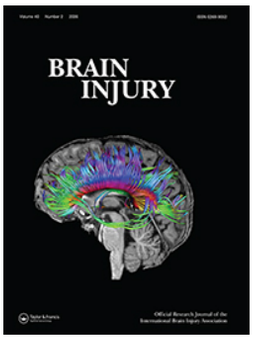

Brain Injury

ISSN: 0269-9052 (Print) 1362-301X (Online) Journal homepage: www.tandfonline.com/journals/ibij20

Differences in symptom duration and return to sport following sport-related concussion between French-speaking Canadian and European athletes

Géraldine Martens, Aurore Thibaut, Louis de Beaumont, Charlotte Beaudart, Colin Bodet, Axel Urhausen, Philippe M. Tscholl, Thomas Romeas, Sébastien Le Garrec, Didier Hannouche, Romain Seil, Jean-François Kaux & Suzanne Leclerc

To cite this article: Géraldine Martens, Aurore Thibaut, Louis de Beaumont, Charlotte Beaudart, Colin Bodet, Axel Urhausen, Philippe M. Tscholl, Thomas Romeas, Sébastien Le Garrec, Didier Hannouche, Romain Seil, Jean-François Kaux & Suzanne Leclerc (21 Jan 2026): Differences in symptom duration and return to sport following sport-related concussion between French-speaking Canadian and European athletes, Brain Injury, DOI: 10.1080/02699052.2026.2617450

To link to this article: https://doi.org/10.1080/02699052.2026.2617450

Published online: 21 Jan 2026.

BRAIN INJURY
https://doi.org/10.1080/02699052.2026.2617450

Taylor & Francis
Taylor & Francis Group

Differences in symptom duration and return to sport following sport-related concussion between French-speaking Canadian and European athletes

Géraldine Martens[a,b,c*], Aurore Thibaut[b*], Louis de Beaumont[d], Charlotte Beaudart[e], Colin Bodet[f], Axel Urhausen[a,g,h], Philippe M. Tscholl[a,i], Thomas Romeas[a,j,k], Sébastien Le Garrec[a,l], Didier Hannouche[a,i], Romain Seil[a,g,h], Jean-François Kaux[a,f*], and Suzanne Leclerc[a,j*]

[a]Réseau Francophone Olympique de la Recherche en Médecine du Sport (ReFORM), IOC Research Centre for Injury Prevention and Protection of Athlete Health, Liège, Belgium; [b]NeuroRecovery Lab, GIGA-Consciousness, University of Liège, Liège, Belgium; [c]Neurology Department, NeuroRehab & Consciousness Clinic, University Hospital of Liège, Liège, Belgium; [d]Centre de Recherche de l'Hôpital du Sacré-Coeur de Montréal, CIUSSS du nord-de-l'Île-de-Montréal, Montréal, QC, Canada; [e]Public Health Aging Research & Epidemiology (PHARE) Group Research Unit in Clinical Pharmacology and Toxicology (URPC) NAmur Research Institute for LIfe Sciences (NARILIS), University of Namur, Namur, Belgium; [f]Department of Physical Medicine and Sports Traumatology, University and University Hospital of Liège, Liège, Belgium; [g]Luxembourg Institute of Research in Orthopedics, Sports Medicine and Science (LIROMS), Eich, Luxembourg; [h]Clinique du Sport, Centre Hospitalier de Luxembourg, Eich, Luxembourg; [i]Department of Orthopaedic Surgery and Traumatology, Geneva University Hospitals, Geneva, Switzerland; [j]Département Recherche et innovation, Institut National du Sport du Québec (INS Québec), Montréal, QC, Canada; [k]École de kinésiologie et des sciences de l'activité physique, Montréal, QC, Canada; [l]Pôle Médical, Institut National du Sport, de l'Expertise Et de la Performance (INSEP), Paris, France

ABSTRACT

Objectives: To examine self-reported sport-related concussion (SRC) symptom duration and return to sport (RTS) timelines across countries and sport demographics in a large international cohort.

Methods: An anonymous survey collected sociodemographic data and concussion history from French-speaking athletes affiliated with the ReFORM IOC Research Center. SRC symptoms and RTS durations were analyzed by geographic origin (Canada, Europe) and a multivariate analysis examined the combined impact of geographic origin, sex, age group (minor, adult), professional status (amateur, professional) and SRC risk (low, moderate, high).

Results: Of 998 participants (Canada: 635; Europe: 363), 409 (41%) reported a history of SRC. Median [IQR] symptom duration was longer in Canada (30 [14, 91] days) than Europe (7 [2, 21] days; $p < 0.001$). RTS was also longer in Canada (28 [14, 61] vs. 10 [7, 21] days; $p < 0.001$).

The binary logistic regression identified geographic origin (Canada) and sex (female) as significant predictors of prolonged symptom duration (i.e. >14 days) and return to sport (i.e. >20 days), while age group, professional status and SRC risk did not significantly influence these durations.

Conclusion: SRC recovery times differ significantly by geography and sex in French-speaking athletes. European athletes and males report shorter symptom and RTS durations.

ARTICLE HISTORY
Received 23 June 2025
Revised 16 December 2025
Accepted 9 January 2026

KEYWORDS
Traumatic brain injury; concussion; head injuries; sports injuries; epidemiology

Introduction

Sport-related concussion (SRC) has been defined as a traumatic brain injury occurring during sports or exercise-related activities and resulting from a direct blow to the head, neck or body, transferring an impulsive force to the brain (1). In Canada, SRC account for more than 54% of all concussions and this rate increases to >85% in the 16- to 34-year-old group (2). In Europe, population-based incidence rates of SRC have been estimated between 15.8 and 19.4 per 100,000 since the years 2000 (3). In European professional soccer, an average SRC rate of 0.05 per 1000 exposure hours has been reported (4). This rate increased to 18.7 per 1000 in English Premier League (5). This pattern is also observed in the United States although with greater rates: among collegiate athletes, SRC incidence rates range from 1.7 to 4.5 per 1000 athlete exposures (6–8), while at the professional level, such as the National Football League, incidence rates can increase as high as 66.1 (9). This rising trend might be partly attributable to the improved knowledge and awareness of possible short- and long-term consequences of SRC. However, it is thought to remain underestimated partially due to concussed athletes not reporting symptoms, not seeking medical advice or being misdiagnosed (10–12).

In a meta-analysis on clinical recovery from concussion conducted as part of the 6th International Conference on Concussion in Sport by the Concussion in Sport Group (CISG) (1), the mean duration until symptom resolution was 14 days and until return to sport (RTS) 20 days (13). These durations can be affected by varying injury modifiers such as initial symptomatology, neuro(psycho)logic antecedents or delayed access to care (13). Additional sociodemographic factors, such as sex, age and level of play appear to play a role in the length of recovery. For example, female athletes experience more severe symptoms and take longer to recover in comparison with their male peers (14–16). This has been attributed to

CONTACT Géraldine Martens geraldine.martens@uliege.be Réseau Francophone Olympique de la Recherche En Médecine du Sport (ReFORM), IOC Research Centre for Injury Prevention and Protection of Athlete Health, Avenue de l'Hôpital 11, 4000 Sart-Tilman, Liège, GIGA B34, Belgium
*These authors contributed equally.

an interplay between sex-specific physiological, physical and social parameters (14) but the heterogeneity and scarcity of available studies prevents a definite interpretation.

Another potential modifying factor which currently remains poorly investigated is geographic origin. Social determinants of health such as community context and neighborhood are indeed often overlooked in the current SRC literature and potential participants tend to be further excluded based on exclusion criteria focused on 'language barriers' such as English proficiency (17). Although international initiatives have put remarkable effort into developing evidence-based concussion care guidelines, there is a need for assessing the translatability of such evidence to diverse geographic origins, healthcare settings, types of sports and cultures (18). The variations in athletes' SRC experience in terms of symptom and RTS duration across different sociocultural backgrounds remain scarcely assessed, especially in the French-speaking community (19). A majority of the available studies are indeed monocentric and/or limited to a specific country, sport or subpopulation (e.g., collegiate athletes), with a dominance from the English-speaking community (i.e., the USA, Canada, the United Kingdom, Australia) (11). This is further reflected by the discrepancy of available public health data on SRC management in Europe compared to North America.

Investigating SRC characteristics in more diverse athletic communities will help designing culture- and setting-compatible concussion care guidelines as well as promoting their proper implementation. We therefore aimed to explore potential SRC recovery disparities among French-speaking athletes of Europe and Canada through a large international survey. We hypothesized intercontinental differences to become apparent given the differences in culture, healthcare systems and SRC public awareness between these two geographic areas. We primarily focused on symptom duration and RTS according to geographic origin (Canada, Europe) and secondarily on these durations according to known modifying factors such as sex, age, professional status and SRC risk category of the sport.

Material and methods

Ethical aspects

This multicentric international cross-sectional study has been approved by a central institutional ethics committee (University of Montréal CERSES-20–118-D) and by additional local ethics committees where required (University and University Hospital of Liège CE-2020/224; University Hospitals of Geneva CCER-2020–02743). Informed consent was obtained from all study participants using a web-based introductory statement.

Data collection and participants

Participants were recruited through the institutional communications (social media and mailing lists) from the ReFORM network (20) through authors' affiliations as well as with partnering sports federations of these institutions (French-speaking parts of Belgium, Canada, France, Luxembourg and Switzerland). They received an anonymous survey link with an introductory statement describing the study objectives and the eligibility criteria (i.e., being an athlete of 14-year-old and above from all levels and types of sport). The survey was hosted at SondageOnline (enuvo GmbH, Zurich, Switzerland) and was available in French for four months (December 2020 to March 2021).

Survey

The survey was initially developed to assess SRC knowledge levels and access to educational resources within the French-speaking community as part of a common project of the ReFORM consortium (21). In short, the electronic survey comprised 33 questions addressing 1) SRC knowledge assessment; 2) awareness of detection tools and management protocols and; 3) access to education resources. It was co-developed with athletes, coaches and health care professionals and validated by an expert panel. The present study is a secondary analysis based on the athlete subpopulation only, those with a history of SRC, and on patterns of symptom and RTS duration following their last SRC, which have not been covered in the primary analysis. The athletes' questionnaire consisted in 8–12 questions depending on the answers provided (e.g., presence of prior SRC) and can be found in Supplementary Material (S1). Its sections focused on 1) sociodemographic variables: country, age (categorized as: 14–18; 19–25; 26–30; 31–35; >35 years old); biological sex; education level; sports experience (including professional status) and; 2) concussion history: frequency, longest duration of symptoms, average length of sports interruption.

Outcomes and analyses

The primary outcome variables were as follows: the self-reported longest duration of SRC symptoms (i.e., symptom duration) and the self-reported average length of interruption of sports activities (i.e., RTS) according to geographic origin (Canada vs. Europe; no country-based comparison could be performed due to the low sample sizes in European countries). Descriptive analyses were performed using counts and frequencies for categorical variables and median and interquartile ranges for quantitative variables following an abnormal distribution tested with a Shapiro–Wilk test. Comparisons between groups were performed using Wilcoxon rank-sum tests for quantitative variables and Chi-square tests for categorical variables.

As a secondary outcome, the potential influence of additional sociodemographic factors on symptom duration and RTS was investigated. A binary logistic regression analysis was performed to examine the association between several independent variables and the likelihood of having an abnormal concussion duration (i.e., above the 14-day period reported in the CISG consensus meta-analysis on SRC recovery (13)). The independent variables included geographic origin (Europe vs. Canada), sex (male vs. female), age group (minor vs. adult; dichotomized into 14–17 and ≥18 years), sport level (amateur vs. professional; athletes reporting professional, national or international levels were

classified as professional, while athletes reporting leisure, school, local club, sports federation or regional levels were classified as amateur ones and SRC risk category (high, moderate, low). SRC risk category (high, e.g., American football, ice hockey; moderate, e.g., cycling, volleyball; low, e.g., swimming, badminton) was determined based on previous work (22,23) and complemented by two sport medicine physicians among the author group (SL and JFK). The risk classification used is available in Supplementary Material (Table S2). Prior to model fitting, the presence of multicollinearity among predictors was assessed using the Variance Inflation Factor; values below 5 were considered acceptable. Missing data were excluded listwise. The model parameters were estimated using maximum likelihood estimation. For each predictor, the regression coefficient (β), standard error, Wald z statistic, p-value and adjusted odds ratio (OR = e^β) with 95% confidence intervals were reported. Statistical significance was set at $p < 0.05$ (two-tailed). Model adequacy was evaluated using the Akaike Information Criterion (AIC) and changes in deviance relative to the null model. An identical approach was used to assess the likelihood of having a prolonged RTS duration (i.e., above the 20-day period reported in the meta-analysis (13)). Statistical analyses were performed using R 4.4.1 (R Core Team, Austria).

Results

Study participants

The online questionnaire was initiated by 998 athletes and completed by 835 (84%). All available answers were analyzed. There were 635 (64%) participants from French-speaking Canada and the participants from French-speaking Europe were distributed as follows: Belgium ($n = 162$, 16%), Luxembourg ($n = 73$, 7%), France ($n = 61$, 6%), Switzerland ($n = 14$, 2%) and other (e.g., French-speaking athletes living in Germany, Romania, Scotland: $n = 53$, 5%). Sociodemographic characteristics (concussion history, sex, age, sport, professional status and experience) are presented in Table 1.

Table 1. Sociodemographic characteristics of the study sample expressed as counts and frequencies.

	n[a]	Total ($N = 998$)	n	Canada ($N = 635$)	n	Europe ($N = 363$)	p-value[b]
Concussion history	950		632		318		
Yes		409 (43.1%)		314 (49.7%)		95 (29.9%)	<0.001
No		541 (56.9%)		318 (50.3%)		223 (70.1%)	
Number of reported concussions	390		303		87		0.385
1		181 (46.4%)		135 (44.6%)		46 (52.9%)	
2		110 (28.2%)		91 (30.0%)		19 (21.8%)	
3		57 (14.6%)		43 (14.2%)		14 (16.1%)	
4		30 (7.7%)		23 (7.6%)		7 (8.1%)	
5		12 (3.1%)		11 (3.6%)		1 (1.1%)	
>5		0 (0%)		0 (0%)		0 (0%)	
Sex	952		634		318		
Female		484 (50.8%)		338 (53.3%)		146 (45.9%)	0.037
Male		468 (49.2%)		296 (46.7%)		172 (54.1%)	
Age	952		634		318		
Minor		465 (48.9%)		342 (53.9%)		123 (33.9%)	<0.001
Adult		487 (51.1%)		292 (46.1%)		195 (54.0%)	
Sport	949		632		317		
Football/Soccer		219 (23.1%)		142 (22.5%)		77 (24.3%)	<0.001
Rugby/American Football		97 (10.2%)		36 (5.7%)		61 (19.2%)	
Ice/Field Hockey		68 (7.2%)		55 (8.7%)		13 (4.1%)	
Swimming		33 (3.5%)		20 (3.1%)		13 (4.1%)	
Figure/Speed Skating		34 (3.6%)		34 (5.4%)		0 (0%)	
Baseball		32 (3.4%)		31 (4.9%)		1 (0.3%)	
Cycling		14 (1.5%)		7 (1.1%)		7 (2.1%)	
Martial Arts		72 (7.6%)		15 (2.4%)		57 (17.8%)	
Multisport[c]		18 (1.9%)		13 (2.1%)		5 (1.6%)	
Combat Sports		7 (0.7%)		5 (0.8%)		2 (0.6%)	
Track and Field/Running		75 (7.9%)		69 (10.9%)		6 (1.3%)	
Basketball		40 (4.2%)		36 (5.7%)		4 (1.3%)	
Cheerleading/Gymnastics		66 (6.9%)		61 (9.6%)		5 (3.1%)	
Volleyball		55 (5.8%)		45 (7.2%)		10 (2.7%)	
Other		119 (12.5%)		63 (9.9%)		56 (17.5%)	
Level of sport	946		630		316		
Amateur		399 (42.2%)		321 (50.9%)		78 (24.7%)	<0.001
Professional[d]		547 (57.8%)		309 (49.1%)		238 (75.3%)	
Level of risk sport	952		633		319		
High risk		354 (37.2%)		188 (29.7%)		166 (52.0%)	<0.001
Moderate risk		353 (37.1%)		274 (43.3%)		79 (24.8%)	
Low risk		245 (25.7%)		171 (27.0%)		74 (23.2%)	
Years of practice	951		633		318		
0–4 years		124 (13.0%)		83 (13.1%)		41 (12.9%)	<0.001
5–9 years		346 (36.4%)		257 (40.6%)		89 (27.9%)	
10–15 years		312 (32.8%)		212 (33.5%)		100 (31.4%)	
>15 years		169 (17.8%)		81 (12.8%)		88 (27.8%)	

[a]number of respondents; [b]chi-square test; [c]practising more than one sport; [d]based on a paid contract.

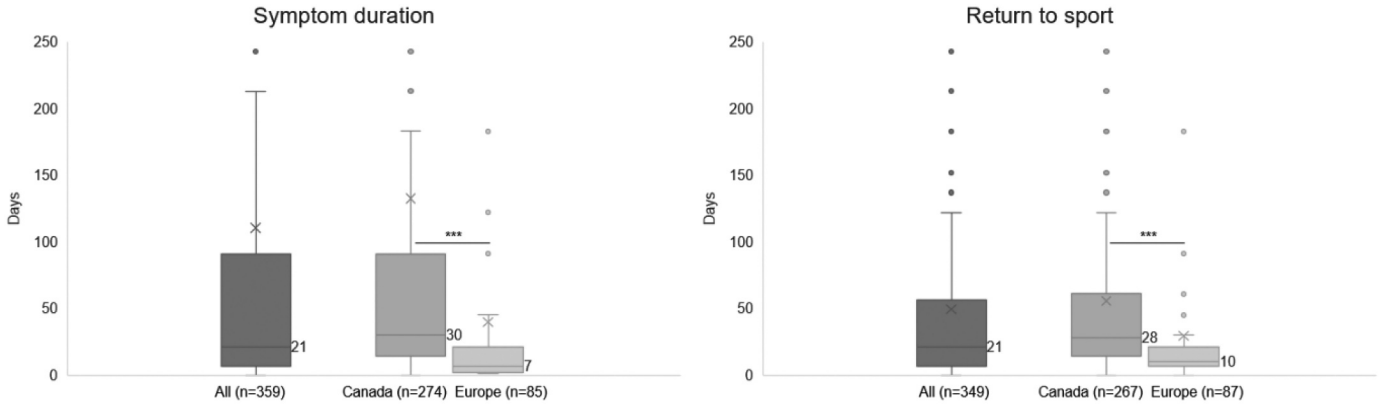

Figure 1. Boxplot distribution of SRC symptom duration and return to sport for the total sample ($n = 359$) as well as for Canada ($n = 274$) and Europe ($n = 87$) separately. ***$p < 0.001$ Wilcoxon rank sum test.

Primary outcome: symptom duration and return to sport according to geographic origin

A total of 409 athletes (43%) reported a history of concussion (Canada: 314, Europe: 95); Their median [IQR] number of sustained concussions was 2 [1, 2] and 209 (54%) reported more than one (see Table 1). Among them, 359 responded to the question about symptom duration and reported a median symptom duration of 21 [7, 91] days. The median symptom duration was significantly higher in Canada (30 [14, 91] days for 274 athletes) than in Europe (7 [2, 21] days for 85 athletes; $p < 0.001$). Regarding RTS, 366 responded and reported a median duration of 21 [7, 53] days. Median RTS duration was significantly higher in Canada (28 [14, 61] days for 279 athletes) than in Europe (10 [7, 21] days for 87 athletes; $p < 0.001$). This is illustrated in Figure 1.

A subsample of 348 participants responded to both questions on symptom duration and RTS (Canada: 267; Europe: 81) and their sociodemographic characteristics are presented in Table 2. Group comparisons showed that the distribution of sex and the number of reported concussions were similar between Canada and Europe. However, significantly different proportions were observed for: age group (i.e., more adults in the European subsample); professional status (i.e., more professional athletes in the European subsample) and sport-related SRC (i.e., more high risk sports in the European subsample), as presented in Table 2.

Secondary outcome: symptom duration and return to sport according to additional sociodemographic factors

The binary logistic regression conducted to identify factors associated with the likelihood of presenting an abnormal symptom duration (i.e., >14 days) was significant for the overall model (Null deviance = 494.26; Residual deviance = 439.37; AIC = 451.37) – see Table 3). After adjusting for all covariates, two predictors were significantly associated with the likelihood of an abnormal symptom duration (1): geographic origin: European athletes were significantly less likely to experience an abnormal symptom duration compared with Canadian athletes ($\beta = -1.68$, $p < 0.001$; OR = 0.19) and (2); sex: male athletes were also less likely to exhibit abnormal symptom duration compared with female athletes ($\beta = -0.83$, $p < 0.001$; OR =

Table 2. Sociodemographic characteristics of the subsample of athletes who reported symptom duration and return to sport expressed as counts and frequencies.

	n[a]	Total ($N = 348$)	n	Canada ($N = 267$)	n	Europe ($N = 81$)	p-value[b]
Number of reported concussions	335		260		74		0.526
1		159 (47.6%)		118 (45.4%)		41 (55.4%)	
2		95 (28.4%)		78 (30.0%)		17 (23.0%)	
3		46 (13.8%)		35 (13.5%)		11 (14.9%)	
4		25 (7.5%)		20 (7.7%)		5 (6.7%)	
5		9 (2.7%)		9 (3.5%)		0 (0%)	
>5		0 (0%)		0 (0%)		0 (0%)	
Sex	348		267		81		
Female		189 (54.3%)		148 (55.4%)		41 (50.6%)	0.446
Male		159 (45.7%)		119 (44.6%)		40 (49.4%)	
Age	348		267		81		
Minor		143 (41.1%)		123 (46.1%)		20 (24.7%)	<0.001
Adult		205 (58.9%)		144 (53.9%)		61 (75.3%)	
Level of sport	348		267		81		
Amateur		156 (44.8%)		142 (53.2%)		14 (17.3%)	<0.001
Professional[c]		192 (55.2%)		125 (46.8%)		67 (82.7%)	
Level of risk sport	348		267		81		
High risk		167 (48.0%)		108 (40.4%)		59 (72.8%)	<0.001
Moderate risk		124 (35.6%)		112 (41.9%)		12 (14.8%)	
Low risk		57 (16.4%)		47 (17.6%)		10 (12.3%)	

[a]number of respondents; [b]chi-square test; [c]based on a paid contract.

Table 3. Results of multivariable binary logistic regression model examining factors associated with abnormal sport-related concussion symptom duration (i.e., >14 days).

Predictor Variable	β (Estimate)	Std. Error	z-value	*p*-value	OR = exp(β)	95% CI for OR
(Intercept)	0.2461	0.4984	0.494	0.621	1.28	[0.48, 3.42]
Europe (vs Canada)	−1.6801	0.3076	−5.462	<0.001***	0.19	[0.10, 0.33]
Male sex (vs Female)	−0.8255	0.2319	−3.560	<0.001***	0.44	[0.28, 0.69]
Minor (vs Adult)	−0.3396	0.2371	−1.432	0.152	0.71	[0.44, 1.13]
Professional (vs Amateur)	0.3561	0.2438	1.461	0.144	1.43	[0.89, 2.31]
SRC risk (high, moderate, low)	0.1909	0.1588	1.202	0.229	1.21	[0.89, 1.65]

Odds ratios (OR) and 95% confidence intervals (CI) are adjusted for geographic origin, sex, age category, competitive level and sport type. Significant associations ($p < 0.001$) are highlighted with asterisk (***).

Table 4. Results of multivariable binary logistic regression model examining factors associated with abnormal return to sport duration (i.e., >20 days).

Predictor Variable	β (Estimate)	Std. Error	z-value	*p*-value	OR = exp(β)	95% CI for OR
(Intercept)	1.5531	0.5679	2.735	0.006**	4.73	[1.58, 14.76]
Europe (vs Canada)	−1.6512	0.3161	−5.224	<0.001***	0.19	[0.10, 0.35]
Male sex (vs Female)	−0.9534	0.2599	−3.668	<0.001***	0.39	[0.23, 0.64]
Minor (vs Adult)	−0.2262	0.2619	−0.864	0.388	0.80	[0.48, 1.33]
Professional (vs Amateur)	−0.1865	0.2673	−0.698	0.485	0.83	[0.49, 1.40]
SRC risk (high, moderate, low)	0.1482	0.1763	0.840	0.401	1.16	[0.82, 1.64]

Odds ratios (OR) and 95% confidence intervals (CI) are adjusted for geographic origin, sex, age category, competitive level and sport type. Significant associations ($p < 0.001$) are highlighted with asterisk (***).

0.44). No statistically significant effects were observed for age group, professional status or SRC risk category ($p > 0.05$).

The binary logistic regression conducted to identify predictors of abnormal RTS duration (i.e., > 20 days) was significant for the overall model (null deviance = 417.47; residual deviance = 367.21; AIC = 379.21) – see Table 4). After adjusting for all covariates, two predictors were significantly associated with the likelihood of an abnormal RTS duration (1): geographic origin: European athletes were significantly less likely to experience an abnormal RTS duration compared with Canadian athletes (β = −1.65, $p < 0.001$; OR = 0.19) and (2); sex: male athletes were also less likely to have an abnormal RTS duration compared with female athletes (β = −0.95, $p < 0.001$; OR = 0.39). No statistically significant effects were observed for age group, professional status or SRC risk category ($p > 0.05$).

Discussion

This study used a large cross-sectional survey, capitalizing on the representation of the French-speaking athlete community, to focus on SRC symptoms duration and RTS in an international sample of athletes from different SRC risk categories and professional status. Our primary analysis revealed that although reported symptoms and RTS durations were similar across the total sample (i.e., 3 weeks), Canadian athletes reported significantly longer durations (~4 weeks) compared to their European counterparts (~1 week). Our additional multivariate analysis confirmed that geographic origin was a significant predictor in the likelihood of prolonged symptom duration and return to sport, along with sex, with Canadian and female athletes showing a higher risk for prolonged recovery times. The remaining variables (age, sport level, SRC risk category) did not show any notable influence on those recovery durations.

Given our hypotheses, the discrepancy in reported SRC recovery between French-speaking Canadian and European athletes was expected. However, the prolonged durations on the Canadian side appeared surprising. This pattern could not be attributed to sex differences since the distribution of female and male athletes was similar in the Canadian and European subsamples. When looking at the variability in reported durations, the dispersion is a lot higher in the Canadian subsample in comparison with the European one, as apparent in the interquartile ranges. The differences observed might therefore be driven by some athletes who presented with symptoms persisting for a very long time.

Cultural specificities likely play a role in these intercontinental differences. The detection of SRC symptoms may be more effective in Canada, as general knowledge and awareness about SRC are higher in this country compared to European French-speaking nations (21). This is particularly evident in the cultural and media attention surrounding high-risk sports such as ice hockey. This trend has been demonstrated by the increase – and subsequent stabilization – of reported SRC cases in Canada over the past two decades, a pattern attributed to improved awareness and more effective symptom detection (24). The transcontinental discrepancy is also reflected in the athletes' participation rate in the present survey, with 635 respondents in Canada (314 with a history of SRC) compared to 363 in Europe (95 with a history of SRC). In addition to the ability to detect SRC symptoms, cultural factors surrounding the self-reporting of such symptoms may also contribute. Specific contexts such as willingness to continue playing and supporting the team have indeed been associated with under-reporting among adolescent athletes (12). The exploration of these reporting attitudes between Canada and Europe remains to be explored as the current literature is dominated by North-American studies.

However, the better awareness and concussion detection on the Canadian side fails to explain their longer duration of symptoms. Another hypothesis lies in the potential differences in access to care. This variable has been explored in a recent epidemiological study conducted with a cohort of 133 Olympic-level athletes from a Canadian sport institute medical

clinic (25). In their cohort, early (≤7 days) versus late (≥8 days) access to multidisciplinary care was a significant modifier of return to sport duration, with the early access group returning to sport after a median duration of 26 days versus 45 days for the late access group. Confirming similar results from a previous US-based study (26), these durations are also in line with the present study findings and go well beyond those reported by the CISG consensus meta-analysis (20 days (13)). Delayed access to multidisciplinary care following a SRC could thus be a potential explanation for the longer durations reported by Canadian athletes. In line with this hypothesis, the subsample of European athletes was predominantly composed of professional players (significantly more than in the Canadian sample) who might have easier early access to medical care. This overrepresentation of European professional players might also explain their shorter RTS duration (i.e., 10 days) since professional athletes face significant financial incentives to return to play as soon as possible, even when dealing with injury.

Epidemiological data on RTS following SRC on the European side is scarce. A retrospective study comparing the effects of SRC in American versus English soccer Leagues showed a significantly higher RTS duration in the American League (37 days; 95% CI, 7–131 days) in comparison with the European one (11 days; 95% CI, 2–28 days) (5). These results, including the disparity in variability, are in line with the present findings and have been attributed to the differences in SRC management protocols between the two leagues – suggesting a more conservative and objective approach, consistent with the CISG recommendations, on the American side. The knowledge and implementation of tailored RTS protocols have already been shown to differ between Canada and Europe (21) with greater standardization and promotion observed in Canada. (e.g., Parachute (27), Smart Hockey (28), concussion MOOC (29)) while European equivalents (e.g., FIFA (30)) are still underrepresented.

Regarding sex, both symptom duration and RTS were significantly higher in females (30 days) as compared to males (14 days) and being a female athlete was significantly associated with a higher risk of prolonged recovery. This finding is consistent with previous literature, which reports greater symptom severity and longer durations before resuming sports activities in females compared to males, particularly in youth (31–37). The above-mentioned study on 133 Olympic-level Canadian athletes also confirmed that female athletes had longer recovery trajectories than their male counterparts (52 and 42 days for RTS, respectively (25)). Several factors have been previously hypothesized to drive such between-sex differences. Hormonal changes, particularly fluctuations in estrogen levels, can influence symptom presentation throughout the menstrual cycle (33). The impact of hormonal status on symptomatology has also been confirmed in studies focusing on the use of hormonal contraceptives (38) and the menarchal status (39). Socio-behavioral factors may further play a role in symptom presentation. Females have been reported to be more forthcoming than males when disclosing SRC symptoms, which may introduce a reporting bias that partly explains the observed sex disparities (38,40,41). The individual symptomatic baseline should therefore be taken into account, as females tend to have higher baseline scores (31,32,42). However, these hypotheses require further investigation, as female populations remain largely understudied.

A concerning finding for French-speaking Canadian athletes is that their median RTS duration (28 days) is shorter than their symptom duration (30 days). In contrast, French-speaking European athletes reported a shorter RTS duration (10 days), but still longer than their median symptom duration of 7 days. This pattern should, however, be nuanced by the higher variability in the symptom duration reports in comparison with the return to sport one. Besides, there was no explicit question about a symptom-free waiting period in the present study. Current recommendations (CISG Amsterdam Consensus 2022) suggest a gradual 6-step return-to-sport strategy with the later steps introduced only after a complete resolution of symptoms (1). Since each step typically takes a minimum of 24 hours, return-to-sport should, however, not be undertaken before 6 days post-injury. The disparity observed in the present study could suggest the Canadian athletes tend to resume sport activities before complete symptom resolution which raises questions about the actual adherence to the specific return-to-play protocols adapted from the 6-step return-to-sport strategy. However, the present data is retrospective and based on self-report, thereby prone to recall bias regarding actual RTS durations.

Indeed, a key limitation affecting the generalizability of the study results is the anonymous, online nature of the survey, which may have introduced sampling and reporting biases. Relying on self-reports of remote injuries may have further obfuscated the study results. This was partly mitigated by the significant number of participants. Additionally, the study subsamples characteristics were different for Canada and Europe, which might have affected the geographic comparisons. Since the response rate was higher in Canada, future studies should use targeted strategies to increase response rates in Europe.

In conclusion, this large-scale survey focused on the under-represented French-speaking athlete community to reveal important disparities in SRC recovery between Canada and Europe, in addition to the previously identified modifying sociodemographic factors. Attitudes surrounding SRC symptomatology and return to play seem to differ by location and should be better considered when managing SRC locally.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work was supported by the Fonds De La Recherche Scientifique - FNRS; International Olympic Committee.

ORCID

Géraldine Martens http://orcid.org/0000-0001-7038-7165

References

1. Patricios JS, Schneider KJ, Dvorak J, Ahmed OH, Blauwet C, Cantu RC, Davis GA, Echemendia RJ, Makdissi M, McNamee M, et al. Consensus statement on concussion in sport: The 6th international conference on concussion in sport–Amsterdam, October 2022. Br J Sports Med. 2023 juin 1;57(11):695–711. doi:10.1136/bjsports-2023-106898.
2. Hon KL, Leung AKC, Torres AR. Concussion: a global perspective. Semin Pediatr Neurol. 2019 juill 1;30:117–27.
3. Theadom A, Mahon S, Hume P, Starkey N, Barker-Collo S, Jones K, Majdan M, Feigin V. Incidence of sports-related traumatic brain injury of all severities: a systematic review. Neuroepidemiology. 2020 jan 14;54(2):192–99. doi:10.1159/000505424.
4. Waldén M, Hägglund M, Orchard J, Kristenson K, Ekstrand J. Regional differences in injury incidence in European professional football. Scand J Med Sci Sports. 2013;23(4):424–30.
5. Ramkumar PN, Navarro SM, Haeberle HS, Luu BC, Jang A, Frangiamore SJ, Farrow LD, Schickendantz MS, Williams RJ. Concussion in American versus European professional soccer: a decade-long comparative analysis of incidence, return to play, performance, and longevity. Am J Sports Med. 2019 août 1;47(10):2287–93. doi:10.1177/0363546519859542.
6. Hallock H, Mantwill M, Vajkoczy P, Wolfarth B, Reinsberger C, Lampit A, Finke C, Sport-related concussion. Neurol Clin Pract. 2023;13(2):e200123.
7. Hootman JM, Dick R, Agel J. Epidemiology of collegiate injuries for 15 sports: summary and recommendations for injury prevention initiatives. J Athl Train. 2007;42(2):311–19.
8. Zuckerman SL, Kerr ZY, Yengo-Kahn A, Wasserman E, Covassin T, Solomon GS. Epidemiology of sports-related concussion in NCAA athletes from 2009-2010 to 2013-2014: incidence, recurrence, and mechanisms. Am J Sports Med. 2015 nov 1;43(11):2654–62. doi:10.1177/0363546515599634.
9. Nathanson JT, Connolly JG, Yuk F, Gometz A, Rasouli J, Lovell M, Choudhri T. Concussion incidence in professional football: position-specific analysis with use of a novel metric. Orthop J Sports Med. 2016 jan 1;4(1):2325967115622621. doi:10.1177/2325967115622621.
10. Salmon DM, Mcgowan J, Sullivan SJ, Murphy I, Walters S, Whatman C, Keung S, Clacy A, Romanchuk J. What they know and who they are telling: concussion knowledge and disclosure behaviour in New Zealand adolescent rugby union players. J Sports Sci. 2020 juill;38(14):1585–94. doi:10.1080/02640414.2020.1749409.
11. Pierpoint LA, Collins C. Epidemiology of sport-related concussion. Clin Sports Med. 2021 jan 1;40(1):1–18.
12. Ferdinand Pennock K, McKenzie B, McClemont Steacy L, Mainwaring L. Under-reporting of sport-related concussions by adolescent athletes: a systematic review. Int Rev Sport Exerc Psychol. 2023 déc 31;16(1):66–92.
13. Putukian M, Purcell L, Schneider KJ, Black AM, Burma JS, Chandran A, Boltz A, Master CL, Register-Mihalik JK, Anderson V, et al. Clinical recovery from concussion–return to school and sport: a systematic review and meta-analysis. Br J Sports Med. 2023 juin 1;57(12):798–809. doi:10.1136/bjsports-2022-106682.
14. McNamee M, Anderson LC, Borry P, Camporesi S, Derman W, Holm S, Knox TR, Leuridan B, Loland S, Lopez Frias FJ, et al. Sport-related concussion research agenda beyond medical science: culture, ethics, science, policy. J Med Ethics. 2025 jan 1;51(1):68–76. doi:10.1136/jme-2022-108812.
15. Zech A, Hollander K, Junge A, Steib S, Groll A, Heiner J, Nowak F, Pfeiffer D, Rahlf AL. Sex differences in injury rates in team-sport athletes: a systematic review and meta-regression analysis. J Sport Health Sci. 2022 janv;11(1):104–14. doi:10.1016/j.jshs.2021.04.003.
16. Hannah TC, Li AY, Spiera Z, Kuohn L, Dai J, McAuley F, Ali M, Durbin JR, Dreher N, Marayati NF, et al. Sex-related differences in the incidence, severity, and recovery of concussion in adolescent student-athletes between 2009 and 2019. Am J Sports Med. 2021 juin 1;49(7):1929–37. doi:10.1177/03635465211008596.
17. Cook NE, Kissinger-Knox A, Iverson IA, Stephenson K, Norman MA, Hunter AA, Saadi A, Iverson GL. Social determinants of health and health equity in the treatment and rehabilitation of sport-related concussion: a content analysis of intervention research and call-to-action. J Neurotrauma. 2024 oct;41(19-20):2201–18. doi:10.1089/neu.2023.0550.
18. Martens G, Patricios JS, Schneider KJ, Davis GA, Blauwet C, Feddermann-Demont N, Tooth C, Thibaut A, Kaux J-F, Leclerc S. Reform synthesis of the 6th International Consensus Statement on Concussion in Sport. Br J Sports Med. 2025 avr 1;59(7):444–47. doi:10.1136/bjsports-2024-109188.
19. Thibaut A, Kaux JF, Martens G, Urhausen A, Tscholl P, Hannouche D, Le Garrec S, Crema M, Winkler L, Cabri J, et al. Way for improvement: Primary survey on concussion knowledge of sports stakeholders in three European countries. Sci Sports. 2022 avr 1;37(2):94–100. doi:10.1016/j.scispo.2021.08.001.
20. Martens G, Edouard P, Tscholl P, Bieuzen F, Winkler L, Cabri J, Urhausen A, Guilhem G, Croisier J-L, Thoreux P, et al. Document, create and translate knowledge: the mission of ReFORM, the Francophone IOC Research Centre for Prevention of Injury and Protection of Athlete Health. Br J Sports Med. 2021 févr;55(4):187–88. doi:10.1136/bjsports-2020-103087.
21. Martens G, Thibaut A, Urhausen A, Tscholl PM, Beaudart C, Romeas T, de Beaumont L, Caron JG, Le Garrec S, Hannouche D, et al. Sport-related concussion knowledge in French-speaking athletes, coaches, and health care professionals: results from an international survey on 2073 participants. Clin J Sport Med. 2025 mar 17. doi:10.1097/JSM.0000000000001388.
22. Van Pelt KL, Puetz T, Swallow J, Lapointe AP, Broglio SP. Data-driven risk classification of concussion rates: a systematic review and meta-analysis. Sports Med. 2021 juin 1;51(6):1227–44. doi:10.1007/s40279-021-01428-7.
23. Clay MB, Glover KL, Lowe DT. Epidemiology of concussion in sport: a literature review. J Chiropr Med. 2013 déc 1;12(4):230–51.
24. Gordon KE, Kuhle S. Canadians reporting sport-related concussions: increasing and now stabilizing. Clin J Sport Med. mai 2022;32(3):313. doi:10.1097/JSM.0000000000000888.
25. Romeas T, Croteau F, Leclerc S. Where is the research on sport-related concussion in Olympic athletes? A descriptive report and assessment of the impact of access to multidisciplinary care on recovery. Br J Sports Med. 2024 sep 1;58(17):993–1000. doi:10.1136/bjsports-2024-108211.
26. Kontos AP, Jorgensen-Wagers K, Trbovich AM, Ernst N, Emami K, Gillie B, French J and Holland C and Elbin R. J. and Collins M. Association of time since injury to the first clinic visit with recovery following concussion. JAMA Neurol. 2020 avr 1;77(4):435–40. doi:10.1001/jamaneurol.2019.4552.
27. Parachute C. Concussion professional ressources [Internet]. Available at: https://parachute.ca/en/professional-resource/concussion-collection/.
28. Cook DJ, Cusimano MD, Tator CH, Chipman ML. Evaluation of the ThinkFirst Canada, Smart Hockey, brain and spinal cord injury prevention video. Inj Prev. 2003 déc 1;9(4):361–66. doi:10.1136/ip.9.4.361.
29. Fremont P, Schneider K, Laroche A, Emery C, Yeates K. Could a massive open online course be part of the solution to sport-related concussion? Participation and impact among 8368 registrants. BMJ Open Sport Exerc Med [Internet]. 2020 [cité 10 avr 2025];févr 27;6(1). Disponible sur: https://bmjopensem.bmj.com/content/6/1/e000700.
30. FIFA. Inside FIFA [Internet]. Available at: https://inside.fifa.com/social-impact/campaigns/concussion/return-to-play-guidelines.
31. Zuckerman SL, Apple RP, Odom MJ, Lee YM, Solomon GS, Sills AK. Effect of sex on symptoms and return to baseline in sport-related concussion: clinical article. J Neurosurg Pediatr. 2014 jan 1;13(1):72–81. doi:10.3171/2013.9.PEDS13257.
32. Baker JG, Leddy JJ, Darling SR, Shucard J, Makdissi M, Willer BS. Gender differences in recovery from sports-related concussion in

adolescents. Clin Pediatr (Phila). 2016 juill 1;55(8):771–75. doi:10.1177/0009922815606417.
33. Brown DA, Elsass JA, Miller AJ, Reed LE, Reneker JC. Differences in symptom reporting between males and females at baseline and after a sports-related concussion: a systematic review and meta-analysis. Sports Med. 2015 juill 1;45(7):1027–40. doi:10.1007/s40279-015-0335-6.
34. Stone S, Lee B, Garrison JC, Blueitt D, Creed K. Sex differences in time to return-to-play progression after sport-related concussion. Sports Health. 2017 jan 1;9(1):41–44.
35. Berz K, Divine J, Foss KB, Heyl R, Ford KR, Myer GD. Sex-specific differences in the severity of symptoms and recovery rate following sports-related concussion in young athletes. Phys Sportsmed. 2013 mai 1;41(2):58–63.
36. Desai N, Wiebe DJ, Corwin DJ, Lockyer JE, Grady MF, Master CL. Factors affecting recovery trajectories in pediatric female concussion. Clin J Sport Med. 2019 sept;29(5):361. doi:10.1097/JSM.0000000000000646.
37. D'Lauro C, Johnson BR, McGinty G, Allred CD, Campbell DE, Jackson JC. Reconsidering return-to-play times: a broader perspective on concussion recovery. Orthop J Sports Med. 2018 mar 1;6(3):2325967118760854. doi:10.1177/2325967118760854.
38. Gallagher V, Kramer N, Abbott K, Alexander J, Breiter H, Herrold A, Lindley T, Mjaanes J, Reilly J. The effects of sex differences and hormonal contraception on outcomes after collegiate sports-related concussion. J Neurotrauma. 2018 juin;35(11):1242–47. doi:10.1089/neu.2017.5453.
39. Bazarian JJ, Blyth B, Mookerjee S, He H, McDermott MP. Sex differences in outcome after mild traumatic brain injury. J Neurotrauma. 2010 mars;27(3):527–39.
40. Kerr ZY, Register-Mihalik JK, Kroshus E, Baugh CM, Marshall SW. Motivations associated with nondisclosure of self-reported concussions in former collegiate athletes. Am J Sports Med. 2016 jan 1;44(1):220–25. doi:10.1177/0363546515612082.
41. Torres DM, Galetta KM, Phillips HW, Dziemianowicz EMS, Wilson JA, Dorman ES, Laudano E, Galetta SL, Balcer LJ. Sports-related concussion: Anonymous survey of a collegiate cohort. Neurol Clin Pract. 2013 août;3(4):279–87. doi:10.1212/CPJ.0b013e3182a1ba22.
42. Ono KE, Burns TG, Bearden DJ, McManus SM, King H, Reisner A. Sex-based differences as a predictor of recovery trajectories in young athletes after a sports-related concussion. Am J Sports Med. 2016 mar 1;44(3):748–52. doi:10.1177/0363546515617746.