Concussion beliefs in varsity athletes: Identifying the good, the bad and the ugly

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Abstract
Objective: Identify and describe attitudes and intentions towards personal concussion risk and protective behaviours among varsity athletes. Determine subgroups of athletes characterized by problematic intentions towards concussion prevention and management behaviours.

Design: Cross-sectional survey.

Main outcome measures: Varsity athletes ($N=175$; 60% male; 55.4% contact athletes; 56.6% history of concussion) completed a survey examining attitudes and intentions towards personal risk and concussion-management behaviours. Cluster and discriminant analyses were used to identify athlete risk response subgroups on intention items. The clusters were examined for differences in attitudes towards concussion prevention behaviours, demographics and concussion exposure.

Results: A substantially problematic subgroup of athletes (28% of the sample) reported low intent to engage in post concussive management practices or primary prevention behaviours. These individuals reported high concussion-risk acceptance and very low belief in the efficacy of concussion-management behaviours. They were also more likely to have sustained a concussion. Two other clusters demonstrated more acceptable behavioural intentions towards concussion prevention and management, with one holding model attitudes and intentions.

Conclusions: Varsity athletes exhibit one of three different patterns of intentions and attitudes towards concussion prevention and management behaviours. Athletes in one of these groups are at much greater risk of concussion injury and poorly follow recommended treatments. Intervention programmes need to target and aim to change these problematic intentions and attitudes to improve the effectiveness of concussion prevention and injury management.

Keywords
Concussion, prevention, risk, behaviour, medical management, athletes

Introduction

Concussion is a prevalent problem among young athletes that can cause long-term, even permanent, impairments in cognitive function and psychological well-being. US data from 2009 estimate that a quarter million children under 19 were treated in emergency departments for a suspected concussion or traumatic brain injury. In the US, estimated 1.6 to 3.8 million sports-related traumatic brain injuries (TBI) – including concussions – occur each year. The incidence and risk of concussion is even greater in higher-level athletes, such as those playing varsity or professionally. Importantly, an estimated 10% to 15% of athletes experience persistent cognitive deficits (e.g. memory problems and decision-making impairments) and emotional-regulation difficulties (e.g. irritability and depressive symptoms) a year or more after their concussion. Current research suggests that roughly 13.2% of reported concussions are recurrent, increasing the risk for these prolonged deficits.

Athletes’ concussion risk is part of a complex system of personal and contextual factors relating to athlete behaviour, sport exposure and resources for management. These include non-modifiable (e.g. age, concussion history, sport type) and modifiable factors, such as personal knowledge and perceptions about
concussion injury, risk and concussion management (e.g. symptoms of concussion, proper response to injury). Concussion education prevention programmes primarily target knowledge and awareness, working under the assumption that by promoting a better understanding of concussion injury, athletes will engage in proper management behaviours. It is well established that factual knowledge, on its own, seldom changes behaviour, and it is well documented that many athletes continue to play with concussion symptoms at their peril. Kroshus et al. demonstrated the limited effect of knowledge gain in researching the effectiveness of concussion education in The National Collegiate Athletic Association (NCAA) ice hockey. They compared six teams before and after receiving concussion specific education materials and found that despite knowledge gain, there was no difference in intention to continue playing sports while experiencing a headache resulting from a concussion. The limited influence of knowledge has also been observed in other health domains. 

Psychosocial predictors (i.e. attitudes, beliefs, social norms) often play a more important role in determining protective behaviours. This may be particularly true in the emotionally charged and intensely social environment of competitive sport. Recent studies have begun to look at psychosocial predictors of concussion reporting behaviour finding that supportive social networks and subjective norms that are more accepting of reporting lead to a greater likelihood of concussion reporting under certain conditions. Risk perception is another key cognitive predictor of protective behaviour and is central to many health behaviour frameworks. Concussion programmes often target risk and risk is a central theme in concussion discussions. Nonetheless, there is a conspicuous absence of research focusing on risk perceptions towards concussion injury.

Hence, there is a need to know what key perceptions about concussion risk need to be altered in order to effectively increase appropriate concussion protective behaviours. Moreover, current concussion prevention programmes are not only limited because they focus on factual information and knowledge gain, but also because they predominantly target secondary prevention strategies (i.e. post-injury management). An increased emphasis on primary prevention strategies (i.e. promoting behaviour that mitigate the risk of the incident or injury) would reduce concussion incidence and hence the concern around injury management. In this study, we examine the attitudes and intentions university athletes hold towards concussion risk and protective behaviours to help close the gap between our ideal of concussion prevention and management and what we see on the field, rink, or in the gym.

In the present study we addressed these gaps by examining athletes’ intentions towards a range of primary and secondary protective behaviours. Rather than focusing on variable relationships, we used athlete responses to investigate whether we could identify subgroups of athletes with problematic intentions towards prevention and management behaviours. We used clustering techniques to investigate whether cases with higher risk intentions towards prevention and management behaviours exist among these athletes. We then identified specific attitudinal, demographic and concussion exposure indicators that differed between the groups. Our analysis not only consolidated different dimensions of prevention and management intentions among the athletes, but clearly defined problematic subgroups of athletes at greater risk of concussion injury and in greater need of attention in concussion prevention and management efforts. Further to this, we enable intervention targeting by identifying specific problematic attitudes that differed between groups.

Method
Design
A cross-sectional survey design was used. Ethical approval was received from the Trent University Research Ethics Board under protocol number 22616.

Context
Trent University (6252 undergraduate students enrolled at the time of the survey) hosts a small, competitive athletics programme with a total of 16 varsity teams which competing in Ontario university leagues and competitions. On average there are approximately 280 registered student athletes at Trent.

Within the athletics programme, Trent University has programmes in place for concussion education and management. Athletes receive concussion education at the beginning of their respective seasons, delivered by a physiotherapist or athletic trainer using a 1-h slide and discussion session (see Supplementary material for greater detail). The programme also includes a gradual return to play protocol based on the guidelines outlined by McCrory et al.

Recruitment strategy
Data were collected between September 2013 and April 2015. Coaches were contacted via email and helped facilitate participation from athletes. A researcher involved with the project came to team practice, introduced the study, and asked the athletes if any of them would like to volunteer their time to complete the
questionnaire. An online version (Qualtrics) of the questionnaire was made available to athletes not in attendance via email. There was no compensation given to any individual who participated in the study.

Participants

Questionnaire responses were received from 197 athletes. A total of 22 (11%) participants were removed from analysis due to incomplete surveys or improperly answering a series of ‘strike’ questions designed to validate cases as having properly completed the questionnaire. These 22 participants did not differ from the demographics of the rest of the sample. The final sample consisted of 175 varsity athletes.

Procedure

Data collection occurred before or after practices or training sessions. Informed, written consent was gained prior to participation. The majority (90%) of participants completed the questionnaire within a classroom in the Athletics Complex under the supervision of a researcher. The other 10% completed an online version of the test at a time more convenient to their schedule. A feedback and information sheet was provided at the end of the questionnaire.

Materials

Demographics. The demographic section of the questionnaire asked the participants about their age, gender, varsity sport participation, duration of sport participation, personal concussion history and history of concussion among people they know. They were also asked about education they received about concussion, and which source they received this from.

Beliefs, attitudes and intentions toward protective behaviours. These sections were an extension of a validated questionnaire on concussion perceptions.22 Items were developed from a self-regulatory perspective23 to understand how athletes perceive the efficacy of strategies to manage their personal risk and they extent to which they utilize such strategies. The attitude scale included 15 items and used a 5-point Likert scale (ranging from 1: Strongly Disagree to 5: Strongly Agree). Items included one’s beliefs and attitudes toward secondary prevention (e.g. hiding concussion symptoms places athletes at greater risk of future problems) and primary prevention through equipment use (e.g. I am safer taking risks while wearing protective equipment), rule changes (e.g. body contact should be eliminated in minor sports), body contact (e.g. full contact practice places me at greater risk of injury) and physical fitness and skill (e.g. being in better shape can reduce the risk of concussion) in relation to concussion injury risk. Athletes were also asked about how their competitive nature might affect their concussion risk and the extent to which they would place him or herself or an opponent at risk of concussion to succeed in sport. Items pertained directly to personal risk (e.g. I feel safer taking risks while wearing protective equipment) and risk more generally (e.g. adopting fair play rules reduces risk).

The intention scale included 17 items where athletes could choose no, maybe, or yes, as to the extent they would engage in various primary and secondary prevention behaviours. These items revolve around protective behaviours such as equipment (e.g. wearing a helmet), injury management (e.g. waiting the recommended recovery time), risk avoidance (e.g. avoiding contact drills in practice), fitness (e.g. get in better physical shape) and social behaviours (e.g. confronting aggressive opponents). Items pertained directly to personal risk (e.g. I would wait the recommended recovery time following concussion.) and risk more generally (e.g. I would advocate for rule changes to reduce risk).

Statistical analyses

All statistical analyses were run using either IBM SPSS Statistics v24 or R v3.3.1 software. Preliminary data inspection and cleaning was performed according to methods suggested by Tabachnick and Fidell.24 Missing demographic information was not replaced. Casewise deletion was used on a per analysis basis (the number of valid cases is noted in each of the results’ tables).

Descriptive statistics were generated for demographic data and scale responses. Items were examined for restricted ranges and tested for parametric assumptions. Chi square goodness of fit tests were conducted to compare the sample demographics to that of the Trent varsity programme to assess the representativeness of the sample. Chi square tests of independence were conducted to investigate relationships between categorical variables (gender, personal history of concussion, concussion specific education exposure, and type of sport involvement). Pearson and Spearman correlations were calculated to determine relationships between attitudes and intentions toward protective behaviours and risk perceptions.

A cluster analysis was performed on the intention dimensions (determined through principal components analysis) to identify groups of cases with particular response patterns. Our methods are based on those outlined by Clatworthy et al.21,25 Intentions scale items related to personal concussion risk behaviours were
identified. Item reduction was achieved through principal component analysis (PCA) with Promax rotation to create composite factors for use in cluster analysis and to minimize multicollinearity effects, as suggested by Tabachnick and Fiddell.24 From this, intention component scores were standardized to $z$-scores. Ward’s method was then used to predetermine the number of clusters to be set in the follow up K-means cluster analysis on the intention components. The $z$-scores were then subjected to a K-means cluster analysis. We used Euclidean distances as our measure of similarity between clusters. Our criteria included the maintenance of a Euclidian distance 1.5 standard deviation units or greater on all measures between neighbouring cluster centres as well as achieving convergence of the data within 10 iterations (with the convergence criterion set to 0).25 We then used a discriminant analysis to determine key dimensions discriminating the groups. We explored all the underlying assumptions in relation to the discriminant analysis.

Differences in attitudes were then examined across intention cluster groups. Attitude scale items related to personal concussion risk behaviours were identified. Item reduction was achieved through PCA with Promax rotation to create composite factors for use in comparative analyses and to minimize multicollinearity effects, as suggested by Tabachnick and Fiddell.24 An exploration of the underlying assumptions was performed. Attitude dimensions across clusters were analyzed using Munzel and Brunner’s robust multivariate analysis of variance (MANOVA) method followed with a Kruskal–Wallis test for each of the attitude dimensions. Clusters were also examined for differences in age, concussion exposure, gender and sport participation using appropriate frequency based tests. Spearman correlations were examined between athlete age and attitude dimensions.

**Results**

**Demographic information**

Demographics of the athlete sample ($N = 175$) are provided in Table 1. The majority of athletes were 19 years or younger (52.6%) and male (60%). One participant failed to report their gender. On average, athletes report involvement in their sport for 8.5 years (range 1–20), and competing at the varsity level for 1.7 years (range 1–5). The majority of the sample (55.4%) consisted of athletes from contact sports.

A majority of the athletes (56.6%) reported having suffered a concussion, however only 43% of the sample

### Table 1. Participant demographic information.

| Item                                                                 | Response | Sample, N (%)\(^a\) | Varsity, N (%)\(^bc\) |
|----------------------------------------------------------------------|----------|-----------------------|-----------------------|
| Gender                                                               | Male     | 104 (59.8%)           | 173 (60.1%)           |
|                                                                      | Female   | 70 (40.2%)            | 115 (39.9%)           |
| Age                                                                  | ≤19       | 91 (52.6%)            |                       |
|                                                                      | 20–22    | 67 (38.7%)            |                       |
|                                                                      | 23+      | 15 (8.7%)             |                       |
| Personal history of concussion                                      | Yes      | 99 (56.6%)            |                       |
|                                                                      | No       | 76 (43.4%)            |                       |
| If yes, diagnosed or undiagnosed\(^d\)                              | Diagnosed| 76 (76.8%)            |                       |
|                                                                      | Undiagnosed| 23 (23.2%)         |                       |
| Concussion specific education\(^d\)                                 | Yes      | 156 (89.1%)           |                       |
|                                                                      | No       | 19 (10.9%)            |                       |
| Know someone with personal history of concussion                     | Yes      | 170 (97.7%)           |                       |
|                                                                      | No       | 4 (2.3%)              |                       |
| Type of sport\(^e\)                                                 | Contact | 97 (55.4%)            | 142 (49.3%)           |
|                                                                      | Non-contact| 78 (44.6%)         | 146 (50.7%)           |

\(^a\)Percentages are based on total sample ($N = 175$).
\(^b\)Percentages are based on total Trent varsity programme (2015/16 season) ($N = 288$).
\(^c\)Chi square test of goodness of fit revealed that the gender distribution of the sample was representative of Trent varsity programme, $\chi^2 (1) = .024, p > .05$.
\(^d\)Percentages based on the sample of those who answered ‘yes’ to having a personal history of concussion injury ($N = 99$).
\(^e\)Contact sports included: Rugby, Lacrosse, and Hockey; non-contact sports included: Soccer, Curling, Rowing, Cross-Country, Golf, and Volleyball. Chi square test of goodness of fit revealed that the contact versus non-contact distribution of the sample did not differ from that of the Trent varsity athlete population, $\chi^2(1) = 2.77, p > .05$. 
reported having their concussion diagnosed by a trained health professional. Concussion history was dependent on sport type whereby, of those reporting concussion, most (68%) played a contact sport, \( \chi^2(1) = 13.84, p < .001 \). Essentially, those who reported a history of concussion were 3.2 times more likely to play a contact sport than those who reported no history of concussion. All athletes reported knowing someone who has sustained a concussion injury (97.7%). Most athletes reported having received concussion specific education (89.1%) (Table 1).

The sports included in this sample consisted of rugby (33.1%), soccer (12.6%), lacrosse (17.7%), curling (5.1%), rowing (10.3%), volleyball (13.7%), hockey (4.6%) and cross-country (2.9%) (Table 2). Based on demographics provided by the Trent Athletics Department the sample slightly under represented non-contact athletes, but otherwise was reflective of the Trent varsity athlete population.

**Item analysis of attitudes and intentions towards concussion risk**

Responses to attitudes and intentions are summarized in Figures 1 and 2. Correlations between items are reported through the text. Correlation matrices can be provided upon request.

**Secondary prevention.** Notably, most athletes (90.3%) reported that hiding concussion symptoms from others puts athletes at a greater risk for further injury or problems and most (94.2%) agreed that waiting the recommended recovery time was important. Nevertheless, athletes (75.4%) agreed that others do hide concussion symptoms to not be removed from play.

When asked whether they would hide their concussion symptoms in order to return to play earlier, a slight majority of athletes (55.2%) reported that they would never do this. Nevertheless, some athletes (8.6%) admitted that this is something they would always do, with the rest of the sample (36.2%) stating they would in some instances. A greater belief that waiting the recommended recovery time before returning to play is important to avoid further injury was negatively related to intentions towards hiding concussion symptoms in order to return to play earlier, \( r_s = -.251, p < .01 \). Athletes who believe that other athletes hide their concussion symptoms, report greater intention to hide symptoms themselves, \( r_s = .379, p < .001 \). This relationship may reflect the influence of perceived social norms among athletes on reporting behaviours or confirmation bias on the part of athletes intent on not reporting symptoms (i.e. believing that others share their tendencies).

**Primary prevention.** Protective equipment use: When asked about the use of protective equipment, the majority of athletes (92% overall; 89.6% contact; 94.9% non-contact) agreed that using protective equipment reduces the risk of concussion. The majority (65.6% overall; 60.4% contact; 71.8% non-contact) also agreed that they feel safer taking risks while wearing protective equipment. These two items were found to correlate (contact athletes, \( r_s = .299, p < .01 \); non-contact athletes, \( r_s = .323, p < .01 \)).

When asked about intention to use protective equipment, some contact athletes (40.2%) reported that they would always wear protective headgear and just under two-thirds of contact athletes (63.9%) reported that they would always wear a mouthguard.

| Factors and items                              | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 | Com  |
|-----------------------------------------------|----------|----------|----------|----------|----------|------|
| 8. Confront aggressive teammates about risk   | .877     | .815     |          |          |          |      |
| 12. Confront aggressive opponents about risk  | .895     |          |          |          |          |      |
| 3. Avoid high-risk sports                     | .807     |          |          | .777     | .776     |      |
| 11. Avoid contact sports                      | .806     |          |          |          |          |      |
| 15. Wait recommended time before returning    |          |          | .721     |          | .711     |      |
| 18. Hide symptoms to return to play quicker\(^a\) | .861     |          |          | .825     | .766     |      |
| 1. Wear protective headgear to reduce risk    |          |          |          |          | .964     | .944 |
| 2. Wear a mouth guard to reduce risk          |          |          |          |          | .944     |      |
| 9. Get in better physical shape               |          |          |          |          |          |      |
| Variance accounted for                        | 18.3%    | 17.5%    | 15.4%    | 13.9%    | 11.5%    | 76.6%|

Note: Bold values under each of the factors represent factor loadings. Percent variance accounted for by the factor is given in the bottom row. Com: communality.

\(^a\)Item reverse scored.
Contact athletes who reported feeling safer taking risks while wearing protective equipment held greater intentions to wear protective headgear ($r_s = .250$, $p < .05$). No relationship was found between athlete’s belief in the efficacy of protective equipment in reducing concussion risk and intent to use either a mouthguard or headgear.

**Competitive nature:** The results also show that roughly half of the sample agreed that their competitive nature increase their risk for concussion injury (52%). This was significantly correlated with agreement towards risking suffering a concussion ($r_s = .221$, $p < .01$) and giving a concussion to someone else (30.2% agreed; $r_s = .189$, $p < .05$) to succeed in sport. Both one’s attitude toward suffering a concussion to succeed ($r_s = .344$, $p < .001$) and giving a concussion to someone else to succeed ($r_s = .336$, $p < .001$) were significantly correlated with athletes’ intent to hide symptoms in order to return to play quicker. A Mann–Whitney U test revealed that none of these individual items were significantly related to whether the athlete reported a history of concussion. More generally, the sample was evenly split on whether the emphasis on winning in competitive sports increases the risk of concussion, where 43.7% of athletes disagreed and 37.3% agreed.

**Confrontation behaviours:** Interestingly, about half of the sample reported that they might confront aggressive teammates (52.3%) or confront aggressive opponents about the risk they pose to others (52.3%). Almost half (48.3%) of the sample would always vocalize their discontent to the referees and officials for missing violent infractions (48.3%).

**Contact and risk avoidance:** Most of the sample (90.2%) reported that they would never avoid contact sports altogether (93.8% contact; 85.7% non-contact) to reduce their risk of concussion. Similarly, a large proportion of the sample (70.9%) reported that they would never avoid sports with a high risk for concussion, although this significantly differed according to sport type. Unsurprisingly, those involved in non-contact sports were significantly more intent on avoiding high risk sports (27.9% contact; 42.9% non-contact), $\chi^2(2) = 13.34$, $p < .01$, regardless of concussion history. Among contact sport athletes with a history of concussion, 70.8% reported no intent to avoid contact in practice drills to minimize the chance of concussion. The majority of contact athletes (54.6%) agreed that full contact practices put them at a greater risk for concussion injury.

**Skill and fitness:** Roughly half of the sample (51.5%) agreed that being in better physical shape can reduce the risk of concussion and 63.2% reported they would get in shape physically to reduce the risk of suffering a concussion. The sample was equally divided on whether unskilled athletes were more likely to suffer a concussion, where 34.8% disagreed and 43.4% agreed.
However, most athletes (75.9%) endorsed the intention to learn proper body position as a way to reduce concussion risk.

**Rules to reduce risk:** The majority of athletes agreed (71.4%) that adopting fair play rules would reduce the risk of concussion, yet most athletes reported that they would not advocate for rule changes that would reduce the risk of injury (71.1%). Athletes also held negative attitudes (62.9% disagreed) towards the idea that body contact should be eliminated in minor sport.

**Intention response clusters**

**PCA of intention scores.** Using PCA, we identified five personal risk dimensions for the intention scale: risk confrontation, risk avoidance, concussion management, protective equipment usage and fitness (see Table 4). Higher scores on all factor items reflect greater intent to engage in the behaviours. Two items loaded onto the protective equipment usage dimension – one’s intent to use protective equipment such as headgear and mouthguards. Intent to get in better shape to reduce concussion risk emerged as a single item.

**Cluster analysis of intention scores.** A K-means cluster analysis on the five standardized (z-scores) intention factors (N = 174) allowed for a three-cluster solution to converge in 10 iterations. Euclidean distances between cluster centres varied from 1.844 to 2.596, adhering to the criteria outlined by Clatworthy et al.21 Cluster labels were rationalized based on the deviation of each factor from each cluster mean (Figure 3). Cluster 1 contained 55 (31.6%) athletes with responses >5 standard deviation units above the mean on all personal risk reduction factors except fitness. This cluster was labelled the proactive group as these responses reflect an athlete whose willingness to engage in risk reduction behaviours extends to each facet covered by the questionnaire. The exception to this was the fitness dimensions where athletes in this group had average responses. Each of the intention dimensions represent behaviours that can be done proactively by athletes.

Cluster 2 contained 70 (40.2%) athletes with responses >5 standard deviation units above the mean on the concussion management factor. This cluster was labelled the reactive group as the only above
average intention response was on a reactive risk reduction behaviour – properly managing the injury works to reduce risk of further injury. Cluster 3 contained 49 (28.2%) athletes with responses .5 standard deviation units below the mean on the confrontation factor and 1.5 standard deviation units below the mean on the concussion management factor. This cluster was labelled the indifferent group. These athletes reported little to no intention to engage in any risk reduction behaviours. With all scores falling below the mean, we identified this cluster as a problematic response group.

A discriminant analysis was used to determine which intention dimensions are driving the clustering. This analysis revealed two distinct functions. The correlations between the intention factors and the discriminant functions revealed that the concussion management (function 1, \( r = .867 \); function 2, \( r = -.333 \)) and fitness (function 1, \( r = .139 \); function 2, \( r = -.051 \)) factors loaded predominantly on function 1 differentiating the indifferent from the proactive and reactive groups. Whereas the remaining factors, protective equipment (function 1, \( r = .23 \); function 2, \( r = .602 \)), avoidance (function 1, \( r = .041 \); function 2, \( r = .457 \)), and confrontation (function 1, \( r = .279 \); function 2, \( r = .443 \)) factors loaded predominantly on factor 2 differentiating the reactive from the proactive and indifferent groups.

An ANOVA comparing the means of the three-cluster solution revealed that intent to manage concussion symptoms was overall the most influential variable for discriminating clusters and the fitness factor was the least (see Table 3).

**Comparisons across intention clusters**

**Group comparisons for intention clusters.** Chi square analyses revealed an association between cluster membership and concussion history, \( \chi^2(2) = 7.05, \ p < .05 \). This effect reflected increased odds of sustaining a concussion when in the indifferent group compared to the proactive group (OR = 2.6, CI\text{lower} = 1.2, CI\text{upper} = 5.8) and when in the reactive group compared to the proactive group (OR = 2.2, CI\text{lower} = 1.1, CI\text{upper} = 4.5). Of all, 65.3% of athletes in the indifferent cluster had previously suffered a concussion. Although cluster membership did not statistically differ based on gender or sport type, the majority of athletes in the indifferent group were males (67.4%) and played contact sports (69.4%). The likelihood of not receiving concussion education did not differ across clusters (12% proactive, 8.7% reactive, 16% indifferent). Athlete age did not differ across intention clusters, \( F(2, 169) = 0.272, \ p = .762 \).

**Differences in attitude dimensions across intention clusters.** Lastly we wanted to explore any relationships between athletes’ attitudes and intention cluster membership. Six personal risk dimensions were identified from the PCA for the attitude scale: risk acceptance, injury management, protective risk mitigation, skill, fitness and competitiveness (Table 4). Three items loaded onto the risk acceptance dimension. A high score on this reflects a greater belief that they would risk giving or receiving a concussion and that wearing protective equipment is a sign of weakness. Two items loaded onto the concussion management dimension, where high scores represent a positive attitude towards properly managing the injury through symptom reporting and giving the proper time to recover. Two items loaded onto the protective risk mitigation factor. These items reflected concurrent beliefs that protective equipment reduces concussion risk and that athletes are safer taking risks while wearing protective equipment. Higher scores reflected greater beliefs in the value of protective equipment and perceptions of safety in taking risks with protective equipment.

Three items did not load onto components but were included as individual dimensions indicating a single attitude belief. The first item reflected skill beliefs. High scores on this item reflect a greater belief that unskilled athletes are more likely to suffer a concussion. Item two identified fitness beliefs such that high scores represented a greater belief that being in

**Figure 3.** Radar plot of standardized average responses on intention dimensions for three cluster solution. Average responses towards the centre of the plot represent lower endorsement of intentions towards the dimension. Average responses towards the outside of the plot represent higher endorsement of intentions towards the dimension.
better shape can physically reduce the risk of concussion. The third item assessed athlete’s beliefs around competitiveness where higher scores reflect a greater belief that one’s competitive nature increases their risk for concussion injury. In summary, PCA reduced the initial 10 items to three components and three individual items reflecting different dimensions of personal risk attitudes.

A MANOVA using Munzel and Brunner’s method (owing to violation of parametric assumptions), revealed a statistically significant difference in students’ scores on attitude dimensions based on their intention cluster membership, $F(5, 169) = 3.29, p < .001$. Post hoc individual Kruskal–Wallis rank sum tests found risk acceptance ($\chi^2(2) = 30, p < .001$) and concussion management attitudes ($\chi^2(2) = 20, p < .001$) differed significantly across clusters. Post hoc analyses for risk acceptance found that the indifferent group had a significantly ($p < .05$) greater inclination toward a higher risk acceptance versus the proactive and reactive groups, who do not differ (Figure 4). In contrast, the indifferent group was significantly ($p < .05$) lower than either the proactive or reactive groups in attitudes towards concussion management who do not differ (Figure 4). Additionally, risk acceptance was higher among athletes who reported sustaining a concussion ($M = .132, SD = .998$) versus those who had not ($M = -.175, SD = .981$), Mann Whitney $U = 2898, p = .042$. These findings are unsurprising and serve to further validate cluster membership. Athlete age was not correlated with risk any of the attitude dimensions.

### Discussion

The interest of this study was twofold. Our first aim was to identify subgroups of athletes with problematic intentions towards concussion risk behaviour that were then differentiated on attitudes, demographics, sport involvement, concussion exposure and education. Second was to examine attitudes towards both

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**Table 3.** Analysis of variance and grouping effect size for the final cluster centres for a three-cluster grouping of athletes intention responses.

| Dimensions          | Final cluster centers (z-scores) | Sig. |
|---------------------|---------------------------------|------|
|                     | Proactive | Reactive | Indifferent | $F$ | $p$ | $\Omega^2$ |
| Confront            | 0.76      | -0.24    | -0.50       | 32.95 | <.001 | .269 |
| Avoidance           | 0.52      | -0.43    | 0.03        | 16.04 | <.001 | .147 |
| Management          | 0.50      | 0.53     | -1.32       | 184.33 | <.001 | .678 |
| Protective equipment| 0.82      | -0.41    | -0.35       | 39.45 | <.001 | .307 |
| Fitness             | 0.14      | 0.14     | -0.36       | 4.69  | <.001 | .041 |

$\Omega^2$: omega squared statistic for the effect size of the grouping effect.

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**Table 4.** Factor loadings and communalities for the attitudes towards protective behaviour scale dimensions.

| Factors and items                                      | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 | Factor 6 | Com |
|--------------------------------------------------------|----------|----------|----------|----------|----------|----------|-----|
| 5. Risk suffering a concussion to succeed              | .826     |          |          |          |          |          | .754|
| 6. Wearing equipment is a sign of weakness              | .585     |          |          |          |          |          | .691|
| 8. Risk giving a concussion to succeed                  | .785     |          |          |          |          |          | .851|
| 11. Waiting proper recovery time before returning       |          | .756     |          |          |          |          | .714|
| 15. Hiding concussion symptoms increases risk           |          | .848     |          |          |          |          | .793|
| 1. Protective equipment reduces risk                    | .606     |          |          |          |          |          | .735|
| 10. I feel safer taking risks wearing equipment         | .898     |          |          |          |          |          | .850|
| 12. Unskilled athletes are at higher risk               | .892     |          |          |          |          |          | .838|
| 7. Being in better physical shape reduces risk          |          | .897     |          |          |          |          | .851|
| 4. My competitive nature increases risk                 |          |          | .959     |          |          |          | .952|

Variance accounted for 18.1% 15.1% 12.5% 11.7% 11.2% 10.4%

Note: Bold values under each of the factors represent factor loadings. Percent variance accounted for by the factor is given in the bottom row. *Total variance accounted for by the six factors: 78.8%.
primary and secondary prevention strategies, meaning concussion prevention and management strategies, respectively.

Identification and differentiation of intention subgroups

Our investigation of intention responses revealed a large (28% of athletes), problematic group of athletes relating to concussion management and prevention behaviours. To our knowledge, this is the first empirical description of such a group of athletes. The primary differentiating features among this subgroup and the proactive and reactive groups were indifference towards concussion-management behaviours and social responses to high-risk behaviour. In terms of attitudes, this group was more accepting of concussion risk and had lower beliefs about the efficacy of management behaviours. The rate of concussion among this group was higher than either of the others.

The other two subgroups demonstrated positive orientations towards managing concussion injury. The proactive intention cluster (32% of athletes) reported higher intentions towards concussion risk reduction and management strategies. The reactive cluster (40% of athletes) held similar intentions towards concussion management. Where they differed was in proactive intentions towards risk mitigation. The proactive group expressed greater intentions towards managing contact exposure, wearing protective equipment and confronting overly aggressive opponents and teammates. Attitudes towards risk did not differ between these groups. The reactive group reported a higher incidence of concussion versus the proactive group.

For prevention programmes these results indicate that athletes are heterogeneous in their intentions and attitudes towards concussion management and prevention. For the proactive athletes, programmes are essentially ‘preaching to the choir’. Their beliefs and behaviours are largely aligned with programme messaging. The indifferent group, on the other hand, would appear to be the least likely to respond to concussion injury appropriately and the most likely to put themselves and others in harm’s way. The reactive group falls somewhere in the middle, where these athletes will take care of themselves if they sustain a concussion, but they are unlikely to engage proactively with personal risk mitigation or socially addressing high risk play.

This research indicates that our current knowledge-based concussion programmes need to have a greater influence on attitudes. Indifferent athletes had lower belief in the efficacy and importance of proper management actions and were more likely to place themselves and others at risk of concussion to succeed. At face value, logical foci in programmes for these athletes include the potential harms associated with improper management, and importantly, personalizing the risk to the individual athlete. While not previously used in

Figure 4. Boxplots of attitude dimension scores for risk acceptance and concussion management across intention clusters. Data are the mean scores for the attitude PCA dimensions on the 1 to 5 scale. Data points are jittered vertically for clarity. The Indifferent cluster demonstrated less favourable attitudes towards risk acceptance (higher scores represent less risky attitudes) and concussion management (higher scores represent greater belief in efficacy of concussion management).
concussion research, prior health research has successfully used clustering to identify groups most likely to respond to health interventions as well as defining attitudes and behaviours held among individuals in those groups that are likely targets for intervention. Based on our findings, we can group athletes based on behavioural intentions and target prevention efforts towards those most in need.

A second implication for programmes is the need to understand where the targeted participants lie in terms of their attitudes and intentions towards precautionary behaviour. Risk perception research suggests there are different stages of awareness and engagement involved in individuals adopting precautionary behaviour. These range from individuals being unaware to unengaged to deciding about acting or not. Presumably awareness did not differ among our clusters as there was no difference in education exposure. As such, our indifferent athletes were either unengaged, undecided or had decided on no action (despite having a greater likelihood of sustaining a concussion).

Those having taken a firm decision not to act are potentially the most problematic to get to. These athletes may have considered but rejected action. Evidence in other health domains indicates that such individuals may be well-informed but may seek information that confirms their bias towards not responding and/or ignore information that disconfirms their beliefs or interpret information (e.g. my buddy got a concussion and went right back in) in a way that supports his or her views. Indifferent athletes may also have regressed in their intentions because personal experience of ‘having gotten away with it’ or the quandary of balancing risk with their desire to compete. Further specification of athlete stage of risk response and risk response trajectories is critical in tailoring programmes. While needing further refinement, the items used in this study provide a starting point to knowing who requires more attention and the specific attitudes that need to be changed.

**Concussion management and prevention behaviours**

Secondly, we wished to examine athlete attitudes and intentions towards both primary (i.e. before the fact) and secondary prevention strategies. As secondary prevention (i.e. recognition, response after the fact) has been the main focus of research to date, we discuss this first.

**Secondary prevention.** In examining individual items relating to one’s injury management behaviours, the current findings clearly demonstrate more or less adaptive and sometimes contradictory intentions and attitudes towards concussion reporting and return to play.

The majority of athletes in the sample (55%) stated they would report, not hide, concussion symptoms. Nonetheless, the majority of the sample believed that athletes do hide their concussion symptoms (75%) a significant proportion indicated they would or may (45%) hide symptoms to remain in play. These findings support those of other studies that demonstrate a lack of reporting and a low level of reporting despite athletes being knowledgeable about concussions. Register-Mihalik et al. found no association between knowledge, or attitudes towards reporting, and in game reporting behaviours but did find a relationship between concussion knowledge and reporting in practice situations. Other literature provides insight into reasons for not reporting concussion. Chrisman et al. studied response to personal concussion scenarios in nine focus groups of high school athletes. When presented a personal concussion scenario, members of three focus groups stated that they would take a brief break then continue to play and the remaining six groups stated that they would just keep playing immediately. Reasons for this included the desire to continue playing (i.e. reporting symptoms would likely result in immediate and potentially prolonged removal from play), the belief that their symptoms could be due to another issue (e.g. dehydration), playing with symptoms was normal, and letting teammates and coaches down.

We also found that athletes who believe that other athletes hide their concussion symptoms, report greater intention to hide symptoms themselves. This may reflect the influence of perceived social norms on management behaviours. Register-Mihalik et al. found that general positive attitudes towards reporting and supportive social norms had the most potent relationship towards reporting behaviours in a sample of high school athletes.

With respect to return to play, athletes in our sample that held lower intentions towards reporting concurrently held lower beliefs that waiting the recommended recovery time was important to avoid further injury. Again, social pressure can play a role. Kroshus et al. found three subgroups of athletes experiencing varying social pressure (from teammates, coaches, parents, and fans) towards returning to play while symptomatic: a low pressure group (experienced little pressure from all sources), a team pressure group (experienced moderate pressure from coaches and teammates), and a high pressure group (experienced high amounts of pressures from all sources). Results showed that the high pressure group held significantly lower intent to report symptoms than both the team pressure group ($d = .50$) and the low pressure group ($d = .40$).
Primary prevention. The competitive sport context may modify athletes’ risk behaviour. Many of athletes in our sample (52%) indicated their competitive nature increased their risk of concussion and (56.6%) of athletes in the current study reported willingness to receive a concussion, with a surprising number (30.6%) reporting willingness to give a concussion to succeed in sport. We also found that one’s attitude toward suffering a concussion to succeed and giving a concussion to someone else to succeed were positively correlated with a greater intent to hide symptoms in order to return to play more quickly. This willingness to give or receive a concussion reflects the tension that exists between safety behaviour on the one hand and the competitive imperative of sport on the other. We are unaware of data speaking to the influence of the competitive environment on protective behaviour. This is an important direction for future research.

Protective equipment use is another commonly discussed feature of concussion prevention. In this sample we observed the coinciding and potentially paradoxical views relating to the usage of protective equipment. The majority of athletes believed that protective equipment reduces risk and reported greater feelings of safety while wearing protective equipment while coincidently reporting a greater willingness to take risks while wearing protective equipment.

This finding is problematic from two standpoints. First the evidence does not support the efficacy of protective equipment reducing the likelihood of concussion. Thus, some athletes are operating with a false sense of security when it comes to protective equipment use. Ironically, those in the proactive and reactive management clusters placed the greatest faith in protective equipment reducing concussion risk. Second, misplaced faith in protective equipment reducing risk might translate into athletes taking risks because they believe they have the ‘leeway’ to do so.

Athletes held other questionable beliefs including the role of fitness and skill in reducing concussion risk, neither of which are determined risk factors. Becoming fitter and more skilled has many benefits for competitive athletes and athletes in the sample may be simply bundling reduction in injury risk alongside those other benefits. What is notable is that athletes hold such beliefs regardless of their factual basis.

Despite the statistical risk associated with contact, the majority of athletes in our sample were not favourable towards avoiding contact sport or avoiding contact in sport. Nor were these athletes generally favourable towards eliminating body contact from minor sport. Research has shown that the majority of first time and recurrent sport concussions occur as a consequence of contact with another player and that body contact is a potent risk factor for concussion. Reducing body contact would be a logical step towards reducing concussion incidence, but not one supported by this sample of athletes.

Concussion prevention, management and risk compensation

Taken as a whole, athletes’ concussion management and prevention behaviour reflects a balance between the personal and social imperatives of competition and self-protective instincts. McCrory et al. suggest the possibility of risk compensation – where an athlete’s behaviour changes, usually by engaging in riskier behaviours, as a consequence of beliefs about another risk reduction factor maintaining/negating actions to reduce risk. While controversial, the idea of risk compensation has been discussed as a possible mechanism for studies demonstrating increased high-risk behaviour and variable effectiveness in public health campaigns in other health behaviour domains such as HIV prevention and driving. Key components of risk compensation include a target acceptable degree of risk on the part of the participant that he or she compares to a perceived level of risk in the environment. This results in adjustments to risk taking behaviour to align perceived and acceptable risk levels.

In the context of concussion injury, target or acceptable risk is influenced by the competitive attitudes held by the athlete and the cultural and social milieu of sport. Thus, what might be unacceptable behaviour (e.g. sustaining concussion to succeed) in another context might be viewed by certain athletes as an acceptable target level of risk in the sport context. Perceived risk is influenced by beliefs that certain behaviours (e.g. protective equipment use) will reduce risk. Thus, the higher target or acceptable risk levels found in competitive environments and modified perceived risk beliefs (whether accurate or not) can operate in tandem to promote an increase in high risk behaviour. It is unlikely that athletes would completely abandon precautions in the belief that protective gear (such as a neoprene serum cap) will keep them safe from concussion. Nonetheless, such erroneous beliefs may produce incremental adjustments in risk behaviour and need to be addressed in concussion prevention programmes. Target risk is perhaps a more important, but also more complex construct. Sport participation requires a certain acceptance of injury risk. For athletes, guiding appropriate levels of target risk through positive sport culture and social influence may be the best way forward.

Strengths and limitations

The cluster analytic approach is a major strength of this study. A main objective of this study was to focus our
analyses on the athletes themselves by identifying subgroups of athletes who hold potentially problematic intentions towards personal concussion risk. Current research is unanimous on the benefits of engaging in proper injury management behaviours (e.g. reporting concussion symptoms to coaches). Despite anecdotes and common-sense suppositions, no previous research has identified this subgroup through examining intentions of athletes towards these behaviours.

The inclusive sampling in the study provides a prime example of how concussion beliefs exist within a population of athletes within a small to medium Canadian university context. Although the dispersion among clusters may vary, we have no reason to believe these groups of athletes would not exist in samples from other institutions or that such attitudes would not be found among the subgroups. So, while generalizability may not be possible to larger institutions and athletic programmes, future studies can compare our clusters and individual item responses to other samples from larger or more competitive school environments.

As a cross-sectional study the design limits causal inference between the attitudes, intentions and concussion exposure. Nonetheless, the current findings leave us in a better position to design studies examining the prospective influence of risk beliefs and changes in risk beliefs on athlete behaviours. Future studies can also use this framework to examine the effect of prevention programmes and other exposures on changing risk perceptions and intentions towards protective behaviours. In examining associations and effects, observational measures of risk behaviour would provide stronger evidence as to the associations between risk beliefs and behaviour in the competitive sport context.

Conclusions

In closing, prevention programmes play a pivotal role in addressing the issue of concussion in sports. However, the success of such programmes is predicated on targeting behavioural attitudes and intentions that are going to impact on concussion risk. This study identified a problematic group of athletes, conflicting attitudes and intentions towards personal concussion risk, and inaccurate beliefs around effective concussion-management behaviours in a sample of varsity athletes despite having an active concussion education and management programme at the university. These findings highlight the importance of examining athlete attitudes and intentions, of considering lay beliefs held by athletes, as well as the importance of being aware of conflicting motivations.

Ideally, all athletes would be a member of the proactive subgroup and would properly engage in preventative behaviours. The current sample is a prime example of how the ideal is also the unlikely. Despite having a concussion education and management programme in place for the athletes and the majority identifying exposure to concussion education, many athletes still report low intent to engage in proper behaviours after suffering a concussion, let alone work towards preventing a concussion altogether. With a focus on concussion reduction, future research and programmes should consider both perceived and acceptable risk as targets for intervention.

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