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Insights from Adolescent Athletes Concerning the Acquisition and Dissemination of Concussion Information

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Palavras-chave Formação

RESUMO

Especialistas notaram que a segurança dos atletas seria maior se eles forem melhor informados sobre concussões. O objetivo deste estudo foi abordar esta questão através da aquisição de conhecimentos dos atletas adolescentes sobre concussões. As questões de investigação neste estudo foram: de que forma os atletas adolescentes adquirem informações sobre concussões? Quem ou o que influencia o conhecimento dos atletas adolescentes de concussões? Como preferem ser ensinados sobre concussões atletas adolescentes? Os participantes foram atletas adolescentes, nove rapazes e nove raparigas (N = 18) com idades entre 15 e 18 anos, que competem na mesma equipa de uma escola secundária canadiana urbana. Foram realizadas entrevistas semiestruturadas com cada participante e os dados qualitativos foram analisados através da análise de conteúdo hierárquico. Os resultados revelaram que a maioria dos atletas adolescentes adquiriu informações sobre concussões através de interações com seus pares e membros da família, reportagens jornalísticas e projetos escolares. Os participantes também indicaram uma preferência por formulários interativos de educação sobre concussão que envolvem componentes audiovisuais, debates e estudos de caso de atletas que sofreram concussão. As conclusões deste estudo podem ser de interesse para profissionais de saúde e educação que são responsáveis pela segurança dos atletas jovens e bem-estar, bem como para pesquisadores que trabalham neste domínio.

Keywords High school sport; Qualitative research; Traumatic brain injury; Knowledge translation

ABSTRACT

Experts have noted that the safety of athletes would be improved if they were better informed about concussions. The purpose of this study was to address this issue by acquiring adolescent athletes' insights about concussions. The research questions guiding this study were: How do adolescent athletes acquire information about concussions? Who or what influences adolescent athletes' knowledge of concussions? How would adolescent athletes prefer to be educated about concussions? The participants were nine male and nine female adolescent athletes (N = 18) aged 15 to 18 years who competed on a varsity sport team from the same urban Canadian high school. Semi-structured interviews were conducted with each participant and the qualitative data were analyzed using hierarchical content analysis. Results revealed the majority of adolescent athletes acquired information about concussions through interactions with peers and family members, sports media reports, and school projects. The participants also indicated a preference towards interactive forms of concussion education that involve audiovisual components, discussions, and case studies of concussed athletes. Findings from this study may be of interest to health and educational professionals who are responsible for young athletes' safety and well being, as well as for researchers working in this domain.

Introduction

A concussion is a type of brain injury that results from impulses transmitted to the head via direct or indirect blows to the face, head, or elsewhere on the body (McCrory, Meeuwisse, Aubry et al., 2013). Sport-related concussions have garnered considerable attention in recent years due to the long-term health consequences that have been linked with the injury (Caron, Bloom, Johnston, & Sabiston, 2013), including Chronic Traumatic Encephalopathy (Galgano, Cantu & Chin, 2014). Although concussion sequelae affect athletes of all ages, researchers have suggested that adolescents suffer from a more severe symptomatology than adults (Williams, Puetz, Giza, & Broglio, 2015). Additionally, rehabilitation strategies for concussions are in the early stages of development (Broglio, Collins, Williams, Mucha, & Kontos, 2015), meaning there is little that medical and health professionals can do to treat or reduce the effects of a concussion after the injury has occurred (McCrory, Meeuwisse, Aubry et al., 2013).

Researchers have found that adolescents' brains undergo important growth and development beginning at 13 years old and extending into young adulthood (Boyd, Johnston, & Bee, 2014; Carman et al., 2015). Concussions suffered during this period have contributed to a prolonged recovery for adolescent athletes compared to both collegiate and professional athletes (Williams et al., 2015). Consequently, there is a need to improve concussion prevention efforts for adolescent athletes. One way to prevent and/or reduce the number of concussions is to ensure adolescent athletes are appropriately educated about the injury (McCrory, Meeuwisse, Aubry et al., 2013).

Indeed, consensus panels have highlighted the importance of educating adolescent athletes about concussions (e.g., Broglio et al., 2014; McCrory, Meeuwisse, Aubry et al., 2013). For example, Broglio and colleagues (2014) suggested that concussion education should include symptom recognition and health professional referral, prevention, return to play/activity, and consequences of improper management. Although there appears to be agreement among experts regarding the *type* of concussion information that athletes should be receiving, there is little consensus regarding *how* this knowledge should be disseminated to athletes (Caron, Bloom, Falcão, & Sweet, 2015). To inform these efforts, it would be beneficial to obtain insights from athletes' about how they typically acquire information about concussions, as well as their preferences for learning about the injury.

Athletes have been educated about concussions through printed materials (e.g., Sarmiento, Hoffman, Dmitrovski, & Lee, 2014), websites (e.g., Ahmed, Sullivan, Schneiders, & McCrory, 2012), and to a lesser extent, formal concussion education programs

(e.g., Caron et al., 2015). Printed materials such as pamphlets, posters, and fact sheets have been the most popular method of educating adolescent athletes about concussions. For example, in North America, the *Heads Up* initiative has created over 50 educational tools that have been distributed to adolescent athletes over the past decade (see Sarmiento et al., 2014 for a review). Although printed materials have been useful in disseminating concussion information on a large scale, researchers have questioned whether printed materials could improve adolescent athletes' concussion knowledge when used as a standalone strategy (e.g., Caron et al., 2015). Concussion-related websites are another method that has been used to disseminate concussion knowledge. Ahmed and colleagues (2012) reviewed 43 concussion-related websites and found that many contained medical jargon, which may not be the most appropriate way to disseminate concussion knowledge, particularly to young athletes. Formal concussion education programs (i.e., initiatives beyond passive dissemination) have also been used to educate adolescent athletes about concussions. These initiatives have included interactive oral presentations, educational videos, and computer-based learning programs (Caron et al., 2015). Caron and colleagues (2015) reviewed the literature on concussion education programs and found that adolescent athletes scored worse on post-educational intervention assessments than collegiate athletes. This suggests that the content and/or delivery of contemporary concussion education programs might not have been appropriately adapted for adolescent athletes. Taken together, despite the increased availability of concussion education initiatives in recent years, there is no consensus on the most appropriate ways of disseminating concussion knowledge to adolescent athletes.

The purpose of the present study was to acquire insights from adolescent athletes about concussions. The research questions guiding this study were: How do adolescent athletes acquire information about concussions? Who or what influences adolescent athletes' knowledge of concussions? How would adolescent athletes prefer to be educated about concussions?

Method

Study design

An instrumental case study design was used to frame this study (Stake, 2005). Case studies are used to understand contemporary issues, questions, or concerns that are bound within a specific time and setting (Stake, 2005). Participants in the current study all attended the same private (i.e., fee-paying)

Canadian high school that had one of the highest tuition fees in their geographical region.

Further to this, the high school employs full-time athletic therapists (ATs) who attend all practices and games, interact regularly with members of the senior athletic teams, and administer concussion baseline testing with athletes at the beginning of the season. ATs are specialists in the human musculoskeletal system and have expertise in emergency care, injury assessment, and rehabilitation (Broglia et al., 2014). ATs were responsible for diagnosing athletes with a concussion at the school and monitoring them throughout the return to play (RTP) protocol (cf. McCrory, Meeuwisse, Aubry et al., 2013).

Participants

Nine male and nine female ($N = 18$) adolescent athletes aged 15 to 18 years ($M_{age}=15.94$; $SD=0.94$) who all competed on one of the school's varsity sports teams participated in this study. None of the athletes reported being symptomatic of a concussion at the time of the study. Each participant was assigned a pseudonym to protect his or her identity.

Procedure

After obtaining approval from the lead author's university research ethics council, the Athletic Director (AD) from a local high school was contacted and agreed to serve as third party for this study. More precisely, the AD was asked to recruit athletes who were members of one of the school's senior (i.e., grade 9-12) athletic teams. The AD was asked to recruit an even number of boys and girls. History of concussions was not a requirement for participation.

Those who were interested in participating collected a sealed envelope from the AD, which contained parent/legal guardian consent and athlete assent forms. Once both forms were completed and returned by the athletes, the AD arranged a time for a meeting between participants and the lead investigator.

Meeting times and locations were selected by the AD. Each athlete was verbally explained his or her rights as a research participant prior to beginning a face-to-face interview with the lead investigator. The same semi-structured interview guide was used with each participant and consisted of two sections: demographic and main interview questions. Demographic questions were asked to obtain biographical information about their sporting history (e.g., "What grade are you in?" and "Which high school team(s) did you play on this past year?"). The second section comprised the main questions for the interview, which included three parts: opening, key, and concluding questions. Opening questions were used to help the lead investigator establish rapport with participants, as well as gather information about the types of injuries the athletes and their teammates have experienced (e.g., "Can you describe the type of injuries that happen most often in the sports you play?" and "Have you or your teammates ever suffered a concussion while playing sports? If yes, describe what happened."). Key questions were more specific to the purpose and research questions identified for this study (e.g., "Describe how you have learned about concussions?", "Has anyone ever talked to you about concussions before? If yes, what did they tell you?", "Do you think it is important for athletes your age to learn about concussions? Why or Why not?", and "What would be some ways you would

Table 1 - *Participants' Characteristics*

Pseudonym	Age	Gender	Current Sports Team(s)	Previous Concussion History (Yes/No)	Grade
Ethan	16	M	Hockey, Football	Yes	10
Walter	15	M	Basketball, Tennis	Yes	9
Sara	16	F	Basketball, Flag Football	No	11
Samantha	17	F	Soccer	No	11
Aaron	16	M	Hockey, Football	No	11
Holly	17	F	Soccer, Basketball	Yes	11
Mark	16	M	Hockey	Yes	11
Jordan	16	M	Hockey, Football	Yes	10
Emmanuel	17	M	Basketball, Football	Yes	11
Lauren	16	F	Soccer, Basketball	Yes	10
Elliot	17	M	Rugby, Hockey	Yes	11
James	15	M	Hockey	Yes	10
Karen	18	F	Hockey, Flag Football	No	12
Luke	15	M	Hockey, Football	Yes	10
Ashley	15	F	Soccer, Basketball	No	9
Veronica	15	F	Soccer	Yes	9
Kelsey	15	F	Soccer, Football	No	10
Amanda	15	F	Hockey, Soccer, Tennis	Yes	10

like to learn about concussions in the future?”). Concluding questions afforded each participant the opportunity to provide additional comments or pose questions to the lead investigator (e.g., “Would you like to add anything else related to our interview?” and “Do you have any comments or questions?”).

Data analysis

The interviews ranged in length from 15 to 40 minutes, with an average of 25 minutes. The interviews were audio recorded, transcribed verbatim, and stored using the NVivo 10 software package (QSR International Pty Ltd). Data were analyzed using hierarchical content analysis, a type of inductive (i.e., bottom-up) method that is used to identify patterns within and between the interviews. Sparkes and Smith (2014) noted that hierarchical content analyses allow for data to be presented in a logical manner that is “amenable for peer dissemination” (p. 117). Côté, Salmela, Baria, and Russell’s (1993) guidelines for conducting a hierarchical content analysis were followed. To begin, the lead investigator gained familiarity with the data by reading each transcript in its entirety several times while listening to the audio recordings. Following this, the interview transcriptions were broken down into *meaning units*, which are blocks of text that represent a single concept, thought, or idea. This process yielded 197 meaning units. The second step involved assigning a *tag* to each meaning unit. A tag is a label that captures the essence of a meaning unit. Similar meaning units were assigned the same tag. Generating tags was an iterative process (see *critical friend* in the trustworthiness subsection for more information), and a final list of 10 tags emerged from this process. The final stage of this hierarchical content analysis involved searching for patterns between the 10 tags. Those with similar characteristics were grouped into *properties*. Three properties emerged from this process and will be further explained in the results section.

Trustworthiness. There has been much discussion on the best ways to establish trustworthiness in qualitative inquiry, with little consensus (see Smith, 2009 for a discussion). Trustworthiness criteria for this study were selected based on the context and purposes of the research. One example was through the use of an *audit trail*, which involved articulating the rationale for decisions made throughout the research process by detailing background information about the participants and their setting, recruitment, consent/assent procedures, and data collection and analysis. A *critical friend* was used in the current study to help ensure the data, interpretations, and outcomes represented the participants’ insights, experiences, and meanings. The critical friend in this study was the third author of this paper, who acted as a theoretical sounding board throughout data analysis to enhance the lead investigators’ reflexive self-awareness (Sparkes & Smith, 2014). More precisely, the lead investigator initially assigned tags to each meaning unit and mapped the names of tags onto a master list. The critical friend reviewed all 18 tagged transcripts and the master list of tags to see if the tags initially assigned by the lead investigator accurately captured the essence of participants’ experiences and perceptions. This process led to some changes in the labelling of tags (e.g., “athlete concussion education – previous exposure” was changed to “formal and informal concussion education”). Additionally, some meaning units were assigned different tags. This process was also repeated for step three of the analysis. Using a critical friend helped to ensure the lead investigator was reflexive throughout data analysis and to ensure data was appropriately categorized. *Researcher triangulation* was also used in the current study by having all of the authors independently review and agree on the data analysis, the results and their interpretations, as well as the conclusions drawn from this study. This process was conducted to help ensure we presented the most realistic representation of the participants’ insights on concussions.

Table 2 - List of Properties and Tags

Properties	1. Personal Interactions about Concussions (69)	2. Exposure to Concussion Information (81)	3. Recommendations to Improve Concussion Education (47)
Tags	Athletic Therapists (18; 11/18) Coaches (8; 6/18) Family members (17; 11/18) Teammates – concussion interactions (26; 17/18)	Media (22; 16/18) Professional athletes (37; 17/18) Formal and informal concussion education (13; 11/18) School project on concussions (9; 4/18)	Importance of concussion education (15; 15/18) Suggestions for concussion education (32; 17/18)

Note. The first number in parentheses represents the frequency of each tag within the interview data. The second number (e.g., 15/18) represents the number of participants who reported or mentioned each tag.

Results

Results from the hierarchical content analysis revealed three properties, which were labeled *Personal Interactions about Concussions*, *Exposure to Concussion Information*, and *Recommendations to Improve Concussion Education*. These three properties will be illustrated using quotes from the participants. Quotes from the participants are identified using a pseudonym.

Personal Interactions about Concussions

The adolescent athletes said that personal interactions with peers, ATs, and family members were an important way they acquired information about concussions. These interactions also appeared to influence their perceptions of the injury. Of all their interactions and discussions, the adolescent athletes said that ATs and family members were most influential in shaping their knowledge and perceptions of the injury.

The participants noted they interacted infrequently with friends and teammates about concussions. For example, Veronica noted, "My friends and I don't really ever talk [to my teammates] about concussions. Maybe it will come up if we're talking about injuries in general".

My teammates and I rarely talk about concussions. Maybe if we were watching a hockey highlight tape that involved a big [body check] or something. We might say, 'that guy is probably concussed' but that's about as much as we talk about concussions (Mark).

Throughout the interviews, it was evident that a large number of participants were not confident when discussing aspects of concussions, which was evidenced by their voices trailing off when discussing aspects of the injury, and the uncertainty in their comments, "I don't know if it's true or not but...", which also suggested they were lacking knowledge about concussions.

More than half of the athletes in this study said they had previously interacted with the school's ATs about concussions: "Anytime I think I have a concussion I get checked out by our AT" (Samantha). Based on their comments, it appeared that interactions with ATs had a meaningful impact on their knowledge and perceptions of concussions, especially when compared to their interactions with peers and teammates:

The AT did all these tests. I told her about how my vision and hearing was enhanced. She said that can happen after a concussion and that she would talk to my parents after the game. She had that whole *concussion talk* with them. You know, that I've been hit to the head and about the concussion protocol (Ethan).

I don't know if it's true but the AT told me that if you play with a concussion and then you got another concussion then you could just collapse. Like, the brain will just shut down. I don't know if it's true or not – she might have just said that to scare me (Jordan).

In addition to ATs, conversations with family members about concussions also appeared to be influential on the adolescent athletes' knowledge and perceptions of the injury. For example, some of the athletes described their siblings' concussion experiences and how they impacted them, "I've heard a whole lot about concussions because of my brother. He got a pretty bad concussion from playing rugby. That concussion had a pretty big effect on my brother. He had a lot of migraines" (Ethan).

I think that I knew a bit about concussions before I had my first concussion because of my sister. She got a really serious one playing basketball. She had serious symptoms for about a year. She was off of school. She wasn't able to go out with her friends anymore. Her lifestyle was totally changed. She was having a difficult time on day-to-day basis. That's pretty much how I have learned about concussions (Mark).

Participants whose siblings had suffered a concussion appeared to be quite knowledgeable about the injury, which may have resulted from observing the challenges their siblings encountered throughout their recovery.

Although a number of adolescent athletes said they interacted with their brothers and sisters, almost all of the participants described instances when they spoke about concussions with their parents:

My mom talked to me about concussions when my brother got one. I remember my mom told me that I should tell someone right away if I ever get hit in the head. She also told me that I should get off the field and see how I feel later. My mom is really big on the saying, 'If you feel that you are injured, get off so you don't make it worse. Take a breather and see how you feel after' (Kelsey).

My mom and dad sat me down and told me that if I ever I get hit to the head that I should tell them right away. That I should monitor how I feel. And if I have headaches I should tell them right away. If I have blurred vision or if I feel dizzy I should tell them right away so they said they can bring me to the hospital and get me checked out (Samantha).

Taken together, peers, ATs, and family members had varying degrees of influence on the adolescent athletes' knowledge and perceptions of concussions. Interactions with ATs and family members appeared to be more influential on the participants than interactions with teammates and peers.

Exposure to concussion information

Aside from their personal interactions about concussions, the participants described being exposed to concussion information through sources such as sports media reports on professional athletes and school projects. Although the quality of the information emanating from these sources is unknown, the participants acknowledged that sports media reports and school projects were important ways they acquired information about the injury. Indeed, sports media reports were a popular method through which the adolescent athletes were exposed to concussion information. Given that all of the participants lived in Canada, it was not surprising the majority described examples from sports media reports involving professional ice hockey players. Although some described concussions involving professional soccer and basketball athletes, most of the participants highlighted professional ice hockey superstar player Sidney Crosby's well-documented concussion experiences:

Sidney got [body checked to the head] during one game. And got hit along the boards in the next game. He bounced off the boards and just dropped. He was done. He was out for a long while after the second one. It was definitely a couple months (Aaron).

Seeing what Crosby went through made me realize that concussions are serious. It's not something you want to joke around with. It made me realize that lying about having a concussion, like I did, is not the right thing to do. I was thinking, 'It's not a big deal, who cares.' But concussions are not something to be taken lightly (Elliot).

In addition to sports media reports, the adolescent athletes said that school projects were another way they were exposed to concussion information. More precisely, four participants said they conducted school projects on concussions or topics related to head injuries out of personal interest. Those who did a school project on concussions focused on the long-term consequences of concussions:

I actually did a presentation on concussions for one of my classes this year. When I was doing some of the research about the long-term effects of concussions... I didn't know that it could affect people that much in the future. I learned that your memory could really, really be affected (Holly).

I just did an essay on concussions for school this year. I did some research about the long-term effects – like CTE and that kind of stuff. I researched a couple of hockey players like Derek Boogaard, how they suffered from it, and how it pretty much ruined their lives. Because he had concussion after concussion, his headaches basically didn't go away. After

a while they started suffering from other diseases like dementia and all that (Jordan).

The majority of the participants who conducted school projects on concussions focused on the long-term consequences of concussions. The participants also noted the content of their school projects were based largely on sports media reports of professional athletes.

Some of the participants in this study described instances when they were given concussion-related information from health professionals. For example, two participants said they were informed about concussions by ATs during baseline testing at the beginning of the season. Kelsey said, "Last year I did my first concussion test with [name of AT] and I guess that was the first time anyone talked to me about concussions", and Amanda noted, "Aside from when I got my concussion test, no one has really ever talked to me about concussions before". Only one of the 18 participants described having previously been exposed to a formal concussion information session. Specifically, Karen noted:

One time a woman came in and spoke to my community hockey team about the neuroscience of concussions. She didn't really tell us what a concussion was. She told us more about how bad concussions could be. I don't remember everything. I definitely found the talk helpful because no one really ever told me how serious concussions were before that.

In sum, results in this property revealed that adolescent athletes in this study were primarily exposed to informal concussion information through channels that included sports media reports on professional athletes. Although some indicated that health professionals provided them with concussion-related information, formal concussion education initiatives were not a common way this group of adolescent athletes acquired knowledge about the injury.

Recommendations to improve concussion education

The adolescent athletes in this study all expressed interest in learning more about concussions. Moreover, the participants described their preferences for receiving concussion education in the future, which included interactive presentations that involved case studies and audiovisual components.

15 of the 18 participants in this study said they felt it was important for athletes their age to be knowledgeable about concussions. For example, Sara noted, "A lot of people get concussions, like our classmates and stuff. But no one seems to think that it's that big of an issue". In particular, the participants felt it was important for athletes to be knowledgeable about concussions so they can "tell someone" if they potentially suffer a concussion,

"It's important that athletes not be ashamed to tell someone right away if they get hit in the head (Ashley)". Additionally, Kelsey said:

You use your brain for everything so you have to be very careful with it. It's important for athletes to know that they should not continue playing if they get hit in the head. A lot of people continue playing. When athletes are getting headaches or a lot of pain in their neck, they should tell someone and make sure that everything is okay.

Some of the participants felt that case studies would be an interesting way to learn about concussions:

It would be helpful if someone came in and gave us relatable stories about athletes who have suffered a concussion... and then tell us what happened. That way, we could relate to the example and think, 'I play that sport so there's a chance I can get one'... (Veronica).

It would be good to use specific case studies about well-known athletes. Because we know these athletes, their names, and we've probably been watching them on television. If you use professional athletes then we would probably be more interested in it. Like, 'If you were Paul George in that situation what would do?' – stuff like that (Emmanuel).

Participants also suggested that concussion education initiatives should be interactive. As an example, Karen noted, "An audiovisual lecture would be a good way to learn about concussions. Maybe group work, too". Additionally, Mark believed that interactive concussion education would be best for teaching adolescent athletes at their age about the injury:

I don't think it would be great to teach athletes about concussions through lectures only. I think you would definitely want to make it interactive and include a visual aspect because that's just more interesting. Athletes my age would enjoy that more.

Collectively, the participants felt it was important for adolescent athletes to be knowledgeable about concussions so they could recognize potential symptoms and "tell someone" (i.e., report the concussion). The participants also revealed preferences towards interactive concussion presentations that involve case studies and audiovisual components.

Discussion

The purpose of the present study was to gather adolescent athletes' insights on concussions. Results from this present study suggest the participants were lacking knowledge of concussions, which aligns with previous research in this domain (e.g., Chrisman, Quitiquit, & Rivara, 2013; McCrea, Hammeke, Olsen, Leo, & Guskiewicz, 2004;

Register-Mihalik et al., 2013). The similarities with previous research were not surprising, given that few of the participants reported previous exposure to formal concussion education. As a result, the present findings highlight a need to improve concussion education interventions for adolescent athletes. This suggestion concurs with previous research that has advocated for improved concussion education strategies to help prevent concussions and improve athletes' safety (Caron et al., 2015; McCrory, Meeuwisse, Aubry et al., 2013).

Results from this study also revealed that adolescent athletes' knowledge and perceptions of concussions were influenced by their interactions with family members and ATs. Researchers have previously discussed the role of ATs with respect to concussions (Broglio et al., 2014; Kelly, Jordan, Joyner, Burdette, & Buckley, 2014; Kerr et al., 2015). In Broglio and colleagues' (2014) consensus statement on concussions, the authors noted that a primary responsibility of ATs is related to the management of concussed athletes, which they said should also involve educating athletes, coaches, parents, and members of the sporting community about the injury and recovery process. Evidence suggests that ATs regularly disseminate concussion information to collegiate and university athletes (Kerr et al., 2015), however less is known about their training and role in concussion education with high school athletes. Adolescent athletes in the present study noted that ATs were influential on their knowledge and perceptions of concussions, particularly through interactions that occurred during preseason baseline concussion testing. Although many ATs deliver concussion education to athletes as part of their preseason assessments (Kerr et al., 2015), it is unclear the extent to which ATs are provided with specific skills and strategies during their education to effectively disseminate concussion education to athletes. Given their influential role on adolescent athletes' knowledge and perceptions of concussions, the current results add to the literature by suggesting ATs may benefit from coursework or continuing education experiences to equip them with effective dissemination strategies for adolescent populations. Ultimately, ATs who have the training to effectively disseminate concussion information could help to improve athlete safety and to promote a safe sport environment that encourages positive concussion-related behaviors, such as accurately reporting this injury.

A unique finding from this study was that the participants reported being exposed to concussion information through sports media reports and school projects. In particular, participants said they chose school projects that were focused on the long-term consequences of concussions, which they felt included Chronic Traumatic Encephalopathy (CTE). CTE is a type of structural brain damage

characterized by tau protein deposits in distinct areas of the brain, and it is believed to accumulate over the course of multiple concussive or subconcussive head trauma (Stein, Alvarez, & McKee, 2015). Although there are correlational data linking repeated concussions with CTE, the lack of long-term, prospective data makes causal inferences concerning the relationship between concussions and CTE premature (McCrory, Meeuwisse, Kutcher, Jordan, & Gardner, 2013). It was somewhat disappointing that the participants in this study reported sports media reports and school projects were primary channels through which they were exposed to concussion information because there have been several large-scale concussion education initiatives in North America that have focused on disseminating information based on empirical evidence (e.g., Sarmiento et al., 2014). Consequently, the present findings underscore the importance of exposing adolescent athletes to information that is rooted in expert guidelines or peer-reviewed data, and presented by individuals (e.g., ATs) who have expertise on concussions or in a format that is amenable for adolescent populations. Participants also described their preferences for receiving concussion education, which included interactive approaches. Interactive audiovisual presentations have rarely been implemented as a concussion education strategy (Caron et al., 2015). One of the few examples is from Bagley and colleagues (2012), who developed an interactive concussion education program for high school students that consisted of an audiovisual presentation and discussions with audience members. Results from their study revealed an improvement in high school students' knowledge of concussions when comparing their pre- and post-intervention quiz scores. However, the methods employed by Bagley and colleagues did not allow the participants to share their perceptions of their concussion education program. Findings from the present study extend previous research in this domain by providing a preliminary understanding of adolescent athletes' preferences for receiving concussion education. That is, the current findings indicate that interactive forms of concussion education that include audiovisual components and discussions may be beneficial for adolescent athlete populations.

Additionally, the participants suggested that case studies were a preferred strategy to acquire information about concussions, which to our knowledge has yet to receive empirical attention. Adolescent athletes reported learning about concussions through observing the experiences of professional athletes, siblings, and peers who had concussions. Bandura (1977) noted that behaviors are learned through social communication and modeling. Thus, it may be beneficial to include case examples of professional concussed athletes to

initially capture the interests of adolescents and then follow-up with age appropriate observational models to improve their knowledge of concussions. Given that little is known about the integration of case studies into concussion education initiatives, educational learning theories such as the Attention, Relevance, Confidence, Satisfaction model (Keller, 2009) may be useful in guiding future research on this topic.

While the current study provided several interesting insights from the adolescent athletes, some limitations must also be acknowledged. First, the current analysis strategy combined male and female participants' insights on concussions rather than searching for differences between genders. It is important to note that participants were not asked to identify their gender. Given that researchers have yet to support gender-specific concussion education initiatives, we felt it was important that the study findings were presented in a way that could inform future research and intervention for both male and female adolescent athletes. Second, all the participants attended the same fee-paying high school where they had access to ATs, which is quite different than the majority of athletes their age in Canada. Although the goal of qualitative inquiry is not to produce generalizable findings (Sparkes & Smith, 2014), future studies may consider selecting samples with greater variability (e.g., participants who come from different regions and socioeconomic statuses).

The present findings contribute to a limited understanding of adolescent athletes' perceptions of concussions, which could inform the development of future research and intervention in this domain. Specific to research, the adolescent athletes in this study noted that family members were influential on their knowledge and perceptions of concussions. To our knowledge, researchers have yet to investigate how family members can impact athletes' knowledge and perceptions of concussions. Focusing on family members appears worthy of future research because they are often the individuals who support concussed athletes throughout their recovery (e.g., Caron et al., 2013). In terms of interventions, the adolescent athletes said they preferred concussion education strategies that involved discussions, case studies, and audiovisual components. These insights could be used to inform future interventions to help ensure that concussion education messaging is being delivered in a preferred yet developmentally appropriate format. In sum, we hope that the findings from this article can provide some insights that can be used to help determine the most effective strategies to prevent concussions and to improve adolescent athletes' safety in sport.

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