Concussion-reporting behaviors among high school athletes in Ireland: Applying the theory of planned behavior

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Abstract

Background: Sport-related concussion is a significant public health issue, especially among children and adolescents. A growing body of evidence suggests that athletes who do not immediately report concussion and continue to play while concussed take longer to recover than their counterparts. Yet, many child and adolescent athletes do not immediately report concussion symptoms to a responsible adult.

Aim: This study examined the utility of the Theory of Planned Behavior (TPB) in predicting concussion reporting intentions and in-season reporting behaviors among high school, Gaelic Athletic Association (GAA) athletes in the Republic of Ireland.

Methods: High school GAA athletes aged 12-18 years completed surveys at baseline and at three-month follow-up. Concussion-related perceived behavioral control (PBC), attitudes, subjective norms, and reporting intentions were assessed at baseline. In-season concussion reporting behaviors were assessed at three-month follow-up. Hierarchical linear regression models were used to examine the relationship between the constructs of the TPB and baseline reporting intentions. Logistic regression models were used to examine the relationship between the constructs of the TPB and in-season reporting behaviors. All data were collected during the 2016–2017 academic year.

Results: A total of 153 adolescent athletes were included (n = 102 [66.7%] females; M_age = 14.4 years, [SD = 1.6]). Consistent with the TPB, results revealed that PBC and reporting intentions contributed to the prediction of in-season reporting behaviors. Reporting intentions, in turn, were strongly influenced by PBC, attitudes, and subjective norms. PBC was the strongest predictor of concussion reporting intentions and in-season reporting behaviors; the stronger the athletes’ PBC, the stronger their reporting intentions and the more likely they were to have reported concussion symptoms during the current season.

Conclusion: Although the findings from the current study must be interpreted cautiously given the small sample size, the findings suggest that the TPB has some utility in the prediction of concussion reporting intentions and behaviors. However, our findings suggest that the TPB should not be used in isolation; other models that incorporate personal factors and environmental constraints may be needed to better our understanding of concussion reporting intentions and behaviors among high school athletes. Concussion education programs that include strategies to enhance PBC over concussion reporting may help improve concussion reporting behaviors among high school athletes.

Keywords
Concussion, intention, Gaelic Athletic Association, sports, theory of planned behavior

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Introduction

Sports-related concussion has been recognized as a significant public health issue, especially among child and adolescent athletes.2,3 It is estimated that, annually, between 1.1 to 1.9 million sport- and recreational-related concussions occur in US children aged ≤18 years.4 Concussion is defined as a traumatic brain injury induced by biomechanical forces.5

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results in a range of clinical signs and symptoms, including physical, cognitive, and emotional symptoms. Resolution of the clinical and cognitive signs and symptoms of concussion vary greatly, from a few days to several weeks. Variants often complicate or prolong the recovery process post-injury, including continued play while symptomatic from concussion. Emerging evidence suggests that athletes who return to contact or collision sports while symptomatic from concussion take longer to recover and may be at an increased risk of more severe post-concusive symptoms and potential short- and long-term complications compared to athletes who are immediately removed from play. Thus, immediate removal from play post-injury is an important component of risk reduction and secondary prevention of concussive injury. Yet, despite the documented importance of timely removal from play, research has suggested that up to half of concussions are unreported and therefore undiagnosed.

In order to increase the disclosure of concussion symptoms to a supervising adult (i.e., parent, coach, medical professional) among adolescent athletes, we need to understand the psychosocial determinants of concussion-reporting behaviors, especially among children and adolescents who are at increased risk of concussion and prolonged recovery. Researchers, to date, have identified a number of factors that influence reporting behaviors among children and adolescent athletes. Among these are inadequate knowledge about concussive injury, motivation to keep playing, fear of letting the team down or looking weak, and beliefs that concussive injury is not serious enough to warrant medical attention. Due to the multifactorial nature of concussion-reporting, the literature suggests that we use existing psychosocial theories of health behavior to further investigate predictors of concussion symptom disclosure in an effort to better understand where to intervene.

**The theory of planned behavior and concussion reporting behaviors**

A theoretical approach that has been extensively used to study a range of health-related behaviors (such as smoking cessation, eating behaviors, and physical activity) is the Theory of Planned Behavior (TPB). The TPB, developed by Icek Ajzen in 1991, is an extension of the Theory of Reasoned Action (TRA). The TPB extends on the TRA by incorporating the concept of perceived behavioral control (PBC) as a determinant of behavioral intentions and of behavior itself. Ajzen’s TPB posits that behavior is co-determined by PBC and the overall intention to perform a behavior. PBC refers to people’s perceptions about whether or not they have the resources to engage in the behavior of interest and the perceived ease or difficulty of performing the behavior. PBC is comprised of two highly related components: perceived self-efficacy (one’s confidence in their ability to perform a behavior) and perceived controllability (the belief that the behavior of interest is under one’s control). Behavioral intentions represent one’s motivation to engage in the behavior of interest, including how hard people are willing to try to perform the behavior and the amount of effort they are planning to exert in order to perform the behavior. According to the TPB, behavioral intention is determined by three factors: (1) attitudes (overall evaluations about performing the behavior), (2) subjective norms (perceived beliefs about whether significant others think they should perform the behavior), and (3) PBC. The TPB posits that the stronger the behavioral intention, the more likely an individual will engage in the behavior, as long as the behavior of interest is under volitional control.

Empirical evidence suggests that concussion-reporting intentions are associated with prospective reporting behaviors and that attitudes and perceived subjective norms are positively associated with concussion-reporting intentions among high school and collegiate athletes. In addition, a study by Chrisman et al. suggested that concussive symptom reporting can be modelled using the TPB. Specifically, Chrisman and colleagues model hypothesized that although athletes understand the risk of continued play while symptomatic from concussion (“attitudes”), they believe that significant others (e.g., teammates, coaches, parents) do not want them to disclose symptoms, which in turn influences their intentions to report concussive symptoms and ultimately influences the disclosure of concussive symptoms to a responsible adult. Early research, therefore, provides qualitative and empirical support for the use of the TPB as an appropriate framework to understand concussion reporting behavior. However, the efficiency of TPB to explain and predict reporting intentions and in-season disclosure behaviors should be tested in other sporting populations, including in high school athletes and across sexes.

**The Gaelic Athletic Association**

Gaelic football and hurling (or camogie for female athletes) are the national sports of Ireland. Both Gaelic football and hurling are amateur sports, governed by the Gaelic Athletic Association (GAA). These Gaelic sports are played by approximately 320,000 playing members, in 3,000 sports clubs throughout the country. These sports are characterized by high-intensity,
high-velocity, multi-directional, and high physical contact elements.26,27 Due to these elements there is a significant rate of injury among GAA athletes,27–29 including concussion.30,31

Like other sports,10,11 the underreporting of concussion among GAA athletes is a common practice and an area of concern;30,31 thus, it is important to investigate factors that may influence concussion-reporting behaviors among this population of athletes. Previous research30,31 examining concussion-related knowledge, attitudes, and reporting practices among this population found that GAA athletes lack a complete understanding of concussive injury, including the signs and symptoms, mechanism of injury, and the potential long-term health effects of repeated concussion and premature return-to-play, all of which may contribute to the under-reporting of concussion among this population. Sullivan and colleagues30 also found that 60% of GAA athletes have reportedly played in practice or during a game with concussion symptoms. This finding is concerning as emerging evidence suggests that athletes who continue to play while symptomatic from concussion require twice as long to recover than athletes who are immediately removed from play,6 highlighting the importance of timely identification of concussion symptoms and immediate removal from play when a concussion is suspected.

Research questions

The primary aim of this study was to examine the efficacy of TPB in predicting concussion-reporting intentions and in-season reporting behaviors in high school, GAA athletes in the Republic of Ireland. We examined the extent of influence of attitudes, subjective norms, and PBC on reporting intentions. Based on previous research findings11,16,19 we hypothesized that athletes’ perceived behavioral control over concussion symptom reporting and reporting intentions would predict in-season reporting behaviors. We also hypothesized that reporting intentions would be determined by athletes’ concussion-related attitudes, perceived behavioral control, and subjective reporting norms.

Methods

Sample and procedure

This longitudinal study was conducted as part of a larger study that evaluated the effectiveness of a concussion education program for high school GAA athletes (see detailed information about the larger study published elsewhere).32 For the purposes of this study, we analyzed data from the control group participants. Athletes were recruited from three high schools located in the West of Ireland. Athletes were eligible if they were aged 12–18 years old and played Gaelic football and/or hurling (or camogie for female athletes) for their school team during the 2016–2017 academic season. Detailed information about the study was provided to all eligible athletes and their parents. Interested athletes and their parents provided written informed assent and consent, respectively, prior to study participation. Participants completed a survey at baseline and at three-month follow-up. The baseline survey assessed participant’s demographics, TPB-related cognitions (i.e., concussion-related PBC, subjective norms, attitudes, and reporting intentions), and past concussion-reporting behaviors. The three-month follow-up survey assessed participant’s in-season concussion-reporting behaviors. The survey used in this study can be found in the Supplementary Appendix. Questions were drawn from surveys used in previous studies.11,16,24 Surveys were administered in-person at a team meeting, during or after school hours. Ethical approval was obtained by the Institutional Review Board at the National University of Ireland, Galway.

Measures

Perceived behavioral control (PBC). PBC was measured at baseline with five Likert-scale items (e.g., I am confident in my ability to recognize when I have symptoms of concussion) drawn from research conducted by Kroshus.
and colleagues.\textsuperscript{16} Items were scored on a 7-point scale (1 = strongly disagree to 7 = strongly agree), with item scores summed and higher scores representing the belief that athletes have more control and confidence over reporting concussion symptoms to an appropriate adult (range = 5 to 35; Cronbach’s $\alpha = 0.88$).

**Subjective norms.** Athletes’ subjective reporting norms were measured at baseline using Rosenbaum & Arnett’s Concussion Attitudes Index (CAI).\textsuperscript{33} Participants reported how strongly they agreed (range 1–7) with five statements (e.g., \textit{Athlete M experienced a concussion during the first game of the season. Athlete O experienced a concussion of the same severity during the semi-final playoff game. Both athletes had persisting symptoms} about what they or one of their teammates would do in various reporting situations. Similar to a survey conducted by Kroshus et al.,\textsuperscript{24} modifications were made so that each item separately referred to personal and teammate reporting norms (i.e., “I would . . .”; “My teammates would . . .”). A total subjective reporting norms score was calculated by summing the responses to the 10 Likert-scale questions (possible range = 10–70; Cronbach’s $\alpha = 0.76$). A higher score reflected more positive normative beliefs about concussion-reporting.

**Attitudes towards the perceived outcomes of reporting.** Attitudes towards the perceived outcomes of concussion-reporting were measured at baseline with eight Likert-scale questions (range = 1–7) (e.g., \textit{If I report what I suspect might be a concussion, my teammates will think I made the right decision}). Items were drawn from a survey conducted by Kroshus and colleagues.\textsuperscript{16} Total attitude score was calculated by summing the responses to the eight 7-point Likert scale questions (possible range = 8–56; Cronbach’s $\alpha = 0.57$), with higher scores representing a more favorable attitude toward concussion and concussion-reporting.

**Knowledge.** Concussion-related knowledge was assessed at baseline with a series of 13 true-false questions concerning symptom recognition, complications related to multiple concussion, and general knowledge of concussion (e.g., \textit{People who have had a concussion are more likely to have another concussion}).\textsuperscript{16,33} Correct responses were summed to create a total knowledge score for each athlete, with higher scores reflecting more concussion-related knowledge (range = 0 to 13).

**Reporting intention.** Concussion Reporting Intention was measured at baseline using Kroshus and colleague’s\textsuperscript{16} eight-item Intention to Report Concussion Symptoms scale. Participants were provided with a list of eight common symptoms of concussion (dizziness; headache at least once during the week; vomited or felt nauseous; bell rung; problems concentrating, studying or doing class work; saw stars; forgot what to do on the pitch; and, lost consciousness or blacked out) and asked whether they intended to immediately report the presence of each symptom to their coach or athletic trainer if the symptom were experienced after an impact.\textsuperscript{14} A Total Concussion Reporting Intention score was calculated by summing the responses to the eight Likert-scale (range 1–7) reporting intention questions (possible range = 8–56; Cronbach’s $\alpha = 0.92$). A higher score represented a greater intention to report symptoms.

**Past concussion reporting behavior.** Past concussion reporting behavior was measured at baseline. Participants reported (yes/no) on whether they had experienced any sensory, somatic, and/or cognitive symptom(s) of concussion, after sustaining an impact or collision, during the current academic season.\textsuperscript{14,16} Subsequently, past concussion reporting behavior was assessed among those who experienced at least one of the eight listed symptoms of concussion in the previous season with a single dichotomized item (‘\textit{Experienced any of these symptoms after an impact but did not immediately tell a coach or medical professional (e.g. kept playing in training or a match)’}), scored 0 or 1, with 1 indicating that concussion was reported.

**In-season concussion symptoms and reporting behavior.** The same item used at baseline to measure past behavior was used at three-month follow-up, to measure in-season reporting behaviors. This variable was assessed among participants who reported that they experienced at least one of the eight listed symptoms of concussion during the current season. The item was scored 0 or 1, with 1 indicating that concussion symptoms were reported.

**Demographic variables.** The following demographic variables were measured at baseline: age, sex, and history of concussion (lifetime) (yes or no).

**Data analyses**

Data analyses were conducted using SPSS version 26.0 statistical package and included descriptive, correlation, hierarchical linear regression, and logistic regression analyses. To answer the first research question, we conducted a hierarchical linear regression. Participants were included in the analyses if they experienced at least one of the eight listed concussion symptoms in the previous season (N = 101). In the first step (step 1), athlete demographic characteristics (e.g., age; sex; and history of concussion) were entered into the model. Sex and history of concussion (lifetime) were dummy coded, allowing for comparisons between groups.
The reference groups were females and athletes without a history of concussion (lifetime). In the next step (step 2), PBC, subjective norms, and attitudes at baseline were added to the model. Subsequently, the variable concussion-related knowledge was added to the equation (step 3) as an independent predictor of concussion-reporting intention (measured at baseline). In the final step of the regression equation (step 4), past reporting behavior was added to the model as an independent predictor of concussion reporting intentions.

Next, we conducted a sequential logistic regression to predict in-season disclosure behaviors (measured at three-month follow-up). Participants were included in the analyses if they experienced at least one of the eight listed symptoms of concussion during both the previous and current seasons (N = 64). In the first step of this model, we entered age, sex, and history of concussion. In the next step (step 2), reporting intentions and PBC at baseline were added to the model. Past reporting behavior was then entered into the third step of the model. The alpha level was set a priori at 0.05 for all analyses.

Results

Response

Of the 198 respondents who completed the baseline survey, 153 (77.3%) also completed the survey at three-month follow-up. The main reasons for attrition include athletes not being at school on the day of data collection or no longer being a member of their school’s GAA team. The final analytic sample (N = 153) was composed of 102 female and 51 male high school GAA athletes, with a median age of 14.4 years old (range = 12-18). Of these 153 athletes, 101 (66.0%) experienced at least one symptom of concussion during the previous season while 75 (49.0%) experienced at least one symptom of concussion during the current season. Table 1 presents a breakdown of participants’ demographic characteristics and concussion reporting behaviors.

Descriptive statistics

Table 2 shows bivariate associations for the study variables. Participants generally had moderately safe/favorable attitudes towards concussion-reporting, perceived that their teammates wanted them to report concussion, perceived themselves to have the capabilities to report concussion (Table 3), and had moderate intentions to report concussion symptoms to a supervising adult (Table 4). As predicted by the TPB, we found moderate correlations between each of the predictor variables and reporting intentions, with attitudes (r = 0.21, P < 0.01), subjective norms (r = 0.31, P < 0.001), and PBC (r = 0.51, P < 0.001) showing significant correlations. PBC (r = 0.38, P < 0.01) and past reporting behaviors (r = 0.25, P < 0.05) were moderately correlated with in-season reporting behaviors, whereas baseline reporting intentions were not correlated with in-season reporting behaviors.

Predicting concussion reporting intentions

The models of hierarchical multiple linear regression (Table 5) show that, in step 1, age, sex, and history of concussion (lifetime) explained 6.0% of the variance in reporting intentions. The model was significant F(3,96) = 3.06, P < 0.05, with only age (β = -0.25, P < 0.05) emerging as a significant independent predictor of reporting intentions. When we entered PBC, subjective norms, and attitudes in the next step of the model these TPB-constructs accounted for an additional 22.0% of variance in the prediction of reporting intentions. This model was significant, F(6,93) = 7.52, P < 0.001, with history of medically diagnosed concussion (lifetime) and PBC significantly associated with reporting intentions (β = 0.21, P < 0.05; β = 0.50, P < 0.001, respectively).

In the next step of the model, knowledge was entered. This model was significant F(7,92) = 6.59, P < 0.001, with history of medically diagnosed concussion (lifetime) and PBC emerging as significant predictors of reporting intentions (β = 0.22, P < 0.05; β = 0.54, P < 0.001). In the final step of the model past reporting behavior was entered and accounted for an additional 2.0% of the variance in the prediction of reporting intentions, with history of medically diagnosed concussion (lifetime) and PBC emerging as significant independent predictors of reporting intentions (β = 0.20, P < 0.05; β = 0.51, P < 0.001). The final model accounted for 30.0% of the variance in reporting intentions, F(8,91) = 6.20, P < 0.001.

Predicting in-season concussion reporting behaviors

Of the 75 participants who reported at least one symptom of concussion this season, 64 (85.3%) also reported at least one symptom of concussion during the previous season. Of these 64 participants, 62.3% (40/64) indicated that they immediately reported their symptoms to a supervising adult. In step 1 of the sequential logistic regression analysis, we entered participant age, sex, and history of concussion into the model (Table 6). The model was not significant. Next, we entered PBC and reporting intentions into the model. The overall model was significant, χ² (5, N = 63) = 12.04, P = 0.034. PBC emerged as the only significant independent predictor of in-season...
concussion-reporting behaviors, with higher levels of PBC associated with an increased likelihood of participants disclosing symptoms of a suspected concussion to their coach or to medical personnel (OR = 1.14). When past behavior was entered in the third step the overall model was significant, $\chi^2 (6, N = 63) = 13.30, P = 0.038$. Again, PBC was the only significant predictor of in-season concussion-reporting behaviors (Exp (B) = 1.14, $P = 0.022$), with every one unit increase in PBC associated with 1.14 greater odds that athletes reported symptoms of concussion this season.

**Discussion**

Using a longitudinal study design, we explored the utility of the TPB in predicting and explaining concussion reporting intentions and in-season concussion reporting behaviors among high school GAA athletes. We found some evidence to suggest that PBC and reporting intentions can partially explain in-season concussion reporting behaviors. Our results showed that PBC is the strongest predictor of concussion reporting intentions and in-season reporting behaviors among this...
population of high school athletes; the stronger an athletes’ baseline PBC, the stronger their reporting intentions and the more likely they were to report concussion symptoms during the season. In addition, we found that reporting intentions were partially derived from athletes’ concussion-related attitudes, subjective norms, and PBC. Taken together, our findings suggest that the TPB may be a useful framework for predicting concussion reporting intentions and in-season reporting behaviors. These findings may have important implications for the development of concussion education and prevention programs for high school athletes. However, the results of this study should be interpreted cautiously given the small sample size.

Unlike previous research, we found that PBC was the strongest and most significant predictor of reporting

### Table 2. Bivariate associations and descriptive data for the constructs of the Theory of Planned Behavior and Concussion Reporting Behaviors.

| Variable          | Possible Range | M (SD) | 1  | 2  | 3  | 4  | 5  |
|-------------------|----------------|--------|----|----|----|----|----|
| 1. Attitude       | 8–56           | 39.24 (6.72) | –  | –  | –  | –  | –  |
| 2. Subjective norms | 10–70       | 53.56 (9.62) | 0.39*** | –  | –  | –  | –  |
| 3. PBC            | 5–35           | 22.48 (7.23) | 0.36*** | 0.31*** | –  | –  | –  |
| 4. Intention      | 8–56           | 41.44 (11.01) | 0.21*** | 0.31*** | 0.51*** | –  | –  |
| 5. Past behavior  | 0–1            | –       | 0.02 | 0.22*  | 0.13 | 0.22* | –  |
| 6. In-season behavior | 0–1       | –       | 0.21 | 0.23 | 0.38*** | 0.23 | 0.25* |

Note. Attitudes, subjective norms, PBC, intentions, and past behavior were assessed at baseline (T1). In-season behavior was assessed at three-month follow-up (T2). For past behavior, participants were included in the analyses if they experienced at least one of the eight listed concussion symptoms in the previous season (N = 101). For in-season behavior, participants were included in the analyses if they experienced at least one of the eight listed symptoms of concussion during both the previous and current seasons (N = 64). M = Mean; SD = Standard Deviation; PBC = Perceived behavioral control; *P < 0.05; **P < 0.01.

### Table 3. Perceived behavioral control over concussion reporting behavior among high school GAA athletes (N = 152).

| Perceived behavior control outcome item | Mean (SD) | Scores ≥6, % (n) |
|----------------------------------------|-----------|-----------------|
| 1. I am confident in my ability to recognize when I have symptoms of a concussion | 4.62 (1.74) | 39.7 (60) |
| 2. I am confident in my ability to report symptoms of a concussion, even when I think my teammates want me to play | 4.62 (1.84) | 39.1 (59) |
| 3. I am confident in my ability to report symptoms of a concussion, even when I really want to keep playing | 4.56 (1.76) | 37.1 (56) |
| 4. I am confident in my ability to report specific symptoms, even if I am not sure that it is actually a concussion | 4.50 (1.74) | 35.1 (53) |
| 5. I am confident in my ability to report symptoms of a concussion, even if I do not think they are all that bad | 4.19 (1.73) | 27.1 (41) |

Note. Data represent mean item scores (scales scored 1–7) and percentage of participants who scored 6 (agree) or 7 (strongly agree) with each statement; SD = Standard Deviation.

### Table 4. Concussion reporting intention among high school GAA athletes (N = 151).

| Reporting intention item                  | Mean (SD) | Scores ≥6, % (n) |
|-------------------------------------------|-----------|-----------------|
| 1. Vomit or nauseous                      | 5.66 (1.56) | 69.9 (107) |
| 2. Experience dizziness or balance problems | 5.39 (1.64) | 60.1 (92) |
| 3. Have a hard time remembering things    | 5.45 (1.60) | 60.1 (92) |
| 4. See stars                              | 5.29 (1.83) | 59.5 (91) |
| 5. Have problems concentrating on the task at hand | 5.07 (1.67) | 47.7 (73) |
| 6. Feel sensitive to light or noise       | 5.04 (1.77) | 51.0 (78) |
| 7. Feel sleepy or in a daze               | 4.93 (1.88) | 52.3 (80) |
| 8. Have a headache                        | 4.61 (1.87) | 39.9 (61) |

Note. Data represent mean item scores (scales scored 1–7) and percentage of participants who scored 6 (agree) or 7 (strongly agree) with each statement; SD = Standard Deviation.
intentions and in-season reporting behaviors. These findings suggest that reporting intentions and behaviors are strongly influenced by athletes’ perceptions about how easy or difficult it is to report concussion symptoms and their confidence in their ability to do so. One potential explanation for these findings is that PBC often reflects the resources and opportunities necessary to perform the behavior (e.g., information, skills, abilities), second-hand information about the behavior (e.g., experiences of teammates or other athletes), and anticipated barriers and obstacles to performing the behavior.17 There are many documented perceived barriers to concussion reporting among high school athletes, including not wanting to let their team down, desire to keep playing, or the belief that you’re supposed to play injured.9,12,13 It is possible that athletes who perceive fewer barriers to concussion reporting may have stronger PBC over concussion reporting, which, in turn, may lead to stronger reporting intentions and an increased likelihood of reporting concussion symptoms during the season. Further research is needed to confirm these results.

Although the findings must be interpreted cautiously because of the small sample size, our findings suggest that concussion education programs for high school athletes could benefit from incorporating approaches

Table 5. Predicting concussion reporting intentions: Hierarchical linear regression (N = 101).

| Step 1       | Model 1 | Model 2 | Model 3 | Model 4 |
|--------------|---------|---------|---------|---------|
|              | β       | P       | β       | P       | β       | P       | β       | P       |
| Age          | -0.25   | 0.012   | -0.13   | 0.158   | -0.13   | 0.164   | -0.13   | 0.155   |
| Sex          | -0.15   | 0.142   | -0.08   | 0.368   | -0.08   | 0.414   | -0.07   | 0.436   |
| History of concussion | 0.12   | 0.215   | 0.21    | 0.022   | 0.22    | 0.017   | 0.19    | 0.036   |
| Step 2       |         |         |         |         |         |         |         |         |
| Perceived behavioral control |       |         |          | 0.50    | P < 0.01 | 0.54    | P < 0.001 | 0.51    | P < 0.001 |
| Subjective norms |       |         |          | -0.02   | 0.875   | -0.05   | 0.654   | -0.07   | 0.504   |
| Attitudes    | -0.05   | 0.486   | 0.06    | 0.534   | 0.06    | 0.541   | 0.07    | 0.411   |
| Step 3       |         |         |         |         |         |         |         |         |
| Knowledge    |         |         |          | 0.09    | 0.323   | 0.08    | 0.410   |         |         |
| Step 4       |         |         |         |         |         |         |         |         |
| Past reporting behavior |       |         |          |        |         |        |         | 0.15    | 0.107   |
| R²           | 0.06    | 0.28    | 0.28    | 0.30    |         |         |         |         |

Note. Participants were included in the analyses if they experienced at least one of the eight listed concussion symptoms in the previous season. 'Past reporting behavior' was coded as follows 0 = non-report and 1 = report; thus, the interpretation is the predicted reporting intentions score would be 0.15 points higher for those who reported symptoms of concussion in the past as compared to those who did not report symptoms of concussion in the past.

Table 6. Predicting in-season concussion reporting behavior: Sequential logistic regression (N = 64).

| Step 1       | Model 1 | Model 2 | Model 3 |
|--------------|---------|---------|---------|
|              | Exp(B)  | P       | Exp(B)  | P       | Exp(B)  | P       |
| Age          | 0.88    | 0.514   | 1.04    | 0.864   | 1.05    | 0.829   |
| Sex          | 0.84    | 0.748   | 1.20    | 0.768   | 1.30    | 0.673   |
| History of concussion | 2.47   | 0.278   | 3.20    | 0.230   | 2.88    | 0.283   |
| Step 2       |         |         |         |         |         |         |
| PBC          |         |         |          | 1.14    | 0.016   | 1.14    | 0.022   |
| Reporting Intention |         |         |          | 1.01    | 0.751   | 1.01    | 0.866   |
| Step 3       |         |         |         |         |         |         |
| Past reporting behavior |       |         |          |        |         |        | 1.99    | 0.264   |
| R²           | 0.04    | 0.24    | 0.26    |         |         |         |         |

Note. Participants were included in the analyses if they experienced at least one of the eight listed symptoms of concussion during both the previous and current seasons (N = 64). For non-report, n = 24 (37.7%); for reporting, n = 40 (62.3%); PBC = Perceived Behavioral Control; Exp (B) represents the odds ratio, for example for every one unit increase in perceived behavioral control the odds that the athlete reported their concussion are 1.14 times larger.
to enhance athletes’ PBC over concussion reporting, especially approaches to increase athlete’s confidence in their ability to report concussion. Evidence shows that PBC can be enhanced through social and verbal persuasion, positive reinforcement, sharing of vicarious experiences, and modelling of behaviors. Such PBC enhancing approaches could be integrated into existing and future concussion education programs. For instance, future concussion education programs could incorporate parent-child and coach-led discussions on concussion safety and the importance of concussion reporting. Parent-child and coach-led discussions about concussion safety may help enhance athletes’ PBC over concussion reporting by reassuring athletes that they should report concussion and that there will be no consequences of reporting concussion (e.g., they will not lose their spot on the team), which, in turn may motivate high school athletes to report future concussion symptoms. Since PBC over concussion reporting is potentially modifiable, programs that focus on enhancing PBC may hold promise for improving concussion-reporting behaviors among high school athletes and may offer new and powerful ways to intervene and increase the reporting of concussion symptoms among this vulnerable population. Future research with a larger sample size, however, is needed to determine whether intervening to change PBC improves concussion reporting behaviors.

This study, unlike previous studies, suggests that in-season concussion reporting behavior may have little to do with the strength of reporting intentions. Possibly, athletes’ inability to enact their reporting intentions may result from various personal and environmental factors. For example, the decision to disclose concussion symptoms needs to be made quickly, during practices/games where there are inherent disincentives to reporting symptoms, including loss of playing time or fear of letting down their teammates, parents, and coaches. Therefore, although athletes may have control over concussion reporting, they may still choose not to disclose their symptoms to an appropriate adult due to competing motivations. Future research should explore the relationship between personal factors (i.e., competing motivations, perceived disincentives to reporting), the environmental, and reporting behaviors.

In addition, we found that baseline reporting intentions and PBC accounted for only 20% of the variance in in-season reporting behaviors. This finding suggests that other factors may contribute to an athlete’s decision to disclose concussion symptoms to an appropriate adult, including an athlete’s prior concussion history. Other factors that may influence reporting behavior include motivation, pressure to perform, and environmental constraints. Our findings, in line with others, suggest that the TPB can partially explain concussion reporting intentions and behaviors. However, we may not be able to use the TPB in isolation. Other models such as the Integrated Behavior Model, which incorporates components such as environmental constraints and the salience of the behavior, may be needed to further our understanding of concussion reporting intentions and behaviors among high school athletes. Our findings should be interpreted with caution given the small sample size and limitations of the measures used to assess the TPB constructs. Nonetheless, our findings may have important implications for the development of concussion education and prevention programs for high school athletes by highlighting the need for multi-level interventions that not only aim to enhance concussion reporting relevant cognitions but that also aim to create environments that support and encourage concussion reporting.

Limitations

The findings of this study should be interpreted in light of a number of limitations. First, the present study was limited by the features of the participants. Specifically, the sample was relatively small, overrepresented females, and only included athletes who competed in one geographic region; thus, results may not be generalizable to the GAA population or to other sporting populations and should be interpreted with caution. Another limitation of this study was the high attrition rate, which limits the generalizability of our findings. Third, the data were exclusively from self-reported measures collected from athletes. Therefore, although the items employed in this study have been extensively piloted and tested, it is important to acknowledge that there will inevitably be error within these data and that measurement and response bias may have affected results. The findings would have been strengthened by more objective behavioral measures such as direct observation of participant’s reporting behaviors. An additional limitation of this study was that the ‘past behavior’ and ‘in-season behavior’ consisted of a single-item. Using a single-item variable to measure a construct may lead to greater measurement error than a variable informed by multiple items, and should be acknowledged as a limitation of the study presented here. The Cronbach’s alpha was also low for the Concussion Attitudes Index. This could be due to a low number of items/questions, poor interrelatedness between items, and/or heterogeneous constructs. Future research should examine predictors of reporting intentions and voluntary removal from play among other contact and collision sports.
Conclusion

Most concussion education programs to date have focused on increasing athletes’ concussion-related knowledge and changing their attitudes towards the perceived consequences of concussion reporting.38 The main findings of this study, however, found that PBC was the strongest predictor of concussion reporting intentions and behaviors. Our findings suggest that concussion education programs for high school athletes may benefit from incorporating strategies such as verbal persuasion and modeling to enhance athletes’ PBC over concussion reporting, which, in turn may increase their concussion reporting intentions and behaviors. Though the results of this investigation support the effectiveness of TPB as a theoretical framework for predicting and understanding concussion-reporting intentions and behaviors, a large percentage of the variance was left unexplained by the TPB model. These findings suggest that other factors may influence concussion reporting behaviors; thus, future research is needed to explore determinants of concussion-reporting behaviors among high school athletes in various sporting populations. We therefore call for multi-level, theory-based interventions that address both the personal and environmental factors associated with the underreporting of concussion among adolescent athletes. Health promotion communication campaigns should also be utilized to help create sporting environments that encourage the disclosure of concussion. Our conclusions accurately reflect the findings reported, but should be interpreted cautiously, given the identified limitations of the study.

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Supplemental material

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