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Examining Concussion Nondisclosure in Collegiate Athletes Using a Health Disparities Framework and Consideration of Social Determinants of Health

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Context: Limited research exists concerning the relationship between the social determinants of health (SDOHs), including race, socioeconomic status (SES), health care access and physical environment and concussion nondisclosure in collegiate athletes. However, among high school athletes, disparities have been noted, with Black athletes who attended under-resourced schools and lacked access to an athletic trainer (AT) disclosing fewer concussions.

Objective: To investigate whether concussion nondisclosure disparities existed by (1) race, (2) SES, or (3) AT health care access before college and understand the differential reasons for concussion nondisclosure between White and Black collegiate athletes.

Design: Cross-sectional study.

Setting: Collegiate athletics.

Participants: A total of 735 college athletes (84.6% White, 15.4% Black).

Main Outcome Measure(s): Participants completed a questionnaire that directly assessed concussion nondisclosure, including reasons for not reporting a suspected concussion. With the premise of investigating SDOHs, race was the primary exposure of interest. The outcome of interest, nondisclosure, was assessed with a binary (*yes* or *no*) question, "Have you ever sustained a concussion that you did not report to your coach, AT, parent, teammate, or anyone else?"

Results: Among the White and Black athletes, 15.6% and 17.7%, respectively, reported a history of concussion nondisclosure. No differences were found by race for distributions of history of concussion nondisclosure ($P = .57$). Race was not associated with concussion nondisclosure when evaluated as an effect modification measure or confounder, and no significant associations were noted by SES or high school AT access. Differences by race for reported reasons for nondisclosure were present for "At the time, I did not think it was a concussion" ($P = .045$) and "I thought my teammates would think I am weak" ($P = .03$), with Black athletes selecting these more frequently than White athletes.

Conclusions: These data help to contextualize race and its intersection with other SDOHs that could influence concussion nondisclosure outcomes in collegiate athletes.

Key Words: race, socioeconomic status, traumatic brain injuries

Key Points

- Our findings differed from those in the high school–aged group, which suggests that racial disparities concerning nondisclosure may be improved from high school to college due to the medical and personnel infrastructure available in the latter environment.
- Race was examined as an effect modification measure and confounder. Race was not associated with nondisclosure in these models; however, other factors included being female, which was associated with lower odds of nondisclosure, while having a previously diagnosed concussion and more concussion knowledge were associated with higher odds.
- These results can serve as examples for larger-scale community-based interventions, as they indicate that equal and equitable access to resources, including an athletic trainer, can mitigate concussion nondisclosure.

An athlete's ability to identify and immediately report a head or brain injury is paramount for facilitating proper management and more favorable recovery outcomes.[1,2] Recent evidence suggested that collegiate[1] and adolescent[3] athletes who delayed concussion reporting took longer to recover than those who were more rapidly removed from activity. Although concussion resources highlight the dangers of playing while concussed and encourage athletes to immediately report their injuries, a sizable portion of collegiate athletes' concussions go

unrecognized and undisclosed.[4,5] Further, concussion nondisclosure may not be rooted in a lack of injury comprehension in this population, as collegiate athletes tended to have favorable levels of concussion knowledge.[6]

Earlier authors[4,5,7] considered differences in concussion reporting based on sex or gender, sport participation, diagnosed concussion history, and injury knowledge among collegiate athletes. However, studies that were intended to ascertain the relationship between the social determinants of health (SDOHs) (eg, upstream factors[8] such as race, socioeconomic status [SES], health care access and the physical environment) and concussion nondisclosure in this population are rare. *Upstream SDOHs* are social factors that can have direct or indirect effects on health and play a fundamental causal role in understanding health outcomes.[8] The only researchers[9] who broached such topics in the collegiate setting observed no differences in concussion-reporting intentions or behaviors between collegiate athletes from high versus mid-SES households. They did not consider low SES due to a lack of sample diversity and did not assess any other SDOHs; therefore, more research is needed.

Several foundational studies in adolescent populations addressed the interplay between different SDOHs and concussion knowledge and reporting. White high school (HS) athletes had greater concussion-symptom knowledge than their Black peers,[10] and this same disparity was observed in the parents of HS athletes.[11] In addition to knowledge, Wallace et al[12] noted differences in concussion reporting by race. Black HS athletes recalled and reported fewer concussive events than White athletes; a reason for not reporting was linked to not recognizing a concussive event as such.[12] The decrease in concussion reporting by Black HS athletes may have been related to symptom-recognition disparities that ultimately stemmed from environmental or structural (eg, low SES, Title I schools, residential segregation) and health care access (eg, onsite sports medicine health care) inequities that limited concussion-education programming.[12] This philosophy was supported by the finding that athletes who attended urban, Title I HSs had poorer concussion knowledge than athletes from suburban, non-Title I schools.[13] Additionally, HS athletes who lacked access to an athletic trainer (AT) were less knowledgeable about concussions than those with AT access.[13,14] Although SES and health care access were identified as factors in knowledge differences, these SDOHs were not linked to more or less favorable injury-reporting behaviors in HS athletes.[14] However, it is unclear if these trends continue among collegiate athletes.

On an all-encompassing level, race and the resulting structural racism have been identified as the SDOH that is a root cause of health inequalities.[8,15,16] The intersection of race with the spectrum of SDOHs has the potential to magnify health disparities. One example of structural racism is *residential segregation*, in which a separation exists between White and Black communities. These residential differences shape health as limited access to health care, poor quality of neighborhoods, less health care utilization, and poor quality of schools are associated with adverse health outcomes.[17] Notably, among collegiate athletes, 81 100 (16%) of all National Collegiate Athletic Association (NCAA) participants identified as Black; however, most Black athletes participated in higher-risk concussion sports, such as football and men's and women's basketball, than sports such as tennis, swimming or diving, rowing, and fencing.[18,19] Before these sociodemographic inequities and barriers can be reduced, eliminated, and overcome, we must first establish the extent of the disparities.

To do this, we used the Health Disparities Research Framework outlined by Kilbourne et al[20] that consists of 3 phases: detecting, understanding, and reducing. Using this comprehensive framework, alongside consideration of the SDOHs, can provide opportunities to design interventions that can improve health and reduce disparities in concussion-related outcomes. Thus, the aim of our study was to investigate concussion nondisclosure in collegiate athletes using a health disparities framework. We specifically sought to detect if disparities existed in concussion nondisclosure by (1) race, (2) SES, or (3) sports medicine (AT) health care access before college and to understand the possible differential factors related to concussion reporting between White and Black collegiate athletes.

METHODS

Participants

The Institutional Review Board at Duquesne University approved this study before data collection. A cross-sectional survey was administered to male and female NCAA athletes at 7 participating universities (Division I = 4, Division II = 2, Division III = 1) in 3 geographic regions of the US (Midwest, East, Southeast). Collegiate athletes were eligible if they were currently participating in an NCAA sport and were $\geq$18 years old. Exclusionary factors were those who indicated being international students, having sustained a concussion in the previous 3 months, or experiencing prolonged symptoms (eg, lingering symptoms, undergoing treatment) related to a previous concussion. We used these exclusionary criteria to decrease the potential bias a recent injury experience might have on survey responses. The final convenience sample involved 735 athletes.

Instrumentation and Variables of Interest

A questionnaire was adapted from previously published research,[14,21,22] and most participants completed it within 15 to 20 minutes. The questionnaire contained sections on demographics and self-reported medical history, followed by concussion perceptions, knowledge, and reporting behaviors. An in-depth examination of concussion perceptions and knowledge was provided in a previous publication.[6] Demographics consisted of age, sex, race or ethnicity, history of free or reduced-price lunch (FRL) in HS (*yes* or *no*), current academic year, current sport, total years of participation in the current sport (overall and at the collegiate level), NCAA Division, and access to an AT while in HS (*yes* or *no*). Finally, participants were asked about a history of concussion diagnosis with a binary (*yes* or *no*) question: "Have you ever been diagnosed with a concussion by a doctor or AT?"

Given the goal of investigating SDOHs, our primary exposure of interest was race. We only evaluated racial comparisons between athletes who self-identified as White or Black (75% of all participants) because these 2 racial

groups identified most athletes in the NCAA, and few individuals from other racial or ethnic groups participated. Additional SDOHs were FRL and HS AT access. Free or reduced-price lunch is a proxy widely used in the education literature and is an indicator of lower SES.[23] Finally, because all participating athletes had access to an AT at their college or university, sports medicine health care access before college was evaluated via HS AT access.

The primary outcome was concussion nondisclosure. Nondisclosure was assessed with a binary (*yes* or *no*) question: "Have you ever sustained a concussion that you did not report to your coach, AT, parent, teammate, or anyone else?" Athletes then noted, from a list of 16 items, all the reasons for not reporting a concussion or possible concussion symptoms (eg, "I thought my coach would get mad"; "At the time, I did not think it was a concussion"; "I thought my teammates would think I am weak"; "I did not think it was a serious injury"; "My team was going to the playoffs when it happened"; "I did not want to let my team down"). Athletes could select more than 1 reason.

Procedures

Research team members made first contact with the ATs at each participating institution to inform them of the study aims and procedures. We then worked in conjunction with the sports medicine teams at each site to schedule data-collection sessions before or after athletic team activities. At each session, a team member presented prospective participants with an informed consent form, described the study orally, and was available to answer questions regarding the survey. Collegiate athletes who agreed to participate completed the survey using a smart device or pencil and paper depending on site-specific resources. Electronic surveys were administered using Qualtrics (Provo, UT). Trained research assistants recorded paper-and-pencil responses in this database, with random comparisons performed to certify accurate survey entry.

Statistical Analysis

Descriptive statistics (ie, frequencies and percentages) were calculated for athlete characteristics. Chi-square tests assessed differences in the distributions of diagnosed concussion history and history of concussion nondisclosure first by race (White, Black) and then by race coupled with FRL (White/FRL, White/no FRL, Black/FRL, Black/no FRL) and HS AT access (White/access, White/no access, Black/access, Black/no access).

Next, we developed multivariable logistic regression models to identify SDOHs associated with concussion nondisclosure. To fully assess the role of race (White versus Black), an a priori plan was established to assess race as an effect measure modifier first and then as a confounder.[24] To evaluate effect measure modification, separate models were conducted for White and Black athletes. For each, model 1 included only FRL (*yes* versus *no*) and HS AT access (*yes* versus *no*) as predictors. Model 2 added sex, diagnosed concussion history (*yes* versus *no*), and concussion-symptom knowledge (1-point increase on the scale) as predictors. Because of the small sample sizes and concerns about low statistical power, we decided to rely on an "eyeball test" versus statistical tests to examine effect measure modification (ie, did the findings seem different at face value?). If effect measure modification was not found, then race was included in a model as a confounder with all athletes combined. For these analyses, model 1 explored race as the sole predictor; model 2 added FRL and HS AT access; and model 3 added sex, diagnosed concussion history, and concussion-symptom knowledge. All adjusted odds ratios (ORs) with 95% CIs that excluded 1.00 were deemed significant.

Last, among athletes who self-reported concussion nondisclosure, we computed frequencies of the reported reasons for nondisclosure. Chi-square tests assessed whether distributions by race differed. Here, P values $<$ .05 were deemed statistically significant.

RESULTS

A total of 735 collegiate athletes (White = 662/735, 84.6%; Black = 113/735, 15.4%) were included in the study (Table 1). Overall, 25.7% and 30.2% of White and Black athletes, respectively, indicated a previous diagnosed concussion; 17.7% and 15.6%, respectively, reported a history of concussion nondisclosure. No differences were found by race for distributions of diagnosed concussion history ($P = .33$) or history of concussion nondisclosure ($P = .57$; Table 2). No further differences were found by FRL or HS AT access.

Logistic Regression Models With SDOHs

Results from the analyses with race as an effect modifier are presented in Table 3. Free or reduced lunch and HS AT access were not associated with concussion nondisclosure by White or Black athletes. Reporting a previous diagnosed concussion was associated with increased odds of concussion nondisclosure among White (OR = 2.59; 95% CI = 1.65, 4.07) and Black athletes (OR = 5.76; 95% CI = 1.97, 16.80). In addition, females were less likely than males to report concussion nondisclosure among White athletes (OR = 0.42; 95% CI = 0.26, 0.68); the findings were similar among Black athletes but were not significant (OR = 0.31; 95% CI = 0.03, 2.98). Similarly, increased concussion-symptom knowledge was associated with increased odds of concussion nondisclosure among White athletes (1-unit increase OR = 1.08; 95% CI = 1.01, 1.15); the findings were similar among Black athletes but were not significant (OR = 1.08, 95% CI = 0.95, 1.24).

Although small variations existed between White and Black athletes, we generated follow-up models to examine race as a confounder (Table 4). In model 3, increased odds of concussion nondisclosure were not associated with race (OR = 1.04; 95% CI = 0.57, 1.91), FRL (OR = 1.07; 95% CI = 0.59, 1.96), or HS AT access (OR = 0.71; 95% CI = 0.39, 1.29). The odds of concussion nondisclosure decreased among females versus males (OR = 0.41; 95% CI = 0.26, 0.67); increased with reporting a previous diagnosed concussion (OR = 2.97; 95% CI = 1.96, 4.50), and increased with concussion-symptom knowledge (1-unit increase OR = 1.07; 95% CI = 1.01, 1.14).

Reasons for Concussion Nondisclosure

The most common reasons for nondisclosure among Black athletes were "I did not want to let my team down" (n = 15/20, 75.0%), followed by "At the time, I did not

Table 1. Characteristics of Sample of Collegiate Athletes (N = 735)

Characteristic	Athletes, No. (%)	
	White (n = 622)	Black (n = 113)
Sex		
Male	338 (54.3)	101 (89.4)
Female	284 (45.7)	12 (10.6)
Age, y		
18	147 (23.6)	29 (25.9)
19	174 (27.9)	25 (22.3)
20	130 (20.9)	25 (22.3)
21	125 (20.1)	21 (18.8)
≥22	46 (7.4)	12 (10.7)
Missing	0	1
Year in college		
First	188 (30.2)	30 (26.5)
Second	174 (27.9)	29 (25.7)
Third	122 (19.6)	22 (19.5)
Fourth	111 (17.8)	21 (18.6)
Fifth	17 (2.7)	6 (5.3)
Graduate student	10 (1.6)	5 (4.4)
Had free or reduced-price lunch in high school		
Yes	58 (9.3)	49 (43.4)
No	564 (90.7)	64 (56.6)
Had access to an athletic trainer in high school		
Yes	508 (81.7)	93 (82.3)
No	114 (18.3)	20 (17.7)
History of diagnosed sport-related concussion		
Yes	188 (30.2)	29 (25.7)
No	434 (69.8)	84 (74.3)
History of concussion nondisclosure		
Yes	97 (15.6)	20 (17.7)
No	525 (84.4)	93 (82.3)
National Collegiate Athletic Association Division		
I	219 (35.2)	63 (55.8)
II	319 (51.3)	49 (43.4)
III	84 (13.5)	1 (0.9)
Years playing sport[a]		
0–5	49 (79.7)	6 (5.5)
6–10	242 (39.3)	44 (40.4)
11–15	247 (40.2)	47 (43.1)
≥16	77 (12.5)	12 (11)
Missing	7	4
Sport		
Baseball or softball	58 (9.3)	2 (1.8)
Basketball	39 (6.3)	21 (18.6)
Bowling	8 (1.3)	0
Cross-country	29 (4.7)	1 (0.9)
Field hockey	22 (3.5)	0
Football	112 (18.0)	68 (60.2)
Golf	9 (1.4)	0
Ice hockey	34 (5.5)	0
Lacrosse	103 (16.6)	0
Rowing	15 (2.4)	0
Soccer	60 (9.6)	8 (7.1)
Swim and dive	17 (2.7)	0
Tennis	23 (3.7)	2 (1.8)
Track and field	13 (2.1)	1 (0.9)
Volleyball	19 (3.1)	3 (2.7)
Water polo	22 (3.5)	2 (1.8)
Wrestling	39 (6.3)	5 (4.4)
Contact	431 (69.3)	104 (92.0)
Limited Contact	77 (12.4)	5 (4.4)
Noncontact	114 (18.3)	4 (3.5)

[a] Only the sport the participant played in college was considered.

think it was a concussion" (n = 13/20, 65.0%), and "I did not want to lose playing time" (n = 12/20, 60.0%; Table 5). The most frequent reasons for nondisclosure among White athletes were "I did not want to miss a game" (n = 70/97, 72.2%), "I did not want to lose playing time" (n = 69/97, 71.1%), and "I did not want to let my team down" (n = 53/97, 54.6%). Differences in distribution by race for reasons for nondisclosure were present for "At the time, I did not think it was a concussion" (White = 38.1% versus Black = 65.0%; $P = .045$) and "I thought my teammates would think I am weak" (White = 24.7% versus Black = 50.0%; $P = .03$).

DISCUSSION

In this study, we aimed to investigate concussion disclosure by collegiate athletes using a health disparities framework with a specific focus on the influences of race, SES, and sports medicine health care access before college. We are among the first to explore race as an effect modifier and observed varied, although small, effects for White and Black athletes concerning concussion nondisclosure. Given the small differences, we also examined race as a confounder. Race was not associated with nondisclosure in these models; however, being female was associated with lower odds of nondisclosure, while having a previous diagnosed concussion or more concussion knowledge was associated with higher odds. This approach offered a more comprehensive understanding of how factors at various levels of the socioecological model, in union with the Pyramid of Influence,[25] may affect nondisclosure and are similarly supported by the literature on collegiate athletes.[9,26,27] These findings provide foundational information to support further exploration of race and the influence of other SDOHs on concussion nondisclosure.

Alongside our primary purpose, we explored basic demographic differences between White and Black athletes, as these factors may identify underpinning differences associated with diagnosed concussion history and nondisclosure. The overall sample was weighted more heavily toward first-year athletes. As such, our study findings may be reflective, in this subset, of their more recent HS experiences versus the full collegiate experience that would be reported by athletes further along in their collegiate careers. Our sample consisted largely of White athletes; however, the proportion of first-year students was similar across White and Black athletes. Additionally, the authors[26,28] of studies of first-year athletes noted findings that were similar to those of athletes further in their collegiate careers. Although White and Black athletes were similar in many aspects of the study sample, a higher proportion of Black athletes played Division I (55.8% versus 35.2%), were male (89.4% versus 54.3%), and reported having FRL in HS (43.4% versus 9.3%). Several of these differences may be the result of recruitment strategies and potential response bias in the survey. Nonetheless, the FRL differences may illustrate disparities before arrival at college that can influence concussion-related outcomes and nondisclosure. When examining associations between a diagnosed concussion history as well as nondisclosure by FRL status and HS AT access, we demonstrated no distinct differences between White and Black collegiate athletes. Therefore, other factors may mediate or moderate the

Table 2. Distributions of History of Diagnosed and Nondisclosed Sport-Related Concussion

Sample	No.	History of Diagnosed Sport-Related Concussion		History of Concussion Nondisclosure	
		No. (%)	*P* Value	No. (%)	*P* Value
All White athletes	622	188 (30.2)	.33	97 (15.6)	.57
All Black athletes	113	29 (25.7)		20 (17.7)	
White athletes, HS FRL	58	16 (27.6)	.75	10 (17.2)	.92
White athletes, no HS FRL	564	172 (30.5)		87 (15.4)	
Black athletes, HS FRL	49	12 (24.5)		9 (18.4)	
Black athletes, no HS FRL	64	17 (26.6)		11 (17.2)	
White athletes, HS AT access	508	159 (31.3)	.15	83 (16.3)	.22
White athletes, no HS AT access	114	29 (25.4)		14 (12.3)	
Black athletes, HS AT access	93	27 (29.0)		19 (20.4)	
Black athletes, no HS AT access	20	2 (10.0)		1 (5.0)	

Abbreviations: AT, athletic trainer; FRL, free or reduced-price lunch; HS, high school.

influence of structural and SDOHs in this population, as these findings differ from those in the HS athletic setting.[12]

Data from the NCAA indicated that most Black-athlete participants, across divisions, are concentrated into a smaller number of sports.[18] Notably, most of the Black athletes (92.0% versus 69.3%) in the current sample participated in higher concussion-risk sports such as football and basketball. Collectively, these data highlight sport-based differences[29,30] and could be related to Black athletes having less of an opportunity or access to more affluent sports throughout their lifetime,[18] and this difference is a relevant edifice for concussion-disclosure interventions designed for sports that may have higher Black representation. Racial demographics in HS and collegiate athletics revealed that Black athletes tended to engage in contact sports more than their White counterparts, and this difference may underlie historical racial discrimination, affordability of certain sports, and limited accessibility to sport-specific infrastructure (eg, golf course, tennis court, swimming pool) in residential spaces.[31] Such inequitable access limits a Black athlete's opportunity to participate in various sports. This can also be seen historically in the US social context, where Black athletes were excluded from collegiate and professional sports due to racial segregation. Black athletes were banned from participation in sports at certain institutions[32] until an influx of civil rights policies and legislation were passed to lawfully prohibit discrimination based on race.[33] Until that point, schools, and consequently sports, were segregated, which allowed institutions to exclude Black athletes from participation. This ostracizing from athletic competition discouraged the Black community from participating in certain sports, further marginalizing it from the White majority due to certain sports being unavailable.[29]

Statistical Models to Assess Nondisclosure

We examined factors associated with nondisclosure to better evaluate race as an effect measure modification using 2 stepwise models for each racial group separately: first, a model including only defined SDOHs and a second including those SDOHs and personal characteristics. For Black athletes, only reporting a previous diagnosed concussion was associated with concussion nondisclosure, whereas among White athletes, being female was associated with lower odds of nondisclosure, and having a

Table 3. Odds Ratios Predicting Sport-Related Concussion Nondisclosure, With Race as an Effect Measure Modifier[a]

Characteristic	Athletes, Odds Ratio (95% CI)			
	White		Black	
	Model 1	Model 2	Model 1	Model 2
Had free or reduced-price lunch in high school				
Yes	1.15 (0.56, 2.35)	1.10 (0.53, 2.34)	0.98 (0.32, 2.92)	0.94 (0.32, 2.76)
No	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)
Had access to an athletic trainer in high school				
Yes	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)
No	0.72 (0.39, 1.32)	0.82 (0.44, 1.53)	0.21 (0.01, 1.49)	0.26 (0.03, 2.27)
Sex				
Male	NA	1.0 (ref)	NA	1.0 (ref)
Female	NA	0.42 (0.26, 0.68)	NA	0.31 (0.03, 2.98)
Diagnosed concussion history				
Yes	NA	2.59 (1.65, 4.07)	NA	5.76 (1.97, 16.80)
No	NA	1.0 (ref)	NA	1.0 (ref)
Concussion-symptom knowledge				
1-unit increase	NA	1.08 (1.01, 1.15)	NA	1.08 (0.95, 1.24)

Abbreviations: NA, not applicable; ref, referent.

[a] Models were run separately for White and Black athletes to assess effect measure modification. Model 1 included only free or reduced-price lunch and access to an athletic trainer in high school as predictors. Model 2 added sex, diagnosed concussion history, and concussion-symptom knowledge as predictors.

Table 4. Odds Ratios Predicting Sport-Related Concussion Nondisclosure, With Race as a Confounder[a]

Characteristic	Athletes, Odds Ratio (95% CI)		
	Model 1	Model 2	Model 3
Race			
White	1.0 (ref)	1.0 (ref)	1.0 (ref)
Black	1.16 (0.69, 1.98)	1.12 (0.63, 1.98)	1.04 (0.57, 1.91)
Had free or reduced-price lunch in high school			
Yes	NA	1.11 (0.62, 1.98)	1.07 (0.59, 1.96)
No	NA	1.0 (ref)	1.0 (ref)
Had access to an athletic trainer in high school			
Yes	NA	1.0 (ref)	1.0 (ref)
No	NA	0.62 (0.35, 1.10)	0.71 (0.39, 1.29)
Sex			
Male	NA	NA	1.0 (ref)
Female	NA	NA	0.41 (0.26, 0.67)
Diagnosed concussion history			
Yes	NA	NA	2.97 (1.96, 4.50)
No	NA	NA	1.0 (ref)
Concussion symptom knowledge			
1-unit increase	NA	NA	1.07 (1.01, 1.14)

Abbreviations: NA, not applicable; ref, referent.

[a] Model 1 included only race as a predictor. Model 2 add free or reduced-price lunch and access to an athletic trainer in high school as predictors. Model 3 added sex, diagnosed concussion history, and concussion-symptom knowledge as predictors.

previous diagnosed concussion or more concussion knowledge was associated with higher odds of nondisclosure. These findings in White athletes are consistent with earlier work[26] among collegiate athletes concerning factors related to nondisclosure. The lack of associations in the Black athletes may be due to the sample size, as many associations were trending in a similar direction to those of White athletes. However, these approaches provide insight into considerations of race using effect measure modification techniques, as many of the findings in earlier research may have been driven by associations in one race and may not reflect trends across heterogeneous racial identities. These data provide one of the first examinations of racial influence on these outcomes, and using such methods may serve as a foundation for future research and outcome interpretation.

The second set of models included race as a confounder with other variables of interest. These models included unadjusted and adjusted approaches: (1) race alone, (2) race and defined SDOHs, and (3) race, SDOHs, and personal characteristics. In these 3 models, race was not significantly associated with nondisclosure. However, being female was associated with lower odds of nondisclosure. Having a concussion history and more concussion knowledge were each associated with greater odds of nondisclosure. Our results, specifically those concerning race, differed significantly from those in the HS age group, with fewer Black athletes reporting concussive events than their White peers.[12] This discrepancy is important, as it highlights possible differences between HS and collegiate athletes. Not all HS athletes can go on to participate in collegiate athletics, and this group may include athletes who pursue nondisclosure. Also, many of the disparities concerning disclosure may have improved from HS to college due to the medical and personnel infrastructure available in the collegiate environment. Given that a high percentage of the Black athletes in the current sample were Division I athletes, this may be even more relevant because differences across divisions can influence how sports medicine departments are financed, staffed, and supported.[34] Moreover, it is possible that sampling differences, including a smaller sample of Black athletes, broader geographic reach, and no apparent disparity in HS AT access by race in our study, limited lateral comparisons of our findings and previous work with HS athletes.[17] Investigating how this infrastructure may improve such outcomes or other disparities that may exist outside of those within the collegiate environment is important for a more thorough understanding.

Reasons for Concussion Nondisclosure

Although reasons for concussion nondisclosure were somewhat similar between White and Black athletes, the latter were more likely (50%) than their White counterparts (24%) to not disclose concussion events in an attempt to assimilate to their environment simply because they did not want their teammates to think they were being weak. This supports research that indicated athletics has a reputation

Table 5. Reported Reasons for Nondisclosure of Sport-Related Concussions[a]

Possible Reasons for Nondisclosure	White Athletes (n = 97)	Black Athletes (n = 20)	*P* Value
I thought my coach would get mad.	28 (28.9)	4 (20.0)	.58
I did not want to go to the doctor.	44 (45.4)	7 (35.0)	.46
I thought my parents would be upset.	12 (12.4)	2 (10.0)	>.99
I did not want to lose playing time.	69 (71.1)	12 (60.0)	.42
I was worried I would have to miss school and get behind on my schoolwork.	28 (28.9)	2 (10.0)	.1
At the time, I did not think it was a concussion.	37 (38.1)	13 (65.0)	.045
I thought my teammates would think I am weak.	24 (24.7)	10 (50.0)	.03
I did not think it was a serious injury.	39 (40.2)	11 (55.0)	.32
I did not have health insurance and could not go to the doctor.	3 (3.1)	1 (5.0)	.53
I did not want to let my team down.	53 (54.6)	15 (75.0)	.13
I did not want to miss a game.	70 (72.2)	11 (55)	.18
My team was going to playoffs when it happened.	17 (17.5)	2 (10.0)	.52
I thought my coach would think I am weak.	26 (26.8)	8 (40.0)	.28
I had an exam or project due at school that I did not want to make up.	4 (4.1)	2 (10.0)	.27
I was concerned it would affect my chances of playing professional sports.	7 (7.2)	4 (20.0)	.09

[a] Of the 622 White and 113 Black athletes, 97 (15.6%) and 20 (17.7%) athletes, respectively, reported a history of concussion nondisclosure.

for encouraging athletes to be "tough"[35] by ignoring possible injury. Black athletes also reported they did not disclose some instances of concussion because, at the time, they "did not think it was a concussion" more often (65%) than White athletes (38.1%). This echoes previously identified disparities in concussion-symptom knowledge. Black athletes displayed poorer concussion-symptom knowledge than White athletes and appeared to obtain concussion information from different sources.[10,13] A multitude of overlapping individual and interpersonal factors influence concussion nondisclosure, as the pressure to conform to societal, cultural, and environmental norms may also be an important factor in concussion nondisclosure. This perspective stems from collegiate athletics upholding the ideal of camaraderie and teamwork as essential to sport success but also encouraging a covert culture of nondisclosure due to various pressure sources and expectations.[27,36] This culture of nondisclosure is continuously displayed through the actions, inactions, or both of athletes' concussion-reporting behaviors and in the action, inaction, or pressure from collegiate athletic stakeholders.[36] Specifically, Black athletes may have battled these pressures in addition to barriers related to their race (eg, discrimination, negative stereotypes, microaggressions) that could have negatively affected their experiences as collegiate athletes[18,37] or their decision to disclose a concussion.

Contextualizing Nondisclosure in the Health Disparities Framework

Although the results of our study help us better understand nondisclosure among White and Black collegiate athletes, ultimately, these findings can aid us in beginning to reduce disparities. *Reducing disparities*, as defined in the Health Disparities Framework,[20] can include clinical and protective interventions, translational approaches, dissemination, or policy change. Combining this framework with the socioecological model and Pyramid of Influence[25] can promote health equity pertaining to concussion. At the foundational or distal level of the health impact pyramid, SES is a strong determinant of health, and mechanisms to reduce and resource inequities and improve poor health care access have the greatest population effect.[25] However, more intermediary and proximal levels of the health pyramid that include changing individuals' contexts to make healthy decisions and educational initiatives require more individual efforts to improve health.[25] Thus, behavioral change interventions or policies for concussion nondisclosure that only include or evaluate concussion knowledge or individual-level factors and do not address foundational SES, environment or structural factors, or all of these that influence health-related decision making will benefit only a limited number of people. This may be of greater importance at the youth sport and HS levels in which more community-based inequities exist. For example, we were unable to replicate the findings from studies of racially diverse HS athletes,[12] suggesting that more equality in the collegiate setting to support concussion disclosure, including equitable access to health care resources and similar environmental or structural circumstances between White and Black athletes (ie, no existing structure of residential segregation or place-based SES disparities) could be contributing to the narrowed disparity gap in collegiate athletes. This can serve as an example for larger-scale community-based interventions, as it demonstrates that equal and equitable access to resources, including an AT, could help to mitigate concussion-nondisclosure disparities.

This investigation had several limitations. First, convenience sampling limited our ability to calculate an accurate response rate. Also, this study included nondisclosure data on White and Black athletes only, limiting generalizability to other ethnically diverse groups. However, we believe this work to be foundational to research on SDOHs related to concussion nondisclosure in collegiate athletes, although we acknowledge our limited data on Black athletes who reported nondisclosure. This limitation may have affected statistical power and effect-size estimates. Thus, being mindful of individuals not included or represented in this research, more data with greater Black athlete representation, as well as other minoritized groups, is needed. Also, inherent limitations to using proxies, such as FRL to measure SES, exist. Future authors should aim to better understand SES measures in collegiate athletes. Finally, we assessed only reasons for not reporting a concussion, and limitations of survey-based research to measure these items could have resulted in response biases. Likely other factors were not measured in this study, contributing to reporting behaviors such as personality and peer pressure resistance, which can be threaded into future investigations. To fill gaps in the current literature, researchers should focus on collecting more mixed methodologic data, with a sociodemographic or socioecological lens (or both) to better understand the nuances of concussion disclosure and nondisclosure among different college-athlete demographics.

A host of internal and external factors can influence an athlete's concussion-reporting behavior, and it is important to note the complex nature of how race and its intersection with other SDOHs could significantly influence concussion nondisclosure. Being subjected to more SDOHs across one's lifetime naturally leads to greater chances of health inequities and disparities.[20] A total of 15.6% of White athletes and 17.7% of Black athletes gave a history of concussion nondisclosure, but no differences were found by race for distributions of a history of concussion nondisclosure. Race was not associated with concussion nondisclosure when evaluated as an effect modification measure or confounder, and no significant associations were noted by SES or HS AT access. However, differences by race in reasons for nondisclosure linked to concussion awareness and peer perceptions were present. Considering the diversity of collegiate athletics, both an opportunity and a need exist to identify and mitigate the disparities in concussion nondisclosure among White and Black athletes to improve and tailor health care initiatives aimed at reducing nondisclosure. Collegiate athletics may be a way to provide Black athletes access to equitable health care resources that they may have lacked access to before their collegiate athletic careers. Strategies to evaluate current procedures and policy to reconstruct and improve concussion interventions for each athletic population being served are warranted in hopes of encouraging a culture of sport that reflects the significance of concussion disclosure.

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