

Factors influencing protective equipment use by mountain bikers: Implications for injury prevention

Christopher F Pratt, Hannah A Primrose, Mark Fulcher

ABSTRACT

AIM: To assess the attitudes of mountain bikers to the use of protective equipment and quantify the use of such equipment.

METHOD: This was a prospective cohort study using an online questionnaire, offered to bikers participating in a series of Enduro races. The attitudes towards various factors that might contribute to a rider's choice to use protective equipment were quantified based on their responses to the questions. The actual reported use of various types of protective equipment was the outcome measure. The correlations between the factors and actual use were analysed for statistical significance, to assess their relative importance.

RESULTS: Equipment use was similar in racing and non-racing settings and could be increased. 55% had experienced an injury requiring a week or more off work. Perceptions of the benefits, costs, cues, comfort and potential injury severity proved to be well correlated with the choice to use equipment, while harm, danger and exposure to media influences did not.

CONCLUSIONS: This study confirmed that in this group, time off work from injuries is high. Interventions aimed at changing the behaviour of riders to reduce injuries should focus on the factors identified in this study, particularly the benefits of wearing protective equipment.

Injury prevention is a topic of growing interest due to the potential to both reduce morbidity and reduce treatment costs. Mountain biking is a large, growing sport, with current participation rates in New Zealand estimated at 8.8%, or 292,000 riders in 2013.¹ Population injury data from ACC (Accident Compensation Corporation, New Zealand's universal public injury insurer) from that year shows there were 29,818 cycling claims costing a total of \$55.2m, a rise of 74% on 2005. Twenty percent of these injuries were attributed to mountain biking, suggesting a large injury burden.²

Studies of specific mountain biking populations document injury rates as high as 4% for an individual event,³ although others are lower, and are likely specific to the

particular event characteristics. Helmets are well documented to prevent injuries in cycling,⁴ and full-face helmets are likely to offer further protection than standard helmets for mountain bikers.⁵⁻⁷ Lower injury rates are also reported in mountain bikers who use other types of protective equipment.^{5,8} This mirrors observations in other sports.⁹⁻¹²

No study has ever compared the relative use of equipment by an individual in a racing versus a non-racing environment. This is important as most of the studies look at an individual race, therefore it is difficult to generalise these results to everyday riding. Additionally, most studies attribute a dichotomous value to the use of equipment, while in reality over time this is unlikely to

be the case, with use on a given day related to specific factors. They are also dichotomous to presence of injury, when in reality the severity of the various injuries is highly important.

The ‘Enduro’ format of mountain biking is a relatively new discipline of racing that was developed to represent the style of riding enjoyed by the ‘weekend warrior’. It involves a series of untimed ascents, with timed downhill runs producing an overall time. No studies have been published on the injury rates in this style of riding, despite its growing popularity. Additionally, there is no evidence for what might influence its use in mountain bikers. A systematic review of preventing adverse health outcomes in all fields concluded that ‘benefits’ and ‘barriers’ to use are generally the most important factors, but the relative importance is dependent on the specific population.¹³ This is consistent with the studies that have evaluated equipment use in sports.¹⁴⁻¹⁷

The main purpose of this study was to collect data that might assist with the development of injury prevention programmes (IPPs) in mountain bikers. Data about the scale and severity of the problem was collected. By assessing rates of equipment use in racing and non-racing environments, alongside injury experiences and correlating with the relative influences on use of protective equipment, the relative importance of various factors was established. This provides guidance on likely effective future targets for an IPP.

Methods

Riders competing in NZ Enduro Crown races across New Zealand (2016/7 season) were eligible to partake, and were approached to participate via race directors (not by researchers). There were no exclusions. Consent was integrated into the start of an online questionnaire, and an incentive of two \$100 vouchers was offered to randomly selected participants. Ethical approval was obtained from the University of Auckland human ethics committee (Ref 018478).

The web-based survey was administered via Survey Monkey. This was based on a questionnaire devised and validated

by Ross et al¹⁷ The complete questionnaire is available as Appendix 1. This questionnaire was initially designed and validated to assess factors predicting helmet use in a cycle-commuting student population. It was modified for this study to assess protective equipment in general, and also to include more specific questions felt to be relevant to the mountain biking community, for example previous injury history. Individual questions assessed aspects of equipment use, demographics, self-reported skill level, injury experiences and rider belief variables, using specific values or Likert scales. Participants were provided free-text boxes at the end of the questionnaire to provide further feedback.

Data from the questionnaires was downloaded into Excel, cleaned and edited to produce frequency reports, and imported into SPSS for further analysis. Input scales were created through summation of the nominal/ordinal values or Likert responses. Output scales were similarly created, with arbitrary double weighting of full-face helmet and goggle use (versus glasses) to acknowledge the increased perceived and real protection offered. The various scales are shown in Table 1. Correlations were analysed using Spearman’s rank.

Table 1: Details of the input and output scales used for the analysis.

Input scales	Output/target scales
Age	Helmet use
Rider skill and experience	Eyewear
Personal injury experiences	Other types of equipment
Harm	Overall score
Danger	
Severity	
Benefits	
Comfort	
Costs	
Cues	
Media	

Table 2: Details of the number of responses to each individual type of equipment used, both in racing and non-racing situations.

Equipment used when racing	Never	Occasionally	Sometimes	Mostly	Always	Total
Full face helmet	94	35	66	49	19	263
Standard helmet	16	30	49	58	110	263
Sun/glasses	111	37	44	38	33	263
Goggles	102	50	60	38	13	263
Gloves	8	9	11	24	211	263
Elbow pads	161	33	21	21	27	263
Knee pads/shin	26	17	25	43	152	263
Torso body armour	241	7	9	1	5	263
Equipment used when not racing	Never	Occasionally	Sometimes	Mostly	Always	Total
Full face helmet	102	67	79	12	3	263
Standard helmet	0	7	33	98	125	263
Sun/glasses	75	46	57	52	33	263
Goggles	117	72	62	8	4	263
Gloves	11	9	18	41	184	263
Elbow pads	174	47	22	13	7	263
Knee pads/shin	33	44	64	61	61	263
Torso body armour	231	21	7	2	2	263

Results

A total of 263 questionnaires were completed, with an estimated response rate of 26.3%. Of the eight race directors who were approached, six agreed to take part.

Rates of equipment use are displayed in Table 2. Frequency of use, whether racing or not, were similar.

Age distribution is shown in Table 3. Correlations are displayed in Table 4. Age correlated with eyewear ($p=0.04$) and other equipment use ($p=0.00$), but not full-face

helmets ($p=0.21$). There were 224 male (85.2%) and 39 female (13.7%) respondents. One hundred and ninety-four (73.8%) identified as New Zealand European, 44 (16.7%) Other European, 12 (4.6%) Māori and the rest 'others'. More than half ($n=137$, 52.1%) had been riding for 11 or more years while 170 (64.7%) were racing three to 10 times per year. Almost two-thirds (65.4%) self-reported their riding level as "advanced". *Rider skill and experience* correlated with full-face helmet use ($p=0.01$) and eyewear ($p=0.00$), but not other equipment ($p=0.71$).

Table 3: Distribution of participant ages.

Age	Number of participants	Percentage (%)
18–25	51	19.4
26–35	67	25.5
36–45	86	32.7
46–55	52	19.8
Over 56	7	2.7

Table 4: Significance of correlations between input domain scales and reported use of various equipment types.

Domain scale	Statistical significance of correlation (<i>p</i> value)			
	Helmets	Eyewear	Equipment	Overall
Injury experiences	0.04	0.00	0.72	0.01
Harm	0.34	0.85	0.37	0.47
Danger	0.98	0.66	0.46	0.38
Severity	0.71	0.01	0.99	0.25
Benefits	0.03	0.14	0.00	0.00
Comfort	0.283	0.24	0.00	0.11
Costs	0.04	0.11	0.00	0.00
Cues	0.01	0.54	0.00	0.00
Media	0.30	0.16	0.78	0.26
Age	0.22	0.04	0.00	0.40
Rider skill and experience	0.01	0.00	0.71	0.03

Injury experiences were high, with over half reporting an injury requiring a week or more off work, and nearly 20%, a month or more. Over 40% reported ongoing symptoms from a mountain biking-related injury. Table 5 displays the details. Greater *injury experience* was correlated with full-face helmet use ($p=0.04$) and eyewear ($p=0.00$), but not other equipment ($p=0.72$).

The individual belief scales and equipment types are displayed in Table 5. *Benefits, costs, cues, comfort* and *severity* had varying correlations, while *harm, danger* and *media* had no correlation. Analysing the *media* components further, a majority of respondents indicated that they had never seen any advertising suggesting the importance or benefit of protective equipment for injury prevention.

Additional feedback that was provided by participants in free-text boxes was reviewed and analysed looking for specific themes. No additional themes were identified that had not been addressed in the survey.

Discussion

The current study confirms that significant injuries (with high morbidity) are common in Enduro mountain bikers, and that uptake of protective equipment has potential to be increased. Modifiable factors determining use were rider skill, and beliefs regarding *benefits, costs, cues, comfort* and *severity*. The non-modifiable determinants were *previous injury experiences* and *age*. Interest in the study from riders and race directors appeared high. Overall this suggests an injury prevention programme targeting this group (IPP) might be effective.

Reported injury experiences were high in the current study. This is in keeping with a prospective study of 494 downhill riders through a season which reported an injury rate of 16.8–17.9 per 1,000h of exposure, of which 65% were mild, 22% moderate and 13% severe.¹⁸ It was not possible to find any comparative figures for cross-country riding, however given the style of riding in Enduro

Table 5: Details of responses regarding details of injury histories.

Injury experiences	Yes	No	Not sure
Week or more off work due to mountain biking injury	144 (54.8%)	114 (43.3%)	5 (1.9%)
Month or more off work due to mountain biking injury	52 (19.8%)	209 (79.5%)	2 (0.8%)
Ongoing symptoms from a mountain biking injury	108 (41.1%)	143 (54.4%)	12 (4.6%)

format, it is reasonable to expect the injury rates and patterns to be more similar to downhill than cross country. This emphasises the high injury burden in this large, growing, but infrequently studied group of riders.

There was a correlation between use of more protective equipment and the perceived *benefits, costs, cues, comfort* and *severity*. There was, however, no correlation between the domains of *harm, danger* and *media* (Table 4). These findings would be an important consideration when developing an injury prevention strategy in this group and have some differences to other sports and populations. These factors have not previously been studied in mountain bikers, but similar studies have been assessed in other sports and are conflicting. In snow sports, having had a previous major crash has been associated with higher helmet use,¹⁹ but wrist guard use was not.²⁰ In commuter cycling, helmet use correlated highly with attitudes of friends and family, emotional benefits, perceived exemption from harm and personal vanity or discomfort factors, and not with severity of harm or cost.¹⁷ In AFL, one study found injury prevention was a major trigger to use head and mouth guards, while discomfort was a negative impact,¹⁶ while in Rugby Union another reported safety and previous injury would motivate, and again discomfort would inhibit.¹⁴ Therefore, the results of this study bear some similarities and differences to each of these. The variability of relative factors with individual populations has been confirmed by a systematic review across any health interventions.¹³ The reason for the variability can be speculated, and is likely to reflect the sociodemographics of the individuals, and the demands and contexts of the sport and environment. For example, Enduro riders may have more disposable income to spend on their sport, but off-setting this is the high cost and volume of types of equipment available, forcing a choice to be made. Family is a strong *cue*, and the demographic of recreational Enduro riders may reflect the lack of free time available, pushing riders from an endurance-style cross-country training programme into one more with more emphasis on skill than outright aerobic capacity. *Comfort* seemed specific to the particular type of equipment, with no impact on helmets

or eyewear, but a strong link with other peripheral items. Therefore, specific studies such as these are vital to developing a targeted approach, but generalising the specific results outside of the population should only be done with caution.

The interest in the study from industry race directors was high, with a participation rate of 75%. The response rate from riders (26%) was in keeping with other single-invitation email surveys, which a meta-analysis found should expect a completion rate of 25–30%.²¹ The same study found a second email increased the mean response to 39.6%. Unfortunately, race directors expressed concern about ‘irritating’ clients and were unwilling to send a follow-up email. Contacting riders directly might also have improved the response rate but was not possible for privacy reasons. Ultimately, race directors and riders appeared keen to support this type of research, demonstrating interest in the field, which might be key to implementing a successful IPP. Recent studies have discussed a gap in injury prevention between research and practice, and factors impacting uptake and compliance as well as the key adopters of a programme may be the missing link.^{22,23} This study therefore demonstrates that the community and industry in Enduro mountain biking may fill this role, as well as offering insight into which factors may provide successful leverage to implement behaviour change. The results of the current study may help illustrate several areas that might help improve compliance. For example, the cost of the equipment appears to be a major factor for many riders. It is possible that it may be cost effective for insurance companies to subsidise the cost of protective equipment. The ACC currently fund injury prevention programmes in other situations, including falls prevention programmes for the elderly,²⁴ or the ‘11+’ programme for injury prevention in team sports. More research would be needed to evaluate the cost effectiveness of this type of strategy. Providing experience of a witnessed injury might increase equipment use, as this study confirms a correlation ($p=0.013$) between these two variables. Practically, this might involve showing videos of injuries, a strategy which has previously been shown to be effective in other sports.²⁵

Encouraging elite riders to use and endorse appropriate equipment might also improve uptake, particularly in younger riders. This was shown to increase the uptake of facial protection by youth basketball players.²⁶ Finally, education to emphasise the benefit of full-face helmets over standard is suggested. Previous evidence suggests that these helmets are more effective,⁵⁻⁷ however, this was not a belief that was shared by the majority of the riders surveyed in the current study. It is worth noting that this study demonstrated little exposure of the riders to media influences, implying there is significant scope for improvement by creating a media campaign.

This study does have some limitations. The relatively small sample size has already been discussed. The predominantly quantitative nature of the research is another limitation. This type of study inherently suffers from problems of context and it is likely that a qualitative study would more completely explore the themes that have been identified during the current study.

Another limitation relates to the type of riders that were studied. Enduro riders are a subgroup of all those riding mountain bikes and as a result the results may not be generalisable to all riders. As discussed earlier, Enduro riders were chosen for this study as it was felt that this style is likely to be most representative of recreational riders who are likely to be the primary target of injury prevention strategies.

Conclusion

Injuries appear to be common in mountain biking, and the interest in injury prevention strategies appears to be high in riders and race organisers. Benefits, costs and cues have the greatest influence on rider choice of protective equipment. This is important to consider when treating riders and planning injury prevention programmes. The authors' recommendations for developing an IPP for mountain biking in New Zealand is available as Appendix 2.

Table 6: Key points from this research.

Key points from this research	
What is already known	What this study adds
Helmets and eyewear reduce injuries	Full-face helmets and other protective equipment types are not always used
The causes of crashes are multifactorial	Benefits, costs, cues, skill and experience level, and personal injury experience are key determinants of use. Older riders are more likely to use eyewear
Mountain biking injuries can cause significant morbidity	Interest in injury prevention is high in riders and race directors

Factors influencing protective equipment use by mountain bikers: implications for injury prevention

Appendix 1: Questionnaire

1. I consent to participate in this project

- Yes
- No

2. Would you like to receive a summary of the results?

- Yes
- No

If so, please enter an email address to send the summary to. (Free text response)

3. Would you like to be entered into the drawer to win a voucher?

- Yes
- No

If so, please enter a contact email address in case you win. (Free text response)

4. Which race(s) are you entered in that invited you to complete this questionnaire?

- Doug Wisor mini Enduro
- 440 Gravity Enduro
- Dunedin Enduro Series
- Santa Cruz Super D
- Mammoth Enduro
- Gravity Canterbury Enduro Series
- Urge 3 Peaks Enduro
- Giant 2W Gravity Enduro
- Top Gun Enduro
- 5th Annual Dodzy Memorial Enduro
- Yeti Trans NZ Enduro
- NZ Enduro

5. What is your age?

- 18–25
- 26–35
- 36–45
- 46–55
- Over 56

6. What is your gender?

- Male
- Female
- Gender diverse

7. What is your ethnicity? (Please select all that apply.)
 - NZ European
 - Māori
 - Pacific Island
 - Asian
 - Other European
 - Other
 - Prefer not to answer
8. How long have you been mountain biking?
 - Less than a year
 - 1–4 years
 - 5–10 years
 - 11+ years
9. How long have you been racing mountain bikes?
 - Less than a year
 - 1–4 years
 - 5–10 years
 - 11+ years
10. On average, how many races do you compete in each year?
 - 1–2
 - 3–5
 - 6–10
 - 11+
11. Which best describes your riding level?
 - Beginner
 - Intermediate
 - Advanced
 - Professional (or ex-professional)
12. How many enduro format races have you competed in?
 - 0
 - 1–2
 - 3–5
 - 6–10
 - 11+
13. How many downhill format races have you competed in?
 - 0
 - 1–2
 - 3–5
 - 6–10
 - 11+
14. How many cross country races have you competed in?
 - 0
 - 1–2
 - 3–5
 - 6–10
 - 11+

15. How many hours a week do you spend mountain biking?

- 0–3
- 4–6
- 7–10
- 11+

16. When RACING ENDURO, how often do you use the following? (scored as: Never/Occasionally/Sometimes/Most of the time/Always)

- Full suspension bike
- Hardtail bike
- Clipless pedals
- Flat pedals
- Full face helmet
- Standard helmet
- Sun/glasses
- Goggles
- Gloves
- Elbow pads
- Knee pads/shin guards
- Torso body armour

17. When NOT RACING, how often do you use the following? (scored as: Never/Occasionally/Sometimes/Most of the time/Always)

- Full suspension bike
- Hardtail bike
- Clipless pedals
- Flat pedals
- Full face helmet
- Standard helmet
- Sun/glasses
- Goggles
- Gloves
- Elbow pads
- Knee pads/shin guards
- Torso body armour

18. Which of the following applies to you? (Each scored as Yes/No/Not sure)

- I've had a mountain biking injury needing a week or more off work.
- I've had a mountain biking injury needing a month or more off work.
- I still have symptoms from an old injury.
- I've seen someone else have a nasty crash.
- I've been saved from a nasty injury by my protective gear.
- I've seen someone else saved from a nasty injury by their protective gear.

19. Which of the following applies to you? (Scored as Do not agree/Slightly agree/Somewhat agree/Mostly agree/Completely agree)

- I do not go fast enough to need protection in a crash.
- I feel that protective gear is unnecessary for short rides.
- With my experience, I can easily avoid crashing when riding.
- Protection is less important for those who ride less frequently.
- Protection is more important for those who ride more often.
- When I'm not racing, I don't really need protection.

20. Rate each of the following as they apply to you: (Scored as Do not agree/Slightly agree/Somewhat agree/Mostly agree/Completely agree)

- When riding, I'm at risk of being injured when I make a mistake.
- When riding, I'm at risk of being injured when something beyond my control happens.
- If I had an accident on my bike, I'd be likely to suffer a significant injury.
- Mountain biking is dangerous all the time.
- Mountain biking is dangerous when racing.

21. Rate each of the following as they apply to you: (Scored as Do not agree/Slightly agree/Somewhat agree/Mostly agree/Completely agree)

- If I was injured when riding, it could seriously affect my social life with friends.
- If I was injured when riding, it could seriously affect my relationship with family members.
- If I was injured when riding, it could seriously affect my ability to function at work.
- If I was injured when riding, it could seriously affect my ability to continue to ride mountain bikes.

22. Rate each of the following as they apply to you: (Scored as Do not agree/Slightly agree/Somewhat agree/Mostly agree/Completely agree)

- I feel unsafe riding without enough protective equipment.
- I feel guilty riding without enough protective equipment.
- Wearing more protective equipment would make me feel less anxious when I ride.
- I think it's my obligation to keep myself safe for the people who care about me by wearing protective gear when I ride.
- Wearing protective gear makes me feel safer.
- When wearing protective gear I feel more aware of the potential dangers of riding.
- Wearing protective gear makes me more likely to "take care" when I ride.

23. Rate each of the following as they apply to you: (Scored as Do not agree/Slightly agree/Somewhat agree/Mostly agree/Completely agree)

- In general, I feel that people who choose to wear protective gear are being safe and responsible.
- Protective gear is effective at reducing my risk of injury if I have a crash while riding.
- I believe that wearing protective gear can prevent serious injury if I have an accident.
- In the event of an accident, wearing protective gear could save me money in medical treatment and time off work.

24. Rate each of the following as they apply to you: (Scored as Do not agree/Slightly agree/Somewhat agree/Mostly agree/Completely agree)

- I would feel embarrassed by wearing more protective gear.
- I feel foolish wearing protective gear on easier trails.
- Wearing protective gear makes me feel foolish if no one else is wearing it.
- Quite frankly, protective gear looks stupid.
- Wearing protective gear is uncomfortable.
- I would wear more protective gear if it didn't restrict my riding.
- I would wear more protective gear if most of the people I ride with did.
- I would wear eye protection more if it didn't affect my vision.
- I would wear a full face helmet more if it didn't affect my vision.

25. Rate each of the following as they apply to you: (Scored as Do not agree/Slightly agree/Somewhat agree/Mostly agree/Completely agree)

- The cost of protective gear is generally more than it's worth.
- The cost of buying protective gear affects whether I use it or not.
- The best protective gear is too expensive for me to buy.
- I would not want to spend money on protective gear.
- Protective gear is not a worthwhile way for me to spend my money.
- Protective gear is not worth the cost.
- I believe protective gear is overpriced.

26. Rate each of the following as they apply to you: (Scored as Do not agree/Slightly agree/Somewhat agree/Mostly agree/Completely agree)

- I have several friends who routinely wear protective gear when they ride.
- I keep my protective gear in a visible place so I won't forget it.
- I usually keep my protective gear with my bike.
- I know that I will feel bad if I don't wear my protective gear, as someone that cares about me wants me to wear it.
- My friends think I should wear protective gear when I ride.
- My close friends think I should wear protective gear when I ride.

27. Rate each of the following as they apply to you: (Scored as Do not agree/Slightly agree/Somewhat agree/Mostly agree/Completely agree)

- I recall seeing TV commercials, billboard ads or posters about the importance of wearing protective gear while mountain biking.
- I have seen articles in bike magazines or online about the benefit of wearing protective gear.
- During the past year, a healthcare professional has advised me about using protective gear.
- During the past year, I've seen adverts in magazines or elsewhere for shops giving a discount on protective gear.
- During the past year, I recall some form of promotion event for protective gear in the community.
- During the past year, I recall reading about/seeing mountain biking accidents in the news.

28. Rate each of the following as they apply to you: (Scored as Do not agree/Slightly agree/Somewhat agree/Mostly agree/Completely agree)

- Do you think a full face helmet protects significantly better than a standard helmet?
- Do you think wearing a helmet increases your chance of injuring your neck?

29. What are the most important reasons that you use/don't use protective gear? (Free text response)

30. Do you have any other comments regarding topics raised in this questionnaire? (Free text response)

Appendix 2: Recommendations for developing an injury prevention programme (IPP) for mountain biking

Injury prevention programmes (IPPs) have been developed and shown to work in other sports, and generally adopt a van Mechelen model approach.²⁷ The approach has been expanded and developed further, particularly by Finch and her colleagues.^{28,29}

Following this approach, based on this research some specific recommendations can be made for developing an IPP for mountain biking. Examples include:

1. The psychological factors that are likely to increase uptake are *benefits* and *cues* (specifically friends and family). Leveraging off this is more likely to be effective than other prompts, for example focusing on the *dangers*. This is also likely to be more palatable to the race directors and industry.
2. *Cost* is a big contributor to some riders' decision making. It is harder to directly influence, given the nature of an individual purchasing the equipment from a private company. However, insurance companies might potentially offer a financial incentive: In the past, ACC (Accident Compensation Corporation, a publicly funded social insurance scheme covering all injuries in New Zealand) have provided wrist guards for snowboarders, and they currently fund orthotics if a person has suffered an injury requiring these as part of the treatment.
3. Increasing rider skill and overall experience levels would likely help, but it might require more extensive resources to provide training. There are comparable primary prevention programmes funded by ACC, such as the falls prevention programme for the elderly,³⁰ or 'FIFA 11-plus' for ACL ruptures, but these are targeted to specific groups at high risk of a specific, relatively high-cost injury (ie, easily measurable) rather than more global prevention.
4. Providing experience of a personal or witnessed injury might increase equipment use, as this study confirms a correlation ($p=0.013$). Practically this might involve showing videos of injuries: A systematic review and meta-analysis in 2013 by Leppänen et al found three such studies, with only one being successful.³¹ Anyhow, the increasing popularity of the sport does mean events are increasingly televised or available online, and along with personal filming and social media it may be more likely riders will be exposed to videos of crashes. However, these may often be dissociated with the actual outcomes, or specifically sanitised for those not resulting in injury. The increasingly professional component of the sport also provides an insight into injury for those riders motivated to follow specific athletes, who might require time off the sport.

Encouraging the professionals to use and endorse appropriate equipment might also have a peer-type effect on uptake, particularly in younger riders. A memorable example of this was the use of a plastic face mask by Kobe Bryant and LeBron James removing stigma and triggering an interest among high school and collegiate basketballers.³²

5. Eyewear was used less frequently by younger riders, who may be at higher risk of eye injuries, therefore an intervention to increase this specific component might be of particularly high value. As above, they might be expected to respond better to a social media campaign championed by a well-known professional.
6. Targeting riders in their 30–40s might provide a significant benefit, due to their high injury rate and costs, versus higher incomes to purchase equipment. They might be better targeted by a club-based intervention, pushing the benefits relative to family.
7. Emphasising the benefit of full-face helmets over standard: Previous evidence suggests this, but many riders surveyed here did not fully agree. Given the relatively high cost of a head injury, this would be worthwhile.
8. Encouraging manufacturers to design more comfortable equipment, offer trials and provide data on its efficacy, would likely be useful.

A strategy based on recommendations by Donaldson might start by forming a focus group with riders and event managers to discuss the prior evidence and data from this study, to consider methods of administering a programme.²⁹

- with Bicyclists. *J Trauma Inj Infect Crit Care*. 1999; 47(July):50–4.
8. Romanow NTR, Hagel BE, Nguyen M, Embree T, Rowe BH. Mountain bike terrain park-related injuries: an emerging cause of morbidity. *Int J Inj Contr Saf Promot*. 2014; 21(1):29–46.
 9. Adams SL, Wyte CD, Paradise MS, Del Castillo J. A prospective study of in-line skating: Observational series and survey of active in-line skaters - Injuries, protective equipment, and training. *Acad Emerg Med*. 1996; 3(4):304–11.
 10. Russell K, Hagel B, Francescutti LH. The effect of wrist guards on wrist and arm injuries among snowboarders: A systematic review. *Clin J Sport Med*. 2007; 17(2):145–50.
 11. De Rome L, Ivers R, Fitzharris M, Du W, Haworth N, Heritier S, et al Motorcycle protective clothing: Protection from injury or just the weather? *Accid Anal Prev* [Internet]. 2011; 43(6):1893–900. Available from: <http://dx.doi.org/10.1016/j.aap.2011.04.027>
 12. Gobbi A, Tuy B, Panuncialman I. The incidence of motocross injuries: A 12-year investigation. *Knee Surgery, Sport Traumatol Arthrosc*. 2004; 12(6):574–80.
 13. Carpenter CJ. A meta-analysis of the effectiveness of health belief model variables in predicting behavior. *Health Commun*. 2010; 25(8):661–9.
 14. Finch CF, McIntosh AS, McCrory P, C.F. F, A.S. M, P. M. What do under 15 year old schoolboy rugby union players think about protective headgear? *Br J Sports Med* [Internet]. 2001; 35(2):89–94. Available from: <http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=emed5&NEWS=N&AN=2001133416%5Cnhttp://articles.sirc.ca/search.cfm?id=S-677638%5Cnhttp://ezproxy.lib.ucalgary.ca/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=s3h&AN=SPHS-677638&site>
 15. Ikingier CM, Jana JB, Spiller A. Factors influencing the safety behavior of german equestrians: Attitudes towards protective equipment and peer behaviors. *Animals*. 2016; 6(2):9–11.
 16. Braham RA, Finch CF, McIntosh A, McCrory P. Community football players' attitudes toward protective equipment - A pre-season measure. *Br J Sports Med*. 2004; 38(4):426–30.
 17. Ross TP, Ross LT, Rahman A, Cataldo S. The bicycle helmet attitudes scale: using the health belief model to predict helmet use among undergraduates. *J Am Coll Health* [Internet]. 2010;59(1):29–36. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/20670926>
 18. Becker J, Runer A, Neunhäuserer D, Frick N, Resch H, Moroder P. A prospective study of downhill mountain biking injuries. *Br J Sports Med*. 2013; 47(7):458–62.
 19. Cundy TP, Systemans BJ, Cundy WJ, Cundy PJ, Briggs NE, Robinson JB. Helmets for snow sports: Prevalence, trends, predictors and attitudes to use. *J Trauma - Inj Infect Crit Care*. 2010; 69(6):1486–90.
 20. Chaudhry T, Noor S, Rajaratnam V. Factors affecting wrist guard use amongst snowboarders. *Eur Orthop Traumatol*. 2012; 3(4):247–50.
 21. Cook C, Heath F, Thompson RL. A meta-analysis of response rates in Web- or internet-based surveys. *Educ Psychol Meas*. 2000; 60(6):821–36.
 22. Donaldson A, Lloyd DG, Gabbe BJ, Cook J, Young W, White P, et al Scientific evidence is just the starting point: A generalizable process for developing sports injury prevention interventions. *J Sport Heal Sci* [Internet]. 2016; 5(3):334–41. Available from: <http://dx.doi.org/10.1016/j.jshs.2016.08.003>
 23. Hanson D, Allegrante JP, Sleet DA, Finch CF. Research alone is not sufficient to prevent sports injury. *Br J Sports Med*. 2014; 48(8):5–7.
 24. ACC. Staying safe from trips and falls [Internet]. New Zealand; 2017. Available from: <http://www.acc.co.nz/preventing-injury/trips-falls/>
 25. Leppänen M, Aaltonen S, Parkkari J, Heinonen A, Kujala UM. Interventions to prevent sports related injuries: A systematic review and meta-analysis of randomised controlled trials. *Sport Med*. 2014; 44(4):473–86.
 26. Gandy JR, Fossett L, Wong BJF. Face masks and basketball: NCAA division I consumer trends and a review of over-the-counter face masks. *Laryngoscope*. 2016; 126(5):1054–60.
 27. van Mechelen W, Hlobil H, Kemper HCG. Incidence, Severity, Aetiology and Prevention of Sports Injuries: A Review of Concepts. *Sport Med*. 1992; 14(2):82–99.
 28. Finch C. A new framework for research leading to sports injury prevention. *J Sci Med Sport*. 2006; 9(1–2):3–9.

29. Donaldson A, Lloyd DG, Gabbe BJ, Cook J, Young W, White P, et al Scientific evidence is just the starting point: A generalizable process for developing sports injury prevention interventions. *J Sport Heal Sci* [Internet]. Elsevier B.V.; 2016; 5(3):334–41. Available from: <http://dx.doi.org/10.1016/j.jshs.2016.08.003>
30. ACC. Staying safe from trips and falls [Internet]. New Zealand; 2017. Available from: <http://www.acc.co.nz/preventing-injury/trips-falls/>
31. Leppänen M, Aaltonen S, Parkkari J, Heinonen A, Kujala UM. Interventions to prevent sports related injuries: A systematic review and meta-analysis of randomised controlled trials. *Sport Med*. 2014; 44(4):473–86.
32. Gandy JR, Fossett L, Wong BJF. Face masks and basketball: NCAA division I consumer trends and a review of over-the-counter face masks. *Laryngoscope*. 2016; 126(5):1054–60.