INTRODUCTION

Concussion has become a major public health priority in recent years resulting in an abundance of published research in the medical literature. The substantial level of research in the area is predicated on sport-related concussion (SRC) being a potential risk to the short- and long-term quality of life of athletes of all ages, sexes, and levels of play. Although because of current scientific limitations, the understanding of this topic remains in its infancy. A universal standardized definition of SRC remains elusive. The scientific community remains divided on several key aspects of SRC including: identification methods, management and return-to-play protocols, recovery diagnoses, and the potential links between repeated concussive and subconcussive blows with the onset of early neurodegenerative diseases. However, despite divergent opinions, there is an across-the-board acceptance of SRC being a significant health priority in adolescent sport, and the need to reduce its prevalence and to manage the injury safely is unquestionable.

The prevalence of SRC is higher in contact- and collision-based sports than noncontact sporting activities. As youth athletes seem to be at a heightened risk of concussion and its associated negative effects, the prompt removal from play and management of the injury for athletes in such sports is crucial. There is an onus on the individual athlete to honestly disclose the presence of any potential concussive symptoms to allow for a medical assessment to be undertaken. Previous research on youth athletes has emphasized several barriers that deter their honest disclosure of potential concussive events. An athlete’s desire to win an important game or not miss a future game, a fear of telling the coach they are injured, and not wanting to let the team down are common examples of the barriers hindering their honest concussion reporting. The influence of such barriers on concussion reporting may vary according to the sex of the athlete.

Over the past decade, the education of important stakeholders such as athletes, parents, coaches, and medical personnel on the dangers of SRC has become a topical area of research. The effective transfer of information and guidelines from clinical research into everyday practice is a difficult task. The efficacy of numerous educational strategies, such as the use of informational handouts, audio-visual presentations, and concussion educational videos and computer games, to effectively disseminate concussion-related information has been investigated. Unfortunately, many past interventions have methodological flaws that need to be...
METHODS

Sample Selection

Irish secondary schools (n = 45) and sports clubs (n = 78) were invited through email to participate in the study between January 2016 and September 2017. Ten secondary schools (22.2%) and 31 sports clubs (39.7%) agreed to allow their athletes to take part in the research. Athletes were eligible to participate if they were aged 12 to 18 years and currently played either rugby union, GAA (Gaelic football, hurling, or camogie), or soccer at an amateur level at the time of testing. The sample was subcategorized according to the sex of the participants. Before testing, the principal investigator visited each school and club to outline the design and purpose of the research. The respective parents or guardians were also informed of the study through letter and email. Participation was voluntary, and the anonymity of the athletes was preserved. No parent or athlete objected to the study, and the research was permitted by the Institute of Technology, Tallaght, Dublin’s Research and Ethics Committee.

Instrumentation

A brief cross-sectional survey instrument consisting of a mixture of dichotomous and multiple choice styled questions (9 questions) was administered to the athletes (see Supplemental Digital Content 1, http://links.lww.com/JSM/A187). Before testing, the survey instrument was reviewed by a panel of 3 experts to determine content validity. Each question was evaluated for relevancy, and needed unanimous approval by the expert panel to be included in the survey. Each question was determined as relevant; yet, the terminology used in 2 of the questions was simplified to ensure that there was no misunderstanding or confusion among the students. A pilot test was conducted using a randomized sample of 50 athletes (n = 29 males and n = 21 females) across 3 and 7 of the participating schools and clubs, respectively. To assess for internal consistency reliability, the pilot sample completed the survey on 2 occasions with a 7-day period between the first and second round of testing. The survey recorded a Cronbach alpha score of 0.91 and so, was deemed a reliable measure of an athlete’s concussion educational history and preferred future methods of education.

The survey was comprised 2 sections and took approximately 10 minutes to complete. The first section examined the athletes’ demographic information. The second section questioned athletes on their concussion educational history and their favored methods of future SRC education. This section was split into 3 categories: (1) educational messenger, (2) modality, and (3) areas of concussion-related interest.

Procedure

Under supervision of the principal investigator, one paper survey was administered per athlete in an examination environment. Testing was performed in groups ranging from 10 to 50 students at the premises of the participating schools and clubs between March 2016 and September 2017. All participating athletes within the same school or club were tested on the same day to limit athlete interaction.

Analysis

Descriptive statistics were used to calculate the athlete frequency responses in each category of the survey (educational messenger, modality, and areas of interest). The data for each category were split according to sex and educational history and were examined using separate contingency tables. A Pearson χ² test of association was used to compare the proportion of responses for each above variable. An alpha priori level of 0.05 was chosen for the study, and all

Clinical Relevance

The effective transfer of concussion knowledge from clinical research into practice in adolescent sport is a difficult task. Currently, no research has explored the opinions of adolescent athletes in the designing of knowledge translation strategies for concussion-related information. Generalized educational strategies may be ineffective methods of educating athletes about SRC, and efforts to design interventions in a population appropriate manner should be explored. A screening of athlete interests on SRC education should be undertaken to allow for a tailored intervention to be developed and to allow for the outcomes to be evaluated, subsequently. If athletes are cognitively engaged throughout the knowledge translation process, they may have a better chance of retaining a long-term knowledge of the material provided.

To date, only 2 studies have investigated athletes and coaches on their opinions of past concussion education they have received and their favored future educational strategies. Using an online survey, Kroshus et al23 and Sullivan and Molcho26 screened US collegiate athletes and Irish Gaelic Athletic Association (GAA) coaches, respectively. Kroshus and Baugh23 found that 57% and 54% of the athletes sought a lecture and a video, respectively, compared with only 27% who sought an informational handout as their educational modality of choice. Forty percent of their sample wanted their coach to be involved in their concussion education. Sullivan and Molcho26 found only 10% of coaches discussed concussion with their athletes before the commencement of their current sporting season. Approximately two-thirds of the coaches in their study believed “in-person training” would be the most efficacious method for educating coaches on concussion. No research has been conducted on adolescent athletes (12-18 years). Therefore, the aim of this study was to screen male and female adolescent athletes on their concussion educational histories and preferred future methods of concussion education. The study aimed to: (1) assess the difference in previous concussion education rates between male and female athletes, (2) examine the impact of sex on an athlete’s desired education on concussion in terms of educational messenger (the individual who would perform the intervention), modality, and content, and (3) test whether methods used in previous concussion educational interventions are matching the preferred future educational methods of the athlete sample.

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descriptive and inferential statistical analyses were performed using SPSS statistical software version 24 (IBM Corporation, Armonk, New York).

RESULTS

In total, 2502 athletes undertook the survey instrument; however, 38 athletes failed to complete the survey. Thus, their responses were discarded from the findings leaving 2464 athlete responses (1854 = males and females = 590) eligible for review. The sample consisted predominantly of rugby players (44.9% , n = 1097), followed by soccer (32.7%, n = 800) and GAA (22.4%, n = 547) players. 33.2% (n = 860) reported receiving previous education on SRC with 19.7% (n = 482) of athletes receiving some education in the past 12 months. The concussion educational histories of the sample are subcategorized by sex in Table 1. Male adolescent athletes have received significantly more previous education on SRC than female athletes in rugby (44% vs 22.5%; \( \chi^2 = 21.3, P < 0.001 \)), GAA (35.7% vs 14.4%; \( \chi^2 = 16.2, P < 0.001 \)), and soccer (40.2% vs 12.7%; \( \chi^2 = 36, P < 0.001 \)).

Sex also played a significant role in the preferred educational methods within the sample (\( \chi^2 \geq 546, P < 0.001 \)). With regards to modality, male athletes were significantly more inclined to opt for an “interactive” (46% vs 12%; \( \chi^2 = 13.7, P < 0.001 \)) or “on-field demonstration” (42% vs 16%; \( \chi^2 = 84.3, P < 0.001 \)) compared with female athletes who had a greater desire for an “informational handout/poster” (8% vs 40%; \( \chi^2 = 289.2, P < 0.001 \)) than males. With reference to educational messenger, male athletes were more likely to choose a “professional/famed coach” (71% vs 30%; \( \chi^2 = 254.4, P < 0.001 \)) or “professional/famed player” (69% vs 35%; \( \chi^2 = 82.5, P < 0.001 \)) than females. Both male (45%) and female (67%) athletes sought their coach to be involved in their concussion education. In terms of concussion-related areas of future learning, female athletes had a considerably greater interest in the potential “long-term complications” (38% vs 57%; \( \chi^2 = 37.4, P < 0.001 \)) of SRC and “impact on academics” (20% vs 63%; \( \chi^2 = 258.7, P < 0.001 \)), whereas male athletes had considerably more eagerness to understand the “short-term complications” (79% vs 62%; \( \chi^2 = 17.1, P < 0.001 \)) of SRC and the “impact on athletic performance” (71% vs 33%; \( \chi^2 = 102, P < 0.001 \)) (Table 2).

DISCUSSION

This study sought to examine the concussion educational histories, preferred future educational methods, and concussion-related areas of interest in a large cohort of adolescent athletes. In the United States and Canada, education on SRC is mandated for youth athletes under new government legislation.27,28 No concussion-related legislation has been passed outside of North America leaving an increased responsibility on Irish sporting organizations to educate their athletes. Regrettably, there is still a worrying lack of concussion education in adolescent athletes. Young athletes (<18 years) are more susceptible to SRC than older athletes and have protracted recovery times.29 Female athletes also seem to have a higher risk of suffering a concussion and its associated negative effects.30 However, it must be stated that the definitive underlying cause has yet to be established in the medical literature. This disparity may simply be a result of environmental factors rather than genetic differences.16,31 For instance, a surfeit of previous research has indicated that female athletes are more likely to report a potential SRC and seek medical care.13–17 Social stigma may be an influencing factor in this discrepancy, as it may be deemed more socially acceptable for female athletes to admit injury and seek aid than male athletes.13,16 Traditional masculine norms of physical resilience and winning have a negative relationship with athlete reporting intentions.46 Nevertheless, the significantly lower rate of previous concussion education in female athletes compared with their male counterparts in this sample (17% vs 41%) should be given consideration by their respective parents, clubs, and schools. Over 80% of the sample did not receive any education on SRC in the past 12 months indicating the need of Irish sporting organizations, schools, and medical bodies to explore effective knowledge translation strategies to disseminate concussion-related education to athletes on a nationwide scale.

There is a large disconnect between the past methods of concussion education athletes have received and their preferred future methods of education. Most athletes recalled receiving an “informational handout/poster” (50%) and/or a “general conversation” (51%) in their previous SRC education, despite only a small proportion of the overall sample favoring these modalities. The use of a handout or poster has become common practice in the concussion education of athletes.42 However, the efficacy of these passive approaches in modifying behavior has been questioned.43 Currently, the use of online platforms for concussion education is failing to match the needs of the athletes (Table 2). With the emergence of readily accessible smartphones, 92% of adolescents’ report being online daily with 71% using more than one social media application.44 Research into Internet-based applications such as Facebook34 and Twitter35 has highlighted their potential ability to educate a wide range of adolescent athletes on SRC. To date, many Irish sporting organizations are failing to provide transparent, informative, and consistent information on SRC on their respective web sites.36 A recent review of concussion educational web sites also found varying standards of content, delivery, and readability of information.37 Future research into the knowledge transfer of concussion-related information using social media and other online platforms is warranted.38

Previous research has proposed tailoring concussion education for differing members within a sample population according to certain concussion modifiers including age39 and concussion history.40 Within the sample, the preferred methods of education of male athletes differ significantly from female athletes. Therefore, it may also be advantageous to modify future interventions according to the sex of the athletes. As displayed in Table 2, male athletes were significantly more likely to choose an “interactive demonstration” (46% vs 12%) and/or an “on-field demonstration” (42% vs 16%) as their modality of choice than female athletes. Chinn and Porter41 emphasized the potential value of a procedural learning approach to concussion education by educating athletes in a setting representative of a game-day environment. If athletes are taught in a slow-paced environment through a lecture or video for example, their cognitive faculties may be ill-equipped to access this information during the contrasting demands of a hectic and adrenaline-filled game scenario.41 “On-field” educational strategies may be an effective, yet
vastly underused method of educating athletes on SRC and should be explored further in future research.

Most female athletes (70%) seek a “medical professional” as their concussion educational messenger (Table 2). With recent legislature in youth sport, medical professionals have an increased responsibility in the identification and management of SRC. For instance, statewide US legislation mandates a clinical diagnosis of the injury and written clearance from a medical professional before returning to play. As female athletes also seek medical personnel in their concussion education, it is imperative that these personnel have up-to-date knowledge of SRC, have the confidence to educate athletes, and can effectively distribute concussion-related medical information to their lay audience.

By contrast, male athletes are keen to have a “professional/famed player” (71%) or “professional/famed coach” (69%) in the educational process (Table 2). The novelty of having an inspirational figure leading their concussion education seems important within the male sample. If these famed figures provide their own insight into the negative complications of underreporting and encourage honest disclosure of concussive symptoms, it may resonate with athletes and facilitate a positive behavior change. In alignment with previous research on collegiate athletes, 50% of the sample wish for their own coach to be a part of their future concussion education (Table 2). Previous research has also highlighted the influence of the coaches’ approval on their athletes’ decision-making processes. As coaches have a considerable impact on their players, they have an obligation to promote a positive reporting culture where athletes will not be punished for openly disclosing their injury. Annual educational strategies to improve coach knowledge, attitude, and compliance to SRC management guidelines are warranted.

**Limitations**

The study used a single methodological approach utilizing a quantitative questionnaire. Future qualitative research of a target population may be used to delve deeper into their rationale and motivation behind their concussion educational interests before designing an appropriate intervention. Albeit, large in quantity, the sample population was restricted to adolescent athletes playing in one of 3 sports, and thus, may reduce the generalizability of the findings. As this was the first

| TABLE 1. Athlete Demographics and Educational History |
| --- |
| **Sport** | **Male** | **Female** | **Total (n)** |
| Rugby | 866 | 231 | 1097 |
| Soccer | 587 | 213 | 800 |
| GAA* | 401 | 146 | 547 |
| **Total** | 1854 | 590 | 2444 |

| Concussion Educational Histories of Male and Female Athletes |
| --- |
| **Modality** | **Total** | **Male** | **Female** |
| **n = 760 (41%)** | **n = 100 (16.9%)** | **n = 860 (35.2%)** |
| Handout/poster | 374 (49.2%) | 52 (52%) | 426 (49.5%) |
| Web site/social media | 188 (24.7%) | 27 (27%) | 215 (25%) |
| Educational video | 80 (10.5%) | 5 (5%) | 85 (9.9%) |
| PC/video game | 7 (0.9%) | — | 7 (0.8%) |
| Presentation | 149 (19.6%) | 15 (15%) | 164 (19.1%) |
| General conversation | 388 (51.1%) | 54 (54%) | 442 (51.4%) |
| Interactive demonstration | 9 (1.2%) | — | 9 (1%) |
| On-field demonstration | 11 (1.4%) | — | 11 (1.3%) |
| Other | 14 (1.8%) | 4 (4%) | 18 (2.1%) |

| **Messenger** | **Total** | **Male** | **Female** |
| --- |
| Parents | 212 (27.9%) | 35 (35%) | 247 (28.7%) |
| Coach | 225 (29.6%) | 21 (21%) | 246 (28.6%) |
| Teacher | 109 (14.3%) | 7 (7%) | 116 (13.5%) |
| Physio | 35 (4.6%) | 5 (5%) | 40 (4.7%) |
| Guest speaker/specialist | 78 (10.3%) | — | 78 (9.1%) |
| Fellow player | 47 (6.4%) | 8 (8%) | 57 (6.6%) |
| Medical professional | 141 (18.6%) | 12 (12%) | 153 (17.8%) |
| Professional/famed player | 29 (3.8%) | 2 (2%) | 31 (3.6%) |
| Professional coach | 10 (1.3%) | — | 10 (1.2%) |
| Other | 6 (0.8%) | 3 (3%) | 9 (1%) |

*GAA, Gaelic Athletic Association consisting of Gaelic football, hurling, and camogie athletes.*
study to investigate the concussion educational interests of adolescent athletes (12-18 years), the application of the findings in future interventions is inconclusive. Future research on the efficacy of incorporating the athletes’ preferred methods of concussion education in the designing of knowledge translational strategies is needed.

**CONCLUSIONS**

Female athletes have received significantly less previous education on concussion in sport. Although both sexes seek further education on concussion, there is a significant difference in their preferred methods of future education. When establishing suitable concussion educational interventions, allowing athletes to voice their opinion on which information is disseminated, who delivers it, and how they deliver it, may be a simple approach to retain athlete cognitions throughout the educational process. There is a disconnect between previous concussion education received and future education desired among adolescent athletes. However, in improving concussion knowledge in adolescent sport, no empirical evidence is available on the efficacy of

| TABLE 2. Preferred Methods for Future Concussion Education |
|----------------------------------------------------------|
| (n) of athletes seeking further education on SRC | Total | Male | Female | Total (n) |
| 1758 (94.8%), n = 1758 | 570 (96.6%), n = 570 | 2328 (95.3%), n = 2328 |
| **Modality** | | | | |
| Handout/poster*† | 132 (7.5%) | 226 (39.6%) | 348 (14.9%) |
| Web site/social media/mobile app*† | 963 (54.8%) | 239 (41.9%) | 1202 (51.6%) |
| Educational video*† | 241 (13.7%) | 125 (21.9%) | 366 (15.7%) |
| PC/video game*† | 255 (14.5%) | 28 (4.9%) | 283 (12.2%) |
| Presentation*† | 127 (7.2%) | 88 (15.4%) | 215 (9.2%) |
| General conversation*† | 133 (7.6%) | 74 (13%) | 207 (8.9%) |
| Interactive demonstration*† | 802 (45.6%) | 68 (11.9%) | 870 (37.4%) |
| On-field demonstration*† | 743 (42.3%) | 90 (15.8%) | 833 (35.8%) |
| **Areas of interest** | | | | |
| Signs and symptoms | 1465 (83.3%) | 503 (88.2%) | 1968 (84.5%) |
| Incidence | 619 (35.2%) | 194 (34%) | 813 (34.9%) |
| Short-term complications* | 1389 (79%) | 352 (61.8%) | 1741 (74.8%) |
| Long-term complications* | 662 (37.7%) | 324 (56.8%) | 986 (42.4%) |
| Importance of self-reporting | 496 (28.3%) | 133 (23.3%) | 631 (27.1%) |
| Impact on athletic performance* | 1253 (71.3%) | 188 (33%) | 1461 (62.8%) |
| Impact on academic performance* | 355 (20.2%) | 360 (63.2%) | 715 (30.7%) |
| Prevention | 1133 (64.4%) | 367 (64.4%) | 1500 (64.4%) |
| Educational strategies | 124 (7.1%) | 29 (5.1%) | 153 (6.6%) |
| Management/Return-to-Play | 1201 (68.3%) | 403 (70.7%) | 1604 (68.9%) |
| Current/future technologies* | 532 (30.3%) | 103 (18.1%) | 635 (27.3%) |
| Legislation | 134 (7.6%) | 49 (8.6%) | 183 (7.9%) |
| Misconceptions/media* | 359 (20.4%) | 193 (33.9%) | 552 (23.7%) |
| Safety equipment* | 385 (21.9%) | 287 (50.4%) | 672 (28.9%) |
| High-profile cases | 656 (37.3%) | 187 (32.8%) | 843 (36.2%) |
| **Messenger** | | | | |
| Parents*† | 137 (7.8%) | 72 (12.6%) | 209 (9%) |
| Coach*† | 784 (44.6%) | 379 (66.5%) | 1163 (50%) |
| Teacher*† | 138 (7.8%) | 73 (12.8%) | 211 (9.1%) |
| Physio* | 86 (4.9%) | 48 (8.4%) | 134 (5.8%) |
| Guest speaker/specialist*† | 664 (37.8%) | 311 (54.6%) | 975 (41.9%) |
| Fellow player* | 94 (5.3%) | 86 (15.1%) | 180 (7.7%) |
| Medical professional*† | 451 (25.7%) | 399 (70%) | 850 (36.5%) |
| Professional player*† | 1246 (70.9%) | 169 (29.6%) | 1415 (60.8%) |
| Professional coach*† | 1205 (68.5%) | 197 (34.6%) | 1402 (60.2%) |

* Significant difference in the preferred method of education between male and female athletes (P < 0.05).
† Significant difference between previous education received and future education desired within the sample (P < 0.05).
tailoring knowledge translation strategies to meet the specific needs of the athletes. Thus, future research is warranted.

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