










BMJ Open Development of a tailored concussion education program for athletes: a pragmatic multimethods design and integrated knowledge translation approach from needs assessment to design

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ABSTRACT

Objectives To understand Canadian university athletic programme concussion management needs, and to describe development and content of a tailored online concussion education tool for Canadian university/college athletes.

Design An integrated knowledge translation multiphased, multimethods approach was used. Phases included a needs assessment survey with university representatives and athletes, content selection, mapping behavioural goals to evidenced-based behaviour change techniques, script/storyboard development, engagement interviews with university athletes and tool development using user-centred design techniques.

Setting Canadian U SPORTS universities (n=56).

Participants Overall, 64 university representatives (eg, administrators, clinicians) and 27 varsity athletes (52% male, 48% female) completed the needs assessment survey. Five athletes participated in engagement interviews.

Outcome measures Surveys assessed previous athlete concussion education, recommendations for concussion topics and tool design, concussion management challenges and interest in implementing a new course.

Results Institutions used a median (Med) of two (range 1–5) approaches when educating athletes about concussion. Common approaches were classroom-style education (50%), online training (41%) and informational handouts (39%). University representatives rated most important topics as: (1) what is a concussion, (2) how to recognise a concussion and (3) how to report a concussion (Med_{all}=4.8/5). Athletes felt symptom recognition (96%) and effects on the brain (85%) were most important. The majority of athletes preferred learning via computer (81%) and preferred to learn alone (48%) versus group learning (7%). The final resource was designed to influence four behaviours: (1) report symptoms, (2) seek care, (3) encourage teammates to report symptoms and (4) support teammates through concussion recovery. Examples of behaviour change techniques included: knowledge/

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This project involved a multimethod pragmatic study design and tool development emerging from a partnership between researchers and the U SPORTS medical committee, the project was driven by stakeholder needs (athletic directors, certified athletic therapists, physiotherapists and athletes).
- ⇒ Tool development was informed by knowledge translation and behaviour change principles.
- ⇒ Both needs assessment surveys were based on small convenience samples, which may limit the generalisability of the findings.
- ⇒ Athlete recruitment coincided with the beginning of the COVID-19 pandemic, thus limiting access to athletes.

skills, problem-solving scenarios, verbal persuasion and social comparison. Athletes are guided through different interactions (eg, videos, flip cards, scenarios, testimonials) to maximise engagement (material review takes ~30 min). **Conclusions** The Concussion Awareness Training Tool for athletes is the first Canadian education tool designed to address the needs of Canadian university/college athletes.

INTRODUCTION

Sport-related concussion (SRC) is a traumatic brain injury caused by biomechanical forces transmitted to the head, resulting in a range of clinical signs and symptoms that may present immediately, or evolve over minutes or hours.¹ Approximately, 1 in 10 Canadian university varsity athletes will sustain a concussion during sport.² Given that annual participation is approximately 14 000 Canadian U SPORTS athletes and 500 000 National Collegiate Athletics Association athletes

annually, reducing potential secondary risks associated with mismanaged SRC remains a high priority.^{3 4}

Factors such as cultural attitudes around injury, sport rules, institutional SRC management practices, coaching behaviours and athlete concussion safety behaviours all influence effective SRC management.^{5–7} As many concussion symptoms are not evident to observers, self-reporting potential concussion symptoms is a vital athlete safety behaviour.^{8 9} Unfortunately, an estimated 30%–70% of concussions go unreported or undetected, resulting in continued play and potentially worse outcomes.^{10–15} Teammates can play a role in reinforcing appropriate concussion management behaviour. Specifically, athletes who believe there are negative health or performance consequences associated with playing with a concussion are more likely to intend to encourage a teammate to seek help.¹⁶

Education is a proposed strategy to address under-reporting and improve concussion management among athletes.^{1 17 18} While increasing knowledge is important, changing attitudes and beliefs, including perceived outcomes, perceived norms and self-efficacy, play a key role in changing athlete behaviours.¹⁹ Behavioural and social science theories, models and frameworks help target behaviour change among athletes.^{19–21} While education has the potential to improve behaviours by influencing safety-related cognitions, inconsistent efficacy of available concussion education programmes points to the need for more evidence-based and theory-based programme development.^{7 8 22–27} Principles of knowledge translation like identification of core messages, tailoring messages to the target audience and considerations of delivery method should be considered during concussion education design to improve uptake.^{28–30}

Concussion legislation has been passed nationwide in the USA, mandating concussion education. However, at the time of writing this article, only one province in Canada has enacted such legislation. Furthermore, although the National Guidelines on Concussion in Sport in Canada recommend annual concussion education, free standardised educational resources targeted to Canadian athletes were lacking at the onset of this study. The existing Concussion Awareness Training Tool (CATT) provided parents/guardians and coaches with eLearning modules on concussion identification and management, and relevant video links and resources for athletes; however, there was no eLearning module specifically for athletes. In 2019, U SPORTS, the national governing body of university sport in Canada, partnered with the creators of CATT to develop a concussion education course specifically for university and college athletes, incorporating best practices for knowledge translation and behaviour change approaches. Understanding the implementation context was a key component to assisting with the development. Therefore, the aims of this study were to understand context and Canadian university athletic programme concussion management needs, and describe the development of CATT for athletes, including: stakeholder

needs assessment surveys, educational content selection, behaviour change strategies assessments and appropriate engagement approaches.

METHODS

An integrated knowledge translation multiphased approach was used to develop the CATT for athletes. Phases included cross-sectional needs assessment surveys and engagement interviews with university representatives and athletes, content selection, mapping core behavioural goals to evidenced-based behaviour change techniques, script/storyboard development and final tool development. All survey and interview participants provided consent prior to participating.

University representative perspective: needs assessment survey

Athletic directors and therapists play a key role in deciding which concussion education resources to share with their athletes. Accordingly, we used an inclusive sampling strategy and recruited university representatives (ie, head athletic therapists, physiotherapists, sports medicine physicians and athletic directors) to complete a needs assessment survey via emails sent to all 56 U SPORTS institutions across Canada. Institutions were instructed to forward the survey to individuals responsible for providing concussion education, and received up to three reminders to complete the survey. Surveys were collected between April and May 2020 through REDCap, a secure online survey platform.^{31 32} Participants could remain anonymous when they completed the survey.

The needs assessment survey was designed and face validated by the research team and was comprised of questions pertaining to: (1) methods institutions currently use for athlete education; (2) perceived importance (rated on a 5-point Likert scale from 1, not important, to 5, very important) of 25 selected concussion topics based on other peer reviewed education tools; (3) open-ended questions about challenges faced when working with athletes recovering from concussions, special requests regarding how they would use an online educational tool to shape design and suggestions for providing concussion training to varsity athletes; (4) interest in implementing the new course once launched; and, (5) demographic questions (eg, role, gender, years of experience). Quantitative data were analysed descriptively using frequencies and proportions. Open-ended responses were read two times by the researcher (AF) to familiarise themselves with the responses, which were then organised into three key topics: (1) challenges to recovery, (2) suggestions for the tool/training and (3) additional topics the tool/training should cover. Inductive content analysis was performed to identify and count arising themes within the respective categories using NVivo software.³³ Coding structures and theme counts were discussed by the research team. Themes and theme counts were verified independently with another researcher (PC) to improve rigour. Conflicts

were resolved using consensus and consultation with the lead author (AMB), and coding structure was revised in two rounds. An audit trail of all coding steps was maintained to ensure credibility and report agreement.³⁴ The analysis process and themes were presented to the research team for final approval.

Athletes' perspective: needs assessment survey and engagement interviews

A convenience sample of athletes was recruited from one university to complete the athlete needs assessment survey. A recruitment email with a survey link was sent out to selected athletes via the athletics department. Surveys were completed between February and March 2020. The survey gathered information concerning: sports the athlete engages in and their main sport; opinions on concussion as an issue for their main sport, the importance of understanding concussion recognition, the importance of reporting and barriers to reporting; what they want to know about reporting and about concussion overall; preferences for accessing online learning (ie, phone, tablet, laptop), individual versus group learning and means of receiving information (eg, videos, animations, person talking directly to the camera); opinions on credible people for delivering information (eg, health-care professionals, researchers, coaches) and information that resonates (ie, facts, personal stories, scenarios); and basic demographic information (Surveys available in online supplemental file 1). Quantitative data were analysed descriptively using frequencies and proportions. Open-ended questions were summarised.

Engagement interviews were conducted with a user-focused design to assist with informing both the content and format of the CATT for athletes tool. Prior to the interview, participants were sent a draft course outline, a breakdown of detailed content and a sample course with a number of interactions for them to explore. Participants were asked to provide feedback on these items during the interviews. Engagement interviews were conducted by members of the research team, audio recorded and a notetaker was present. Participants were asked questions related to concussion topics covered in the course, such as: 'Do you know how to report a concussion?' and 'As an athlete, what information do you think is most important to know about concussion?'. Athletes were also asked questions related to the course overall, including: 'Do the course questions/objectives incorporate the main questions that you may have about concussions?' and 'Does the course content for the section *What is a concussion?* incorporate the main questions that university athletes may have about concussions?'. Lastly, participants were asked about specific course elements such as: (1) whether they liked certain interfaces; (2) if the interfaces conveyed content effectively; (3) whether the interfaces were easy to use; (4) how content should be displayed so that it resonated with the participants; and (5) who they trust for sport injury information (Interview guide available in online supplemental file 2).

Content selection

Content selection was based on existing concussion education programmes, peer-reviewed journal articles, the Consensus Statement on Concussion in Sport,¹⁷ and findings from the university representatives' and athletes' needs assessment surveys and interviews.

Mapping core behaviour goals to evidenced-based behaviour change techniques

The Behaviour Change Techniques Theory and Technique Tool was used to identify behaviour techniques associated with mechanisms of action identified within specific domains of the Theoretical Domains Framework.³⁵ This framework synthesises constructs from 33 behaviour change theories into 14 domains,³⁶ and is a comprehensive, systematic approach to identify predictors of behaviour. This framework can assist with informing the development and evaluation of health-related behaviour change interventions.^{36 37} Four core behaviours were targeted based on studies on concussion management: (1) report symptoms; (2) seek care; (3) encourage teammates to report symptoms; and (4) support teammates through their concussion recovery.

Script/storyboard development, engagement interviews with athletes, final tool development

In addition to the needs assessment surveys and engagement interviews, the CATT for athletes script was developed using evidence-based materials^{17 38-40} and existing CATT eLearning modules. Findings from academic journals and peer-reviewed resources noted the following topics as relevant for a university/ college athlete audience: (1) concussion symptoms and recovery; (2) academic considerations; (3) cognitive rest; (4) student-athlete concerns regarding concussion; (5) networks of support; (6) factors that cause injury; (7) reasons for not reporting or seeking medical attention; (8) athlete mental health following concussion; and (9) the role of the coach.^{39 41-50} The CATT for athletes course outline, script and storyboard went through 32 iterations by the CATT team and concussion experts, with a final draft completed in May 2020.

Patient and public involvement

An integrated knowledge translation approach was used to develop, disseminate and evaluate CATT for athletes. The research and educational tool presented was initiated based on a partnership between researchers, the developers of the CATT and the U SPORTS medical committee. U SPORTS, the Canadian Academy of Sport and Exercise Medicine, the Canadian Athletic Therapy Association, Ontario Athletic Therapy Association and the Atlantic Provinces Athletic Therapists' Association acted as knowledge brokers in contributing to the design, recruitment and dissemination. University administrators, sports medicine doctors, certified athletic therapists, physiotherapists and athletes at U SPORTS universities

also informed the design of the tool and the implementation at the majority of the 56 U SPORTS institutions.

RESULTS

Needs assessment survey: athletic directors and therapists

In total, 64 university representatives completed the needs assessment survey (72% athletic therapists/physiotherapists, 14% programme administrators, 11% physicians and 3% unknown role; 50% identified as male, 50% female). Overall, 64% of participants had one or more years of experience in their field of work, 21% had 6–10 years of experience, 13% had 2–5 years of experience, 2% less than 2 years and 1 participant did not specify. Overall, 92% answered at least one open-ended question. After 2 rounds of coding, 2 independent reviewers reached 94% agreement on coded subcategories. Remaining conflicts were resolved by the lead author.

Understanding institutional context and the challenges when working with athletes recovering from concussion

Institutions used a median (Med) of two (range 1–5) approaches when educating athletes about concussion. Common approaches were: classroom-style education (50.0%), online training (40.6%), informational handouts (39.1%), university-specific sports medicine concussion training/materials (34.4%) and one-on-one education (32.8%). A few institutions used other forms (9.4%) or did not provide concussion education (4.7%). Examples of online education used included Ontario Government post-Rowan's law online material (Rowan's Law *Hit Stop Sit*), Sport Risk Online training, Dr. Evan's *Concussion 101* video and *USA Soccer: Recognize to Recover and the Concussion Wise* online learning platform.

Overall, 90% of respondents reported challenges when working with athletes recovering from concussion. Key themes related to these challenges are described in [table 1](#) (sample quotations available in online supplemental file 3). Mental health was identified as the greatest challenge to recovery (n=21), including pre-existing conditions, which can mask or worsen symptoms of concussion, postconcussive mental health problems, and anxieties surrounding concussion and return to play/return to learn. Academic conflicts (n=20) such as conflict with professors or academic pressure, athlete dishonesty regarding symptoms (n=20) and athlete buy-in and adherence to recovery protocols (n=18) followed.

Topic rating and requests by university representatives

University representatives rated: (1) how to report concussion, (2) what is a concussion and (3) how to recognise a concussion, as the most important topics for their athletes (Med_{all}=4.8/5). The perceived level of importance for specific concussion education topics is described in [table 2](#).

The most requested additional topics included considerations for recovery (n=20) such as nutrition and exercise, importance of response and reporting (n=11) and

Table 1 Challenges to recovery: university representative survey (n=64)

Description of challenge	n (%)
Mental health	21 (32.8%)
Mental health (general)	10
Mental health (injury or recovery related)	3
Mental health (pre-existing)	3
Anxiety about RTL	2
Anxiety about RTP	2
Anxiety around concussions	1
Academic conflicts	20 (31.3%)
Pressure and lack of support	5
Return to learn (general)	5
School-sport conflict	4
Communication with professors	3
Suspicion of using concussion to get out of school commitments	2
Professors not understanding injury and recovery	1
Athlete dishonesty and issues with disclosure	20 (31.3%)
Athlete dishonesty regarding symptoms and recovery	16
Athletes reporting symptoms late	3
Athletes lying to get out of sport	1
Athlete buy-in and adherence	18 (28.1%)
Athlete adherence to recovery protocol	9
Athlete buy-in to recovery protocol	3
Athlete not patient, wanting to expedite recovery	3
Athlete not following up	1
Nutrition affecting recovery	1
Visiting athletes not trusting medical staff	1
Length and complexity of recovery	17 (26.6%)
Long term cases, prolonged symptoms	7
Non-linear and individual recovery	4
Multiple concussions, not being cleared to play anymore	3
Complex symptoms, recovery	2
Postconcussive syndrome	1
Coach factors	16 (25.0%)
Pressure from coaches	5
Coaches' lack of understanding of injury and recovery	5
Coaches challenging decisions	2
Coach desire to expedite recovery	1
Coaches not referring to athletes	1
Lack of support from coaches	1
Visiting coaches not trusting medical staff	1
Clinician-related factors	11 (17.2%)

Continued

Table 1 Continued

Description of challenge	n (%)
Ability to monitor recovery and lifestyle habits	3
Interclinician differences in management leading to confusion	2
Limited access to resources and specialists	2
Managing expectations around RTP/RTL dates	1
Non-CASEM physicians clearing athletes with symptoms	1
Not enough staff	1
Recognition	1
Athlete understanding of injury and recovery	10 (15.6%)
Athlete not understanding importance of recovery protocol	6
Athlete not understanding injury and consequences	4
Other external pressures	9 (14.1%)
Lack of support or exclusion from teammates and friends	2
Other pressures to RTP	2
Parental influence	2
Peer and community influence	1
Poor stigma surrounding concussions	1
Financial pressure	1

CASEM, Canadian Academy of Sport and Exercise Medicine; RTL, Return to Learn; RTP, Return to Play.

prevention strategies (n=11) such as equipment use and technique. See online supplemental file 4 for full list of additional recommended topics.

Tool suggestions and intention to use

Suggestions for a concussion tool included characteristics such as conciseness (n=20), clarity (n=8) and engaging/impactful (n=8). Participants requested methods for ensuring completion (n=20) such as virtual confirmation (n=11), quizzes or questions (n=4) and suggestions for the format of the tool (n=17) such as videos (n=5). See online supplemental table 5 for full list of suggestions. In total, 17 (27%) respondents reported plans to make the tool optional for their athletes, 42 (66%) mandatory and 5 (8%) were unsure.

Needs assessment survey and engagement interviews: athletes

In total, 27 varsity athletes (age range 17–23 years; 52% identified as male, 48% female; 89% playing their sport >11 years) completed the needs assessment survey. Their primary sports were football (37%), rugby (15%), ice hockey (11%), rowing (11%), soccer (7%), baseball (7%), swimming (4%), field hockey (4%) and track and field (4%). Overall, 78% of respondents agreed

concussion is an issue for their sport. Overall, 96% agreed it is important to tell someone if you think you have a concussion. All athletes reported they think it is important for university athletes to know how to recognise a concussion. Athletes indicated that the most important concussion topics were: (1) symptom recognition in self or others (96%); (2) how the brain is affected (85%); (3) concussion outcomes (59%); and (4) where to seek support (59%). The topics athletes indicated were important to include in the tool are summarised in [table 3](#).

Athletes preferred computer learning (81%), and more preferred to learn alone (48%) versus group learning (7%). Common preferences for presentation of material included: video based with text on screen (70%), voiceover with images/videos (59%), interactive content (59%) and animations (52%).

During the engagement interviews, athlete-participants (n=5) explained the importance of highlighting that concussion is a serious, invisible injury that can have lasting effects. They suggested providing information on: recognising signs and symptoms of concussion (n=1); the importance of rest (n=2); and consequences of concussion (n=4). Two participants explained that scenarios outlining how to identify situations in which a teammate may have suffered a concussion would be valuable. The respondents requested guidance on reporting a concussion, managing stigma around reporting and barriers to reporting (eg, time away from sport and team, acceptance of injury, lack of understanding from coaches and/or teammates). All athlete-participants requested the module be accessible at their convenience, and to include: (1) scenario-based learning; (2) engaging content; (3) personal stories; (4) videos; and (5) interactive elements. They also provided feedback on various interfaces and course elements by identifying the ones they liked (eg, videos, flip cards, card sorting) and which they felt could be improved (eg, process slides).

Course content, behaviour change strategies, final tool

The final resource included content on: (1) what is a concussion? (2) do I have a concussion? (3) why is reporting important? (4) how can a concussion affect my life? (5) how do I get back to normal? and (6) how can I cope with concussion? (see [table 4](#) for detailed learning objectives and which source recommended the inclusion).

The resource was designed to influence four behaviours: (1) report symptoms, (2) seek care, (3) encourage teammates to report symptoms and (4) support teammates through their concussion recovery. Examples of behaviour change techniques included: information to address knowledge/skills; problem-solving scenarios; verbal persuasion; and social comparison (see [table 5](#) for examples of behaviour techniques used, mechanism of action and sample approaches).

Athletes are guided through different interface types (eg, videos, flip cards, scenarios, testimonials) to maximise engagement and required to complete each interface in

**Table 2** Perceived level of importance for specific concussion education topics: university representative survey (n=64)

Topic	Level of importance n (%)						Proportion rated 4 or 5
	1—not important	2	3	4	5—very important	Missing	
How to report a concussion	(0.0%)	(0.0%)	(0.0%)	11 (3.8%)	53 (18.9%)	(0.0%)	64 (100.0%)
What is a concussion	(0.0%)	(0.0%)	1 (0.4%)	7 (2.4%)	56 (19.9%)	(0.0%)	63 (98.4%)
How to recognise a concussion: signs and symptoms	(0.0%)	(0.0%)	(0.0%)	3 (1.0%)	60 (20.9%)	1 (0.4%)	63 (98.4%)
How to respond to a concussion	(0.0%)	(0.0%)	1 (0.4%)	10 (3.5%)	53 (19.0%)	(0.0%)	63 (98.4%)
Seeking support for mental health challenges	(0.0%)	1 (0.8%)	(0.0%)	16 (5.5%)	47 (17.3%)	(0.0%)	63 (98.4%)
Seeking support for persistent concussion symptoms	(0.0%)	1 (0.8%)	1 (0.4%)	20 (7.0%)	42 (15.9%)	(0.0%)	62 (96.9%)
Red flags for serious brain injury requiring emergency medical care	(0.0%)	2 (1.6%)	1 (0.5%)	11 (3.9%)	50 (18.5%)	(0.0%)	61 (95.3%)
Returning to school	(0.0%)	1 (0.8%)	2 (0.9%)	9 (3.2%)	52 (19.1%)	(0.0%)	61 (95.3%)
When to seek help during concussion recovery	(0.0%)	(0.0%)	3 (1.3%)	11 (3.9%)	50 (18.5%)	(0.0%)	61 (95.3%)
Medical clearance	(0.0%)	2 (1.6%)	1 (0.5%)	14 (5.0%)	47 (17.6%)	(0.0%)	61 (95.3%)
Long-term consequences of concussion	(0.0%)	1 (0.8%)	3 (1.4%)	17 (6.1%)	43 (16.5%)	(0.0%)	60 (93.8%)
Returning to sport	(0.0%)	1 (0.8%)	3 (1.4%)	9 (3.2%)	51 (19.0%)	(0.0%)	60 (93.8%)
Managing social life, partying, substance use during concussion recovery	(0.0%)	(0.0%)	5 (2.3%)	24 (8.8%)	35 (14.0%)	(0.0%)	59 (92.2%)
Stresses and fears (time away from training) during concussion recovery	(0.0%)	1 (0.8%)	4 (1.8%)	28 (10.2%)	31 (12.6%)	(0.0%)	59 (92.2%)
Accommodations for dealing with concussion symptoms	1 (1.6%)	2 (1.6%)	3 (1.4%)	27 (10.0%)	31 (12.7%)	(0.0%)	58 (90.6%)
Mental health challenges during concussion recovery	(0.0%)	(0.0%)	6 (2.7%)	16 (5.9%)	42 (16.5%)	(0.0%)	58 (90.6%)
How to support a teammate with concussion	(0.0%)	(0.0%)	7 (3.2%)	21 (7.9%)	36 (14.6%)	(0.0%)	57 (89.1%)
Importance of rest during concussion recovery	1 (1.6%)	(0.0%)	8 (3.8%)	22 (8.5%)	33 (13.9%)	(0.0%)	55 (85.9%)

Continued

Table 2 Continued

Topic	Level of importance n (%)						Proportion rated 4 or 5
	1—not important	2	3	4	5—very important	Missing	
Managing screen time during concussion recovery	(0.0%)	1 (0.8%)	8 (3.8%)	21 (8.1%)	34 (14.2%)	(0.0%)	55 (85.9%)
How common concussion is	(0.0%)	(0.0%)	10 (4.7%)	25 (9.8%)	28 (12.2%)	1 (0.5%)	53 (82.8%)
Typical recovery time from concussion	(0.0%)	3 (2.3%)	8 (3.8%)	22 (8.7%)	31 (13.4%)	(0.0%)	53 (82.8%)
Low energy levels during concussion	(0.0%)	2 (1.6%)	14 (7.0%)	31 (13.2%)	17 (8.3%)	(0.0%)	48 (75.0%)
Returning to work	(0.0%)	6 (4.7%)	12 (6.2%)	24 (10.5%)	22 (10.8%)	(0.0%)	46 (71.9%)
Baseline testing	3 (4.7%)	8 (6.4%)	12 (6.6%)	25 (11.9%)	16 (8.6%)	(0.0%)	41 (64.1%)
Athletic scholarships during concussion recovery	5 (7.8%)	10 (8.1%)	19 (11.9%)	21 (12.3%)	9 (6.0%)	(0.0%)	30 (46.9%)

order to move to the next session. Visit <https://cattonline.com/athlete/> for access to the 30-minute tool.

DISCUSSION

Concussion education has the potential to improve management behaviours and reduce negative consequences associated with concussion. Developing evidence-based, theoretically-driven content tailored for a specific audience is an important step towards this goal. The aim of this study was to describe the development of the CATT for athletes, an eLearning module created to provide university/college athletes with concussion education. Both athletes and university representatives provided input into its creation to ensure relevant and valuable content for the target audience. Findings are reported from needs assessment surveys with stakeholders; the process of selecting educational content, strategies and engagement approaches; and the primary components of the final tool are summarised.

The suggestions made by university representatives align with key topics essential for addressing concussion education within the college and university context, as documented in the existing literature. This underscores the importance of incorporating these topics into concussion education initiatives. For example, Kroshus and Baugh⁵¹ investigated concussion education provided to US collegiate athletes. Athletes indicated content should include information on concussion symptoms, managing a concussion, long-term consequences of concussion, impact on athletic and/or academic performance and importance of reporting symptoms.⁵¹ Interestingly, most athletes also wanted to learn about athletic consequences of continued play with a concussion.⁵¹ Furthermore, support for these findings emerged from a consensus process from the NCAA Department of Defense Mind

Matters Research & Education Grand Challenge.⁷ This process involved academic researchers, policy-makers, programme developers and stakeholders such as coaches and athletes. They collectively identified critical educational components, including: (1) addressing the dilemma of disclosure, (2) highlighting the short-term benefits of early symptom reporting, (3) elucidating possible long-term effects, (4) correcting misconceptions about concussions and (5) outlining the steps to take if an athlete suspects a concussion.⁷

In studies investigating concussion knowledge, it has been observed that emotional symptoms, such as depression and anxiety, are less commonly recognised.⁵² Interestingly, our results also highlighted mental health challenges in concussion management. In response to this, the CATT for athletes includes information about the emotional response to concussion into two specific sections of our material, namely ‘What challenges am I facing’ and ‘How can I support a teammate’. Within these sections, we provided explicit guidance and advice, aiming to address the link between mental health, and concussions. By doing so, we aimed to empower athletes with knowledge and strategies that promote not only better self-care but also encourage support of teammates recovering from concussion.

In the current study, both athletes and university representatives identified the need for support and information related to reporting a concussion. Common reasons for lack of intention to report or not reporting concussion included athletes not thinking concussion is a serious injury, not wanting to lose playing time, not being aware that they had a concussion and not wanting to let their team down.^{53,54} Fear has also been described as a common reason for under-reporting or misreporting concussion symptoms, as players do not want to disappoint their

**Table 3** Key suggestions from athletes: athlete survey (n=27)

Topic	n (%)					
Preferences for concussion knowledge content						
How to recognise symptoms in self or others	26 (96.3%)					
How the brain is affected	23 (85.2%)					
Concussion outcomes	16 (59.3%)					
Where to seek support	16 (59.3%)					
Where to seek medical care	10 (37.0%)					
Who to tell	9 (33.3%)					
Reporting on concussion (qualitative data)						
What do you want to know about in terms of how to report a concussion? What do you want to know about concussion?						
▶ How to recognise signs and symptoms; which signs to look for/report?						
▶ How to quickly diagnose symptoms severity?						
▶ Who to report symptoms to?						
▶ That the process for a suspected concussion may not be as arduous as the process for a diagnosed concussion?						
▶ That the person will not be penalised for reporting?						
▶ How to report without being a snitch?						
▶ Is there a limit to how many concussions you can get before you should stop playing your sport?						
▶ Where to seek treatment for postconcussion symptoms?						
▶ What are the long-term impacts and when to expect to see them?						
Preferences for content presentation						
Video-based content with text on screen	19 (70.4%)					
Voiceover with images/video	16 (59.3%)					
Interactive	16 (59.3%)					
Animations	14 (51.9%)					
Diagrams and flowcharts	11 (40.7%)					
Text based	8 (29.6%)					
Video without text on screen	1 (3.7%)					
Person taking directly to camera	1 (3.7%)					
Preferences for device access						
Laptop/desktop	22 (81.5%)					
Mobile phone	4 (14.8%)					
Tablet/iPad	1 (3.7%)					
	Level of trust/resonance					
	n (%)					
Topic	1 – not trusted	2	3	4	5 – most trusted	Proportion rated 4 or 5
Who do you trust as a credible source for sport injury information?						
Healthcare professionals	(0.0%)	(0.0%)	(0.0%)	(0.0%)	27 (100%)	27 (100%)
Strength and conditioning coach	(0.0%)	(0.0%)	1 (3.7%)	15 (55.6%)	11 (40.7%)	26 (96.3%)
Researchers	(0.0%)	(0.0%)	7 (25.9%)	12 (44.4%)	8 (29.6%)	20 (74.1%)
Coaches	4 (14.8%)	3 (11.1%)	9 (33.3%)	9 (33.3%)	2 (7.4%)	11 (40.7%)
Athletes who play my sport	2 (7.4%)	6 (22.2%)	10 (37.0%)	8 (29.6%)	1 (3.7%)	9 (33.3%)
Athletes	2 (7.4%)	9 (33.3%)	13 (48.1)	3 (11.1%)	(0.0%)	3 (11.1%)
People like me/peers	5 (18.5%)	8 (29.6%)	12 (44.4%)	2 (7.4%)	(0.0%)	2 (7.4%)
	1 – resonates the least	2	3	4	5 – resonates the most	Proportion rated 4 or 5

Continued

Table 3 Continued

Topic	Level of trust/resonance n (%)					Proportion rated 4 or 5
	1 – not trusted	2	3	4	5 – most trusted	
What resonates with you?						
Just the facts	(0.0%)	1 (3.7%)	10 (37.0%)	8 (29.6%)	8 (29.6%)	16 (59.3%)
Scenario-based learning (responding to hypothetical situations)	1 (3.7%)	4 (14.8%)	6 (22.2%)	12 (44.4%)	4 (14.8%)	16 (59.3%)
Personal stories and experiences	1 (3.7%)	3 (11.1%)	8 (29.6%)	8 (29.6%)	7 (25.9%)	15 (55.6%)

teammates or jeopardise their reputation.⁵⁵ In a comprehensive review of concussion and mental health outcomes among elite athletes, associations were apparent between concussion and depression symptoms, as well as longer-term effects of depression symptoms.⁴⁹ Evidence is less consistent regarding anxiety symptoms and other mental health outcomes such as mood disturbance, alcohol use and sleep disturbance.⁴⁹ Overall, it is evident there is an association between mental health, particularly depression and concussion,⁴⁹ supporting the inclusion of mental health management and monitoring in concussion education for athletes and their support networks (eg, athletic therapists, healthcare providers, parents or guardians).

Concussion can also have a negative impact on academic performance. Specifically, concussion symptoms such as headache, difficulty concentrating, sensitivity to light and feeling slowed down have been cited as significant barriers athletes face in academic settings.⁵⁶ In addition to classes, varsity athletes face pressures, such as participation in study halls, team meetings and student organisations, which can affect scholarships, athletic eligibility and/or postgraduation ambitions.⁵⁷ Pressure to meet these obligations may prolong concussion recovery, resulting in long-term consequences.⁵⁷ Sleep disturbances, concussion symptoms and quality of life dysfunctions (eg, fatigue, ability to maintain previous workload, coping with family demands) have been noted in collegiate athletes with a concussion history.⁵⁸ These persistent outcomes can have a significant impact on return-to-play and return-to-learn protocols.⁵⁸ To prevent academic setbacks and prolonged recovery, researchers recommend providing guidelines and accommodations to support students with concussion in academic settings and education for educators and administrators.⁵⁷

The new CATT for athletes provides athletes with information on recognising concussion and concussion symptoms, impact on daily life (including academics, social life and coping strategies), recovery, importance of reporting a concussion and managing mental health symptoms. As the majority of athletes in this study preferred independent learning via computer, athletes are guided through different interfaces (eg, videos, flip

cards, scenarios, testimonials) to maximise engagement in the course. While roughly 50% of university representatives had previously employed group concussion education, the CATT for athletes programme adopts a self-paced learning approach based on participant feedback. Although concussion laws exist in only one of Canada's provinces, universities and colleges are encouraged to make concussion education mandatory for their athletes. The CATT for athletes facilitates this objective by offering a method for tracking course completions. Mandating concussion education may reflect an institution's commitment to athlete health, thereby creating a safer sport environment.

Many concussion education evaluations have examined change in concussion knowledge as a primary outcome.⁵⁹ However, in more recent literature, emphasis has been placed on the need for psychosocial, theory-driven evaluation measuring behavioural outcomes and psychosocial predictors of reporting (eg, perceived reporting norms and intention to report symptoms).²⁵ It has also been recommended that concussion education programmes target long-term knowledge, attitudes and behaviours.⁶⁰ In a study evaluating whether preseason concussion knowledge and reporting intention predicted in-season reporting behaviour, knowledge was not significantly associated with reporting, intent to report was significantly associated with reporting, and athletes were more likely to report a concussion as additional symptoms were experienced.⁶¹ While health education is important, education alone is insufficient in producing behaviour change.⁶² Specifically, presenting information may increase knowledge about concussion; however, it does not produce long-term changes in behaviour among athletes.⁵⁹ Moreover, informing and educating athletes about concussions may decrease their willingness to report symptoms and thus they may avoid disclosing them, given that it would prevent them from participating in their sport.⁵⁹ Therefore, concussion interventions and education initiatives should address psychosocial barriers, involve multiple stakeholders, and be evidence-based and strategic.⁵⁹ The Theoretical Domains Framework was integrated into the design and evaluation of the CATT for athletes course in order to develop long-term behaviour change.

**Table 4** Detailed learning knowledge objectives and content with source we discussed

What was included in the CATT athlete course	Suggestions from athletes	Suggestions from university representatives	Peer-reviewed journal articles	Consensus statement
What is a concussion?			X	X
How do I know if I have a concussion?	X		X	X
What is baseline testing?				X
Do I have a concussion?		X		
Why do I need to know about concussion?	X			
What do I do if I suspect a concussion?	X			
How many symptoms are needed for concussion diagnosis?		X	X	
Red flags		X	X	
Why is reporting important?	X	X	X	
What is second impact syndrome?	X	X		
What happens when you report a concussion?	X			
How can I encourage a teammate to report?	X			
How do I report a concussion?		X	X	
How can concussion affect my life?				
How long does it take to recover from a concussion?	X	X		
How will my daily life be affected?	X			
How do I return to school and sport?	X	X	X	X
How do I get back to normal?		X		
How long do I need to rest?	X		X	X
Why is sleep important?				
How can I deal with low energy?			X	
What kind of support do I need?	X	X	X	
Academic considerations/scholarships		X	X	
How can I cope with concussion?				
What challenges am I facing?			X	
How can I help myself?	X			
Who can I ask for help?			X	
How can I support a teammate with concussion?	X			
Course format				
Accessible online, desktop or mobile device		X		
Video and text-based content; interactive	X			
Scenario-based learning	X			
Short and concise		X		
Self-guided	X	X		
Spokespeople: student athlete, researchers, doctor, nurse, high performance athlete	X	X		
Learning checks		X		
Certificate of completion		X		

CATT, Concussion Awareness Training Tool.

Table 5 Evidence-based behaviour techniques and mechanisms of action

Behaviour change technique	Mechanism of action	Example from course
Instructions on how to perform behaviour	Kn, Sk, BaCa	Learners are provided with a figure that outlines the steps of reporting and how they can encourage a friend to report.
Information about health consequences	Kn, BaCo, In	The beneficial and negative consequences of reporting were restated throughout the course.
Problem-solving	BaCa, BR	Learners navigate through practical problem-solving scenarios on how to navigate barriers to reporting.
Social support	SI	Information is given about how to give peer support and where and how to seek support.
Rehearsal	Sk, BaCa	Interactive practice question, flip card sorting and problem-solving-scenario provides an opportunity for the athlete to practice applying knowledge learnt.
Information about emotional consequences	BaCo	Learners navigate resources related to the emotional responses to concussion.
Restructure the social environment	ECR	Course provides information on how learners can support a teammate with concussion with the goal of creating a social environment that supports reporting.
Social comparison and information about other's approval	SI	Learners are provided testimonials from peers that highlight the positive support that was provided when they reported their concussion and reflect that concussion reporting culture is changing.
Reduce negative emotions	Em, BR	Learners are provided with suggestions how to cope with concussion and reduce stress.

BaCa, beliefs about capabilities; BaCo, beliefs about consequences; BR, behavioural regulation; ECR, environmental context and resources; Em, emotion; In, intention; Kn, knowledge; SI, social influence; Sk, skills.

In particular, the final resource was designed to influence four behaviours based on this framework: reporting symptoms, seeking care, encouraging teammates to report symptoms, and supporting teammates through their concussion recovery.

Limitations

Convenience sampling for the surveys and engagement interviews and recruitment during a season where no competition was occurring due to COVID resulted in small sample sizes, which may have introduced a selection bias and affected the generalisability of these findings. Further, some of the individuals who are included in the administrator needs assessment survey (ie, athletic directors) may not work directly with athletes and may not be as well equipped as other participants (eg, physiotherapists or athletic therapists) to understand an athlete's concussion experience. Due to the challenges of COVID, the engagement interviews were only done with athletes from two institutions, which may not readily apply to all institutions in Canada. Participant feedback was incorporated into the tool to target material specific to this audience; however, it was a challenge to include all recommendations into one resource. The aim to create a short, concise tool informed the inclusion of priority topics. All included topics were considered important by at least 80% of participants, reinforcing the inclusion of information to meet the needs of the target audience. While CATT for athletes takes approximately 30

min to complete, some may consider this too long, as U SPORTS athletes are also required to complete the Canadian Centre for Ethics and Sport online learning and institution-specific preparticipation activities.

CONCLUSION

This study describes the development of a tool tailored to Canadian university and college athletes, providing relevant, evidence-based information and strategies on concussion recognition, management and recovery. Engaging athletes and university representatives to identify import topics and formats most relevant to this audience ensured that the material and overall course is accessible, applicable and valuable. Incorporating behaviour change strategies into the development of the course, rather than providing concussion education alone, may lead to long-term behaviour change regarding reporting symptoms, seeking care, encouraging teammates to report symptoms and supporting teammates through their concussion recovery.

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