

Magnitude of translational and rotational head accelerations during downhill mountain biking

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Introduction

- Notable increase in research and media interest in head injuries/concussion.
- Team sports are the predominant focus of most studies.
- Studies generally report occurrence of head injuries and impact forces resulting from direct contact.
- Mountain bike (MTB) athletes also potentially at risk of head injuries.



Concussion vs mild traumatic brain injury (mTBI)

- Both result from impulsive forces transmitted to the brain.
 - Concussion more transient.
 - mTBI longer lasting.
- Zhang et al. (2004) proposed clinical cut-offs for translational and rotational accelerations and irreversible mTBI.
 - >85 g translational
 - Impact duration 10-30 ms
 - >6000 rads/s² rotational



Image credit: Michael Donlevey, Cyclist Magazine (2018)

Epidemiology of MTB injuries

- Concussion accounted for 13% of all reported injuries in XCO and DHI MTB during 1995 NORBA MTB series (Kronisch et al., 1996).
- 23 self-reported concussions from a total of 494 injuries (5%) during 2011 European DHI season (Becker et al., 2013).
- Comparable to head injury rates in alpine skiing (8-10%) (Florenes et al., 2009).
- Mean and peak translational loads of ~25 g and ~83-162 g respectively in alpine snow sports (Scher at al., 2006; Steenstrup et al., 2017)
- Peak translational loads of ~22-29 g in BMX (Hurst et al., 2017).

Aims & hypotheses

A background image of a mountain biker in a blue and yellow jersey riding a rocky trail. The biker is wearing a helmet and is leaning forward on the handlebars. The trail is composed of large, light-colored rocks. In the background, there are mountains and a clear sky. A cable car or gondola is visible in the upper left corner of the image.

- Determine magnitude of translational and rotational accelerations during DHI.
- Establish the influence of course profiles on head accelerations.
- Hypothesised values would be greater than other 'extreme' sports.

Methods

Rd 1 – Fort William (Scotland)

- Course length = 2.82 km
- Start Elevation = 655 m
- Vertical Drop = 555 m

Rd 2 – Rhyd-y-Felin (Wales)

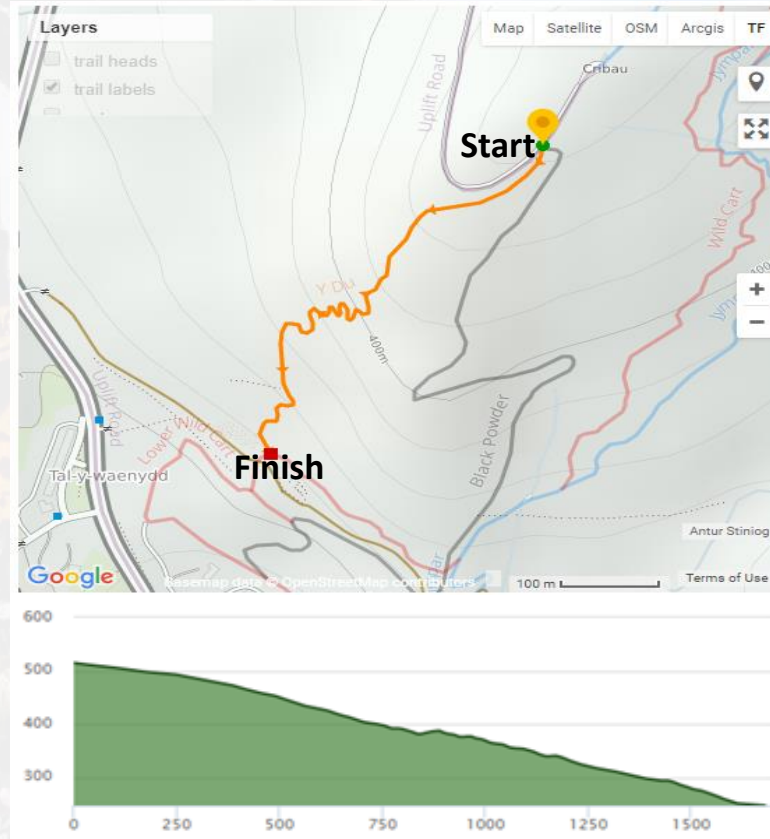
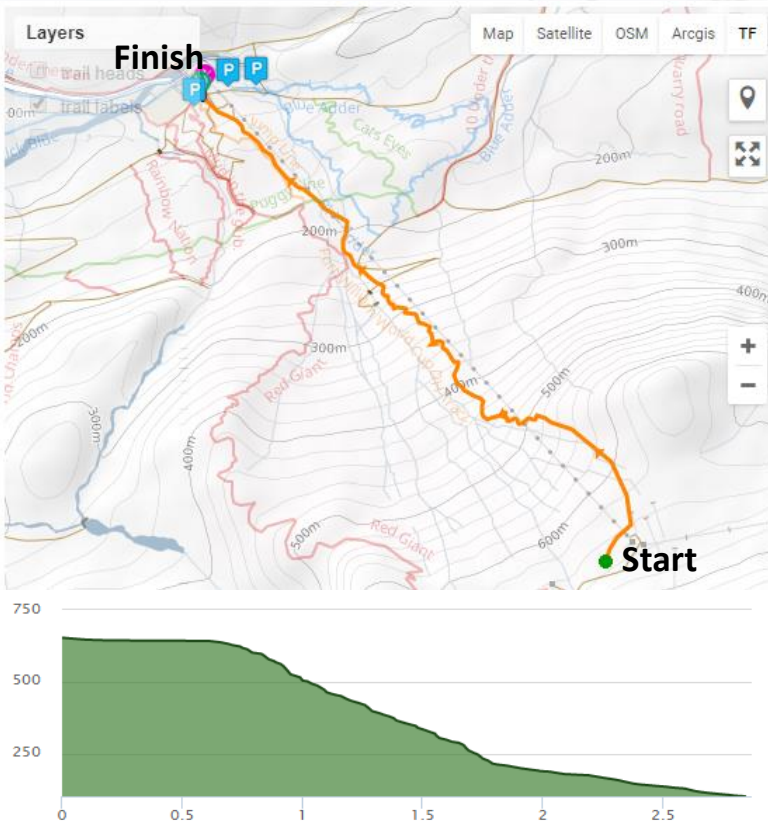
- Course length = 1.5 km
- Start Elevation = 543 m
- Vertical Drop = 367 m

Participants

- 16 male DHI cyclists
- Age = 26.4 ± 8.4 yrs
- Stature = 179.4 ± 7.2 cm
- Mass = 75.3 ± 5.9 kg
- Minimum 4 yrs racing experience

Mean run times:

- Fort William = 5.41 ± 1.07 min
- Rhyd-y-Felin = 3.15 ± 0.65 min



Accelerometry



An 'acceleration' defined as any event >10 g

Sampling rates

1000 Hz Translational

800 Hz Rotational

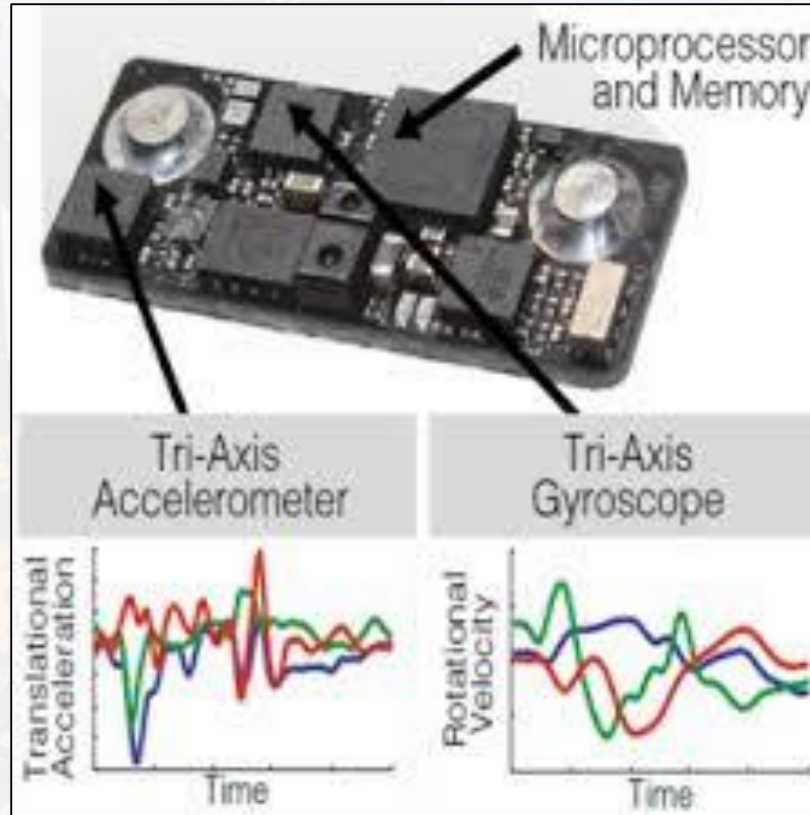


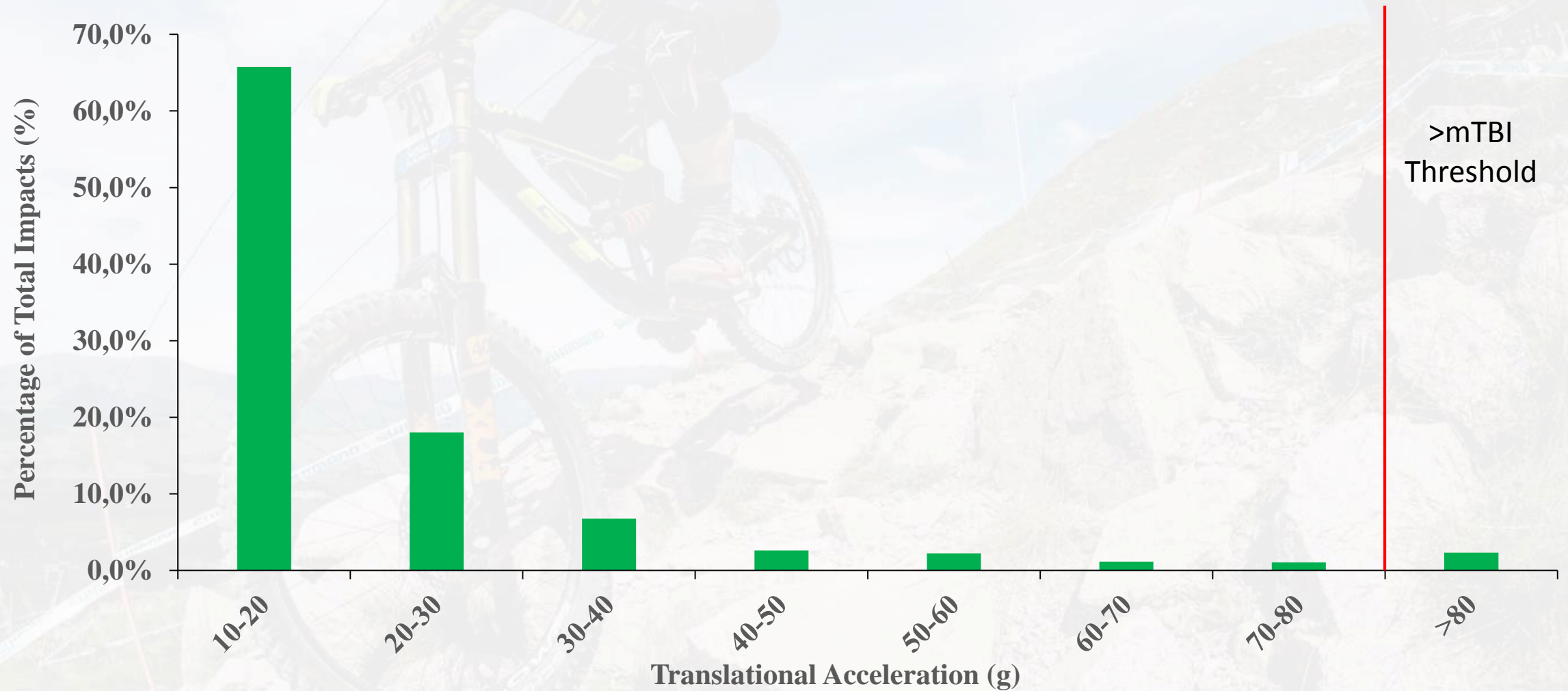
Image Credit: Morrison M, Daigle JN, Ralston J (2015)

Results

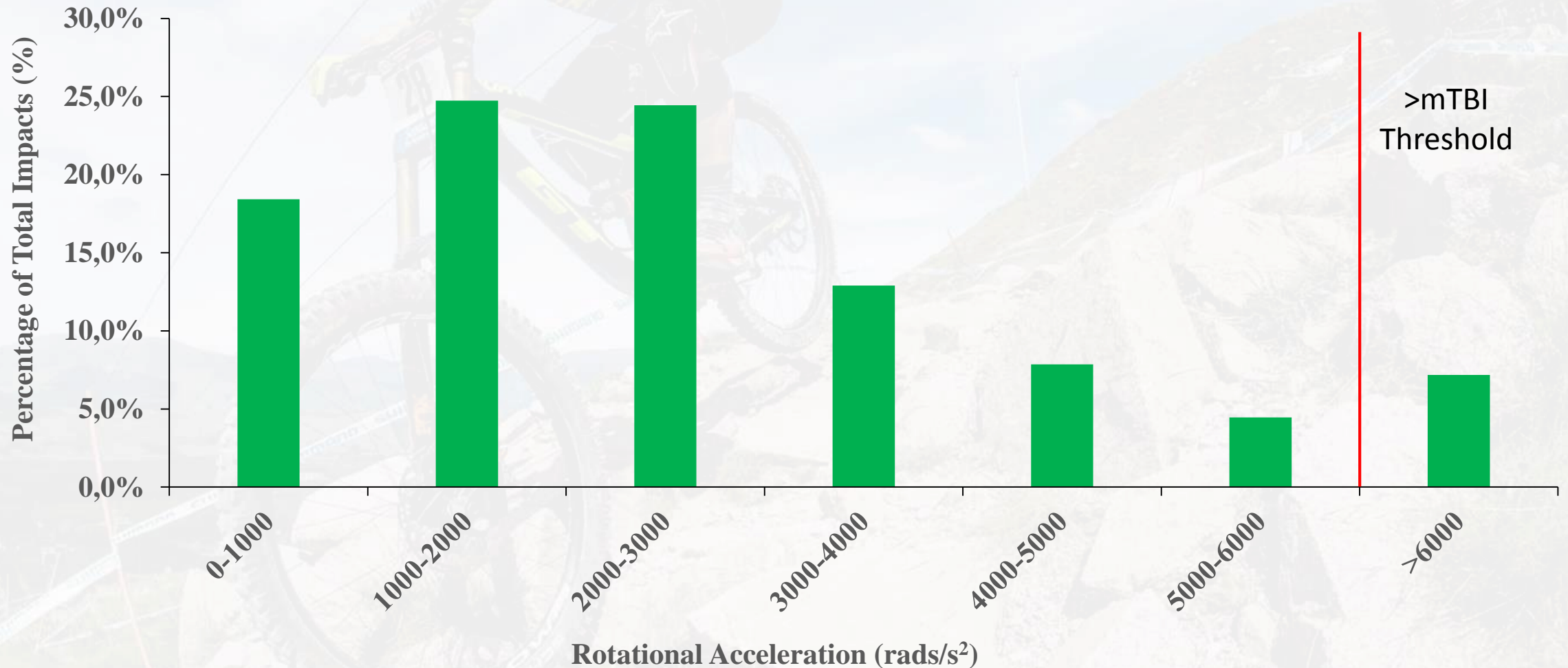
Translational and rotational accelerations and impact duration by course and overall. Data are presented as mean \pm SD.

	Course		p value
	FW	RYP	
Mean Number of Impacts	12.5 \pm 7.6	42.8 \pm 27.4	<.001
Mean Translational acceleration (g)	25.1 \pm 7.8	24.1 \pm 7.8	.72
Mean Peak Translational acceleration (g)	72.5 \pm 33.3	85.2 \pm 34.9	.30
Mean Rotational acceleration (rads/s ²)	2453.0 \pm 918.6	2738.8 \pm 639.3	.29
Mean Peak Rotational acceleration (rads/s ²)	6805.4 \pm 3073.8	9799.9 \pm 3381.7	.01
Mean Impact Duration (ms)	4.7 \pm 1.2	6.5 \pm 1.4	<.001
Mean Peak Impact Duration (ms)	11.6 \pm 4.5	21.2 \pm 9.1	.001

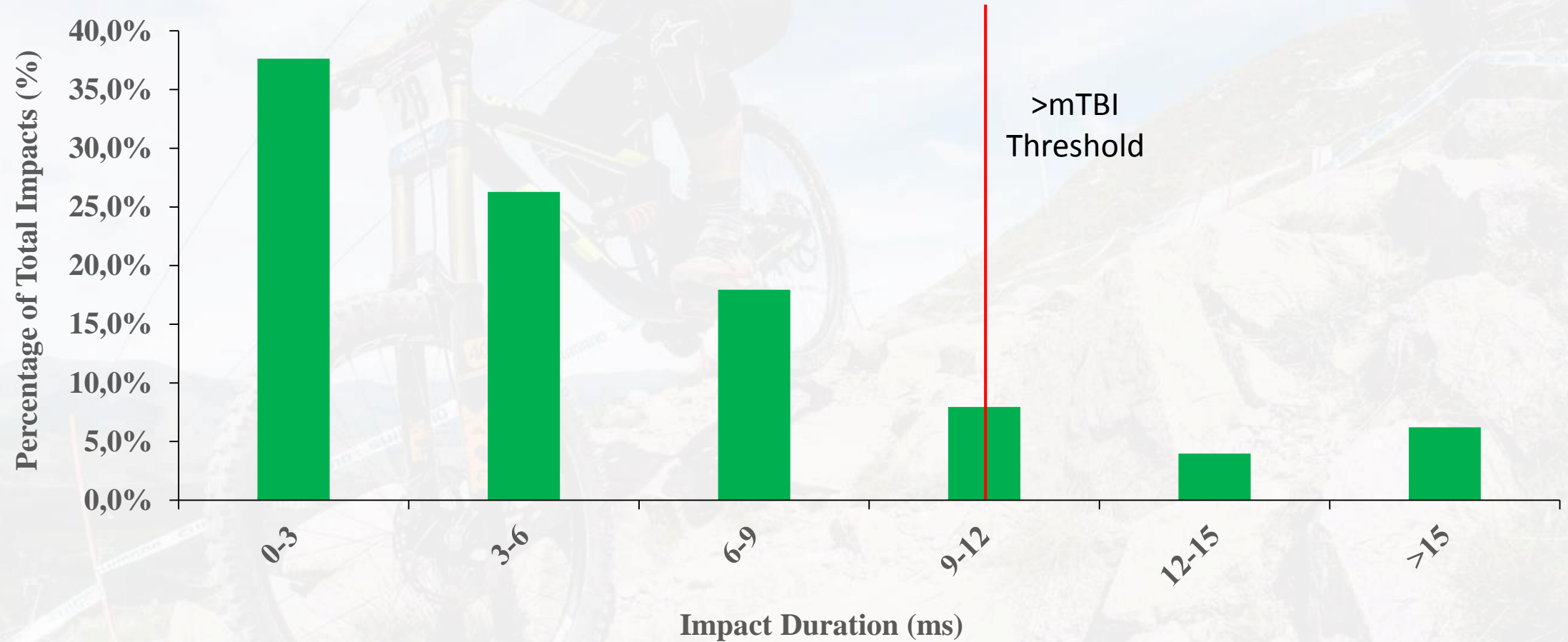
Frequency distributions – *Translational accelerations*



Frequency distributions – *Rotational accelerations*

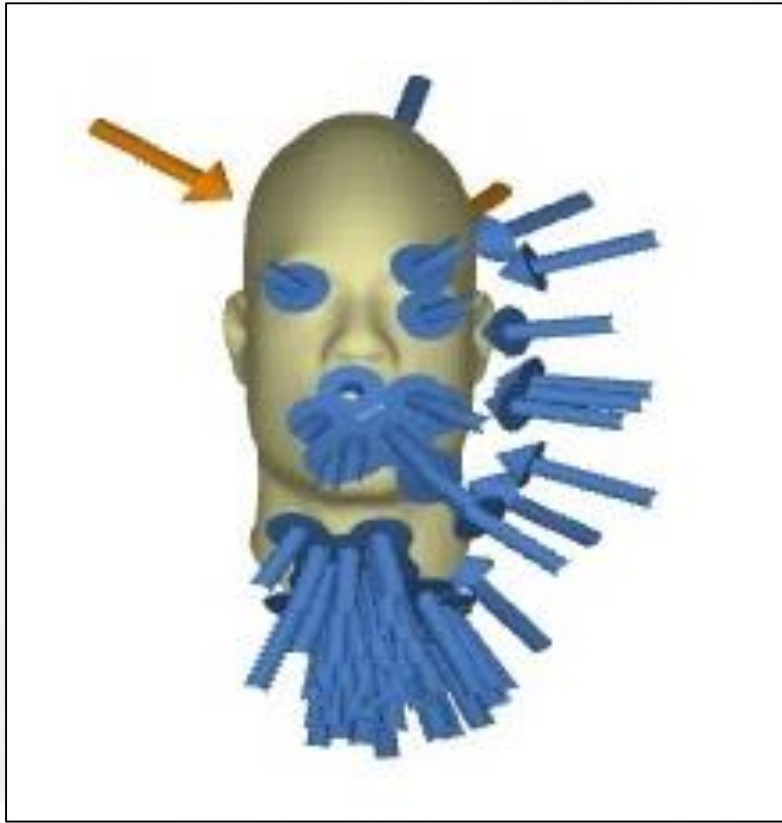


Frequency distributions – *Impact duration*

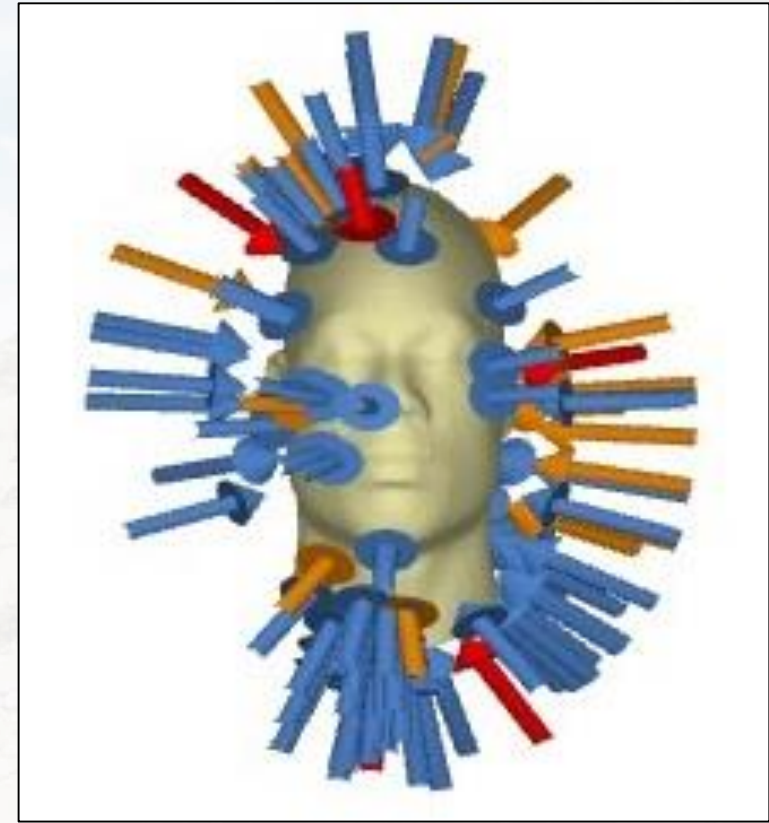


Example distribution of accelerations

Fort William



Rhyd-y-Felin



Summary

A mountain biker in a blue and yellow jersey is riding a trail bike on a rocky, steep descent. The rider is wearing a helmet and a backpack. The background shows a clear blue sky and a rocky trail.

- Translational loads comparable to BMX, snow sports and field sports.
- Rotational loads greater than in BMX.
- Course profile highly influential.
- Riders exposed to accelerations greater than proposed mTBI thresholds.

Future research

A mountain biker in a blue and yellow jersey is riding a rocky trail. In the background, a cable car is visible against a blue sky with light clouds. The scene is set on a steep, rocky hillside.

- Longitudinal studies/more courses.
- Sync data with GPS.
- Impact on cognitive function.

Acknowledgements

A background image of a mountain biker in a yellow and black jersey riding a full-suspension bike on a rocky, steep trail. The biker is wearing a helmet and has a backpack. The scene is set in a mountainous area with a clear sky and some distant structures.

- Co-authors: Dr Stephen Atkins and Ben Dickinson.
- British Downhill Series
- Thanks you!!