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Lost in translation: the association of international status and native language on concussion in collegiate athletes in the United States

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ABSTRACT

Objective: The purpose of this study was to characterize the associations of international student status and native language on time (in days) with the date of injury to (i) diagnosis, (ii) symptom resolution, and (iii) return to sport.

Methods: Utilizing data from a cross-sectional cohort of 1,044 concussion cases from LIMBIC MATARS member institutions ($n = 11$) in the US, we conducted two, matched case-control designs. Cases were divided into two groups: (i) international ($n = 32$) or domestic students ($n = 32$) and (ii) English as an Additional Language (EAL) speakers ($n = 18$) or Native English language speakers ($n = 18$). Both groups were individually matched to their respective controls based on gender, age, sport, and preexisting health conditions.

Results: There were no significant differences in days from injury to diagnosis ($p = 0.94$), symptom resolution ($p = 0.64$), or return to sport ($p = 0.15$) between international and domestic athletes. EAL speakers experienced symptom resolution approximately 7.5 days sooner (Md = 4.50; IQR = 4.00, 8.00) than Native English language speakers (Md = 12.00; IQR = 7.00, 21.00, $p = 0.01$).

Conclusions: Our findings suggest that native language is associated with symptom resolution in collegiate athletes. Healthcare professionals should consider barriers related to native language that may impact symptom reporting and the overall injury experience of diverse collegiate athletes.

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Introduction

The demography of the United States (US) brings diverse cultures, languages, and athletic populations to various institutions. This is highlighted in the National Collegiate Athletic Association (NCAA), a leading platform for amateur athletes in the US. As of 2021, over 20,000 international athletes were enrolled in and competing at NCAA member institutions, representing a wide range of cultures, languages, and athletic backgrounds (1). Having an appreciation for spoken and written language, in addition to lived experiences, beliefs, and cultural values, is central to providing high quality, patient-centered healthcare (2). Meeting the healthcare needs of diverse athletes across college athletics is essential for reducing health disparities and fostering trusting relationships between healthcare professionals (i.e., athletic trainers) and athletes (3,4). However, despite the diversity present in collegiate athletics, the socio-cultural components that impact healthcare delivery are currently understudied.

Sport-related concussion (SRC) is associated with numerous potential outcomes of public health concern. For example,

the accumulation of multiple lifetime SRCs, particularly if unreported, unrecognized, or untreated in a timely manner, may contribute to an increased risk of poor outcomes in later adulthood, though this relationship has yet to be elucidated (5,6). Rates of SRCs have increased among collegiate athletes, particularly among athletes who participate in contact/collision sports, including soccer and ice hockey (7,8). This is likely due, in part, to better awareness of, and access to, resources for concussion management. Of note, a considerable proportion of athletes participating in these high-risk sports at the college-level come from international backgrounds (e.g., men's soccer $n = 1582/4026$, 39.29%; women's soccer $n = 1013/8707$, 11.63%; men's ice hockey $n = 533/1468$, 36.31%; women's ice hockey $n = 314/698$, 44.98%) (9). However, many studies on SRCs include homogenous samples of US athletes, and seldom report on specific socio-cultural factors, such as language preference and international student status. This may contribute to the lack of recognition and treatment of SRCs among diverse athlete groups (10) and limit culturally responsive care.

Prior research on socio-cultural variables and concussion has largely focused on clinical assessment outcomes. For

example, research on common concussion assessments [e.g., Sport Concussion Assessment Tool Third and Fifth Version (SCAT3/SCAT5)] have documented differences in pre-injury baseline scores (i.e., in the absence of concussion) among athletes by age (11–16), gender (11,14–16), preexisting health conditions (13,14,17), and social determinants of health (4,18,19). In addition, prior research on concussion assessments suggests that international athletes (20) and athletes with preferred languages other than English (21–23) have lower baseline outcome scores among collegiate (20–22), high school (23), and middle school athletes (24). Further, it is important to note that differences reported on concussion assessment tools can be attributable to limitations in the tools, such as inadequate validity/reliability (25), administration of these tools in English, and acculturative experiences (26,27). These factors could result in delays in receiving appropriate care and treatment, leading to longer symptom resolution times (10). However, research is limited in characterizing the associations of sociocultural factors, specifically language and international student status, with post-concussion outcomes. Prior studies have investigated the association of socio-demographic variables (e.g., gender, age, race and ethnicity, sport-type) and preexisting health conditions (e.g., Attention Deficit/Hyperactivity Disorder [ADHD], migraine history, concussion history) on concussion recovery timelines with mixed results (28–31). Collectively, these studies suggest that gender (31–33), age (28,33), migraine history (34), and history of concussion (35,36) may be associated with clinical recovery following concussion. Moreover, systematic reviews examining influences on clinical recovery often omit ‘language barriers’ as exclusion criteria for epidemiology, etiology, and prognostic inquiry into concussion outcomes and are often ‘North American-centric’ (29,37–40). While these approaches allow for replicable study design, they may inadvertently promote homogeneity and limit the representation of research on concussion from a global perspective. In an effort to better understand the associations of international status and language on concussion recognition and recovery in collegiate athletes, our aim was to characterize the associations of international student status, as well as native language, on time (in days) from the date of injury to (i) date of concussion diagnosis, (ii) date of symptom resolution, and (iii) date of return to sport.

Materials and method

Participants

Data on participants for the present study were extracted from a cross-sectional cohort of 1,044 concussion cases representing collegiate athletes from the LIMBIC (41) Military and Tactical Athlete Research Study (LIMBIC MATARS) (42) member institutions ($N = 11$; NCAA DI: $n = 8$, NCAA DII: $n = 2$, and NCAA DIII: $n = 3$). Participants in the study were collegiate athletes who sustained concussions from 2015–2016 through 2019–2020 sport seasons. Concussion cases following March 2020 were omitted due to the COVID-19 pandemic. Athlete concussion cases in this study must have reported international student status

and Native language.. International student status was operationally defined as an international athlete who moved to the US to attend their respective institution and dichotomized into: ‘International’ (i.e., athletes originating from countries outside of the US) and ‘Domestic’ (i.e., athletes originating from the US). Native language was operationally defined as the language inherent to their respective countries of origin or their first language acquisition. Due to small sample sizes, all concussion cases that occurred to an athlete whose native language was not English were allocated into one group for analyses [i.e., ‘English as an additional language (EAL) speakers’]. The term ‘EAL’ was selected to acknowledge that there is variation in proficiency and fluency, and potential multilingualism. Counterparts who listed ‘English’ as their native language were herein referred to as ‘Native English language speakers.’

Of the 1,044 concussions cases, 34 (3.3%) were sustained by international athletes and 27 (2.6%) cases were sustained by EAL speakers. The international athletes were individually matched to domestic athletes by biological sex (dichotomized as male and female), age, sport, and preexisting health conditions, such as prior concussion history (including number of prior concussions), ADHD, learning disabilities, depression, and anxiety. EAL speakers were similarly individually matched to Native English language speakers using the same criteria. These two groups (International student status & Language) represent the two individual samples for the analyses of the present study. Of the international athlete cases, two cases were missing date-of-injury data and were subsequently removed from analyses. Similarly, nine cases of the EAL speakers were missing date-of-injury data and were removed from analyses. The final samples were made up of the following: (i) International student status [i.e., International ($n = 32$) vs Domestic ($n = 32$)], and (ii) EAL speakers ($n = 18$) vs Native English language speakers ($n = 18$).

Our matching methods prioritized criteria based on the majority of demographic variables capable of being matched per each pair. Among the international versus domestic pairs, 22 (68.8%) were ‘exact’ matches (i.e., matched on all demographic and health history questions). Among the 10 pairs that were not exact matches two pairs could not be matched on sport (e.g., international squash athlete was matched with domestic tennis athlete), one international athlete reported five prior concussions and the closest match was a domestic athlete with three prior concussions, and eight international athletes could not have their exact age matched, but were matched within 1 year of age difference, and did have their year in school matched with a domestic athlete. Among the 18 pairs of EAL and Native English language speakers, 12 (66.7%) were ‘exact’ matches. Within the six pairs that were not exact matches, one EAL athlete reported five prior concussions, and the closest match was a Native English Language speaker with three prior concussions, and five EAL athletes could not have their exact age matched with their Native English language speaking counterpart but were matched within 1 year of age difference and did have their year in school matched. See Table 1 for demographic and health history information per group.

Table 1. Summary of sample demographics.

Descriptive Variables	International Status		Language Groups	
	International n = 32	Domestic n = 32	EAL Speakers n = 18	Native English Language Speakers n = 18
Age (mean, SD)	19.7 (1.5)	19.7 (1.4)	20.0 (1.5)	20.5 (1.3)
Biological Sex				
Female, n (%)	20 (62.5%)	20 (62.5%)	10 (55.6%)	10 (55.6%)
Male, n (%)	12 (37.5%)	12 (37.5%)	8 (44.4%)	8 (44.4%)
Race, n (%)				
Black or African American	3 (9.4%)	2 (6.3%)	4 (22.2%)	1 (5.6%)
Hispanic or Latino	2 (6.3%)	2 (6.3%)	2 (11.1%)	—
White	14 (43.8%)	20 (62.5%)	10 (55.6%)	14 (77.8%)
Asian	—	—	1 (5.6%)	—
Native Hawaiian or Other Pacific Islander	—	—	—	—
American Indian or Alaska Native	—	—	—	1 (5.6%)
Did not report	13 (40.6%)	8 (25.0%)	1 (5.6%)	2 (11.1%)
Native Language, n (%)				
English	9 (28.1%)	22 (68.8%)	—	18 (100%)
German	4 (12.5%)	—	7 (38.9)	—
Hungarian	1 (3.1%)	—	1 (5.6%)	—
Dutch	1 (3.1%)	—	2 (11.1%)	—
Spanish	3 (9.4%)	—	3 (16.7%)	—
French	—	—	1 (5.6%)	—
Italian	—	—	1 (5.6%)	—
Tamil	—	—	1 (5.6%)	—
Akan	—	—	1 (5.6%)	—
Did not report	14 (43.8%)	10 (31.3%)	—	—
Sport, n (%)				
Men's Basketball	3 (9.4%)	3 (9.4%)	3 (16.7%)	3 (16.7%)
Women's Basketball	5 (15.6%)	5 (15.6%)	—	—
Football	2 (6.3%)	2 (6.3%)	1 (5.6%)	1 (5.6%)
Field Hockey	2 (6.3%)	1 (3.1%)	4 (22.2%)	4 (22.2%)
Women's Golf	2 (6.3%)	2 (6.3%)	—	—
Men's Gymnastics	1 (3.1%)	1 (3.1%)	—	—
Women's Gymnastics	1 (3.1%)	1 (3.1%)	1 (5.6%)	1 (5.6%)
Men's Track & Field	—	—	2 (11.1%)	2 (11.1%)
Women's Lacrosse	2 (6.3%)	2 (6.3%)	—	—
Rowing	1 (3.1%)	1 (3.1%)	—	—
Men's Soccer	3 (9.4%)	3 (9.4%)	4 (22.2)	4 (22.2)
Women's Squash	1 (3.1%)	—	—	—
Men's Tennis	1 (3.1%)	2 (6.3%)	—	—
Women's Tennis	3 (9.4%)	3 (9.4%)	3 (16.7)	3 (16.7)
Wrestling	1 (3.1%)	1 (3.1%)	—	—
Volleyball	—	1 (3.1%)	—	—
Pre-existing health conditions				
Prior concussions, mean (SD)	3 (9.4%)	3 (9.4%)	0.9 (1.3)	0.7 (1.02)
ADHD, n (%)	4 (12.5%)	4 (12.5%)	1 (5.6%)	1 (5.6%)
Anxiety, n (%)	2 (6.3%)	2 (6.3%)	1 (5.6%)	1 (5.6%)
Depression, n (%)	3 (9.4%)	3 (9.4%)	1 (5.6%)	1 (5.6%)
Learning Disability, n (%)	2 (6.3%)	2 (6.3%)	2 (11.1%)	2 (11.1%)
Headache Disorder/Migraine History, n (%)	3 (9.4%)	3 (9.4%)	4 (22.2%)	4 (22.2%)

Note. EAL = English as an Additional Language, ADHD = Attention-Deficit/Hyperactivity Disorder. Cases were matched by: biological sex (dichotomized as male and female), age, sport, and preexisting health conditions, such as prior concussion history (including number of prior concussions), ADHD, learning disabilities, depression, and anxiety...

Data collection procedures

Detailed criteria on the LIMBIC MATARS consortium methods are described by Resch and colleagues (42). Institutional Review Board approval was granted via the University of Virginia. Confidentiality Disclosure and Data Use Agreements were approved by or granted by the University of Virginia and each contributing consortium member's administration in accordance with institutional ethics standards. Prior to data collection, the LIMBIC MATARS investigators agreed upon common data elements (42). Institutional principal investigators from the LIMBIC MATARS consortium examined medical records of athletes who were diagnosed with concussions who were then documented by their sports medicine healthcare teams. Upon extracting data from the medical records belonging to each

institution, each investigator generated a database using Microsoft Excel (Microsoft Corporation, version 2021) unique to their institution. The consortium Co-Principal Investigator then aggregated and de-identified all site-specific concussion data. The deidentified, aggregated database was shared with the research consortium contributors for analyses.

Concussions were operationally defined using criteria established at the 4th and 5th International Conference on Concussion in Sport, relative to the time in which these data were gathered (43,44). Licensed healthcare professionals (i.e., athletic trainers, team physicians, etc.) were responsible for the recognition, diagnosis, evaluation, documentation, and return to sport management for all collegiate athletes following concussion in accordance with site-specific institutional policies and respective state laws.

The present study extracted concussion diagnosis and recovery data from the shared database. Recognition of concussion was operationally defined as the difference (in days) from date in which the athlete sustained the concussion (i.e., ‘date of injury’) to the date in which the athlete received a clinical diagnosis of concussion (i.e., ‘date of diagnosis’). Recovery variables were captured at two clinical time points. The first, was the difference (in days) from the date of injury to the date in which the athlete was documented to have complete concussion symptom resolution (i.e., ‘date of symptom resolution’). The second was the difference (in days) from the date of injury to the date in which the athlete was provided medical clearance to return to their respective sport without restrictions on their participation (i.e., ‘date of return to sport’). These three timepoints are reported on per international status and language group comparisons.

Statistical analyses

Dependent variables included time (in days) from the date of injury to (i) date of diagnosis, (ii) date of symptom resolution, and (iii) date of return to sport. Two separate matched case-control designs were conducted for (i) international vs

domestic athletes, and (ii) EAL speakers vs Native English language speakers on the aforementioned dependent variables. Each dependent variable was non-normally distributed ($p < 0.05$ for all Shapiro–Wilk tests). As such, independent Mann Whitney U tests were used to examine group differences for both the international versus domestic athletes and the EAL speakers vs Native English language speakers on each of the dependent variables. The Z scores from the Mann-Whitney U tests were then used to calculate a nonparametric effect size estimate ($r = \frac{z}{\sqrt{N}}$) (45) and interpreted according to prior established guidelines: $r = 0.10$, small; $r = 0.30$ medium; $r = 0.50$, large (46). Alpha was defined *a priori* at $p < 0.05$.

Results

International vs domestic athletes

No differences were observed among SRCs for international versus domestic collegiate athletes on any of the dependent variables (Table 2; Figure 1). Specifically, groups did not statistically vary on days from date of injury to: (i) date of diagnosis ($p = 0.94$), (ii) date of symptom resolution ($p = 0.64$), or (iii) date of return to sport ($p = 0.15$).

Table 2. Summary statistics for international status on concussion recognition and recovery measures.

Dependent Variables (in days)	International ($n = 33$)		Domestic ($n = 33$)		Group comparisons	
	Md	IQR	Md	IQR	U Statistic, P-value	Effect Size (r)
Date of Injury to Date of Diagnosis	1.00	0.00, 1.75	0.50	0.00, 2.75	U = 506.50, $p = 0.94$	-0.01
Date of Injury to Date of Symptom Free	5.00	4.00, 11.00	7.00	4.00, 16.00	U = 389.00, $p = 0.64$	-0.06
Date of Injury to Date of Return-to-Sport	10.00	8.00, 16.00	15.50	10.00, 22.75	U = 336.5, $p = 0.15$	-0.19

Note. Md=Median, IQR= Interquartile Range (25th percentile, 75th percentile).

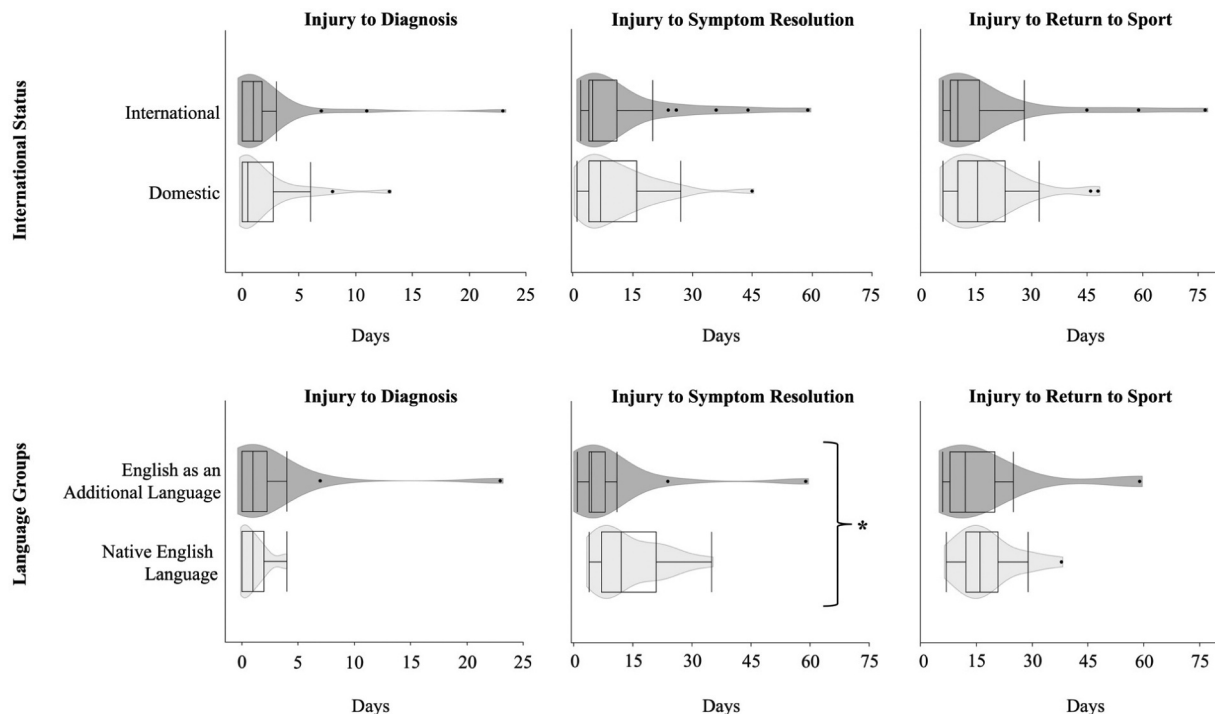


Figure 1. International status and language group comparisons on clinical milestones of diagnosis and recovery following concussion. Notation (*) indicates statistical significance between the respective groups at $p < 0.05$.

Table 3. Summary statistics for language groups on concussion recognition and recovery measures.

Dependent Variables (in days)	English as an Additional Language (<i>n</i> = 18)		Native English Language (<i>n</i> = 18)		Group Differences	
	Md	IQR	Md	IQR	U Statistic, <i>P</i> -value	Effect Size (<i>r</i>)
Date of Injury to Date of Diagnosis	1.00	0.00, 2.25	1.00	0.00, 2.00	U = 139.00, <i>p</i> = 0.48	-0.13
Date of Injury to Date of Symptom Free	4.50	4.00, 8.00	12.00	7.00, 21.00	U = 61.00, <i>p</i> = 0.01	-0.47
Date of Injury to Date of Return-to-Sport	12.00	8.00, 20.00	16.00	12.25, 20.75	U = 49.50, <i>p</i> = 0.21	-0.26

Note. Md=Median, IQR= Interquartile Range (25th percentile, 75th percentile).

EAL speakers vs Native English language speakers

EAL speakers and Native English language speakers statistically differed with medium effects on days from injury to symptom resolution ($U = 61.00$, $p = 0.01$, $r = -0.47$; Table 3; Figure 1). Specifically, EAL speakers experienced a complete symptom resolution approximately 7.5 days earlier (Md = 4.50; IQR = 4.00, 8.00) than Native English language speakers (Md = 12.00; IQR = 7.00, 21.00). Language groups did not differ from date of injury to (i) date of diagnosis ($p = 0.48$) or (ii) date of return to sport ($p = 0.21$).

Discussion

The present study examined the influence of sociocultural variables of international status and native language on concussion recognition and recovery among collegiate athletes. To the best of our knowledge, this was the first study to consider the impact of these factors on concussion diagnosis and recovery among collegiate athletes. Overall, our results demonstrate that there were no differences by international student status on any of the post-concussion clinical milestones reported upon in this study. However, native language was associated with one key recovery time point following a concussion, in that EAL speakers exhibited symptom resolution significantly sooner than their counterparts. These findings collectively suggest that the native language athletes speak may be more relevant than simply where they come from when considering concussion outcomes from a global perspective. Moving forward, sports medicine healthcare providers should seek strategies to overcome language barriers that may exist between themselves and the diverse athletes for which they provide care.

Our findings of domestic versus international athlete status on concussion outcomes have yielded favorable, yet complex results. One favorable finding is that there were no statistically significant differences in time to concussion diagnosis, symptom resolution, or return to sport. This finding may suggest that domestic and international athletes had access to similar levels of care within their respective universities. Similar recovery times between athletes with domestic or international status are noteworthy because it may be evidence of equity in the care provided to international athletes at the collegiate level of sport, despite potential cultural differences in concussion awareness (21,47), prior knowledge acquisition (21,48), and general healthcare structures and access. Additional research is needed at the secondary level of sport. However, the comparison did reveal some clinically meaningful differences in median values between the two groups, although these differences were not statistically significant. Specifically, international

collegiate athletes returned to their sport following a concussion approximately six days earlier than domestic athletes. This may suggest that there are subtle differences that may warrant further clinical consideration (e.g., culturally responsive validity investigations for SRC assessments). Further, prior research (20) has noted that international collegiate athletes report greater symptom severity upon baseline neurocognitive concussion testing than their domestic counterparts. However, from our observations, it is unclear how these differences transfer to post-concussion outcomes. Overall, while there may be differences in healthcare and sports medicine access among NCAA institutions and sports, access to sports medicine care among NCAA institutions may level the playing field, suggesting positive strides toward ensuring equitable access to care for all athletes, regardless of their nationality.

The most pressing finding that we observed in this investigation is that EAL speakers who were diagnosed with a concussion experienced symptom resolution approximately 1 week earlier than their native English language speaking counterparts. Although this finding may suggest a positive clinical outcome for EAL speakers to experience earlier symptom resolution, it may consequently demonstrate a health disparity in the opposite direction. Some terms related to concussion and symptoms of concussion are not directly translatable outside of the English language, and therefore, the concept of concussion may differ in languages other than English. For example, Eirale and colleagues (49) observed concussion incidence among Qatari professional football (i.e., American soccer) athletes to be lower than European professional football athletes. The authors concluded that the lower incidence of concussion was likely attributed to different knowledge acquisition and symptom recognition among Qatari athletes. Further, Beidler and colleagues (47) observed that concussion awareness and reporting behaviors varied among collegiate athletes from the US, Ireland, and Jordan. Using a validated survey instrument, the authors observed concussion awareness was highest in the US, which was likely due, in part, to concussion publicity and legislation. However, concussion awareness was lowest amongst the Jordanian athletes, who received a translated Arabic version of the survey (47). Notably, only 9 (28.1%) of the 32 international athletes from our study were also EAL speakers. This further supports the importance of language considerations, as opposed to broad international classifications for consideration in concussion care. Collectively, these findings may demonstrate variance in concussion diagnosis and symptom reporting amongst athletes of that speak different languages. This is further compounded by the fact that translations of concussion assessment tools are still in their infancy (50–52). Further, the

natural progression from direct language translations should also include culturally relevant and ecological measures of concussion among diverse communities. This may include community integration, or the inclusion of culturally appropriate social roles following injury; a paradigm that has been well established in traumatic brain injury research (53,54). Moreover, there are limitations in the availability of concussion education materials across different languages. Specifically, the NCAA concussion safety materials are solely distributed in English at this time (55). This can lead to a lack of understanding and reporting of concussions among EAL speaking athletes, as information sheets written in English may not be sufficient to educate athletes with different native languages about the injury. In contrast, the Centers for Disease Control and Prevention provides both discharge instructions and symptom-based recovery suggestions in English and Spanish, but not in any other language. As such, more global initiatives are needed when providing culturally responsive concussion care and to develop educational modules that are accessible to all athletes that are inclusive of their native language.

The analyses in the present study yielded several limitations, including not having the ability for equal representation of sports and athlete demographics across all institutions. However, our sample summary data were reflective of the demographic profile distributions of all NCAA athletes (9). The available data at each institution were limited with regard to native language variables and other socio-cultural factors, which led to aggregating data for all individuals whose native language was not English. Although we were able to match concussion cases in both groups, there is limited generalizability with our sample. However, a strength of our study design was the detailed matching criteria, which enabled us to generate respective controls for demographic and health history considerations known to potentially influence concussion incidence and recovery (28). Broad identification of international status and native language did not provide opportunities to identify the impact of specific factors of an athlete's background, culture, or ethnicity on concussion recognition and recovery.

Studies using multiple institutions should examine the potential for individual institutions (e.g., practice patterns) and sport cultures (e.g., stigmatization) to influence time to recovery. For example, a notable limitation of the present study was a lack of matching concussion cases by institutions or institution types (e.g., NCAA DI, DII, DIII). Analyses of prospective data will allow for the determination of more specific sociocultural factors to examine in this population, as opposed to the sole identification of international status. Some cultural and language differences may vary across language and/or nation of origin, as such larger studies with a larger sample of international athletes and athletes with a diverse array of native languages would provide the sensitivity to capture additional information. Future studies should also specifically examine what facilitators and/or barriers contribute to a difference in time to symptom resolution. For example, it is unknown at present what specific symptoms or groups of symptoms may be the greatest influence in reporting symptom resolution status among athletes with varying

language backgrounds. Further, future research should consider exploring regional influence on concussion literacy among athletes. A limited spread of time from date of injury to diagnosis demonstrated timeliness for athletes who were identified as having a concussion and removed from sport. Further analyses of these timepoints can help to identify what opportunities contribute to the success of concussion identification and diagnosis with regard to cultural and language differences.

Among collegiate athletes, there are sociocultural and demographic background information that are relevant factors when providing care following a concussion. Specifically, language may be associated with differences in time to reach clinical milestones in concussion management. Clinicians working with this population should consider the barriers present in the tools or administration of assessments, when determining symptom resolution following a concussion. Athletic trainers and physicians in the collegiate setting are often the first to identify concussions and manage athletes' care to the point of return to sport. As such, all healthcare providers involved in concussion care for collegiate athletes have a responsibility to do so in a culturally responsive manner to ensure optimal brain health outcomes.

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