ORIGINAL ARTICLE

What is the knowledge of Newfoundland and Labrador Coaches' regarding recognition of and response towards sports related concussive injury in the adolescent?

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ABSTRACT

Objective: To examine coaches' knowledge, recognition of, and response to, concussion in the adolescent athlete population.
Methods: Using a non-experimental correlational design, adult coaches (N = 120) responsible in the coaching of adolescent junior high and high school athletes were recruited from sports associations and schools in the province of Newfoundland and Labrador (NL). A 28 item questionnaire called Coaches' Knowledge of Sports Related Concussive Injury in the Adolescent Athlete Survey was provided online.
Results: Majority of participants were knowledgeable of what is a concussion, its causes, and what visual clues observed that indicate a possible concussion in a player. In relation to the Age of coach category, only the 55+ age group responded correctly to what is an example of sport specific activity with body contact. Years of coaching and return-to-play knowledge after a concussion showed incorrect responses for both the step wise approach and the 20-30 minute player participation with no contact. Having attended an education concussion session or not showed no difference on return-to-play knowledge in the step wise approach progression as the majority responded incorrectly with 71.4% (attended an education session) versus 91.7% of participants (no attendance on concussion education), respectively.
Conclusions: Benefits gained through this research study will serve to evaluate coaches' knowledge and improve standardized concussion knowledge. Such preparation can assist in better recognizing and effectively managing a sports related concussion (SRC) and the potential to facilitate sport policy changes. Actions by coaches can impact preventative education, encourage safe behaviors and the reporting of concussive symptoms by the adolescent, therefore reducing burden on overall long term negative health outcomes.

Key Words: Concussion, Adolescent, Return to play, Coach knowledge, Concussion management

1. INTRODUCTION

Sport, as an activity, contributes to overall health and well-being of any age group. While injuries can occur at any sport level, knowledge of injuries, and how it presents, is essential to management and prevention of negative health outcomes. Youth and adolescents can be particularly vulnerable to injury

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and the impact it may have on their growth and development.

Thus, there has been a growing awareness for greater understanding of sport related concussion (SRC) in the younger athlete and the knowledge of coaches as they instruct and evaluate performance. Concussion has implications for the adolescent's recovery, potentially interfering with school, group, and family relationships. The Centre for Disease Control and Prevention (CDC), Parachute Canada and the 5th Berlin Group Consensus statement have maintained that coach, athlete and parent education in concussion injuries is central to its early recognition and management, and in the prevention of associated complications in the younger sports related player.[1–3]

Concussion, as an injury, is a recognized public health issue in sports and the health care community worldwide.[1,2,4–7] In Ontario Canada, 1.2% (1,330,336) of the population experienced concussion, the highest reported[8] over a nine year period. Males under the age of 18 had the greatest incidence with children and youth, as an age group, having one of the highest ratios (5,400/100,000). Underscoring public attentiveness to concussion knowledge, concussion treatment and policy direction for overall health for this population.

Concussion, commonly is underreported by the adolescent however monitoring of subjective symptoms is essential to concussion prevention, improve safety and ensure positive outcomes.[9,10] While young athletes who have played with concussive symptoms and the relationship to coach concussion education has been studied, coaches' knowledge of concussive symptoms and the evaluative criteria for specific groups who play sports and sustain concussions have not been examined in depth. Precise, consistent and factual methods of concussion identification and knowledge of concussion management are needed among coaches to understand when return to play can occur in younger populations. The purpose of this non-experimental correlational study was to explore the knowledge, recognition, and understanding of concussion in a sample of adult coaches from sports associations and schools in one Canadian province. The findings of this research study will contribute to the existing literature on coaches' concussion knowledge and return to play activities for the youth population.

2. LITERATURE REVIEW

There is confusion regarding the definition of concussion[11] and evident that the term is used interchangeably with traumatic brain injury.[12] Traumatic brain injury (TBI)[9,13] is a term in recreational and organized sports that has been used in the concussion literature, but its ambiguous interpretation has led to problems in concussion management.[14] Nevertheless, following numerous international conferences, a consensus statement regarding SRC has been accepted as a "traumatic brain injury induced by biomechanical forces" (p. e2)[1] with common descriptions. The descriptions or signs and symptoms associated with concussion are somatic (headache, nausea), physical (neural deficit), balance (gait problems, dizziness), cognitive (difficulty with memory & concentration), emotional (sadness, irritability), and /or sleep related (drowsiness or difficulty falling asleep). The symptoms may or may not involve loss of consciousness.[1,14] A SRC is therefore hard to recognize and diagnose due to the variability of symptoms. A lack of attentiveness by coaches to athlete self-reporting of concussion symptoms or fear of activity restrictions by the athlete if they do report symptoms,[15] make coaching management difficult. Clear objective definitions, assessment and management techniques are needed.

SRC is a common injury among children and adolescent youth who participate in a variety of contact and non-contact sports.[9] Notably, children and youth are more susceptible to concussion because of brain development, gait related impairment, take longer to recover, and experience more long-term impairments during recovery and complications post-concussion.[9,12,14,16,17] The incidence of concussion varies across contact and non-contact sports and gender of the athlete.[16,18] A Canadian retrospective study,[19] described that the number of concussions among varsity athletes were highest for females in contact sports [rugby, ice hockey & basketball]. The highest rates of concussion were found in women's rugby and ice hockey and men's basketball. Conversely, other authors[20] found no difference in gender specific concussion rates.

Online data from the high school reporting information surveillance system (HS RIO), examined U.S. male athlete exposure (AE) to concussion injury over an eight year period.[16] During ice hockey sessions three hundred and forty-eight SRCs occurred after the first period in competition (85.6%) and after the first practice hour (60%), citing fatigue as a contributory risk factor. Players in the wing position and contact with another body part accounted for almost half (47.7%) of the SRC. 40.4% accounted for the concussed head making player contact with another body part. Overall, concussion rate (0.68/1000 AE) was highest for competition contact, with symptoms of headache and dizziness/ unsteadiness most reported. Return-to-play occurred at under 7 days after resolution of symptoms. The authors concluded further studies in gameplay intensity associated with injury risk, player position, prevention strategies and policy/legislation would aid player outcomes.

2.1 Coaches knowledge

Several studies have revealed that while coaches have knowledge of concussion, what it is and its physical symptoms, gaps in knowledge still exist.[21–24]

Despite continued research and dedication to education strategies to prevent concussive injuries, identified unfamiliarity with return to play activities among coaches has been identified.[24] Standardized knowledge of SRC has been underreported despite formal education on concussion associated risks.[16, 25–27] Evaluation of a coach delivered Heads UP (HU) program for 2,514 U.S. high school football players reported a reduced SRC injury by 33% with 27% faster to full RTP.[28] Significant lower ratio rates (4.1 SRC/100 players) were noted for those players with HU education than the non-HU (6.0 SRC/100 players) group, concluding that structured concussion prevention and management programs have positive health outcomes. Unequal sample size, selection bias, game exposure and play position were not accounted for and therefore contributed to study limitations. In a systematic review, over half of the studies reported competence in coaches' identification of common physical symptoms associated with concussive injury. Coaches however were unfamiliar with return-to-play protocols and had poor knowledge to manage concussion injuries despite having received first aid and sport injury management courses. The lack of standardized questionnaires, selection bias and inadequate concussion education were cited as areas that impeded full comparison across studies.[24] Similarly, a Canadian cross-sectional study of parental and coach (N = 794) concussion knowledge, education and management behavior communicated that both groups had not heard of the stepwise RTP protocol whether having received concussion education (41.6%) or not (72.8%) and 79.7% were unaware that younger players take longer to recovery time. The authors of this study cited further research on concussion education and its influence on behavioral change and the impact it may have on RTP decisions was warranted.[29] Unfamiliarity with return-to-play activities in U.S. football high school coaches[30] reported that no coaches (N = 77) in the study were able to recall return-to-play protocols and 76.7% reported being untrained to manage concussion injuries despite having received first aid and sport injury management courses. While this study is dated it is still representative of current research findings.[24, 26, 31]

Likewise, 80.8% to 83% of youth hockey coaches would return concussed athletes' to play especially for final or championship games.[31] The strongest statistical variable for this study was coaches' age and return-to-play activities. An inverse relationship between age (N = 299) and decision to continue play was statistically significant (p = .006), with the majority of coaches (81.4%) having less than 5 years' experience. Notably coaching level was also found to be statistically significant. Coaches with I-IV certification levels would not allow a concussed player to return-to-play t (268,383) = 2.097, p = .037, indicating correct concussion management.

Determining concussion reporting among coaches is a fundamental point in the acknowledgement of symptoms and the management of concussion injuries. Early recognition, physical and cognitive rest, along with the timing of when the athlete can return to the game are fundamental in the prevention of long term health problems.[8, 16, 32]

2.2 Athlete knowledge

Between the ages of 10-15 years concussion research is less examined despite over a million reported cases yearly in the United States.[25] Adolescents between the ages of 13-17 account for over 250,000 participants in elite hockey, as a sport, and SRC sustained during play can negatively impact their cognitive development.[16] Concussion incident rates (IR) of Canadian youth athletes were reported as (IR) 17.60/100 players hours (95%CI, 15.09-20.44) and (IR) 1.31/1,000 players hours (95%CI, 109-1.57).[20] Median recovery time from the first concussion was reported at 17 days and second concussion at > 10 days (74%) and > 30 days (20%) respectively. Adherence to consensus guidelines and return to play management were reported to have potentially contributed to this finding, concluding that education prevention strategies and adherence to best practice guidelines for safe outcomes for the youth athlete as essential.

Adolescent reporting of concussion symptoms to coaches is important for concussion management. In a U.S. study, although high school athletes from three football teams (N = 120) had prior knowledge of concussive symptoms, 53% would continue play with concussive symptoms and 22% responded that continued play would occur especially if the game was considered important.[33] Interestingly, 75% of study participants recognized concussion symptoms or having had (70%) prior concussion education, however only 54% indicated that they would report symptoms of concussion to their coach. The authors concluded that adolescent athletes may not encourage safe behaviors especially if continued playing is prohibited. Using the Rosenbaum Concussion Attitude and Knowledge Survey and Sports Orientation Questionnaire (SOQ) 161 Canadian athletes (ages 14-32 years), were studied examining knowledge, competitiveness and reporting.[34] Although females had higher knowledge F(2, 158) = 140.5, p = .00, the authors reported the SOQ was significant (p = .03, OR = 1.03; 97.5%CI) for competiveness and non-reporting of past and future concussive injury.

Concluding that concussion knowledge does not account for non-disclosure for at risk youth athletes. Coaches' non-adherence of athlete reporting of concussive symptoms, lack of supervision to RTP activities and lack of knowledge in concussion management contribute to further risk of cognitive and physical injury for youth in sport.[2,35,36]

The last fifteen year period, overall knowledge and recommended practice activities for concussion injury among high school athletes and coaches remain very similar, signifying that not all learned information nor preventative education is being retained.

2.3 Challenges to on site concussion management and return-to-play (RTP)

As many high school athletes and recreational players begin their chosen sport activities at an early age, the parent may be the first witness to a concussive injury. Therefore, parental recognition and understanding of concussion symptoms is principal since adolescent athletes' prolonged recovery time from concussive injury can be significant.[37–39] As the primary caregiver, parents are often relied upon to report history, symptoms and progress of injury to coaches' and health clinicians. However, parental knowledge in the adolescent athlete concussion symptoms, seeking care for recovery and return-to-play activity is still deficient.[13,21,26,39,40]

Management of concussion in sports must begin prior to the start of the season to assist in recognizing and effectively managing a SRC. These pre-season assessments include baseline neurocognitive, balance and standardized assessments, which can be used to compare to current assessments when a concussion is suspected and are also useful to monitor repeated assessments during the recovery period. It is recommended that an on the field assessment of a possible concussion is necessary to accurately determine the presence or absence of a concussion, rule out serious injury and determine the best return-to-play timing for the athlete.[1]

Signs of concussion may be subtle and difficult to detect, even for experienced healthcare providers.[13,14] Lack of reporting or underreporting of concussive symptoms by the athlete, lack of communication of coach expectations and parental knowledge of SRC are contributory factors making diagnosis of a concussion difficult.[32,37,41] Challenges to symptom reporting are unawareness, quick presentation, spontaneous resolution or inability to describe signs, making concussion recognition by the athlete or the coach unlikely.[14] Additionally, adolescents may respond differently to a concussion as compared to SRC in adults.[11,42] This is an important factor to consider when assessing the adolescent population for concussion symptoms.

Early recognition, physical and cognitive rest, along with the timing of when the athlete can return-to-play are fundamental in the prevention of long-term health problems.[1] Numerous organizations, the International Concussion in Sport Group (CISG) consensus statement, the American Medical Society for Sports Medicine (AMSSM), the Academy of Neurology (AAN), ThinkFirst Canada, the Canadian Concussion Collaborative (CCC) and Parachute Canada, all recommend the prohibition of returning-to-play the same day as the suspected injury. Once a concussion is determined, standard medical precautions are implemented, medical personnel are notified, and the adolescent may be transported to the nearest emergency medical facility for further management. It is been argued for some time that a multimodal approach be used to aid in the diagnosis of concussion on the day of the suspected injury based on symptoms as well as standardized testing of cognitive ability and balance that can impact management and treatment.[43] Standardized assessment tools (Sport Assessment Concussion Tool 3 [SCAT 3]; Standardized Assessment of Concussion [SAC]) are utilized by some coaches for adolescents in sports. Regardless of the choice of tool utilized and adopted, it is more important that each suspected concussion case be highly individualized as many factors such as age, past medical history, symptom assessment, cognitive examinations, coaching techniques and responses, and parental knowledge all influence return-to-play decisions.[1,21,40,43,44]

Determining when the adolescent can return-to-play can be difficult in the younger population due to a reliance on or lack of reported symptoms, which can result in early clearance to RTP. This premature RTP can have significant consequences since a repeat concussion before resolution can be life altering. The effects of a concussion may not always end with its resolution but may have long term effects on cognitive processing, mood and behavior which constitute the need for long-term monitoring even years after a concussive injury. Consequently, several studies have indicated a longer recovery period is needed in the younger population compared to the older athlete population.[1,14,15,20,45]

2.4 Knowledge transfer and legislation policy

Presently, there are many online resources available in print and video, in addition to side line tools, that provide information regarding concussion and concussion management, but coaches' electronic learning preferences and how it is used is less understood.[44,46,47] Over the past decade the transfer of knowledge regarding concussion and concussion management, by coaches of all levels, for return-to-play and overall management of youth populations are indisputable.[48] Parachute Canada, developed and released the Canadian

guideline on concussion in sport, to assist coaching medical staff and sport organizations across the country with consistent messages of return to sport and school practices. Although recent studies on coaches' knowledge of concussions and concussion management has increased, when compared with earlier studies on this topic, gaps in the literature still exist around emotional symptom identification, mechanism of injury, education needs of coaches, resource allocation, retention of knowledge and behavior change as a result of that knowledge.[44,46,49] Local and regional sports organizations can provide consistent messages to ensure return-to-play protocols are communicated clearly.

Equally a priority of concern is the lack of polices and legislation to protect young players from a life time of disability. Zachery Lystedt law, passed in 2009 in Washington, focused on return-to-play guidelines, the need for mandatory education for coaches on concussion management and the need for medical clearance prior to the return-to-play of the injured athlete. This law also mandated that athletes and parents sign an information sheet about concussion prior to the start of a competitive sport season.[3] Subsequently, all 50 states in the United States have some type of sports related concussion legislation. Several Canadian provinces (British Columbia, Nova Scotia, Ontario, and Quebec) have introduced the idea of legislation pertaining to concussions. Ontario passed Rowan's law in 2018, to enact sport safety legislation with the intent of improving concussion prevention, management and return-to-play for athletes. Notably, Newfoundland and Labrador (NL) still lags behind in any movement on legislation on sports related concussion.

While it is a positive step that legislation is being discussed regarding sports related concussions, there has been limited research completed on the impact of registration/laws as to whether or not schools, or sport clubs use guidelines advocated in federal or provincial legislation or how that legislation has impacted education programs.[3,14,32,42,44,50–52] Numerous concussion studies on coaches, parents and athletes knowledge have been conducted,[9–11,13,21–24,37,38,41,47,53,54] since laws and legislation has been passed, but the link with SRC reduction as a result of these changes in current sport practice is less clear.

In summary, research conducted on the impact of coaches' knowledge and response to concussion management remains challenging and ambiguous. Therefore, it is timely that this research study conducted in NL may be a starting point in the management of sport related concussion within the adolescent population.

3. METHODS

3.1 Design

Using a non-experimental design coach's knowledge was measured using education tools Pocket Concussion Recognition Tool, Concussion Guidelines for the Coach/Trainer and Guidelines for Return to Play after a Concussion that were developed by Parachute Canada.[6] The researchers obtained written permission from the author to utilize and modify the tool for use in this study. The tool had been previously validated for adequate face validity, test-retest reliability, and adequate construct validity for knowledge. The Cronbach a for knowledge construct (Cronbach a 0.72) and attitude constructs (Cronbach a 0.80) was calculated on the survey instrument.[55]

The modified instrument was titled Coaches' Knowledge of Sports Related Concussive Injury in the Adolescent Athlete Survey. The survey contained a 10-item participant and demographic section and the remaining 17-items were multiple choice questions assessing coaches' concussion knowledge. The authors looked specifically at coaches' age, and number of years coaching related to concussion knowledge; concussion management and knowledge of return-to-play activities.

The questionnaire was pilot tested for readability, clarity, and content validity by two class B coaches. Overall, the coaches agreed that the content of the survey was appropriate, valid and clear.

3.2 Population

A convenience sample of participants, aged 21 and older (N = 120) who coached adolescent athletes in soccer, football, basketball and hockey, through sport organizations and school physical education programs in NL, were recruited for this study. Recruitment occurred through primary designates of four provincial sports associations and all school principals responsible, within the general education system, for Grades 7-Level 4 with an adolescent population.

To aid sample procurement, a letter/email describing the research study and seeking research participants, was sent to the presidents of four provincial sports associations and to all school principals responsible for the adolescent population. The researchers requested that the online questionnaire be forwarded to all coaches responsible for coaching adolescents in sport. The principal investigator contacted all presidents and school principals twice to remind them of forwarding the email to the coach designate. Completing the survey was taken as implied consent to participate in the study. Data was kept on a computer system accessible only to the researchers.

3.3 Procedures

Data was analysed using the Statistical Package for Social Sciences (SPSS). Descriptive statistics were used to explore the data and relationships among variables. Subscales were created for concussion knowledge; concussion management and knowledge of return to play activities.

3.4 Ethical considerations

Ethical approval was obtained from the NL Health Research Ethics Board, the Newfoundland and Labrador English School District (NLESD), Newfoundland & Labrador Soccer Association (NLSA), Football Newfoundland and Labrador (FNL), Basketball Newfoundland and Labrador (BasketballNL) and Hockey Newfoundland & Labrador (HockeyNL).

4. RESULTS

One hundred and twenty (120) schools were contacted based on adolescent age criteria. Twenty-three (23) schools reported no sports program were offered; the school was too small or the learner profile was inappropriate. Thirty-one (31) school contacts (principal) affirmed receipt of study request and willingness to contact the coach designate. Sixty-six (55%) schools did not respond to the initial or follow-up email from the primary author. Three sports organizations agreed to contact the coach designate(s). One sport organization decided not to participate in the study. A total of N (26) surveys were completed. The majority of participants were from the Eastern (61.5%) region of the province given it is the largest populated geographical area in NL. The remaining participants came from the Central (11.5%), Western (19.2%), and Labrador (7.7%) regions of the province. The majority of the coaches who participated (see Table 1) were male and were under 55 years of age. Majority of the participants reported highest level of education completed was university 24 (92.3%), with 42.3% reporting between 1-15 years of coaching experience and 57.7% with 17-21+ years of coaching experience. All participants received some level of coaching certification.

Table 1. Demographics of participants

Variables	Frequency (%)	Mean	Standard Deviation
Age groups		3.3462	.84580
Age (26-35)	19.2%		
Age (36-45)	30.8%		
Age (46-55)	46.2%		
Age 55 +	3.8%		
Gender		1.1923	.40192
Female	19.2%		
Male	80.8%		
Highest level of Education		2.8846	.43146
High school	3.8%		
College	3.8%		
University	92.3%		
Number of Years Coaching		3.3462	1.57334
1-5	23.1%		
6-10	7.7%		
11-15	11.5%		
16-20	26.9%		
21+	30.8%		

Majority of participants were knowledgeable of what is a concussion, its causes, and what visual clues observed indicate a possible concussion in a player. Majority of the participants were also knowledgeable of the concussion symptoms in a player and that when a player receives a second concussion healing will take longer.

When comparing age and concussion knowledge varied responses were reported to high speed stops as an example of sport specific activity with body contact (see Figure 1); with only the 55+ age group choosing correctly. When comparing age and return-to-play the majority of the participants were incorrect. When asked what step in the return to sport activity

indicates that the player can participate for 20-30 minutes and have no contact, the majority of age groups chose the incorrect response (see Figure 2).

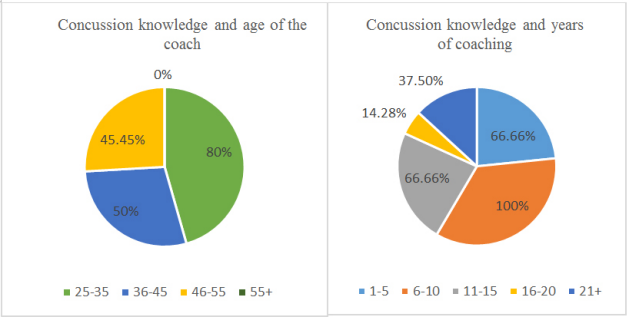

Figure 1. Age of coach and percentage of incorrect responses to high speed stops as an example of concussion knowledge and a sport specific activity with body contact; only the 55+ age group responded correctly. Years of coaching and percentage of incorrect correct responses to high speed stops as an example of concussion knowledge and a sport specific activity with body contact. All participants in the 6-10 years coaching group chose incorrect responses.

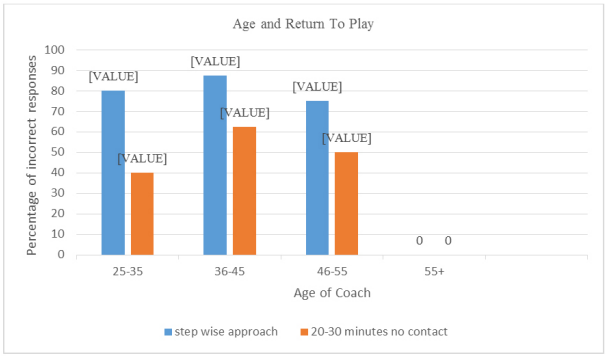

Figure 2. Age of coach and percentage of incorrect RTP responses in the step-wise approach, and how long must each step take before progressing to the next and what step in the return to sport activity indicates that the player can participate for 20-30 minutes but have no contact. The > 55 was the only age group that chose the correct response for both questions.

When comparing age and concussion management, participants in the 36-45 age group chose alternate options (25%) to the correct response of transport by ambulance compared to 16.7% in the 46-55 age group. There were mixed responses in relation to the question *if the coach suspects a concussion what is a good question to ask the player to assess player memory*, 20% [26-35 age group]; 50% [36-45 age group]; and 25% of participants [46-55 age group] choosing the incorrect response. Only the >55 years age group responded correctly.

All age groups had knowledge of who clears a player to return to sport play after a concussion, as well as when can a player return to full sport activities.

When compared, concussion knowledge and the number of years coaching, majority of the participants were knowledgeable of what is a concussion, its causes and what visual clues observed indicate a possible concussion in a player in all experience (# of years coaching) levels. Majority of the participants were also knowledgeable of what are the symptoms of a concussion in a player. For coaching years and concussion knowledge (see Figure 1) incorrect responses varied on the question surrounding *high speed stops as an example of sport specific activity* with body contact with all participants in 6-10 years responses being incorrect.

In comparing number of years coaching and concussion management, majority of the participants were knowledgeable of not to leave the player alone with suspected concussion (100%). There were mixed responses however in assessing player memory, with 16.7% (1-5), 100% (6-10), 28.6% (16-20), and 37.5% coaching 21 or greater years choosing the incorrect response.

In relation to return-to-play knowledge after a concussion, the years of coaching group showed incorrect responses for both the step wise approach and the 20-30 minute player participation with no contact (see Figure 3). Fifty percent or greater in all groups chose incorrectly for the step wise approach. While there were varied responses when asked what step in the return to sport indicates that the player can participate for 20-30 minutes and have no contact; 50% or greater in the 6-10 years; 11-15 years; and in the 16-20 years coaching chose incorrectly.

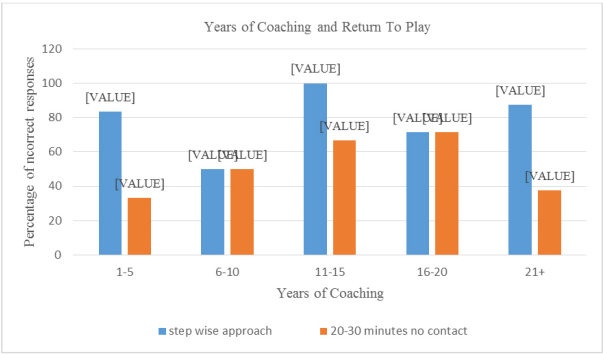

Figure 3. Years of coaching and percentage of incorrect responses in the step-wise approach to concussion and how long must each step take before progressing to the next. What step in the return to sport indicates that the player can participate for 20-30 minutes and have no contact, 71.4% in the 16-20 years of coaching responded incorrectly to both questions.

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Having attended concussion education, 53.8% of coaches reported sessions provided (73.1%) by their organization, with 69.2% being aware of organizational policies regarding attendance at concussion training. However, 46.2% did not attend any concussion education, 26.9% reported not being provided with concussion education and 30.8% of the participants reported no policies on coaching education within their organization.

Having had attended an education concussion session or not showed no difference on return-to-play knowledge in the step wise approach progression as the majority responded incorrectly with 71.4% (attendance on concussion education) versus 91.7% of participants (no attendance on concussion education), respectively. Despite attendance at a concussion education session, when asked what is a sport-specific activity with body contact, 53.8 of that group chose incorrectly.

Number of years coaching and concussion education attendance, both groups whether having attended an education session (28.5%) or not (33.4%), reported incorrect responses for player memory assessment. Both groups also reported incorrect responses for coach management associated with player complaints of arm and leg weakness after a body check, 14.35% in the education session group and 16.7% in the non-education group. Additionally, when asked what step in the return to sport indicates that the player can participate for 20-30 minutes and have no contact, 42.8% who had attended a concussion education session and 66.7% who did not attend a concussion education session chose incorrectly. Both groups (attended concussion education session and not) were aware of who clears a player to return to sport play after a concussion, as well as when can a player return to full sport activities.

5. DISCUSSION

To our awareness this is the first study to assess coaches' knowledge regarding recognition of and response towards sports related concussive injury in the adolescent in NL. The findings demonstrate that coaches have knowledge on concussion specifically what is a concussion, its causes, and what visual clues observed that indicate a possible player concussion. This is consistent with the literature demonstrating that coaches have knowledge of concussion cause and symptoms however some gaps in concussion knowledge and transfer of that knowledge to concussion management still exist.[1,22–24,28,31,40,44,54]

Age of coach and percentage of correct responses to high speed stops, as an example of sport specific activity with body contact; the majority of coaches < 55 years, incorrect responses ranged from 45.45% to 80% with only the 55+ age group (100%) responding correctly. The understanding of and exposure to high speed stop may have different meaning and interpretation for some of the participants. That is to say the older the coach, their knowledge of roles and responsibilities and life coaching experiences may have influenced their response. Age and percentage of incorrect responses for RTP was high for coaches < 55 years, a similar finding in the literature.[31] The younger age of the coach, less experience with roles and responsibilities and the recall of concussion knowledge may have resulted in incomplete knowledge transfer in the coaches' interpretation of on field maneuvers/actions by athletes.

Concussion knowledge of coaches and the importance of knowledge transfer in the prevention of concussion is congruent with research findings.[1,10,21,29,54] In this study, years of coaching and percentage of incorrect responses to high speed stops reported 66.6% from the 1-5 and 11-15 groups, 100% in the 6-10 years group and 37.5% of the 21+ years of coaching group. Only the 16-20 years coaching group had fewer incorrect responses at 14.28%. This study did not examine the number of years coaching and knowledge transfer and therefore cannot account for this finding. However, gaps in concussion knowledge and transfer of that knowledge to concussion management is consistent with the literature.[1,22–24,28,31,40,44,54]

Almost half of the participants in this study (46.2%) did not attend an education concussion session, with (30.8%) indicating their organization/agency did not have concussion education policies. Coaches who responded in this study may have not been aware that their organization provided concussion education. Equally the sport and school organizations may not have clearly communicated concussion education as a requirement for all who coach the adolescent population and is congruent with research findings.[32,42]

Despite attendance on education concussion in this study incorrect responses were reported for knowledge of sport specific activity with body contact. Lack of awareness of body contact, its impact on the concussion, has been suggested by some researchers as barriers to knowledge transfer and RTP decision making.[1,29,36]

The findings for this study indicate that coaches' knowledge, return-to-play knowledge and the step wise approach in concussion management are insufficient and corresponds with numerous research findings.[3,8,14,30,33,50,52] This study did not examine the RTP concussion management and the retention of concussion knowledge over time. That is to say the interval between when concussion education had occurred and the retention of that knowledge and recall, may have influenced participants' responses. Coach attendance at con-

cussion education sessions can impact concussion prevention and improve concussion management is a consistent finding in the literature.[8, 16, 20, 24, 28, 30–32]

While the overall response rate for this study was low the information in concussion education sessions is not retained or interpreted appropriately or the lapse of time between the provision of education sessions and its application to the sport setting impede knowledge transfer. Concussion education and knowledge of RTP protocols is essential in the prevention of further cognitive or physical injury and aid on field management by coaches.[10, 21, 24] The needs of the intended audience prior to developing an education program is crucial and may potentially have an impact on the knowledge transfer for intended coaches. Equally necessary is that coaches examine their own biases regarding concussion and concussion management as this will have a trickledown effect on athletes.[46]

Attendance at a concussion education session and sport and school organization policy/legislation awareness are all contributory factors to coaches' overall knowledge on concussion and contribute to its effective management.

Study limitations

There were several limitations to this study. The convenience sample procured via professional and sport organizations may not be a true representation of the broader population of Canadian coaches and therefore may not be generalizable. The respondents self-reporting, responding in a socially desirable manner, may introduce response bias.

The survey response rate (26%) was small for this study. Some respondents may have been contacted and intended to participate in the study but did not complete the online survey. The length of time of being a coach may have influenced participation. The less time involved in coaching, the less familiar the respondent would be to concussion knowledge. The survey multiple choice questions may have represented more than one subject area or may have been interpreted and evaluated differently by the participants'; resulting in different responses. Accessibility and survey fatigue may have also contributed to low response rates.

The primary author accessed sport organizations and a provincial list of predetermined junior high and high school principals within four geographical regions of the province, informing them of the study and sought their assistance for coach contact. Communication was required through several levels of both sport organizations and academic administration, a factor that may have hindered sample procurement. Eighteen (18) principals reported the size of the school as too small for sports programs or no sports program offered. Sixty-six (66) did not acknowledge receipt of initial or subsequent email requests and may have not contacted coaches for participation as requested. Five (5) principals reported their school as inappropriate based on learner profiles. A random sample of pre-identified coach participants may have assured better communication and a greater response rate.

This study did not assess parent or player understanding of concussion policies and return to school and play activities. This knowledge, as stakeholders of sport activity, may have contributed to concussion knowledge overall for the adolescent population. Research on parental knowledge, athlete knowledge, coaches' knowledge, return-to-play guidelines, and policy/legislation directives all have an impact on concussion knowledge in general, as one has influence on the other and ultimately prevent injury and protect players.

6. Conclusions

Much attention surrounds concussion and concussion management in children and youth populations. Consequently, what does this attention mean for adolescents playing at any sports level? Benefits gained through this research study will serve to evaluate coaches' knowledge and improve standardized concussion management and consistent messaging of Return-to-Play protocols for local and regional sports organizations in NL for the adolescent population. Attendance at concussion education sessions and sport and school organization policy/legislation awareness are all contributory factors to coaches' overall knowledge on concussion and contribute to its effective management. The transfer of knowledge regarding concussion and concussion management to coaches of all levels; with early recognition, physical and cognitive rest, timing of when the athlete can return to play along with adolescents education on concussion; are fundamental in SRC prevention.[1] Other potential benefits are to encourage adolescent safe behaviors and the reporting of concussive symptoms to coaches in sport.

The researchers of this study recommend further exploration of coach knowledge in concussive injury in younger populations of children and youth, given longer recovery times. Equally parental perception of adolescent athlete concussion recovery could be explored. Additional research on the impact of registration/law as to whether or not schools, or sport clubs are using guidelines as advocated by sport organizations and government would be of benefit. Research that would ultimately influence concussion legislation with any changes in current sport practice is critical. These actions have the potential to reduce burden on long-term negative health outcomes.

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CONFLICTS OF INTEREST DISCLOSURE

The authors declare no conflicts of interest.

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