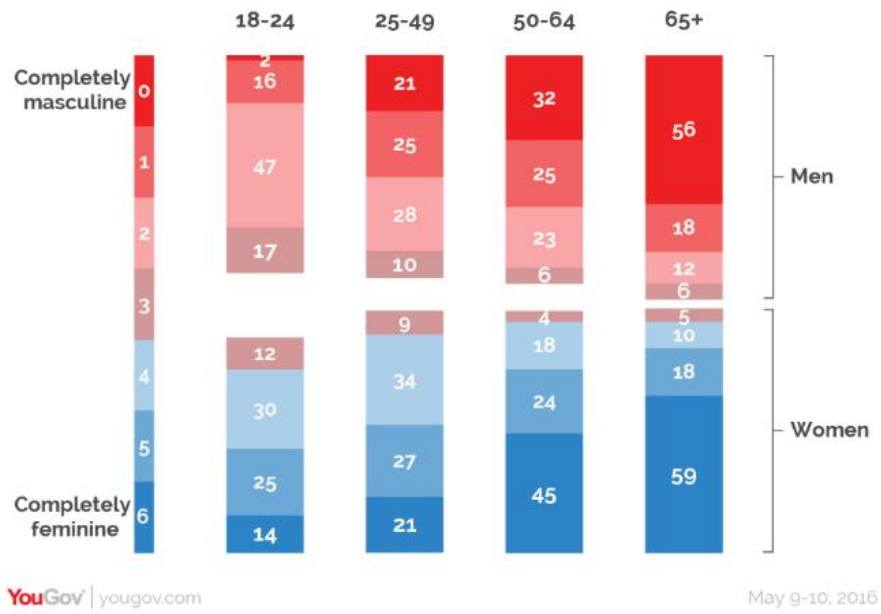



**Figure 5**: Survey respondents answers (YouGov, 2016)

Of course, the data from YouGov must be approached with caution, and is not without limitations. The sample size is not representative of the total population, and there will be a level of bias on those that chose to participate in the research. But, the increasing literature around changing masculinities in a variety of social domains (See; Baker and Hotek, 2011; McCormack, 2011; Anderson & McCormack, 2015; Anderson et al., 2012; Drummond et al., 2014; Peterson & Anderson, 2012; Anderson, 2008) and the trends seen in data on men's relationship with their self-disclosed masculine identity shows that masculinities are rapidly changing. The declining hegemony of homophobic and homohysteric attitudes is affording boys and men greater freedoms in their gender expressions.

### Inclusive masculinities in 21st century sport

The historical intersection of sport and society has been outlined, with a focus on the utility of sport to produce orthodox masculine archetypes of men in the Industrial Age. I have touched on the theoretical landscape of masculinities scholarship and highlighted the most prominent critiques. The field has been dominated by Connell's (1995) theory of hegemonic masculinity throughout the 1990s, and into the first decade of the new millennium. I have noted the critiques of this and outlined Andersons (2009) Inclusive Masculinity Theory which draws on more recent data to reflect contemporary society. Here, I will expand on the discussion of changing masculinities within the context of sport.

The grip competitive organized sport had on western society is loosening, with participation levels in organised and competitive sport consistently dropping (Eime et al., 2016). I have discussed the utility of competitive sport in the Industrial Age to reproduce orthodox masculine boys, and this will now be brought into the twenty-first century. The changing dynamics of masculinity is being reflected on sports fields, team changing rooms and amongst university sports teams across the western world. Athletes now display differing characteristics to those of the 1990s and before. Anderson (2014) notes athletes are softer, more fluid and egalitarian in their engagement with gender performances.

Empirical research, from across western sporting contexts, has shown athletes to be increasingly emotionally open (Robinson et al., 2017), physically tactile (White and Hobson, 2017) and, importantly, gay men are not stigmatised or excluded in sport as previously seen (Anderson, Magrath & Bullingham, 2016; White et al., 2020). An extension of this is the increasing existence of loving 'bromances' amongst athletes (Anderson, 2014; Robinson, et al., 2017). Indeed, Anderson (2008) found in one study that 40 percent of an athlete sample had experienced some form of same-sex sexual experience, and none were homosexualised as a result.

Sport, traditionally, involved military discourse around mock battles and the acceptance and infliction of pain (Sheard & Dunning, 1973; White & Vagi, 1992; Anderson & White, 2018). Twenty-first century athletes, however, are becoming increasingly critical of this narrative. A tool often used by coaches is to challenge an athlete's masculinity to shame them and encourage engagement with an orthodox masculine environment geared toward success (Adams et al*.*, 2010). This is increasingly being met with resistance, as athletes reject the hypermasculine frameworks that still exist in sport (Adams et al*.,* 2010). Anderson (2014) suggests athletes are no longer subject to the orthodox masculine risk-taking narratives of previous generations. These wider shifts in masculinities are yet to be researched within competitive cycling.

**Contentions and different approaches to theorising and understanding masculinities**

A key contention amongst masculinity scholars, and masculinity research more broadly, is the question: is masculinity theory concerned with the gender of men, or the attributes of sex? Different answers to this question amongst scholars problematises the research field of men and masculinities, of which a detailed exploration is not in the scope of this thesis. Importantly, IMT scholars are mostly concerned with the gender of men, and this analysis provides further rationale for IMT forming the theoretical framework for the thesis.

Dominant frameworks for understanding masculinity have shifted through paradigms, from Sex Role Theory (Bem, 1974), to Connell's (1995) concept of hegemonic masculinity; and more recently, to

Anderson's Inclusive Masculinity Theory (2009). Borkowska (2018) has described the modern epoch of sociological research into masculinities as 'Andersonian'. However, there are other approaches to understanding masculinities that must be acknowledged, particularly in light of concerns highlighted over the 'hegemony' of masculinity theories undermining empirical research (Hearn, 2004; Matthews, 2016).

A common misconception of IMT is that the theoretical framework can only be used if homosexuality is a variable of interest in the research. This is not true. However, homosexuality is the primary explanatory factor, amongst many other variables examined by Anderson (2009) for understanding broad societal changes in masculinity. There are other prominent theorists that do not include homosexuality as a variable for understanding masculinities that must be acknowledged.

For example, Atkinson's (2010) work examines conditions of late modernity, arguing that historical 'certainties' have been broken down resulting in men having to construct new ways of being a man within institutional spaces and social relations. Atkinson (2010) claims that in response to this lack of certainty some men seek certainty by entrenching themselves in orthodox masculinity, whilst others 'discover innovative ways to reframe their bodies/selves as socially powerful in newly masculine manners' (2010:5), what Atkinson terms "pastiche hegemony".

Another alternative theorizing of masculinity is Aboim's (2016) concept of 'Plural Masculinities', which examines the multiple, sometimes contradictory, ways in which men construct a masculine identity. Alboim's (2016) work examines men's behaviours in their relationships with women and their changing femininities, and the analysis is situated within understanding changes to the family and women, and resulting influence on masculinities.

Other scholars have adopted the term 'hybrid masculinities' in a development of hegemonic masculinity that recognises the changing nature of masculinities (Arxer, 2011). Bridges (2014) claims that the changing behaviours seen amongst young straight men widely documented are somewhat malicious in that they are done so 'without challenging the systems of inequality from which they emerge' (P.80). Whilst IMT scholars document this phenomenon as significant evidence of broader social change, Bridges (2014) contends it is just an embracement of 'gay aesthetics' without a decrement toward gay men. This is reflective of a feminist orientated approach to understanding masculinities.

It is also important to acknowledge intersecting features that influence masculinity and men's behaviours. For example, scholars have examined the intersect of ethnicity and the construction of

masculinity (Carrington, 2010). Another impactful influence masculinity scholars have examined is consumerism and material consumption (Srivastava, 2015).

IMT was developed in fraternity and sport settings, with data collected from white middle-class youth. No claim to wider generalisation is made in Andersons (2009) original work. However, the theory has since been refined and expanded, with scholars developing a class analysis. For example, Roberts (2013) work on heterosexual working-class men in the service industry, where softer versions of masculinity were found that are consistent with IMT. McCormack (2014) also examined class, through deploying Bourdieu's conceptualization of a symbolic economy of class in a working-class high school in England. Whilst there is no current research using the IMT framework to examine the intersect of ethnicity and masculinity, amongst other variables, it has been welcomed by the theory's architect (Anderson & Magrath, 2019).

This is not an exhaustive list of different approaches to theorising and understanding masculinities, but instead aims to highlight there is prominent scholarship outside of the dominant frameworks of masculinity scholarship. IMT is the chosen framework for this thesis as it accounts for the large societal shifts seen in masculinity and accounts for changes across cultures and time periods. Further, it is an inductive and data driven theory that Anderson and McCormack (2018) have described as an 'open theory', which welcomes critique and refinement. It has also been substantially developed to account for early criticisms (see Anderson and McCormack 2018 for a detailed overview of this). Whilst I acknowledge there are a myriad of factors that are important to account for when examining masculinities, it is not in the scope of this thesis, nor possible, to discuss all of them. In sum, the non-dogmatic, meso-level and data driven approach to understanding contemporary masculinities, particularly in sport settings, outlines the utility and rationale for using IMT in this thesis.

## Chapter conclusion

In this chapter I have outlined the theoretical grounding of men and masculinities. I have acknowledged the historical construction of masculinity and the changing terrains of masculinities, highlighting the need for masculinity scholarship to reflect this. Further, I have highlighted the limitations of the application of Connell's (1995) Hegemonic Masculinity Theory to understanding these changing terrains and gender dynamics seen in boys and men.

With this theoretical understanding, I have outlined the function of sport in the Industrial Era as a vehicle to remedy the perceived 'crisis of masculinity' to produce disciplined, stoic, and masculine

boys. Applying this chapter's discussions to the parameters of this thesis, competitive road cycling is a domain in which orthodox masculinity, together with its harmful associated attributes, still flourishes. Much like contact sports, the allure of pain, injury and warrior narratives are still present from the days of yesteryear. The sport appears to demonstrate a cultural lag (Ogburn 1957), which presents significant problems and requires further research.

# Chapter 6: Risk management in sport

## Introduction

Road cycling has been identified as a sport that carries a high risk of injury (See; Barrios et al., 2015; De Bernardo et al., 2012; Decock et al., 2016). A longitudinal study of professional road cyclists found an incidence rate of injury to be 0.018 per 1000 km of training and competition (De Bernardo et al., 2012). This study accounted for overuse and traumatic injuries. Overuse injuries were defined as injuries resulting from the biomechanical demands of riding a bicycle. Traumatic injuries were defined as physical injuries of sudden onset and severity sustained from anything in the external environment that caused a crash (De Bernardo et al., 2012).

To apply this level of risk to likelihood of injury for professional cyclists, the nature of the sport must be noted: professional road cycling is an extreme, endurance-based sport (Clarsen et al., 2010). Studies place the approximate figure of kilometres covered per year in training and competition to be around 25,000-35,000 km (See; Sanchis-Gomar et al., 2011; Jeukendrup et al., 2000; Mujika et al., 2001). De Barnardo and colleagues (2012) longitudinal study concluded professional cyclists had an overall injury risk rate of 0.504 per season (training and racing), equating to at least one in two professional athletes being exposed to injury, every season.

The risk of injury measured against the benefits that may be drawn from sporting participation is an important consideration for policy in sport. Detractors from critical discussion around injury in sport often engage in a risk-negation disposition, suggesting that risk exists in all walks of life and the benefits sport offers outweighs the need to resource efforts to reduce injury in sport. Risk-negation is different than a more academic examination of risk, risk management. In this chapter, I will outline key theories of risk and risk management in relation to sporting injury to examine this position.

## Risk Management

The process of assessing and controlling risk is normally termed ‘risk management’ (Fuller & Vassie, 2004). In sport, this process starts with an assessment of situational and event-based risk factors that impact the stakeholders (Fuller & Drawer, 2004). With epidemiological research input on identified risk factors, the cost of the risk and potential outcomes are then deduced (Fuller & Drawer, 2004).

Once the risks and all potential outcomes are identified, the risk evaluation takes place. For a robust evaluation, there must be a consideration for industry standards and the accepted level of risk for a given context (Fuller & Vassie, 2004). The 1974 Health and Safety at Work Act makes it a legal obligation for risks to be evaluated in what is 'reasonably practicable'. If, after evaluation, a risk is deemed to be unacceptable then risk mitigation is attempted through preventative or therapeutic interventions (Fuller & Vassie, 2004). If the risk is deemed acceptable, the results and process of evaluation should be communicated with all stakeholders (Fuller & Drawer, 2004).

**Objective risk management**

Important to the understanding and management of risk is the identification of objective levels of risk. Here, epidemiological studies provide the likely incidence and severity of a given risk, and the frameworks where injury takes place allowing for informed decisions to mitigate risk. Fuller and Drawer suggest: 'A 'hazard' or 'risk factor' is a condition, object or situation that may be a potential source of harm to people, and 'risk' is the probability or likelihood that a hazard will have an impact on these people' (2004: 349). Often used in the literature, both academic and industry, is the Royal Society's (1983) definition of risk: 'as the probability that a particular adverse event occurs during a stated period of time or results from a particular challenge'.

Objective risk in sport refers to the incidence of injury in relation to hours participated or an athlete's exposure within a given sport or activity. This approach draws on positivistic ontology to prove and record the risk of an activity which can then inform decisions around mitigating risk (Adams, 1995).

**Van Mechelen sequence of prevention model**

In 1992, van Mechelen et al. published a "sequence of prevention model" based on a four-step process for the prevention of sports injuries. This model has been widely used to implement preventive measures to manage sports injuries, with Finch (2006) suggesting it is the dominant model in sport injury. Robertson (2015) comments on how the model has been deduced from a framework from standard public health prevention models and applied to the sporting injury context. The four-step process offers a framework to understand the nature of sport injuries in terms of incidence and severity and the aetiology (how it is caused and what the associated risks are) of the injury before designing and evaluating intervention strategies.

In summary, stage one of the model examines the extent of the injury through establishing incidence and severity. Stage two seeks to establish the aetiology and mechanisms of the injury. Stage three sees the introduction of interventions and preventative strategies to reduce the risk of injury, and the final stage being the re-assessment of the incidence and severity of the injury to see how effective the interventions were. The widely used model is outlined in figure 6.

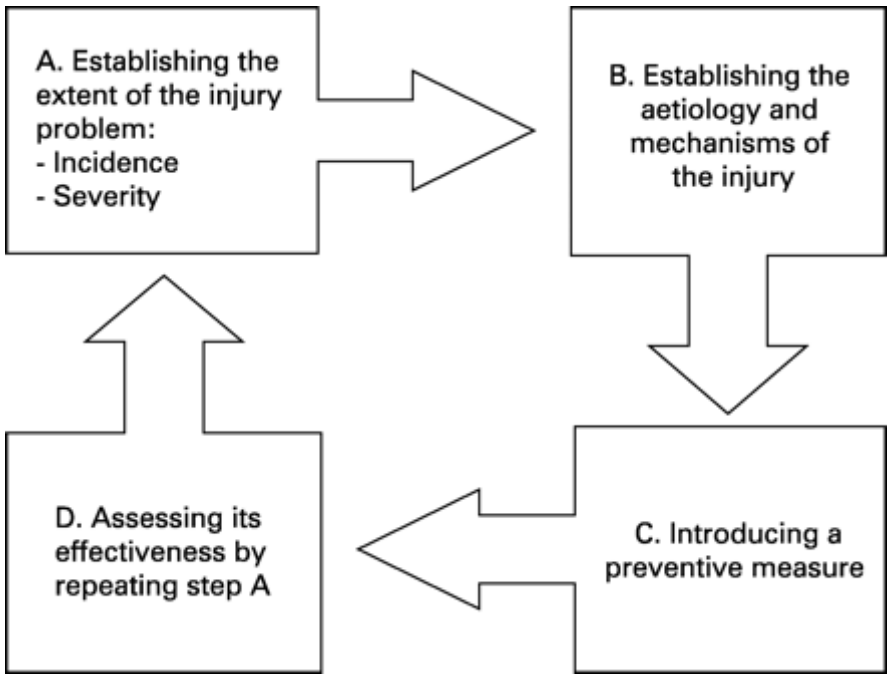



**Figure 6**: van Mechelen 'sequence of prevention model' (1992)

*Stage one: Establishing the problem*

This stage involves injury monitoring in sport to establish the extent of the problem, of which incidence and severity are the predictors. In chapter two, I outlined the complexity of defining sports-related concussion and lack of a consensus on the measurement of severity levels with the injury. This can complicate this stage of the model when used to assess the risk of sports-related concussion as the use of standardised definitions for injury allow for more valid comparisons within and between sports (van Mechelen, Hlobil & Kemper, 1992). However, Spinks and McClure (2007) suggest there is little utility in cross-sport injury comparison with the nature of exposure being so different in various activities.

*Stage two: Establishing the aetiology and mechanism of the injury*

Understanding the mechanisms of a sport injury is important for the development of effective injury-prevention interventions (van Mechelen et al., 1992). Here, the developers of the model divide risk factors into either internal or external (van Mechelen et al., 1992). Internal factors include physiology of the body, injury history and other personal demographics. External factors include the weather, equipment, and coaching provisions (van Mechelen et al., 1992). Key to this stage is the understanding of the mechanism of an injury and causal factors.

There are several approaches and models to understand the mechanism of sport injury. A common model is the stress/capacity model which works on the basis that when the stress exceeds personal capacity, then injury will be incurred (van Mechelen et al., 2013)

However, many reject this model as too simplistic and adopt a more holistic model to understand the aetiology of injury (Lysen et al., 1986). These models account for the broad spectrum of factors that exist in sporting injury, such as both the internal and external risk factors, protective equipment, human influences, and the physical environment (Backx et al., 1990).

*Stage three: Introducing preventative measures*

Stage three of van Mechelen (1992) model sees the introduction of interventions to either prevent the injury entirely, or to reduce either the incidence or severity of the injury. Fuller and Ward (2008) outlined an empirical approach to evaluating levels of acceptable risk in team sports. In their evaluation matrix, seen in figure 7, they outline a risk assessment based on injury incidence and severity. The section of the matrix of low incidence and low severity is the 'ideal' area for sports to work towards. Injuries that have a high severity and incidence will fall under the unacceptable boxes on the scale, and thus must be intervened with to move to another area of the matrix (Fuller & Ward, 2008).

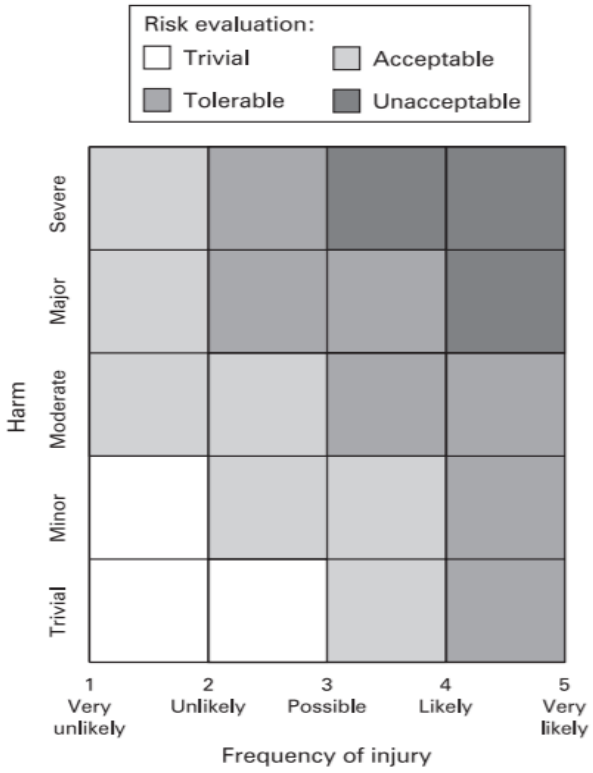



**Figure 7**: Risk matrix for assessing acceptable level of acute and chronic injuries (Fuller and Ward, 2008)

*Stage four: Assessing the effectiveness by repeating stage 1*

The last stage of the model is situated in the evaluation of the process and has little explanation for its effective use or application. Van Mechelen et al. (1992) do not outline the theoretical perspectives or practical implementations of this phase. With the cultural and political contentions around sporting injuries, there are few interventions that move through all four phases of the model (Chandran et al., 2019).

**TRIPP Model**

Understanding the sequence of injury prevention has proved useful for sporting injury research and informing interventions, however, there have been highlighted limitations of these models. Finch (2006) critiques the simplistic nature of the van Mechelen (1992) model. Central to the critique, Finch (2006) observes how the 'drop off' in theoretical consideration for the real-life application of interventions in the van Mechelen (1992) model renders it ineffective in real-world settings. The

approach works from the premise that an intervention must be accepted by the athletes and organisations in the sport, or it will not succeed.

Moreover, 'Sports bodies will not implement sport safety policies until they are sure that the safety measure will actually prevent injuries, are acceptable to their participants, do not change the essential nature or appeal of the sport, and do not adversely affect participation or performance' (Finch, 2006:5). Here, Finch (2006) acknowledges the importance of acceptance from sporting authorities for any initiatives to succeed.

Finch (2006) proposes the 'Translating Research into Prevention Practice' (TRIPP) model to build upon the van Mechelen et al. (1992) model. The model follows the van Mechelen (1992) model by establishing the risk and understanding the mechanisms of injury within a given sporting context. At stage three, the TRIPP model follows a different process to address the limitations outlined of the previous model. Here, Finch (2006) introduces a *development* of preventative measures rather than the *introduction* of these measures at this stage, followed by the introduction of two new stages proceeding. Here, the further focus on context and infrastructure to allow for more realistic and achievable interventions to be developed.

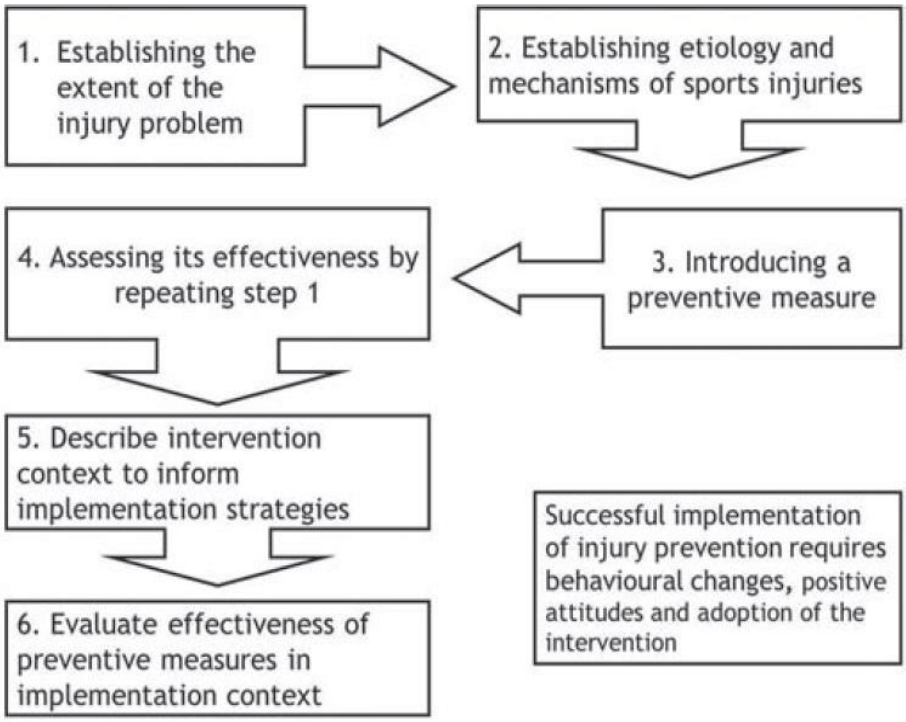



**Figure 8**: Four-step model from van Mechelen *et al* (1992) with Six-step TRIPP model from Finch (2006)

## Social construction of risk

The previously outlined definitions of risk from the Royal Society (1983) were widely accepted and revisited again in 1992. Here, we see an increased complexity in the area with Adams (1995) observing the introduction of social scientists instigating a divergence in approaches between the positivist and objective conception of risk, with a socially orientated perspective. Key to this definitional gap were the issues of perception, behaviour, acceptance, and benefits (Adams, 1995).

*Perceptions*

Adams (1995) discusses how, from an early age, we develop cognitions to process and perceive risk in everyday activities, such as walking or crossing the road. However, our perception of risk can often diverge from objective risk indicators (Adams, 1995; Fuller & Vassie, 2004). Fuller and Drawer (2004) outline how risk perception can be influenced by multiple theoretical factors including: knowledge theory, personality theory, economic theory, and cultural theory.

Knowledge, being a theoretical influence on risk perception, has instigated the importance of communicating objective risk within processes of risk management (Fuller, Junge & Dvorak, 2012). The issue, here, is that risk information is often jargon-laden and packaged in inaccessible statistical denominations that are not easily disseminated. There are conflicting approaches to getting around this. Parekh et al. (2012) suggest a Poisson probability distribution to present probability of injury, Fuller (2007) advocates the use of relative risk to every-day activities.

Knowledge, being a strategy to positively influence awareness towards risk, has its limitations; with an affiliation bias and cognitive dissonance having the potential to influence the engagement with this knowledge (Fuller & Vassie, 2004). An individual may have a range of self-interests or affiliations which will impact how they estimate risk (Fuller & Vassie, 2004). This could also be viewed as a 'conflict of interest', where financial interests can affect an individual's objectivity (Backynski & Goldberg, 2017).

Within the sporting context, this is important to consider. The sporting bodies are usually responsible for risk management, while simultaneously relying on maintaining and increasing participation levels to secure funding and demonstrate success. Specifically, this means that, on the interpersonal level, an individual's perceptions of reality can be impacted by cognitive dissonance (Festinger, 1962). As such, there exists stress as information an individual is presented with may be in conflict (Fuller & Vassie, 2004). In this scenario, the individual must either readjust their position and remove the dissonance based on their experiences (unlikely), or discard and discredit the information that conflicts with their own worldview (most likely).

*Behaviour*

The perception of risk influences interactions with risky behaviours, this process is known as vigilance (Adams, 1995). Activities that carry a high risk will, for most, result in an individual to behave more vigilantly and cautious. Thus, levels of risk decline in line with a person's adjusted behaviours. It is this relationship between individual and the existential world that leads to the conception of risk being in a subjective and perspective realm, rather than representing an objective and static concept (Adam, 1995).

Following this, individual behaviour has the power to nullify the effectiveness of any risk controls implemented (Wilde, 1998). Accounting for this, risk homeostasis theory recognises that there is a level of risk that people willingly subject themselves (Wilde, 1998). As such, Wilde comments 'risk homeostasis theory posits that people, at any moment of time, compare the amount of risk they perceive with their target level of risk and will adjust their behaviour in an attempt to eliminate discrepancies between the two' (1998:89-90).

Therefore, each person has a set level of risk and will adjust their behaviours around this to still engage in some risky behaviours to get the associated benefits. For example, many understand the health costs and dangers associated with drinking alcohol, but it is common practice. The level of risk is accepted, and the behaviours may be adjusted to drink within moderation to still engage with the behaviour and can gain the perceived benefits, such as socialising.

Similar to this is the concept of risk compensation, which asserts that when an individual feels protected from risk, they will be more forthcoming in engaging in riskier activities (Adams, 1995; Adams & Hillman, 2001; Thompson, Thompson & Rivara, 2001). Working with this theory, considerable research has examined the role of the helmet in cyclists' behaviours. Adams and Hillman (2001) found that when wearing a helmet, cyclists were more likely to ride more recklessly and out of their ability because of the perceived reduced risk of injury.

Further, Gamble and Walker (2016) found that helmet use significantly increased risk taking and sensation seeking behaviours when compared to a control group wearing a baseball cap, which does not carry the safety connotations of a helmet. In another context, Morrongiello, Walpole and Lasenby (2007) found that children aged between seven and twelve would take greater risks while on an obstacle course when wearing protective equipment than without.

It is clear, then, that perception of risk influences behaviour in a variety of ways. An individual may adjust their behaviours to be more cautious and vigilant if there is a perceived risk and the perception of safety can also influence people to engage in more risky behaviours. In summary, the

social interactions between people, risk and perceptions, has influence on behaviours and can reduce the scope of objectively measured risk predictors of behaviour.

*Acceptance*

Every activity has an associated level of risk attached to it. Yet, every day we take risks without much contemplation, for example crossing the road at a Zebra crossing incurs a level of risk, as does being in the sun, but we nonetheless engage in these behaviours to live out our daily lives (Adams, 1995). This is because these activities symbolise an acceptable level of risk to most. There are activities that carry higher levels of risk which may trigger arousal and exhilaration, these can be an allure for many (Adams, 1995). Every individual has a risk threshold which is determined by their physical abilities, personality, the environment, their past experiences, and group pressure. Everyone's threshold is dependent on these factors and thus it is not universal.

In cycling, for example, a professional rider reaching a speed of 100kph racing down a mountain road is deemed an acceptable risk based on this person's abilities and experience. Whereas, for a novice, the same activity would be an unacceptable risk. Adams (1995) describes this as a thermostat. Individuals have the agency to adjust their own levels of acceptable risk and adjust their experience and behaviours accordingly.

This risk threshold is often deduced by a cost-to-benefit analysis (Adams, 1995). An individual will seek to work out the risk of an activity (the cost) with the associated positive outcomes (the benefits). Here, Adams notes 'the decisions that are made in the face of uncertainty involve weighing the potential rewards of an act against its potential adverse consequences' (1995:3).

Sport is often deemed a high-risk domain and, as such, Fuller (2007) notes how people will have a higher risk threshold when an activity is voluntary, like sport. On this, Fuller (2007) observes how activities that carry a high level of risk does not make risks unacceptable as such, rather, people will accept risks in voluntary activities that are up to 1000 times higher than risks within a non-voluntary domain (Trimpop et al., 2006).

The study from Fuller (2007) used a comparison of sports-related injuries with work-based activities. Higher levels of accepted risk were found in voluntary sport arenas, compared to those accepted in the work environment. For many athletes, it was suggested that the response triggered from high-risk sports, such as arousal and excitement, were a key draw towards participation in the sport.

This suggests, then, that sports which operate in the voluntary domain allow participants to set a higher risk threshold. Even within extremely high-risk domains, this process of risk analysis still

occurs; it is just the thresholds are different. For example, Green and colleagues (2003) found that skydivers will still go through this process of cost-benefit analysis of risk.

Therefore, risk thresholds are subjective and unique, based on individual factors and context. For effective risk evaluation, there needs to be some universal agreement on a socially accepted level of risk. Working within the sport domain, Fuller and Ward (2008) explored this area. Using both athletes and spectators, they surveyed the perceived acceptable levels of risk in sport in relation to acceptable probability of an injury based on severity. Interestingly, spectators had a higher threshold of risk acceptance than the athletes (Fuller & Ward, 2008). Here, we see the intersection of our own experiences in influencing risk thresholds. For example, an athlete that has suffered a serious injury is likely to reduce their acceptable risk threshold. This complicates the development of objective levels of risk thresholds.

*Benefits*

Synonymous with the term, risk management, is concern about managing risk, not eliminating it entirely. It is concerned with setting the threshold at a level that allows the benefits of an activity to be gained within an acceptable level of risk. Health and safety rhetoric is often concerned with the removal of risk and no-risk environments. Adams (1995) is critical of this, as it overlooks the benefits that can be gained from risk-taking behaviours. Indeed, this is human nature and risk homeostasis theory suggests people will aim to optimize benefits and thus engage in some risky activities to achieve this.

The cost-benefit analysis can be complicated in many contexts (Fuller & Vassie, 2004). We see the costs of an activity can be easily quantified such as injury data, but the benefits can be vaguer and less matter of fact, particularly in the leisure context (Fuller & Vassie, 2004). For example, competitive cycling carries high injury rates and risk of brain injury, with the associated benefits often being based around improved cardiovascular health gained from cycling. These benefits are varied and hard to quantify. Indeed, Tudor (2004) observes how the benefits are often indirect, making the measurement of the benefits within society challenging.

These social components of risk are central to the risk estimation and risk evaluation stages of the risk management framework (Fuller & Drawer, 2004; Fuller, Junge & Dvorak, 2011). Thus, understanding the intersection of perception, interaction, and acceptance of risk in people is crucial in decision making in risk management.

## Social variables impacting risk-taking behaviour

I have discussed that risk taking is a subjective experience and presented reasons why individuals may engage with risk-taking behaviours. Here, I will explore some of the social variables that may make certain groups more likely to engage in damaging risk-taking behaviours. Understanding these variables is important in public health and sport settings because it can inform targeted interventions, policy and improve understanding of injury aetiology.

*Group pressure*

Few models of risk-taking account for group pressure, but research shows this is salient. This is particularly germane in sport settings, where high-group cohesion and over-conformity to norms exist. The impact of peers and group pressure can be observed to impact behaviours, both positively and negatively.

Much of the literature on risk taking behaviours is situated in the examination of moto-vehicle use. Here, research has found the presence of peers to positively impact young driver behaviours (Gheorghiu et al., 2015). Research has shown, when accompanied by peers, young drivers more frequently comply with highway laws such as speed limits (Black, 1978), motorway chevrons (Evansm, Wasielewski, & von Buseck, 1982) and warning signs to slow down or stop (McKelvie & Schamer, 1988). This influence has been seen to result in a lower risk of car crashes (Engstrom et al., 2008, Rueda-Domingo et al., 2004, Vollrath et al., 2002). However, much research cites peer presence and pressure as negatively impacting young drivers' behaviours resulting in higher crash risk and injury severity (Lambert-Bélanger et al., 2012, Lee and Abdel-Aty, 2008, Preusser et al., 1998).

The effect of group and peer pressure on increasing risk-taking behaviours is widely acknowledge across various domains, with much focus on adolescent due to the high peer cohesion and social development at this life stage (explored further below). In the following chapter, I outline Social Norms Theory (Perkins and Berkowitz, 1986) and the Theory of Planned Behaviour (Ajzen, 1991) both of which include the influence of group norms in behavioural outcomes pertaining to health risks. Competitive team sports exist within an environment of high group cohesion and group behaviours, where group pressure is particularly salient. This can result in athletes being more likely to take risks, such as competing whilst injured, due to group pressure (Kroshus et al., 2014). This variable is thus important to factor into risk management within sport and forms the basis of the following chapter.

*Sex and Gender*

Another variable in risk-taking behaviours is the sex of an individual, and the gendered behaviours attached to each sex. Across cultural domains, males are more likely to take risks that may result in injury or death than females (Eaton et al., 2012; Anderson & McGrath, 2019; Lloyd & Doring, 2019) and are more likely to engage in risk-taking behaviours such as drug taking and gambling (Byrnes, Miller & Schafer, 1999).

Explanations for this are multiple and broadly fall under either biological or social approaches to explaining the differences. Observing biological explanations, research suggests males engage in risk-taking behaviours due to elevated levels of the hormone testosterone (Price, 2005), which regulates male body development and puberty (Mehta, Welker, Zilioli, & Carré, 2015). Research has shown a relationship between testosterone and the activation of the brain areas associated with risk-taking behaviours (Braams et al., 2015; de Macks et al., 2011). Biologically, then, males can be seen to be more predisposed to engage in risk-taking behaviours due to physiological differences to females.

Social explanations, from psychology and sociology, examine the influence of gendered expectations that are attached to sexes. This is a broad area, with many approaches and contentions around the role of sex and gender, I will only briefly touch on this due to the scope of the thesis. In chapter five I detailed the social construction of masculinity and, importantly, what constitutes orthodox masculinity. This is salient as the characteristics of this archetype create an environment of over-conformity to group norms leading to increased risk-taking behaviours. Much research has found masculinity to be a variable in increased risk taking (See; Plummer, 2013; Sheaffer, Bogler & Sarfaty, 2011; Giaccardi et al., 2017). The gendered behaviours of masculinity are mostly associated with males (Anderson & McGrath, 2019), thus offering an explanation for the elevated risk-taking behaviours found in males.

*Age*

The research on risk-taking over the life span is not conclusive (Mamerow, Frey & Mata, 2016). Some studies have suggested an increase in risk taking with age, and others finding no differences in risk-taking between older and younger cohorts (See; Best & Charness, 2015; Henninger, Madden, & Huettel, 2010; Mata, Josef, Samanez-Larkin, & Hertwig, 2011; Shao & Lee, 2014). However, the overall trend of research, across various measures and contexts, suggests a decline in risk taking with age (Mamerow, Frey & Mata, 2016).

Research outlines that physical risk-taking behaviours are most associated with younger age groups (Turner & McClure, 2003; Defoe et al., 2019). Rhodes and Pivik (2011) conducted a phone survey of 504 teen (age 16–20) and 409 adult (age 25–45) drivers in the USA. They found riskier behaviours were more frequently expressed within the teen cohort. Much of the literature is situated in research of risky behaviours in age groups motor-vehicle use, with little specific work on age differences in injurious risk-taking behaviours in sport. One study by Mrazik and colleagues (2015) found in a sample of Hockey players that younger athletes were more likely to ignore best practice and hold fewer desirable attitudes towards concussion.

The explanations for this can again be seen to fall under biological and social approaches. In cognitive psychology, research has shown that ageing is associated with changes in cognitive function and motivations which impact behavioural decision making (Figner & Weber, 2011; Samanez-Larkin & Knutson, 2015). One example of declined function is the decrease in dopamine release over the lifespan. Rutledge and colleagues (2016) examine the Pavlovian influence of reward resulting from risk-taking behaviours. The dopamine release, triggering a positive response, from engaging with risk-taking behaviours decreased with age. Framed within Pavlovian influence, this reduced physiological reward leading to individuals engaging with less risk over the life span.

From a social perspective, adolescence is a period of rapid social development and a stage at which individuals are particularly sensitive to peer influence (Albert, Chein, & Steinberg, 2013). This sensitivity to peers impacts risk-taking (Centifanti et al., 2014), and research shows this influence of peers is not observed in adults (Albert et al., 2013; Gardner & Steinberg, 2005). As such, the research outlined above on the impact of group pressure on risk taking is particularly salient amongst younger cohorts.

Outside of peer pressure, there are of course many other social attributes to reduced risk-taking over the lifespan such as increased responsibilities, paternal instincts, past experiences (particularly pertaining to injury) and positive peer pressure to be more conservative in risk-taking behaviours.

*Ability and self-efficacy*

There is limited literature on the impact of ability and self-efficacy on risk-taking behaviours. We see some research in sport that ability is causally related to risk-taking regarding injury in skill-based sports, particularly extreme sports such as rock climbing. Thompson and Carlson (2015) found self-perceived proficiency was associated with increased patterns of risky behaviours in skiers and

snowboarders. Further, in a study of parkour/free runners, self-efficacy was found to play a mediation role in the negotiation of risk-taking (Merritt & Tharp, 2013).

In the sports-related concussion field, higher ability and status of athletes is associated with greater willingness to engage with risk. In a study of university students on a sports course, in Australia, Pearce and colleagues (2016) found that students believed that elite athletes that continued to play following a concussion were to be admired and viewed as living up to the expectations of elite-level sport.

If we observe the trajectory from novice to expert, across sports, it often occurs in small steps. With each step, an individual becomes more invested in the sport as well as there being an increased pressure to perform. Framing this in the concept of Adams (1995) cost-to-benefit model, it is plausible to suggest that as an individual moves through the ranks in a sport, the costs-to-benefit becomes more skewed as the perceived benefits and rewards become greater with the increased ability and level of competition. Thus, an individual may be more willing to engage in risk-taking behaviours to achieve the greater perceived benefits.

**Controlling risk**

In many contexts, particularly sport, the risk of injury can be reduced or removed allowing a safer conception of the activity with the same associated benefits. In most cases, risk controls are put in place to remove or reduce the levels of risk associated with a given activity (Fuller & Drawer, 2004). A frequently used model, particularly for industry standards, is the hierarchy of risk controls. The most effective risk control is at the top and least effect at the bottom.

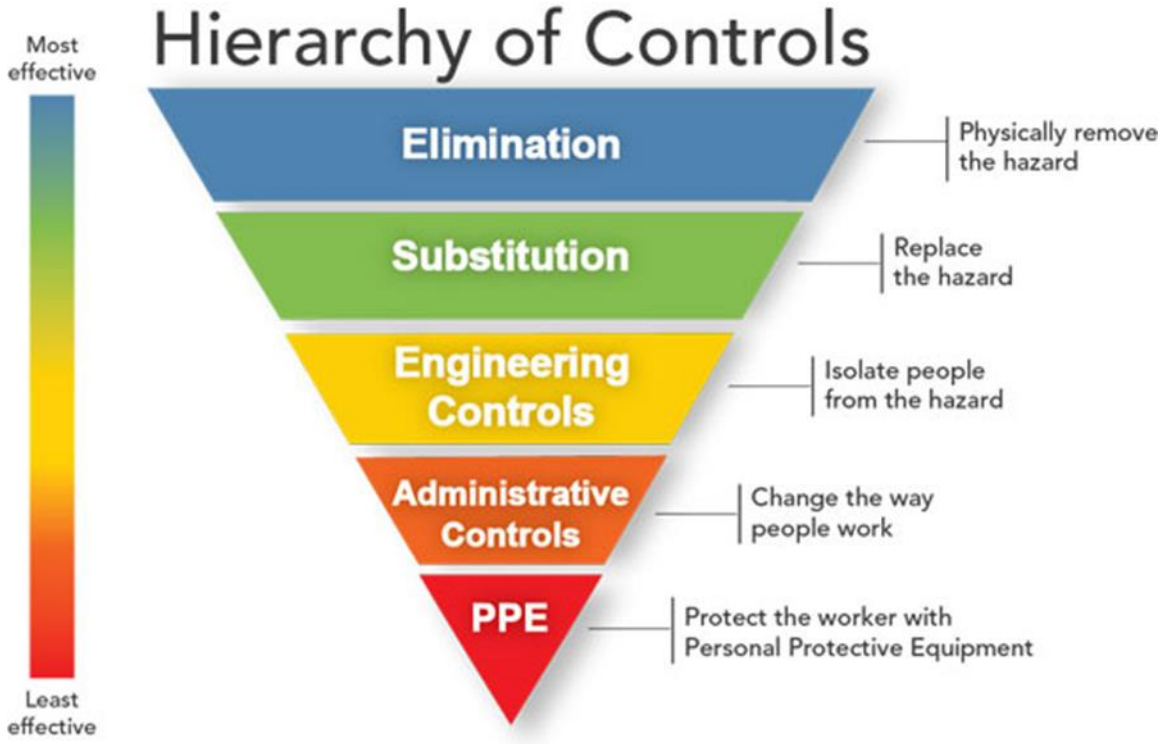



**Figure 9**: Hierarchy of risk control (CDC, 2015)

The first tier of the hierarchy involves the elimination of the risks associated with the given activity. This action would be taken if there is no deemed benefit from an activity which carries risk. The next level suggests substitution of the activity. A safer or less risky activity is used in place of the previous activity. Next, engineering controls involve using technology to make an activity safer. Fourthly, administrative controls involve regulations and training on how an activity should be safely conducted. Finally, the least effective control of risk is personal protective equipment, such as clothing or helmets.

In sporting bodies' approach to injury, however, we often see a reverse approach to managing this risk. Regarding head trauma, we see a large emphasis put on protective equipment in sport despite research showing it is not an effective control (Benson et al., 2009). In cycling, this is seen through the widespread promotion and advocacy for helmets, which do have protective properties in the case of impact injuries such as fractures and abrasion. However, they have also been misrepresented as preventing against brain injury, which no research supports (Sone et al., 2017; Honarmandi et al., 2014; Alfrey et al., 2020).

In recent years, in the domain of brain injury in sport, we see a move to the next least effective step on the hierarchy of control, administrative controls. Governing bodies are now placing efforts into

educational initiatives and regulations in sport. Examples of this in the UK include the RFU Headcase initiative, the HeadsUP campaign, and the 'If in doubt, sit them out' rhetoric.

These approaches have many limitations in an approach to concussion in sport. Taking the Headcase initiative as an example, Batten and colleagues (2016) note it is insufficient. Crucially, it does not prevent concussion, rather, it attempts to dampen the damage once already sustained. White, Gamble and Batten (2017) further critique the Headcase initiative in the UK as it is voluntary, un-evaluated and does not prevent concussions from happening. White (2018) comments that Southern hemisphere rugby authorities often enforce this training, but in the UK, there are no repercussion for non-completion or not staying up to date with best practice in managing concussion. A systematic review from Fraas and Burchiel (2016) concluded that education programmes are not effective in preventing concussion in sport.

We see, then, that personal protective equipment and administration controls (education initiatives) are the least effective in controlling risk, and therefore in controlling concussion in sport. In contact sports, particularly Rugby, we see these controls in action and can assess the effectiveness of the measures. In competitive road cycling, matters are worse: governing bodies have not endorsed or utilised any of the controls as there is currently extremely limited action to address concussion in cycling.

**Eliminating the risk**

The most effective control to prevent concussion in sport is to eliminate the risk. This is possible in a lot of sports and we are increasingly seeing some efforts from governing bodies to work on this basis. The decision from the FA to remove heading from youth football (BBC, 2020) is aiming to eliminate one area of the game in which head trauma is caused. This was implemented in light of the evidence of increased risk of dementia from repetitive head trauma associated with heading a football (Mackay et al., 2019).

In rugby, this approach involves a move towards touch rugby, removing the contact element. Batten and colleagues (2016) have suggested the focus should be solely on preventative measures to ensure player safety. Here, they recognise that the bottom three tiers of the hierarchy of risk controls do not provide a strategy to prevent concussion, the most effective endeavour would be to substitute the tackle.

The Sport Collision Injury Collective, a multidisciplinary collective of academics, wrote an open letter in 2016 to the governing bodies calling for the removal of the collision elements of the school game

so children can play touch and non-contact rugby in UK schools. Here, we see an effective initiative that works within the most effective controls for risk, elimination, and substitution. This is yet to be implemented by any governing bodies in the UK.

In competitive road cycling, the structure and features of the sport requires different approaches to contact sports. The primary source of traumatic injury and brain injury occurs in crashes (Greve & Modabber, 2012). The management of this risk is different to other sports, such as rugby discussed above, as crashes cannot be eliminated themselves from the sport. Riding a bike in any context carries a risk of crashing. However, the mechanisms that cause an elevated risk of crashes can be eliminated and substituted in road cycling if governing bodies were invested in reducing injury rates.

Competitive road cycling takes place within a large bunch context, and this is a primary source of injury. There is sparse literature in this area, but one significant paper by Wijlhuizen and colleagues (2016) demonstrated that bunch riding experience and competitive attitudes typically held by cyclists had an influence on the frequency of crashes. A large-scale survey was administered to cyclists within the Dutch cycling federation; results indicated that relatively inexperienced cyclists involved in bunch riding, as seen in competitive road cycling, had a higher risk of crashing.

The application of this study must be questioned, as it was conducted within one cultural context, but studies have suggested similar results in different cultural contexts (Tin Tin et al., 2013; Martha & Delhomme, 2009). Therefore, one effective method to reduce risks in road cycling would be adjusting competitive cycling to follow individualised performances, such as that seen in Time Trailing and Triathlon.

The previously outlined cognitive dissonance theory aids the understanding to why this has a small probability of being implemented. The removal of group racing would conflict with the attitudes, experiences and historical context associated with road cycling, thus placing stakeholders and athletes in the sport in a state of cognitive dissonance. This leads to a situation in which athletes will be more likely to reject this change and continue with the sport as it is, to restore balance and nullify the dissonance.

A consideration for affiliations is also important as this change would threaten the financial investments in the sport, demonstrating a ‘conflict of interests’ in the objective assessment of this risk (Backynski & Goldberg, 2017).

Preventative approaches are the only effective way to stop the negative health impacts from head trauma. Dr Cantu (2006:2) comments:

> The brain is not an organ that can be conditioned to withstand concussive injury, there are relatively few means by which such injury can be minimized in sports. Thus, perhaps the most important ways to reduce or prevent concussions are rule changes and rule enforcement.

Preventative approaches seek to remove the hazards and prevent the problem in the first instance, rather than being reactive and relying on tertiary care (Pollock, 2014). This approach is important, as we are only recently understanding the gravitas of concussive injuries, and treatments once the injury is sustained are under-developed and ineffective (Meehan, 2011). Unfortunately, governing bodies in competitive cycling are doing minimal to control the risks of concussion in the sport.

### Health-Belief Model

The health-belief model is a social psychological health behaviour change model developed in the 1950s to explain the low uptake of health services and collective failure of people to engage with disease detection and prevention initiatives (Hochbaum, 1958; Rosenstock, 1974). Becker (1974) further explored the model. It is one of the most well-known and utilised theories in health behaviour research (Carpenter, 2010).

The model suggests that six contributing variables influence individual engagement with a health initiative (Becker, 1974; Janz & Becker, 1984). It suggests that individuals' beliefs, perceived benefits or action and barriers and self-efficacy all help to understand the choice to engage or not in health-promoting behaviours (Rosenstock, 1974; Janz & Becker, 1984). Also, a stimulus or cue to action must be present to instigate health promoting behaviour (Janz & Becker, 1984). Figure 10 outlines this process components of the health-belief model.

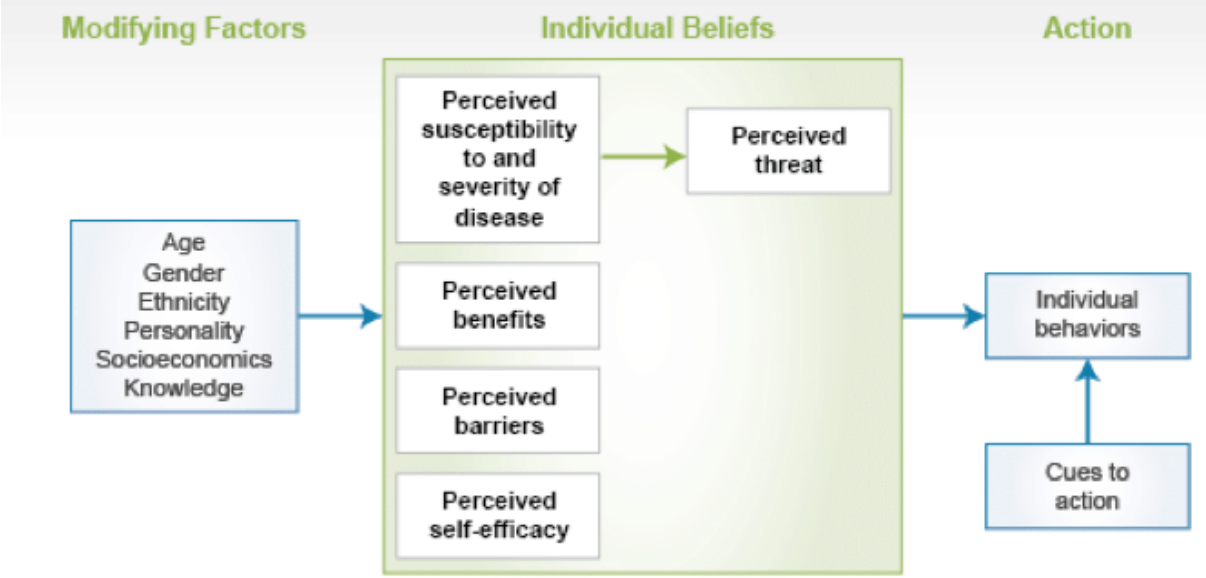



**Figure 10**: Components of the health-belief model (Champion & Skinner, 2008: 48)

In a systematic review of research using this model, Janz and Becker (1984) found significant support for the model, also recognising that the perceived barriers were often central to the engagement with health initiatives (Champion & Skinner, 2008). We see then that, similar to the TRIPP model, it is important to understand the barriers and reasons for people and organisations not to engage with health initiatives. With initiatives working with sporting injury, the low engagement in such initiatives (Fraas & Burchiel, 2016) makes this approach more salient.

### Quantified risk and Precautionary principles

Central to understanding risk is the notion of uncertainty (Adams, 1995), with a steadfast argument for detractors often being there is not enough research on a given topic to inform discussions of risk. This discourse is ongoing in the NFL, with the discovery and increasing findings around Chronic Traumatic Encephalopathy often being rejected on the basis of not enough research or understanding being present to make any conclusions on the risks associated with contact sports (Holstein, Koonce & Jones, 2014; Nowinski, 2012).

Indeed, competitive road cycling suffers with this, as there is limited research on injury monitoring, concussion rates and mechanisms of injury which complicates quantifying the risks involved to develop risk management controls. There is potential that an intervention may offset risk to another area in the activity and then negate the intervention's efficacy (Adams 1995; Adams & Hillman 2001;

Thompson & Rivara, 2001). However, when there is a lack of data but substantial data suggesting a serious risk, such as in cycling, then this should not curb attempts to negate these risks.

To overcome such situations, Barnnet and O'Hagan (1997) developed the precautionary principle in an environmental setting where there is often a lack of scientific data. Here, they suggest that in occasions where evidence is lacking the emphasis is placed on proponents of an activity to justify its safety (Barnett & O'Hagan, 1997). Therefore, stricter measures are needed initially, based on the precautionary principle, and when activities are proven safe the measures are relaxed. Martuzzi comments, '[the precautionary principle] is usually taken to state that lack of scientific certainty must not be used as a reason to ignore or postpone preventive or remedial action when there are other good reasons to do so' (2007:569). In the last two decades, the approach has received much discussion and there exists a large body of work in public health fields using its theoretical framework (See; Steel, 2014, Munthe, 2011; Gardiner, 2006).

This approach has also received utility within the sports-related concussion field to help navigate best practice to reduce risk, particularly amongst vulnerable groups such as children. Goldberg (2020) offers a framework to apply the precautionary principle to policy considerations around sport concussions (In Ventresca & Mcdonald, 2020). Key to this is the emphasis placed on preventative approaches when the extent of risk from a hazard is unknown and unquantifiable, the impacts of concussions on youth athletes being one such case.

The approach critically questions what an acceptable risk is to expose youths and adolescents to, despite the state of empirical epidemiologic data (Goldberg, 2019). Goldberg and Bachynski (2014) posit the importance of social and political questions around the potential harm caused from sport concussions. They acknowledge the importance of epidemiologic evidence but argue that this, alone, should not dictate policy. Here, the precautionary principle offers an epistemic tool that justifies public health action in situations of imperfect evidence of causal links between hazard exposures and population health harms (Goldberg, 2019).

Acknowledging the difficulties here, Goldberg states that decisions around sport concussion risks present a 'complex moral, social and political inquiry' (Goldberg, 2019:119). Although the science around the devastating impacts of concussions is increasingly rigorous and evident, many sports must operate on this principle to get ahead of the move towards dealing with sports concussion problem.

## Chapter conclusion

Chapters two, three and four outlined the associated risks of concussion and specifically in competitive road cycling. This chapter outlines how risk can be evaluated, managed, and mitigated (Fuller & Vassie, 2004). Common injury prevention models in sport have been presented, the van Mechelen et al. (1992) sequence of injury prevention and the TRIPP model (Finch, 2006), and their worth in epidemiological research.

Central to understanding and managing risk in all these models is deeming what could successfully be implemented and engaged with and framing what are acceptable risks in sport (Fuller, 2007). I have highlighted the issue with the knowledge transfer of risk management to stakeholders in sport, with neither the TRIPP model nor van Mechelen sequence of injury prevention addressing how to disseminate the knowledge effectively.

Adams (1995) acknowledges that, central to understanding risk and managing it, is that individuals have agency in engaging with risky behaviours, developing their own risk thresholds to determine behaviours. Here, greater informed consent in sport on the known risks would allow these thresholds to be set with greater empowerment for many athletes in sport.

Finally, I have outlined how much of sporting governing bodies approaches to concussion fall under the least effective approaches to risk management. With the epidemiological study of sporting injury, the only approach that works is preventive measures, everything under this is useful, but is only softening the damage that is already incurred.

It is clear that there is no adherence or acknowledgement for these frameworks for the management of risk within the sport of road cycling regarding concussion as at the time of writing, no approaches are being taken by governing bodies in competitive cycling. This is a situation that needs addressing.

# Chapter 7: Theorising sports-related concussion

**Introduction**

Examining the intersection of sport and culture is crucial for a developed, and holistic, understanding of processes that occur within sport. Germane to this thesis is understanding how this intersection relates to the presence and management of sports-related injury, the focus of this chapter. Drawing on social science perspectives, the chapter theorises sports-related concussion. This thesis is interdisciplinary, as such, I draw on macro, meso and micro theorising from the literature to investigate the research area.

Firstly, the position of sport in western culture, the socio-context of this thesis, is discussed as well as its position in public health narratives. This discussion provides the context for the argument that sports-related concussion is a social problem, and thus the solution is inherently social; which I frame through a sociological analysis. I conclude the chapter with a psychological analysis and application of theory to understand individual concussion management behaviours we see in sport, laying the framework for the research undertaken for this thesis.

**Sport, Culture and Injury**

Sport holds great cultural value and political power (Boyle, 2009; Craig, 2016; Anderson & White, 2018) in many countries. It is frequently heralded as a socio-positive vehicle for the development of healthy and happy individuals and communities, a position often reflected in public discourse and policy (Piggin, Jackson & Lewis, 2009; Anderson & White, 2018). Governments often support this narrative within public health discourses, with a focus on how sport focused initiatives for young people can develop long-term influence on addressing public health issues, such as rising obesity rates (Taylor-Robinson et al. 2019).

In the UK, an examination of the Government School Sport and Activity Action Plan (HM Government, 2019) exemplifies the marketing of sport as a socio-positive vehicle to address national health concerns and ensure the positive development of adolescents to effectively integrate into society. The introduction to the action plan reads:

> All young people should have the opportunity to live healthy and active lives. As set out in our 2015 cross-government sport strategy Sporting Future, sport and physical activity improve our children's physical and mental wellbeing and help them to develop important skills like teamwork and leadership.
>
> A positive experience of sport and physical activity at a young age can build a lifetime habit of participation and is central to meeting the government's ambitions for a world-class education system. Physical literacy (building physical competency alongside confidence, enjoyment, knowledge and understanding) and high quality, modern physical education (PE) lessons that engage boys and girls of different backgrounds and abilities should be a fundamental part of every child's school experience.
>
> Ensuring young people have access to the right amount of daily activity can have wider benefits for pupils and schools, improving behaviour as well as enhancing learning and academic achievement. (HM Government, 2019:3)

This government action plan is a response to challenges the UK faces: the rising child obesity rates, increased child mental health prevalence and nationally increasing rates of sedentary lifestyles and the associated health consequences of this (HM Government, 2019; Sport England, 2019). Here, the government turns to sport and physical activity in an attempt to reduce health costs and ensuring the development of civil citizens. Key to this, however, is the conflation of sport and physical activity (exercise), as the two represent different constructs. This conflation is rarely untangled in policy or political rhetoric (Sterchele, 2016). Within this rhetoric, where formal competitive sport prevails, acknowledgement of the limitations of competitive sport are often absent in sporting discourse and policy (Piggin et al., 2009).

One salient example is the limited open discussion of the injury rates attached to sport, and the burden of this on the public health system. The position of pain and injury in sport was outlined in previous chapters. The presence of risk, pain and injury is an accepted and propagated norm in sport (Anderson, 2012; Hughes and Coakley 1991; Sabo, 2004; Howe, 2004). Yet, political discourses nonetheless frequently package competitive organised sport as a cure for much of societies health-related problems.

Involvement in competitive sport is regularly cited as a leading cause of injury for children in many different cultures (Emery & Tyreman, 2009). On this phenomenon, Van Mechelen, Hlobil and Kemper even comment on this fact decades ago: 'Notwithstanding the healthy influence of sporting activities on risk factors, in particular those of cardiovascular disease, it is becoming increasingly

apparent that sports can present a danger to health in the form of sports injuries' (1992:82). Despite the rising research and data on injury prevalence and risk in sport, it is too often ignored, denied, or crucially, unknown by many stakeholders, policymakers, and key figures within sporting domains.

In summary, sport and physical activity can hold many benefits for participants both physiologically and psychologically. In western cultures, competitive and organised sport is the favoured method to obtain these benefits and is exalted within the culture. However, a result of this cultural cherishment is the complication of a clear, open, and honest discussion around the negative aspects of competitive sport, particularly pertaining to injury rates. As such, sports-related injuries are cultural and present an inherently social problem.

## Sports-related concussion as a social problem

Narratives around sports-related concussion are predominantly housed within medicine and public health domains, with a focus on the physical injury and physiological outcomes (Malcom, 2018). Noted in chapters two and three, the association of long-term neurodegenerative diseases with repeated brain trauma have been known as early as the 1920s (Martland, 1928). Yet, with the increasing knowledge of the negative outcomes of brain trauma in sport, there has been extremely limited progress in prevention, mitigation, and management of sports-related concussion (Pollock, 2014).

The prevention of this injury is not a challenge of medical domains, as the physical condition itself cannot be prevented when a head trauma is suffered (outlined in chapter two). There is no safe scenario where a human brain can sustain a violent impact. Rather, this issue is an inherently socio-cultural one, as dealing with it requires a transformation of the structures of many western competitive sports to remove trauma inducing behaviours. Therefore, I understand sport as a cultural product, and thus sports-related concussion must be understood as socially produced, which presents a social problem.

Linda Weber, a professor of Sociology, proposes a criterion to define a social problem in her work 'The Analysis of Social Problems' (1994). Here, she posits a social problem must be social in *origin, damage, definition* and *solution*. This framework might seem to be a slight misfit for concussion, given the biological damage caused. However, if we examine the impact of concussion more broadly, Weber's framework fits the case, and thus can be used to understand sports-related concussion as a social problem. The injury occurs within sports that have emerged from a set culture, they are thus social in *origin*. Although concussions present numerous issues on an individual physiological and

neurological level, in chapter three I presented the broader social damage concussion in sport has. This can be economic, too. For example, recent research by Yengo-Kahn and colleagues (2020) found the average direct healthcare cost of a single concussion to be $800 in American High School football players. Concussion is thus social in its *damage.*

In Weber's (1994) work, she suggests social problems are socially constructed through public discourse, and thus are social in definition. I previously outlined in this chapter the hegemonic position of competitive sport in cultural, and political, public discourse. A by-product of this proliferation and cultural exaltation of sport is sustained rates of sports-related concussion. It is here we see how sports-related concussion has become social in d*efinition*.

The final criterion proposed by Weber (1994) is that social problems require collective solutions and cannot be solved single-handedly. To deal with sports-related concussion, there is need for policy change and large-scale cultural change in how we view and value sport. We must allow health to take precedence over sporting values and traditions, resulting in the *solution* to sports-related concussion being inherently social.

*Norbert Elias and the civilizing process*

Following on from Weber's (1994) criteria for social problems, the final criteria is most pertinent: dealing with concussion in sport requires collective social action. To make sense of this, Norbert Elias's (1978) concept of the civilizing process provides an understanding of how sport is beginning to transform its structures, and culture, around concussion, and how this can be understood as a social process.

Over recent decades, we have seen sport undergo minor, and more major, structural adjustments to make them safer and more socially acceptable (Anderson & White, 2018). Included in this is the levels of acceptable practice, particularly around physical injury, and violence, being adapted to allow sport to be more culturally palatable and promote the welfare of athletes (Anderson & White, 2018).

A recent example of this in practice is the decision of the Football Association to ban heading in football in the UK for youth players amongst concerns of long-term neurological conditions (BBC, 2020). This is only half the story, however. Anderson notes that it's not just that sport 'becomes' safer; we must change people's emotions to demand regulatory changes. This is because 'people tend to rationalize their feelings, rather than feel their rationality' (2018:69).

Norbert Elias's work was concerned with the understanding of differences present between societies and how they came to be civilised. Elias grew up in a period of decivilization, which resulted from World War I and II (Elias & Jephcott, 1982). Throughout his early life, Elias moved from Germany to France, and then England. Here, he recognized that while Germany's civilization was regressing, elsewhere in Europe, societies were becoming more civilized (Elias & Dunning, 2008). On this phenomenon, he was not so much concerned with the comparison of different socio-cultural contexts seen across civilizations, but the process of civilization itself. Exemplifying this is the number of deaths due to duelling increasing in Germany in the early 1900s, while both France and England observed decreases (Sánchez García, 2010).

Drawing on empirical data from historical contexts of Western European societies, Elias identified a cultural shift in social norms and acceptable behaviours. As the continuum of time and socio-spatial context progresses, behaviours in the social sphere were gradually regulated and aggressive and coarse behaviours were reduced and adapted as stricter social codes were established (Anderson, 2010).

Cultural expectations, and social pressure, exist to regulate acceptable codes of behaviour for a given zeitgeist, with individuals that deviate from these codes being tarnished as deviant societal agents (Goffman, 1963). Too much transgression makes them outcasts. Here, we see a self-policing and internalized system of regulation that dictates the social coding of behaviours. The emotive responses of shame, guilt and anxiety that results from deviating from the dominant social codes work to subconsciously reproduce and support this system.

The process of civilizing is two-fold. Firstly, there is a lowering of the 'threshold of repugnance' (Elias, 1978). This means that certain behaviours move from social acceptability to unacceptability. The second is the internalization of stricter taboos (Elias, 1978). This involves the self-regulation of behaviours through the emotive responses of conflicting with norms.

Sports can be seen to be undergoing a civilizing process as they were largely founded in a set historical context, between the years 1880 and 1920. The structures that exist in sport through rules, leagues, financial investment, and the integration of sport into the education system, allows for processes of reform in line with changing levels of social acceptances to be observed (Giulianotti, 2015).

This can be seen on many levels within sport; the increasing rejection of the masculine warrior narrative as socially acceptable (Adams et al., 2010), the rejection of homophobia and rising acceptance of homosexual's in sport (Anderson, Magrath and Bullingham, 2016; Bush et al., 2012;

White et al., 2020), and the rising awareness and adjustments to the, previously unknown, long-term impacts of traumatic brain injury in sport (Holstein et al., 2014). This process is positive, and we are increasingly seeing these mentioned areas move into the socially unacceptable realm. Regarding concussion, this is an on-going project, however, and there remains much more work and pressure to be applied to push brain trauma inducing sports over the 'threshold of repugnance' (Elias, 1978). When this happens, this theoretical framework would suggest these sports will become socially unacceptable and must adapt to meet the demands of the current cultural zeitgeist.

## Understanding athlete behaviours

Key to the thesis research questions is understanding athletes' behaviours, knowledge, and concussion reporting behaviours. This is germane as it is estimated that over half of all sports-related concussions go unreported (Harmon et al., 2013). Athletes also frequently mask concussion for a variety of reasons (Baron et al., 2013) and these findings are consistent amongst competitive cyclists (see; Hurst et al., 2018; O'Reilly et al., 2020). Much of this is due to the over conformity to sporting norms amongst athletes to compete through injury, masking injury in order to not display any weakness or threaten their masculinity (Baron et al., 2013).

However, we must also understand this on the individual level, and how athletes interact with these cultural processes within sporting domains. Here, I draw on three theories to frame an understanding of behavioural outcomes of athletes regarding concussion management behaviours. They are: Social Norms Theory, Inclusive Masculinity Theory and Theory of Planned Behaviour.

## Social Norms Theory

Situated within health psychology, Social Norms Theory was first used by researchers Perkins and Berkowitz (1986) to understand alcohol use amongst college students. Since this preliminary work, the approach has gained much utility in public health campaigns such as tobacco use, drink driving and sexual assault prevention. This is a macro theory which seeks to understand the specific environment in which the outlined problematic behaviours occur and the interpersonal factors that influence the behaviours (Perkins & Berkowitz, 1986). The premise of the theory is that changing collective behaviours through social norms analysis and intervention can be more effective than focusing on individual behaviour changes (Berkowitz, 2004).

The influence of peers on individual decision-making is the primary focus of the theory (Perkins & Berkowitz, 1986). The majority of the early work using this theory is situated within youth settings, specifically college and high school students (Berkowitz, 2004). It is in this environment that peer influence and normative beliefs are highly influential, and thus important to understand when looking at risk-taking behaviours in youth populations.

The key concepts of the theory are injunctive and descriptive norms (Perkins & Berkowitz, 1986). Injunctive norms refer to behaviours that are socially coded as acceptable or unacceptable, they guide an individual's decision making on behaviours based on how they are socially perceived. These are based on the morals or beliefs of an individual's interpersonal network or social group (Berkowitz, 2004).

Descriptive norms are based on the perceptions an individual holds of behaviours that are usually performed within a social group and are based on the observations of the immediate social environment, informing an individual on how to behave to assimilate into a group (Berkowitz, 2004). The gap between injunctive and descriptive norms is termed misperception, understanding this gap is the foundation of the Social Norms' Theory.

The term describes the gap between an individual's actual attitudes or behaviours, and what an individual perceives about peer attitudes or behaviours (Berkowitz, 2004). The theory suggests that individual behaviour is guided by the overestimation or underestimation of the prevalence of an attitude and/or behaviour within a given group (Berkowitz, 2004). An individual can misperceive their social groups behaviours in several ways which can then influence their own behaviours (Berkowitz, 2004).

An individual may overestimate the prevalence of a problem behaviour, which will then cause an increase of that individuals own problem behaviours. For example, a university student may overestimate the prevalence of alcohol consumption within their immediate social environment, which then justifies their own alcohol consumption. Perkins and Berkowitz (1986) refer to this as 'False consensus'.

Alternatively, and individual could underestimate the prevalence of problem behaviours, which would discourage them from engaging with such behaviours as they perceive this to be the minority. This is what Perkins and Berkowitz (1986) refer to as 'pluralistic ignorance'. The final misperception Perkins and Berkowitz (1986) outline is 'false uniqueness' which refers to an individual perceiving their behaviours to be more unique than they really are, which works to reproduce the behaviour.

The misperceptions discussed operate in different ways to influence an individual's behaviour (Berkowitz, 2004). Social Norms Theory is an applied intervention theory that targets the misperceptions around behavioural norms to drive behaviour change. Much of the work of this theory has been conducted on student populations around alcohol consumption rates. Exemplifying it in practice, there exists a body of work that demonstrates the success of social norms media campaigns to reduce drinking rates in universities (See; Fabiano, 2003; Glider et al., 2003; Perkins et al., 2006).

These campaigns utilised social marketing campaigns grounded in Social Norms Theory (Berkowitz, 2004). The campaigns involve the identification of the problem behaviour, the misperceptions around it, and the promotion of healthy norms to address the misperceptions. In this body of research, the campaigns resulted in a reduction of 20 percent or more in high-risk drinking rates within two years of the social norms marketing campaign (Berkowitz, 2004). It is clear, then, that approaches grounded in Social Norms Theory can be effective in influencing behavioural change, as well as understanding the norms that regulate certain behaviours.

The theory, and its application to campaign development, is not without limitations. The approach relies largely on assumptions on behavioural norms and that individuals are subject to these without agency. On this, Baer and Carney's (1993) research showed that an individual's misperceptions of drinking problems were not related to their own personal consumption, highlighting that perceived norms do not always drive individual behaviour. There is also a body work that showed social norms marketing campaigns had no impact on behaviour changes compared to controlled environments without intervention (Wechsler, 2003; Clapp et al*.,* 2003).

Dempsey and colleagues (2018) outline three core limitations of the theory; 1) Lack of clarity in methodological approaches of testing the approach's assumption on the role of misperceptions on behaviours and differentiating these from the wider research base of other forms of 'social norms'; 2) The theoretical model is vague and a more explicit, unified and testable model of how normative misconceptions are developed would benefit the application and use in further research; 3) Greater evaluation of the theory in practice, with more controlled trials, qualitative studies of participants experience with social norms feedback and alternative study designs which better reflect real-world public health settings.

*Applying Social Norms Theory to sports-related concussion*

Despite these published critiques, I think that the theory has utility to better understand athlete's concussion management behaviours, which can have a significant impact on their health. This is because, the under-reporting of concussion in sport is a significant issue both on understanding the overall rates of the injury, and on individual management behaviours of continuing in competition when symptomatic. Social Norms Theory can be used here to understand these behaviours and inform educational interventions to address these problematic behaviours in sport.

The theory postulates that individuals compare their behaviours with those in their immediate social environment, and this regulates whether they change or continue their behaviours. Behaviours deemed as unacceptable will not be reproduced within the social group and, if exhibited, may be met with negative feedback from peers which works to regulate an individual's behaviour. Important here, is that a behaviour that may be harmful to the individual, but beneficial to the social group, can be reinforced and reproduced.

This is often seen in sport through the self-sacrifice for team benefit. Kroshus et al. (2015) suggest that an athlete playing through an injury falls into this category. Sports teams present an environment in which there is frequent interactions between members, high cohesion and shared values which provides a highly influential model for regulating individual behaviours through 'team norms' (Kroshus et al., 2015).

This can have an influence on the concussion management behaviours of athletes, and their reporting behaviours and intentions. Research supports this assertion (See; Register-Mihalik et al., 2012, 2013; Chrisman et al., 2013). Exemplifying this theory in practice, Kroshus et al. (2014) found in a sample of male collegiate ice hockey players, that pre-season perceptions about what 'most athletes' would do if suffering a concussion were significantly associated with their own in-season concussion reporting behaviours. Participants tended to over-estimate their own behaviours believing that they had safer concussion management behaviours than 'most athletes', which represents a misperceived norm that could negatively impact behavioural change in this area (Kroshus et al., 2014).

Social Norms Theory can aid the understanding of why athletes do not report concussions or chose to continue to compete following a concussion. Continuing in competition, following a suspected concussion, can be viewed as an adherence to the 'accepted' behaviour within that social group (the sports team), as withdrawal may be of detriment to the team and viewed by others as a negative behaviour (Kroshus, 2015).

Applying Social Norms Theory to resolving this issue would involve utilising social norms marketing campaigns within the specific sports environments to change the misperceptions around concussion in sports. This is an area of increasing research interest, with educational interventions to sports-related concussion being adopted (See; Kroshus, 2015; Register-Mihalik et al., 2012, 2013; Chrisman et al., 2013). The increased exposure of academic dissemination in the media of the severity of concussion in sport, coupled with high-profile athletes increasingly withdrawing from competition following a concussion (See; Anderson & Kian, 2012), helps contribute to changing the misperceptions of continuing when concussed being the perceived norm amongst athletes.

**Inclusive Masculinity Theory**

Although the solution to sports-related concussion lays in macro structural changes to how we conceive and 'do' sport, the above theories help us to understand individual behaviours and work towards safer sport in its current form. Here, I draw on a meso-level theory to greater understand norm construction, and how they are subject to change, regarding gendered behaviours. I will apply Andersons (2009) Inclusive Masculinity Theory to explore how athletes' concussion behaviours are changing and locate these behaviours in wider cultural shifts.

I outlined the changing landscape of masculinities in chapter five (Anderson, 2009; Anderson & McCormack, 2012), and how athletes are now far more fluid in practices of masculinity (Anderson, 2014; Murray & White, 2017). Here, I will discuss the impact of these processes specifically on concussion management behaviours in athletes.

The problem I present in this chapter is the under-reporting of concussion (Harmon et al., 2013), and tendency for athletes to continue in competition when sustaining a concussion (Kroshus et al., 2015). Although the literature is currently sparse on the area, there is evidence of increasing safe concussion attitudes amongst several sports (Williams et al., 2017), along with the increasing cultural consciousness of the issue. Inclusive Masculinity theory can be utilised to account for a proportion of this shift and aid the understanding of these trends.

Characteristics of orthodox masculinity are associated with harmful concussion management behaviours in sport. These include risk-taking behaviours, sacrificing body for team success, embracing, and playing through pain to not display weakness and inflicting pain on others (Dunning, 1999; Messner, 1990). However, we see boys and men across society, including sport, are starting to reject this gendered discourse and are now more fluid in their gender performance, not being so strictly regulated by adhering to orthodox scriptures of masculinity (Anderson, 2009; Anderson &

McCormack, 2012; Adams et al., 2010). As a result, this changing terrain in sporting identities and team norms can impact concussion management behaviours.

For example, as athletes become increasingly fluid and egalitarian in their engagement with gender performances (Anderson, 2014), it is plausible to suggest they would be more forthcoming in reporting concussions and withdrawing themselves from a competition. In relation to Social Norms Theory and the Theory of Planned Behaviour, we see a shift in the social norms that are so powerful in regulating behaviours. As such, the subjective norm of sacrificing body for team may erode, making space for the new norm of health taking precedence and individuals' behaviours adjust around this norm change accordingly.

A case study from Anderson and Kian (2012) examining Aaron Rodgers self-withdrawal from an important NFL game demonstrates this change. Although the researchers here were concerned with the examination of the media reporting around the event, it also demonstrates a shift in behavioural norms in an elite athlete competing within a traditionally masculine sport. After suffering the head injury, Rodgers' would have undergone an individual level analysis of factors that resulted in his behavioural outcome of withdrawing himself.

It could be hypothesised that the wider cultural change towards inclusive masculinities has reduced the subjective norms that were previously modelled around orthodox masculinity, allowing for athletes to make these decisions more readily. Further supporting this notion is the work from Adams and colleagues (2010), who demonstrate athletes are increasingly rejecting the orthodox masculine frameworks in sport. Consequently, they are adapting to new social norms, beliefs and attitudes, and behavioural intentions and outcomes are shifting accordingly.

Further, Andersons (2009) Inclusive Masculinity Theory (outlined in chapter five) provides an understanding of reduced engagement with orthodox masculinity and participation rates in traditionally masculine team sports. Anderson (2009) discusses the taboo nature of homosexuality in the twentieth century and the pressure for straight men to prove their heterosexuality. The response was to adopt orthodox forms of masculinity to distance themselves from being social perceived as homosexual and thus risk-taking sports offered a vehicle to 'prove' heterosexuality and assert an orthodox archetype of masculinity.

However, with wider social changes men no longer have this pressure to be perceived as straight and thus have less need to perform orthodox masculinities (Anderson, 2009, Anderson & McCormack, 2012). When competing in traditionally masculine sports, this would suggest less pressure to exhibit orthodox masculinities which would include harmful concussion management

behaviours. However, there is also less pressure to play competitive team sports in the first place, evidenced through the declining participation rates in traditionally masculine sports (Eime et al. 2016). Anderson (2009) argues that these sports are no longer required for boys and men to gain masculine capital.

This theoretical application does not answer all aspects of changing attitudes around concussion management but is useful to capture an aspect of it. Further, although we are seeing some positive changes, sport still faces many entrenched issues around safe concussion management behaviours. Inclusive Masculinity Theory is not so much an application to intervene with these problems, but more a framework to greater understand some of the processes which influence the changing behaviours seen in athletes.

### Theory of Planned Behaviour

Another theory that also works with the concept of social norms regulating behaviour is the Theory of Planned Behaviour. Housed in psychology and proposed by Ajzen (1991), the theory is an extension on the Theory of Reasoned Action (Fishbein & Ajzen, 1967). The theory is an integrated model combining macro, meso and micro elements of theory suggesting that attitudes, subjective norms, and perceived behavioural control all shape an individual's behaviour. Figure 11 shows the intersection of these factors and processes that influence a behavioural outcome.

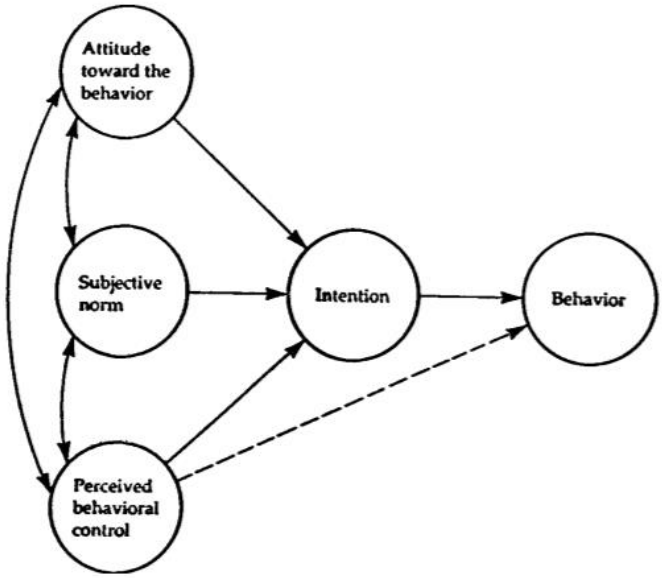



**Figure 11**: Theory of Planned Behaviour (Ajzen, 1991)

In this model, three factors impact the outcome of a behaviour. First, the individuals' attitude toward the behaviour based on whether it will positively or negatively impact their life influences a behaviour. The second construct is the subjective norm, this is concerned with the individuals surrounding social network of peers, cultural norms, and group beliefs which impact behaviour. The final construct is perceived behavioural control, this refers to how easy or hard an individual feels it is to display a certain behaviour or act a certain way. The theory predicts that a positive attitude towards the behaviour, favourable social norms and a high level of perceived behaviour control are predictors for forming a behavioural intention, resulting in the behavioural outcome. If any of these constructs are unfavourable, the individual is less likely to display the behaviour.

The theory has received much utility across a range of areas to understand human behaviours, such as voting behaviours (Tung et al*.,* 2012), environmentally friendly behaviours (Stern, 2008) and most prominently in understanding health-related behaviours such as diets (Connor et al*.*, 2003), exercise (Nguyen et al*.*, 1997), leisure choices (Ajzen & Driver, 1992) and condom use (Albarracin et al*.*, 2001).

*Applying the Theory of Planned Behaviour to Sports-related concussion*

The theory also has utility in understanding concussion reporting behaviours and safe concussion attitudes amongst athletes, which is receiving increasing application in the literature (See; Kroshus et al*.,* 2014; Register-Mihalik et al*.*, 2013; Rigby et al*.,* 2013; Murphy et al*.*, 2017). This research shows how social norms, attitudes towards concussion and perceived behavioural control, influences an athlete's decision to report a concussion. Here, I will apply the Theory of Planned Behaviour model to a hypothetical situation in which an athlete has suffered a concussion within competition and the possible factors (positive and negative) under each construct that will impact the behavioural intention and outcome.

*Attitude towards the behaviour*

- Continuing to play will negatively impact their health and they are at a greater risk of injury if they continue.
- Reporting the concussion may impact their playing time and threaten their place on their team.
- Teammates may perceive them as weak for reporting the injury.
- They will be back at full strength sooner if they report the concussion and withdraw from competition.

*Subjective Norms*

- Players must compete through injury and prioritise team success.
- Withdrawing from competition is a sign of weakness.
- The athlete withdrawing is the right decision and health should take precedence.

*Perceived behavioural control*

- The athlete can withdraw themselves and be substituted for another athlete.
- There are no substitutes left, if the player withdraws the team will be at a disadvantage.
- This occurred in a sport in which substitutes are not possible, such as road cycling

Here, we see conflicts with the three constructs, which will impact the behavioural outcome. For the individual, continuing to compete puts them at risk of injury and furthering the damage from the concussion. It is also within their control to make the decision to withdraw. However, the subjective norm makes this behaviour unfavourable as it may be a detriment to the team's success. As such, every time an athlete suffers a concussion in competition, we see many conflicting factors around these three constructs which impact the resultant behaviour. This demonstrates the multifaceted processes which operate within sporting domains that have a significant impact on athletes' concussion management and reporting behaviours. Targeted educational approaches can address all three of these factors to foster a sporting environment in which athletes are empowered to withdraw themselves when a concussion is suffered.

**Chapter Summary**

In this chapter I have outlined how sports-related concussion should be understood as a social problem, grounding this argument in theory. Drawing on contemporary examples, I demonstrate how the solution to the problem is inherently social in nature. Collective social action is required to remove brain trauma inducing behaviours from sport. I have outlined the interdisciplinary nature of this PhD throughout the thesis, this chapter highlights the utility of macro (Social Norms Theory), meso (Inclusive Masculinity Theory) and integrated macro, meso and micro (Theory of Planned Behaviour) theories in researching sports-related concussion. These three theories will be used throughout the following research chapters and applied in chapter 12 to the overall thesis findings.

I have demonstrated how social norms can regulate behaviour, and the utility of Social Norms Theory and Theory of Planned Behaviour in understanding concussion management behaviours in sport. I discussed the application of these theories to targeted educational approaches to sports-related concussion, which forms the grounding of Study 2, 3 and 4 in this thesis. I then Introduced

Inclusive Masculinity Theory to capture why some of these processes are changing in sport and provide a framework for understanding why athletes may exhibit safer concussion management behaviours.

Sports-related concussion is a multi-faceted and complex issue to study and address. The purpose of this chapter was to highlight the importance of the social world in sports-related concussion research. We must understand where sports came from, why they are culturally exalted and their position within public discourse. Further, we must understand where these wider cultural processes intersect to produce individual behaviours of athletes in sporting domains.

A key point from this chapter is the understanding that dealing with concussion in sport is a social process, which is currently in full swing and gathering significant momentum. If we look at history and social movement theory, it is rare for these processes to move backwards once significant momentum is gained. As we learn more about the detrimental impacts of concussion and when that information is disseminated into popular culture, many sports will become socially unacceptable. Thus, we are at a stage at which sports must face this reality and either radically alter many of its structures or become relics of yesteryear.

# Chapter 8: Methodology

## Introduction

This chapter attends to the philosophical and methodological groundings of the overall project, and how it influenced the research process. I first work through a brief discussion of the philosophy of science and research more broadly before a consideration for ontology, epistemology, and methodology. The chapter concludes with a more practical discussion around researcher reflexivity and positionality. I explore how these have impacted the research process and the steps I have taken to manage the challenges and opportunities that my position in the field brought to this project.

## The philosophy of science and research

The nature of what 'science' is and how it should be 'done' has been debated and contested throughout modern human history. A detailed account of the historical roots of science will not be explored here. However, it is important to acknowledge this history and different approaches to doing science. Even more important is that, in my assessment, there can be no objective claim to the 'right' way to do science and produce knowledge. This is because, as with all philosophical discussion, the premises are always contestable, problematic, and inconclusive. Furthermore, I view science as a cultural project that seeks to understand the world. As such, it shifts, changes, and moves through different 'paradigms' (Kuhn, 1962) relative to the social world it is situated, and developments in scientific knowledge and observations. This leads to my conclusion that no science, or scientific knowledge, is absolute and will always be subject to change; it is fallible.

In what follows, I will outline the main branches of philosophy and basic assumptions that shape research traditions and approaches. I have structured the following discussion in line with how I conceptualise the philosophy of scientific research. That being: Ontology forms the foundational structure from which epistemology, methodology and methods logically flow. I will briefly describe each, before situating my position as a social researcher. In this chapter I take this discussion up to methodology, and leave the discussion of the practical 'who, what, where and when' of research methods to be addressed separately in each research chapter.

## Ontology

Simply put, ontology is the study of being. It is concerned with the metaphysical consideration of what is 'reality' and what can be considered as 'real' (Hathcoat, Meixner & Nicholas, 2018). It seeks the classification and explanation of phenomena, with a focus on the object of inquiry, to make 'claims' about the world. Blaikie offers some clarity here suggesting that ontological claims are:

…claims and assumptions that are made about the nature of social reality, claims about what exists, what it looks like, what units make it up and how these units interact with each other. In short, ontological assumptions are concerned with what we believe constitutes social reality (2000: 8).

Different scholarly disciplines have varying, and contrasting, responses to these questions and considerations, outlining ontological positions which inform worldviews and research practices.

There exists a myriad of terms that relate to different ontological positions. To (attempt to) sift through the fluff, ontological positions can be broadly positioned into two positions in the social sciences. One being the belief that an objective reality exists 'out there', and this is independent of the observer and the human mind. As such, science seeks to discover and test objective 'facts' and universal laws (Gorski, 2013). This position will typically be labelled as objectivist, realist, foundationalist, positivist, amongst other guises (Bryman, 2001).

The other being the belief that multiple subjective realities exist that are negotiated and produced in the social world between individuals and groups. Reality does not exist beyond the human mind. Proponents of this philosophy 'assert that social phenomena and their meanings are continually being accomplished by social actors. It implies that social phenomena and categories are not only produced through social interaction but that they are in a constant state of revision' (Bryman, 2001: 16–18). As such, knowledge is socially constructed rather than being objectively determined and perceived (Berger and Luckman, 1967). Positions in line with this thinking fall broadly under categories of interpretivism, anti-positivism and constructionism (Grix, 2001).

Each of the two broad approaches hold basic assumptions on how the world can be understood, and importantly how it should be studied (considered below). In the development of modern science, and early social science, the dominant philosophy was positivism (Gorski, 2013), and this remains entrenched in much contemporary science. Its oldest 'rival' offering a contrasting stance is interpretivism, with social constructivism offering a relatively new expansion on this philosophy (Gorski, 2013). As outlined above, both have different social ontologies. Gorski comments on this and how social scientists navigate these philosophical assumptions '…positivism is the dominant form of orthodoxy and interpretivism the dominant form of heterodoxy, and that most social

scientists position themselves methodologically in relationship to them, even if only tacitly.' (2013: 661). I will endeavour to position myself as a researcher in relationship to this discussion in the following sections.

## Epistemology

With ontology being the study of being, epistemology is concerned with the study of how we come to know the things we claim to. In short, it relates to theories of knowledge and how claims about what is assumed to exist can be known (Grix, 2001). It is focused on the relationship between the researcher and the reality or how this reality is captured or known (Carson et al., 2001). Ejnavarzala outlines that epistemology '…deals with questions such as what is knowledge, what counts as knowledge, how knowledge claims are justified and nature of explanations, subject–object relations and fact–value relations.' (2019: 94). Again, there are many branches and approaches in epistemology which can be largely condensed into two broad camps which align with the above discussion: objectivist (positivist) and subjectivist (interpretivist). However, this is by no means an exhaustive list of different approaches but frames the general discussion.

Speaking in broad terms, an objectivist epistemological position advocates the use of methods from the natural sciences to the study of the human world (Grix, 2001). This follows the assumption that it is possible to obtain objective knowledge, outside of the observers influence and human mind, through observation. Approaches to knowledge are guided by a search for an objective 'truth' (Fathi, 2013). Gaining knowledge from this epistemological standpoint is often done so with the aim to explain, predict, and control (Grant & Giddings, 2002).

Whereas a subjectivist epistemological position is based on the premise that knowledge is constructed and cannot be separated from the human mind. Bryman expands on this by suggesting a subjectivist epistemological position is 'predicated upon the view that a strategy is required that respects the differences between people and the objects of the natural sciences and therefore requires the social scientist to grasp the subjective meaning of social action' (2001: 12–13). In this paradigm, multiple meanings and ways of knowing are accepted and 'knowledge is relative to particular circumstances—historical, temporal, cultural, subjective—and exists in multiple forms as representations of reality (interpretations by individuals)" (Benoliel, 1996: 407). As such, it is argued that an objective reality can never be 'captured' (Denzin & Lincoln, 2005: 5), it can only be understood through representations.

The two approaches outlined offer a broad discussion of epistemological standpoints. However, it is important to note that this is not a binary dichotomous relation and there are positions that fall in between. These are important to understand and appreciate as each position will have different views on how we can produce knowledge, and the tools required to do so.

## Methodology

Methodology refers to the choice of approach and research methods used in a given study (Grix, 2001). This choice is underpinned by a researchers ontological and epistemological assumptions. Specifically, it is the study of the science of methods and the assumptions of the various tools available to us, as researchers, to produce knowledge (Bryman, 2001). It is closely linked to research 'methods' but is distinctly different, with the 'ology' (the Greek derived term meaning the 'study of') providing some insight to this distinction. The suffix implies there is a debate, a thought process, and a rationale. Research methods are simply the 'techniques or procedures used to collate and analyse data' (Blaikie, 2000: 8), whereas methodology, as Grix neatly outlines, is '…concerned with the logic of scientific inquiry; in particular with investigating the potentialities and limitations of particular techniques or procedures.' (2001: 179). It is for this reason why methods are not discussed in this chapter and left to the individual research chapters to address.

There are two broad methodological approaches to social science research: qualitative and quantitative. Both have long been framed in opposition, with debates over which is 'best' littering much of the history of social science (Becker, 2017). My thinking on this largely aligns with Jenkins (2002) commentary on this debate, 'The longest-running, best known, and possibly most irritating, example of this kind of non-problem is the well-worn debate about respective value of quantitative and qualitative research methods.' (P.105). We need both if we are to attempt to understand the human world. Again, there are countless sub-branches in both and a detailed text-book recital of these, and their history, is not in the scope of this thesis. Importantly, however, is each approach is broadly associated with ontological and epistemological positions. Qualitative approaches mostly align with subjectivist/interpretivist positions, and quantitative with objectivist/positivist (Crotty, 1998), and this is reflected in the favoured methods that fall under each.

A third approach is important to highlight (particularly as it is the approach of this thesis), and that is the 'mixed-methodological' approach that draws on both qualitative and quantitative methodologies in its research design and production of knowledge. The ontological and epistemological assumptions of this, and its relation to my own position, will be explored below.

**Personal philosophical position and research approach**

In my development as a social researcher, I have undergone a (very much ongoing) process of understanding the above philosophical discussions and situating myself in relation to them. I have reframed from aligning myself strictly with any 'camp', something that often feels forced upon developing researchers and particularly PhD students. The rationale for this is that, in my assessment, strictly aligning to any sides of the above debates logically implies an absolute 'claim' to something I do not think is possible. This is the nature of philosophy, exploring questions that are without definitive answers. Further, epistemological arguments, more broadly, cannot be definitively 'resolved' because meaning will always be inseparable from human experience and is dependent upon context (Dillon et al., 2000).

As such, I do not buy into any approaches with absolute claims to philosophical questions. A further extension of my thinking is that the project of social science is to understand the human world. This is a big task. The human world is unexplainably complex and, in my view, will never be fully understood. Thus, I argue most social science theory and research are informed 'best guesses' of what is going on. An extension of this is my position that all research methods in the social sciences are fundamentally flawed because of the above loose ends, and for a myriad of practical reasons too. Or, as my supervisor, Professor Eric Anderson, more succinctly puts it 'they all [research methods] suck, are all riddled with problems' leading to the position of using the method that 'sucks least' for the question you are trying to examine (personal communication documented in Matthews, 2021: 57).

This leaves the question of how these personal positions I have outlined tie into broader positions and research traditions. And, how to approach researching the human world if it is so complex. A seemingly logical fit is pragmatism, a philosophy developed in the US from the 1970's onwards. The spirit of the pragmatist tradition makes sense to me, and my assessments of the above discussions. Dillon et al. (2001: 17) comment on this, suggesting that the pragmatist spirit '…asserts that conducting inquiry to useful ends takes precedence over finding ways to defend one's epistemology.' Importantly, as a philosophy, it posits that the process of acquiring knowledge occurs on a continuum, and not in binary dichotomous relations framed in opposition like objectivity and subjectivity (Goles and Hirschheim, 2000). This firmly aligns with my worldview in that we must use all tools and concepts available (this is explored further below in my methodological rationale) to understand the world and appreciate we will still likely be wrong and should be open to theory reformulation.

However, it is Critical Realism (CR) that I find most fruitful in fleshing out my understanding of the world and the process of research. CR has evolved from the writings of Roy Bhaskar, and particularly his work *A realist theory of science* (1975). The CR philosophy has subsequently shaped the framework for this thesis. Pragmatism and CR share many basic assumptions and hold fallibilism as central to their understanding of knowledge (Elder-Vassa and Karin Zotzmann, 2021). Indeed, *The Journal of Critical Realism* currently has an open special issue (2022) on the possibilities of these two traditions offering opportunities for synthesis in knowledge production. This is complicated, however, by the variety of interpretations of both schools of thought. Importantly, pragmatists are often critical of CR's realist ontology (Elder-Vassa and Karin Zotzmann, 2021), and it is my own agreeance with realist ontology that makes CR resonate with me.

As a philosophy, CR holds that there is a reality that is independent to the human mind. A realist ontology is broadly defined as '…the view that entities exist independently of being perceived, or independently of our theories about them.' (Phillips 1987,: 205). This is something I agree with and believe to be important not to neglect when researching and theorising. For example, biology 'exists', I have been sick enough times to appreciate this. Further, I believe there are 'real' social structures that determine human behaviours. I do not freely walk around naked for example. I will explore this further below with a consideration of structure and agency. As such, Schwandt comments that 'scientific realism is the view that theories refer to real features of the world. 'Reality' here refers to whatever it is in the universe (i.e., forces, structures, and so on) that causes the phenomena we perceive with our senses' (1997: 133).

Importantly, CR makes a distinction between the 'real' world and the 'observable' world (Archer, 1998). In short, the 'real' is not observable and exists independent from the human mind. What we do know and understand about the world is constructed through our perspectives and experiences through what we can observe (Dean, 2006). Jenkins (2002) provides a useful distinction here between 'reality' and 'observable reality' arguing there is a reality independent of the human mind, but it is the 'observable reality' (what we can comprehend with the human senses) that is of interest to us as researchers; and that *does* exist. Thus, according to CR, unobservable structures cause observable events and to understand the social world the structures that influence events must be understood (Collier, 1994). In terms of knowledge production, CR holds that knowledge is fallible, open to critique and capable of being wrong (Dean, 2006). Knowledge is also theory-dependent, it is constructed in the human mind, and not theory determined. More broadly, CR also understands and accounts for ontologies being fallible (Gorski, 2013). This attends to my concerns stated above about my reservation to buy into any ontologies that hold absolute claims to unsolvable philosophical questions.

A key debate that centres much social theory, and ontological positions, is structure vs agency. In short, this refers to the extent that human behaviour is determined by external structures (A more positivist leaning belief) or that humans are free social agents that can construct their own meanings and behaviours (an interpretivist perspective on the social world). Again, CR offers a perspective on this debate that aligns with my own position: both are important features that exist in the social world and are inseparable. Jenkins (2002: 73) clarifies this point nicely by commenting:

The observable and experiential realities of the human world suggest that the individual and the collective co-exist in the same space; that, in some sense which has so far proved sociologically elusive, they may not be so different after all.

Danermark et al. (2019: 79) explore this within the CR framework by first positioning the observation that society is complex, fluid and contains a myriad of mechanisms and structures that influence human behaviour. They pose the question of how can something this complex be studied? This aligns with my previous supposition that the project of social sciences is an extremely big task, and we should not limit ourselves to simple explanations for complex phenomena. CR aligns with my thinking in this respect as it does not reside itself firmly to either camp of the structure vs agency debate. Rather, it acknowledges both are ontological features of the social world which have 'real' influence on human behaviour. As a philosophy, CR recognises that we must appreciate both structure and agency as separate entities with power and focus our analysis on the links between the two across time and culture (Danermark et al. 2019). This is opposed to theorising that firmly positions itself on one side of this debate.

In summary, I broadly align myself with CR as it somewhat negates my concerns with philosophical discussion and outlines an ontological and epistemological position that fits with my approach to research and understanding the human world. That being, there is a 'real' world that exists, but the knowledge produced to understand it is fundamentally subjective. Further, the process of knowledge production and methods of how we come to know should be orientated around the object of inquiry. As such, method choice should be driven by the research question at hand. And, despite the deep thinking and rationale behind whatever is chosen, it will likely still suck.

*Critical Realist Methodology*

The broader philosophical underpinnings of my thinking have been attended to; this will now be considered in how these influenced this project in terms of the methodological approach taken. If we take the starting point that all research methods are to a degree lacking, where does this leave

the researcher that wants to get on and do research? Logically, if they all lack, but we still want to do research, then we must select the best method, of all those available, to attend to the research question at hand. Closing off options of research methods because they do not align with a certain philosophy seems counter-intuitive. As such, a mixed-method approach to research is the most viable option and CR offers a philosophical position that accounts for this belief.

Proponents of CR make the point that it is fruitless to set up a dichotomy between subjectivism vs objectivism and quantitative and qualitative methods, as if either side has any substantive and conclusive claim to anything. Rather, CR philosophy calls for mixed methodology research where no method is excluded beforehand, and it is acknowledged that a combination of methods is required to understand the phenomena of interest (Danermark et al. 2019). This is not to say that all methods go for all contexts. There are, of course, bad methods to use for certain research questions. This relates to 'critical methodological pluralism', the idea that all methods should be available to the researcher, but they are not all equal. The choice of method should be directed by the object of study (Danermark et al. 2019) and not by a researcher's philosophical beliefs or previous assumptions.

This makes sense to me, and I am on board with it. As such, due to the breadth of the research area in this thesis and my position on research, this thesis adopted a mixed-method approach guided by Critical Realism. In combining research approaches, I hope to draw on the strengths of different methodologies, subsequently negating any weaknesses of singular method designs, a frequently cited benefit of this methodological approach (Creswell and Plano Clark, 2007).

### Reflexivity, researcher positionality and rigour

Cycling has always been a part of my life. From a young age I was on a bike, and weekends regularly consisted of family bike rides. I raced intermittently throughout my childhood but took up competitive road cycling in earnest when I was sixteen years old. Every former athlete has stories of their competitive past that are of great interest to themselves, and that is usually the extent of the captive audience. I will not depict my cycling 'career' as it is not important, nor is it of any interest to anyone but myself. But the important point is that I was completely invested in the sport, I lived and breathed cycling for over ten years. Further, I have also suffered the effects of brain injuries through first-hand experience of crashing on a bike (multiple times). Sharing a biography with the object of study (concussion), and subjects of study (cyclists) brings unique benefits and challenges to the research for this thesis that must be attended to.

Firstly, Hamdan (2009) writes that, as researchers, we do not approach a topic in a value-free vacuum but have distinctive agendas in seeking answers to research questions. As a result, a somewhat common-sensical observation is that most researchers research stuff they are interested in, or have a background in. This is particularly true within sport studies. Hill and Dao (2021) comment on this, stating that accompanying many researchers is an attraction toward studying topics that they have a personal connection to. As such, '…those who undertake research that stems from personal histories and biographies, a space of subjectivity is constantly present, underlying the entire project' (Hill and Dao, 2021: 521). This can be problematic if not addressed. Hamdan (2009) argues we must apply reflexive scrutiny to unpack the researcher's identities and how biography may guide and shape the entire research process. This is the task of the following discussion.

A key idea to first consider is the insider/outsider relationship of the researcher and the data. I have outlined my close relationship and experiences in the research area, highlighting my somewhat 'insider' position. Merton (1972) has described the 'insider' as someone who holds a substantial amount of knowledge of a community and its members. This is true of my position, as I am known within the UK competitive cycling 'community' and have deep knowledge of the intricacies and nuances of the sport that would not be available to someone that has not participated in competitive cycling. Further, Gair (2012) suggests insider status in the field is developed when shared and common experiences are discussed and materialise throughout the research process. This was present during the interviews conducted for study 4, of which rationale will be provided below.

There are, of course, problems to being close to the object of study. Hill and Dao (2021) outline two key disadvantages being hyper-subjectivity and the inability to remove the researcher from the research. Resultantly, this poses the risk that personal biases will steer the research based on previous assumptions and beliefs about the object/subjects of study (Chavez, 2008). This is an on-going issue in social science research which positions the importance of 'reflexivity'.

Reflexivity can be defined as 'the process or faculty by which the mind observes and examines its own experiences and emotions, intelligent self-awareness, introspection' (Sherry, 2013: 283). It is a process which enables researchers to acknowledge their influence on the research and plan to limit and mitigate issues of subjectivity where possible. It also brings into question researcher biography and identity in how it may benefit or limit the collection and interpretation of data (Kidd and Kral, 2005; Lincoln and Guba, 2005).

The above discussion relates to the concept of 'objectivity'. The term has a long history in the social sciences, and specifically sociology. Much common-sense approaches in sociology, largely from

interpretivists, is that objectivity is a myth (Jenkins, 2002). An argument goes that it cannot be obtained when you have humans researching humans, within the human world. We are the objects of our study, and this brings with it a can of worms that must be considered. However, I believe we should not abandon attempts to obtain objectivity when researching the human world. This becomes even more important when deploying qualitative methodology informed by interpretive philosophies, as done in Study 4 of this thesis.

Objectivity can be thought of on two levels in how it impacts research. These are: 1) politics and personal values and 2) the production of knowledge. Firstly, I believe that sociology is a tool to understand the world and the ability to critically examine social issues is a strength of the discipline (McCormack et al., 2020). As such, I do not desire a value-free approach to social research, nor do I think it is possible. Politics, personal values, and ethics will always be present in social science research but, as Jenkins (2002) argues, this need not prevent us from striving toward the second level of objectivity. Our subjectivities as researchers of the human world should be acknowledged and grappled with, not ignored as if they do not exist or viewed as an unavoidable flaw of social research.

To achieve the above desire, a plan and a process is required. Jenkins (2002) discussion of this process is useful here with his comments on objectivity meaning '…working hard to prevent politics and values getting in the way of finding out as much as we can, as honestly as we can, and as systematically as we can.' (P.10). I believe this to be a worthwhile pursuit to produce good social science research. Whilst we cannot achieve complete objectivity, as researchers we can work towards it even if it is only ever achieved partially.  Without doing so, claims of knowledge about the human world will often not be taken seriously (Jenkins, 2002). This is important for the research contained in this thesis that hopes to have impact inside and outside of the academy.

*Steps taken for the research project to ensure rigor*

The above discussion will now be applied to the process taken for the research conducted for the thesis. I have discussed the concept of 'reflexivity', acknowledging my shared biography and experiences with the object and subjects of study for this project. Importantly, this was engaged with before, during and after the entire research process. In designing the methodological approach, I drew on both distanced (Study 2 and 3) and involved (Study 1 and 4) methods and data analysis. This was to use my experiences as a research tool, but also to triangulate any findings with alternative methodologies in which I was removed from the process of data collection and analysis.

Due to my experiences in the sport, and with sports-related concussion, my ability to be entirely critically distanced from the data is somewhat compromised (Chavez, 2008). This is pertinent for the studies using qualitative methodologies. I acknowledge this as a potential limitation of the research and will outline the steps taken to mitigate my personal biases steering the research. The primary method used here was a network of 'critical friends' (see Smith & McGannon, 2018 for a detailed discussion on the utility of this process and its relationship to qualitative research traditions).

From the beginning of the project, through to research design, data collection and analysis, I was in continuous critical dialogue with my supervisory team. This involved the presentation of alternative interpretations of the data and critical questioning of research questions and data analysis. Important to note here is the diversity of my supervisory team and the benefits this brought to the process. One is a sport sociologist with no experience (or interest) in cycling; one an educational psychologist with no experience in cycling; and the final an exercise physiologist with a background in mountain biking (the focus of this thesis is road cycling). This diversity resulted in wide-ranging interpretations and discussions of the research and data that afforded me the space to reflect on my own assumptions and biases throughout the research process.

In doing this, reflexivity was encouraged by the challenging of my construction of knowledge (Cowan & Taylor, 2016). Through this process, I was able to obtain detailed insider knowledge of competitive road cycling culture and lived experiences of sports-related concussion, but also pursue a deeper critical interpretation and analysis of the data gained. Further, this systematic process aided me in pursing the need to keep a critical distance from the data to then attempt to provide the best possible honest view of it (Jenkins, 2002).

Although these steps were taken, and I have made the point that my insider position in the field has provided insights that may not have been available to 'outsiders' there are also limitations. Insights may have been concealed from me due to this insider status. Road cycling has previously been identified as a sport with a strong subculture in which members constantly assert and negotiate their membership (Rees et al. 2013). Importantly, Albert (1999) has argued that acceptance of risk and injury is part of the cyclist's identity. Thus, as a competitive cyclist myself, the interviews undertaken may have encouraged this process whereby participants descriptions of injury, risk and sports-related concussion were led by an adherence to the cycling subculture in the acknowledgement I am part of that. In doing so, I may have acted as a space for the cyclists to assert certain attitudes to almost 'prove' themselves as cyclists to me. Someone without the experience and understanding of the sport may not have been viewed in this way by the participants and thus obtained different insights if they conducted the research.

## Chapter summary

This chapter has explored broad philosophical and methodological discussions, and situated myself as a researcher, and this research specifically, in relation to these. The overall guiding philosophical framework for this work is Critical Realism, which has been explicated in how I find this fruitful and its influence on the research approach taken. Acknowledging issues of conducting research into the human world, I have outlined these issues and the steps taken to mitigate them where possible. In doing so, it is hoped this chapter has provided insight to the research process and the confidence readers can have in the results presented.

# Chapter 9 (Study 1): Twitter discourse around competitive cycling and sports-related concussion

**Introduction**

In chapter four, and various other points in this thesis, I have discussed the paucity of literature on concussion in competitive road cycling. This is particularly pertinent in terms of qualitative data and interpretive work; there is no formal literature that researches the experiences of concussion and athletes' interactions and attitudes around the injury in competitive road cycling. This limits the overall scope of the research area, without understanding the experiences and motivations of the athletes, then effective interventions cannot be created. To begin to address this, I conducted a content analysis of twitter data to understand the perspectives and interactions with concussion in the competitive cycling community.

In the twenty-first century, the rapid development of the internet, and evolution of Web 2.0, has redefined the utility of online technology, and social agents' interaction with the internet. Web 2.0 has shaped online interaction to include active engagement, collaboration, and distribution of information (Deshpande et al., 2006). Indeed, this development has seen a shift from the internet being a source of passive information distribution, to a domain of active engagement in which users can create content, critique information and transfer knowledge on open and interactive platforms (Van De Belt et al., 2010).

The platforms facilitating this include social networking sites, which allow users to communicate and exchange information, opinions, and commentaries in real time (Eysenbach, 2008). One of the most popular global social networking sites is Twitter (Miller, 2009). Twitter is an accessible platform in which users 'Tweet' a range of content and 'retweet' information, circulating it around this online community. Indeed, over half a billion tweets are sent everyday equating to 5,787 tweets per second (Mention, 2018). This large pool of data has been utilised extensively to research human behaviour on a global scale (Macy et al., 2015).

The first tweet was posted by the platform's creator, Jack Dorsey, in 2006 (Murthy, 2018). Since then, every tweet produced is held within the platform, providing a bank of data now spanning over a decade. Here, researchers not only have access to contemporary online communities, but can

track trends over time. A key feature to this platform is the use of key search terms and hashtags. A hashtag often comes at the end of tweet and assigns the tweet to a larger body of tweets under the same topic. Researchers can input key search terms or hashtags into the platform and retrieve specific data on topics.

This allows for researchers to quickly obtain large data sets on topics, with insight to trends with various statistical analysis available of such data (Murthy, 2018). Indeed, Zimmer and Proferes (2014) observe how the utility of this platform has been recognised by academic researchers to greater understand users, its use, and its impacts on society and culture from various perspectives (See; Boyd, 2013; Boyd & Ellison, 2008; Weller et al., 2014).

In chapter seven, I discussed the importance of understanding an athlete's perspectives and interactions with sports-related concussion. This aids the understanding of the problem, and the implementation of effective interventions. In the sports-related concussion literature there has been limited work using the vast amounts of data available online, with most studies that do exist focusing on the media reporting around sports-related concussion (Anderson & Kian, 2012; McGannon et al., 2013; Ahmed et al., 2017).

Ahmed and colleagues (2016) conducted a content analysis of concussion-related images retrieved from Pinterest, Instagram, and Flickr. Here, they found that most images found did comply with the Sports Concussion Assessment Tool (SCAT 3) guideline. Recognising the wide audience on social media, the researchers suggest health clinicians should consider the influence of online content on athletes with sports-related concussion. Further, health organisations should also engage with this method to promote best practice through accurate concussion information on image-sharing sites (Ahmed et al*.,* 2016).

There are limited studies using Twitter to understand sport-related concussion. Sullivan and colleagues (2012) used a prospective observational study design to examine sports-related concussion content on Twitter, over a seven-day period in July 2010. The researchers used eight concussion-related search terms to retrieve results. Here, the most frequent theme was 'news' followed by 'sharing personal information/situation' (Sullivan et al*.,* 2012). The study concluded that Twitter represents a powerful broadcast medium for sports concussion information and education.

A more recent study from Workewych and colleagues (2017) focused more on the athlete interaction with sports-related concussion. They used Twitter data to understand public perceptions and misperceptions of sport-related concussion. Using a content and sentiment analysis of 7483 tweets related to concussion, researchers found a misperception in the public understanding of

concussion being a form of traumatic brain injury (Workewych et al., 2017). They also conclude that social media provides a useful insight to the cultural frameworks around a health issue, which the study of can aid the implementation of prevention and treatment strategies.

The literature on sports-related concussion in competitive road cycling is limited and dominated by quantitative methodology. The current study seeks to address this gap and improve the understanding of sports-related concussion in competitive cycling to inform preventative strategies. This forms study one of this thesis and uses a content analysis of Twitter data, using a customised search strategy and thematic coding to understand the competitive cycling communities' relationship with sports-related concussion.

## Method

*Procedures*

A qualitative content analysis was used, analysing publicly available cycling-specific concussion-related tweets posted on the Twitter website. No contact was made between the lead researcher and the twitter users.

No specific time frame was adopted due to the limited overall number of specific tweets available, but data after 31st December 2019 was not included to allow only complete years to be included in the analysis. Only tweets relating specifically to competitive cycling were included for analysis, with recreational and transport cycling related content being excluded.

Both scientific and colloquial terms were used to yield the data as the study aimed to capture the wide array of Twitter users that interact with this area, namely both researchers and athletes. After scoping the available data and trialling a range of search terms, the following 7 key search terms were used obtain the data: "Concussion in cycling" "Traumatic Brain Injury in cycling" "TBI pro cycling" "Concussion British Cycling" "Concussion UCI" "Head injury cycling" "Concussion cycling crash". The Boolean operator 'And' was used between key search terms. Each key term was searched systematically, using Twitters advanced search settings to work chronologically through all retrieved results until saturation.

*Analysis*

Twitter data was manually collated and input into a data template on Microsoft Excel 2016 (Microsoft Corp). The template included search term, date and relationship to the topic and gender,

if identifiable. The relationship to the topic was broken into 8 categories: Academic Researcher, Athlete, Parent, Journalist, Cycling news reporting organisation, Cycling company, Concussion specific organisation or Other.

Data was collected over a two-week period in short sessions to reduce fatigue and ensure a constant focus. Each tweet was analysed and coded in isolation to other tweets. Data collection was stopped once saturation in tweets was met on each key word search.

The data was manually collated and analysed to allow for the immersion into the research context to understand the themes that emerged. Primary analysis involved general descriptive analysis of the data with initial code production. Emerging themes and subthemes were then more closely analysed, drawing on a thematic analysis of the twitter data to produce the final emergent themes (Braun & Clarke, 2019).

A general inductive approach (Thomas, 2010) was used in the initial data collection phase to develop initial codes. Following a reflexive analytical approach (Braun and Clarke, 2019), the coding scheme was created and adapted throughout the data collection phase, with the aim of collating data within emerging themes.

**Table 1:** Description of coding strategy.

| Code | Description | Example tweets |
|---|---|---|
| **Policy and Protocol** | Commentary on policy or protocol related to concussion in competitive cycling. | *New@HeadCheckHealth #concussion blog out! "Unfortunately, there is no internationally agreed-upon protocol for concussion in cycling." #cycling*<br><br>*Thinking out loud: What is Uci doing minimising head concussions in cycling? For example, incorporating MIPS in helmets would make a difference for starters.* |
| **Reporting** | News article, journalist commentary or media reporting. | *We spoke to @bikeradar to raise awareness of #Concussion in #Cycling: http://bikeradar.com/commuting/gear/article/concussion-and-cycling-48185/ #ConcussionAware #Education #UseYourHead*<br><br>*Another honest, true reflection of the impact of concussion in pro cycling from @user. It's great that these discussions are being had to increase awareness around concussion and concussion management. However, the sport needs more focus around this topic.* |
| **Crash Reporting** | Reports of crashes that included an athlete that had sustained a concussion. | *Concussion in cycling: Toms Skujins: Latvian rider out of Tour of California after heavy crashhttp://bbc.co.uk/sport/cycling/39939952*<br><br>*Horner in hospital with concussion, may be forced out of Tour de France http://goo.gl/fb/lgqLg #cycling* |
| **Publications** | Any research outputs such as journals, reports, or blogs. | *Little article I co-write with @user on concussion in cycling https://theconversation.com/amp/tour-de-france-does-pro-cycling-have-a-concussion-problem-100419?__twitter_impression=true*<br><br>*My first concussion blog post is live! The goal of this blog series is to raise awareness about concussion prevalence in cycling and educate the community about how to prevent, identify, and recover from concussions.* |

*Ethics*

This research methodology has been growing over the past decade, but the consideration for ethical implications of working with publicly available data on social networking sites is subject to debate, with no robust and agreed best practice (Zimmer and Proferes, 2014). Indeed, Twitter users have the option to make their data private, however research shows that fewer than ten per cent of all users take steps to gain privacy or restrict access to their accounts (Meeder et al., 2010; Moore, 2009).

There has been some work to develop specific ethical guidelines for Twitter-based research (See; Kraut et al., 2004; Ess & Jones, 2004; Markham & Buchanan, 2012; Williams et al., 2017; Chiauzzi & Wicks, 2019). This remains inconsistent, and no collectively agreed best practice has been established.

The current study follows principles outlined by Williams et al. (2017) as well as guidance from the Association of Internet Researchers guidelines (Internet Research Ethics 3.0, 2019) to appreciate and mitigate ethical concerns. A reflexive ethical approach through a social science lens was adopted, appreciating the study aims and the community analysed (Williams et al., 2017). In practice, all twitter data used was anonymised and, although it is public data, no information deemed personal was used. Due to the research area, and sensitivities around concussion, a pragmatic approach to user content was used; anything deemed personal and sensitive was not included in the study.

## Results

*Search Results*

The seven key word search terms retrieved 196 tweets from January 2008 to December 2019. The largest number of tweets were seen in 2019 (27%), with a consistent decline in twitter activity with each year working backwards to 2008 (Figure 12). The dominant groups interacting with this research area were in the category 'Other' (40%). This was a twitter user that had no clear affiliation to the sport. Second was 'Researchers' (27%) followed by 'Cycling news reporting organisation' (16%). Athletes only made up 7% of the cohort. See Table 2 for full break down of users.

The codes with the most twitter activity were: policy or protocols (40%), reporting (23%), crash reporting of an athlete suffering a concussion (16%); and tweets of publications on concussion in cycling (15%). Table 1 details the primary codes used and rationale for each. The gender distribution of the sample was predominately male (*n*=115, 58%), followed by unidentifiable accounts or organisations (*n*=63, 32%) and female (*n*=18, 9%).

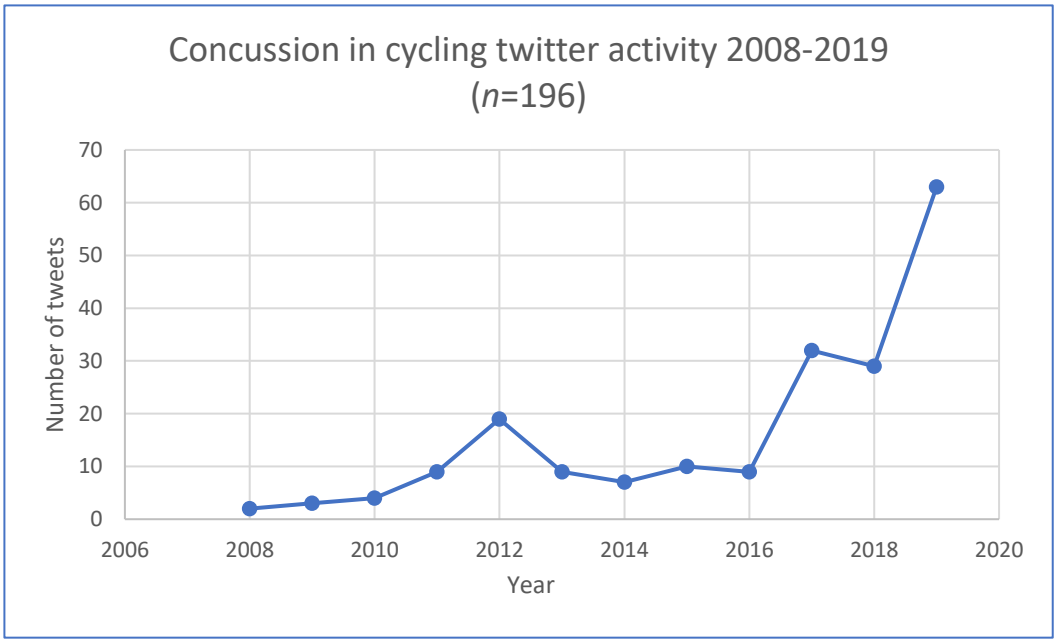



**Figure 12**: Twitter activity over the years of data collected.

| Relation to cycling | Number of tweets |
|---|---|
| Other | 78 (40%) |
| Researcher | 53 (27%) |
| Cycling news reporting organisation | 31 (16%) |
| Athlete | 13 (7%) |
| Concussion specific organisation | 8 (4%) |
| Journalist | 6 (3%) |
| Cycling company | 3 (1.5%) |
| Cycling team | 2 (1%) |
| Cycling shop | 1 (0.5%) |
| Governing body | 1 (0.5%) |

**Table 2**: Stakeholders interacting with keyword searches.

**Discourse Results**

*Policy and protocol*

The leading discourse found from the data coding was discussions concerning policy and protocol in competitive cycling (40%). This involved tweets that expressed an explicit reference to policy or protocol. A number of subthemes emerged here. First was around policy curiosity:

> *Just saw the @richie_porte and @DanMartin86 crash in @LeTour. @thejensie and @NBCSNCycling does @UCI_cycling have a concussion protocol?*
>
> *What's the UCI concussion protocol? Watching Tom stumble through the line of descending riders was terrifying.*
>
> *Is there actually a concussion protocol in place in the UCI World Tour or cycling in general?*

The second subtheme was the expression of animosity towards the lack of policy in place and being enforced in the sport:

> *@UCI_cycling has a major organizational problem if a racer with an obvious concussion is allowed to continue racing.*
>
> *Does the UCI have a concussion protocol such as SCAT? Searching concussion on their website yields no results! In honesty I think the best place to start with this is education for the athlete and the support network. A concrete protocol would help too…*
>
> *I wish you took concussion seriously, same goes across Cycling. It's treated as not so when if we called it a traumatic brain injury then it would be taken more so. The tests taken still mean sit them out. You only have to look at other sports for the damage it does.*
>
> *With the increased knowledge re concussion and dangers of follow up knocks, this seems a crazy risk by Martin, his team and the UCI!*

*Reporting*

The second most common discourse that emerged was reporting (23%) on concussion related areas including news articles, journalist commentary or media reports. These tweets covered a wide range of topics within concussion in cycling, with blogs or articles being shared and commented on. Again,

two subthemes emerged here. Firstly, reporting on the issue in the sport and levels of awareness were a clear discourse across a range of twitter users:

> *Dealing with concussion in cycling -- http://podiumcafe.com/2017/5/16/15647534/dealing-with-concussion-in-cycling?utm_campaign=podiumcafe&utm_content=fan-post%3Atop&utm_medium=social&utm_source=twitter via @PodiumCafe*
>
> *Pro Cycling Plagued By Head Injuries | Cyclingnews.com: http://bit.ly/pAMfKY >>head injury assessment.*
>
> *Concussion is a hot topic in sport at the moment. But road cycling is often left out of the conversation, which tends to be far more focussed on contact team sports. Conor set out to open up the conversation around concussion with two experienced riders*

The second subtheme involved the reporting and commentary on the experiences or events around a rider that had suffered a concussion:

> *Concussion in cycling, another career ending example of the seriousness of this "silent" condition. "I have symptoms every day, now nine months later. My career as a cyclist is over."*
>
> *Kelly Catlin's tragic story underscores the seriousness of traumatic brain injuries. Her family says the three-time world cycling champion committed suicide after struggling with depression and after-effects of a #concussion sustained in a cycling crash.*
>
> *A scary crash led to a yearlong #concussion recovery for @user and her retirement from pro cycling. She learned plenty of lessons in her concussion journey and is sharing them in this week's #ConcussionHope sequence! Hear her story and the importance of patience:*

*Crash Reporting*

The third theme, like the second, was crash reporting (16%). Whereas discourses around the second theme were more concerned with the experiences of concussion, this theme was purely factual reporting of incidents in professional cycling that resulted in a concussion. For example:

> *Cyclist Graham Charlton is back cycling again after suffering with a traumatic brain injury: from @cyclingweekly*
>
> *Pozzovivo suffers concussion in Fleche Wallonne crash #cycling http://cyclingnews.com/news/pozzovivo-suffers-concussion-in-fleche-wallonne-crash/*

*Niki Terpstra will miss Paris Roubaix after suffering 'severe #concussion' in Tour of Flanders crash - Cycling Weekly https://buff.ly/2IrT64i #DDFUND*

*Publications*

The final discourse from initial coding was publications (15%). This concerned any tweets relating to research outputs such as journals, reports, or blogs. As well, commentary around these outputs were included under this theme. For example:

*Sports-related concussion (SRC) assessment in road cycling: a systematic review and call to action*

*New Article: An Epidemic of Traumatic Brain Injury in Professional Cycling: A Call to Action: No abstract available http://bit.ly/zmlzMJ*

*Concussion in cycling http://medicineofcycling.com/wp-content/uploads/2012/01/ConcussionsInCyclists2012.pdf*

**Thematic Analysis findings**

*Increasing awareness*

Findings from a thematic analysis of the data reflects discourses seen in the literature, namely that research into concussion in competitive road cycling is in its infancy (Elliots et al., 2019). The relatively small data set (*n*=196) that was able to be obtained perhaps reflects the lower overall levels of awareness in the sport. Workewych and colleagues (2017), for example, conducted a similar study, but on sport in general, in which they obtained a sample of 72,952 tweets, which were mainly situated in field sports.

The data does, however, reveal rising engagement with this issue in the cycling community. In the graph pictured in figure 12 there is an increasing level of twitter activity, with a significant increase from 2016 onwards. Overall, the data shows an increasing awareness in the sport.

Interestingly, there is a reactive discourse in the data with three events causing an increase in twitter engagement. In 2012, Abramson et al. (2012), under the scope of the Cycling Concussion Task Force, released a Concussion in Cycling Consensus Statement 2012. The document discusses best practice for concussion awareness and management in cycling. The release of the document can be seen to have stimulated a spike in the twitter data, with conversations around the issue being instigated.

The second spike, in 2017, concerned an infamous crash involving Tom Skujins in the Tour of California. Skujins suffered a crash involving a head impact which was caught on camera, the video proceeds to show Skujins returning to his bike dazed and unsteady on his feet. A mechanic helps him back onto his bike and he remounts to attempt re-joining the race. The event instigated a spike in the twitter data as there are commentaries around the mismanagement of the injury and questioning of the protocols in place for such events. Indeed, one significant tweet stated '*if you're referring to the skuijns crash I think it is an incident that should be learned from by changing the concussion culture of cycling'.*

The final spike seen comes in 2019. This spike is multicausal, however, appeared to be spearheaded by the tragic death of young American Track Cyclist Kelly Caitlin, whose death was attributed to the mismanagement of concussive injuries (CLF, 2019). Again, this instigated a discussion around the policy and role of the governing bodies in enforcing policy to prevent such events.

Overall, the twitter engagement with the area is relatively low but is on a gradual increase as awareness is growing. When particularly pertinent events happen in the professional sport, a resultant spike in activity follows with sharing of the stories and discussions around the policy in the sport.

*A narrative of apathy in policy*

The second theme found in the study was around concussion policy in competitive cycling, and the apathy of the governing bodies to manage this injury. Indeed, the most twitter activity (40%) was around this code.

Discussions around this first appeared in 2011, and every year since has included debates, discussions and calls to action around concussion policy and implementation in competitive cycling. This narrative was still consistent into 2020. The reactive activity around events, such as the tragic death of Kelly Caitlin, triggers more engagements and discussions but there have been little practical responses from the UCI and national governing bodies. It appears that the sport must move to a more proactive approach to deal with concussion management to prevent more events like this happening.

Data either directly questioned the UCI or suggested a wider questioning on the concussion policy in cycling. These discussions bring to light the invisibility of policy and lack of effective implementation in competitive cycling. This is problematic, as the sport cannot start to effectively deal with the

problem and raise awareness without clear and overt policy being implemented for fans, athletes, and stakeholders to view. Example tweets included:

> *Is there actually a concussion protocol in place in the UCI World Tour or cycling in general?*
>
> *Is pro #cycling waiting for something to happen a rider before it does something about #concussion post crash!!?? #giroditalia2014*
>
> *Moments after Skujins crash. Concussion protocol? Cycling again showing it is years behind other sports in the safety of it's athletes.*

A number of discussions around the management of concussion by governing bodies, and a concern for rider health, were found in the data. Here, a discourse around the impact the lack of policy is having on rider health and several people in the cycling community were outspoken on this. Example tweets include:

> *When it comes to riders' health, cycling management has a "they're disposable" attitude. It is shocking that cycling, a sport that has an inherent crash issue, still has no official concussion protocol to protect its men and women. #RidersAreDisposable'.*
>
> *Not that this is anything new, but pro sports need to step their shit up with concussions. UCI and AMA both let riders compete after. Sad!*
>
> *Louis Meintjes should never have been allowed back on the bike after that crash. Looked completely dazed. Get serious about concussions Pro Cycling*

*Education and Misperceptions*

The final theme that emerged was around education and misperceptions. In terms of education, there was limited cycling specific resources or informational tweets for cyclists to follow if suffering from a concussion. However, from engaging with the data it was apparent that most of the community concerned with the injury had good levels of understanding of the injury and its severity. Although, of course, those with this knowledge are more likely to be commenting on the subject.

Another reoccurring theme was discussions around the role of helmets and concussion prevention. This was mainly concentrated within a wider consideration of cycling in recreational and transport domains, so was not included for this study. However, there were several misperceptions present on the role of helmets protecting from concussion, which is not supported in the literature (Sone et al., 2017).

Although there was no data available through the twitter analysis, it is plausible to suggest these misperceptions are also held within the competitive cycling community. Indeed, O'Reilly and colleagues (2020) found that knowledge that helmets do not prevent concussion was low amongst adult competitive cyclists.

Contributing to this misperception is the recent increase in cycling helmet manufacturers utilising the rising cultural awareness of concussion to market new technologies advertised to reduce concussion; something not supported by science (Alfrey et al., 2020). An example tweet comes from the recent release of Bontrager's 'wavecell' technology: *#Trek and #Bontrager announce 'most advanced helmet technology ever designed' with XXX #WaveCel Road Bike Helmet | this Collapsible layer massively reduce risk of concussion in cycling crashes.* Marketing such as this may lead to misperceptions around the role of helmets in reducing concussions and may lead many to not seek medical help following a crash, under the belief the helmet protected them.

Another misperception that emerged was around the risk and rates of concussion in cycling. The lack of injury surveillance in cycling (Rooney et al., 2020), paired with the difficulties in concussion diagnosis (McCory et al*.,* 2017), makes understanding the true rates and frequency of the injury in competitive cycling a difficult task. However, there is literature that shows competitive cyclists have high rates of crashes, traumatic injuries, and self-reported concussions (Silberman, 2013; Rice et al*.,* 2020; Hurst et al., 2018; Hardwicke & Hurst, 2020).

Through the content analysis and observations, there appeared to be a dissociation of concussion and cycling, despite research suggesting high rates (Rooney et al., 2020). This aligns with the wider cultural detachment which often assigns concerns of concussion with contact and combat sports. One twitter thread collected highlights this misperception:

> *Mate, you literally said "Crashes are fairly common in cycling, as are concussions". I appreciate you have personal experience with concussion. But context please: in no sane universe is concussion in cycling 'common'. It happens, but it's rare. Like once-in-a-million-miles rare.*

With the lack of visible policy, concentrated efforts from governing bodies and lower levels of awareness, the issue in cycling and understanding that cyclists are a high-risk group for concussion is often overlooked.

## Discussion

The purpose of this study was to understand the discourses around sports-related concussion in competitive cycling. The research design was selected to allow for greater freedom in the exploration of the data. Although the available data was limited, the assertion that competitive cycling has a concussion problem is supported by the research findings. There appears to be a collective concern and increasing awareness around the issue. A thematic analysis of the coded data (Braun & Clark, 2019) revealed three main themes: “Increasing Awareness”, “A narrative of apathy in policy” and “Education and Misperceptions”.

The findings presented in this chapter show that, compared to other sports, the twitter activity around concussion in competitive cycling is significantly low, reflecting the position of the sport in wider cultural narratives. However, awareness appears to be growing. The data shows that there has been a concern around the governing bodies dealing with the injury for nearly a decade, with many in the community feeling let down and angered by this. Further, there is a need for greater education around sports-related concussion and several misperceptions exist because of the lower levels of awareness present in the sport.

These results add to previous literature around misperceptions that exist amongst cyclists regarding concussion incidence, risks, and helmet use (Hardwicke & Hurst, 2020; O’Reilly et al., 2020). This research can help direct the development of targeted educational resources to address these gaps in knowledge, of which social media would be an effective platform to transfer this knowledge.

This data provides some practical applications for research in this capacity. Firstly, Sullivan and colleagues (2012) work supported the notion that twitter offers a powerful platform for the promotion of educational resources for sports-related concussion, further supported by work from Workewych et al. (2017). Following this assertion, social media may offer a platform to address the low levels of awareness and dangerous attitudes around concussion in cycling that research has highlighted (Hardwicke & Hurst, 2020; Hurst et al., 2018). At present, this opportunity is being missed and there exists very limited educational resources for cycling-specific concussion issues, with limited engagement from governing bodies.

Secondly, this study reinforces the need for greater policy attention in competitive cycling. The data shows the consistent trend of pressure being put on the UCI to act on this and implement more effective concussion policy, as well as enforce it. This has been ongoing with impetus since 2011, yet many athletes continue to be put at risk from the lack of policy (Heron et al., 2020). There have been many calls for this to be reviewed in formal literature, this study contributes the voice of athletes, clinicians and other stakeholders that also echo this sentiment.

Thirdly, the misperceptions around the role of the helmet, risk of concussion in cycling and frequency of the injury, confirms the need for further research into the area. Namely, to start understanding concussion frequency in competitive cycling, a centralised injury surveillance is required as well as an evidenced based cycling-specific concussion diagnosis protocol, of which stakeholders in the sport are trained to use so they can act in line with UCI protocol of removing riders from competition that show signs of concussion (UCI, 2020).

## Ensuring validity

The research design subjects the study to issues with validity. In this methodological framework, triangulation of the data is often used to improve the validity of the research findings (Riemer, 2012). The most significant finding in this study was the ongoing narrative around the lack of engagement from governing bodies on concussion policy in competitive cycling. This was deduced from the data through customised search strategies from the lead researcher, and then further analysed through thematic coding and analysis. The cohort included members related to cycling in a range of capacities which engaged with this theme. Supporting this research finding is the multiple formal calls to action in the literature for governing bodies to address the issues that cycling presents with concussion, and the mismanagement of it (See; Greve et al., 2012; Anderson & Heron, 2018; Babcock, 2019; Elliot et al*.,* 2019). Here, the combination of the current study's findings with previous literature to legitimise this finding, and concern in the research area.

## Conclusions

In summary, this chapter highlights that competitive cycling is significantly behind other sports in dealing with the current concussion crisis and awareness amongst those in the sport is low. Greater efforts are needed from the governing bodies in the sport to increase the level of awareness and educate participants on the risks involved pertaining to sports-related concussion. Finally, social media sites offer a platform to transfer knowledge on sports-related concussion to athletes and stakeholders, which the governing bodies in competitive cycling should adopt to address the lower levels of awareness regarding sports-related concussion in the sport.

# Chapter 10 (Study 2): Concussion knowledge and attitudes amongst competitive cyclists

## Introduction

The issues sports-related concussion presents to individuals, and society, has been presented throughout this thesis. In chapter seven I discussed the impact of social norms and behavioural attitudes on the concussion management and reporting behaviours of athletes. This study works within these parameters, adopting a quantitative approach to understand the athlete-level interaction with the injury regarding knowledge, attitudes, and reporting behaviours towards concussion.

### *Concussion education*

To address athletes' concussion behaviours, much research focuses on educational strategies to target gaps in knowledge and change dangerous attitudes athletes may embody. Safer attitudes around concussion have been seen to increase the reporting rates in various sports (Caron et al., 2015). Further, several key studies have demonstrated the positive influence of increased education on concussion can have on athletes' attitudes and reporting behaviours (See; Miyashita et al., 2013; Provvidenza et al., 2013; Register-Mihalik et al., 2017; Register-Mihalik et al., 2020).

Schmidt and colleagues (2020) showed in a collegiate athlete sample in the US that concussion reporting behaviours and attitudes greatly increased following a year-long educational intervention programme. Further, Rice and Curtis (2019) showed that adult-learning concussion educational interventions improved parental knowledge around concussion. This is important as parents represent significant stakeholders in managing sports-related concussion in youth sport.

Prior to developing educational interventions, the levels of knowledge and attitudes must be obtained within a sport to gauge where the gaps lay within specific cohorts. Key to this is the work from Rosenbaum (2010), and the development of the Rosenbaum Concussion Knowledge and

Attitudes Survey (RoCKAS). Prior to the development of this survey, research into concussion knowledge and attitudes to inform education was not uniform, and often the surveys used were not psychometrically sound (Rosenbaum & Arnett, 2010). The RoCKAS offers a psychometrically sound, and validated, survey to assess concussion knowledge and attitudes in athlete populations. This provides an insight to baseline knowledge levels, which can then be used to assess the effectiveness of interventions and to identify where gaps in knowledge exist.

*Concussion knowledge and attitudes in competitive cycling*

In chapter four I presented the literature on concussion in cycling, including the research into concussion knowledge and attitudes within cycling. Here, I will briefly readdress this literature as it is germane to this study.

At the time of writing there have been just two studies examining concussion knowledge and attitudes amongst competitive cyclists, Hurst et al. (2019) and O'Reilly et al. (2020). Both studies find that concussion knowledge was sound, and symptom recognition was good amongst competitive cyclists. Issues were found, consistent across both studies, in the attitudes and reporting intentions of the participants. Good knowledge of concussion is seemingly undermined when in a competitive setting, and athletes were willing to not disclose a concussion to continue in competition. At current, there is no research into why these attitudes exist and which demographics of athletes are more likely to hold such attitudes.

*Age and ability as variables of dangerous attitudes and risk-taking*

In chapter six I outlined variables that impact propensity to engage in risk-taking behaviours and to exhibit dangerous attitudes regarding injury management. Here, I focus on age and ability in how these may impact such behaviours.

In sport, risk taking behaviours are heightened with the high injury rates seen across sport (Fuller & Vassie, 2008), with Fuller (2007) observing athletes having a higher risk threshold in comparison to the general population. In an examination of sports-related concussion, there is an intersection of an athlete's risk threshold and engagement with risk taking behaviours being coupled with their attitudinal beliefs, both of which influences their interaction with concussion management behaviours and outcome of behavioural actions.

There has been much research into age differences in risky decision making, mostly housed in the field of psychology. An often-assumed phenomenon is that younger individuals will more freely engage with risk taking behaviours. Defoe and colleagues (2015) conducted a meta-analysis on age differences in risky decision making, examining adolescents against children and adults. Utilising meta-regression analyses, researchers found that adolescents took more risks than adults on 'hot tasks' in which there is immediate effect on loss or reward.

Looking at motor-vehicle users, Turner and McClure (2010) used multivariate logistic regression analysis, finding drivers aged 17-29 were twice as likely to report being involved in a recent crash than those over the age of 50. Conclusions were that risk-taking behaviours were more associated with young and male drivers (Turner & McClure, 2010).

There is limited research on the role of ability and propensity for injury, and the role of competition in heightened risk-taking behaviours. Much of the literature focuses on injury from a performance and physiological perspective. One study from Llewellyn and Sanchez (2008) found in a sample of male climbers, those high in self-efficacy were more likely to take greater risks.

Chen and colleagues (2019) reviewed risk-taking behaviour and sporting injury in elite athletes from an occupational health and safety perspective. They observe how professional athletes are at high injury risk, exposing themselves to risky behaviours and a higher acceptable level of occupational risk compared to other domains (Chen et al., 2019). The review found awareness of injury was low amongst elite athletes, not meeting the occupational health and safety standards. Here, those at the top tiers of sports did not report injury, continued to compete through injury and held limited knowledge on the risks of injury (Chen et al., 2019).

The acceptance of this risk is key, as it is viewed as an acceptable occupational hazard. There is little work examining this level of acceptable risk held by amateur athletes, which could be influenced by their ability and perceived self-efficacy.

*The current study*

The aim of the current study was to utilise the RoCKAS instrument to assess the levels of concussion knowledge and attitudes within UK competitive road cyclists and ascertain where the most problematic behaviours may be amongst age and ability groups. There is currently an absence of formal monitoring, return to competition and in-competition assessment for concussion in professional and amateur road cycling. Approaching this issue from a bottom-up perspective, raising the levels of awareness to the consequences of the mismanagement of a concussion in athletes is

important to inform policy and educational interventions. Therefore, this study reviews the current knowledge of concussion and attitudes held in UK competitive cyclists to inform evidence-based policy.

## Materials and Methods

*Participants*

The study consisted of a cross-sectional sample of 118 athletes from the UK involved in competitive road cycling, with a range of ages and abilities (See table 3). Participants for the study were achieved through the distribution of a survey via social media outlets, such as Twitter and Facebook, where it was advertised on cycling pages and groups.

*Procedures*

An amended version of the RoCKAS instrument (Rosenbaum & Arnett 2010) was recreated on JISC's Online Surveys (Jisc 2020) and administered to assess knowledge and attitudes towards concussion in road cycling. The version used for this study removed questions referring to field sports, instead replacing them with road cycling specific questions.

Because social desirability has the potential to influence the attitudes section of this survey, Rosenbaum and Arnett (2010) validated the questionnaire against the Marlowe-Crowne Social Desirability Scale. No significant relationship was found between the two measures ($p > 0.05$, $r = 0.09$), indicating the instrument was a valid indicator of attitudes towards concussion without influence of social desirability. Furthermore, the instrument has high test-retest reliability and has undergone extensive psychometric testing and is therefore is a valid and reliable instrument (Williams et al. 2016).

The survey comprised of five sections. Section one obtained demographic data and concussion incidence and training (see tables 3 and 4). Section two, three and five assessed concussion knowledge through 33 true/false statements to produce a concussion knowledge index score (CKI). Section two used 15 basic items (e.g. "After 10 days, symptoms of a concussion are usually gone") and section three used three applied items based on a sport scenario that had been adapted for road cycling.

Section five contained a checklist of eight commonly reported post concussive symptoms (e.g. headache) and eight distractor symptoms (e.g. hives). The legitimate post concussive symptoms are among the most reported symptoms by concussed athletes (Guskiewicz et al. 2000; McCrea et al. 2003). Correctly answered items received one point, and incorrectly answered items received no points. The CKI was derived by summing the scores across sections two, three and five. Possible scores range from 0-33, with higher scores indicating higher levels of knowledge.

Section four of the survey assessed attitudes through 15 items, each with a five-point Likert scale ranging from “strongly disagree” to “strongly agree”. This was broken into two sections, the first section assessed personal opinions through 5 basic items (e.g., “I feel that coaches need to be extremely cautious when determining whether an athlete should return to play”).

The second section used 10 applied opinion items based on sport scenarios; again, these had been adapted to be specific to road cycling. Like the applied knowledge questions, participants were provided a road cycling specific scenario and then a range of statements they could respond to on the five-point Likert scale to signify the extent they either agreed or disagreed with the statement. Participants received 1 to 5 points for each item, depending on the safety of their response (1 point for a very unsafe response and 5 points for a very safe response). The scores from section four comprised the Concussion Attitudes Index (CAI). Possible scores of the CAI ranged from 15-75, with higher scores representing safer attitudes (Rosenbaum & Arnett 2010).

Acknowledging the validity issues with self-report surveys (Li et al. 2020), the instrument used for the current study included seven items to assess inconsistent responses and/or lack of engagement in responding to questions, which produced the validity scale. Correct responses warranted 1 point, and incorrect responses 0 points for the true/false items and higher scores on 1-5 Likert scale items indicated the correct answer (Rosenbaum & Arnett 2010). The validity index was derived from summing the total score from the seven items and dividing this figure by 7. Validity index scores of two or above are considered valid. Nine subjects had scores below this threshold and were taken out the data before analysis, leaving a sample of 118.

**Table 3**: Participant details.

| Characteristic (Total number of participants) | *n*= Frequency (%) |
|---|---|
| **Sex (n=118)** | |
| *Male* | 105 (89) |
| *Female* | 13 (11) |
| *Other* | 0 (0) |
| *Prefer not to say* | 0 (0) |
| **Age (n= 115)** | |
| < 18 | 12 (10.4) |
| 19-28 | 46 (40) |
| 29-38 | 19 (16.5) |
| 39-48 | 21 (18.3) |
| 49-58 | 11 (9.6) |
| 59+ | 6 (5.2) |
| **British Cycling race category (for the 2019 season) (n=115)** | |
| *Elite* | 6 (5.2) |
| *First category* | 11 (9.6) |
| *Second category* | 31 (26.9) |
| *Third category* | 19 (16.5) |
| *Fourth category* | 14 (12.2) |
| *Recreational cyclist (Not raced before)* | 12 (10.4) |
| *I race outside of the British Cycling System* | 22 (19.1) |

*Data analysis*

All data were exported from JISC's online surveys (Jisc 2020) to Microsoft Excel 2016 (Microsoft corp 2016). Data were then analysed using IBM SPSS Statistics 26 (2020). Descriptive statistics were generated to assess participant knowledge and attitudes. Mean ± standard deviation is presented for CKI (0-33) and CAI (15-75) scores, along with the frequency and percentage of respondents who answered correctly to concussion knowledge items (see Table 5).

The study also examined for cohort differences in attitude scores. Two independent variables, age and ability, were run as separate tests against the dependent variable (CAI scores) to ascertain any significant differences. The sample data (n=118) was deemed not normally distributed, calculated using a Kolmogrorov-Smirnov test ($p=0.04$). As such, nonparametric Mann-Whitney U tests were run to establish any statistically significant differences in concussion attitudes between groups. The Alpha level was set at $p \leq 0.05$.

*Ethics*

Ethical approval for the study was granted following Faculty level review from the Faculty of Health and Wellbeing at the University of Winchester, UK (reference number: HWB_REC_20_04). Online resources for more information on sports-related concussion, and appropriate recovery protocols following a concussive injury, were signposted at the end of the survey for participants that may have been affected by concussion. A participation information sheet was provided as a pre-amble to the survey and given its on-line procedure, the ability to withdrawal was salient. Participants were not required to give written permission to be part of this study.

## Results

*Concussion knowledge and attitudes*

The sample of 118 was male dominated (89%), with the highest concentration of responses being in the 19-28 age group (40%). All respondents were UK based, and had been involved in competitive road cycling in some capacity. Table 4 presents the incidence rates and level of formal training on cycling related concussion.

The mean score for the CKI was 26.4 ± 4.12. Looking at concussion knowledge, the most correctly identified general knowledge items were 'Symptoms of a concussion can last for several weeks' (True; 98.3%), 'If you receive one concussion and you have never had a concussion before, you will become less intelligent.' (False; 99.1%) and 'Concussions can sometimes lead to emotional disruptions.' (True; 97.5%). The most correctly identified symptoms of concussion were 'headache' (True; 96.9%), 'dizziness' (True; 95.3%) and 'difficulty concentrating' (True; 94.3%).

Of the incorrect responses, the most common misperceptions in general knowledge were 'An athlete who gets knocked out after getting a concussion is experiencing a coma.' (True; 13.6%), 'After a concussion, people can forget who they are and not recognise others but be perfect in every other way.' (False; 26.3 %) and 'After a concussion occurs, brain imaging (e.g., CAT Scan, MRI, X-Ray, etc.) typically shows visible physical damage (e.g., bruise, blood clot) to the brain.' (False; 32.2%). The most incorrectly identified symptoms of concussion were 'Difficulty Speaking' (82%), 'Panic Attacks' (26.5%) and 'Reduced Breathing Rate' (18.7%).

Mean score for the CAI was 63.1 ± 6.4. With regard to attitudes towards concussion, the safest and most desirable responses were related to being cautious when determining whether an athlete should return to play following a concussion (Agree; 96.6%), that concussions are less important than other injuries (Disagree; 94.1%) and that athletes should report symptoms to coaches or medical personnel (Agree; 94.9%). The least desirable and dangerous attitudes were participants stating they would continue to compete following a concussion (Agree; 23.4 %; Neutral; 11.1 %).

*Cohort analysis of attitudinal differences*

1. *Age differences*

A Mann-Whitney U test showed a statistically significant difference (U=130.5, p=0.013) between two age groups, with the CAI scores being greater for the 49-58 age group (n=11) than the 19-28 age group (n=46). The mean CAI score for 19-28 was 61.4 ± 6.7, compared to 67.2 ± 5.5 for the 49-58 group. All other age groups were tested, with no significant statistical differences.

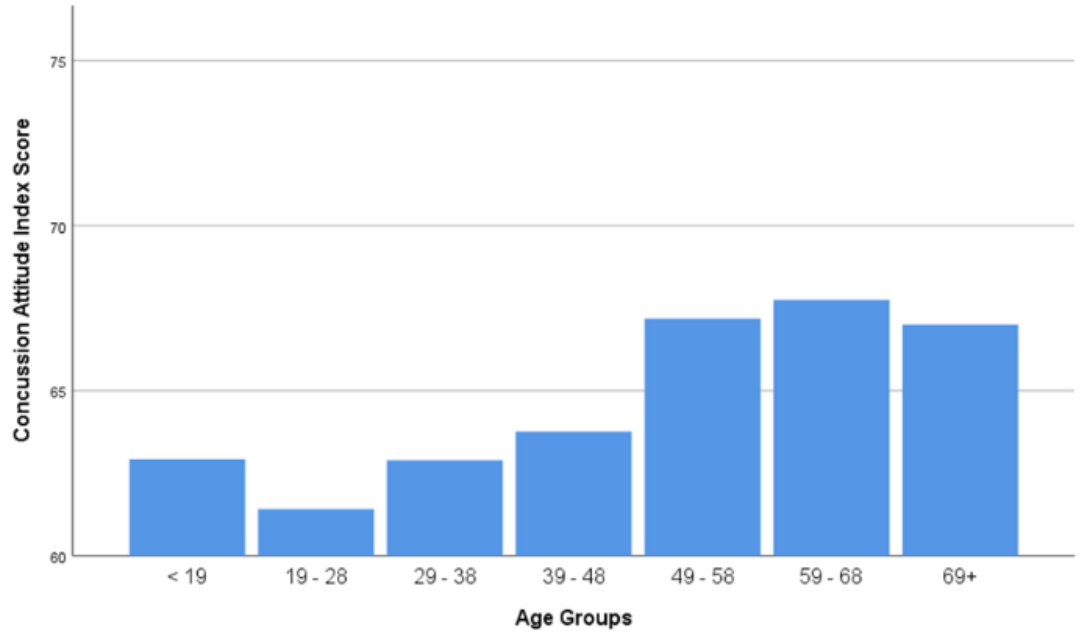



**Figure 13**: Mean concussion attitude index (CAI) scores by age groups

2. *Ability differences*

Mann-Whitney U tests showed statistically significant differences between ability groups. Tests showed that there was a statistically significant difference (U=33.5, p=0.045) between first category riders (n=11) and recreational riders (n=12) for CAI scores (mean CAI score were 62.4 ± 6 and 68.3 ± 5.8 for first category and recreational riders, respectively).

There was also a statistically significant difference (U=91.5, p=0.009) between second category riders (n= 31) and recreational riders (n=12) in CAI scores. The mean CAI score for second category riders was 62.1 ± 6.2, compared to 68.3 ± 5.8 for recreational riders.

Further, the difference was also seen (U=64, p=0.042) between third category riders (n= 19) and recreational riders (n=12) in CAI scores. The mean CAI score for third category riders was 63.2 ± 7.3, compared to 68.3 ± 5.8 for recreational riders.

There was a statistically significant difference (U=67.5, p=0.019) between those that race outside the British Cycling system (n= 22) and recreational riders (n=12) in CAI scores. The mean CAI score for those racing outside the British Cycling system was 63.4 ± 5.8, compared to 68.3 ± 5.8 for recreational riders.

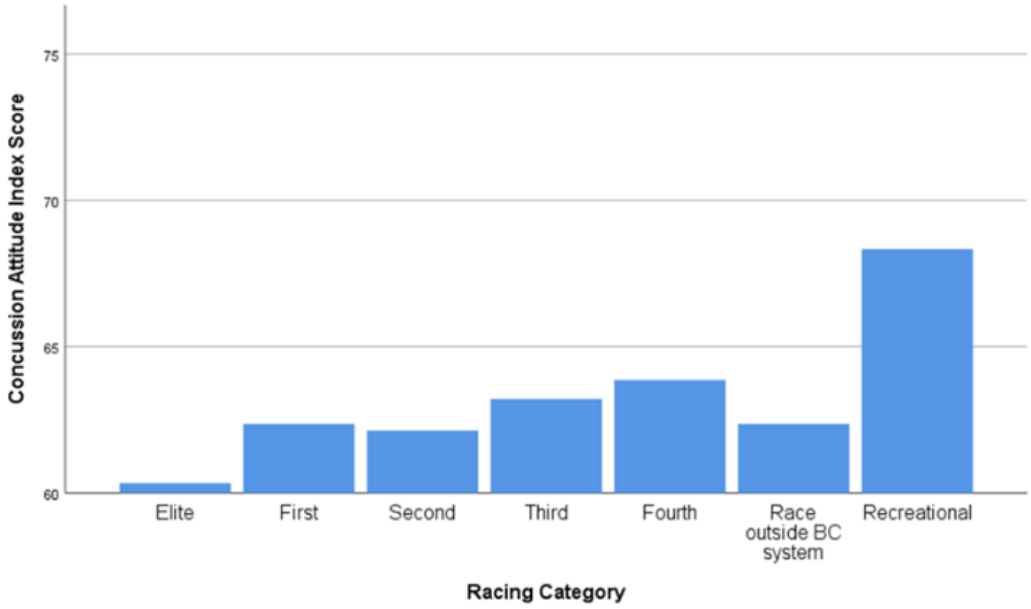



**Figure 14**: Mean concussion attitude index (CAI) scores by racing category

| **Concussion item (Total number of respondents)** | ***n*=Frequency (%)** |
|---|---|
| ***Have you ever had a concussion or suspected that you had a concussion as a result of a crash? (n= 118)*** | |
| Yes | 64 (54.2) |
| No | 54 (45.8) |
| | |
| ***Have you ever undertaken any training on concussion? (n= 118)*** | |
| Yes | 28 (23.7) |
| No | 84 (71.9) |
| Not sure | 6 (5.1) |

**Table 4**: Incidence and training of cycling related concussions

| **Please read the following statements and tick TRUE or FALSE for each question.** | **n=Frequency (%)** |
|---|---|
| There is a possible risk of death if a second concussion occurs before the first one has healed. [True] (n=118) | 101 (85.6%) |
| People who have had one concussion are more likely to have another concussion. [True] (n=118) | 48 (40.7 %) |
| In order to be diagnosed with a concussion, you must be knocked out. [False] (n=118) | 110 (93.2%) |
| A concussion can only occur if there is a direct hit to the head. [False] (n=118) | 89 (75.4%) |
| Being knocked unconscious always causes permanent damage to the brain. [False] (n=118) | 102 (86.4%) |
| Symptoms of a concussion can last for several weeks. [True] (n=118) | 116 (98.3%) |
| Sometimes a second concussion can help a person remember things that were forgotten after the first concussion. [False] (n=118) | 94 (79.7%) |
| After a concussion occurs, brain imaging (e.g., CAT Scan, MRI, X-Ray, etc.) typically shows visible physical damage (e.g., bruise, blood clot) to the brain. [False] (n=118) | 38 (32.2%) |
| If you receive one concussion and you have never had a concussion before, you will become less intelligent. [False] (n=118) | 117 (99.1%) |
| After 10 days, symptoms of a concussion are usually completely gone. [True] (n=118) | 64 (54.2%) |
| After a concussion, people can forget who they are and not recognise others but be perfect in every other way. [False] (n=118) | 31 (26.3%) |
| Concussions can sometimes lead to emotional disruptions. [True] (n=118) | 115 (97.5%) |
| An athlete who gets knocked out after getting a concussion is experiencing a coma. [True] (n=118) | 16 (13.6%) |
| There is rarely a risk to long-term health and well-being from multiple concussions. [False] (n=118) | 98 (83.1%) |

**Table 5**: Frequency of correct responses to knowledge items

## Discussion

This study aimed to assess the extent of concussion knowledge and attitudes held by competitive cyclists in the UK along with any cohort differences in attitudes towards concussion. Over half of the respondents (54.2%) had experienced a concussion, or a suspected concussion, because of a crash; and much of the cohort had not received any training on concussion (71.9%). Using inferential statistical analysis, statistically significant differences were found in attitudes between age and ability groups.

The concussion knowledge index data suggests this cohort of UK competitive cyclists had moderate levels of knowledge compared to those seen in other sports, and the general population (Weber & Edwards 2012; Register-Mihalik et al. 2013; Krohus et al. 2013). Indeed, the current study presents some higher scores than seen in other studies, with a mean CKI of 78.8%. The study by Hurst and colleagues (2018) found an almost identical score in an international sample of cyclists and cycling personnel (78.5%). Compared to other sports, the current study's score was higher than those reported in English professional football players (65.6%) (Williams et al. 2016), Irish amateur and semi-professional football players (74.8%) (Gallagher & Falvey 2017), amateur South African rugby players (65.9%) (Viljoen et al. 2017) and amateur American motocross riders (63.8%) (Miller et al. 2016)

When comparing to other sports, the modifications to the RoCKAS to make it cycling-specific should be considered. However, UK competitive cyclists appear to demonstrate sound concussion knowledge. In terms of correct symptom recognition, this study suggests UK competitive cyclists have a good grasp of concussion signs and symptoms, with a mean reporting of 7.2/8 of the correct symptoms, these present higher scores than previous studies in other sports (Valovich et al. 2007; Fraas et al. 2014).

A notable misperception in concussion general knowledge included 59.3% not believing that a person is more likely to suffer another concussion following a first incidence, despite research demonstrating this (Zemper 2003; Guskiewicz et al. 2003). This is significant as it could have implications on athletes deciding to continue riding following a crash and suspected concussion, both in training and in competition.

The cohort analysis sought to greater understand any demographic variables in concussion attitudes within the sample. Significant differences were found in responses according to age groups, with safer attitudes being associated with older age groups.

These results fit with research seen in the literature that risky behaviours are more associated with younger age groups (Turner & McClure 2003). Rhodes and Pivik (2010) conducted a phone survey of 504 teen (age 16–20) and 409 adult (age 25–45) drivers in the USA. They found riskier behaviours were more frequently expressed within the teen cohort. Much of the literature is situated in research of risky behaviours in age groups motor-vehicle use, with little specific work on age differences in sports-related concussion. One study by Mrazik and colleagues (2015) found in a sample of Hockey players that younger athletes were more likely to ignore best practice and hold fewer desirable attitudes towards concussion.

An alternative interpretation is that those in the older cohort may have experienced more crashes and concussions, resulting in a more cautious approach. Further, this cautious approach may be compounded by more responsibilities associated with the older cohort, such as jobs and family commitments. Regardless of the reasons, further research is required into sports-related concussion to greater understand the processes behind these age differences, and if it is universal across sport. In competitive road cycling, it seems greater emphasis must also be placed on the education of younger riders to address this apparent gap in attitudes.

The ability of the participants was also analysed for any attitudinal differences. This was obtained through participants indicating their level of ability based on the British Cycling race categorisation system, which provides an insight to the experience and ability of the athletes. The option of racing outside of this system or being a recreational cyclist was also provided. Recreational cyclists here represent those that are engaged with the competitive cycling community, but do not race.

There is limited literature on the impact of ability level on concussion attitudes held by athletes. Hurst and colleagues (2018) found participants involved in competitive cycling favoured performance over health in attitudes towards concussion, whilst Wijlhuizen and colleagues (2016) found competitive attitudes typically held by cyclists had an influence on the frequency of crashes. In a study of university students on a sports course, in Australia, students believed that elite athletes that continued to play following a concussion were to be admired and viewed as living up to the expectations of elite-level sport (Pearce et al. 2016). They also indicated they would also adopt these behaviours. Thompson and Carlson (2014) found self-perceived proficiency was associated with increased patterns of risky behaviours in skiers and snowboarders.

This study shows that those involved in competitive cycling were associated with less desirable and unsafe attitudes towards concussion compared to cyclists that did not race. This finding concurs with the literature on competitive sport propagating performance over bodily health, and normalising pain and injury (Curry 1993; Loland et al. 2012; Sabo 2009).

Additionally, within competitive cycling, this study found that the higher abilities in the sport were more associated with the dangerous attitudes towards concussion. The reasons for this may be multifaceted and require further research. One possible explanation is the increased self-perceived proficiency of higher-level athletes, which has been shown to be associated with high propensity to engage in risky behaviours (Thomson & Carlson 2014).

## Chapter conclusion

This chapter has presented the second stage of my mixed-methods approach to understanding concussion in competitive cycling. The study provides insight to the state of concussion knowledge and attitudes, specifically amongst UK competitive road cyclists. Knowledge was moderate in the cohort, but dangerous attitudes were present regarding continuing in competition following a concussion. Youth participants displayed less concern for concussion than older participants. Further, being involved in racing was associated with more dangerous attitudes towards concussion, which increased with the higher ability participants.

The findings align with wider research that knowledge of concussion symptoms in sport may not be of major concern (Chrisman et al. 2013; Register-Mihalik et al. 2013; Frass et al. 2014). Rather, the translation of knowledge and safe attitudes into action may be of greater concern. This study therefore supports the need for interventions to target behavioural outcomes of competitive cyclists, with more emphasis on attitudinal changes than solely knowledge-based resources. I discuss this further in Chapter 12, alongside the results from study 3, and use the Theory of Planned Behaviour to address this issue.

The need for a greater understanding of the attitudes, and driving factors of these attitudes, in competitive cycling has been reinforced through this study. Over the next two chapters I seek to explore these attitudes in greater detail to greater understand the reasons behind certain concussion management behaviours amongst competitive cyclists.

# Chapter 11 (Study 3): An investigation of masculinity amongst road cyclists

**Introduction**

Understanding the intersection of gender and sport is important as it influences many cultural processes that occur within sport, as detailed in chapter five and seven. Particularly germane to this thesis are the gendered influences on injury management. As such, this study examines masculinity within competitive road cycling through a further quantitative analysis of data gained from Study 2 to understand the culture of the sport and test against prima facia evidence that road cycling is a sport in which orthodox masculinity flourishes.

*Sport, masculinities and injury*

Organised and competitive team sport has long been framed as a domain in which male boys and adults affirm and exalt their masculinity (Adams, Anderson and McCormack 2010), with a function to meet the demands of the culture and economy of the Industrial Era (Anderson & White, 2018). This was achieved through socializing boys into physical violence, aggression, competitiveness, sexism, obedience to authority, willingness to sacrifice bodily health, default heterosexuality and opposition to homosexuality (Kimmel, 1994). Competitive sport was a social institution that offered a vehicle to instil these cultural desires for boys and men, producing what Anderson (2005) describes as an orthodox archetype of masculinity (See chapter five for greater detail).

Central components of this orthodox masculinity in sport are predicated on accepting pain, engaging in high-risk movements in a sport, and continuing in participation through injury (Dunning, 1999). The notion of risk-taking and bodily sacrifice for sport are conceptualised as key features to an athlete's masculine identity (Messner, 1990). Men and boys are positively reinforced in the sporting environment to engage in dangerous behaviours in pursuit of athletic glory (Adams et al., 2010).

An extension of this is the encouragement of continuing to compete through injury, with masculinising and demasculising discourses being utilised to achieve this (Pascoe 2005; Roderick et al. 2000; Adams, 2010). As such, masculinities, and interactions with masculinity, can be predictors of dangerous and high-risk behaviours in sport, outlining the research interest of this study.

*Road cycling and masculinity*

Men's response to adopt more risky cycling practices in response to the rising feminised coding of the bicycle in the industrial era was presented in chapter five (Mackintosh, 2005). Indeed, it was in this cultural environment that the modern competitive sport was born (Mackintosh & Norcliffe, 2007), which was predicated on hyper-competitive attitudes and high risk-taking (Mackintosh & Norcliffe, 2007). As such, competitive cycling shares the industrial footprint sports such as rugby have, where the culture was formed in an epoch vastly different from contemporary western society.

The only identifiable study in the literature on road cycling and masculinity comes from Powell and colleagues (2005) based on US males. Results found the sample more strongly identified as masculine than the general population (See chapter five for greater detail). Since the Powell et al. (2005) study, mainstream youth culture has shifted in response to declining homophobia (McCormack, 2012). For example, researchers find that behaviours once coded as feminine or gay, such as young heterosexual men kissing in the UK, are now widely accepted or increasingly accepted social behaviours amongst heterosexual males in the UK (Anderson et al., 2012; Anderson, McCormack and Ripley 2018; Wignall et al 2019).

These changes are apparent in the athletic domain, as well. Empirical research from across western sporting contexts has shown athletes to be increasingly emotionally open (Anderson and McCormack 2015; Robinson et al., 2017), physically tactile (White and Hobson, 2017) and, importantly, gay men are not stigmatised or excluded in sport as previously seen (Anderson, Magrath & Bullingham, 2016).

However, much of the literature is predicated on organised team sports, such as rugby and football. Anderson (2009) has described these sports as primary domains for studying shifts in masculinity because they have been theorized to be social locations of men steeped in orthodox understandings of gender. To date, only two studies have examined inclusive masculinity among individual sport athletes in modern times, one on American high school runners (Morales and Caffyn-Parson, 2017) and one on high school wrestlers (Michael, 2013); both report findings consistent with inclusive masculinity.

As suggested throughout this thesis: the structure of road cycling has not changed. It remains highly dangerous, with frequent crashes and high injury rates (See; Silberman, 2013; De Bernardo et al., 2012; Barrios et al., 2015; Decock et al., 2016). Research shows that bodily health is often sacrificed in favour of sporting performance (Hurst et al., 2019; Hardwicke & Hurst, 2020; O'Reilly, 2020).

Dahliquist and colleagues (2015) recently found a high acceptance rate of injury and willingness to compete when injured amongst amateur road cyclists.

More so, there are no openly gay athletes in the professional cycling ranks, and professional road cycling is notably absent from diversity and inclusion discourses, particularly pertaining to racial issues (Hylton, 2017). Other evidence of a hyper-masculinization of road cyclists comes from Barrie, Waitt and Brennan-Horley (2019), who comment on the exclusive nature of over-competitive cycling and Prati and colleagues (2019) found involvement in cycling incidents were higher amongst males due to riskier attitudes held. Further, Balkmar (2018) comments on the increasing 'pro-cycling' discourses and competitive cyclists occupying road space resulting in greater conflicts and tensions between various road users.

*The Current Study*

The multiple avenues of enquiry noted, and under-researched area of masculinity in road cycling, outlines the rationale for this preliminary study on UK athletes. This study is situated within the conceptual framework of Inclusive Masculinity theory, recognising the wider changes in masculinity towards a more inclusive form which results in behavioural and cultural changes within sport. Prima facia evidence suggests that competitive road cycling appears to be an environment in which orthodox masculinity remains esteemed, even though sports thought to be more squarely masculine, like rugby and football, have shown shifts in masculine idolization away from the extreme forms of masculine identification. As such, the purpose of this study was to examine competitive road cyclist's notion of their gender and discuss the implications this may have on athletes' general attitudes, and concussion behaviours, contributing to an extremely limited field.

## Method

*Participants and Procedure*

The study consisted of a cross-sectional study of 105 male-identifying athletes from the UK involved in competitive road cycling. This sample was drawn from the original sample of 118 athletes from Study 2, with females excluded for this study. The youngest participant was 15 and oldest 77, allowing a cross-generational analysis to be possible. Procedures and ethics from Study 2 apply here and thus will not be repeated (see Chapter 9, Study 2).

*Measures*

**Self-reported identity with masculinity**. Participants self-reported identity with masculinity and femininity was the measure for this study. An 8-point Likert scale was administered which ranged from 'Exclusively masculine' to 'Exclusively feminine', with an eighth option of 'Prefer not to say' provided. This measure was included in the demographic section of the RoCKAS used in Study 2. See Table 6 for the full scale of options. This instrument was modelled on that used by YouGov (2016) in a survey on the UK general population, allowing a direct comparison to be inferred.

**Concussion Attitude Index (CAI) score.** Participants CAI scores from the instrument used in Study 2 were taken as a dependent variable to test against the independent variable of self-reported identity with masculinity to ascertain if this influenced participant attitudes.

*Analysis*

All data were exported from JISC's online surveys (Jisc, 2020) to Microsoft Excel 2016 (Microsoft Crop., Redmond, WA, USA). Data were then analysed using IBM SPSS Statistics 26 (IBM SPSS Statistics Arnmonk, NY, version 26.0). The sample data ($n$=105) was deemed not normally distributed, calculated using a Kolmogrorov-Smirnov test ($p$=0.04). As such, nonparametric tests were used. Kruskal-Wallis H tests were run to establish any statistically significant differences in associations to masculinity between age and ability groups. Mann-Whitney U tests were run to establish any statistically significant differences in concussion attitudes between the different self-reported gendered groups. The Alpha level was set at $p \leq 0.05$. Descriptive and cohort percentage statistics were generated to present results and provide insight to the data.

## Results

The sample was most weighted towards younger athletes, with the with the highest concentration of responses being in the 19-28 age group (39%). The mean age of the sample was 33 (SD=14). All respondents were UK based, and had been involved in competitive road cycling. It should be noted that the sample was not evenly distributed. Nonetheless, consideration for the trends that emerged from this data present a range of interesting findings, despite the preservation of generalising results and strength of assertions to be drawn out to wider populations in competitive cycling.

Figure 14 presents the total responses ($n$=105) to the self-disclosed gender identification scale grouped by age. The data shows the most selected response from the sample was 'Exclusively masculine' ($n$=64), with this being the mode choice across age groups (see Table 6). Within those

that responded, 'Exclusively masculine', percentages per age groups were <18 (35.7%, *n*=5), 19-28 (55.6%, *n*=25), 29-38 (42.1%, *n*=8), 39-48 (61.9%, *n*=13), 49-58 (72.7%, *n*=8) and 59+ (62.5%, *n*=5).

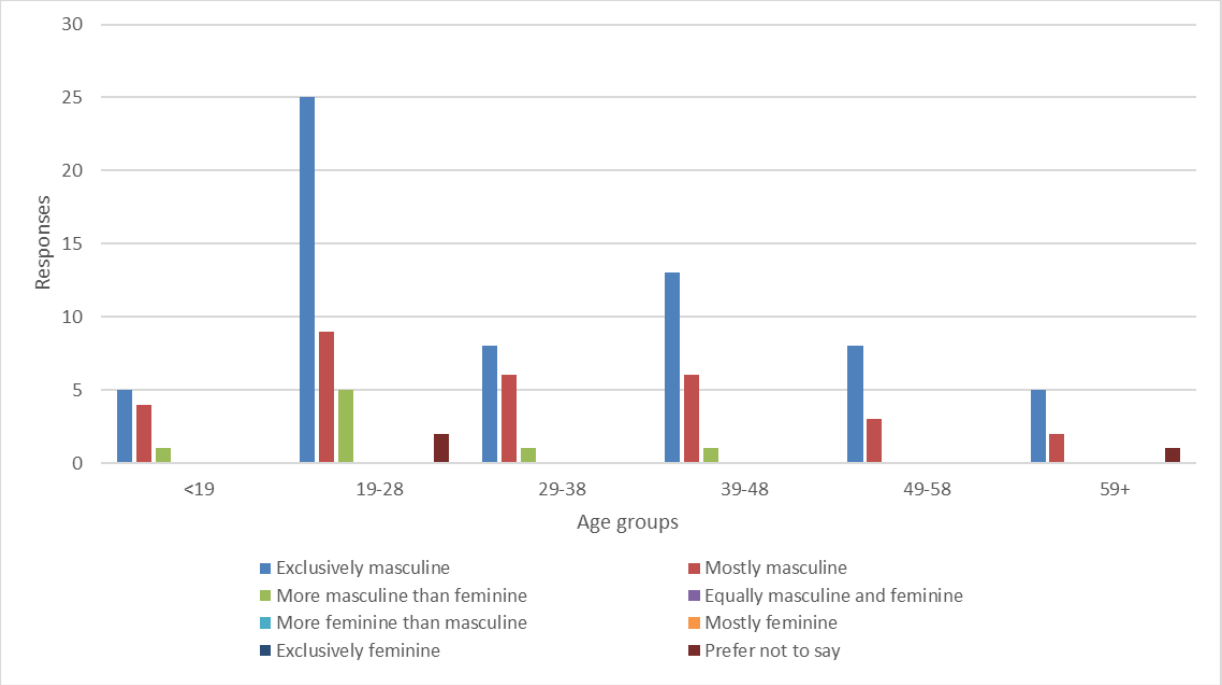



**Figure 14:** Total responses (*n*=105) to self-disclosed gender identification scale group by age.

| **Age groups** | **<18** | **19-28** | **29-38** | **39-48** | **49-58** | **59+** |
|---|---|---|---|---|---|---|
| Exclusively masculine | 5 | 25 | 8 | 13 | 8 | 5 |
| Mostly masculine | 4 | 9 | 6 | 6 | 3 | 2 |
| More masculine than feminine | 1 | 5 | 1 | 1 | 0 | 0 |
| Equally masculine and feminine | 0 | 0 | 0 | 0 | 0 | 0 |
| More feminine than masculine | 0 | 0 | 0 | 0 | 0 | 0 |
| Mostly feminine | 0 | 0 | 0 | 0 | 0 | 0 |
| Exclusively feminine | 0 | 0 | 0 | 0 | 0 | 0 |
| Prefer not to say | 0 | 2 | 0 | 0 | 0 | 1 |
| **Total** | **10** | **41** | **15** | **20** | **11** | **8** |

**Table 6:** Total responses (*n*=105) grouped by age

The second most selected option was 'Mostly masculine' (*n*=30). Again, this was across age groups (Table 6). Within those that responded 'Mostly masculine', percentages per age groups were <18, (28.6%, *n*=4), 19-28 (20%, *n*=9), 29-38 (31.6%, *n*=6), 39-48 (28.6%, *n*=6), 49-58 (27.3%, *n*=3) and 59+ (25%, *n*=2).

With regards to those that identified as 'More masculine than feminine' (*n*=8), there was limited selection of this option and the distribution across age groups was <18 (7.1%, *n*=1), 19-28 (11.1%, *n*= 5), 29-38 (5.3%, *n*=1) and 39-48 (4.8%, *n*=1).

A Kruskal-Wallis H Test was conducted to examine the differences in age groups on the identity with masculinity. No significant differences (p = .539) were found among the six age groups categories of participants (<18, 19-28, 29-38, 39-48, 49-58 and 59+). In this sample, age was not found to be a factor influencing closer identity with exclusive masculinity.

A Kruskal-Wallis H Test was also conducted to examine the differences in ability groups on identity with masculinity. No significant differences (p = .629) were found among the seven ability groups categories of participants (Elite, First Category, Second Category, Third Category, Fourth Category, Recreational Cyclist and Those that race outside of the British Cycling System). In this sample, ability was not found to be a factor influencing closer identity with exclusive masculinity.

*Masculinity and CAI score*

Mann-Whitney U tests showed no statistically significant differences between gendered groups on CAI scores (*n*=105). There was a close to significant difference (U=728, p=0.059) between those that identified as exclusively masculine (*n*=64) and those that identified as mostly masculine (*n*=30) in CAI scores. The mean CAI score for exclusively masculine identifiers was 64.1 ± 6.4, compared to 61.1 ± 7.1 for those that identified as mostly masculine. There was no significant difference in concussion attitudes in those that identify more closely with masculinity. As such, in this study, self-reported masculinity on the research instrument was not a predictor of lower CAI scores (more harmful attitudes towards concussion).

## Discussion

Competitive cycling emerged from the Industrial Era, where a strict archetype of orthodox masculinity maintained social utility as a response to the perceived increased urban effeminacy (Chauncey, 1994; Kimmel, 1996) and increasing feminised coding of bicycle use (Mackintosh &

Norcliffe, 2007). Since the inception of mass sport in the UK, however, other highly masculinized sports have undergone a fundamental shift in relation to self-identification of masculinity, and a revaluing of inclusive forms of masculinity (Anderson 2009). This study examined this cultural nexus among road cyclists.

The sample of competitive cyclists (*n*=105) demonstrate an explicit notion of masculinity in elevated levels compared to the general population. The comparative is made with YouGov (2016) data, from a survey using the same instrument which found males identifying as 'Completely masculine' were at lower rates than found in the current study, across all age groups. Rates from that data were: 18-24 (2%), 25-49 (21%), 50-64 (32%) and 65+ (56%). A similar trend is seen in both data sets of increased explicit identity with masculinity as groups increase with age, but the current study found far higher rates within the sample.

Further, in the younger cohorts of the national data, the mode option across the 18-24 (47%) and 25-49 (28%) age groups was 'More masculine than feminine' (YouGov, 2016). Although the same trend was seen with younger groups selecting this option in higher rates than older group, the net responses here were far lower in the current study. This highlights the large cohort differences of these competitive cycling males and the general population, reinforcing previous findings (Powell et al. 2005).

The statistical analysis found that neither age nor ability were predictors of holding the explicit notion of masculinity, but the overall sample trend was towards this explicit notion, regardless of these factors. Further, self-reported masculinity on the research instrument was not a predictor of lower CAI scores. However, findings from Study 2 found the sample overall had low CAI scores and held dangerous attitudes toward concussion, regardless of identity with masculinity within the sample.

These findings contradict what previous research would predict. For example, the older age cohorts would be expected to exhibit closer identity to masculinity than the younger, being reflective of generational cultural changes. Exemplifying this in the general population, Anderson and Fidler (2018) conducted in-depth interviews with twenty-seven heterosexual British men aged between 65 and 91. Findings demonstrated a generational gap in attitudes, with participants expressing negative views towards the softer masculinities that are increasingly visible today. Here, Anderson and Fidler (2018) conclude that these attitudes reflect the cultural homophobia and homohysteria the participants experienced growing up in the early decades of the twentieth century. The data in this study contrarily indicates age was not a factor on notions of masculinity held by participants.

Similarly, holding higher athletic capital and winning in sport has been cited as characteristics of orthodox masculinities (Wellard, 2010). In this sample, however, this higher ability of the participant (the more they have achieved in the sport) was not a predictor of holding the explicit notion of masculinity. Of course, all participants were involved in competitive road cycling, in some capacity, so may exhibit this close identity to masculinity because of the competitive environment, explaining the elevated rates against the general population.

The structures of competitive sport have been noted as a vehicle to encourage excessive competitiveness and establish masculinity amongst males (Adams, Anderson & McCormack, 2010). This structure can influence individual behaviours and beliefs towards gender. For example, Ogilvie and McCormack (2020) found the structure of sport leads elite male and female athletes to focus on gender differences which they attributed to biology, but when mixed-gender training was introduced this belief was dissipated. Further, Magrath's (2017) research on homosexually themed chanting amongst football fans found that men use language in sport they would not in other contexts, and that may diverge form their own personal beliefs.

This research supports the notion that the structures of competitive sport are still reproducing and/or producing orthodox notions of gender, and this may explain the results of the current study, where cycling exists as a sport that still perpetuates many aspects of orthodox masculinity within its culture.

Ogburn's (1957) concept of Cultural Lag offers a framework to theorise these findings, with the understanding that competitive cycling may hold a strong subculture that influences individual behaviours and beliefs. The concept refers to the differing rates that segments of culture adapt to social change. Inclusive Masculinity Theory recognises the changing nature of masculinities towards a softer archetype as a product of social changes (See; Anderson, 2009 McCormack, 2012; Anderson & McCormack, 2015). This is particularly salient with the sample from the current study being more heavily weighted towards younger age groups, which the literature would suggest are less restrictive in their gender performances (See; Carrillo & Hoffman, 2017; McCormack, 2011; McCormack & Anderson, 2014).

These changes have been observed in other sports, perhaps most notably in football (See; Adams, 2011; Adams & Kavanagh, 2018; Adams & Anderson, 2012; Magrath,2019) but comparable findings have been shown in other sports, such as rugby (Anderson & McGuire, 2010), collegiate team sports (Anderson, 2009) and even in less culturally dominant sports, like equestrianism (Dashper, 2012).

This research has several implications for men in the sport. First, a body of literature examines the role of strong identification with orthodox masculinity in predicting risky or health-avoidant behaviours. Orthodox masculinity has been shown to be a predicter for risky behaviours and higher propensity for injury (See; Adams et al., 2010). Orthodox masculinity is also associated with men refraining from seeking medical help for fear of this detracting from masculine status, or from seeking help for mental health issues (See; Fleming et al., 2014; Levant and Wimer 2014; Morioka 2014; Reed, 2013).

Increased willingness to risk and under-reporting of medical issues is particularly relevant to sports-related concussion (Harmon et al., 2013; Baron et al., 2013). For example, in a study of male college athletes, Schlosser (2016) found that those that identified closer with orthodox scriptures of masculinity were associated with less desirable attitudes towards concussion, and the view they did not present a serious issue.

This was also supported by Baron and colleagues (2013) who note the role of orthodox masculinity and the reporting of injury being coded as a sign of weakness (Baron et al., 2013). This influence of masculinity has been researched in American football players (Anderson et al., 2012) and seen to impact both male and female athletes (Sanderson et al., 2016). It is, therefore, of contemporary interest and concern for safer cycling as survey studies on competitive cyclists and concussion reporting reveal that cyclists were willing, in significant numbers, to mask injuries to continue in competition (Hurst et al., 2019; O'Reilly et al., 2020), as well as the findings from Study 2.

The next area of concern is that orthodox masculinities can negatively impact attitudes towards diversity and inclusion, particularly sexual minorities. There is a large body of academic work in sporting domains that demonstrate straight athletes accept and support openly gay teammates, particularly amongst youth athletes (See; Magrath 2017, 2018; Roberts et al. 2017, White et al., 2020); however there lacks academic attention to this cultural aspect of cycling. Prima facia evidence suggests that homophobia might still be a salient issue: competitive road cycling is regularly described as having a conservative culture (Cycling News, 2017) and insights from professional riders have noted that being gay is coded as a weakness in competitive cycling (Guardian, 2018).

Competitive road cycling, particularly the professional level, is also noticeably absent from positive gay institutional discourses, as well as there being no openly gay athletes at the time of writing. Findings from the current study, and understanding the context of the sport, therefore highlight the need for academic investigation into this question.

A final problematic area is how this orthodox masculine and competitive culture manifests in public spaces. Competitive cycling is unique in that its participants spend large amounts of time training on public roads, and there exists a body of literature on masculinities in cycling within the transport field (see; Zheng et al. 2020; Ravensbergen et al. 2019; Balkmar, 2018). However, there are no studies on cyclists using these public spaces for sporting pursuits. The concern here is that competitiveness, coupled with aggression, have been cited as aspects of orthodox masculinities (Clyde & Franklin, 2012) and that Wiljhuizen and colleagues (2016) noted competitive attitudes amongst cyclists as a variable for increased risk of crashing when on public roads. The results from the current study suggest that this sample of competitive cyclists more closely identify with orthodox scriptures of masculinity and may be more likely to engage with competitive and aggressive behaviours, which can cause accidents with those accessing the roads for transport purposes alone.

## Chapter conclusion

In summary, this study picks up from Powell and colleagues (2005) study, seemingly yielding similar findings over a decade later. This is salient, and highlights the still existent cultural lag (Ogburn, 1957) that exists in competitive cycling. The findings suggest competitive cyclists have an explicit notion of masculinity that was consistent across age groups. Further research is needed to establish how this notion of masculinity is produced and/or reproduced within the culture of the sport. Importantly, further research is needed to understand how this can manifest in problematic behaviours in terms of athlete injury management, inclusion and diversity issues, and public relations when these athletes are in public spaces.

These findings are important for this thesis, offering an insight into a cultural aspect of the sport that may have a significant influence on the way athletes manage concussions as well as reporting behaviours. Although policy and protocols are important, they will always be limited without this appreciation of the cultural level of the sport and why these behaviours exist in the first place.

# Chapter 12 (Study 4): An investigation into perceptions of risk and concussion amongst competitive cyclists

**Introduction**

The final stage of the research process for this thesis involved adopting a qualitative approach to address some of the limitations of the previous methodology and gain a greater understanding of the context to the research area. Using qualitative methods of inquiry, this chapter explores the perceptions of risk and concussion amongst competitive cyclists.

*Individual Risk Perception and Risk-taking*

Risk perception refers to 'people's beliefs, attitudes, judgements and feelings, as well as the wider social or cultural values and dispositions that people adopt, towards hazards and their benefits' (Pidgeon et al. 1992:89). Importantly, it concerns the *subjective* assessment of risk and the potential outcomes, positive and negative, of engaging in a given activity (Sjoberg et al. 2004:8).

Much of the literature examining risk perception is housed in occupational hazard and health and safety domains. The literature on individual risk perception, and risk-taking, that does exist in sports is largely dominated by extreme sports. Here, research is often restricted to theoretical models of risk perception grounded in *personality theory* that assumes participation in such sports are motivated by risk-taking and adrenaline seeking behaviours of individuals (Baker & Simon, 2002; Brymer, 2010; Olivier, 2006; Self et al. 2007).

However, there has been increasing commentary that these theoretical models of risk are reductionist, and not a true representation of motivations for participation in extreme sports (Jones et al., 2015; Clough et al., 2016; Zajc and Berzelak, 2016). With these sports occupying much of researcher's interest, determining risk perception and interactions in other sports, such as road cycling, is difficult. Road cycling is not, by definition, an extreme sport, however it does carry a high risk of injury (See; Barrios et al., 2015; De Bernardo et al., 2012; Decock et al., 2016; Rooney et al., 2020).

Looking at the literature that is available, an understanding of athlete risk taking, and perceptions can be gained. Fuller (2007), for example, found team sport athletes to be willing to accept a far higher level of risk than those in non-voluntary domains, such as the workplace, suggesting that the act of risk taking was a draw for many towards sporting participation.

I draw on *knowledge theory* and *economic theory* of risk perception to apply specifically to sporting domains. Knowledge theory posits that individuals construct their perceptions of risk based on their knowledge and previous experience of an activity to gauge whether it is dangerous or not (Fuller & Vassie, 2004). For example, research has suggested that past successful experiences of engaging in risky behaviours in a sport leads to a reduction in the perceived risk, thus having the potential to increase the likelihood of an athlete taking similar risks in the future (Horvath & Zuckerman, 1993).

Whereas *economic theory* focuses on the transactional process of risk taking, being grounded on the premise of greater risks producing greater rewards (Fuller & Vassie, 2004). This forms the theoretical grounding of the cost-to-benefit analysis model of risk which is salient in discussions on sport participation (Adams 1995). This can work on the micro level of risk-taking within a sport to gain advantages, such as an athlete performing a particularly risky manoeuvre in a mountain bike race to gain an advantage over opponents.

The focus here, however, is the more macro consideration of risk analysis for participation in the sport in general. This process of cost-to-benefit analysis can be observed in sporting participation where the associated health and social benefits are seen to outweigh the risk of injury (Larkin & Griffiths, 2004). Research from Roberts and colleagues (2018) demonstrate this is in practice within mountain biking, where the benefits of improved mental health outweighed risks of injury and thus encouraged continued participation.

*Pain, Injury and Cultures of Risk in sport*

There is a large body of sociological literature that examines the intersects of pain, injury, and risk in sport that is useful when examining socio-cultural factors and concussion. Indeed, this has been of interest to sociologists for over 30 years (Young, 2019). Nixon's (1992) seminal work is germane here, where the argument is made that sporting contexts operate within 'cultures of risk' which encourage athletes to accept risk, and risk-taking, in sport as the norm. Further, pain and injury are to be brushed off and an athlete's ability to tolerate both is valorised. Nixon (1992) theorised that that these attitudes toward injury, pain and risk flourish in sporting cultures because of 'sports nets' which are the influential social networks around athletes such as teammates, coaches, fans and the media.

Through this interaction with sporting culture, athletes learn what Hughes and Coakley (1991) term 'the sports ethic'. This leads to athletes being culturally expected to sacrifice their bodies and health for sporting success, something that would be deviant in broader society but is normative in sport (Hughes & Coakley, 1991; Anderson & White, 2018). This ethic also normalises the presence of risk and encourages risky behaviours in sporting contexts. As such, many athletes will continue to compete despite pain and/or injury (Nixon, 1992). This is true of SRC, also. For example, Liston et al. (2018) suggest amateur rugby players would downplay concussive injuries to present being 'head strong' and to align with the sporting culture.

Much previous sociological studies on injury and risk have focused on elite athletes and those in highly organised settings where an athletic identity is the individual's primary identity. Early sociological work was also largely focused on hierarchal environments like high-school and college-level athletes (Curry and Strauss, 1994; Messner, 1992; Nixon, 1994, 1996) and within a professional context (Messner, 1990; Messner and Sabo, 1994; Young & White 1995). But how relevant is this theorising in more individualised sports and amongst amateur athletes? There have been studies into risk within specific sporting subcultures that are more focused on sport-as-leisure and athletes that have less extrinsic rewards and pressures of the professional athlete or institutionalised college athlete.

Lyng's (1990, 2005) research is important here. Focusing on voluntary risk taking, Lyng argues that individuals engage in high-risk environments, such as skydiving, to temporarily escape from social boundaries and constraints of everyday life. This is known as the notion of 'edgework', where individuals flirt with the edge of mental and physical boundaries resulting in a feeling of control over their lives, whilst pushing limits. Research has also been done looking into experiences of risk in skateboarding cultures (see Atencio et al. 2009; Haines et al. 2010; Kern et al. 2014) finding risk to form a central feature to the subculture. Matthews (2020) research into boxing suggests risky body cultures are engrained into boxing subcultures resulting in physical risks to the body being a normal, and expected, phenomenon.

Turning more specifically to the focus of this thesis, competitive road cycling, I can locate just one study that explores the nexus of risk and (sub)culture in the sport. Albert's (1999) study of risk in road cycling culture outlines the first (and only) comprehensive work in this area. Drawing on interview data, participant observation, media analysis and internet blog posts, Albert presents the argument that competitive road cyclists negotiate risk and injury by embodying both as inherent features of the sport. Road cyclists were not seen to '…court risk for it's own sake' (1999: 169), but as risk was deemed so inherent to the sport it is normalised amongst cycling subcultures.

Sociological examinations of pain and injury in sport are numerous. It is argued that the acceptance of pain is widespread in sport (Anderson, 2012). Indeed, Hughes and Coakley comment that 'accepting risks and playing through pain' (1991: 309) forms a central tenant of the sporting ethic. Athletes are required to endure all constructs of pain and compete with significant risks (Curry, 1993; Young et al., 1994). Roderick comments, 'athletes learn to disregard the risk of physical harm to normalize pain and injury as part of their sporting experience' (2006: 18-19). Howe's (2004) ethnographic work highlights how athletes learn to embody exhaustive pain as a positive experience. Whilst limited studies exist exploring experiences of pain and injury in road cycling, Atkinson (2008) ethnographic study of triathlon offers some insight. He examines how triathletes' bond over a 'pain community' where physical and mental suffering is valued and sought after.

*Athlete perceptions of concussion*

An athlete's perceptions of concussion, often measured through knowledge and attitudes, has a significant impact on their concussion management behaviours and reporting intention (Kroshus et al. 2015). Miyashita and colleagues (2014) found, amongst high school athletes, that perceptions of concussion did not align with the severity and seriousness of the injury which impacted their reporting intentions if they suffered a concussion. Further, in chapter two, I outlined the impact that terminology has on the perceptions and behaviours of athletes regarding concussion (See; Weber & Edwards, 2010; Kelly & Erdal, 2016; Sussman et al., 2019). This psychological aspect of sports-related concussion is thus salient when seeking to understand athlete interactions with the injury.

Self-report survey data from competitive cyclists indicates that these athletes hold harmful attitudes towards concussion and concussion reporting behaviours, particularly when in competition (Hurst et al. 2018; O'Reilly et al. 2020). This study sought to provide a more detailed exploration of these perceptions and how they are shaped, and ultimately how they may be changed toward safer attitudes.

*Qualitative research and methodology*

Addressed in the methodology chapter of this thesis is the ontological dualism of my research, seen through the mixed-method and interdisciplinary approach. Study 1 and 2 were designed to remove the researcher from the research process to present 'objective' data with the methodology being drawn from positivist schools of thought.

This study adopts a purely qualitative approach, utilising researcher subjectivity and reflexivity to undertake an exploratory design and analytic process (Finlay and Gough 2003; Gough and Madill

2012). Here, the researcher is positioned within the context to create greater understanding of the research, working in line with interpretivist research philosophy.

The chosen methodology for this was semi-structured interviews, with the exact rationale for this selection outlined in the methods section of this chapter. In a broad sense, qualitative interviews allow researchers to explore participants perspectives, stories and experiences with a given research topic (Arksey & Knight, 1999). The method is one of the most powerful and commonly used to understand the underlying motivations for human behaviours and attitudes (Fontana & Frey, 2000). Therefore, the purpose of this study was to utilise qualitative interviews to gain a better understanding of the aforementioned areas within competitive road cycling.

## Methodology

Much research to date on sports-related concussion has been quantitative, and there is limited research using qualitative methods to explore the intersection of SRC, risk and sporting subcultures (Dean and Bundon, 2020). Specifically, in the cycling literature, there are not any previous studies using qualitative inquiry to examine SRC, risk and injury. This is important as without such qualitative inquiry, an understanding of how SRC, injury and risk is experienced, reflected upon and constructed in different sporting contexts cannot be gained (Young 2012). Further, when designing the study, and drawing on previous literature in the area (Liston et al. 2018; Engström et al. 2020) I expected cyclists lived experiences of SRC, injury and risk would hold many emotions, meanings, and values. Consequently, an interpretive approach was valued to gain an understanding of how cyclists define, experience, and respond to the areas of interest.

*Participants and Procedure*

Participants for this study were recruited from the original sample gained from Study 2 of this thesis. Within the survey design of Study 2, an option was added in the demographic section of the survey to provide an email address if the participant was happy to be contacted regarding participation in future research.

Of the 118 participants from Study 2, 64 provided emails. The 64 emails were put into a list and every 4th email was selected. If any of the selected emails did not wish to participate, or the researcher did not receive a reply within 14 working days, the next email down the list would be contacted.

A request for participation and details of the proposed study were emailed to prospective participants obtained from the above strategy. The first phase of participant recruitment emailed 16 potential participants (the desired sample size), with a low uptake of 4. This process was repeated a total of four times to obtain a final sample of 8 participants (see table 7 for details). This was lower than the desired sample size, but low uptake was a barrier for the researcher, something explored elsewhere as a limitation with research of this design (See; Taylor, Bogdan & DeVault, 2015).

Once agreement had been received, participants were provided with an information sheet (See Appendix 1) to read through, sign, and return to confirm consent to be involved in the study. All participants were reminded of their right to withdraw without detriment, and that all data would anonymous. Ethical approval for the study was granted following Faculty level review from the Faculty of Health and Wellbeing at the University of Winchester, UK (reference number: HWB_REC_20_04).

All participants were provided with contact details for the researcher and provided the opportunity to review transcripts prior to analysis. All procedures were conducted in line with the British Sociological Association ethical procedures, as per the faculty level ethics approval from the University of Winchester.

**Table 7**: Participant details

| | **Sex** | **Age** | **Racing category** | **Years competing** | **Had a diagnosed or suspected concussion** |
|---|---|---|---|---|---|
| Participant 1 | Male | 26 | Second Category | 6 | Yes |
| Participant 2 | Male | 27 | First Category | 5 | Yes |
| Participant 3 | Male | 39 | Second Category | 25 | Yes |
| Participant 4 | Male | 50 | Fourth Category | 13 | No |
| Participant 5 | Female | 34 | Second Category | 13 | Yes |
| Participant 6 | Male | 37 | Third Category | 10 | Yes |
| Participant 7 | Male | 45 | Fourth Category | 11 | Yes |
| Participant 8 | Male | 20 | Elite | 8 | No |

*Measures*

The selected method for this study was semi-structured interviews. The rationale for this was due to the capacity to have a guided interview, with the lead researcher having freedom to ask further questions on points that may arise unexpectedly (Seale, 1999). This is a frequently cited advantage of semi-structured interviews over other similar methods (Sarantakos, 2005).

The interviews were conducted online using Microsoft Teams (Microsoft Corp, 2020) video software. Although in-person interviews are often understood as the most effective qualitative interview technique to yield the highest quality and rich data (Deakin and Wakefield, 2014), online interviews were most practical for this study.

Although this may potentially limit some of the rapport building potential with participants, I chose this platform as it still allows for the visual interaction to aid the communication and rapport development (Bauman et al., 2002; Bryman, 2016; Holt, 2010). Further rationale includes time efficiency, geographical location of participants and costs (Hanna, 2012), which all had to be considered in my capacity as a doctoral research student. Much research has utilised Skype for qualitative interviews, and the pros and cons explored (See; Lacono, 2016). I chose to use Microsoft Teams in order to ensure adherence to GDPR regulation, and work within institutional regulations.

Further, the adoption of an online platform for interviewing may afford more people the opportunity to participate in the interview without practical restrictions that come with face-to-face interviews (Deakin & Wakefield, 2014). Reactive to the social climate during the research process, this method also allowed for me to continue my research safely during Covid-19. The online platform also offers ease of interview recording and transcription (Hanna, 2012).

Of course, there are limitations to this method of data collection. Commonly identified weaknesses include call drop-out due to internet connection, background noise and inaudible speech due to internet lag (Seitz, 2015). Also, the reliance on technology can lead to potential issues of representation, effectively excluding those that are not I.T. proficient or without access to the internet (Deakin & Wakefield, 2014). These issues can be negated through ensuring a quality internet connection prior to interview, asking participants to minimise background noise where possible and establish some contact prior to interview to begin the rapport building process. In this case, these issues are void, as the sample was drawn from a separate research study which required participants to access the internet, this follows the assumption that those invited to interview would be able to meet the technological requirements to be involved in the study.

The interviews did not follow a strict script, rather, several topic areas were identified prior to the interviews which I intended to cover. This allowed for greater flexibility to react to any unexpected themes that emerged (Bryman, 2016). Interviews were recorded within the in-house software hosted by Microsoft Teams, allowing for an uninterrupted interview and natural flow of conversation. The interviews focused on attitudes and experiences of injury, risk, competition, and concussion in competitive cycling, with loose themes of:

- Experience with injury
- Perceptions of risk
- View of the sporting culture
- Motivations to compete
- Knowledge of and experience with concussion
- Perception of concussion

The nature of discussions had potential to be personal, and subject to social desirability impacting participants responses (Bryman, 2016). To negate this and ensure ethical consideration for participants involved, a number of measures were put in place. Firstly, following the methodological framework proposed by Hutchinson et al. (2002) all interviews began with an informal and colloquial conversation with the participant before moving onto any more detailed topics. Further, I would disclose my own involvement in the research area, my experiences and perspectives to allow the participants to feel more at ease in knowing I have empathy and experience with the topics being covered (Glesne, 2014).

*Analysis*

The research is situated within a novel and under-researched area. As such, this study was conducted within an inductive framework guided by grounded theory, and the data analysis followed this philosophy. In doing this, conclusions drawn from the interviews can be seen to be rooted within the data, as opposed to a deductive approach testing for hypotheses which, in this area, could lead to potential researcher subjectivity and risk of leading participants in a certain direction to meet the research aims (Braun & Clarke, 2006).

All interviews were transcribed using software and were then analysed working within the thematic analysis framework outlined by Braun and Clarke (2006), and recently updated as *reflexive* thematic analysis (see; Braun, Clarke, Hayfield & Terry, 2018; Braun & Clarke, 2019). This analytic method

approach is a widely used method in qualitative sport and exercise research (Braun & Clarke, 2006; 2012; 2013; 2019). This analytical method is conceptualised as a completely qualitative approach, with all process of data collection and analysis being situated within a qualitative paradigm (Braun et al*.,* 2018).

The architects of the approach have recently updated its position and utility within the scholarly academy, citing its frequent misconception and use without consideration for the analytical philosophy that the approach is grounded in (See; Braun and Clarke, 2019). The approach is predicated on the view of qualitative research being a creative, reflexive, and subjective practice, with the researcher subjectivity being utilised as a resource, rather than a limitation (Gough & Madill, 2012). Braun & Clarke comment:

> Qualitative research is about meaning and meaning-making, and viewing these as always context-bound, positioned and situated, and qualitative data analysis is about telling 'stories', about interpreting, and creating, not discovering and finding the 'truth' that is either 'out there' and findable from, or buried deep within, the data. For us, the final analysis is the product of deep and prolonged data immersion, thoughtfulness and reflection, something that is active and generative. We emphasised that themes do not passively emerge from data to capture this process. (2019:591)

The approach overlaps with many principles of grounded theory, without the explicit association to a given theoretical perspective (Braun & Clarke, 2019). Rather, the approach is open to use for researchers with detachment from rigid theoretical paradigms, with researcher flexibility being encouraged (Braun & Clarke, 2019). This flexibility requires researchers working with the analytical method to exercise reflexivity in the assumptions and theory that informed the chosen approach (Braun & Clarke, 2019).

The approach follows the assertion that findings and, ultimately, theory is generated from working with data as opposed to it being 'discovered' in the data, as if it were pre-existent. This, often post-positivist, approach overlooks the process and influence in producing research findings (Holloway & Todres, 2003; Hallberg, 2006; Braun & Clarke, 2019). This is the framework the current study works within, utilising researcher subjectivity and reflexivity to undertake an open, exploratory design and analytic process (Finlay and Gough 2003; Gough and Madill 2012).

This flexible approach is important in the process of coding and theming the data collected. Braun and colleagues (2018) comment that when working with reflexive thematic analysis, the aim of coding and theme development should not be to provide an accurate summary of the data, removed

from the researcher subjectivity in the process of data analysis. Rather, the focus should be placed on providing a coherent and compelling interpretation of the data, which has been generated from the data itself and not pre-established hypothesis, themes, or assumptions (Braun et al., 2018).

I drew on this philosophy in the analysis of my interview data, adopting an organic and open process of data analysis. As such, my theme production and coding were subject to change throughout the process as I engaged, reflexively, with the data without being shackled to fixed frameworks prior to analysis, such as a coding frame (Braun et al., 2018).

My exact procedure for the data analysis aligned with the "six-phase" approach outlined by Braun and Clarke (2006; 2012; 2013) and further developed by Terry et al. (2017). I worked within this framework to ensure rigour, and the correct application of reflexive thematic analysis.

Firstly, familiarisation. The researcher must diverge from data generation to in-depth analysis, through immersive interactions with the data. As such, the researcher becomes familiar with the data through the engagement and immersion. For the current study, this involved the re-watching of the video interviews, multiple times, picking up all the visual cues present coupled with reading through the written transcripts to search for reoccurring patterns across the data. The second stage involved generating codes and a more detailed and systematic engagement with the data. Here, initial codes were produced to start assigning meaningful themes to sections of the data, accordingly.

The next stage involves constructing themes through gathering similar codes into broad, overarching themes, coupled with smaller, sub-themes. At this stage, I examined the themes in their interactions with each other and the relations between the data. Stage four involves refinement. The themes were refined, some were adapted, dropped, or incorporated into larger themes according to the data present for each. Stage five requires further revision and refinement of themes, ensuring the data accurately relates to the assigned theme, and themes to not attempt to host too much. The final stage is producing the written report. Braun and Clarke (2019) comment here that this is not just a writing-up exercise, but the researcher must reflect and revisit the process to internalise the findings and assertions being made through the data analysis.

## Results

### Risk perception

All participants identified road cycling as a high-risk and dangerous sport. The participants interviewed all described the sport as carrying a high risk, and an elevated physical risk when asked in comparison to other sports. For example, participant 3 comments, 'It's incredibly high risk and I think it's one those rare sports where it's based on athletic ability, but it's also incredibly high risk'. There was one exemption, with one participant describing the risk as relatively low, but more serious when an accident does occur. They comment:

> You can have really bad accidents, and I know people that have had really, really, bad accidents. But there aren't huge volumes of them, of the people I know that cycle and the people that have had injuries ermm like a lot of people have had medium injuries shall we say, broken bones that kind of thing, but the number of people competing and having really serious injuries is actually quite low. And even the number of bad crashes, considering you could have a road race with 80 guys in it doing well over 20mph, the number of crashes is relatively low (Participant 5).

All other participants referenced the injurious nature of the sport, with one participant providing an interesting and meaningful account of viewing professional cycling from a fan perspective:

> You see horrific injuries like every year at the Tour de France, the first week is carnage. There aren't many sports where you'd have a, you know, like the first week of a football world cup people aren't being carted off to hospital with blood pouring out of them like they are in professional cycling (Participant 6).

After referencing the sport as high-risk, participants were asked to quantify this on a scale in comparison to other sports. The mean response from participants was that road cycling is in the top tier when it comes to physical risk across sports. Participant 1 said:

> I think you would have to put combat sports ahead of cycling. Things like combat sports, martial arts, boxing, and that sort of stuff. You would have to put that highest and then cycling to be honest probably does follow pretty closely underneath that. So I would probably say cycling is below martial arts and combat sports, but probably above most other contact sports just due to the inherent nature of riding a bike on an open road with no protective equipment.

Similarly, participant 4's response resonated with the theme:

> Risk of injury in cycling? Yeah it's probably quite high. If you say a scale of 1 to 10, 10, the most-risky, like kind of free climbing. Cycling probably a 7 or 8. There's definitely a risk of at least some injury.

Participant 6 also identified the sport to be high risk:

> Sort of maybe, probably near the top. I would say probably in the top, maybe Rugby's near the top, maybe. Combat fighting is quite high up. I'd say cycling is right near the top actually, I mean, if you hit the deck at 35 miles an hour there's a good chance you'll break something.

Finally, participant 8's story followed the theme suggesting road cycling to hold a greater physical risk than most other sports:

> Yes, I think the seriousness of the risks are higher than most sports. It's got to be up there, like there's obviously other sports that are pretty risky as well, but it's got to be up there and at the top really. I mean you come into a sprint finish with like 200 meters to go in a group of 200 people, there can't be many more things that are riskier than that.

**Perceptions of concussion**

Participant perceptions of concussion varied, but a significant finding was how these perceptions changed with personal experience of the injury. Six out of the eight participants reported experiencing concussion, either diagnosed or suspected, with a range of severities. The levels of knowledge and understanding of the injury were significantly better amongst those that had personal experience with the injury, with this increasing with the severity of the concussion the participant had experienced. For example, participant 3 commented on his perception before suffering with post-concussive syndrome:

> Yeah, I think I had the same view as everyone else the 'just a concussion thing'. Yeah. Just thinking you're a bit fuzzy headed for a few days. I didn't realize how bad it could be. The realization actually concussion is a brain injury.

Participant 7 had the most severe experience with the injury, being involved in an accident resulting in over two years of being symptomatic of post-concussive syndrome. A lot can be learnt from their story and interaction with the injury. Commenting on the experience, they stated:

> I think the biggest thing with this concussion thing is most people don't understand it, most people don't know what it's all about. It's like you've got a strange disease and they've never heard of it and you kind of like have to explain it every time. The way it's portrayed in the media is a problem too, both sports and just in films, because it's not really telling people what it really is and what's like to hit your head. The public perception of concussion is the main problem. And awareness, my bike club only know about it because I've told them. But if I hadn't done that, they wouldn't know (Participant 7).

This theme was consistent across the data. Participants all expressed that knowledge of the injury was primarily gained from personal experience with the injury, and prior to that, they did not know of it or its severity. Related to this was a dissociation of the injury with cycling, with all participants stating they either did not (until personal experience) or currently do not associate concussion as an injury that cyclists are at risk of. Participant 1's reflections on this resonated with the theme:

> I think because it's not something which is visually there to see like an open cut is or a break is which you can see on an x ray, concussion can have, you know, many forms. And some of those forms aren't shown or some of those forms are not easily visual. So it's, yeah, it's something which I probably wasn't aware of seeing in a way of what concussion is. And you've heard of it in many different aspects, but I never related it to cycling, especially because I didn't have too many crashes, especially no head injuries.

Similarly, participant 2 identified that they did not associate concussion with cycling:

> No, no its not. I knew very, very little about it. If someone mentioned concussion sport to me, I'd think of rugby, American football, boxing, hockey.

Participant 8's response also highlighted this belief:

> To be honest, concussion in sport the first I would think of, would be rugby.

This lack of knowledge and awareness regarding concussion was demonstrated through a story from one participant who described to me a crash, and then continued to describe symptoms of a concussion, yet disclosed they have never had a diagnosed or suspected concussion:

> Yeah just one crash that was really serious, I mean I've had others. Like I had one this year that knocked me out of training for maybe 7 or 10 days, which in the racing season was quite problematic. It really knocked me, just the impact, but there wasn't anything majorly serious just road rash really that prevented me from sort of training and pushing hard. In the

> crash I hit my head fairly hard, I did a fair bit of damage to my helmet, but I never had any kind of symptoms or anything (Participant 8).

**Injury management**

The expectation to continue competing following a crash and/or injury in road cycling was a clear theme. For example, participant 1 comments:

> I think you could call it an expectation, if you have a crash, you carry on. There is no real kind of thought process behind it.

When further questioned on this, participants recognised competition and external pressures as influencing this behaviour. For example:

> I think you probably feel a lot of pressure, I feel pressure from my coach because…yeah I'd feel pressure from my coach and probably from my cycling friends to get back and get on with it. Um, it's quite a famous phrase in cycling, you're almost 'soft' if you don't do it. And I guess you wanna live up to that expectation of being macho and getting on with it and being the person that got over the hurdle if you like (Participant 2).

Similarly, participant 8 identified this pressure to perform:

> I think when you go into a race, there's so much pressure to, like, like you crash and you get back up. And your first thought is how to get back into that race.

It was evident that this was an unwritten rule within the sporting culture and all participants acknowledged this attitude toward 'getting back on the bike' as quickly as possible, both within a specific race and regarding returning from longer term injury. This was viewed as part of the sport, with injury being inherent to the nature of the sport. For example, one participant commented *'*Overcoming injury is a big part of it and having the guts and determination just to get over it.' (Participant 3). A number of participants reflected on personal experiences of how they managed crashes they had experienced:

> I've definitely done that myself. I've crashed and been in a rush to get back on the bike. And not just in that race, but if I crashed in one race I'd be in a rush to get back into another race as soon as I could, sometimes probably sooner than I should (Participant 2).

One participant, that was well established within the cycling world, being an athlete and coach, recalled a story from when they assisted a professional team during a multi-day stage race providing a detailed insight to the culture in private domains. Describing an event retrospectively, they commented:

> One of the riders crashed on the day. He was quite young lad. Got back to the hotel in the evening and he had some bandages on and there was an older guy on the team who had been around cycling for a long time; one of the old guard, so to speak. And I just remember him saying to the young lad like, you're not going to quit, are you? You are gunna carry on tomorrow. You look a bit soft. You look a bit downbeat. It's just a few grazes like. Just man up and get on with it (Participant 1).

When exploring this phenomenon further with participants, I inquired where they believed this attitude came from and why it existed. The glorification of such behaviours within the sports culture and perceptions from peers and the media was the theme that emerged. For example:

> Yeah, again, like if you compare that to different sports, it probably is. It is praised. Like you see a rider crashed down in their bib shorts get ripped, jerseys ripped, and they carry on riding like the commentators and everyone's like ahh what a hero (Participant 1).

Following this area, participant 2 also commented on the role of the media:

> I think something for me that's has a massive impact is when cycling is televised, as soon as there is a crash then the cameras are fixated on that crash so the rider in the crash probably feels pressure because the camera is on him, to get back onto the bike. That's the image portrayed across to all the fans watching, its almost the done thing. So um, the commentators will often talk about how heroic they are, it's almost just become the norm in cycling, I guess.

Further exploring this on an individual level, some of the contributing factors to the phenomenon from a practical angle was revealed by one elite athlete with a description of their experience in the sport at the top level. They comment:

> Yeah, I mean, they're quite hard on it all really, it's sort of like er. Especially when you get to a fairly decent level they almost see you as like an object. Like we give you money, we give you this kit and we expect you to be on the start line. The minute you're not they are like well get back there as quick as possible. I've never really seen any kind of support, like getting those people saying how can I help or checking in on you on a daily basis, you're almost just left to your own devices. We don't have a team doctor, there's race doctors, but yeah its up to yourself to decide to race or not (Participant 8).

Consistent with this theme, another participant observed the same phenomenon but from the position of a fan of professional cycling:

> One thing I do worry about is the way people are rushed back from injury. Obviously from a team's perspective, they've got this guy on a two-year contract. They've made an investment. For them, if some rider has an injury, they're paying money for something they're not getting. They want to get them back on the road as quickly as possible and the athletes can feel that. I think there's a lack of care and the emphasis is more about getting on the road quickly, getting back as fast as you possibly can. Rather than a duty of care towards the athlete to make sure they do it in a healthy way (Participant 3).

**Individual risk analysis and management**

After perception of the risks involved in cycling were discussed and established, participants were asked in more detail how they interact and manage these on an individual level. Participants described several personal actions they undertake in order to adjust their own levels of acceptable risk when in competition, with the most frequent being readjusting position within the peloton (group of cyclists in a race) when racing to reduce risk. For example:

> I have been in races where conditions have been less than favourable in regard to rain and dodgy road surfaces and you can kind of sense agitation and nervousness in the bunch. And the way I deal with that is I just drop back and try and not be involved at the sharp end (Participant 1).

When asked why participants expose themselves to these risks, the majority expressed a normalisation of the risk and expressed that the benefits they gained from participation in the sport outweigh the costs (risk of injury). For example, 'The rewards definitely outweigh the risks, definitely' (Participant 2). One participant recalled a story from a previous injury that provides an insight to this mentality and interaction with risk. They comment:

> I had a crash..last year? Yeah, last year, I snapped the chain during team pursuit, stopped and just use my leg as a break at 50kph. I mean, I didn't hit anything. I didn't hit my head or anything. Just like cheese grater down my leg. My whole leg was bandaged up for a while and I remember a work colleague asked if I was mental doing this sport. And I just thought, this is purely transactional for me. I get so much out of cycling that this is a price worth paying (Participant 3).

When further exploring this risk acceptance when in competition, all participants referenced that they rarely think about the risks when competing, despite being aware of them. Participants suggest the stimulus of a road cycling race distracts from thoughts of the risks involved. Participant 8 was an

elite athlete who was a 'sprinter', this means they are frequently involved in high-speed sprint finishes which are considered one of the most dangerous aspects of road cycling. When asked how they manage these risks, the response is interesting:

> I mean, I don't really think about it too often, really, I just sort of try not to dwell on it and and, you know, like, well, I'm not really a risk taker as such, but eventually like when you come into a sprint finish you've just got to do it and you know you don't really think about the risks there, you just sort of act so quickly you don't really get time to process anything. Yeah, just that sort of that racing brain takes over really (Participant 8).

## Discussion

Road cycling has been identified as a sport with an elevated physical risk and high injury rates (De Bernardo et al., 2012; Rooney et al., 2020). Considering risk of physical injury in competitive road cycling, quantitative research shows that the sport carries a high risk of injury. De Barnardo and colleagues (2012), for example, conducted a longitudinal study concluding that professional cyclists had an overall injury risk rate of 0.504 per season (training and racing), equating to at least one in two professional athletes being exposed to injury, every season. Research also highlights the high rates of injury and concussion in the sport (See; Barrios et al., 2015; Decock et al., 2016; Rooney et al. 2020).

Further, research on competitive cyclists has highlighted that problematic behaviours regarding injury management and reporting exist (Hurst et al. 2018; O'Reilly et al. 2020; Rice et al. 2020). The purpose of this study was to examine how the athletes interact with these risks and explore reasons for the harmful injury management behaviours that previous research has identified.

It was found that competing whilst injured and 'getting back on your bike' was a behavioural norm within the culture of competitive cycling. Although the norm of competing when injured is seen across sport (Howe, 2004), and particularly pertaining to concussion management (Baron et al. 2013), it is particularly germane here due to cycling's limited protocols for managing concussion (Elliot et al. 2019). This research thus establishes the problem of performance over health and provides greater detail to the construction of this norm within the sports culture. This is important to understand when designing protocol and interventions to target safer concussion management behaviours amongst these athletes.

Interestingly, amongst the cyclists, SRC and superficial 'road rash' injuries were trivialised and often framed in opposition to an injury such as a broken bone that was viewed as more serious, as it was

deemed to require a longer time to recover from. The finding echoes some of Matthews (2020) discussion of how boxers self-assess injury severity by differentiating between 'run of the mill' neurological disruption and a person losing consciousness from a knock-out. A similar phenomenon was present in the cyclists in this study, where injuries were assessed in relation to the immediate impact on sporting performance, with this often-taking precedence over health.

The current study affirms these findings through the presentation of the athlete's perceptions of risk in the sport. It was unanimous across the data that these athletes believed the sport to be dangerous and to carry a high risk of injury. On this understanding, this research revealed how these athletes navigate knowledge of the risks and their methods of self-management to continue participating in the sport.

Knowledge theory of risk perception suggests individual knowledge, and perceptions of an activity, influences their propensity to engage with it (Fuller & Vassie, 2004). Interestingly, all participants here identified road cycling as being a risky activity, with a high risk of physical injury, yet all are active participants in the sport, despite many having experience with serious injury.

A number of factors were evident in why the participants competed in the sport, despite acknowledging the risks involved. The cost-to-benefit analysis of risk (Adams, 1995), grounded in the economic theory of risk perception (Fuller & Vassie, 2004), offers a conceptual tool to frame these findings. All participants cited various perceived benefits of participation, ranging from psychological to physiological aspects, that, for them, outweighed the risk of injury. Indeed, all participants had suffered various injuries which was conceived as a 'price worth paying' and did not deter them from continued participation.

From a sociological perspective, Lyng's (1990, 2005) concept of 'Edgework' was also salient here in providing further understanding of attitudes towards risk present amongst participants, particularly those at the 'lower levels' of the sport representing serious amateurs that competed alongside work and family responsibilities. Lyng makes the argument that individuals engage in high-risk environments to temporarily escape from social boundaries and constraints of everyday life. Whilst no participants reported being motivated to participate in road cycling because of the risks involved, which was also reported by Albert (1999), there was evidence of the deviation from mundane 'day-to-day' life being a motivating factor for participation.

The sample were mostly of middle-class backgrounds, which is reflective of the profile of the sport (Faclous, 2017). Wilson (2006) has suggested that middle-class service and managerial work is a variable in increasing likelihood for involvement in sporting subcultures, such as road cycling. Lyng's

(1990, 2005) concept of 'Edgework' provides some insight into understanding the risk practices amongst these competitive cyclists, where engagement with the high-risk sport of road cycling offered an outlet to push mental and physical boundaries that contrasted from mundane 'everyday' experiences. Atkinson (2008) reported similar findings amongst triathlete's, where pushing physical limits and enduring pain and suffering were an attraction to the sport and an 'escape' from normal life.

Related to the finding of the cultural norm of competing through injury, was the acceptance of the risks, and normalisation of injury in cycling. Sociological research shows us that over-conformity to sporting norms is prevalent in competitive sport (Baron et al. 2013), leading to increased risk taking, injurious behaviours as well as sacrifice of health for the 'sport ethic' (Hughes & Coakley, 1991).

It was clear amongst the athletes from the current study that they acknowledged the existence of such norms and subscribed to them. From this, there was a normalisation of injury and an expectation to sacrifice bodily health evident amongst the participants. Crashing was reported as a common experience of the competitive road cyclist. Nixon's (1992) argument of sport operating in a "culture of risk" was apparent within the sport of road cycling. Whilst similar findings have been reported in rugby (Daley et al., 2021) and boxing (Matthews, 2020), it is an underexplored area in the cycling literature, with the only identifiable study coming from Albert (1999) in which he concluded that risk was normalised within competitive cycling culture. Further, he suggests accepting these risks served to 'exhibit and to assert membership in the cycling subculture' (Albert, 1999:157). In chapter 13, I discuss this phenomenon within the framework of Social Norms theory.

Nixon's (1992) concept of 'Sports nets' is also useful to provide insight to some of these findings. Nixon (1992) theorised that attitudes toward injury, pain and risk are reproduced in sporting cultures because of the influential social networks around athletes such as teammates, coaches, fans, and the media. It was clear that the operations of various 'Sports nets' had an influence on the participants attitudes toward injury, risk and pain providing an insight to how harmful norms around injury management may be constructed within competitive cycling culture.

Focusing specifically on concussion, a number of important findings can be drawn from this data. Firstly, the majority of the participants had suffered with concussion(s) from cycling, with some detailing emotionally distressing experiences with the injury. Although not included in the thematic analysis, participants detailed having suspected concussions but not knowing where to seek appropriate medical care from. Many cited that general practitioners and hospital staff did not identify concussion or post-concussive syndrome or offer support, something affirmed by previous research (Rashid et al., 2020). This was not explored further here, as it is out of the scope of the

thesis. Nonetheless, it provides insight to issues around medical care for sports-related concussion and the need for governing bodies to be more proactive as a source of knowledge for such injuries.

Knowledge of concussion, and perception of its severity, significantly changed depending on the participants experience with the injury. For example, the two participants that reported never having a suspected or diagnosed concussion were the least knowledgeable on the injury and downplayed its severity. Whereas one participant that had suffered with post-concussive syndrome for over two years was very engaged with the topic and concerned around its severity.

There is a lack of research into this specific area, with most research on concussion history focussing on reporting intentions (For example, O'Connor et al. 2020; Register-Mahlik at al. 2017; Kroshus et al. 2020). However, of interest here, is how personal experience influenced participant perceptions of the injury. The application of this is that educational interventions need to address this knowledge gap so attitudes regarding concussion in sport are formed proactively, rather than reactively through personal experience.

Further, with medical support being limited in competitive cycling at the competitive amateur level, cyclists often gain knowledge of injuries, and SRC, through peers. AlHashmi and Matthews (2021) reported a similar phenomenon amongst combat sport athletes, finding that coaches often acted as the source of knowledge for medical concerns and health issues despite not being medically qualified. The authors suggest that this source of knowledge offered 'lay medical certainty' to combat sport athletes, often justifying and allowing continued participation despite injury (AlHashmi & Matthews, 2021). A similar phenomenon was present amongst the cyclists in this study, where knowledge of dealing with injury and SRC were largely reported to be gained from experiential sources, either personal experience with injury or from peers' experiences. Exploring the construction of medical knowledge amongst competitive cyclists is an area that would be interesting for future research.

Importantly, all participants exhibited a disassociation of concussion being an injury that cyclists may be at risk of before suffering with the injury, personally. This finding supports the notion that levels of awareness of the injury in road cycling is low, despite research showing concussion accounts for between 5-15% of all injuries (Rooney et al. 2020). The lower levels of awareness highlight numerous issues within the sport, namely the lack of protocol and accountable medical care for cyclists with potential brain injuries—something highlighted in the literature (Heron et al. 2020; Scullion and Heron, 2022). From these findings, governing bodies should adopt a more proactive approach to raising awareness of concussion being an injury that cyclists are at risk of, and work on producing greater educational resources and stakeholder training to deal with this issue.

## Chapter Summary

This chapter has presented the final phase of research for this thesis. Through semi-structured interviews, with eight competitive cyclists, findings show that road cycling exists as a sport with a strong culture of harmful injury management behaviours which are reproduced through the media and peers into a subculture.

Participants' knowledge of concussion was only formed through personal experience with the injury, with many suggesting that, prior to personal experience, they did not consider concussion to be a risk-factor for cyclists; nor did they appreciate its severity. These findings thus highlight the need for increased efforts from governing bodies to educate participants to form this knowledge proactively, as opposed to reactively through experience.

Once participants were aware of the physical risks involved in competition, they used cognitive processing methods to rationalise these risks and allow continued participation. This cognitive strategy was mainly achieved through a cost-to-benefit analysis of the risks (Adams, 1995), in which the benefits were perhaps unduly rated. The risks involved in the sport were also normalised by participants and seen as 'part of the sport', supporting previous findings on road cycling culture (Albert, 1999).

# Chapter 13: Epilogue

**Introduction**

This chapter brings this thesis to its end. Here, I will present an account of the PhD process and the main findings from this research. First, I will provide a general summary of the thesis, taking the reader through this project and why it is important. I will then revisit my methodology before presenting the main findings. With the desire of doing good, and robust, science I will then outline the limitations of this work. The epilogue concludes with a discussion around directions for future research in this field, the practical implications of this work and a concise summary of the project.

**General Summary**

Throughout this thesis I have referenced the unique and complex nature of competitive road cycling, as well as its subordinate position in popular sport culture. Also, I have posited that as it is deemed a non-contact sport it has been overlooked in the current concussion crisis in sport. Yet, research shows us it is a sport in which traumatic injury is frequent (Silberman, 2013), with significant rates of concussive injures (Rooney et al., 2020). Further, the last few years have seen numerous 'call to actions' for more research and policy attention to this issue (See; Elliot et al., 2019; Greve & Modabber, 2012; Heron et al., 2019). The area remains understudied, and not well understood.

As such, this thesis was conceived with the aim to address this gap in the literature in two primary ways. Firstly, I hoped to improve the understanding of concussion in a non-mainstream, non-contact, sport which I perceive to have a problem that has been overshadowed by the cultural attention placed on contact sports. Secondly, I sought to add to the extremely limited body of primary research into this topic. Related to this, I also selected a mixed-method approach to address the current gap in qualitative research in this field. Indeed, this work represents the first social science approach to the topic, as well as the first qualitative study in the field.

As detailed throughout, this research is grounded in a socio-context of which I was immersed for much of my early life. The issues raised, discussions with participants, and investigation of road cycling culture all represent a context I have first-hand experience with. And, perhaps most importantly, I have personally suffered the effects of concussion.

These factors represent some of my motivations to undertake this research. Important to this thesis, and my development as a researcher, is the process I have undertaken from athlete to critical scholar. Prior to starting this thesis, I was retiring from sport in a competitive capacity due to a fall out with the many demands of elite sport, as well as my history of injuries. In the early phases of this PhD, I recognised my cognitive dissonance as I was still, somewhat, invested in the sport as it had formed such a large part of my life up that point.

However, as more time passed since my involvement in the sport and my critical reflections on my interactions with competitive sport developed, I find myself in a place more detached from the sport in an emotional capacity. As such, this thesis presents a robust academic insight into the sport which is supported by a deep understanding gained through personal experience, something I value in my research philosophy and follows principles of Elias' (1956; 1987) concepts of involvement and detachment within social research, as well as the benefit of 'intimate familiarity' in social science research (Matthews, 2021).

## Methodology

This thesis was designed as a four study, mixed-method, research project with the aim to undertake an interdisciplinary exploration into the culture of competitive road cycling with reference to masculinity, risk and injury, with a principle focus on concussion. This design was adopted as the mixed method approach reflects my ontological position, and the development of producing my research, giving the findings greater validity, and producing impactful original work (Hurmerinta-Peltomäki & Nummela, 2006). Further, a mixed-method approach allowed for the combination of the strengths of different methods, negating the negatives of singular method designs, and allows the findings to be produced from an organic process (Creswell & Plano, 2007).

I will outline what work was undertaken to remind the reader of the overall research of this thesis. In Study 1, I adopted a qualitative content analysis of social media data to gain an insight to the social and cultural engagement with concussion within the competitive road cycling community. Study 2 and 3 were purely quantitative, drawing on a self-report survey design to capture data which I could analyse and compare against other sports. Study 1, 2 and 3 were designed to remove myself from the research process, being distanced observations of the research area. Study 4, however, adopted a purely qualitative approach where my subjectivity and experiences were positioned as a research tool (Gough & Madill, 2012). I conducted semi-structured interviews with athletes to gain an understanding of their perspectives on the sport, risk, and concussion.

## Research findings

Due to the structure of the thesis, I presented the findings from each study within each research chapter. Here, I will present more overall findings from the entire research process.

*Is awareness of concussion increasing in cycling?*

Research has commented on the relative position of competitive cycling compared to more widely participated sports that occupy most of researchers' attention within the concussion crisis (see; Hurst et al. 2018; Hardwicke & Hurst, 2020). Although competitive road cycling is, by definition, a non-contact sport, it is established as an extremely dangerous sport where crashes and injuries are frequent (See; Silberman, 2013; De Bernardo, Barrios, Vera, Laíz, & Hadala, 2012; Barrios et al., 2015; Decock et al., 2016; Rooney et al. 2020). Yet, the attention given to it with concerns around concussion are extremely limited.

Due to this limited attention, and evident lack of effective protocol in competitive cycling (Heron et al., 2019; Scullion & Heron, 2022), I hypothesised in the introduction to this thesis that there is a widespread lack of awareness of the injury in cycling, a phenomenon I observed from my own involvement in the sport. This hypothesis has largely been supported by the findings from this thesis.

The results from Study 1 outline the relatively small engagement with concussion on twitter amongst the cycling community when compared to other sports. The paucity of academic literature on the area outlines its subordinate position within the academy. Although results from Study 2 suggest good concussion knowledge, the problematic attitudes found, and common misperceptions present a lack of awareness around the severity of concussion and propensity of cyclists being at risk. Further, the findings from Study 4 showed the athletes associated issues of concussion with contact sports and did not know about it prior to personal experience with the injury.

However, the findings from Study 1 did find that awareness is increasing, measured here through increased engagement on social media. Although competitive cycling has a long way to go in terms of increasing knowledge and awareness around concussion, I hypothesis that awareness is growing due to the overspill from mainstream sports amongst the current concussion crisis.

Within the time of working on this PhD, many sports have been in the mainstream media due to concerns around brain trauma, namely football and rugby. I believe this increased cultural engagement is providing a platform for more sports to come under consideration for the effects of

brain trauma as society becomes more educated on the issue. This is encouraging, however, from my observations I reassert that any increased awareness in competitive cycling is an overspill from other sports, as, at the time of writing, the governing bodies are doing extremely little to raise awareness around brain trauma within cycling.

*Getting back on the bike*

Another phenomenon which I had very personal experience with whilst being an athlete in the sport is the act of 'getting back on the bike' after a crash. Although I believe personal experience to hold value in social scientific research, this phenomenon has been verified in previous research with findings presenting cyclists as a group that place precedence on performance over health (see; Hurst et al., 2019; O'Reilly, 2020; Dahliquist et al. 2015).

Indeed, this cultural norm within cycling presents a significant finding of this thesis. Study 2 found significant numbers (23%) of the sample would continue to compete following a concussion. Further, Hurst et al. (2018) also found this, and that athletes would mask signs of concussion to continue in competition. Compounded by other research with the same findings (see; O'Reilly, 2020; Dahliquist et al. 2015), this phenomenon can be observed as a social fact amongst the culture of road cycling.

I sought to greater understand athlete's perception and interaction with this norm, which was achieved through Study 4 where I conducted in-depth interviews. The findings present that all the athletes were aware of this and subscribed to the behaviour. It was outlined that external pressures in the sport, media reporting of injury, and peers were the main factors in the production and reproduction of this attitude. This finding has implications for the effective management of injury, specifically concussive injuries, within the sport of cycling.

In chapter seven I detailed the utility of Social Norms Theory in understanding sports-related concussion. The theory guided much of this research, which I will now apply to this research finding. The findings from this thesis suggest that competing whilst injured is an accepted injunctive norm (Borowitz, 2004) in cycling culture. Study 4 demonstrated that athlete's perception of this norm is that it is an 'expectation' amongst the social group of competitive cyclists and that most other athletes adhere to this, forming a descriptive norm (Borowitz, 2004).

Using this theoretical grounding it can be inferred from the thesis findings that competitive cycling culture works to reproduce dangerous injury management behaviours through the acceptance and normalisation of the behavioural norm of 'getting back on the bike' after a crash. Further, Social Norms Theory recognises that behaviours that benefit a group, but not an individual, can be

reinforced which is seen through team norms in sport (Kroshus et al. 2015). This self-sacrifice for team benefit is problematic in dealing with sports-related concussion and represents a factor that may explain the behaviours found in cycling around injury management. This is particularly germane to cycling where substitutes are not possible but there is high team cohesion and dependence, particularly in professional multi-day stage races. As such, withdrawal from competition can be detrimental to the 'team', as such, individuals may self-sacrifice individual health for team benefit to assimilate to the expected norm within this sport.

*Does cycling have a masculinity problem?*

Results from Study 3 found male cyclists in this sample showed elevated rates of identification with orthodox masculinity when compared to the general male population. This is an interesting finding that has much application and need for further research. The only previous study into the area was Powell and colleagues (2005) study, which had similar findings.

Importantly, the previously outlined finding on cyclist's injury management practices represents central tenants of orthodox masculinities (Dunning, 1999; Messner, 1990). This attitude can be traced back to road cycling operating within a highly masculine domain, in which athletes subscribe to norms associated with orthodox masculinities. In the concussion crisis, this is presented in the form of under reporting and downplaying of the severity of the injury.

Not only does this finding have application to understanding the culture of injury management in the sport, but it also frames an understanding of why road cycling is so frequently referred to as having a conservative culture (Cycling News, 2017), being absent from equality and diversity discourses (Hylton, 2017) and having structural issues with sexism (Cycling News, 2017; Clemitson, 2019).

Further, Justin Laevens, a Belgian U23 professional cyclist, came out as the world's first openly gay professional cyclist in early January 2021 (Cycling News, 2021). All previous gay cyclists have only come out after retirement from the sport. I hypothesis that the idolization of orthodox masculinity in competitive cycling culture is a significant reason for the lack of openly gay male cyclists. Indeed, it has been noted by a prominent figure in road cycling that being homosexual is still coded as a weakness and threatens an athlete's masculinity (Kelner, 2018). This is an area that has not been researched, but I plan to undertake this research to improve the understanding of the sport.

I discussed the wider issues associated with this finding in chapter ten. It has utility in understanding the concussion reporting intentions of competitive road cyclists and the cultural norm of the undesirable management of injury. I argue cycling has a masculinity problem and the governing

bodies need work to make the sport more inclusive, and to create a more desirable culture for injury reporting.

*Concussion reporting behaviours and intention*

The final major finding from this thesis, with direct application to dealing with concussion in cycling, is the high rates of negative concussion reporting intentions. Further, I found that the worst attitudes were present amongst youth athletes and those of greater ability within the sport. These findings align with wider research that knowledge of concussion symptoms in sport may not be of major concern (See; Chrisman et al. 2013; Register-Mihalik et al. 2013; Frass et al. 2014). Rather, the translation of knowledge and safe attitudes into behavioural action is of greater concern.

The issue, here, is that all current measures of concussion reporting behaviours (including that used for this thesis) are atheoretical. As such, truly effective educational interventions and attempts at cultural change cannot be undertaken, demonstrated by the research highlighting the lack of efficacy in concussion education programmes having long-term influences on behaviour (Kroshus et al. 2015). It is for this reason I outlined the Theory of Planned Behaviour in chapter seven. I believe this theory holds great utility for the development of measures to understand concussion reporting behaviours in sport that are grounded in theory. In this approach, the culture and environment of competitive sport is considered in the examination of behavioural actions.

The Theory of Planned Behaviour is useful in understanding this finding regarding concussion reporting behaviours and suggesting effective interventions. As detailed in chapter seven, the model works around three factors which form a behavioural intention and outcome: attitude towards the behaviour, subjective norms and perceived behavioural control. If any of these factors are unfavourable, then an individual is less likely to display a behaviour.

In light of the findings in this thesis, the attitude towards reporting a concussion and withdrawing from competition amongst cyclists may be unfavourable due to the lower levels of awareness in the sport to the severity of the injury. As such, an informed decision on whether the behaviour will positively or negatively impact them cannot be made. The subjective norm would encourage under reporting and continuing in competition whilst injured, as outlined above through the behavioural norm of 'getting back on the bike'. Finally, the perceived behavioural control of reporting a concussion or withdrawing from competition in cycling is low. The lack of educational resources, robust protocol, and medical training of stakeholders, particularly at amateur levels, makes reporting a concussion difficult. Further, the sport does not have the capacity in its current form to

allow substitutes or pause competition time for assessment, thus cyclists have little control without detriment to their performance.

Therefore, these findings support the need for interventions to target these areas to maximise positive behavioural outcomes of competitive cyclists, but the emphasis should be on behaviour changes grounded in theory, and not solely knowledge-based resources. How this is achieved effectively remains a challenge in the field, and an area in need of further development by cycling governing bodies.

## Research limitations

As with all research, this thesis is not without limitations. Here, I will briefly outline the key specific limitations for each study and discuss more overall limitations of the work.

*Study 1*

The data collection process used for this study is subject to researcher bias as the coding and thematic analysis of the data was customised by the lead researcher. Personal subjectivities, here, may have influenced the outcome and presentation of the data. Also, the study was only able to collect publicly available twitter data, which may have limited the population size and demographics. The use of Twitter as the platform analysed may also restrict findings, as users are limited to 140-characters when producing a tweet. This may inhibit users' expressions and opinions.

*Study 2*

Further research is needed with larger sample sizes to establish the reasons for the differences found in this study. The data used was gained from a self-reporting survey, which has potential to suffer from social desirability bias.

There are also limitations of the RoCKAS as an instrument to measure concussion knowledge and attitudes (Chapman et al., 2018; Williams et al., 2016). Alhashmi and Matthews (2021) have recently discussed some epistemological concerns with the instrument also. Namely that such a fixed method provides only a 'snapshot' of what is a phenomenologically complex and fluid area. Acknowledgement of this limitation was the rationale for Study 4, where a deeper understanding of concussion knowledge, attitudes and experiences was sought after. Despite these limitations, it is the only validated instrument currently available. For this reason, the study used this instrument but acknowledges its limitation in measurement. For this preliminary study into the UK competitive

cycling context, it provided a validated instrument which can be used in comparison to other sports, and as an extension to the work of Hurst and colleagues (2018).

*Study 3*

Although a large sample was achieved, verifying the findings from Powell et al. (2005), the self-report nature of the research design may be subject to social desirability bias. Further, the measure used may not provide an in-depth insight to these athlete's interaction with gender but offers a preliminary starting point for future research. This is research I have planned.

The study is also limited to one national cultural context, the UK. Future research into other cultural contexts where competitive cycling is a popular sport would aid the further understanding of these findings.

*Study 4*

The findings presented in Study 4, and meanings attached to data produced by participants, were collected, and analysed by the lead researcher, and, as such, are subjective. Positivist-empiricist models of research, and proponents of this philosophy, criticise this subjectivity as producing research with little validity (Braun et al. 2018). However, as I outlined, using the reflexive thematic analytic approach positions this subjectivity as part of the process; a tool rather than a limitation (Gough & Madill, 2012). In order to reduce subjectivity in the data collection phase, I followed reflexive principles. In accordance with this, I avoided leading questions, I had broad topics to cover, and I asked participants specific questions and asked for clarity on responses if I deemed them to be vague.

The sample size could be deemed as small, and non-significant to generalise the findings. Here, I reassert the position of this study being one part of a mixed method approach, so the time constraints would not allow for a larger sample as this is not a single method thesis. Further, I outline that prior to this study, there has been no previous qualitative research into this research topic, again: this work is a preliminary study. Finally, drawing on Braun and Clarkes (2013) practical guides for reflexive thematic analysis, they propose a pragmatic 'rule of thumb' of five to six interviews for a small project, in which this study fits the criteria. Exceeding this rough advice of sample size posits the study as meaningful and socially relevant research.

*Overall limitations*

Here, I will address a more overall limitation in the research findings: the generalisability of the results. The participants from Study 2, 3 and 4 may suffer from bias which has implications on the application of findings. The sampling method may have led to those with a personal interest or experience with concussion being more likely to undertake the research. As such, they may hold higher previous knowledge and have more defined opinions and perspectives on the injury. This must be noted and considered in the dissemination of the findings from these studies.

However, this limitation was out of the control of the researcher. The study did still achieve a large sample size, with a range of ages and abilities, which I argue is representative of UK competitive cyclists.

## Practical Implications

The findings outlined from this thesis have a number of implications for research and policy in this field. Firstly, there is a lack of understanding for the cultural nuances of competitive road cycling, many of which impact athlete concussion management behaviours. Outlining the first comprehensive investigation into masculinity amongst competitive road cycling, I offer a starting point for further research into decoding the presence of competing through injury amongst cyclists. Further, this research acknowledges athlete perceptions of the sport, their views of the risks and how they deal with them. Without this level of investigation, policy developed to target concussion lacks substance and appreciation for the context and culture of the sport.

The implications for policy are related to this cultural angle. Indeed, in the time of writing this thesis the UCI released new protocols for the elite level of the sport (UCI, 2021). This was in a period of mainstream sports, football and rugby, facing severe media pressure around brain trauma. This may be a tokenistic, protective measure. Time will tell on the efficacy and implementation of the protocols.

Regardless, my research identifies large proportions of the problem being cultural and current policy does not negate this. For example, rugby governing bodies have notionally been dealing with concussion for over a decade now with policy and rules. Yet, the issue remains in the sport. Policy and knowledge-based education addressing concussion in competition does not appreciate the culture of why athletes in the sport continue to put their health at risk by joining races after a crash. This is also a result of the rules and regulation of the sport forcing riders to do so, particularly in multi-day stage races, which are rigid and resistant to change due to cultural attachments to the preservation of the sport.

Above all, there are still no protocols, or even tokenistic gesture, addressing concussion amongst athletes outside of the very elite end of the sport. This is illogical since this cohort represents a far larger net group of people. Indeed, the context of this research and the participants are governed by British Cycling. British Cycling has not a single official rule on concussion at the time of writing. It is clear there is much to be done, and these research findings offer a small part to the approach to start dealing with this issue in competitive cycling.

**Comments on future research in the field**

Being so deeply involved with this field, and working closely with the literature, I have a few comments about future directions. First, there is an absence of any epidemiological research on concussion incidence, making an understanding of the scale of the issue problematic. The issues for this specifically for concussion are multiple, and covered in chapter four, but outline a large gap in the literature. However, a recent consensus on injury reporting in road cycling gives hope that, moving forward, this gap may start to be addressed, but this remains to be seen (For consensus see; Heron et al. 2020).

Second, it is still largely unknown what happens to the brain when it experiences a bicycle crash. I covered this in chapter four, but essentially the pathophysiology of brain trauma in all disciplines of competitive cycling is unknown. With increasing developments in neuroscience, this is an area that may be addressed over the next decade.

If we look specifically at road cycling, the concern is with high-velocity impacts that may occur 2-3 times a year in an athlete. Whereas concerns in contact sports are with the repeated lower velocity impacts. This cycling specific mechanism of concussion requires further research attention. Through my research experience, observations, media analysis of professional cyclists' experiences with concussion and a key study by Moore et al (2020), I hypothesis that the most pressing issue in road cycling is Post-Concussive Syndrome. There are a lot of unknowns that remain regarding the long-term brain health of cyclists, and increasingly we are seeing disturbing stories in the media of cyclists suffering with long-term complications due to brain injuries (CLF, 2019).

Finally, as already suggested through-out the thesis, is the dearth of qualitative research and a consideration for cultural aspects of the sport. This represents a significant area in need of further research which will have much application to the improvement of injury management within competitive road cycling, as well as informing governing bodies on how to make the sport more inclusive.

## Conclusion

To summarise, I argue that competitive road cycling has a concussion problem which governing bodies are not currently dealing with appropriately, and the academic field does not yet comprehensively understand. The sports culture, traditions and official structure are producing and reproducing negative injury management behaviours that in-competition injury protocols and education alone cannot address. As I have shown, the sport of competitive road cycling exhibits an industrial footprint which has shaped the construction of the contemporary sport. Many facets from the Industrial Era remain in today's sport, where we see a culture of orthodox masculinity, hyper competitiveness and health being sacrificed in a protection of athletic status.

Finally, there is still a long way to go to greater understand concussion in competitive cycling in all domains of the injury. In light of the lack of cycling-specific understanding of the pathophysiology of brain trauma, I argue governing bodies must adopt an approach to manage the injury based on the precautionary principle to manage these risks. Further, as I have shown, the issue with concussion is not solely knowledge, but knowledge transfer to positive behavioural outcomes in regard to athlete concussion reporting and management. To address that, research needs to be grounded in theory to understand behaviour change and a holistic approach must be taken to understand athletes' interactions with the sport is required.

From the presentation of evidence in this thesis, I argue that serious cultural change and official action is needed to bring competitive road cycling in line with the current zeitgeist and concussion crisis.

## Reference List


Adams, A. (2011). “Josh Wears Pink Cleats”: Inclusive Masculinity on the Soccer Field. Journal of Homosexuality, 58(5), 579–596. https://doi.org/10.1080/00918369.2011.563654

Adams, A., Anderson, E., & McCormack, M. (2010). Establishing and challenging masculinity: The influence of gendered discourses in organized sport. *Journal of language and social psychology*, *29*(3), 278-300.

Aboim, S. (2016). *Plural Masculinities*. Taylor & Francis.

Abramson, M. (2012, September 14). *Homepage - Medicine Of Cycling*. Concussion in Cycling Consensus Statement 2012. https://www.medicineofcycling.com/

Adams, A. (2011). “Josh Wears Pink Cleats”: Inclusive Masculinity on the Soccer Field. *Journal of Homosexuality*, *58*(5), 579–596. https://doi.org/10.1080/00918369.2011.563654

Adams, A., & Kavanagh, E. (2017). Inclusive ideologies and passive performances: exploring masculinities and attitudes toward gay peers among boys in an elite youth football academy. *Journal of Gender Studies*, *27*(3), 313–322. https://doi.org/10.1080/09589236.2017.1391073

Adams, A., & Kavanagh, E. (2017). Inclusive ideologies and passive performances: exploring masculinities and attitudes toward gay peers among boys in an elite youth football academy. Journal of Gender Studies, 27(3), 313–322. https://doi.org/10.1080/09589236.2017.1391073

Adams, A., Anderson, E., & McCormack, M. (2010). Establishing and Challenging Masculinity: The Influence of Gendered Discourses in Organized Sport. *Journal of Language and Social Psychology*, *29*(3), 278–300. https://doi.org/10.1177/0261927x10368833

Adams, J. (1995). *Risk* (1st ed.). Routledge.

Adams, J. (2001). The risk compensation theory and bicycle helmets. *Injury Prevention*, *7*(2), 89–91. https://doi.org/10.1136/ip.7.2.89

Ahmed, O. H., Lee, H., & Struik, L. L. (2016). A picture tells a thousand words: A content analysis of concussion-related images online. *Physical Therapy in Sport*, *21*, 82–86. https://doi.org/10.1016/j.ptsp.2016.03.001

Ahmed, O. H., Schneiders, A. G., McCrory, P. R., & Sullivan, S. J. (2017). Sport Concussion Management Using Facebook: A Feasibility Study of an Innovative Adjunct “iCon”. *Journal of Athletic Training*, *52*(4), 339–349. https://doi.org/10.4085/1062-6050-52.2.13

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-t

Ajzen, I., & Driver, B. L. (1992). Application of the Theory of Planned Behavior to Leisure Choice. *Journal of Leisure Research*, *24*(3), 207–224. https://doi.org/10.1080/00222216.1992.11969889

Ajzen, I., (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50(2), pp.179-211.

Albarracín, D., Johnson, B. T., Fishbein, M., & Muellerleile, P. A. (2001). Theories of reasoned action and planned behavior as models of condom use: A meta-analysis. *Psychological Bulletin*, *127*(1), 142–161. https://doi.org/10.1037/0033-2909.127.1.142

Albert, D., Chein, J., & Steinberg, L. (2013). The Teenage Brain. *Current Directions in Psychological Science*, *22*(2), 114–120. https://doi.org/10.1177/0963721412471347

Albert, E. (1999). DEALING WITH DANGER. *International Review for the Sociology of Sport*, *34*(2), 157–171. https://doi.org/10.1177/101269099034002005

Alfrey, E. J., Tracy, M., Alfrey, J. R., Carroll, M., Aranda-Wikman, E. D., Arora, T., Maa, J., & Minnis, J. (2021). Helmet Usage Reduces Serious Head Injury Without Decreasing Concussion After Bicycle Riders Crash. *Journal of Surgical Research*, *257*, 593–596. https://doi.org/10.1016/j.jss.2020.08.009

Alfrey, E. J., Tracy, M., Alfrey, J. R., Carroll, M., Aranda-Wikman, E. D., Arora, T., Maa, J., & Minnis, J. (2021). Helmet Usage Reduces Serious Head Injury Without Decreasing Concussion After Bicycle Riders Crash. *Journal of Surgical Research*, *257*, 593–596. https://doi.org/10.1016/j.jss.2020.08.009

AlHashmi, R & Matthews, C (2021) Athletes' understanding of concussion – uncertainty, certainty and the 'expert' on the street, *Qualitative Research in Sport, Exercise and Health*, DOI: 10.1080/2159676X.2021.1974928

Alosco ML, Stein TD, Tripodis Y, et al. Association of White Matter Rarefaction, Arteriolosclerosis, and Tau With Dementia in Chronic Traumatic Encephalopathy. *JAMA Neurol.* 2019;76(11):1298–1308. doi:10.1001/jamaneurol.2019.2244

Alosco, M., Kasimis, A., Stamm, J. *et al.* Age of first exposure to American football and long-term neuropsychiatric and cognitive outcomes. *Transl Psychiatry* **7,** e1236 (2017). https://doi.org/10.1038/tp.2017.197

Anderson E, White A. (2018) *Sport, Theory And Social Problems*. London: Routledge Taylor & Francis Group.

Anderson, E. (2005). *In the game: Gay athletes and the cult of masculinity*. SUNY Press.

Anderson, E. (2005). Orthodox and Inclusive Masculinity: Competing Masculinities among Heterosexual Men in a Feminized Terrain. *Sociological Perspectives*, *48*(3), 337–355. https://doi.org/10.1525/sop.2005.48.3.337

Anderson, E. (2009). *Inclusive Masculinity: The Changing Nature of Masculinities (Routledge Research in Gender and Society)* (1st ed.). Routledge.

Anderson, E. (2014). *21st Century Jocks: Sporting men and contemporary heterosexuali*ty. London: Palgrave MacMillan.

Anderson, E. and McCormack, M. (2015) 'Cuddling and Spooning: Heteromasculinity and Homosocial Tactility among Student-athletes', *Men and Masculinities*, 18(2), pp. 214–230. doi: 10.1177/1097184X14523433.

Anderson, E. and McCormack, M. (2018) 'Inclusive masculinity theory : overview, reflection and refinement.', *Journal of gender studies*., 27 (5). pp. 547-561.

Anderson, E., & Fidler, C. O. (2017). Elderly British men: homohysteria and orthodox masculinities. *Journal of Gender Studies*, *27*(3), 248–259. https://doi.org/10.1080/09589236.2017.1391690

Anderson, E., & Fidler, C. O. (2017). Elderly British men: homohysteria and orthodox masculinities. Journal of Gender Studies, 27(3), 248–259. https://doi.org/10.1080/09589236.2017.1391690

Anderson, E., & Kian, E. M. (2012). Examining Media Contestation of Masculinity and Head Trauma in the National Football League. *Men and Masculinities*, *15*(2), 152–173. https://doi.org/10.1177/1097184x11430127

Anderson, E., & Magrath, R. (2019). *Men and Masculinities* (1st ed.). Routledge.

Anderson, E., & McCormack, M. (2015). Cuddling and spooning: Heteromasculinity and homosocial tactility among student-athletes. *Men and masculinities*, *18*(2), 214-230.

Anderson, E., & McCormack, M. (2016). *The changing dynamics of bisexual men's lives: Social research perspectives*. New York: Springer.

Anderson, E., & McCormack, M. (2018). Inclusive masculinity theory: Overview, reflection and refinement. *Journal of Gender Studies*, *27*(5), 547-561.

Anderson, E., & McGuire, R. (2010). Inclusive masculinity theory and the gendered politics of men's rugby. *Journal of Gender Studies*, *19*(3), 249–261. https://doi.org/10.1080/09589236.2010.494341

Anderson, E., 2009. *Inclusive Masculinity*. New York, N.Y: Routledge.

Anderson, E., Adams, A., & Rivers, I. (2012). "I Kiss Them Because I Love Them": The Emergence of Heterosexual Men Kissing in British Institutes of Education. *Archives of Sexual Behavior*, *41*(2), 421–430. https://doi.org/10.1007/s10508-010-9678-0

Anderson, E., Magrath, R., & Bullingham, R. (2016). *Out in Sport* (1st ed.). Routledge.

Anderson, E., McCormack, M. and Lee, H., 2012. Male Team Sport Hazing Initiations in a Culture of Decreasing Homohysteria. *Journal of Adolescent Research*, 27(4), pp.427-448.

Anderson, E., Ripley, M., & McCormack, M. (2019). A mixed-method study of same-sex kissing among college-attending heterosexual men in the US. *Sexuality & Culture*, *23*(1), 26-44.

Archer, M. S. (1998). Critical realism : Essential readings. London ; New York: Routledge.

Arksey, H., & Knight, P. T. (1999). *Interviewing for Social Scientists: An Introductory Resource with Examples* (1st ed.). SAGE Publications Ltd.

Arxer, S. L. (2011). Hybrid Masculine Power: Reconceptualizing the Relationship between Homosociality and Hegemonic Masculinity. Humanity & Society, 35(4), 390–422. https://doi.org/10.1177/016059761103500404

Association of Internet Researchers. (2019). *Ethics*. Internet Research: Ethical Guidelines 3.0. https://aoir.org/ethics/

Atencio, M. Beal, B & Wilson, C. (2009) The distinction of risk: urban skateboarding, street habitus and the construction of hierarchical gender relations, Qualitative Research in Sport and Exercise, 1:1, 3-20, DOI: 10.1080/19398440802567907

Atkinson, M (2008) Triathlon, suffering and exciting significance, *Leisure Studies*, 27:2, 165-180, DOI: 10.1080/02614360801902216

Atkinson, M. (2010). *Deconstructing Men & Masculinities (Themes in Canadian Sociology)*. Oxford University Press.

Bachynski, K. E., & Goldberg, D. S. (2014a). Youth Sports & Public Health: Framing Risks of Mild Traumatic Brain Injury in American Football and Ice Hockey. *Journal of Law, Medicine & Ethics*, *42*(3), 323–333. https://doi.org/10.1111/jlme.12149

Bachynski, K. E., & Goldberg, D. S. (2014b). Youth Sports & Public Health: Framing Risks of Mild Traumatic Brain Injury in American Football and Ice Hockey. *Journal of Law, Medicine & Ethics*, *42*(3), 323–333. https://doi.org/10.1111/jlme.12149

Backx. (1990). FIMS POSITION STATEMENT: Eye injuries and eye protection in sports. *National Strength & Conditioning Association Journal*, *12*(5), 42. https://doi.org/10.1519/0744-0049

Baer, J. S., & Carney, M. M. (1993). Biases in the perceptions of the consequences of alcohol use among college students. *Journal of Studies on Alcohol*, *54*(1), 54–60. https://doi.org/10.15288/jsa.1993.54.54

Bailes, J. E., Petraglia, A. L., Omalu, B. I., Nauman, E., & Talavage, T. (2013). Role of subconcussion in repetitive mild traumatic brain injury: a review. *Journal of neurosurgery*, 119(5), 1235-1245.

Bailey, M. J. (2003). *The Man Who Would Be Queen: The Science of Gender-Bending and Transsexualism*. Joseph Henry Press.

Bailey, P. (2014). *Leisure and Class in Victorian England: Rational Recreation and the Contest for Control, 1830–1885*. Abingdon: Routledge.

Baker, Phyllis L., and Douglas R. Hotek. 2018. "Grappling with Gender: Exploring Masculinity and Gender in the Bodies, Performances, and Emotions of Scholastic Wrestlers." *Journal of Feminist Scholarship* 1 (Fall): 49-64. https://digitalcommons.uri.edu/jfs/vol1/iss1/14

Baker, T., & Simon, J. (2002). *Embracing Risk: The Changing Culture of Insurance and Responsibility*. University of Chicago Press.

Balkmar, D. (2018). Violent mobilities: men, masculinities and road conflicts in Sweden. *Mobilities*, 1–16. https://doi.org/10.1080/17450101.2018.1500096

Barnett, & O'Hagan, A. (1997). *Setting Environmental Standards: The Statistical Approach to Handling Uncertainty and Variation* (1st ed.). Chapman and Hall/CRC.

Barnett, V and O'Hagan, A. 1997. *Setting environmental standards: the statistical approach to handling uncertainty and variation*, London: Chapman & Hall.

Baron D, Reardon C, Baron S. *Clinical Sports Psychiatry*.
Baron, D., Reardon, C. & Baron, S.H. (2013) *Clinical Sports Psychiatry: An International Perspective*. John Wiley & Sons, Ltd.

Baron, D., Reardon, C. & Baron, S.H. (2013) *Clinical Sports Psychiatry: An International Perspective*. John Wiley & Sons, Ltd.

Barrie, L., Waitt, G., & Brennan-Horley, C. (2019). Cycling Assemblages, Self-Tracking Digital Technologies and Negotiating Gendered Subjectivities of Road Cyclists On-the-Move. *Leisure Sciences*, *41*(1–2), 108–126. https://doi.org/10.1080/01490400.2018.1539682

Barrios C, Bernardo ND, Vera P, Laíz C, Hadala M. (2015) Changes in Sports Injuries Incidence over Time in World-class Road Cyclists. *International Journal of Sports Medicine*. 36 (3) 241–248. Available at: https://www.thieme-connect.de/products/ejournals/abstract/10.1055/s-0034-1389983

Bashir, A., Abebe, Z., McInnes, K., Button, E., Tatarnikov, I., Cheng, W., Haber, M., Wilkinson, A., Barron, C., Diaz-Arrastia, R., Stukas, S., Cripton, P. and Wellington, C. (2020). Increased severity of the CHIMERA model induces acute vascular injury, sub-acute deficits in memory recall, and chronic white matter gliosis. *Experimental Neurology*, 324, p.113116.

Batten, J., White, A. J., Anderson, E., & Bullingham, R. (2016). From management to prevention: the new cure for sports concussion. *British Journal of Sports Medicine*, *50*(21), 1293–1294. https://doi.org/10.1136/bjsports-2015-095949

Baugh, C. M., Stamm, J. M., Riley, D. O., Gavett, B. E., Shenton, M. E., Lin, A., ... & Stern, R. A. (2012). Chronic traumatic encephalopathy: neurodegeneration following repetitive concussive and subconcussive brain trauma. *Brain imaging and behavior*, 6(2), 244-254.

Bauman, Z., Beck, U., Beck-Gernsheim, E., Benhabib, S., Burgess, R., ... & Solberg, A. (2002). Qualitative interviewing: asking, listening and interpreting. In May, T. (Ed.), *Qualitative research in action* (pp. 226-241). SAGE Publications Ltd, https://www.doi.org/10.4135/9781849209656.

BBC News. (2020, February 24). *FA guidelines: Children to no longer head footballs during training*. https://www.bbc.co.uk/news/uk-scotland-51614088

BBC Sport. 2020. *Thomas Rides With Fractured Pelvis*. [online] Available at: <https://www.bbc.co.uk/sport/wales/23114057> [Accessed 12 October 2020].

Bear, M., Connors, B. and Paradiso, M. (2016). *Neuroscience*.

Becker, H. S. (2017). *Evidence* (1st ed.). University of Chicago Press.

Becker, M. H. (1974). The Health Belief Model and Sick Role Behavior. *Health Education Monographs*, *2*(4), 409–419. https://doi.org/10.1177/109019817400200407

Bem, S. L. (1974). The measurement of psychological androgyny. *Journal of Consulting and Clinical Psychology, 42*(2), 155–162. https://doi.org/10.1037/h0036215

Bem, S. L. (1974). The measurement of psychological androgyny. *Journal of Consulting and Clinical Psychology, 42*, 155–162.

Benoliel, J. Q. (1996). Grounded theory and nursing knowledge. Qualitative Health Research, 6, 406-428

Benson, B. W., McIntosh, A. S., Maddocks, D., Herring, S. A., Raftery, M., & Dvořák, J. ř. (2013). What are the most effective risk-reduction strategies in sport concussion? *British Journal of Sports Medicine*, *47*(5), 321–326. https://doi.org/10.1136/bjsports-2013-092216

Berger, P. L., and Luckman, T. (1967). *The Social Construction of Reality: A Treatise in Sociology of Knowledge*, New York: Irvington Publishers.

Berkowitz, A. (2004). An Overview of the Social Norms Approach. In book: *Challenging the Culture of College Drinking: A Socially Situated Health Communication*. Hampton Press. Editors: Linda P Lederman and Leah P Stewart.

Best, R., & Charness, N. (2015). Age differences in the effect of framing on risky choice: A meta-analysis. *Psychology and Aging*, *30*(3), 688–698. https://doi.org/10.1037/a0039447

Bey, T., & Ostick, B. (2009). Second impact syndrome. *Western Journal of Emergency Medicine*, 10(1), 6.

Beynon, J (2002) *Masculinities and Culture.* Open University Press

Bhaskar, R. (1975). A realist theory of science. York: Books.

Bíl, M., Dobiáš, M., Andrášik, R., Bílová, M. and Hejna, P., 2018. Cycling fatalities: When a helmet is useless and when it might save your life. *Safety Science*, 105, pp.71-76.

Binney ZO, Bachynski KE. Estimating the prevalence at death of CTE neuropathology among professional football players. Neurology. 2019 Jan 1;92(1):43-45. doi: 10.1212/WNL.0000000000006699. Epub 2018 Nov 28. PMID: 30487144.

Bjärsholm, D., Gerrevall, P., Linnér, S., Peterson, T. and Schenker, K., 2018. Ethical considerations in researching sport and social entrepreneurship. *European Journal for Sport and Society*, 15(3), pp.216-233.

Blaikie, N. (2000), *Designing Social Research*, Cambridge: Polity.

Bolin, A., & Granskog, J. (2003). *Athletic Intruders: Ethnographic Research on Women, Culture, and Exercise (SUNY series on Sport, Culture, and Social Relations)*. SUNY Press.

Borkowska, K. (2018). Approaches to Studying Masculinity: A Nonlinear Perspective of Theoretical Paradigms. Men and Masculinities, 23(3–4), 409–424. https://doi.org/10.1177/1097184X18768376

Borkowska, K. (2020). Approaches to Studying Masculinity: A Nonlinear Perspective of Theoretical Paradigms. *Men and Masculinities*, 23(3–4), 409–424. https://doi.org/10.1177/1097184X18768376

Bourdieu, P., & Wacquant, L. J. (1992). *An invitation to reflexive sociology*. University of Chicago press.

Boyd, D, & Ellison, N. B. (2007). Social Network Sites: Definition, History, and Scholarship. *Journal of Computer-Mediated Communication*, *13*(1), 210–230. https://doi.org/10.1111/j.1083-6101.2007.00393.x

Boyle, R., & Haynes, R. (2009). *Power Play: Sport, the Media and Popular Culture* (2nd ed.). Edinburgh University Press.

Braams, B. R., van Duijvenvoorde, A. C. K., Peper, J. S., & Crone, E. A. (2015). Longitudinal Changes in Adolescent Risk-Taking: A Comprehensive Study of Neural Responses to Rewards, Pubertal Development, and Risk-Taking Behavior. *Journal of Neuroscience*, *35*(18), 7226–7238. https://doi.org/10.1523/jneurosci.4764-14.2015

Branion-Calles, M., Nelson, T. and Winters, M., 2017. Comparing Crowdsourced Near-Miss and Collision Cycling Data and Official Bike Safety Reporting. *Transportation Research Record: Journal of the Transportation Research Board*, 2662(1), pp.1-11.

Braun, V & Clarke, V (2006) Using thematic analysis in psychology, Qualitative Research in Psychology, 3:2, 77-101, DOI: 10.1191/1478088706qp063oa

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Braun, V., & Clarke, V. (2012). Thematic analysis. In H. Cooper, P. M. Camic, D. L. Long, A. T. Panter, D. Rindskopf, & K. J. Sher (Eds.), APA handbooks in psychology®. APA handbook of research methods in psychology, Vol. 2. Research designs: Quantitative, qualitative, neuropsychological, and biological (p. 57–71). American Psychological Association.

Braun, V., & Clarke, V. (2012). *Thematic analysis.* In H. Cooper, P. M. Camic, D. L. Long, A. T. Panter, D. Rindskopf, & K. J. Sher (Eds.), *APA handbooks in psychology®. APA handbook of research methods in psychology, Vol. 2. Research designs: Quantitative, qualitative, neuropsychological, and biological* (p. 57–71). American Psychological Association. https://doi.org/10.1037/13620-004

Braun, V., & Clarke, V. (2013). *Successful Qualitative Research: A Practical Guide for Beginners* (1st ed.). SAGE Publications Ltd.

Braun, V., & Clarke, V. (2019). Reflecting on reflexive thematic analysis. Qualitative Research In Sport, Exercise And Health, 11(4), 589-597. doi: 10.1080/2159676x.2019.1628806

Braun, V., & Clarke, V. (2019). Reflecting on reflexive thematic analysis. *Qualitative Research in Sport, Exercise and Health*, *11*(4), 589–597. https://doi.org/10.1080/2159676x.2019.1628806

Braun, V., & Clarke, V. (2019). Reflecting on reflexive thematic analysis. *Qualitative Research in Sport, Exercise and Health*, *11*(4), 589–597. https://doi.org/10.1080/2159676x.2019.1628806

Braun, V., Clarke, V., Hayfield, N. and Terry, G. (2018) *Thematic Analysis*. In: Liamputtong, P, Ed., Handbook of Research Methods in Health Social Sciences, Springer Singapore, Singapore, 843-860

Brett, B., Kuhn, A., Yengo-Kahn, A., Solomon, G. and Zuckerman, S., (2018). Risk Factors Associated With Sustaining a Sport-related Concussion: An Initial Synthesis Study of 12,320 Student-Athletes. *Archives of Clinical Neuropsychology*, 33(8), pp.984-992.

Bridges, T., & Pascoe, C. J. (2014). Hybrid Masculinities: New Directions in the Sociology of Men and Masculinities. *Sociology Compass*, *8*(3), 246–258. https://doi.org/10.1111/soc4.12134

British Cycling reaches 150,000 members milestone for first time. (2019). British Cycling. https://www.britishcycling.org.uk/campaigning/article/20190502-campaigning-BRITISH-CYCLING-REACHES-150-000-MEMBERS-MILESTONE-FOR-FIRST-TIME-0

British Cycling reaches 150,000 members milestone for first time. British Cycling. https://www.britishcycling.org.uk/campaigning/article/20190502-campaigning-BRITISH-CYCLING-REACHES-150-000-MEMBERS-MILESTONE-FOR-FIRST-TIME-0. Published 2020. Accessed June 26, 2020.

British Cycling reaches 150,000 members milestone for first time. British Cycling. https://www.britishcycling.org.uk/campaigning/article/20190502-campaigning-BRITISH-CYCLING-REACHES-150-000-MEMBERS-MILESTONE-FOR-FIRST-TIME-0. Published 2020. Accessed June 26, 2020.

Broglio, S. P., Vagnozzi, R., Sabin, M., Signoretti, S., Tavazzi, B., & Lazzarino, G. (2010). Concussion occurrence and knowledge in Italian football (soccer). *Journal of sports science & medicine,* 9(3), 418. Available at: https://www.researchgate.net/publication/258035661_Concussion_Occurrence_and_Knowledge_in_Italian_Football_Soccer

Broglio, S., 2018. Return to play following sports-related concussion. *Sports Neurology*, pp.193-198.

Brooks, M., Peterson, K., Biese, K., Sanfilippo, J., Heiderscheit, B. and Bell, D., 2016. Concussion Increases Odds of Sustaining a Lower Extremity Musculoskeletal Injury After Return to Play Among Collegiate Athletes. *The American Journal of Sports Medicine*, 44(3), pp.742-747.

Bruce, D. A., Alavi, A., Bilaniuk, L., Dolinskas, C., Obrist, W., & Uzzell, B. (1981). Diffuse cerebral swelling following head injuries in children: the syndrome of "malignant brain edema". *Journal of neurosurgery*, 54(2), 170-178.

Bryman, A. (2001) Social Research Methods. Oxford University Press, Oxford

Bryman, A. (2016). *Social Research Methods* (5th ed.). Oxford University Press.

Brymer, E. (2010). Risk taking in Extreme Sports: A phenomenological perspective. *Annals of Leisure Research*, *13*(1–2), 218–238. https://doi.org/10.1080/11745398.2010.9686845

Bu.edu. 2020. *VA-BU-CLF Brain Bank | CTE Center*. [online] Available at: <http://www.bu.edu/cte/our-research/brain-bank/> [Accessed 7 October 2020].

Buckley, T., Munkasy, B. and Clouse, B., 2016. Acute Cognitive and Physical Rest May Not Improve Concussion Recovery Time. *Journal of Head Trauma Rehabilitation*, 31(4), pp.233-241.

Buckley, T., Vallabhajosula, S., Oldham, J., Munkasy, B., Evans, K., Krazeise, D., Ketchem, C & Hall, E. (2016) Evidence of a conservative gait strategy in athletes with a history of concussions. *Journal of Sport Health Science*. 5 (4) 417-423. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6188874/

Byrnes, J. P., Miller, D. C., & Schafer, W. D. (1999). Gender differences in risk taking: A meta-analysis. *Psychological Bulletin*, *125*(3), 367–383. https://doi.org/10.1037/0033-2909.125.3.367

Cancian, F. M. (1987). *Love in America: Gender and Self-Development*. Cambridge University Press.

Cantu R. (2006) Concussion Classification: Ongoing Controversy. In: Slobounov S., Sebastianelli W. (eds) Foundations of Sport-Related Brain Injuries. Springer, Boston, MA . https://doi.org/10.1007/0-387-32565-4_5

Cantu, R. C. (2001). Posttraumatic retrograde and anterograde amnesia: pathophysiology and implications in grading and safe return to play. *Journal of athletic training*, 36(3), 244.

Cantu, R. C. (2016). Dysautoregulation/second-impact syndrome with recurrent athletic head injury. World neurosurgery, 95, 601-602.

Cantu, R. C., & Hyman, M. (2012). *Concussions and our kids: America's leading expert on how to protect young athletes and keep sports safe*. Houghton Mifflin Harcourt.

Cardoso, M., Faleiro, R., de Paula, J., Kummer, A., Caramelli, P., Teixeira, A., de Souza, L. and Miranda, A., 2019. Cognitive Impairment Following Acute Mild Traumatic Brain Injury. *Frontiers in Neurology*, 10.

Carlozzi, N., Tyner, C., Kisala, P., Boulton, A., Sherer, M., Chiaravalloti, N. and Tulsky, D., 2019. Measuring Self-Reported Cognitive Function Following TBI. *Journal of Head Trauma Rehabilitation*, 34(5), pp.308-325.

Carpenter, C. J. (2010). A Meta-Analysis of the Effectiveness of Health Belief Model Variables in Predicting Behavior. *Health Communication*, *25*(8), 661–669. https://doi.org/10.1080/10410236.2010.521906

Carrillo, H., & Hoffman, A. (2017). 'Straight with a pinch of bi': The construction of heterosexuality as an elastic category among adult US men. *Sexualities*, *21*(1–2), 90–108. https://doi.org/10.1177/1363460716678561

Carrillo, H., & Hoffman, A. (2017). 'Straight with a pinch of bi': The construction of heterosexuality as an elastic category among adult US men. Sexualities, 21(1–2), 90–108. https://doi.org/10.1177/1363460716678561

Carroll, L. and Rosner, D., n.d. *The Concussion Crisis*.

Carson, D., Gilmore, A., Perry, C. and Gronhaug, K., (2001), Qualitative Marketing Research, Sage Publications, London

Casper, S., 2018. Concussion: A History of Science and Medicine, 1870-2005. *Headache: The Journal of Head and Face Pain*, 58(6), pp.795-810.

Centifanti, L. C. M., Modecki, K. L., MacLellan, S., & Gowling, H. (2014). Driving Under the Influence of Risky Peers: An Experimental Study of Adolescent Risk Taking. *Journal of Research on Adolescence*, *26*(1), 207–222. https://doi.org/10.1111/jora.12187

Centre for Disease Control and Prevention (2019) *Traumatic Brain Injury*. Available at: https://www.cdc.gov/traumaticbraininjury/ [Accessed 5 October 2020].

Champion, V. L., & Skinner, C. S. (2008). *The health belief model.* In K. Glanz, B. K. Rimer, & K. Viswanath (Eds.), *Health behavior and health education: Theory, research, and practice* (p. 45–65).

Chauncey, G. (1994). *Gay New York: Gender, Urban Culture, and the Making of the Gay Male World, 1890-1940* (Illustrated ed.). Basic Books.

Chauncey, G. (1994). Gay New York: Gender, Urban Culture, and the Making of the Gay Male World, 1890-1940 (Illustrated ed.). Basic Books.

Chavez, C. (2008). Conceptualizing from the Inside: Advantages, Complications, and Demands on Insider Positionality. *The Qualitative Report*, *13*(3), 474-494. https://doi.org/10.46743/2160-3715/2008.1589

Cherry, J. D., Stein, T. D., Tripodis, Y., Alvarez, V. E., Huber, B. R., Au, R., ...& Alosco, M. L. (2017). CCL11 is increased in the CNS in chronic traumatic encephalopathy but not in Alzheimer's disease. PloS one, 12(9), e0185541.

Chiauzzi, E., & Wicks, P. (2019). Digital Trespass: Ethical and Terms-of-Use Violations by Researchers Accessing Data From an Online Patient Community. *Journal of Medical Internet Research*, *21*(2), e11985. https://doi.org/10.2196/11985

Chrisman, S. P., Quitiquit, C., & Rivara, F. P. (2013). Qualitative Study of Barriers to Concussive Symptom Reporting in High School Athletics. *Journal of Adolescent Health*, *52*(3), 330-335.e3. https://doi.org/10.1016/j.jadohealth.2012.10.271

Clapp, J. D., Lange, J. E., Russell, C., Shillington, A., & Voas, R. B. (2003). A failed norms social marketing campaign. *Journal of Studies on Alcohol*, *64*(3), 409–414. https://doi.org/10.15288/jsa.2003.64.409

Clarke, V., & Braun, V. (2013). Teaching thematic analysis: Overcoming challenges and developing strategies for effective learning. Psychologist, 26(2), 120-123

Clarke, V., & Braun, V. (2018). Using thematic analysis in counselling and psychotherapy research: A critical reflection. Counselling And Psychotherapy Research, 18(2), 107-110. doi: 10.1002/capr.12165

Clarsen, B., Krosshaug, T., & Bahr, R. (2010). Overuse Injuries in Professional Road Cyclists. *The American Journal of Sports Medicine*, *38*(12), 2494–2501. https://doi.org/10.1177/0363546510376816

Clemitson, S. (2019, February 7). Another cycling season, another shameful case of sexism. The Guardian. https://www.theguardian.com/sport/100-tours-100-tales/2019/feb/07/cycling-stop-treating-women-sex-objects-iljo-keisse

Cloots RJ, van Dommelen JA, Nyberg T, Kleiven S, Geers MG. Micromechanics of diffuse axonal injury: influence of axonal orientation and anisotropy. Biomech Model Mechanobiol. 2011 Jun;10(3):413-22. doi: 10.1007/s10237-010-0243-5. Epub 2010 Jul 16. PMID: 20635116.

Clough, P., Houge Mackenzie, S., Mallabon, L., & Brymer, E. (2016). Adventurous Physical Activity Environments: A Mainstream Intervention for Mental Health. *Sports Medicine*, *46*(7), 963–968. https://doi.org/10.1007/s40279-016-0503-3

Clyde, L & Franklin, W (2012). The Changing Definition of Masculinity (Perspectives in Sexuality) (Softcover reprint of the original 1st ed. 1984 ed.). Springer.

Coakley, J (2002) Using sports to control deviance and violence among youths: Let's be critical and cautious. In Paradoxes of Youth and Sport (Suny Series on Sport, Culture, and Social Relations). State University of New York Press.

Coakley, J. (2016). *Youth Sports in the United States*. In, Green, K., & Smith, A. (Eds.). Routledge Handbook of Youth Sport. Routledge

Collie, A., Makdissi, M., Maruff, P., Bennell, K., & McCrory, P. (2006). Cognition in the days following concussion: comparison of symptomatic versus asymptomatic athletes. *Journal of Neurology, Neurosurgery & Psychiatry*, 77(2), 241-245. Available at: https://www.ncbi.nlm.nih.gov/pubmed/16421129

Collier, A. (1994). Critical realism: An introduction to roy bhaskar's philosophy. London ; New York: Verso.

Concussion Legacy Foundation (2020) *Kelly Catlin*. [online] Available at: https://concussionfoundation.org/story/kelly-catlin [Accessed 5 October 2020].

Concussion Legacy Foundation. 2020. *What Is CTE?*. [online] Available at: <https://concussionfoundation.org/CTE-resources/what-is-CTE> [Accessed 7 October 2020].

Connell, R. W. (1995). *Masculinities*. University of California Press.

Connell, R. W. (2005). *Masculinities* (Second ed.). University of California Press.

Conner, M., Norman, P., & Bell, R. (2002). The theory of planned behavior and healthy eating. *Health Psychology*, *21*(2), 194–201. https://doi.org/10.1037/0278-6133.21.2.194

Cooky, C., Messner, M. A, & Musto, M. (2015). "It's dude time!: A quarter century of excluding women's sports in televised news and highlight shows. *Communication & Sport*, 1-27.

Corrigan JD, Yang J, Singichetti B, Manchester K, & Bogner J (2017). Lifetime prevalence of traumatic brain injury with loss of consciousness. Inj Prev. doi:10.1136/injuryprev-2017-042371

Corsellis, J. A. N., Bruton, C. J., & Freeman-Browne, D. (1973). The aftermath of boxing. Psychological medicine, 3(3), 270-303.

Covassin, T., Moran, R. and Wilhelm, K., 2013. Concussion Symptoms and Neurocognitive Performance of High School and College Athletes Who Incur Multiple Concussions. *The American Journal of Sports Medicine*, 41(12), pp.2885-2889.

Cowan, D & Taylor, I. (2016) 'I'm proud of what I achieved; I'm also ashamed of what I done': a soccer coach's tale of sport, status, and criminal behaviour, Qualitative Research in Sport, Exercise and Health, 8:5, 505-518, DOI: 10.1080/2159676X.2016.1206608

Cresswell, J. and Plano Clark, V., 2007. Designing and Conducting Mixed Methods Research. *Australian and New Zealand Journal of Public Health*, 31(4), pp.388-388.

Crisco, J., Fiore, R., Beckwith, J., Chu, J., Brolinson, P., Duma, S., McAllister, T., Duhaime, A. and Greenwald, R., 2010. Frequency and Location of Head Impact Exposures in Individual Collegiate Football Players. *Journal of Athletic Training*, 45(6), pp.549-559.

Critchley, M. (1949) Punch-drunk syndromes: the chronic traumatic encephalopathy of boxers. *Hommage a Clovis Vincent*

Crotty, M. J. (1998). *The Foundations of Social Research: Meaning and Perspective in the Research Process* (First ed.). SAGE Publications Ltd.

Curry, T. J. (1993). A little pain never hurt anyone: Athletic career socialization and the normalization of sports injury. *Symbolic Interaction*, 16(3), 273- 290.

Curry, T., & Strauss, R. H. (1994). A Little Pain Never Hurt Anyone: A Photo-Essay on the Normalization of Sports Injury. Sociology of Sport Journal, 11, 195-208.

Cycling News. (2017, December 12). *Philippa York: Cycling's conservative culture suppresses LGBT issues*. Cyclingnews.Com. https://www.cyclingnews.com/news/philippa-york-cyclings-conservative-culture-suppresses-lgbt-issues/

Cycling, B. (2017). *British Cycling | 2017 - a year in review*. British Cycling. http://www.ourstory.britishcycling.org.uk/

Cyclingnews. (2021, January 7). Belgian U23 'cross racer Justin Laevens comes out as gay. Cyclingnews.Com. https://www.cyclingnews.com/news/belgian-u23-cross-racer-justin-laevens-comes-out-as-gay/

Dagi TF: The management of head trauma, in Greenblatt SH (ed) (1997). A History of Neurosurgery. Park Ridge, IL: *American Association of Neurological Surgeons*, pp 289-343

Dahlberg, K., 2019. *Natural Resources And People*. Milton: Routledge.

Dahlquist, M., Leisz, M. C., & Finkelstein, M. (2015). The club-level road cyclist: injury, pain, and performance. *Clinical journal of sport medicine : official journal of the Canadian Academy of Sport Medicine*, *25*(2), 88–94. https://doi.org/10.1097/JSM.0000000000000111

Dallmeier JD, Meysami S, Merrill DA, Raji CA. Emerging advances of in vivo detection of chronic traumatic encephalopathy and traumatic brain injury. Br J Radiol. 2019 Sep;92(1101):20180925. doi: 10.1259/bjr.20180925. Epub 2019 Jul 26. PMID: 31287716; PMCID: PMC6732918.

Daly, E., White, A., Blackett, A. D., & Ryan, L. (2021). Pressure. A Qualitative Analysis of the Perception of Concussion and Injury Risk in Retired Professional Rugby Players. *Journal of Functional*

*Morphology and Kinesiology*, *6*(3), 78. MDPI AG. Retrieved from http://dx.doi.org/10.3390/jfmk6030078

Danermark, B., Ekström, M., & Karlsson, J. C. (2019). Explaining Society: Critical Realism in the Social Sciences (Routledge Studies in Critical Realism) (2nd ed.). Routledge.

Daneshvar D, Nowinski C, McKee A, Cantu R (2011). The Epidemiology of Sport-Related Concussion. *Clin Sports Med*. 30(1):1-17. doi:10.1016/j.csm.2010.08.006

D'Ascanio S, Alosco ML, Stern RA. Chronic traumatic encephalopathy: clinical presentation and in vivo diagnosis. Handb Clin Neurol. 2018;158:281-296. doi: 10.1016/B978-0-444-63954-7.00027-6. PMID: 30482356.

Dashper, K. (2012). 'Dressage Is Full of Queens!' Masculinity, Sexuality and Equestrian Sport. Sociology, 46(6), 1109–1124. https://doi.org/10.1177/0038038512437898

Dave Elder-Vass & Karin Zotzmann (2021) Call for papers: Special issue of Journal of Critical Realism on Critical Realism and Pragmatism, Journal of Critical Realism, 20:1, 123, DOI: 10.1080/14767430.2021.1875318

Davidson J. A. (2005). Epidemiology and outcome of bicycle injuries presenting to an emergency department in the United Kingdom. *European journal of emergency medicine : official journal of the European Society for Emergency Medicine*, *12*(1), 24–29. https://doi.org/10.1097/00063110-200502000-00007

Davis, G. (2015). *Contesting Intersex: The Dubious Diagnosis (Biopolitics, 10)* (1st ed.). NYU Press.

De Bernardo N, Barrios C, Vera P, Laiz C, Hadala M. (2012) Incidence and risk for traumatic an overuse injury in top-level road cyclists. *Journal of Sports Science*. 30 (10) 1047-53. Available at: 10.1080/02640414.2012.687112

De Marco, A. and Barth, J., 2014. Historical Perspectives of Sport-Related Concussion. *Oxford Handbooks Online*,.

Deakin, H., & Wakefield, K. (2014). Skype interviewing: reflections of two PhD researchers. *Qualitative Research*, *14*(5), 603–616. https://doi.org/10.1177/1468794113488126

Dean, K. (2006). Realism, philosophy and social science. Basingstoke England ; New York: Palgrave Macmillan.

Dean, N. & Bundon, A. (2020) 'You're only falling into water!': exploring surfers' understandings of concussion in Canadian surf culture, Qualitative Research in Sport, Exercise and Health, 12:4, 579-596, DOI: 10.1080/2159676X.2019.1657930

Decock M, De Wilde L, Van den Bossche L, Steyaert A. and Van Tongel A. (2016) Incidence and aetiology of acute injuries during competitive road cycling. *British Journal of Sports Medicine*, 50: 669-672. Available at: https://bjsm.bmj.com/content/50/11/669

Defoe, I. N., Semon Dubas, J., & Romer, D. (2019). Heightened Adolescent Risk-Taking? Insights From Lab Studies on Age Differences in Decision-Making. *Policy Insights from the Behavioral and Brain Sciences*, *6*(1), 56–63. https://doi.org/10.1177/2372732218801037

Dempsey, R. C., McAlaney, J., & Bewick, B. M. (2018). A Critical Appraisal of the Social Norms Approach as an Interventional Strategy for Health-Related Behavior and Attitude Change. *Frontiers in Psychology*, *9*, 1. https://doi.org/10.3389/fpsyg.2018.02180

Denzin, N. K., & Lincoln, Y. S. (2005). Introduction: The Discipline and Practice of Qualitative Research. In N. K. Denzin & Y. S. Lincoln (Eds.), *The Sage handbook of qualitative research* (pp. 1–32). Sage Publications Ltd.

Department for Education. (2019, July 15). *School sport and activity action plan*. GOV.UK. https://www.gov.uk/government/publications/school-sport-and-activity-action-plan

Desai, N., Wiebe, D., Corwin, D., Lockyer, J., Grady, M. and Master, C., 2019. Factors Affecting Recovery Trajectories in Pediatric Female Concussion. *Clinical Journal of Sport Medicine*, 29(5), pp.361-367.

Deshpande, A., & Jadad, A. R. (2006). Web 2.0: Could it help move the health system into the 21st century? *The Journal of Men's Health & Gender*, *3*(4), 332–336. https://doi.org/10.1016/j.jmhg.2006.09.004

Dessy, A., Rasouli, J. and Choudhri, T., 2015. Second Impact Syndrome. *Neurosurgery Quarterly*, 25(3), pp.423-426.

Dillon, D. R., O'Brien, D. G., & Heilman, E. E. (2000). Literacy research in the next millennium: From paradigms to pragmatism and practicality. *Reading Research Quarterly*, *35*(1), 10-26. https://doi.org/10.1598/RRQ.35.1.2

Ditz, T. L. (2004). The New Men's History and the Peculiar Absence of Gendered Power: Some Remedies from Early American Gender History. *Gender History*, *16*(1), 1–35. https://doi.org/10.1111/j.0953-5233.2004.324_1.x

Doty, J. (2006). Sports Build Character?! *Journal of College and Character*, *7*(3), 1. https://doi.org/10.2202/1940-1639.1529

Drummond, M. J. N. *et al.* (2015) 'Homosocial intimacy among Australian undergraduate men', *Journal of Sociology*, 51(3), pp. 643–656. doi: 10.1177/1440783313518251.

Dunning, E. (1999). *Sport Matters: Sociological Studies of Sport, Violence and Civilisation* (1st ed.). Routledge.

Dunning, E. G., & Sheard, K. G. (1973). The Rugby Football Club as a Type of 'Male Preserve': Some Sociological Notes. *International Review of Sport Sociology*, *8*(3), 5–24. https://doi.org/10.1177/101269027300800301

Durand, E., Chevignard, M., Ruet, A., Dereix, A., Jourdan, C., & Pradat-Diehl, P. (2017). History of traumatic brain injury in prison populations: A systematic review. *Annals of physical and rehabilitation medicine*, *60*(2), 95–101. https://doi.org/10.1016/j.rehab.2017.02.003

Eime, R., Harvey, J., Charity, M., & Payne, W. (2017). Population levels of sport participation: Implications for sport policy. *Journal of Science and Medicine in Sport*, *20*, e34. https://doi.org/10.1016/j.jsams.2017.01.099

Eitzen, S. (2001). *Sport in Contemporary Society: An Anthology*. New York: MacMillian.

Ejnavarzala, H. (2019). Epistemology–Ontology Relations in Social Research: A Review. Sociological Bulletin, 68(1), 94–104. https://doi.org/10.1177/0038022918819369

Elias N (1987) 'The retreat of sociologists into the present', Theory, Culture and Society, 4:2–3, pp. 223–47

Elias, N. (1956) 'Problems of involvement and detachment', British Journal of Sociology, 7, pp. 226–52.

Elias, N. (2008). *Quest for Excitement: Sport and Leisure in the Civilising Process (Volume 7) (The Collected Works of Norbert Elias)* (2nd ed.). University College Dublin Press.

Elias, N., & Jephcott, E. (1978). The civilizing process (Vol. 1). Oxford: Blackwell.

Ellemberg, D., Henry, L., Macciocchi, S., Guskiewicz, K. and Broglio, S., (2009). Advances in Sport Concussion Assessment: From Behavioral to Brain Imaging Measures. *Journal of Neurotrauma*, 26(12), pp.2365-2382.

Elliot, J. Anderson, R. Collins, S & Heron, N. (2019) Sports-related concussion (SRC) assessment in road cycling: a systematic review and call to action. *BMJ Open Sports and Exercise Medicine*. 1 (5) 1-5. Available at: https://bmjopensem.bmj.com/content/5/1/e000525

Elliott J, Anderson R, Collins S, Heron N. Sports-related concussion (SRC) assessment in road cycling: a systematic review and call to action. *BMJ Open Sport Exerc Med*. 2019;5(1):e000525. doi:10.1136/bmjsem-2019-000525
Elliott, J., Anderson, R., Collins, S., & Heron, N. (2019). Sports-related concussion (SRC) assessment in road cycling: a systematic review and call to action. *BMJ Open Sport & Exercise Medicine*, *5*(1), e000525. https://doi.org/10.1136/bmjsem-2019-000525

Emery, C. A., & Tyreman, H. (2009). Sport participation, sport injury, risk factors and sport safety practices in Calgary and area junior high schools. *Paediatrics & Child Health*, *14*(7), 439–444. https://doi.org/10.1093/pch/14.7.439

Engström, I., Gregersen, N. P., Granström, K., & Nyberg, A. (2008). Young drivers—Reduced crash risk with passengers in the vehicle. *Accident Analysis & Prevention*, *40*(1), 341–348. https://doi.org/10.1016/j.aap.2007.07.001

Engström, S., Jumisko, E., Shahim, P., Lehto, N., Blennow, K., Zetterberg, H., & Tegner, Y. (2020). Losing the identity of a hockey player: the long-term effects of concussions. *Concussion*, *5*(2). https://doi.org/10.2217/cnc-2019-0014

Esterov D, Greenwald B. (2017) Autonomic Dysfunction after Mild Traumatic Brain Injury. *Brain Sci*. 7(12):100. doi:10.3390/brainsci7080100

Esterov D, Greenwald B. Autonomic Dysfunction after Mild Traumatic Brain Injury. *Brain Sci*. 2017;7(12):100. doi:10.3390/brainsci7080100
Evansm, L., Wasielewski, P., & von Buseck, C. R. (1982). Compulsory Seat Belt Usage and Driver Risk-Taking Behavior. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, *24*(1), 41–48. https://doi.org/10.1177/001872088202400105

Eysenbach, G. (2008). Medicine 2.0: Social Networking, Collaboration, Participation, Apomediation, and Openness. *Journal of Medical Internet Research*, *10*(3), e22. https://doi.org/10.2196/jmir.1030

Fabiano, P. M., Perkins, H. W., Berkowitz, A., Linkenbach, J., & Stark, C. (2003). Engaging Men as Social Justice Allies in Ending Violence Against Women: Evidence for a Social Norms Approach. *Journal of American College Health*, *52*(3), 105–112. https://doi.org/10.1080/07448480309595732

Faden, A. I., & Loane, D. J. (2015). Chronic neurodegeneration after traumatic brain injury: Alzheimer disease, chronic traumatic encephalopathy, or persistent neuroinflammation?. *Neurotherapeutics : the journal of the American Society for Experimental NeuroTherapeutics*, *12*(1), 143–150. https://doi.org/10.1007/s13311-014-0319-5

Fainaru-Wada, M. and Fainaru, S., 2014. *League Of Denial*. New York: Three Rivers Press.

Falcous, M. (2017). Why We Ride: Road Cyclists, Meaning, and Lifestyles. Journal of Sport and Social Issues, 41(3), 239–255. https://doi.org/10.1177/0193723517696968

Fann, J. R., Ribe, A. R., Pedersen, H. S., Fenger-Grøn, M., Christensen, J., Benros, M. E., & Vestergaard, M. (2018). Long-term risk of dementia among people with traumatic brain injury in Denmark: a population-based observational cohort study. *The lancet. Psychiatry*, *5*(5), 424–431. https://doi.org/10.1016/S2215-0366(18)30065-8

Farrell M, Aherne S, O'Riordan S, O'Keeffe E, Greene C, Campbell M. (2019) Blood-brain barrier dysfunction in a boxer with chronic traumatic encephalopathy and schizophrenia. *Clin Neuropathol*. 38(03):51-58. doi:10.5414/np301130

Farrell M, Aherne S, O'Riordan S, O'Keeffe E, Greene C, Campbell M. Blood-brain barrier dysfunction in a boxer with chronic traumatic encephalopathy and schizophrenia. *Clin Neuropathol*. 2019;38(03):51-58. doi:10.5414/np301130

Farrell, K. C., Reisinger, K. D., & Tillman, M. D. (2003). Force and repetition in cycling: possible implications for iliotibial band friction syndrome. *The Knee*, 10(1), 103–109. https://doi.org/10.1016/s0968-0160(02)00090-x

Fathi K. (2013) Positivism/Neopositivism. In: Runehov A.L.C., Oviedo L. (eds) Encyclopedia of Sciences and Religions. Springer, Dordrecht. https://doi.org/10.1007/978-1-4020-8265-8_201297

Fausto-Sterling, A. (2000). *Sexing the Body: Gender Politics and the Construction of Sexuality* (Revised ed.). Basic Books.

Festinger, L. (1962). Cognitive Dissonance. *Scientific American*, *207*(4), 93–106. https://doi.org/10.1038/scientificamerican1062-93

Figner, B., & Weber, E. U. (2011). Who Takes Risks When and Why? *Current Directions in Psychological Science*, *20*(4), 211–216. https://doi.org/10.1177/0963721411415790

Finch, C. (2006a). A new framework for research leading to sports injury prevention. *Journal of Science and Medicine in Sport*, *9*(1–2), 3–9. https://doi.org/10.1016/j.jsams.2006.02.009

Finch, C. (2006b). A new framework for research leading to sports injury prevention. *Journal of Science and Medicine in Sport*, *9*(1–2), 3–9. https://doi.org/10.1016/j.jsams.2006.02.009

Finch, C., Valuri, G., & Ozanne-Smith, J. (1998). Sport and active recreation injuries in Australia: evidence from emergency department presentations. *British journal of sports medicine*, 32(3), 220-225.

Finlay, L., & Gough, B. (2003). *Reflexivity: A Practical Guide for Researchers in Health and Social Sciences* (1st ed.). Wiley-Blackwell.

Fishbein, M. (2008). Reasoned Action, Theory of. *The International Encyclopedia of Communication*, 1. https://doi.org/10.1002/9781405186407.wbiecr017

Fleming, P. J., Lee, J. G., & Dworkin, S. L. (2014). "Real men don't": constructions of masculinity and inadvertent harm in public health interventions. *American journal of public health*, *104*(6), 1029–1035. https://doi.org/10.2105/AJPH.2013.301820

Fontana, A., & Frey, J. H. (2000). *The interview: From structured questions to negotiated text*. In N. K. Denzin, & Y. S. Lincoln (Eds.), Handbook of qualitative research (2nd ed., pp. 645-672). Thousand Oaks, CA: Sage.

Fraas, M. R., & Burchiel, J. (2016). A systematic review of education programmes to prevent concussion in rugby union. *European Journal of Sport Science*, *16*(8), 1212–1218. https://doi.org/10.1080/17461391.2016.1170207

Freud, S., Strachey, J., Marcus, S., & Chodorow, N. J. (1905). *Three Essays on the Theory of Sexuality* (Revised ed.). Basic Books.

Fuller, C. W. (2008). Catastrophic Injury in Rugby Union. *Sports Medicine*, *38*(12), 975–986. https://doi.org/10.2165/00007256-200838120-00002

Fuller, C. W., Junge, A., & Dvorak, J. (2011). Risk management: FIFA's approach for protecting the health of football players. *British Journal of Sports Medicine*, *46*(1), 11–17. https://doi.org/10.1136/bjsports-2011-090634

Fuller, C. W., Molloy, M. G., Bagate, C., Bahr, R., Brooks, J. H. M., Donson, H., Kemp, S. P. T., McCrory, P., McIntosh, A. S., Meeuwisse, W. H., Quarrie, K. L., Raftery, M., & Wiley, P. (2007). Consensus Statement on Injury Definitions and Data Collection Procedures for Studies of Injuries in Rugby Union. *Clinical Journal of Sport Medicine*, *17*(3), 177–181. https://doi.org/10.1097/jsm.0b013e31803220b3

Fuller, C., & Drawer, S. (2004). The Application of Risk Management in Sport. *Sports Medicine*, *34*(6), 349–356. https://doi.org/10.2165/00007256-200434060-00001

Fuller, C., & Vassie, L. H. (2004). *Health And Safety Management: Principles And Best Practice* (1st ed.). Pearson College Div.

Gair, S. (2012). Feeling Their Stories: Contemplating Empathy, Insider/Outsider Positionings, and Enriching Qualitative Research. Qualitative Health Research, 22(1), 134–143. https://doi.org/10.1177/1049732311420580

Gamble, T., & Walker, I. (2016). Wearing a Bicycle Helmet Can Increase Risk Taking and Sensation Seeking in Adults. *Psychological Science*, *27*(2), 289–294. https://doi.org/10.1177/0956797615620784

Gammons, M. (2013) Helmets in Sport: Fact and Fallacy. *Current Sports Medicine Reports.* 12 (6) 377-380. Available at: https://journals.lww.com/acsm-csmr/Fulltext/2013/11000/Helmets_in_Sport___Fact_and_Fallacy.9.aspx

Garavito, D., Reyna, V. and DeTello, J. (2018). A concussion by any other name: Differences in willingness to risk brain injury by label and level of participation in high-school and college sports. *Applied Cognitive Psychology*,.

Gardiner, S. M. (2006). A Core Precautionary Principle*. *Journal of Political Philosophy*, *14*(1), 33–60. https://doi.org/10.1111/j.1467-9760.2006.00237.x

Gardner, M., & Steinberg, L. (2005). Peer Influence on Risk Taking, Risk Preference, and Risky Decision Making in Adolescence and Adulthood: An Experimental Study. *Developmental Psychology*, *41*(4), 625–635. https://doi.org/10.1037/0012-1649.41.4.625

Gatz, M., Messner, M. A., & Ball-Rokeach, S. J. (2002). *Paradoxes of Youth and Sport (Suny Series on Sport, Culture, and Social Relations)*. State University of New York Press.

Gavett, B. E., Stern, R. A., & McKee, A. C. (2011). Chronic traumatic encephalopathy: a potential late effect of sport-related concussive and subconcussive head trauma. Clinics in sports medicine, 30(1), 179-188.

Gavett, B. E., Stern, R. A., & McKee, A. C. (2011). Chronic traumatic encephalopathy: a potential late effect of sport-related concussive and subconcussive head trauma. Clinics in sports medicine, 30(1), 179-188.

Ghaill, M. (1994). *Making Of Men: Masculinities, Sexualities and Schooling* (1st ed.). Open University Press.

Gheorghiu, A., Delhomme, P., & Felonneau, M. L. (2015). Peer pressure and risk taking in young drivers' speeding behavior. *Transportation Research Part F: Traffic Psychology and Behaviour*, *35*, 101–111. https://doi.org/10.1016/j.trf.2015.10.014

Giaccardi, S., Monique Ward, L., Seabrook, R. C., Manago, A., & Lippman, J. R. (2017). Media Use and Men's Risk Behaviors: Examining the Role of Masculinity Ideology. *Sex Roles*, *77*(9–10), 581–592. https://doi.org/10.1007/s11199-017-0754-y

Giulianotti, R. (2015). *Sport: A Critical Sociology* (2nd ed.). Polity.

Giza, C., Choe, M. and Barlow, K., 2018. Determining If Rest Is Best After Concussion. *JAMA Neurology*, 75(4), p.399.

Glesne, C. (2014). *Becoming Qualitative Researchers: An Introduction* (5th ed.). Pearson.

Glick, P., Gangl, C., Gibb, S., Klumpner, S., & Weinberg, E. (2007). Defensive reactions to masculinity threat: More negative affect toward effeminate (but not masculine) gay men. Sex Roles, 57(1-2), 55-59

Glider, P., Midyett, S. J., Mills-Novoa, B., Johannessen, K., & Collins, C. (2001). Challenging the Collegiate Rite of Passage: A Campus-Wide Social Marketing Media Campaign to Reduce Binge Drinking. *Journal of Drug Education*, *31*(2), 207–220. https://doi.org/10.2190/u466-epfg-q76d-yhtq

Goffman, E. (1963). *Stigma;: Notes on the management of spoiled identity (A Spectrum book)*. Prentice-Hall.

Goldstone, J. A. (1996). Gender, Work, and Culture: Why the Industrial Revolution Came Early to England but Late to China. *Sociological Perspectives*, *39*(1), 1–21. https://doi.org/10.2307/1389340

GOLES T, HIRSCHHEIM R (2000) The paradigm is dead, the paradigm is dead … long live the paradigm: the legacy of Burell and Morgan, Omega, Vol 28, p 249-268

Gordon, K., Thompson, W., McFaull, S & Taylor, B. (2013) 'knock on the noggin', *Paediatrics & Child Health*,18 (3) 142. https://doi.org/10.1093/pch/18.3.142

Gorgoraptis, N., Li, L., Whittington, A., Zimmerman, K., Maclean, L., McLeod, C., Ross, E., Heslegrave, A., Zetterberg, H., Passchier, J., Matthews, P., Gunn, R., McMillan, T. and Sharp, D. (2019). In vivo detection of cerebral tau pathology in long-term survivors of traumatic brain injury. Science Translational Medicine, 11(508), p.eaaw1993.

Gorski, P. S. (2013). "What is Critical Realism? And Why Should You Care?" Contemporary Sociology, 42(5), 658–670. https://doi.org/10.1177/0094306113499533

Gough, B., & Madill, A. (2012). Subjectivity in psychological science: From problem to prospect. *Psychological Methods*, *17*(3), 374–384. https://doi.org/10.1037/a0029313

Graham, R. Council, N., Medicine, I. and Board on Children, Y. (2014). *Sports-Related Concussions In Youth*. Washington: National Academies Press.

Grant, B. M., & Giddings, L. S. (2002). Making sense of methodologies: A paradigm framework for the novice researcher. *Contemporary Nurse*, *13*(1), 10–28. https://doi.org/10.5172/conu.13.1.10

Green, M., Turner, C., Purdie, D. M., & McClure, R. (2003). Injury related risk behavior — a study of Australian skydivers. *Journal of Science and Medicine in Sport*, *6*(2), 166–175. https://doi.org/10.1016/s1440-2440(03)80252-9

Greve, M. W., & Modabber, M. R. (2012). An Epidemic of Traumatic Brain Injury in Professional Cycling. *Clinical Journal of Sport Medicine*, *22*(2), 81–82. https://doi.org/10.1097/jsm.0b013e318243bf32

Greve, MW & Modabber MR. (2012) An epidemic of traumatic brain injury in professional cycling: a call to action. *Clinical Journal of Sports Medicine*. 22 (2) 81-2. Available at: 10.1097/JSM.0b013e318243bf32

Grix, J. (2001). Introducing Students to the Generic Terminology of Social Research. *Politics*, *22*(3), 175–186. https://doi.org/10.1111/1467-9256.00173

Grous, A. (2012). The 'Olympic cycling effect': a report prepared for Sky and British Cycling.

Grunbaum, J. A., Kann, L., Kinchen, S. A., Williams, B., Ross, J. G., Lowry, R., & Kolbe, L. (2002). Youth Risk Behavior Surveillance - United States, 2001. *Journal of School Health*, *72*(8), 313–328. https://doi.org/10.1111/j.1746-1561.2002.tb07917.x

Guardian (2018, May 1). *Philippa York says macho culture prevents cyclists coming out*. The Guardian. https://www.theguardian.com/sport/2018/apr/30/philippa-york-macho-culture-cyclists-coming-out

Guba, E. G., & Lincoln, Y. S. (2005). Paradigmatic Controversies, Contradictions, and Emerging Confluences. In N. K. Denzin & Y. S. Lincoln (Eds.), *The Sage handbook of qualitative research* (pp. 191–215). Sage Publications Ltd.

Guskiewicz K, McCrea M, Marshall S et al. Cumulative Effects Associated With Recurrent Concussion in Collegiate Football Players. *JAMA*. 2003;290(19):2549. doi:10.1001/jama.290.19.2549

Guskiewicz, K. and Mihalik, J. (2011). Biomechanics of Sport Concussion. *Exercise and Sport Sciences Reviews*, 39(1), pp.4-11.

Haeberle, H. S., Navarro, S. M., Power, E. J., Schickendantz, M. S., Farrow, L. D., & Ramkumar, P. N. (2018). Prevalence and Epidemiology of Injuries Among Elite Cyclists in the Tour de France. *Orthopaedic journal of sports medicine*, *6*(9), 2325967118793392. https://doi.org/10.1177/2325967118793392

Haines, C., Smith, T. M., & Baxter, M. F. (2010). Participation in the risk-taking occupation of skateboarding. *Journal of Occupational Science*, *17*(4), 239–245. https://doi.org/10.1080/14427591.2010.9686701

Halberstam, J. J. (1998). *Female Masculinity*. Duke University Press Books.

Hall, R., Hall, R. and Chapman, M., 2005. Definition, Diagnosis, and Forensic Implications of Postconcussional Syndrome. *Psychosomatics*, 46(3), pp.195-202.

Hallberg, L. R.-M. (2006). The "core category" of grounded theory: Making constant comparisons. *International Journal of Qualitative Studies on Health and Well-Being*, *1*(3), 141–148. https://doi.org/10.1080/17482620600858399

Hamdan, A. K. (2010). REFLEXIVITY OF DISCOMFORT IN INSIDER-OUTSIDER EDUCATIONAL RESEARCH. *McGill Journal of Education / Revue Des Sciences De l'éducation De McGill*, *44*(3). Retrieved from https://mje.mcgill.ca/article/view/689

Hanna, P. (2012). Using internet technologies (such as Skype) as a research medium: a research note. *Qualitative Research*, *12*(2), 239–242. https://doi.org/10.1177/1468794111426607

Hardwicke, J., & Howard Hurst. (2020). Concussion knowledge and attitudes amongst competitive cyclists. *Journal of Science and Cycling*, *9*(3), 53-66. https://doi.org/10.28985/1220.jsc.05

Hargreaves, J. A. (1990) 'Gender on the Sports Agenda', *International Review for the Sociology of Sport*, 25(4), pp. 287–307. doi: 10.1177/101269029002500403.

Harmon K, Drezner J, Gammons M et al. American Medical Society for Sports Medicine Position Statement. *Clinical Journal of Sport Medicine*. 2013;23(1):1-18. doi:10.1097/jsm.0b013e31827f5f93 Harmon, K. (2013) "American Medical Society for Sports Medicine Position Statement." *Clinical Journal of Sport Medicine*. 23 (1), 1–18. Available at: doi:10.1097/jsm.0b013e31827f5f93

Harmon, K. (2013) "American Medical Society for Sports Medicine Position Statement." *Clinical Journal of Sport Medicine*. 23 (1), 1–18. Available at: doi:10.1097/jsm.0b013e31827f5f93

Hathcoat J.D., Meixner C., Nicholas M.C. (2018) Ontology and Epistemology. In: Liamputtong P. (eds) Handbook of Research Methods in Health Social Sciences. Springer, Singapore. https://doi.org/10.1007/978-981-10-2779-6_56-1

Hazrati, L (2016). *Dave Mirra Had Brain Trauma Disease CTE When He Died, Doctors Say*. The Guardian [online] Available at: <https://www.theguardian.com/sport/2016/may/24/bmx-dave-mirra-brain-trauma-disease-cte> [Accessed 12 October 2020].

Hearn, J. (2004). From Hegemonic Masculinity to the Hegemony of Men. Feminist Theory, 5(1), 49–72. https://doi.org/10.1177/1464700104040813

Henninger, D. E., Madden, D. J., & Huettel, S. A. (2010). Processing speed and memory mediate age-related differences in decision making. *Psychology and Aging*, *25*(2), 262–270. https://doi.org/10.1037/a0019096

Herek, G. M. (2004). Beyond “Homophobia”: Thinking about sexual prejudice and stigma in the twenty-first century. *Sexuality Research and Social Policy*, *1*(2), 6–24. https://doi.org/10.1525/srsp.2004.1.2.6

Heron, N & Elliot, J., Jones, N., Loosemore, M & Kemp, S. (2020) Sports-related concussion (SRC) in road cycling: the RoadsIde heaD Injury assEssment (RIDE) for elite road cycling. *British Journal of Sports Medicine*. 54(3) Available at: https://bjsm.bmj.com/content/54/3/127

Heron, N. (2020). Editorial: How do you diagnosis and manage sports-related concussion (SRC) in road cycling? A Plan for developing SRC-assessment and management protocols within road cycling. *Journal of Science and Cycling*, *9*(1), 1-4. https://doi.org/10.28985/0620.jsc.07

Heron, N., Elliott, J., Jones, N., Loosemore, M., & Kemp, S. (2019). Sports-related concussion (SRC) in road cycling: the RoadsIde heaD Injury assEssment (RIDE) for elite road cycling. *British Journal of Sports Medicine*, *54*(3), 127–128. https://doi.org/10.1136/bjsports-2019-101455

Heron, N., Sarriegui, I., Jones, N., & Nolan, R. (2020). International consensus statement on injury and illness reporting in professional road cycling. *The Physician and Sportsmedicine*, 1–7. https://doi.org/10.1080/00913847.2020.1830692

*Hierarchy of Controls | NIOSH | CDC*. (2015). Centre for Disease Control. https://www.cdc.gov/niosh/topics/hierarchy/default.html

Hirad, A., Bazarian, J., Merchant-Borna, K., Garcea, F., Heilbronner, S., Paul, D., Hintz, E., van Wijngaarden, E., Schifitto, G., Wright, D., Espinoza, T. and Mahon, B., 2019. A common neural signature of brain injury in concussion and subconcussion. *Science Advances*, 5(8), p.eaau3460.

Hobson, W., 2020. *From Scientist To Salesman How Bennet Omalu, Doctor Of ‘Concussion’ Fame, Built A Career On Distorted Science*. [online] Available at: <https://www.washingtonpost.com/graphics/2020/sports/cte-bennet-omalu/> [Accessed 7 October 2020].

Holloway, I., & Todres, L. (2003). The Status of Method: Flexibility, Consistency and Coherence. *Qualitative Research*, *3*(3), 345–357. https://doi.org/10.1177/1468794103033004

Holstein, J. A., Jones, R. S., & Jr., G. K. E. (2016). *Is There Life After Football?: Surviving the NFL* (Reprint ed.). NYU Press.

Holt, A. (2010). Using the telephone for narrative interviewing: a research note. *Qualitative Research*, *10*(1), 113–121. https://doi.org/10.1177/1468794109348686

Honarmandi, P., Sadegh, A. & Cavallaro, P. (2014) Do American Football Helmets Protect Players Against Concussions?. *International Mechanical Engineering Congress and Exposition.* 15-21. Available at: https://asmedigitalcollection.asme.org/IMECE/proceedings-abstract/IMECE2013/56222/V03BT03A052/260624

Honarmandi, P., Sadegh, A. M., & Cavallaro, P. V. (2015). Modelling and impact analysis of football player head with helmet toward mitigating brain concussion. *International Journal of Experimental and Computational Biomechanics*, *3*(4), 267. https://doi.org/10.1504/ijecb.2015.074732

Horvath, P., & Zuckerman, M. (1993). Sensation seeking, risk appraisal, and risky behavior. *Personality and Individual Differences*, *14*(1), 41–52. https://doi.org/10.1016/0191-8869(93)90173-z

Howe, D. (2003). *Sport, Professionalism and Pain: Ethnographies of Injury and Risk (Ethics and Sport)* (1st ed.). Routledge.

Howe, D. (2004). *Sport, Professionalism and Pain: Ethnographies of Injury and Risk (Ethics and Sport)* (1st ed.). Routledge.

Høye, A., 2018. Bicycle helmets – To wear or not to wear? A meta-analyses of the effects of bicycle helmets on injuries. *Accident Analysis & Prevention*, 117, pp.85-97.

Hoyert DL, Xu J. Deaths: preliminary data for 2011. Natl Vital Stat Rep. 2012 Oct 10;61(6):1-51. PMID: 24984457.

Hughes, R., & Coakley, J. (1991). Positive Deviance among Athletes: The Implications of Overconformity to the Sport Ethic. *Sociology of Sport Journal*, *8*(4), 307–325. https://doi.org/10.1123/ssj.8.4.307

Hurley, D. (2017). Brain Bank Study of Football Players Finds Pervasive CTE, but True Prevalence Remains Unknown. Neurology Today, 17(17), 1. doi: 10.1097/01.nt.0000524836.75151.34

Hurmerinta-Peltomäki, L. and Nummela, N., 2006. Mixed methods in international business research: A value-added perspective. *Management International Review*, 46(4), pp.439-459.

Hurst, H. T., Atkins, S., & Dickinson, B. D. (2018). The magnitude of translational and rotational head accelerations experienced by riders during downhill mountain biking. *Journal of Science and Medicine in Sport*, *21*(12), 1256–1261. https://doi.org/10.1016/j.jsams.2018.03.007

Hurst, H. T., Hancock, S., Hardwicke, J., & Anderson, E. (2020). Does participation in Downhill mountain biking affect measures of executive function?. *Journal of Science and Cycling*, *9*(3), 83-93. https://doi.org/10.28985/1220.jsc.04

Hurst, H. T., Novak, A. R., Cheung, S. S., & Atkins, S. (2019). Knowledge of and attitudes towards concussion in cycling: A preliminary study. *Journal of Science and Cycling*, *8*(1), 11–17. https://doi.org/10.28985/1906.jsc.03

Hurst, H., Atkins, S & Dickinson, B. (2018) The magnitude of translational and rotational head accelerations experienced by riders during downhill mountain biking. *Journal of Science and Medicine in Sport*. 21 (12) 1256-1261. Available at:https://www.ncbi.nlm.nih.gov/pubmed/29606559

Hurst, H., Novak, A., Cheung, S & Atkins, S. (2019) Knowledge of and attitudes towards concussion in cycling: A preliminary study. *Journal of Science and Cycling.* 8 (1) 11-17. Available at: http://www.jsc-journal.com/ojs/index.php?journal=JSC&page=article&op=view&path%5B%5D=10.28985%2F1906.jsc.03&path%5B%5D=534

Hurst, H., Rylands, L., Atkins, S. & Roberts, S. (2018) Profiling of translational and rotational head accelerations in youth BMX with and without neck brace. *Journal of Science and Medicine in Sport*. 21 (3) 263-267. Available at: https://www.ncbi.nlm.nih.gov/pubmed/28595865

Hutchinson, S., Marsiglio, W., & Cohan, M. (2002). Interviewing Young Men about Sex and Procreation: Methodological Issues. *Qualitative Health Research*, *12*(1), 42–60. https://doi.org/10.1177/1049732302012001004

Hylton, K. (2017, April 27). *The unbearable whiteness of cycling*. The Conversation. https://theconversation.com/the-unbearable-whiteness-of-cycling-76256

Hyman, M. (2009). *Until It Hurts: America's Obsession with Youth Sports and How It Harms Our Kids* (2nd ed.). Beacon Press.

Iverson, G., 2019. Network Analysis and Precision Rehabilitation for the Post-concussion Syndrome. *Frontiers in Neurology*, 10.

Jafari, S., Etminan, M., Aminzadeh, F., & Samii, A. (2013). Head injury and risk of Parkinson disease: A systematic review and meta-analysis. *Movement Disorders*, *28*(9), 1222–1229. https://doi.org/10.1002/mds.25458

Janz, N. K., & Becker, M. H. (1984). The Health Belief Model: A Decade Later. *Health Education Quarterly*, *11*(1), 1–47. https://doi.org/10.1177/109019818401100101

Jenkins, R. (2002). *Foundations of Sociology*. Macmillan Publishers.

Jeukendrup, A. E., Craig, N. P., & Hawley, J. A. (2000). The bioenergetics of world class cycling. *Journal of Science and Medicine in Sport*, *3*(4), 414–433. https://doi.org/10.1016/s1440-2440(00)80008-0

Jewkes, R., Morrell, R., Hearn, J., Lundqvist, E., Blackbeard, D., Lindegger, G., Quayle, M., Sikweyiya, Y., & Gottzén, L. (2015). Hegemonic masculinity: combining theory and practice in gender interventions. *Culture, Health & Sexuality*, *17*(sup2), 112–127. https://doi.org/10.1080/13691058.2015.1085094

Johansson, T., & Herz, M. (2019). *Youth Studies in Transition: Culture, Generation and New Learning Processes (Young People and Learning Processes in School and Everyday Life (1))* (1st ed. 2019 ed.). Springer.

Johnson, V. E., Stewart, W., & Smith, D. H. (2013). Axonal pathology in traumatic brain injury. *Experimental Neurology*, 246, 35-43.

Jones, G., Llewellyn, D., & Johnson, M. I. (2015). Previous injury as a risk factor for reinjury in rock climbing: a secondary analysis of data from a retrospective cross-sectional cohort survey of active rock climbers. *BMJ Open Sport & Exercise Medicine*, *1*(1), bmjsem-2015. https://doi.org/10.1136/bmjsem-2015-000031

Junge, A., Engebretsen, L., Mountjoy, M. L., Alonso, J. M., Renström, P. A., Aubry, M. J., & Dvorak, J. (2009). Sports injuries during the Summer Olympic Games 2008. *The American journal of sports medicine*, *37*(11), 2165–2172. https://doi.org/10.1177/0363546509339357

Kamins J, Bigler E, Covassin T, et al. (2017) What is the physiological time to recovery after concussion? Systematic review. *Br J Sports Med*. doi:10.1136/ bjsports-2016-097464

*Kelly Catlin*. (2019, February 23). Concussion Legacy Foundation. https://concussionfoundation.org/story/kelly-catlin

Kelly K, Erdal K. Diagnostic terminology, athlete status, and history of concussion affect return to play expectations and anticipated symptoms following mild traumatic brain injury. (2016) *J Clin Exp Neuropsychol*. 39(6):587-595. doi:10.1080/13803395.2016.1250870

Kelly K, Erdal K. Diagnostic terminology, athlete status, and history of concussion affect return to play expectations and anticipated symptoms following mild traumatic brain injury. *J Clin Exp Neuropsychol*. 2016;39(6):587-595. doi:10.1080/13803395.2016.1250870

Kelner, M. (2018, May 1). *Philippa York says macho culture prevents cyclists coming out*. The Guardian. https://www.theguardian.com/sport/2018/apr/30/philippa-york-macho-culture-cyclists-coming-out

Kern, L., Geneau, A., Laforest, S., Dumas, A., Tremblay, B., Goulet, C., Lepage, S., & Barnett, T. A. (2014). Risk perception and risk-taking among skateboarders. *Safety Science*, *62*, 370–375. https://doi.org/10.1016/j.ssci.2013.08.009

Kerr, G., & Fowler, B. (1988). The Relationship Between Psychological Factors and Sports Injuries. *Sports Medicine*, *6*(3), 127–134. https://doi.org/10.2165/00007256-198806030-00001

Khurana, V. and Kaye, A. (2012). An overview of concussion in sport. *Journal of Clinical Neuroscience*, 19(1), pp.1-11.

Khurana, V. and Kaye, A., 2012. An overview of concussion in sport. *Journal of Clinical Neuroscience*, 19(1), pp.1-11.

Kidd, S. A., & Kral, M. J. (2005). Practicing participatory action research. *Journal of Counseling Psychology, 52*(2), 187–195. https://doi.org/10.1037/0022-0167.52.2.187

Kiernan P, Montenigro P, Solomon T, McKee A. (2015) Chronic Traumatic Encephalopathy: A Neurodegenerative Consequence of Repetitive Traumatic Brain Injury. *Semin Neurol*. 35(01):020-028. doi:10.1055/s-0035-1545080

Kiernan P, Montenigro P, Solomon T, McKee A. Chronic Traumatic Encephalopathy: A Neurodegenerative Consequence of Repetitive Traumatic Brain Injury. *Semin Neurol*. 2015;35(01):020-028. doi:10.1055/s-0035-1545080
Kimmel, M. (1994). Masculinity as homophobia: Fear, shame and silence in the construction of gender identity. In H. Brod & M. Kaufman (Eds.), *Theorizing masculinities* (pp. 119-141). Newbury Park, CA: Sage.

Kimmel, M. (1994). Masculinity as homophobia: Fear, shame and silence in the construction of gender identity. In H. Brod & M. Kaufman (Eds.), Theorizing masculinities (pp. 119-141). Newbury Park, CA: Sage.

Kimmel, M. (1996). *Manhood in America* (4th ed.). Oxford University Press.

Kroshus, E., Garnett, B., Hawrilenko, M., Baugh, C. M., & Calzo, J. P. (2015). Concussion under-reporting and pressure from coaches, teammates, fans, and parents. *Social Science & Medicine*, *134*, 66–75. https://doi.org/10.1016/j.socscimed.2015.04.011

Kuhn, T. S. (1962). *The Structure of Scientific Revolutions*. University of Chicago Press.

Kulkarni P, Morrison T, Cai X et al. Neuroradiological Changes Following Single or Repetitive Mild TBI. *Front Syst Neurosci*. 2019;13. doi:10.3389/fnsys.2019.00034
Kulkarni, P., Morrison, T. R., Cai, X., Iriah, S., Simon, N., Sabrick, J., Neuroth, L., & Ferris, C. F. (2019). Neuroradiological Changes Following Single or Repetitive Mild TBI. *Frontiers in Systems Neuroscience*, *13*, 1–12. https://doi.org/10.3389/fnsys.2019.00034

Lambert-Bélanger, A., Dubois, S., Weaver, B., Mullen, N., & Bédard, M. (2012). Aggressive driving behaviour in young drivers (aged 16 through 25) involved in fatal crashes. *Journal of Safety Research*, *43*(5–6), 333–338. https://doi.org/10.1016/j.jsr.2012.10.011

Lange, D. (2019, November 6). *Sports in the United Kingdom (UK) - Statistics & Facts*. Statista. https://www.statista.com/topics/3685/sports-in-the-united-kingdom-uk/

Langlois, J., Rutland-Brown, W. and Wald, M., 2006. The Epidemiology and Impact of Traumatic Brain Injury. *Journal of Head Trauma Rehabilitation*, 21(5), pp.375-378.

Larkin, M., & Griffiths, M. D. (2004). Dangerous sports and recreational drug-use: rationalizing and contextualizing risk. *Journal of Community & Applied Social Psychology*, *14*(4), 215–232. https://doi.org/10.1002/casp.770

Leddy, J., Baker, J., Haider, M., Hinds, A. and Willer, B., 2017. A Physiological Approach to Prolonged Recovery From Sport-Related Concussion. *Journal of Athletic Training*, 52(3), pp.299-308.

Leder, D. (1990) *The absent body*. Chicago: University of Chicago Press.

Lee, C., & Abdel-Aty, M. (2008). Testing Effects of Warning Messages and Variable Speed Limits on Driver Behavior Using Driving Simulator. *Transportation Research Record: Journal of the Transportation Research Board*, *2069*(1), 55–64. https://doi.org/10.3141/2069-08

Lee, T., & shao, R. (2014). Aging and risk taking: toward an integration of cognitive, emotional, and neurobiological perspectives. *Neuroscience and Neuroeconomics*, 47. https://doi.org/10.2147/nan.s35914

Levant, R. F., & Wimer, D. J. (2014). Masculinity Constructs as Protective Buffers and Risk Factors for Men's Health. American Journal of Men's Health, 110–120. https://doi.org/10.1177/1557988313494408

Li, Y., Li, Y., Li, X., Zhang, S., Zhao, J., Zhu, X., & Tian, G. (2017). Head injury as a risk factor for dementia and Alzheimer's disease: a systematic review and meta-analysis of 32 observational studies. PloS one, 12(1), e0169650.

Ling H, Hardy J, Zetterberg H. Neurological consequences of traumatic brain injuries in sports. Mol Cell Neurosci. 2015 May;66(Pt B):114-22. doi: 10.1016/j.mcn.2015.03.012. Epub 2015 Mar 12. PMID: 25770439.

Liston, K., McDowell, M., Malcolm, D., Scott-Bell, A., & Waddington, I. (2018). On being 'head strong': The pain zone and concussion in non-elite rugby union. International Review for the Sociology of Sport, 53(6), 668–684. https://doi.org/10.1177/1012690216679966

Lloyd, A., & Döring, A. K. (2019). When do peers influence adolescent males' risk taking? Examining decision making under conditions of risk and ambiguity. *Journal of Behavioral Decision Making*, *32*(5), 613–626. https://doi.org/10.1002/bdm.2141

Lo Iacono, V., Symonds, P., & Brown, D. H. K. (2016). Skype as a Tool for Qualitative Research Interviews. *Sociological Research Online*, *21*(2), 103–117. https://doi.org/10.5153/sro.3952

Lumba-Brown, A. et al. (2018). Centers for Disease Control and Prevention Guideline on the Diagnosis and Management of Mild Traumatic Brain Injury Among Children. *JAMA Pediatrics*, 172(11), p.e182853.

Lyng, S. (1990). Edgework: A social psychological analysis of voluntary risk taking. *American Journal of Sociology, 95*(4), 851–886. https://doi.org/10.1086/229379

Lyng, S. (2005). *Edgework: The Sociology of Risk-Taking* (1st ed.). Routledge.

Mackay, D. F., Russell, E. R., Stewart, K., MacLean, J. A., Pell, J. P., & Stewart, W. (2019). Neurodegenerative Disease Mortality among Former Professional Soccer Players. *New England Journal of Medicine*, *381*(19), 1801–1808. https://doi.org/10.1056/nejmoa1908483

Mackintosh, P & Norcliffe, G. (2007) Men, Women and the Bicycle: Gender and Social Geography of Cycling in the Late Nineteenth Century. In book: *Cycling and Society* (pp.153-178)

Mackintosh, P. G. (2005). Scrutiny in the Modern City: The domestic public and the Toronto Local Council of Women at the turn of the twentieth century. *Gender, Place & Culture*, *12*(1), 29–48. https://doi.org/10.1080/09663690500082836

Magrath, R. (2018). 'To Try and Gain an Advantage for My Team': Homophobic and Homosexually Themed Chanting among English Football Fans. Sociology, 52(4), 709–726. https://doi.org/10.1177/0038038517702600

Magrath, R. (2018). *Inclusive Masculinities in Contemporary Football: Men in the Beautiful Game (Critical Studies of Men and Masculinities)* (1st ed.). Routledge.

Magrath, R. (2019). Inclusive masculinities of working-class university footballers in the South of England. *Sport in Society*, 1–18. https://doi.org/10.1080/17430437.2019.1672157

Malcolm, D. (2018). Concussion in Sport: Public, Professional and Critical Sociologies. *Sociology of Sport Journal*, *35*(2), 141–148. https://doi.org/10.1123/ssj.2017-0113

Malcolm, D. (2019). *The Concussion Crisis in Sport* (1st ed.). Routledge.

Malcolm, D., (2018). Concussion in Sport: Public, Professional and Critical Sociologies. *Sociology of Sport Journal*, 35(2), pp.141-148.

Malcom, D. (2019) *The concussion crisis in Sport*. Routledge

Malcom, D., (2017) Sport, Medicine and Health: The Medicalization of Sport? (Abingdon and New York: Routledge, 2017) , ISBN: 978-1-138-82645-8. *Medical History*, 62(2), pp.247-248.

Markham, A., Buchanan, E., & AOIR Ethics Working Committee. (2012). Ethical decision-making and internet research (Version 2). Association of Internet Researchers

Maroon, J. C., Winkelman, R., Bost, J., Amos, A., Mathyssek, C., & Miele, V. (2015). Chronic traumatic encephalopathy in contact sports: a systematic review of all reported pathological cases. PloS one, 10(2), e0117338.

Martha, C., & Delhomme, P. (2009). Risk comparative judgments while driving a car among competitive road cyclists and non-cyclists. *Transportation Research Part F: Traffic Psychology and Behaviour*, *12*(3), 256–263. https://doi.org/10.1016/j.trf.2008.11.004

Martland, H. S. (1928). Punch drunk. *Journal of the American Medical Association*, 91(15), 1103-1107.

Martuzzi, M. (2007). The precautionary principle: in action for public health. *Occupational and Environmental Medicine*, *64*(9), 569–570. https://doi.org/10.1136/oem.2006.030601

Marwick, A. E., & boyd, D. A. N. A. H. (2010). I tweet honestly, I tweet passionately: Twitter users, context collapse, and the imagined audience. *New Media & Society*, *13*(1), 114–133. https://doi.org/10.1177/1461444810365313

Masferrer R, Masferrer M, Prendergast V, Harrington RT. (2000) Grading scale for cerebral concussions. *BNI Quarterly* 2; 16(1): 4-9.

Mata, R., Josef, A. K., Samanez-Larkin, G. R., & Hertwig, R. (2011). Age differences in risky choice: a meta-analysis. *Annals of the New York Academy of Sciences*, *1235*(1), 18–29. https://doi.org/10.1111/j.1749-6632.2011.06200.x

Matthews, C. (2021) *Doing Immersive Research: Using social science to understand the human world*. Vol 1. Beeston Publishing House

Matthews, C. R. (2016). The appropriation of hegemonic masculinity within selected research on men's health. *NORMA*, *11*(1), 3–18. https://doi.org/10.1080/18902138.2015.1063761

Matthews, C. R. (2020). 'The fog soon clears': Bodily negotiations, embodied understandings, competent body action and 'brain injuries' in boxing. *International Review for the Sociology of Sport*, 56(5), 719–738. https://doi.org/10.1177/1012690220907026

Matthews, C. R., & Channon, A. (2016). "It's Only Sport"-The Symbolic Neutralization of "Violence". *Symbolic Interaction*, *39*(4), 557–576. https://doi.org/10.1002/symb.265

McCaffrey, M., Mihalik, J., Crowell, D., Shields, E. and Guskiewicz, K. (2007). MEASUREMENT OF HEAD IMPACTS IN COLLEGIATE FOOTBALL PLAYERS. *Neurosurgery*, 61(6), pp.1236-1243.

McCormack, M. (2011). Hierarchy without hegemony: Locating boys in an inclusive school setting. *Sociological Perspectives*, 54(1), 83-101.

McCormack, M. (2012). *The Declining Significance of Homophobia: How Teenage Boys are Redefining Masculinity and Heterosexuality*. Oxford University Press.

McCormack, M. (2014). The intersection of youth masculinities, decreasing homophobia and class: An ethnography. *The British journal of sociology*, *65*(1), 130-149.

McCormack, M., & Anderson, E. (2010). The re-production of homosexually-themed discourse in educationally-based organised sport. *Culture, Health & Sexuality*, *12*(8), 913-927.

McCormack, M., & Anderson, E. (2014). Homohysteria: Definitions, Context and Intersectionality. *Sex Roles*, *71*(3–4), 152–158. https://doi.org/10.1007/s11199-014-0401-9

McCormack, M., & Anderson, E. (2014a). The influence of declining homophobia on men's gender in the United States: An argument for the study of homohysteria. *Sex Roles*, *71*(3-4), 109-120.

McCormack, M., & Anderson, E. (2014b). Homohysteria: Definitions, context and intersectionality. *Sex Roles*, *71*(3-4), 152-158.

McCormack, M., Anderson, E., Jamie, K., & David, M. (2021). *Discovering Sociology* (2nd ed.). Red Globe Press.

McCory, P. *et al* (2017) Consensus statement on concussion in sport—the 5th international conference on concussion in sport held in Berlin, October 2016. *British Journal of Sports Medicine*. 51 (11) 838-847. Available at: https://bjsm.bmj.com/content/51/11/838

McCrory P, Meeuwisse W, Aubry M et al. Consensus Statement on Concussion in Sport—the 4th International Conference on Concussion in Sport Held in Zurich, November 2012. *Clinical Journal of Sport Medicine*. 2013;23(2):89-117. doi:10.1097/jsm.0b013e31828b67cf

McCrory P, Meeuwisse W, Dvorak J et al. Consensus statement on concussion in sport—the 5thinternational conference on concussion in sport held in Berlin, October 2016.
McCrory, P. (2001). Does second impact syndrome exist?. *Clinical Journal of Sport Medicine*, 11(3), 144-149.

McCrory, P. and Berkovic, S., 2001. Concussion: The history of clinical and pathophysiological concepts and misconceptions. *Neurology*, 57(12), pp.2283-2289.

McCrory, P. R., Berkovic, S. F., & Cordner, S. M. (2000). Deaths due to brain injury among footballers in Victoria, 1968-1999. The Medical Journal of Australia, 172(5), 217-219.

McCrory, P., Davis, G., & Makdissi, M. (2012). Second impact syndrome or cerebral swelling after sporting head injury. *Current sports medicine reports*, 11(1), 21-23.

McCrory, P., et al. (2013). *Consensus Statement On Concussion In Sport: The 4Th International Conference On Concussion In Sport Held In Zurich, November 2012*.

McCrory, P., Meeuwisse, W., Dvorak, J. ř., Aubry, M., Bailes, J., Broglio, S., Cantu, R. C., Cassidy, D., Echemendia, R. J., Castellani, R. J., Davis, G. A., Ellenbogen, R., Emery, C., Engebretsen, L., Feddermann-Demont, N., Giza, C. C., Guskiewicz, K. M., Herring, S., Iverson, G. L., … Vos, P. E. (2017). Consensus statement on concussion in sport—the 5thinternational conference on concussion in sport held in Berlin, October 2016. *British Journal of Sports Medicine*, bjsports-2017. https://doi.org/10.1136/bjsports-2017-097699

McCrory, P., Meeuwisse, W., Johnston, K., Dvorak, J., Aubry, M., Molloy, M., & Cantu, R. (2009). Consensus Statement on Concussion in Sport 3rd International Conference on Concussion in Sport Held in Zurich, November 2008. Clinical Journal of Sport Medicine, 19(3), 185-200.

McGannon, K. R., Cunningham, S. M., & Schinke, R. J. (2013). Understanding concussion in socio-cultural context: A media analysis of a National Hockey League star's concussion. *Psychology of Sport and Exercise*, *14*(6), 891–899. https://doi.org/10.1016/j.psychsport.2013.08.003

McKee A, Daneshvar D, Alvarez V, Stein T. The neuropathology of sport. *Acta Neuropathol*. 2013;127(1):29-51. doi:10.1007/s00401-013-1230-6
McKee, A. C., Cantu, R. C., Nowinski, C. J., Hedley-Whyte, E. T., Gavett, B. E., Budson, A. E., ... & Stern, R. A. (2009). Chronic traumatic encephalopathy in athletes: progressive tauopathy after repetitive head injury. Journal of Neuropathology & Experimental Neurology, 68(7), 709- 735.

McKee, A. C., Daneshvar, D. H., Alvarez, V. E., & Stein, T. D. (2014). The neuropathology of sport. *Acta neuropathologica*, 127(1), 29-51.

McKee, A. C., Daneshvar, D. H., Alvarez, V. E., Stein, T. D. (2014). The neuropathology of sport. Acta Neuropathologica, 127(1), 29–51.

McKelvie, S. J., & Schamer, L. A. (1988). Effects of Night, Passengers, and Sex on Driver Behavior at Stop Signs. *The Journal of Social Psychology*, *128*(5), 685–690. https://doi.org/10.1080/00224545.1988.9922922

McKim, C. (2016) The Value of Mixed Methods Research. *Journal of Mixed Methods Research*, 11(2), pp.202-222.

McKinlay A, Bishop A, McLellan T (2011). Public knowledge of 'concussion' and the different terminology used to communicate about mild traumatic brain injury (MTBI). *Brain Inj*. 25(7-8):761-766. doi:10.3109/02699052.2011.579935

McKinlay A, Bishop A, McLellan T. Public knowledge of 'concussion' and the different terminology used to communicate about mild traumatic brain injury (MTBI). *Brain Inj*. 2011;25(7-8):761-766. doi:10.3109/02699052.2011.579935
McKinlay, A., & Albicini, M. (2016). Prevalence of traumatic brain injury and mental health problems among individuals within the criminal justice system. *Concussion (London, England)*, *1*(4), CNC25. https://doi.org/10.2217/cnc-2016-0011

Meaney, D. and Smith, D. (2011). Biomechanics of Concussion. *Clinics in Sports Medicine*, 30(1), pp.19-31.

Meeder, B., Tam, J., Kelley, P., & Cranor, L. (2010). IWantPrivacy : Widespread Violation of Privacy Settings in the Twitter Social Network.

Meehan, W. P. (2011). Medical therapies for concussion. *Clinics in sports medicine*, 30(1), 115-124.

Meehan, W.P. (2017). *Concussions*. ABC-Clio.

Mehta, P. H., Welker, K. M., Zilioli, S., & Carré, J. M. (2015). Testosterone and cortisol jointly modulate risk-taking. *Psychoneuroendocrinology*, *56*, 88–99. https://doi.org/10.1016/j.psyneuen.2015.02.023

Meier, T. Brummel, B., Singh, R., Nerio, C., Polanski. & Bellgowan, P. (2015) The underreporting of self- reported symptoms following sports-related concussion. *Journal of science and medicine in sports and exercise*, 18 (5), 507-511. Available at: https://www.ncbi.nlm.nih.gov/pubmed/25150463

Meier, T., Huber, D., Bohorquez-Montoya, L., Nitta, M., Savitz, J., Teague, T., Bazarian, J., Hayes, R., Nelson, L. and McCrea, M., 2020. A Prospective Study of Acute Blood-Based Biomarkers for Sport-Related Concussion. *Annals of Neurology*, 87(6), pp.907-920.

Mention. (2018). *Mention's Twitter Engagement Report 2018*. Https://Info.Mention.Com/Twitter-Report. https://info.mention.com/twitter-report

Merritt V, Padgett C, Jak A. A systematic review of sex differences in concussion outcome: What do we know?. *Clin Neuropsychol*. 2019;33(6):1016-1043. doi:10.1080/13854046.2018.1508616
Merritt, C. J., & Tharp, I. J. (2013). Personality, self-efficacy and risk-taking in parkour (free-running). *Psychology of Sport and Exercise*, *14*(5), 608–611. https://doi.org/10.1016/j.psychsport.2013.03.001

Merton, R. K. (1972). Insiders and Outsiders: A Chapter in the Sociology of Knowledge. *American Journal of Sociology*, *78*(1), 9–47. http://www.jstor.org/stable/2776569

Messner, M. A. (1990). When bodies are weapons: Masculinity and violence in Sport. International Review for the Sociology of Sport, 25(3), 203–220. https://doi.org/10.1177/101269029002500303

Messner, M. A. (1990). When bodies are weapons: Masculinity and violence in sport. *International Review for the Sociology of Sport*, 25(3), 203-220.

Messner, M. A. (1990). When bodies are weapons: Masculinity and violence in Sport. *International Review for the Sociology of Sport*, *25*(3), 203–220. https://doi.org/10.1177/101269029002500303

Messner, M. A. (1992). Like family: Power, intimacy, and sexuality in male athletes' friendships. In P. M. Nardi (Ed.), *Men's friendships* (pp. 215–237). Sage Publications, Inc. https://doi.org/10.4135/9781483325736.n12

Messner, M. A., & Sabo, D. F. (1994). *Sex, violence & power in sports: rethinking masculinity.* Freedom, CA: Crossing Press.

Mez, J., Daneshvar, D. H., Kiernan, P. T., Abdolmohammadi, B., Alvarez, V. E., Huber, B. R., ... & Cormier, K. A. (2017). Clinicopathological evaluation of chronic traumatic encephalopathy in players of American football. *Jama*, 318(4), 360-370.

Michael, B. (2015). 'Just don't hit on me and I'm fine': Mapping high school wrestlers' relationship to inclusive masculinity and heterosexual recuperation. International Review for the Sociology of Sport, 50(8), 912–928. https://doi.org/10.1177/1012690213501168

Microsoft Corp. (2020). *Microsoft Teams | Group Chat, Team Chat & Collaboration*. Microsoft. https://www.microsoft.com/en-gb/microsoft-teams/group-chat-software

*Microsoft Excel*. WA,USA: Microsoft Corporation; 2016.

Miller, C. C. (2009, August 26). *Who's Driving Twitter's Popularity? Not Teenagers*. The New York Times. https://www.nytimes.com/2009/08/26/technology/internet/26twitter.html

Mills, C. W. (1959). *The sociological imagination*. Oxford University Press.

Mills, C. W. (2000). *The sociological imagination*. Oxford University Press.

Millspaugh, J. A. (1937). Dementia pugilistica. US Naval Med Bulletin, 35(297), e303.

Miracle, A. W., & Rees, R. C. (1994). *Lessons of the Locker Room: The Myth of School Sports* (First Edition). Prometheus Books.

Miyashita, T., Timpson. W., Frye, M & Gloceckner, G. (2013) The impact of an educational intervention on college athletes' knowledge of concussions. *Clinical Journal of Sports Medicine.* 23 (5) 349-353. Available at: https://www.ncbi.nlm.nih.gov/pubmed/23528843

Moller, M. (2007). Exploiting Patterns: A Critique of Hegemonic Masculinity. *Journal of Gender Studies*, *16*(3), 263–276. https://doi.org/10.1080/09589230701562970

Monahan, K., Goldfine, A. and Biegon, A., 2017. Traumatic brain injuries in victims of intimate partner violence: an underappreciated source of neurological morbidity. *Future Neurology*, 12(4), pp.189-191.

Monahan, K., n.d. *Intimate Partner Violence, Traumatic Brain Injury, And Social Work: Moving Forward*.

Montgomery S, Hiyoshi A, Burkill S, Alfredsson L, Bahmanyar S, Olsson T. Concussion in adolescence and risk of multiple sclerosis. *Ann Neurol*. 2017;82(4):554-561. doi:10.1002/ana.25036
Montgomery, S., Hiyoshi, A., Burkill, S., Alfredsson, L., Bahmanyar, S., & Olsson, T. (2017). Concussion in adolescence and risk of multiple sclerosis. *Annals of neurology*, *82*(4), 554–561. https://doi.org/10.1002/ana.25036

Moore R, Lepine J, Ellemberg D. (2017) The independent influence of concussive and sub-concussive impacts on soccer players' neurophysiological and neuropsychological function. *International Journal of Psychophysiology*. 112:22-30. doi:10.1016/j.ijpsycho.2016.11.011

Moore R, Lepine J, Ellemberg D. The independent influence of concussive and sub-concussive impacts on soccer players' neurophysiological and neuropsychological function. *International Journal of Psychophysiology*. 2017;112:22-30. doi:10.1016/j.ijpsycho.2016.11.011

Moore, C., Baharikhoob, P., Khodadadi, M. and Tator, C., 2020. Bicycling-related concussions leading to postconcussion syndrome in adults. *BMJ Open Sport & Exercise Medicine*, 6(1), p.e000746.

Moore, C., Baharikhoob, P., Khodadadi, M., & Tator, C. H. (2020). Bicycling-related concussions leading to postconcussion syndrome in adults. *BMJ Open Sport & Exercise Medicine*, *6*(1), e000746. https://doi.org/10.1136/bmjsem-2020-000746

Morales, L., & Caffyn-Parsons, E. (2017). "I Love You, Guys" : A Study of Inclusive Masculinities among High School Cross-Country Runners. *Boyhood Studies*, *10*(1), 66–87. https://doi.org/10.3167/bhs.2017.100105

Morioka R. (2014). Gender difference in the health risk perception of radiation from Fukushima in Japan: the role of hegemonic masculinity. Social science & medicine (1982), 107, 105–112. https://doi.org/10.1016/j.socscimed.2014.02.014

Morrongiello, B. A., Walpole, B., & Lasenby, J. (2007). Understanding children's injury-risk behavior: Wearing safety gear can lead to increased risk taking. *Accident Analysis & Prevention*, *39*(3), 618–623. https://doi.org/10.1016/j.aap.2006.10.006

Mrazik, M., Perra, A., Brooks, B. L., & Naidu, D. (2015). Exploring Minor Hockey Players' Knowledge and Attitudes Toward Concussion. *Journal of Head Trauma Rehabilitation*, *30*(3), 219–227. https://doi.org/10.1097/htr.0000000000000018

Mujika, I., & Padilla, S. (2001). Physiological and Performance Characteristics of Male Professional Road Cyclists. *Sports Medicine*, *31*(7), 479–487. https://doi.org/10.2165/00007256-200131070-00003

Munthe, C. (2011). *The Price of Precaution and the Ethics of Risk (The International Library of Ethics, Law and Technology Book 6)* (2011th ed.). Springer.

Murdaugh D.L., King T.Z., Sun B., Jones R.A., Ono K.E., Reisner A., Burns T.G. Longitudinal Changes in Resting State Connectivity and White Matter Integrity in Adolescents With Sports-Related Concussion. J. Int. Neuropsychol. Soc. 2018;24:781–792. doi: 10.1017/S1355617718000413.

Murthy, D. (2013). *Twitter: Social Communication in the Twitter Age (Digital Media and Society)* (1st ed.). Polity.

National Academy, 2005. *Facilitating Interdisciplinary Research*. Washington, D.C.: The National Academies Press.

Negy, C. (2014). Homohysteria: Useful construct? Or an unnecessary splitting of hairs? *Sex Roles*. doi:10.1007/s11199-014-0386-4.

Nel, K., Govender, S., Rapetsoa, M. and Nel, C., 2017. Cumulative mild head injury (CMHI) among college rugby players: A replication and extension study. *Journal of Psychology in Africa*, 27(6), pp.549-552.

Nguyen, M.N., Potvin, L. & Otis, J. (1997) Regular Exercise in 30- to 60-Year-Old Men: Combining The Stages-of-Change Model and The Theory of Planned Behavior to Identify Determinants for Targeting Heart Health Interventions. *Journal of Community Health* **22,** 233–246 (1https://doi.org/10.1023/A:1025196218566

Nixon, H. L. (1992). A Social Network Analysys of Influences On Athletes To Play With Pain and Injuries. Journal of Sport and Social Issues, 16(2), 127–135. https://doi.org/10.1177/019372359201600208

Nixon, H. L. (1993). Accepting the Risks of Pain and Injury in Sport: Mediated Cultural Influences on Playing Hurt. *Sociology of Sport Journal*, *10*(2), 183–196. https://doi.org/10.1123/ssj.10.2.183

Nixon, H. L. (1994). SOCIAL PRESSURE, SOCIAL SUPPORT, AND HELP SEEKING FOR PAIN AND INJURIES IN COLLEGE SPORTS NETWORKS. Journal of Sport and Social Issues, 18(4), 340–355. https://doi.org/10.1177/019372394018004004

Nixon, H. L. (1996). EXPLAINING PAIN AND INJURY ATTITUDES AND EXPERIENCES IN SPORT IN TERMS OF GENDER, RACE, AND SPORTS STATUS FACTORS. Journal of Sport and Social Issues, 20(1), 33–44. https://doi.org/10.1177/019372396020001004

Norcliffe, G. (2001). *Ride to Modernity: The Bicycle in Canada, 1869-1900* (Illustrated ed.). University of Toronto Press, Scholarly Publishing Division.

Norcliffe, G. (2006), 'Associations, modernity and the insider-citizens of a Victorian highwheel bicycle club'. *Journal of Historical Sociology, 19*(2), 121-150. https://doi.org/10.1111/j.1467-6443.2006.00275.x

Norcliffe, G. (2006), 'Associations, modernity and the insider-citizens of a Victorian highwheel bicycle club'. Journal of Historical Sociology, 19(2), 121-150. https://doi.org/10.1111/j.1467-6443.2006.00275.x

Nordström, A., Nordström, P. and Ekstrand, J., 2014. Sports-related concussion increases the risk of subsequent injury by about 50% in elite male football players. *British Journal of Sports Medicine*, 48(19), pp.1447-1450.

Nowak, M., Bevilacqua, Z & Keisuke, E. (2020) Subconcussive Head Impacts: A Randomized Clinical Trial. *The Journal of the American Medical Association*. Available at: https://jamanetwork.com/journals/jamaophthalmology/article-abstract/2761538

Nowinski C. (2013). Hit parade: the future of the sports concussion crisis. *Cerebrum : the Dana forum on brain science*, *2013*, 2.

Nowlinski, C. (2012). *Head Games: The global concussion crisis.*

Nphn.scot.nhs.uk. 2020. *Scottish Health In Custody Network*. [online] Available at: <https://www.nphn.scot.nhs.uk/> [Accessed 7 October 2020].

O'Connor, S., Geaney, D., & Beidler, E. (2019). Non-disclosure in Irish collegiate student-athletes: do concussion history, knowledge, pressure to play and gender impact concussion reporting? *The Physician and Sportsmedicine*, *48*(2), 186–193. https://doi.org/10.1080/00913847.2019.1671141

O'Reilly, M., Mahon, S., Reid, D., Hume, P., Hardaker, N. and Theadom, A., (2020). Knowledge, attitudes, and behaviour toward concussion in adult cyclists. *Brain Injury*, 34(9), pp.1175-1182.

O'Reilly, M., Mahon, S., Reid, D., Hume, P., Hardaker, N., & Theadom, A. (2020). Knowledge, attitudes, and behavior toward concussion in adult cyclists. *Brain Injury*, *34*(9), 1175–1182. https://doi.org/10.1080/02699052.2020.1793386

Ogburn, W. F. (1957). *Social Change With Respect to Culture and Original Nature (Classic Reprint)*. Forgotten Books.

Ogilvie, M., & McCormack, M. (2020). Gender-collaborative training in elite university sport: Challenging gender essentialism through integrated training in gender-segregated sports. International Review for the Sociology of Sport. https://doi.org/10.1177/1012690220980149

Olivier, J. and Creighton, P., 2016. Bicycle injuries and helmet use: a systematic review and meta-analysis. *International Journal of Epidemiology*, p.dyw153.

Olivier, S. (2006). Moral Dilemmas of Participation in Dangerous Leisure Activities. *Leisure Studies*, *25*(1), 95–109. https://doi.org/10.1080/02614360500284692

Omalu, B. (2008). *Play hard, die young: Football dementia, depression, and death*. Neo Forenxis Books.

Omalu, B. I., Bailes, J., Hammers, J. L., & Fitzsimmons, R. P. (2010). Chronic traumatic encephalopathy, suicides and parasuicides in professional American athletes: the role of the forensic pathologist. *The American journal of forensic medicine and pathology*, 31(2), 130-132.

Omalu, B. I., DeKosky, S. T., Hamilton, R. L., Minster, R. L., Kamboh, M. I., Shakir, A. M., & Wecht, C. H. (2006). Chronic traumatic encephalopathy in a national football league player: part II. Neurosurgery, 59(5), 1086- 1093.

Omalu, B. I., DeKosky, S. T., Minster, R. L., Kamboh, M. I., Hamilton, R. L., & Wecht, C. H. (2005). Chronic traumatic encephalopathy in a National Football League player. Neurosurgery, 57(1), 128-134.

Omalu, B., Small, G. W., Bailes, J., Ercoli, L. M., Merrill, D. A., Wong, K. P., ... & Fitzsimmons, R. P. (2017). Postmortem Autopsy-Confirmation of Antemortem [F-18] FDDNP-PET Scans in a Football Player With Chronic Traumatic Encephalopathy. Neurosurgery, 82(2), 237-246.

OMMAYA, A. and GENNARELLI, T. (1974). CEREBRAL CONCUSSION AND TRAUMATIC UNCONSCIOUSNESS. *Brain*, 97(1), pp.633-654.

Ommaya, A. and Hirsch, A. (1971). Tolerances for cerebral concussion from head impact and whiplash in primates. *Journal of Biomechanics*, 4(1), pp.13-21.

Online surveys. Onlinesurveys.ac.uk. https://www.onlinesurveys.ac.uk/. Published 2020. Accessed June 26, 2020.

ONS. (2019). *Population estimates for the UK, England and Wales, Scotland and Northern Ireland, provisional: mid-2019 - Office for National Statistics*. https://www.ons.gov.uk/releases/populationestimatesfortheukenglandandwalesscotlandandnorthernirelandprovisionalmid2019nationalandsubnationalmidyearpopulationestimatesfortheukanditsconstituentcountriesbyadministrativeareaageandsex

Op de Macks, Z. ň. A., Bunge, S. A., Bell, O. N., Kriegsfeld, L. J., Kayser, A. S., & Dahl, R. E. (2016). The effect of social rank feedback on risk taking and associated reward processes in adolescent girls. *Social Cognitive and Affective Neuroscience*, *12*(2), 240–250. https://doi.org/10.1093/scan/nsw125

Paechter, C. (2006). Masculine femininities/feminine masculinities: power, identities and gender. *Gender and Education*, *18*(3), 253–263. https://doi.org/10.1080/09540250600667785

Parekh, N., Hodges, S. D., Pollock, A. M., & Kirkwood, G. (2011). Communicating the risk of injury in schoolboy rugby: using Poisson probability as an alternative presentation of the epidemiology. *British Journal of Sports Medicine*, *46*(8), 611–613. https://doi.org/10.1136/bjsports-2011-090431

Park, P., & Macy, M. (2015). The paradox of active users. *Big Data & Society*, *2*(2), 205395171560616. https://doi.org/10.1177/2053951715606164

Pearce, A. J., Young, J. A., Parrington, L., & Aimers, N. (2016). Do as I say: contradicting beliefs and attitudes towards sports concussion in Australia. *Journal of Sports Sciences*, *35*(19), 1911–1919. https://doi.org/10.1080/02640414.2016.1241420

Pearce, A., 2016. The Neurophysiological Response Following Sub-Concussive Soccer Heading. *EBioMedicine*, 13, pp.3-4.

Perkins, H. and Berkowitz, A., 1986. Perceiving the Community Norms of Alcohol Use among Students: Some Research Implications for Campus Alcohol Education Programming*. *International Journal of the Addictions*, 21(9-10), pp.961-976.

PERKINS, H. W. E. S. L. E. Y., & CRAIG, D. A. V. I. D. W. (2006). A Successful Social Norms Campaign to Reduce Alcohol Misuse Among College Student-Athletes. *Journal of Studies on Alcohol*, *67*(6), 880–889. https://doi.org/10.15288/jsa.2006.67.880

Perkins, H. W., & Berkowitz, A. D. (1986). Perceiving the Community Norms of Alcohol Use among Students: Some Research Implications for Campus Alcohol Education Programming*. *International Journal of the Addictions*, *21*(9–10), 961–976. https://doi.org/10.3109/10826088609077249

Peterson, G. T. and Anderson, E. (2012) 'The Performance of Softer Masculinities on the University Dance Floor', *The Journal of Men's Studies*, 20(1), pp. 3–15. doi: 10.3149/jms.2001.3.

Phillips D (1987) *Philosphy, science, and social inquiry: contemporary methodological controversies in social science and related applied fields of research.* Oxford, England : Pergamon Press.

Pidgeon, N. et al. (1992) Risk perception. In: The Royal Society Study Group (ed.), *Risk*: analysis, perception and management. London: The Royal Society, p. 89-134.

Piggin, J., Jackson, S. J., & Lewis, M. (2009). Knowledge, Power and Politics. *International Review for the Sociology of Sport*, *44*(1), 87–101. https://doi.org/10.1177/1012690209102825

Pinker, S. (2012). *The Better Angels of Our Nature: Why Violence Has Declined* (Illustrated ed.). Penguin Books.

*Planning for sport*. (2019). Sport England. https://www.sportengland.org/how-we-can-help/facilities-and-planning/planning-for-sport

Plummer, D. (1999). *One of the Boys: Masculinity, Homophobia, and Modern Manhood (Haworth Gay & Lesbian Studies)* (1st ed.). Routledge.

Plummer, D. C. (2013). Masculinity and Risk: How Gender Constructs Drive Sexual Risks in the Caribbean. *Sexuality Research and Social Policy*, *10*(3), 165–174. https://doi.org/10.1007/s13178-013-0116-7

*Policy reports and publications | Royal Society*. (1983). Royal Society. https://royalsociety.org/topics-policy/publications/

Pollock, A. (2014). *Tackling Rugby: What Every Parent Should Know about injuries*. Verso Books.

Pollock, A. (2014). Tackling Rugby: What Every Parent Should Know about injuries. Verso Books.

Powell, D., Stiles, B., Haff, G., & Kilgore, L. (2005). THE NOTION OF MASCULINITY IN MALE COLLEGIATE ROAD CYCLISTS. *Creative Sociology*, *33*(2), 153. https://ojs.library.okstate.edu/osu/index.php/FICS/article/view/1558

Powell, D., Stiles, B., Haff, G., & Kilgore, L. (2005). THE NOTION OF MASCULINITY IN MALE COLLEGIATE ROAD CYCLISTS. Creative Sociology, 33(2), 153. https://ojs.library.okstate.edu/osu/index.php/FICS/article/view/1558

Prati, G., Fraboni, F., De Angelis, M., & Pietrantoni, L. (2019). Gender differences in cyclists' crashes: an analysis of routinely recorded crash data. *International Journal of Injury Control and Safety Promotion*, *26*(4), 391–398. https://doi.org/10.1080/17457300.2019.1653930

Preusser, D. F., Williams, A. F., Ferguson, S. A., Ulmer, R. G., & Weinstein, H. B. (1998). Fatal crash risk for older drivers at intersections. *Accident Analysis & Prevention*, *30*(2), 151–159. https://doi.org/10.1016/s0001-4575(97)00090-0

Priest, R. F., Krause, J. V., & Beach, J. (1999). Four-Year Changes in College Athletes' Ethical Value Choices in Sports Situations. *Research Quarterly for Exercise and Sport*, *70*(2), 170–178. https://doi.org/10.1080/02701367.1999.10608034

Pringle, R., & Markula, P. (2005). No Pain Is Sane after All: A Foucauldian Analysis of Masculinities and Men's Rugby Experiences of Fear, Pain, and Pleasure. *Sociology of Sport Journal*, *22*(4), 472–497. https://doi.org/10.1123/ssj.22.4.472

Provvidenza, C., Engebretsen, L., Tator, C., Kissick, J., McCrory, P., Sills, A & Johnston, K. (2013) From consensus to action: knowledge transfer, education and influencing policy on sports concussion. *British Journal of Sports Medicine.* 47: 332-338. Available at: https://bjsm.bmj.com/content/bjsports/47/5/332.full.pdf

Rashid, H., Dobbin, N., & Mishra, S. (2020). 104 Management of sports-related concussion in UK emergency departments: a multi-centre study. *Emergency Medicine Journal*, *37*(12), 822.2-822. https://doi.org/10.1136/emj-2020-rcemabstracts.2

Ravensbergen, L., Buliung, R., & Laliberté, N. (2019). Toward feminist geographies of cycling. *Geography Compass*, 1. https://doi.org/10.1111/gec3.12461

Reed, K. (2013). Beyond Hegemonic Masculinity: The Role of Family Genetic History in Men's Accounts of Health. Sociology, 47(5), 906–920. https://doi.org/10.1177/0038038513494505

Rees, A., T. Gibbons and K. Dixon. 2014. The Surveillance of Racing Cyclists in Training: A Bourdieusian Perspective. Surveillance & Society 11(4): 466-480

Register-Mihalik J, Guskiewicz K, McLeod T, Linnan L, Mueller F, Marshall S. Knowledge, Attitude, and Concussion-Reporting Behaviors Among High School Athletes: A Preliminary Study. *J Athl Train*. 2013;48(5):645-653. doi:10.4085/1062-6050-48.3.20

Register-Mihalik, J., Kay, M., Kerr, Z., Peck, K., Houston, M., Gildner, P., Svoboda, S., Marshall, S. and Cameron, K., 2019. Influence of Concussion Education Exposure on Concussion-Related Educational Targets and Self-Reported Concussion Disclosure among First-Year Service Academy Cadets. *Military Medicine*, 185(3-4), pp.e403-e409.

Rhodes, N., & Pivik, K. (2011). Age and gender differences in risky driving: The roles of positive affect and risk perception. *Accident Analysis & Prevention*, *43*(3), 923–931. https://doi.org/10.1016/j.aap.2010.11.015

Rice, S., Alexis, M., Bhatnagar, S., Robidoux., Zafonte, R & Kotler, D. (2020) Reporting of Concussion-Like Symptoms After Cycling Crashes: A Survey of Competitive and Recreational Cyclists. *Journal of Athletic Training.* 55 (1) 11-16. Available at: https://www.natajournals.org/doi/full/10.4085/1062-6050-91-19

Rice, S., Iaccarino, M. A., Bhatnagar, S., Robidoux, G., Zafonte, R., & Kotler, D. H. (2020). Reporting of Concussion-Like Symptoms After Cycling Crashes: A Survey of Competitive and Recreational Cyclists. *Journal of Athletic Training*, *55*(1), 11–16. https://doi.org/10.4085/1062-6050-91-19

Rice, S., Parker, A., Rosenbaum, S., Bailey, A., Mawren, D. and Purcell, R., 2017. Sport-Related Concussion and Mental Health Outcomes in Elite Athletes: A Systematic Review. *Sports Medicine*, 48(2), pp.447-465.

Rice, T. and Curtis, R., 2019. Parental knowledge of concussion: Evaluation of the CDC's "Heads up to parents" educational initiative. *Journal of Safety Research*, 69, pp.85-93.

Rigby, J., Vela, L., & Housman, J. (2013). Understanding Athletic Trainers' Beliefs Toward a Multifacted Sport-Related Concussion Approach: Application of the Theory of Planned Behavior. *Journal of Athletic Training*, *48*(5), 636–644. https://doi.org/10.4085/1062-6050-48.3.10

Roberts, L., Jones, G., & Brooks, R. (2018). Why Do You Ride?: A Characterization of Mountain Bikers, Their Engagement Methods, and Perceived Links to Mental Health and Well-Being. *Frontiers in Psychology*, *9*, 1. https://doi.org/10.3389/fpsyg.2018.01642

Roberts, S. (2013). Boys will be boys... won't they? Change and continuities in contemporary young working-class masculinities. *Sociology*, 47(4), 671-686.

Roberts, S. (2020). *Young Working-Class Men in Transition (Critical Studies of Men and Masculinities)* (1st ed.). Routledge.

Roberts, S., Anderson, E., & Magrath, R. (2016). Continuity, change and complexity in the performance of masculinity among elite young footballers in England. *The British Journal of Sociology*, *68*(2), 336–357. https://doi.org/10.1111/1468-4446.12237

Robertson, G. A. J. (2015). Fractures in sport: Optimising their management and outcome. *World Journal of Orthopedics*, *6*(11), 850. https://doi.org/10.5312/wjo.v6.i11.850

Robinson, S., White, A. and Anderson, E. (2019) 'Privileging the Bromance: A Critical Appraisal of Romantic and Bromantic Relationships', *Men and Masculinities*, 22(5), pp. 850–871. doi: 10.1177/1097184X17730386.

Robinson, S., White, A. and Anderson, E. (2019) 'Privileging the Bromance: A Critical Appraisal of Romantic and Bromantic Relationships', Men and Masculinities, 22(5), pp. 850–871. doi: 10.1177/1097184X17730386.

Roderick, M. (2006). Adding insult to injury: workplace injury in English professional football. *Sociology of health & illness*, 28(1), 76-97.

Rooney, D., Sarriegui, I., & Heron, N. (2020). 'As easy as riding a bike': a systematic review of injuries and illness in road cycling. *BMJ Open Sport & Exercise Medicine*, *6*(1), e000840. https://doi.org/10.1136/bmjsem-2020-000840

Root, J., Sady, M., Gai, J., Vaughan, C. and Madati, P., 2020. Effect of Cognitive and Physical Rest on Persistent Postconcussive Symptoms following a Pediatric Head Injury. *The Journal of Pediatrics*,.

Rosenstock, I. M. (1974). The Health Belief Model and Preventive Health Behavior. *Health Education Monographs*, *2*(4), 354–386. https://doi.org/10.1177/109019817400200405

Rotundo, A. E. (1993). *American Manhood: Transformations In Masculinity From The Revolution To The Modern Era* (Reprint ed.). Basic Books.

Rowe, N. F. (2009). The Active People Survey: a catalyst for transforming evidence-based sport policy in England. *International Journal of Sport Policy and Politics*, *1*(1), 89–98. https://doi.org/10.1080/19406940802681244

Rueda-Domingo, T., Lardelli-Claret, P., Luna-del-Castillo, J. D., Jiménez-Moleón, J. J., García-Martín, M., & Bueno-Cavanillas, A. (2004). The influence of passengers on the risk of the driver causing a car collision in Spain. *Accident Analysis & Prevention*, *36*(3), 481–489. https://doi.org/10.1016/s0001-4575(03)00043-5

Rutledge, R. B., Smittenaar, P., Zeidman, P., Brown, H. R., Adams, R. A., Lindenberger, U., Dayan, P., & Dolan, R. J. (2016). Risk Taking for Potential Reward Decreases across the Lifespan. *Current Biology*, *26*(12), 1634–1639. https://doi.org/10.1016/j.cub.2016.05.017

Ryan, L. and Warden, D., 2003. Post concussion syndrome. *International Review of Psychiatry*, 15(4), pp.310-316.

Sabo, D. (2004). *The Politics of Sports Injury: Hierarchy, Power, and the Pain Principle.*

Samanez-Larkin, G. R., & Knutson, B. (2015). Decision making in the ageing brain: changes in affective and motivational circuits. *Nature Reviews Neuroscience*, *16*(5), 278–289. https://doi.org/10.1038/nrn3917

Sánchez García, R., & Malcolm, D. (2010). Decivilizing, civilizing or informalizing? The international development of Mixed Martial Arts. *International Review for the Sociology of Sport*, *45*(1), 39–58. https://doi.org/10.1177/1012690209352392

Sanchis-Gomar, F., Olaso-Gonzalez, G., Corella, D., Gomez-Cabrera, M. C., & Vina, J. (2011). Increased Average Longevity among the "Tour de France" Cyclists. *International Journal of Sports Medicine*, *32*(08), 644–647. https://doi.org/10.1055/s-0031-1271711

Sanderson, J., Weathers, M., Snedaker, K., & Gramlich, K. (2017). "I Was Able to Still Do My Job on the Field and Keep Playing": An Investigation of Female and Male Athletes' Experiences With (Not) Reporting Concussions. Communication & Sport, 5(3), 267–287. https://doi.org/10.1177/2167479515623455

Sarantakos, S. (2005). *Social Research*. Basingstoke: Palgrave Macmillan.

Sariaslan, A., Sharp, D. J., D'Onofrio, B. M., Larsson, H., & Fazel, S. (2016). Long-term outcomes associated with traumatic brain injury in childhood and adolescence: a nationwide Swedish cohort study of a wide range of medical and social outcomes. PLoS medicine, 13(8), e1002103.

Saunders, R., 1984. The Second Impact in Catastrophic Contact-Sports Head Trauma. *JAMA: The Journal of the American Medical Association*, 252(4), p.538.

Schlosser, Allyssa Jean, "Concussion Knowledge And Attitudes: The Impact Of Hegemonic Masculinity" (2016). Theses and Dissertations. 1958. https://commons.und.edu/theses/1958

Schmidt, J., Weber, M., Suggs, D., Bierema, L & Miller, S. (2020) Improving Concussion Reporting across National College Athletic Association Divisions Using a Theory-Based, Data-Driven, Multimedia Concussion Education Intervention. *Journal of Neurotrauma.* 37 (4). Available at: https://www.liebertpub.com/doi/pdf/10.1089/neu.2019.6637

Schneider, D., Grandhi, R., Bansal, P., Kuntz, G., Webster, K., Logan, K., Barber Foss, K & Myer, G. (2017) Current state of concussion prevention strategies: a systematic review and meta-analysis of prospective, controlled studies. *British Journal of Sports Medicine.* 51 (20) 1473-1482. Available at: https://www.ncbi.nlm.nih.gov/pubmed/27251896

Schwab N, Tator C, Hazrati LN. DNA damage as a marker of brain damage in individuals with history of concussions. Lab Invest. 2019 Jul;99(7):1008-1018. doi: 10.1038/s41374-019-0199-8. Epub 2019 Feb 13. PMID: 30760862.

Schwandt, T. A. (1997). Reading the “Problem of Evaluation” in Social Inquiry. Qualitative Inquiry, 3(1), 4–25. https://doi.org/10.1177/107780049700300101

Scoats, R. (2017). Inclusive masculinity and Facebook photographs among early emerging adults at a British university. *Journal of Adolescent Research*, 32(3), 323-345.

Scott, L., Bazargan-Hejazi, S., Shirazi, A., Pan, D., Lee, S., Teruya, S. and Shaheen, M., 2019. Helmet use and bicycle-related trauma injury outcomes. *Brain Injury*, 33(13-14), pp.1597-1601.

Seale, C. (1999). Quality in Qualitative Research. *Qualitative Inquiry*, *5*(4), 465–478. https://doi.org/10.1177/107780049900500402

Seedhouse, E., 2013. *Pulling G*. New York, NY: Springer.

Seitz, S. (2015). Pixilated partnerships, overcoming obstacles in qualitative interviews via Skype: a research note. *Qualitative Research*, *16*(2), 229–235. https://doi.org/10.1177/1468794115577011

Self, D. R., Henry, E. D. V., Findley, C. S., & Reilly, E. (2007). Thrill seeking: the type T personality and extreme sports. *International Journal of Sport Management and Marketing*, *2*(1/2), 175. https://doi.org/10.1504/ijsmm.2007.011397

Sheaffer, Z., Bogler, R., & Sarfaty, S. (2011). Leadership attributes, masculinity and risk taking as predictors of crisis proneness. *Gender in Management: An International Journal*, *26*(2), 163–187. https://doi.org/10.1108/17542411111116563

Sherry, E. (2013), "The vulnerable researcher: facing the challenges of sensitive research", Qualitative Research Journal, Vol. 13 No. 3, pp. 278-288. https://doi.org/10.1108/QRJ-10-2012-0007

Silberman, M. (2013) Bicycling Injuries. *Current Sports Medicine Reports*. 12 (5) 337-345. Available at: 10.1249/JSR.0b013e3182a4bab7

Silberman, M. (2013) Bicycling Injuries. *Current Sports Medicine Reports*. 12 (5) 337-345. Available at: 10.1249/JSR.0b013e3182a4bab7

Silberman, M. R. (2013). Bicycling Injuries. *Current Sports Medicine Reports*, *12*(5), 337–345. https://doi.org/10.1249/jsr.0b013e3182a4bab7

Sivák S, Kurca E, Jancovic D, Petriscák S, Kucera P. [Contemporary view on mild brain injuries in adult population] Casopis Lekaru Ceskych. 2005 ;144(7):445-50; discussion 451-4.

Sjöberg, L. (2004). Explaining Individual Risk Perception: The Case of Nuclear Waste. *Risk Management*, *6*(1), 51–64. https://doi.org/10.1057/palgrave.rm.8240172

Smith, B & McGannon, K (2018) Developing rigor in qualitative research: problems and opportunities within sport and exercise psychology, International Review of Sport and Exercise Psychology, 11:1, 101-121, DOI: 10.1080/1750984X.2017.1317357

Smith, D. H., Johnson, V. E., & Stewart, W. (2013). Chronic neuropathologies of single and repetitive TBI: substrates of dementia?. *Nature reviews. Neurology*, *9*(4), 211–221. https://doi.org/10.1038/nrneurol.2013.29

Sone, J. Y., Kondziolka, D., Huang, J. H., & Samadani, U. (2017). Helmet efficacy against concussion and traumatic brain injury: a review. *Journal of neurosurgery*, *126*(3), 768–781. https://doi.org/10.3171/2016.2.JNS151972

Sone, J. Y., Kondziolka, D., Huang, J. H., & Samadani, U. (2017). Helmet efficacy against concussion and traumatic brain injury: a review. *Journal of Neurosurgery*, *126*(3), 768–781. https://doi.org/10.3171/2016.2.jns151972

Speed, W., 1989. Closed Head Injury Sequelae: Changing Concepts. *Headache: The Journal of Head and Face Pain*, 29(10), pp.643-647.

Spencer, C. (1995). *Homosexuality a History* (0 ed.). Fourth Estate Ltd.

Spinks, A. B., & McClure, R. J. (2007). Quantifying the risk of sports injury: a systematic review of activity-specific rates for children under 16 years of age. *British Journal of Sports Medicine*, *41*(9), 548–557. https://doi.org/10.1136/bjsm.2006.033605

Sport England. (2017). *Active People Survey 2016/2017*. https://www.sportengland.org/know-your-audience/data

Sport England. (2018). *Active Lives Survey 2018*. https://activelives.sportengland.org/

Spring, J. H. (1974). "Mass Culture and School Sports." History of Education Quarterly 14: 483–499.

*SPSS Statistics Arnmonk*. NY: IBM; 2020.

Srivastava, S. (2015). Modi-Masculinity: Media, Manhood, and "Traditions" in a Time of Consumerism. Television & New Media, 16(4), 331–338. https://doi.org/10.1177/1527476415575498

Stamm, J., Bourlas, A., Baugh, C., Fritts, N., Daneshvar, D., Martin, B., McClean, M., Tripodis, Y. and Stern, R., 2015. Age of first exposure to football and later-life cognitive impairment in former NFL players. *Neurology*, 84(11), pp.1114-1120.

Steel, D. (2014). *Philosophy and the Precautionary Principle: Science, Evidence, and Environmental Policy*. Cambridge University Press.

Sterchele, D. (2015). De-sportizing physical activity: From sport-for-development to play-for-development. *European Journal for Sport and Society*, *12*(1), 97–120. https://doi.org/10.1080/16138171.2015.11687958

Stern, P. C. (2008). Environmentally significant behavior in the home. *The Cambridge Handbook of Psychology and Economic Behaviour*, 363–382. https://doi.org/10.1017/cbo9780511490118.015

Stewart, W., McNamara, P. H., Lawlor, B., Hutchinson, S., & Farrell, M. (2015). Chronic traumatic encephalopathy: a potential late and under recognized consequence of rugby union?. QJM: An International Journal of Medicine, 109(1), 11-15.

Strange, L. S. (2002). The Bicycle, Women s Rights, and Elizabeth Cady Stanton. *Women's Studies*, *31*(5), 609–626. https://doi.org/10.1080/00497870214048

Stryker, S., & Bettcher, T. M. (2016). Introduction. *TSQ: Transgender Studies Quarterly*, *3*(1–2), 5–14. https://doi.org/10.1215/23289252-3334127

Stuart, S., Hickey, A., Morris, R., O'Donovan, K., & Godfrey, A. (2017). Concussion in contact sport: A challenging area to tackle. *Journal of Sport and Health Science* 10, 1016.

Stubbs, J. L., Thornton, A. E., Sevick, J. M., Silverberg, N. D., Barr, A. M., Honer, W. G., & Panenka, W. J. (2020). Traumatic brain injury in homeless and marginally housed individuals: a systematic review and meta-analysis. *The Lancet Public Health*, *5*(1), e19–e32. https://doi.org/10.1016/s2468-2667(19)30188-4

Stubbs, J., Thornton, A., Sevick, J., Silverberg, N., Barr, A., Honer, W. and Panenka, W., 2020. Traumatic brain injury in homeless and marginally housed individuals: a systematic review and meta-analysis. *The Lancet Public Health*, 5(1), pp.e19-e32.

Sullivan, S. J., Schneiders, A. G., Cheang, C.-W., Kitto, E., Lee, H., Redhead, J., Ward, S., Ahmed, O. H., & McCrory, P. R. (2011). 'What's happening?' A content analysis of concussion-related traffic onTwitter. *British Journal of Sports Medicine*, *46*(4), 258–263. https://doi.org/10.1136/bjsm.2010.080341

Supplemental Material for Parents' Intentions to Allow Youth Football Participation: Perceived Concussion Risk and the Theory of Planned Behavior. (2017). *Sport, Exercise, and Performance Psychology*, 1. https://doi.org/10.1037/spy0000102.supp

Supplemental Material for Risk Taking Across the Life Span: A Comparison of Self-Report and Behavioral Measures of Risk Taking. (2016). *Psychology and Aging*, 1. https://doi.org/10.1037/pag0000124.supp

Sussman E, Pendharkar A, Ho A, Ghajar J. (2018) Mild traumatic brain injury and concussion: terminology and classification. *Sports Neurology*. 21-24. doi:10.1016/b978-0-444-63954-7.00003-3

Sussman E, Pendharkar A, Ho A, Ghajar J. Mild traumatic brain injury and concussion: terminology and classification. *Sports Neurology*. 2018:21-24. doi:10.1016/b978-0-444-63954-7.00003-3
Szostak, R (2013). THE STATE OF THE FIELD: Interdisciplinary Research. *ISSUES IN INTERDISCIPLINARY STUDIES* No. 31, pp. 44-65.

Taghdiri F, Multani N, Tarazi A et al. Elevated cerebrospinal fluid total tau in former professional athletes with multiple concussions. *Neurology*. 2019;92(23):e2717-e2726. doi:10.1212/wnl.0000000000007608

Taghdiri, F., Multani, N., Tarazi, A., Naeimi, S. A., Khodadadi, M., Esopenko, C., Green, R., Colella, B., Wennberg, R., Mikulis, D., Davis, K. D., Goswami, R., Tator, C., Levine, B., & Tartaglia, M. C. (2019). Elevated cerebrospinal fluid total tau in former professional athletes with multiple concussions. *Neurology*, *92*(23), e2717–e2726. https://doi.org/10.1212/wnl.0000000000007608

Taylor, S. J., Bogdan, R., & DeVault, M. (2015). *Introduction to Qualitative Research Methods: A Guidebook and Resource* (4th ed.). Wiley.

Taylor-Robinson D C, Lai E T, Whitehead M, Barr B. (2019) *Child health unravelling in UK*. British Medical Journal 364-963 doi:10.1136/bmj.l963

Teresa Hill & Michael Dao (2021) Personal pasts become academic presents: engaging reflexivity and considering dual insider/outsider roles in physical cultural fieldwork, Qualitative Research in Sport, Exercise and Health, 13:3, 521-535, DOI: 10.1080/2159676X.2020.1731576

Terry, G., Hayfield, N., Clarke, V., & Braun, V. (2017). Thematic Analysis. *The SAGE Handbook of Qualitative Research in Psychology*, 17–36. https://doi.org/10.4135/9781526405555.n2

Thomas, D. R. (2006). A General Inductive Approach for Analyzing Qualitative Evaluation Data. *American Journal of Evaluation*, *27*(2), 237–246. https://doi.org/10.1177/1098214005283748

Thompson, D. C. (2001). Risk compensation theory should be subject to systematic reviews of the scientific evidence. *Injury Prevention*, *7*(2), 86–88. https://doi.org/10.1136/ip.7.2.86

Thomson, C. J., & Carlson, S. R. (2015). Increased patterns of risky behaviours among helmet wearers in skiing and snowboarding. *Accident Analysis & Prevention*, *75*, 179–183. https://doi.org/10.1016/j.aap.2014.11.024

Tin Tin, S., Woodward, A., & Ameratunga, S. (2013). Incidence, risk, and protective factors of bicycle crashes: Findings from a prospective cohort study in New Zealand. *Preventive Medicine*, *57*(3), 152–161. https://doi.org/10.1016/j.ypmed.2013.05.001

Torres, D., Galetta, K., Phillips, W., Dziemianowicz, M., Wilson, J., Dorman, E., Laudano, E., Galetta, S & Balcer, L. (2013) Sports-related concussion; Anonymous survey of a collegiate cohort. *Clinical and Ethical challenges*, 3 (4) 279-287. Available at: https://www.ncbi.nlm.nih.gov/pubmed/24195017

Trimpop R, Zimolong B. Risk acceptance. In: JM Stellman (Editor) Encyclopaedia of Occupational Health and Safety, Fourth edition. Available: http://www.ilo.org/encyclopedia/?hdoc&nd=857000002. [24 November 2006].

Tudor-Locke, C., & Bassett, D. R. (2004). How Many Steps/Day Are Enough? *Sports Medicine*, *34*(1), 1–8. https://doi.org/10.2165/00007256-200434010-00001

Tung, G. J., Vernick, J. S., Reiney, E. V., & Gielen, A. C. (2012). Legislator Voting and Behavioral Science Theory: A Systematic Review. *American Journal of Health Behavior*, *36*(6), 823–833. https://doi.org/10.5993/ajhb.36.6.9

Turner, C., & McClure, R. (2003). Age and gender differences in risk-taking behaviour as an explanation for high incidence of motor vehicle crashes as a driver in young males. *Injury Control and Safety Promotion*, *10*(3), 123–130. https://doi.org/10.1076/icsp.10.3.123.14560

UCI (2021) A new protocol specific for cycling to deal with concussion. https://www.uci.org/pressrelease/a-new-protocol-specific-for-cycling-to-deal-with-concussion/2oZaRMYkxQMxQ0MIuIHu0X

UCI. (2019). *The UCI 2019 Annual Report*. https://www.uci.org/inside-uci/press-releases/the-uci-publishes-its-2019-annual-report

Uci.org. 2020. *Regulations*. [online] Available at: <https://www.uci.org/inside-uci/constitutions-regulations/regulations> [Accessed 12 October 2020].

Valovich McLeod, T. and Hale, T., 2014. Vestibular and balance issues following sport-related concussion. *Brain Injury*, 29(2), pp.175-184.

Van De Belt, T. H., Engelen, L. J. L. P. G., Berben, S. A. A., & Schoonhoven, L. (2010). Definition of Health 2.0 and Medicine 2.0: A Systematic Review. *Journal of Medical Internet Research*, *12*(2), e18. https://doi.org/10.2196/jmir.1350

van Mechelen, D. M., van Mechelen, W., & Verhagen, E. A. L. M. (2013). Sports injury prevention in your pocket?! Prevention apps assessed against the available scientific evidence: a review. *British Journal of Sports Medicine*, *48*(11), 878–882. https://doi.org/10.1136/bjsports-2012-092136

van Mechelen, W., Hlobil, H., & Kemper, H. C. G. (1992). Incidence, Severity, Aetiology and Prevention of Sports Injuries. *Sports Medicine*, *14*(2), 82–99. https://doi.org/10.2165/00007256-199214020-00002

Vandello, J. A., & Bosson, J. K. (2013). Hard won and easily lost: A review and synthesis of theory and research on precarious manhood. Psychology of Men & Masculinity, 14(2), 101.

Ventresca, M., & McDonald, M. G. (2019). *Sociocultural Examinations of Sports Concussions (Routledge Research in Sport and Exercise Science)* (1st ed.). Routledge.

Vollrath, M., Meilinger, T., & Krüger, H.-P. (2002). How the presence of passengers influences the risk of a collision with another vehicle. *Accident Analysis & Prevention*, *34*(5), 649–654. https://doi.org/10.1016/s0001-4575(01)00064-1

Waddington, I., & Smith, A. (2000). *Sport, Health and Drugs: A Critical Sociological Perspective*. Routledge.

Washington, P., Villapol, S. and Burns, M., 2016. Polypathology and dementia after brain trauma: Does brain injury trigger distinct neurodegenerative diseases, or should they be classified together as traumatic encephalopathy?. *Experimental Neurology*, 275, pp.381-388.

Wasserman, E., Kerr, Z., Zuckerman, S. and Covassin, T., 2015. Epidemiology of Sports-Related Concussions in National Collegiate Athletic Association Athletes From 2009-2010 to 2013-2014. *The American Journal of Sports Medicine*, 44(1), pp.226-233.

Wayment H, Huffman A, Lane T, Lininger M. Relationship of athletic and academic identity to concussion reporting intentions. *Musculoskeletal Science and Practice*. 2019;42:186-192. doi:10.1016/j.msksp.2019.04.003

Weber M, Edwards M. (2010) The effect of brain injury terminology on university athletes' expected outcome from injury, familiarity and actual symptom report. *Brain Inj*. 24(11):1364-1371. doi:10.3109/02699052.2010.507110

Weber M, Edwards M. Sport Concussion Knowledge in the UK General Public. *Archives of Clinical Neuropsychology*. 2012;27(3):355-361. doi:10.1093/arclin/acs029

Weber M, Edwards M. The effect of brain injury terminology on university athletes' expected outcome from injury, familiarity and actual symptom report. *Brain Inj*. 2010;24(11):1364-1371. doi:10.3109/02699052.2010.507110
Weber M, Suggs D, Bierema L, Miller L, Reifsteck F, Schmidt J. Collegiate student-athlete sex, years of sport eligibility completed, and sport contact level influence on concussion reporting intentions and behaviours. *Brain Inj*. 2019;33(5):592-597. doi:10.1080/02699052.2019.1568573
Weber, L. R. (1994). *Analysis of Social Problems, The* (1st ed.). Allyn & Bacon.

Wechsler, H., Nelson, T. E., Lee, J. E., Seibring, M., Lewis, C., & Keeling, R. P. (2003). Perception and reality: a national evaluation of social norms marketing interventions to reduce college students' heavy alcohol use. *Journal of Studies on Alcohol*, *64*(4), 484–494. https://doi.org/10.15288/jsa.2003.64.484

Wellard, I. (2010). Men, sport, body performance and the maintenance of 'exclusive masculinity'. *Leisure Studies*, *21*(3–4), 235–247. https://doi.org/10.1080/0261436022000030641

Weller, K., Bruns, A., Burgess, J., Mahrt, M., & Puschmann, C. (2013). *Twitter and Society (Digital Formations)* (Illustrated ed.). Peter Lang Inc., International Academic Publishers.

White, A. J., D. Parry, K., Humphries, C., Phelan, S., Batten, J., & Magrath, R. (2020a). Duty of Karius: Media Framing of Concussion Following the 2018 UEFA Champions League Final. *Communication & Sport*, 216747952094804. https://doi.org/10.1177/2167479520948048

White, A. J., D. Parry, K., Humphries, C., Phelan, S., Batten, J., & Magrath, R. (2020b). Duty of Karius: Media Framing of Concussion Following the 2018 UEFA Champions League Final. *Communication & Sport*, 216747952094804. https://doi.org/10.1177/2167479520948048

White, A. J., Magrath, R. and Emilio Morales, L. (2020) 'Gay male athletes' coming-out stories on Outsports.com', *International Review for the Sociology of Sport*. doi: 10.1177/1012690220969355.

White, A. J., Magrath, R., & Emilio Morales, L. (2020). Gay male athletes' coming-out stories on Outsports.com. International Review for the Sociology of Sport. https://doi.org/10.1177/1012690220969355

White, A., & Hobson, M. (2015). Teachers' stories: physical education teachers' constructions and experiences of masculinity within secondary school physical education. *Sport, Education and Society*, *22*(8), 905–918. https://doi.org/10.1080/13573322.2015.1112779

White, A., & Hobson, M. (2015). Teachers' stories: physical education teachers' constructions and experiences of masculinity within secondary school physical education. Sport, Education and Society, 22(8), 905–918. https://doi.org/10.1080/13573322.2015.1112779

White, P.G., & Vagi, A.B. (1990). "Rugby in the 19th-Century British Boarding-School System: A Feminist Psychoanalytic Perspective." Pp. 67–78 in Sport, Men, and the Gender Order, ed. Michael Messner and Don Sabo. Champaign, IL: Human Kinetics. Whitehead, N. J., & Hendry, L. B. (1976). Teaching Physical Education.

Whittaker, R., Kemp, S. and House, A (2007). Illness perceptions and outcome in mild head injury: a longitudinal study. *Journal of Neurology, Neurosurgery & Psychiatry*, 78(6), pp.644-646.

Wignall, L., Scoats, R., Anderson, E., & Morales, L. (2020). A qualitative study of heterosexual men's attitudes toward and practices of receiving anal stimulation. *Culture, health & sexuality*, *22*(6), 675-689.

Wijlhuizen, G., van Gent, P., & Stipdonk, H. (2016). Sport Cycling Crashes among Males on Public Roads, the Influence of Bunch Riding, Experience and Competitiveness. *Safety*, *2*(2), 11. https://doi.org/10.3390/safety2020011

Wijlhuizen, G., van Gent, P., & Stipdonk, H. (2016). Sport Cycling Crashes among Males on Public Roads, the Influence of Bunch Riding, Experience and Competitiveness. *Safety*, *2*(2), 11. https://doi.org/10.3390/safety2020011

Wilde, G. J. S. (1998). Risk homeostasis theory: an overview. *Injury Prevention*, *4*(2), 89–91. https://doi.org/10.1136/ip.4.2.89

Williams J, Langdon J, McMillan J, Buckley T. English professional football players concussion knowledge and attitude. J Sport Health Sci. 2016;5(2):197-204. doi:10.1016/j.jshs.2015.01.009
Williams, I J S. & Goodman, D. (2006) Converging evidence for the under-reporting of concussions in youth ice hockey. *British Journal of Sports Medicine*, 40, 128–132. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2492052/

Williams, M. L., Burnap, P., & Sloan, L. (2017). Towards an Ethical Framework for Publishing Twitter Data in Social Research: Taking into Account Users' Views, Online Context and Algorithmic Estimation. *Sociology*, *51*(6), 1149–1168. https://doi.org/10.1177/0038038517708140

Williams, W. H., Chitsabesan, P., Fazel, S., McMillan, T., Hughes, N., Parsonage, M., & Tonks, J. (2018). Traumatic brain injury: a potential cause of violent crime?. *The lancet. Psychiatry*, *5*(10), 836–844. https://doi.org/10.1016/S2215-0366(18)30062-2

Williams, W. H., Cordan, G., Mewse, A. J., Tonks, J., & Burgess, C. N. (2010). Self-reported traumatic brain injury in male young offenders: a risk factor for re-offending, poor mental health and violence?. *Neuropsychological rehabilitation*, *20*(6), 801–812. https://doi.org/10.1080/09602011.2010.519613

Wills, S & Leathem, M. (2001). Sports-related brain injury research: methodological difficulties associated with ambiguous terminology. *Brain Injury*, 15(7), pp.645-648.

Wilmoth, K., Tan, A., Hague, C., Tarkenton, T., Silver, C., Didehbani, N., Rossetti, H., Batjer, H., Bell, K. and Cullum, C., 2019. Current State of the Literature on Psychological and Social Sequelae of Sports-Related Concussion in School-Aged Children and Adolescents. *Journal of Experimental Neuroscience*, 13, p.117906951983042.

Wilson L, Stewart W, Dams-O'Connor K et al. (2017) The chronic and evolving neurological consequences of traumatic brain injury. *The Lancet Neurology*. 16(10):813-825. doi:10.1016/s1474-4422(17)30279-x

Wilson L, Stewart W, Dams-O'Connor K et al. The chronic and evolving neurological consequences of traumatic brain injury. *The Lancet Neurology*. 2017;16(10):813-825. doi:10.1016/s1474-4422(17)30279-x
Wilson, B. 2006. *Fight, flight, or chill: Subcultures, youth, and rave into the 21st century*, Montreal and Kingston: McGill-Queen's University Press.

Wittenberg, M. (2005). *Industrialisation and surplus labour: A general equilibrium model of sleep, work and leisure.* School of Economics, University of Cape Town, South Africa.

Workewych, A. M., Ciuffetelli Muzzi, M., Jing, R., Zhang, S., Topolovec-Vranic, J., & Cusimano, M. D. (2017). Twitter and traumatic brain injury: A content and sentiment analysis of tweets pertaining to

sport-related brain injury. *SAGE Open Medicine*, *5*, 205031211772005. https://doi.org/10.1177/2050312117720057

Wright, D., Liu, S., van der Poel, C., McDonald, S., Brady, R., Taylor, L., Yang, L., Gardner, A., Ordidge, R., O'Brien, T., Johnston, L. and Shultz, S., 2016. Traumatic Brain Injury Results in Cellular, Structural and Functional Changes Resembling Motor Neuron Disease. *Cerebral Cortex*,.

Yengo-Kahn, A. M., Kelly, P. D., Liles, D. C., McKeithan, L. J., Grisham, C. J., Khan, M. S., Lee, T., Kuhn, A. W., Bonfield, C. M., & Zuckerman, S. L. (2020). The cost of a single concussion in American high school football: a retrospective cohort study. *Concussion*, *5*(4), CNC81. https://doi.org/10.2217/cnc-2020-0012

YouGov. (2016, May 13). *Only 2% of young men feel completely masculine (compared to 56% of over 65s)*. https://yougov.co.uk/topics/politics/articles-reports/2016/05/13/low-young-masculinity-britain

YouGov. (2016, May 13). Only 2% of young men feel completely masculine (compared to 56% of over 65s). https://yougov.co.uk/topics/politics/articles-reports/2016/05/13/low-young-masculinity-britain

Young, K. (2012). Sport, Violence and Society. London: Routledge.

Young, K. (2019). *Sport, Violence and Society* (2nd ed.). Routledge.

Young, K., & White, P. (1995). SPORT, PHYSICAL DANGER, AND INJURY: THE EXPERIENCES OF ELITE WOMEN ATHLETES. Journal of Sport and Social Issues, 19(1), 45–61. https://doi.org/10.1177/019372395019001004

Young, K., White, P., & McTeer, W. (1994). Body talk: Male athletes reflect on sport, injury, and pain. *Sociology of sport journal*, 11(2), 175-194.

Zajc, P., & Berzelak, N. (2016). Riding styles and characteristics of rides among Slovenian mountain bikers and management challenges. *Journal of Outdoor Recreation and Tourism*, *15*, 10–19. https://doi.org/10.1016/j.jort.2016.04.009

Zemper E. Two-Year Prospective Study of Relative Risk of a Second Cerebral Concussion. *Am J Phys Med Rehabil*. 2003;82(9):653-659. doi:10.1097/01.phm.0000083666.74494.ba

Zhang, L., Yang, K. and King, A. (2004). A Proposed Injury Threshold for Mild Traumatic Brain Injury. *Journal of Biomechanical Engineering*, 126(2), pp.226-236.

Zheng, Y., Ma, Y., & Cheng, J. (2020). Cycling anger in China: The relationship with gender roles, cycling-related experience, risky and aggressive riding. *Transportation Research Part F: Traffic Psychology and Behaviour*, *68*, 52–66. https://doi.org/10.1016/j.trf.2019.12.002

Zimmer, M., & Proferes, N. J. (2014). A topology of Twitter research: disciplines, methods, and ethics. *Aslib Journal of Information Management*, *66*(3), 250–261. https://doi.org/10.1108/ajim-09-2013-0083

## Appendices

### Appendix 1. Participant consent form for study 4

Thank you for expressing an interest in this research. Please read the following information *carefully* before deciding whether to participate in the research. If you choose to participate in the research, I thank you. If you do not decide to participate in the research, there will be no disadvantage to you of any kind and I thank you for considering this request.

**What are the aims of the research?**

The aim of the research project is to build on previous research obtained through survey data on the current knowledge and attitudes of UK competitive cyclists towards concussion. This project in an extension of this, providing a more detailed in sight to the area and improve the understanding of the culture of competitive cycling.

**What type of participants does the research require?**

This research project hopes to recruit fifteen competitive cyclists from across the British Cycling ability categories and from across the UK.

**What will participants be asked to do?**

Individuals who volunteer to participate in the research will be asked to complete a semi-structured interview with the lead researcher. Interviews will be conducted on Microsoft Teams and should take no longer the one hour.

**What are the potential risks and discomforts of the research?**

The potential risks and discomforts of this research are likely to be minimal. However, some questions will be asked around concussion history and experience which may raise some psychological consequences for participants. Participants will be debriefed prior to the interview on the questions and areas, being provided the option to withdraw or skip questions if they wish. Confidentiality and anonymity will always be maintained, and you may contact the researcher at any point should you wish to discuss any issues or concerns associated with your participation in the project. Please also be aware that you may decide not to participate in the research and there will be no disadvantage to you of any kind.

**Can participants change their mind and withdraw from the research?**

Individuals may withdraw from participation in the research at any time and without any disadvantage of any kind.

**What information will be collected, and how will it be used?**

The interviews will be recorded on Microsoft Teams. The lead other will transcribe and analyse this data, no other individuals will see the data. Some direct quotes may be drawn from the interviews for the data write up, but participants will be asked if they consent to this prior to

any content being used and all data will be anonymous. The research is novel and one of the first studies of this kind in the research area, your participation will help the progress of the sport in dealing with the issue of concussion. All data will be anonymous. The results of this project may be published, but the information will not be linked to any specific person. Once transcribed, you will be provided the opportunity to review the transcript before any analysis is conducted.

This research study complies with Article 6(1)(e) of the GDPR regulations with data being processed under the basis of public task and in accordance with 5.23 of the University's Articles of Association.

For further information please contact the lead investigator with regards to obtaining the University's Data Protection Policy.

**What if participants have any questions?**

If you have any questions about the project, please feel free to contact:

Jack Hardwicke

Postgraduate Research Student, The University of Winchester

J.Hardwicke.15@unimail.winchester.ac.uk

Based on this information, I confirm that by signing below the investigators have explained the full details and parameters of all tests and procedures to me, that I have understood what participation will involve, that I have been made aware of all the potential benefits and risks of participation, and that I am agreeing to participate in a research study.

I know of no reason why participation in these testing procedures might present a risk to my safety and understand that any personal information that I have submitted will be treated as highly confidential.

**Name:**

**Signature (Initials):**

**Date:**

Ethical approval for this study has been given following Faculty level review from the Faculty of Health and Wellbeing at the University of Winchester, UK (HWB_REC_20_04). For correspondence on this please contact:

Dr James Faulkner
Faculty HWB Ethics Officer Lead
James.Faulkner@winchester.ac.uk