Institution:
Edinburgh Napier University

Unit of Assessment:
Unit of Assessment 24 – Sport and Exercise Sciences, Leisure and Tourism

Title of case study:
Protecting the Health of Elite and Recreational Athletes in Competitive Mountain Biking

Period when the underpinning research was undertaken:
July 2016-December 2020

Details of staff conducting the underpinning research from the submitting unit:

Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Debbie Palmer	Associate Professor (PI)	Nov 2015 – October 2020
Geraint Florida-James	Professor	August 2000 – Ongoing

Period when the claimed impact occurred:
July 2017-December 2020

Is this case study continued from a case study submitted in 2014?
No

1. Summary of the impact (indicative maximum 100 words)

Research by Edinburgh Napier University on elite mountain biking injury has been utilised by its governing body and by elite and recreational riders, in order to protect rider health. Dr Palmer's research with the international governing body, the Enduro World Series (EWS), is the first study of its kind in Enduro mountain biking. The research has led to impact on:

- **The Enduro World Series**. The research has contributed to recognition of EWS as a new mountain biking discipline, and has contributed to the organisation introducing amended and more safe qualifying criteria.
- **Race Event Organisers**. The research has led organisers to adopt targeted medical provision during race events to improve the quality of care. It also informed the production of a concussion guidance tool, including a standardised concussion assessment protocol, for event organisers and their medical staff and marshals.
- **Enduro Riders**. Materials produced as part of the study include a lay public document on the injury risks associated with enduro racing and riding, and a rider concussion recognition and education pocket guide. Both have increased rider engagement with injury prevention.

2. Underpinning research (indicative maximum 500 words)

Elite sports can take a significant toll on the physical health of sportspeople. For example, across the Vancouver 2010 Winter Olympics and the Sochi 2014 Winter Olympics, an average of 12.6 per 100 athletes experienced injury. Some rates are even higher. The rate for aerial Skiing events at Sochi 2014 was 48.8 injuries per 100 athletes. In order for sporting bodies to effectively protect these athlete's health, they require robust data on the rate and epidemiology of these injuries. Dr Palmer's research has focused on understanding the frequency and context of sport-related injury across a number of sports. The work has informed organising bodies strategies to reduce the rate of sports related injuries.

Dr Palmer was an Associate Professor at Edinburgh Napier University between November 2015 and October 2020. Dr Palmer's EWS research has been undertaken with Professor Geraint Florida-James, a specialist in mountain biking research, and Professor at Edinburgh Napier University. The work has also been undertaken in collaboration with Chris Ball, Managing Director of the Enduro World Series.

In 2017, Dr Palmer profiled injury and illness rates at the Rio 2016 Olympics **[O1]**. The research recorded daily incidences of athlete injury and illness reported by the National Olympic Committee medical teams. Findings indicated that 8% of athletes incurred at least one injury during the games. BMX cycling was found to have had the highest rate at 38% of athletes incurring an injury, with mountain biking ranking third-highest at 24%. This work continued in 2018 with a more specific cross-sectional study regarding hip and knee pain in British Olympic athletes over 40 **[O2]**, and a similar injury profiling study in 2019, on the PyeongChang 2018 Winter Olympics **[O3]**. In 2020, using similar techniques, Dr Palmer completed a study which profiled a much larger sample size of 3,357 retired Olympic athletes ,to understand the epidemiology of injuries sustained throughout their careers **[O4].**

Dr Palmer's research into the 2016 Rio Olympics found that 24% of athletes competing in the discipline of mountain biking were injured during the games **[O1]**. This work led to her leading research with the Enduro World Series (EWS), an international competitive mountain biking organisation, between 2016 and 2019 **[O5, O6]**. The Enduro Word Series is an elite series of international competitive mountain bike races, which given the speed and terrain, involve high numbers of athlete injuries.

The research involved a two-part study undertaken on behalf of the EWS**.** The first part was a two-season prospective injury and illness surveillance study, concerning the years 2017 and 2018 **[O5, O6]**. Dr Palmer collected injury data from event medical staff at 10 international EWS race events, at which 2,010 riders participated. 188 riders reported injury, 8.9% of the total. The research also uncovered data concerning the causes of injury and the commonality of types of injury. For example, 71% of injuries were caused by contact with the ground, and 60% occurred on rocky stages. The most frequently reported injury diagnosis was concussion at 7.3% of all injuries diagnosed. Only 57% were noted to have taken time off riding after concussion, with 29% confirming they continued racing. The most common injury was to the shoulder/clavicle area at 13.3% of all injuries. Shoulder injuries were found to be the most severe, with an average of 24.9 days lost as a result of those recorded. It was also found that almost a third of the total injuries recorded occurred to inexperienced riders.

The second part of this project involved a cross-sectional health study of enduro riders at all levels, looking to discover any broader risks to health from the sport **[O5]**. The survey asked detailed questions about individuals riding exposure and injury history, asking them to identify significant injuries which had lasted one month or more. The majority of responders were amateur or recreational enduro riders, and 40.7% recorded that they had suffered a significant injury as a result of enduro riding. Again, concussion was the third highest diagnosed injury. A quarter of these riders reported continuing their ride immediately after the accident, and half of those who reported concussion recorded a significant reoccurrence of the injury. Equally, shoulder or clavicle injuries were again found to be the most common at 25.6% of total injuries. Shoulder fracture and dislocation accounted for the highest number of lost days due to injury.

This two-part study led to a series of recommendations for the discipline, both at an elite and recreational level. For example, additional medical provision was recommended to be provided by the EWS for rocky stages where injuries were recorded as high (60%). Concussion was highlighted as a concern for the sport, and as such a new rider assessment protocol was introduced for use at race events (supplemented by a concussion guide created by Dr Palmer). Additionally, the research recommended improved concussion and injury education for both elite and recreational riders.

3. References to the research (indicative maximum of six references)
O1, O2, O3, O4 are published in the British Journal of Sports Medicine, which serves 25 clinical societies with over 13,000 members. All have undergone blind peer-review.

- [O1] T Soligard, K Steffen, D Palmer, JM Alonso, R Bahr, A Dias Lopes, J Dvorak, ME Grant, W Meeuwisse, M Mountjoy, LO Pena Costa, N Salmina, R Budgett, L Engebretsen. (2017). *Sports injuries and illnesses in the Rio de Janeiro 2016 Olympic Summer Games*. British Journal of Sports Medicine; 51:1265-1271. https://doi.org/10.1136/bjsports-2017-097956. **Submitted to REF2.**
- **[O2] Cooper D J, Scammell B E, Batt M E, Palmer D. *Factors associated with pain and osteoarthritis at the hip and knee in Great Britain's Olympians: a cross-sectional study*. (2018). British Journal of Sports Medicine. 2018; 52:1101-1108. https://doi.org/10.1136/bjsports-2017-098315.** Submitted to REF2.
- [O3] T Soligard, **D Palmer**, K Steffen, A Dias Lopes, J Dvorak, ME Grant, DS Kim, SY Lee, N Salmina, B Toresdahl, V Yanina, J Young, R Budgett, L Engebretsen. (2019). *Sports injury and illness in the PyeongChang 2018 Olympic Winter Games: A prospective study of 2914 athletes from 92 countries*. British Journal of Sports Medicine, 2019; 53:1085-1092. http://dx.doi.org/10.1136/bjsports-2018-100236. **Submitted to REF2.**
- [O4] D Palmer, D Cooper, C Emery, M Batt, L Engebretsen, BE Scammell, P Schamasch, M Shroff, T Soligard, K Steffen, JL Whittaker, R Budgett. (2021, online first 10th Nov 2020) *Self-reported sports injuries and later-life health status in 3,357 retired Olympians from 131 countries: a cross-sectional survey among those competing in the Games between London 1948 and PyeongChang 2018*. British Journal of Sports Medicine. http://dx.doi.org/10.1136/bjsports-2019-101772
- [O5] D Palmer, C Ball, G Florida-James. Enduro Mountain Bike Medical Study. (2019). Enduro World Series Public Medical Report. (https://admin.enduroworldseries.com/uploads/documents/EWS%20Medical%20Study%20v6.pdf
- [O6] D Palmer, C Ball, G Florida-James. *Enduro World Series Mountain Biking Injuries: a two-year prospective study of 2010 Riders*. (2020) International Journal of Sports Medicine. Epub ahead of print. https://doi.org/10.1055/a-1320-1116. **Submitted to REF2.**

Key research grants:
- World Olympians Association: Retired Olympian Musculoskeletal Health Study (ROMHS), July 2017 for 2 years - £90,192 ($120,000)
-Enduro World Series (EWS) Injury/Illness Performance Project - surveillance study, March 2017 for 2 years - £23,563.

4. Details of the impact (indicative maximum 750 words)
The research described has allowed Dr Palmer to support Enduro Mountain Biking and has benefitted distinct groups. 34 countries and 6,500 riders participate in the Enduro World Series at elite level, with 71 countries and over 25,000 riders engaging with EWS at lower tiers. EWS estimates its social media reached 37million people in 2020, with an average of 1.8million visits to their website each year **[C6]**. A robust and reliable data set for both elite and recreational Enduro riders has impacted:

- **The Enduro World Series**.
- **Race Event Organisers**.
- **Enduro Riders**.

Enduro World Series
In 2017 the EWS sought to gain recognition and accreditation as a new mountain biking discipline from world cycling's governing body, the International Cycling Union (UCI). In order for the UCI to admit the EWS, it required robust evidence that it recognised the importance of monitoring and protecting athlete health. To strengthen the bid to the UCI, the EWS used Dr Palmer's research findings **[O5, O6]** to evidence that the discipline was actively monitoring athlete health, and that risk reduction strategies were informed by empirical data, in alignment

with other International Sports Federations. For example, the research recognised concussion as a risk for Enduro athletes, and recommended increased prevention protocols and guidance. Guidance documents were subsequently created to this effect **[C3, C4, C5]**. The UCI recognised the official status of EWS as a new discipline in 2019. Chris Ball, Managing Director of the Enduro World Series notes '*EWS used the injury surveillance project outputs from the Edinburgh Napier study as part of their bid to International Cycling Union, and this made a significant contribution in our successful application in 2019'*.**[C6]**.

In addition to this recognition, the research has been utilised by the EWS to amend its processes in the interests of rider safety. The research report **[O5]** found that over a third of injuries over 2017 and 2018 occurred to local, inexperienced riders, who were attending only one local race event in the series. As such, a recommendation was made in the report to reassess the qualifying criteria for inexperienced riders. The EWS has since amended its qualifying criteria by introducing qualifier and challenger events. These have decreased the number of first-time, only-time riders (those who the research shows to be more frequently injured), competing in higher risk EWS tier 1 events. This has ensured qualified riders possess sufficient skill and experience to compete safely at that level. Chris Ball notes that the research has led to '*New changes to World Governing Body policy for EWS tier 1 rider race qualifying criteria to ensure riders possess the appropriate experience and skills to compete at that level'* **[C6]**.

Race Event Organisers

The Enduro World Series consists of a number of race events organised by different national organisers in one year. Recommendations were made in the EWS research report **[O5]** for the benefit of race event organisers. Due to the findings that a 60% of severe injuries occurred on steep and rocky sections of the race track **[O1]**, organisers were guided by Dr Palmer's research to provide concentrated medical provision on these stages. Chris Ball confirms that this research led to '*Positive changes to international professional practice with targeting medical provision during race events'*. **[C6].**

In addition, as a result of the findings that almost a quarter of riders continued riding after concussion **[O5]**, Dr Palmer created a concussion guide for event organisers and medics **[C3].** This document outlines red flags and assessment protocols for concussion, recommended treatment of riders, and return to riding advice. This is utilised by the estimated 25,000 EWS riders each year, as well as the high numbers of the public engaging in Enduro mountain biking for leisure. Chris Ball states that the research led to '*New concussion recognition and easy to use return-to-riding pocket guides which are freely accessible to endure(o) race event organisers and international and domestic/recreational riders, worldwide on the EWS website',* a website which he states sees '*1.8 million visits per year'* **[C6]**.

A national event organiser notes the benefit of the research to their preparation: '*our rescue team and medical staff had to face challenges and evolution in the way they approach the race. Together with EWS staff we grew a lot in that part of the organization and the* ***Enduro Mountain Bike Medical Study*** *helped us to step up the game big time. It also helped us to be ready for situations that we have never faced before on the field. We have been using this resource in conjunction with our medical staff to train the rescue teams on the stages and grow their knowledge. The EWS Medical Study has been and is an incredible asset for our team and part of the race documents we provide to the local staff'* **[C7]**.

Enduro Riders

The research **[O5]** found that alongside the injuries sustained by athletes in EWS race events, a higher proportion of injuries were experienced by both elite and recreational riders in other settings. It also found that the most commonly reported and occurring injuries in elite and recreational Enduro racing were concussion and clavicle/shoulder injuries, with the latter accounting for the injury causing the most disruption to athletes lives and schedules. As a result, the recommendation was made for greater educational material to support riders in monitoring their own health and preventing injury when outside of race events.

To further this educational end, the report was made freely available on the EWS website **[O5],** and has been successfully disseminated by three mountain biking media organisations **[C1]**. Dr

Palmer also created freely available guides for riders to use to prevent and deal with both concussion and shoulder injuries. The concussion guide for riders **[C2]** is freely available via the EWS website, and details how riders can notice concussion, what to do after suffering one, and how long to rest for afterwards. This importance of the report and this concussion tool are evident, as both were highlighted to riders by the Global Mountain Biking Network, in a 2020 video, viewed over 34,000 times **[C2]**.

Also created were support materials for riders to use outlining rehabilitation and prehabilitation exercises for shoulder injuries. These resources have guided riders on appropriate methods to avoid and recover quickly from shoulder injuries **[C5]**. In support of the impact of this material, Chris Ball states that Dr Palmers research has allowed '*A global approach to concussion assessment not only benefiting existing expert riders but also new entrants to the sector creating lasting legacy'* **[C6]**

International Dissemination

The research has also been of great interest in the wider field of sports injury prevention. Dr Palmer was invited to speak about the EWS research at the University of Calgary, Canada in 2019, and at the International Olympic Committee Prevention of Injury and Illness in Sport Conference in 2020.

5. Sources to corroborate the impact (indicative maximum of 10 references)

[**C1]** Media Coverage of EWS Health Study
https://www.singletracks.com/blog/mtb-news/worlds-largest-medical-study-of-mountain-biker-health-and-injury-commissioned-by-the-enduro-world-series/
https://www.enduroworldseries.com/news/1309-ews-publish-three-yearinjury-study--concussion-guidelines/
https://www.pinkbike.com/news/6-key-facts-from-the-ews-health-study.html#cid2288905
[C2] Global Mountain Biking Network Video Report
https://www.youtube.com/watch?v=dXq2r_re9S8
[C3]Concussion Guide for Riders
https://admin.enduroworldseries.com/uploads/documents/RIDER%20EWS%20Concussion%20Guide%20A6%20FINAL%20WEB.pdf
[C4] Concussion Guide for Race Event Organisers
https://admin.enduroworldseries.com/uploads/documents/EWS%20Concussion%20Pocket%20Guide%20A6%20FINAL%20WEB.pdf
[C5] Shoulder Injury Resources
https://www.enduroworldseries.com/ews-general/ews-medical-resources/
[C6] Support Letter from Chris Ball, Managing Director of EWS
[C7] Email from a national Enduro Event Organiser