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SPORT-RELATED CONCUSSION KNOWLEDGE IN FRENCH-SPEAKING ATHLETES, COACHES, AND HEALTH CARE PROFESSIONALS: RESULTS FROM AN INTERNATIONAL SURVEY ON 2073 PARTICIPANTS

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KEYWORDS: concussion; education; head injuries; health knowledge; mild traumatic brain injury; prevention; sports injuries.

ABSTRACT

Objective: Evaluating sports-related concussion (SRC) knowledge, awareness of evaluation tools and management protocols, and access to educational resources within the French-speaking sports community in Canada and Europe.

Design: Cross-sectional, anonymous online survey.

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Participants: French-speaking athletes, coaches, and health care professionals (HCPs).

Intervention: The electronic survey consisted of 33 questions that can be grouped into the following 3 categories: (1) SRC knowledge assessment through self-report and general knowledge questions, (2) awareness of internationally recommended detection tools and managements protocols, and (3) access to educational resources. The survey was codeveloped with athletes, coaches, and HCP and validated by and expert panel.

Main outcome measures: A SRC knowledge score was built based on answers to 4 questions on SRC mechanisms, symptoms, and management. Awareness of the Sport Concussion Assessment Tool 5, the Concussion Recognition Tool 5, and the 6-step return to sport protocol were collected with coaches and HCPs.

Results: Overall, 2073 participants responded to the survey, comprising 48% athletes, 33% coaches and 19% HCP. Knowledge scores (/100, median [IQR]) were highest among HCPs [98.1 (96.2, 100)], followed by coaches [96.2 (73.1, 98.1)], and athletes [90.4 (67.3, 92.3)] with significant differences between the groups ($P < 0.001$). Participants from Canada demonstrated higher knowledge scores [92.3 (75.0, 98.1)] than those from Europe [75.0 (67.3, 96.2); $P < 0.001$]. Similar differences were observed for the awareness of recommended tools and the access to educational resources.

Conclusions: Knowledge translation strategies should be adapted to better reach the French-speaking sports community in Europe and further individualized according to professional role.

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INTRODUCTION

Concussion is a mild traumatic brain injury occurring after a direct or indirect external force to the head.[1] In 10% to 30% of cases, cognitive symptoms can persist beyond 4 weeks and lead to persisting symptoms that can significantly affect the quality of life and return to school or work.[2–4] Sport-related concussions (SRC) can account for more than half of all concussions, especially in youth.5 Incidence reports vary from 0.1 to 21.5 SRC per 1000 athlete exposures, underlining its impact on public health.[6,7] Evidence-based guidelines have been proposed by successive expert consensus to improve SRC management.2 On the field, the responsibility of recognizing SRC signs and symptoms and taking appropriate actions (eg, removing the athlete from the game) falls on coaches, health care professionals (HCP, when available), and the athletes themselves, depending on the setting (amateur or professional). To protect the athletes' health, these stakeholders need (1) sufficient general knowledge of SRC; (2) sufficient practical knowledge of SRC management, which implies; (3) proper access to educational resources on SRC knowledge and management.

General knowledge of SRC is a broad concept referring to health literacy, which represents the extent to which individuals in the sport environment (eg, athletes, coaches, HCP) can understand and interpret information to promote and foster safe and supportive environments.[8] Sport-related concussions health literacy thus represents an important driver for health behaviors and should be considered and assessed when building, implementing, and evaluating SRC-related tools. For example, investigations in high-school athletes have demonstrated important knowledge gaps related to prevention and management of SRC, with poor recognition and reporting of SRC symptoms.[9,10] Interestingly, the knowledge and attitudes around SRC were influenced by factors such as sex, age, concussion history, type of sport, and concussion education, among others.9 In addition, 2 systematics reviews have emphasized the insufficient level of SRC knowledge in coaches and identified significant knowledge gaps, including symptom recognition and misconceptions about prevention, recovery, and return to play.[11,12] By contrast, HCP in the high-performance environment seem to demonstrate adequate knowledge of SRC. For example, a study conducted in elite football in the United Kingdom showed that 97% of the 120 surveyed team physicians knew about international SRC guidelines.[13] These studies are however limited to SRC knowledge assessment of a particular subgroup (eg, athletes only, coaches only) and do not compare knowledge levels across professional occupations. Likewise, they are primarily conducted in North America and tend to focus on a particular setting and fail to perform cross-cultural comparisons (eg, across different countries or languages).

Regarding practical knowledge of SRC and its management, the international Concussion in Sport Group has developed and refined specific tools, such as the recently updated Sport Concussion Assessment Tool (SCAT) for HCP,[14] the Concussion Recognition Tool (CRT) for non-HCP[15] and standardized strategies for safely resuming sports [ie, 6-step Return to Sport (RTS)[2]] to better equip stakeholders in recognizing and managing SRC. But in contrast to SRC knowledge assessment studies, the literature is scarce regarding the implementation and reported use of these tools,

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particularly in amateur settings.[16] A systematic review focusing on SRC screening and diagnostic tools used in a field setting retrieved 26 studies, among which less than half reported the use of SCAT tools.[16] In the abovementioned elite football study, 78% of physicians indicated that their teams performed baseline concussion assessments, 99% of which used the SCAT.[13] Consequently, further evaluating the reported use of these tools and protocols becomes crucial to gauge whether end users effectively assimilate SRC health literacy and follow adequate practical knowledge for SRC management.

Finally, SRC knowledge and awareness of standardized management tools require access to appropriate educational resources. Sports-related concussion education and management tools are primarily developed in English with little, or very recent, consideration for translation and adaptation in different languages.[17] Underrepresented groups include the French-speaking community, which is glaringly absent from the current SRC literature, although French is the fifth native-spoken language worldwide, across 112 countries and 320 million people.[18] French-speaking SRC athletes and stakeholders might therefore be at risk of having inadequate SRC knowledge given the scarcity of tools and resources available in French.[19,20] A preliminary survey on SRC knowledge in 3 French-speaking sports medicine communities in Belgium, Switzerland, and Luxembourg highlighted important knowledge gaps, with half of the 36 participants unaware of SRC international guidelines.[21] This was especially pronounced in athletes and coaches, who also reported a limited access to SRC training and education, thereby suggesting insufficient health literacy.

Given these gaps and the need to refine future knowledge translation efforts and harmonize levels of SRC health literacy across French-speaking communities, this study focused on (1) the assessment of SRC knowledge; (2) the awareness of internationally recommended tools (ie, SCAT, CRT) and protocols (ie, 6-step RTS), as well as; (3) the access to educational resources on SRC among the French-speaking sports community, capitalizing on the representation of both Europe and Canada. Our aim was to characterize the current state of play to identify potential knowledge gaps and heterogeneity between geographic origin (Canada, Europe) and professional role (athletes, coaches, HCP), while accounting for modifying factors (age, sex, concussion history, sportrisk level).

MATERIAL AND METHODS

SURVEY DEVELOPMENT

To develop this survey, an initial literature review was conducted to identify relevant items for inclusion in the questionnaire. Previous surveys with similar constructs were examined,[22,23] and relevant items were extracted. These items were then discussed by an expert panel during dedicated meetings. The panel proposed additional items based on their scientific and clinical expertise. A final list of items to be included in the survey was determined through a consensus vote by the panel. The finalized list of items was subsequently translated into questions, forming the first version of the questionnaire. This initial version was reviewed by 6 HCP, 4 subelite athletes, and 4 coaches from all

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countries involved (ie, Belgium, Canada, France, Luxembourg and Switzerland), and modifications were made to create a second version. This second version was then pretested on a sample of 5 athletes, 5 HCP, 5 coaches, and 1 epidemiologist, and the updated version was considered final. The survey used 3 versions targeting athletes, coaches, and HCP and included the following common sections: (1) sociodemographic information [country, sex, sport(s), level of sport(s), years of experience, SRC history]; (2) SRC knowledge assessment [self-reported and tested with a knowledge score (%) based on 4 questions on SRC mechanisms, symptom recognition, and management, described in **Supplemental Digital Content 1** (see **Material**, http://links.lww.com/JSM/A520)], awareness of the latest available internationally recommended tools for HCP (SCAT-5) and coaches (CRT5) and 6-step RTS protocol; (3) access to educational SRC resources (availability of specific training, training materials)—detailed in supplementary material. The total length of each version of the survey varied between 25 and 33 questions depending on the branching logic. The full questionnaires (original in French and translated in English for review purposes only) are available in **Supplemental Digital Content 1** (see **Material**, http://links.lww.com/JSM/A520.

DATA COLLECTION AND PARTICIPANTS

An electronic anonymous survey link was shared through social media and institutional emails of the ReFORM institutions[19]: University and University Hospital of Liège (Belgium), Institut national du sport du Québec (Canada), National Institute of Sports, Expertise and Performance (France), Luxembourg Institute for Research in Orthopedics, Medicine and Science (Luxembourg), and Geneva University Hospitals (Switzerland) as well as with HCP associations and sports federations partnering with these institutions. The survey's introductory statement described the following eligibility criteria: being an athlete of 14 years and older (all levels and types of sport) or being an HCP involved in athletes' care (physician, physiotherapist, neuropsychologist, psychologist) or a coach/trainer of 25 years and older. The survey was hosted at SondageOnline (enuvo GmbH, Zurich, Switzerland) and was available from December 2020 to March 2021. The outreach of the questionnaire could not be assessed, as multiple diffusion sources were used (no participation rate available).

ANALYSES AND OUTCOMES

Statistical analyses were performed using R 4.2.1 (R Core Team, Austria). Descriptive analyses were performed using counts and frequencies for categorical variables and median and quartiles (because of the absence of normality of the distribution) for quantitative variables. Comparisons between occupation (athletes, coaches, HCP) and geographic origin (Canada, Europe) were performed using x^2 tests for categorial variables and Kruskal–Wallis or Wilcoxon tests for quantitative variables, with a significant threshold set at $P < 0.05$. When significant, post hoc Bonferroni-corrected pairwise comparisons were performed.

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TABLE 1. Sociodemographic Characteristics of the Study Sample Expressed as Counts and Frequencies

	n*	Athletes n = 998	n	Coaches n = 677	n	Health Care Professionals n = 398
Country	998		677		397	
Belgium		162 (16.2%)		219 (32.3%)		42 (10.6%)
Canada		635 (63.6%)		343 (50.7%)		111 (28.0%)
France		61 (6.1%)		25 (3.7%)		40 (10.1%)
Luxembourg		73 (7.3%)		36 (5.3%)		125 (31.5%)
Switzerland		14 (1.4%)		6 (0.9%)		19 (4.8%)
Other		53 (5.3%)		48 (7.1%)		61 (15.1%)
Sex	954		641		356	
Female		484 (50.7%)		143 (22.3%)		125 (35.1%)
Male		468 (49.1%)		496 (77.4%)		228 (64.0%)
Other/did not report		2 (0.2%)		2 (0.3%)		3 (0.8%)
Age	954					
14–18 yrs		465 (48.7%)				
19–25 yrs		316 (33.1%)				
26–30 yrs		69 (7.2%)				
31–35 yrs		29 (3.0%)				
>35 yrs		75 (7.9%)				
Years of education	953		641			
<12 yrs		363 (38.1%)		120 (18.7%)		
12–15 yrs		400 (42.0%)		293 (45.7%)		
15–18 yrs		160 (16.8%)		190 (29.6%)		
>18 yrs		30 (3.1%)		38 (5.9%)		
Sport (practiced/working with)–MC	951		641		351	
Football/soccer		220 (23.1%)		251 (39.2%)		82 (23.4%)
Rugby/American football		97 (10.2%)		42 (6.6%)		71 (20.2%)
Ice/field hockey		68 (7.2%)		24 (3.7%)		18 (5.1%)
Cheerleading/gymnastics		66 (6.9%)		42 (6.6%)		8 (2.3%)
Martial arts		72 (7.6%)		33 (5.1%)		9 (2.6%)
Running		75 (7.9%)		17 (2.7%)		5 (1.4%)
Volleyball		55 (5.8%)		26 (4.1%)		6 (1.7%)
Basketball		40 (4.2%)		39 (6.1%)		6 (1.7%)
Swimming		33 (3.5%)		26 (4.1%)		4 (1.1%)
Multisport†		18 (1.9%)		32 (5.0%)		111 (31.6%)
Baseball		32 (3.4%)		18 (2.8%)		1 (0.3%)
Figure/speed skating		34 (3.6%)		10 (1.6%)		3 (0.9%)
Cycling		14 (1.5%)		6 (0.9%)		4 (1.1%)
Combat sports		7 (0.7%)		10 (1.6%)		2 (0.6%)
Other		120 (12.6%)		65 (10.1%)		21 (6.0%)
Level of sport (practiced/working with)–MC	953		677		398	
Amateur		51 (5.4%)		164 (24.2%)		122 (30.7%)
School sports		265 (27.8%)		243 (35.9%)		107 (26.9%)
Local club		78 (8.2%)		270 (39.9%)		106 (26.6%)
Sports federation		72 (7.6%)		189 (27.9%)		115 (28.9%)
Regional level		82 (8.6%)		256 (37.8%)		107 (26.9%)
National level		170 (17.8%)		178 (26.3%)		146 (36.7%)
International level		153 (16.1%)		81 (12.0%)		123 (30.9%)
Professional level		40 (4.2%)		52 (7.7%)		146 (36.7%)
None		0 (0.0%)		0 (0.0%)		7 (1.8%)

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TABLE 1. Sociodemographic Characteristics of the Study Sample Expressed as Counts and Frequencies *(Continued)*

	n*	Athletes n = 998	n	Coaches n = 677	n	Health Care Professionals n = 398
Other		/		18 (2.7%)		7 (1.8%)
Years of involvement	953		641		356	
0–4 yrs		124 (13.0%)		94 (14.7%)		71 (19.9%)
5–9 yrs		347 (36.4%)		130 (20.3%)		89 (25.0%)
10–15 yrs		312 (32.7%)		135 (21.1%)		56 (15.7%)
>15 yrs		170 (17.8%)		282 (44.0%)		125 (35.1%)
Not working/practicing anymore		0 (0.0%)		0 (0.0%)		15 (4.2%)

** Number of respondents.*
† Practicing or working with more than 1 sport.
MC = multiple choice question.

Our primary outcome was the difference in knowledge scores across professional occupation and geographic origin. Our secondary outcomes included the following: (1) the awareness about SCAT5 (HCP), CRT5 (coaches), and 6-step RTS (both) across professional occupation and geographic origin; (2) the access to educational resources on SRC across professional occupation and geographic origin; (3) the differences in knowledge scores across sex (female, male) in athletes, coaches, and HCP as well as across sport-risk level (high, moderate, low), concussion history (yes, no), and age (minor, adult) in athletes.

RESULTS

STUDY PARTICIPANTS

The online questionnaire was initiated by 2073 participants and completed by 1704 (82%). All available answers were analyzed. The study sample included 998 athletes (48%), 677 coaches (33%), and 398 HCP (19%) and is detailed in Table 1. Participants originated from Canada (n = 1089, 53%), Belgium (n = 423, 20%), Luxembourg (n = 234, 11%), France (n = 629, 6%), and Switzerland (n = 39, 2%). Regarding sex, 752 participants (39%) were female, 1192 male (61%), and 7 other (0.4%) or did not report. In athletes, 465 (49%) were minor (ie, between 14 and 18 years), and 354 (37%) were practicing high-risk sports (eg, American football, ice hockey), another 354 (37%) moderate-risk sports (eg, cycling, skating), and 246 (26%) low-risk sports (eg, swimming, running). The risk classification is available in **Supplemental Digital Content 1** (see **Material**, http://links.lww.com/JSM/A520. For HCP, 164 (46%) reported working as physicians, another 164 (46%) as physiotherapists or sports therapists, and 28 (8%) as other (ie, nurse, occupational therapist, neuropsychologist, psychologist).

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TABLE 2. Knowledge Scores (/100) and Self-Reported Concussion Knowledge Ratings Across Occupation (Athletes, Coaches, HCPs) and Geographic Origin (Canada, Europe)

	Occupation						
	n*	Athletes n = 998	n	Coaches n = 677	n	Health Care Professionals n = 398	Statistic; *P*; ES†
Knowledge score	884	90.4 [67.3, 92.3]	584	96.2 [73.1, 98.1]	324	98.1 [96.2, 100]	K = 516.6; <0.001; 0.25 L
Reported knowledge	889		597		325		χ^2 = 119.8; <0.001; 0.25 S
Excellent		25 (2.8%)		27 (4.5%)		27 (8.3%)	
Very good		132 (14.8%)		119 (19.9%)		103 (31.7%)	
Good		368 (41.4%)		267 (44.7%)		154 (47.4%)	
Poor		314 (35.3%)		169 (28.3%)		41 (12.6%)	
None		50 (5.6%)		15 (2.5%)		0 (0%)	

	Geographic Origin				
All	**n**	**Canada n = 1089**	**n**	**Europe n = 984**	***P***
Knowledge score	1018	92.3 [75.0, 98.1]	774	75.0 [67.3, 96.2]	W = 479 820; <0.001; 0.19 S
Reported knowledge	1025		786		χ^2 = 306.0; <0.001; 0.41 M
Excellent		64 (6.2%)		15 (1.9%)	
Very good		280 (27.3%)		74 (9.4%)	
Good		509 (49.7%)		280 (35.6%)	
Poor		167 (16.3%)		357 (45.5%)	
None		5 (0.5%)		60 (7.6%)	
Athletes		**n = 635**		**n = 363**	
Knowledge score	589	90.4 [67.3, 92.3]	295	67.3 [63.5, 90.4]	W = 117 900; <0.001; 0.30 S
Reported knowledge	590		299		χ^2 = 227.4; <0.001; 0.51 L
Excellent		21 (3.6%)		4 (1.3%)	
Very good		120 (20.3%)		12 (4.0%)	
Good		306 (51.9%)		62 (20.7%)	
Poor		138 (23.4%)		176 (58.9%)	
None		5 (0.8%)		45 (15.1%)	
Coaches		**n = 343**		**n = 334**	
Knowledge score	322	98.1 [96.2, 100]	262	73.1 [69.2, 94.2]	W = 68 922; <0.001; 0.55 L
Reported knowledge	328		269		χ^2 = 202.6; <0.001; 0.58 L
Excellent		24 (7.3%)		3 (1.1%)	
Very good		105 (32.0%)		14 (5.2%)	
Good		174 (53.1%)		93 (34.6%)	
Poor		25 (7.6%)		144 (53.5%)	
None		0 (0%)		15 (5.6%)	
Professionals		**n = 111**		**n = 287**	
Knowledge score	107	100 [96.2, 100]	217	98.1 [94.2, 100]	W = 13 988; 0.002; 0.18 S
Reported knowledge	107		218		χ^2 = 60.5; <0.001; 0.43 M
Excellent		19 (17.8%)		8 (3.7%)	
Very good		55 (51.4%)		48 (22.0%)	
Good		29 (27.1%)		125 (57.3%)	
Poor		4 (3.7%)		37 (17.0%)	
None		0 (0%)		0 (0%)	

**Number of respondents.*
† Kruskal–Wallis (K, effect size: eta squared) or Wilcoxon (W, effect size: r) test for quantitative variables and χ^2 test (χ^2, effect size: w) for qualitative variables. Results are presented as median [quartile1, quartile3] for quantitative variables and as counts (proportions) for qualitative variables. ES magnitudes are indicated as small (S), moderate (M), or large (L).

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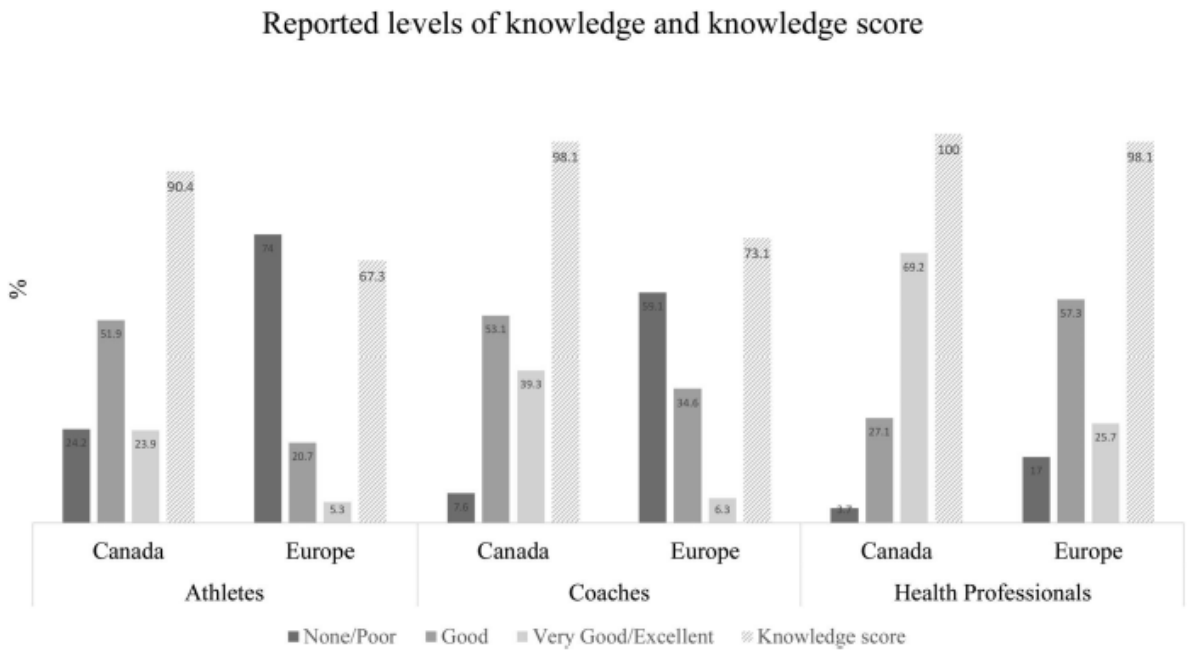

Figure 1. Proportions (%) of participants rating their SRC knowledge as none/poor; good; very good/excellent (subjective evaluation) and SRC knowledge score (%, objective evaluation—Methods section for score calculation) across professional occupation (athlete, coach, HCP) and geographic origin (Canada, Europe).

PRIMARY OUTCOME: SPORTS-RELATED CONCUSSION KNOWLEDGE

The SRC knowledge scores [/100 (interquartile range)], presented in Table 2, differed significantly ($P < 0.001$) between athletes [90.4 (67.3, 92.3)], coaches [96.2 (73.1, 98.1)], and HCP [98.1 (96.2, 100)]. Post hoc Bonferronicorrected pairwise comparisons showed significant differences between all pairs. These SRC knowledge scores were consistently significantly higher for Canada [92.3 (75.0, 98.1, n = 1089)] than for Europe [75.0 (67.3, 96.2), n 5 984], for the whole sample, and for each occupation {athletes [Canada: 90.4 (67.3, 92.3), n = 635, Europe: 67.3 (63.5, 90.4, n 5 363)]; coaches [Canada: 98.1 (96.2, 100), n = 343, Europe: 73.1 (69.2, 94.2), n = 334]; HCP [Canada: 100 (96.2, 100), n = 111, Europe: (94.2, 100), n 5 287]}, with the largest difference for coaches. The detailed answers used to compute the knowledge score can be found in **Supplemental Digital Content 1** (see **Table**, http://links.lww.com/JSM/A521).

Likewise, the self-reported level of knowledge ratings (Table 2), differed significantly ($P < 0.001$) between athletes, coaches, and HCP. There were more HCP rating their knowledge as very good or excellent (n = 130, 40%) as compared with coaches (n = 146, 24%) and athletes (n = 157, 17%). Post hoc pairwise comparisons showed significant differences ($P < 0.001$) between all pairs. When comparing European countries versus Canada, reported knowledge was significantly higher in Canada, with more Canadian participants (n = 344, 34%) rating their knowledge as very good or excellent as compared with European participants (n = 89, 11%). This was also the case within each professional occupation [athletes (Canada: n = 141, 24%, Europe: n = 16, 5%); coaches (Canada: n = 129, 39%, Europe: n = 17, 6%); HCP (Canada: n = 74, 69%, Europe: n = 56, 26%)]. The self-reported

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levels of knowledge and knowledge score across occupation and geographic origin are illustrated in Figure 1.

SECONDARY OUTCOME: AWARENESS OF EVIDENCE-BASED INTERNATIONAL RECOMMENDATIONS

The reported awareness about the SCAT5/CRT5 and the 6-step RTS protocol, presented in Table 3, was significantly ($P < 0.001$) lower in coaches than in HCP: 267 coaches (47%) reported using the CRT5 when suspecting a concussion, whereas 247 HCP (76%) reported being familiar with the SCAT5. Regarding the 6-step RTS protocol, 268 coaches (46%) reported knowing it against 223 HCP (71%). This reported awareness about the SCAT5/CRT5 and the 6-step RTS protocol was also significantly higher ($P < 0.001$) in Canada than in Europe for the whole sample: 293 Canadian participants (65%) reported use or familiarity with the CRT5 and the SCAT5, respectively, whereas 221 European participants (40%) did. For the 6-step RTS protocol, 328 Canadian participants (77%) reported knowing it against 163 European ones (34%). The same observation held true when looking at coaches and HCP separately: 195 Canadian (57%) versus 72 European coaches (22%) reported using the CRT5, and 233 Canadian (72%) versus 35 European (13%) coaches reported knowing the 6-step RTS protocol. Regarding HCP, 98 Canadian (92%) versus 149 HCP (68%) reported being familiar with the SCAT5 and 95 Canadian (91%) versus 128 European (61%) HCP reported knowing the 6-step RTS.

SECONDARY OUTCOME: ACCESS TO EDUCATIONAL RESOURCES

When asked about the existence of a concussion-specific training in their environment, the reported access was significantly different between occupations with significantly ($P < 0.001$) higher reported access for HCP (n = 187, 63%), then for coaches (n = 255, 45%), and then for athletes (n = 146, 17%), as presented in Table 4. Post hoc pairwise comparisons showed significant differences ($P < 0.001$) between all pairs. This access to educational resources was also significantly ($P < 0.001$) higher in Canada (n = 432, 44%) than in Europe (n = 156, 21%) for the whole sample. This pattern held when looking at professional categories within the 2 Canadian and European subgroups: 125 Canadian athletes (22%) reported access to resources versus 21 European ones (8%); 226 Canadian coaches (71%) versus 29 European ones (11%) and; 81 HCP (82%) versus 106 European ones (53)%.

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TABLE 3. Reported Awareness of the Internationally Recommended SCAT5 (for HCPs), CRT5 (for Coaches), and 6-Step RTS Protocol Across Occupation (Coaches, HCPs) and Geographic Origin (Canada, Europe)

	Occupation				
SCAT5/CRT5 Awareness	N a	Coaches n = 677	N	Health Care Professionals n = 398	Statistic; *P*; ES*
Yes	566	267 (47.2%)	326	247 (75.8%)	$\chi^2 = 69.3$; <0.001; 0.28 S
No		299 (52.8%)		79 (24.2%)	

	Geographic Origin				
All	N	Canada n = 1089	n	Europe n = 984	*P*
Yes	450	293 (65.1%)	553	221 (40.0%)	$\chi^2 = 62.8$; <0.001; 0.25 S
No		157 (34.9%)		332 (60.0%)	

Coaches [CRT]		n = 343		n = 334	
Yes	343	195 (56.9%)	334	72 (21.6%)	$\chi^2 = 88.3$; <0.001; 0.36 M
No		148 (43.1%)		262 (78.4%)	

Professionals [SCAT]		n = 111		n = 287	
Yes	107	98 (91.6%)	219	149 (68.0%)	$\chi^2 = 21.7$; <0.001; 0.26 S
No		9 (8.4%)		70 (32.0%)	

	Occupation				
6-Step RTS Awareness	n	Coaches n = 677	n	Health Care Professionals n = 398	*P*
Yes	586	268 (45.7%)	316	223 (70.6%)	$\chi^2 = 51.4$; <0.001; 0.24 S
No		318 (54.3%)		93 (29.4%)	

	Geographic Origin				
All	N	Canada n = 1089	n	Europe n = 984	*P*
Yes	428	328 (76.6%)	474	163 (34.4%)	$\chi^2 = 161.9$; <0.001; 0.42 M
No		100 (23.4%)		311 (65.6%)	

Coaches		n = 343		n = 334	
Yes	323	233 (72.1%)	263	35 (13.3%)	$\chi^2 = 202.2$; <0.001; 0.59 L
No		90 (27.9%)		228 (86.7%)	

Professionals		n = 111		n = 287	
Yes	105	95 (90.5%)	211	128 (60.7%)	$\chi^2 = 30.0$; <0.001; 0.31 M
No		10 (9.5%)		83 (39.3%)	

aNumber of respondents.
**Chi-square test (χ^2, effect size: w). Results are presented as counts (proportions). ES magnitudes are indicated as small (S), moderate (M), or large (L).*

SECONDARY OUTCOME: IMPACT OF ADDITIONAL FACTORS ON SPORTS-RELATED CONCUSSION KNOWLEDGE

When exploring the impact of potentially modifying factors [sport-risk level, concussion history, age, sex—**Supplemental Digital Content 2** (see **Table**, http://links.lww.com/JSM/A522)], age and concussion history significantly impacted the knowledge scores in athletes, whereas sport-risk level and sex did not. The 489 adult athletes had slightly, but significantly ($P < 0.001$), higher scores [90.4/100 (67.3, 92.3)] than the 465 minors [88.5 (67.3, 92.3)], and the 410 athletes with a history of concussion had significantly higher scores [90.4 (67.3, 92.3)] than the 542 without [86.5 (65.4, 92.3)]. Sex impacted knowledge scores for the coaches' subgroups only, with significantly ($P < 0.001$) higher scores for the 143 female coaches [98.1 (94.2, 100)] than for the 496 male coaches [94.2 (73.1, 98.1)].

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TABLE 4. Reported Access to Educational Resources Across Occupation (Athletes, Coaches, HCPs) and Geographic Origin (Europe, Canada)

	Occupation						
Access to Training	n*	Athletes n = 998	N	Coaches n = 677	n	Health Care Professionals n = 398	Statistic; *P*; ES†
Yes	842	146 (17.3%)	573	255 (44.5%)	298	187 (62.8%)	χ^2 = 241.9; <0.001; 0.38 M
No		396 (47.0%)		189 (33.0%)		68 (22.8%)	
Do not know		300 (35.6%)		129 (22.5%)		43 (14.4%)	

	Geographic Origin				
All	n	Canada n = 1089	n	Europe n = 984	*P*
Yes	979	432 (44.1%)	734	156 (21.3%)	107.1; <0.001; 0.25 S
No	292 (29.8%)			361 (49.2%)	
Do not know	255 (26.0%)			217 (29.6%)	
Athletes		**n = 635**		**n = 363**	
Yes	561	125 (22.3%)	281	21 (7.5%)	42.7; <0.001; 0.23 S
No		225 (40.1%)		171 (60.9%)	
Do not know		211 (37.6%)		89 (31.7%)	
Coaches		**n = 343**		**n = 334**	
Yes	319	226 (70.8%)	254	29 (11.4%)	202.2; <0.001; 0.59 L
No		56 (17.6%)		133 (52.4%)	
Do not know		37 (11.6%)		92 (36.2%)	
Professionals		**n = 111**		**n = 287**	
Yes	99	81 (81.8%)	199	106 (53.3%)	23.1; <0.001; 0.28 S
No		11 (11.1%)		57 (28.6%)	
Do not know		7 (7.1%)		36 (18.1%)	

* Number of respondents.
† Chi-square test (χ^2, effect size: w). Results are presented as counts (proportions). ES magnitudes are indicated as small (S), moderate (M), or large (L).

DISCUSSION

This study used simple general knowledge questions about SRC and awareness of existing tools (SCAT5 and CRT5) and protocols (6-step RTS) among athletes, coaches, and HCP sampled from a larger French-speaking sports medicine community in Europe and Canada. The results show a higher level of knowledge, along with a better access to education, in HCP, then coaches, then athletes, with higher levels in Canada than Europe. Likewise, SRC tools and protocols awareness as well as access to education were greater in HCP than in coaches, with greater levels in Canada.

SPORTS-RELATED CONCUSSION KNOWLEDGE AND AWARENESS OF EVIDENCE-BASED TOOLS AND PROTOCOLS

Disparities in levels of SRC knowledge between athletes, coaches, and HCP were found. Although somewhat expected given their different roles and education profiles, it still appears concerning because differences in SRC understanding between roles might impact proper communication and interpersonal dynamics around prevention and management.

Health care professional managing athletes are expected to possess excellent SRC knowledge, which is confirmed with the high knowledge scores observed in both Canada (100%) and Europe (98%). The awareness of the SCAT5 and 6-step RTS was relatively high (above 70%), but efforts

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should be made to achieve the high levels (approximately 95%) reported by medical team staff in elite environments.[13] Our HCP population stemmed from both professional and amateur settings. In professional environments, pitch-side recognition and appropriate follow-up is their crucial and leading role. Conversely, for the HCP who are not primarily involved with athletes (eg, primary care), appropriate SRC knowledge and use of tools can represent a challenge, as confirmed by a survey on primary care doctors in New Zealand where more than half of the 230 participants had no knowledge of recommendations and did not use the SCAT5.[24]

Coaches had significantly lower knowledge score than HCP, with a large difference between Canada (98%) and Europe (73%). Female coaches were less represented (22%) but demonstrated significantly higher knowledge than male coaches (14%). In previous findings, with a smaller sample size, male coaches scored significantly higher than female coaches on a SRC knowledge survey.[25] This higher knowledge in male coaches was associated with the higher likeliness to coach a high-risk sport and experience SRC. The potential sex differences in SRC knowledge among coaches remain under investigated and challenging to evaluate, partly because of the overall underrepresentation of female participants in sports and exercise medicine research.[26,27]

Finally, athletes demonstrated the lowest knowledge scores with, again, higher scores in Canada (90%) than in Europe (67%). Two additional modifying factors toward higher knowledge scores were identified: higher age (> 18 year old) and SRC history. Two previous studies reported a significant association between better SRC knowledge and concussion history,[28,29] whereas others showed no such association.[30–32] Regarding age, some studies conducted with minor athletes report a higher level of knowledge in the older ones,[33,34] whereas recent findings show better knowledge in "younger" athletes when assessing 16- to 82-year-old participants,[29] suggesting a knowledge peak around 18-year-old participants. The nature of SRC knowledge in athletes is highly multifactorial, and the interplay between sociodemographic (eg, sex, age, ethnicity) and institutional (eg, access to SRC education, sport played) factors appears to play a significant role in this subgroup.[9]

GEOGRAPHIC DIFFERENCES

The higher levels of knowledge, awareness of tools, and access to education in French-speaking Canada as compared with Europe could be partly explained by cultural variations. Highrisk sports, such as ice hockey or football, are extremely popular in Canada, and preventing and managing SRC has been a core component of public health programs for over a decade.[35] Recent findings from a Canadian national public health survey demonstrated that SRC increased 2 and halffold between 2006 and 2014, then remained stable between 2014 and 2018. This was attributed to enhanced knowledge and earlier recognition of concussions before 2014, rather than actual incidence increases.[35] The quantity and structure of large-scale SRC educational initiatives and tools are more prominent in Canada (eg, Parachute,[36] concussion Massive Open Online Course (MOOC),[37] Canadian Olympic and Paralympic Sports Institute Network (COPSIN) guidelines[38]) than in Europe, where such programs are less developed and tend to be confined to specific sports or organizations within each country.[39] Furthermore, there is a lack of national data related to SRC, which suggests the overall awareness of SRC as a public health matter is lower. The French-speaking community as a whole

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suffers from a lack of access to evidence-based SRC resources in French, which can translate into poor levels of knowledge and confidence.[19,20] The differences between countries' policies and publicity around SRC lead indeed to knowledge disparities. For example, SRC awareness, understanding, and reporting behaviors significantly differed between collegiate athletes from the United States, Ireland, and Jordan according to the national level of concussion publicity.[40] Within Canada, Frenchspeakers demonstrate significantly lower SRC knowledge than English speakers.[23] This has been associated with lesser public involvement in SRC awareness in the French-speaking regions but remains to be further explored. These results emphasize the higher vulnerability of the French-speaking community to poor SRC knowledge.

LIMITATIONS

This study encompasses some limitations that needs to be considered before generalizing these findings. First, the anonymous online nature of the survey might introduce selfselection and sampling biases, although this approach has been increasingly used due to its flexibility, rapidity, and wide reach.[41] Second, the level of SRC knowledge has not been assessed using standardized tools. As opposed to existing tools focusing on specific subgroups (eg, athletes, parents, coaches), the aim was to evaluate athletes, coaches, and HCP with identical questions to allow for intergroup comparisons. This prevents the direct comparison of our findings to the existing literature. The knowledge assessment used, although basic, allowed to capture significant intergroup differences, underlining the knowledge gaps. Finally, this study focused on professional occupation and geographic origin but did not, or only little, account for other factors known to influence SRC knowledge (eg, ethnicity, household income, access to health care). The international interdisciplinary nature of the survey and the significant number of participants, however, provide added value to the current state of the art.

CLINICAL IMPLICATIONS AND FUTURE DIRECTIONS

Sports medicine professionals should be aware that athletes, coaches, and—to a lesser extent—HCP from French-speaking Canada and Europe are not equal when managing SRC because their theoretical and practical knowledge and access to education are highly heterogeneous. In addition to guiding by example, well-trained stakeholders can further promote educational initiatives adapted to the setting they evolve in. For instance, French-speaking stakeholders can benefit from a dedicated MOOC.[37] Finally, all sports medicine professionals should use the latest available evidence-based recommended tools (ie, SCAT and CRT tools).[17] A collaborative evidence-based approach on SRC education is urgently needed to harmonize SRC health literacy and needs to be paralleled with better injury surveillance. Such collaborative epidemiological studies would inform on SRC recognition rates associated with improved educational approaches.

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