Research Paper

PAIN 164 (2023) 2370–2379

PAIN®

OPEN

Race differences in pain and pain-related risk factors among former professional American-style football players

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Abstract

The burden of pain is unequal across demographic groups, with broad and persisting race differences in pain-related outcomes in the United States. Members of racial and ethnic minorities frequently report more pervasive and severe pain compared with those in the majority, with at least some disparity attributable to differences in socioeconomic status. Whether race disparities in pain-related health outcomes exist among former professional football players is unknown. We examined the association of race with pain outcomes among 3995 former professional American-style football players who self-identified as either Black or White. Black players reported more intense pain and higher levels of pain interference relative to White players, even after controlling for age, football history, comorbidities, and psychosocial factors. Race moderated associations between several biopsychosocial factors and pain; higher body mass index was associated with more pain among White but not among Black players. Fatigue and psychosocial factors were more strongly related to pain among Black players relative to White players. Collectively, the substantial social and economic advantages of working as a professional athlete did not seem to erase race-related disparities in pain. We highlight an increased burden of pain among elite Black professional football players and identify race-specific patterns of association between pain and biopsychosocial pain risk factors. These findings illuminate potential future targets of interventions that may serve to reduce persistent disparities in the experience and impact of pain.

Keywords: Race, Ethnicity, Pain, Disparities, Football, Psychosocial

1. Introduction

Persistent or chronic pain is estimated to affect over 100 million American adults, is among the leading global causes of reduced quality of life,[9] and carries direct and indirect costs approaching one trillion dollars annually in the United States.[17,32,46] A recent survey found that the proportion of adults in the United States reporting at least one painful health condition increased from just over 30% in 1997 to 1998 to 41% several decades later.[33] However, the burden of pain is unequally distributed across racial and ethnic groups.[30,36] Recent reviews highlight the greater intensity of acute pain, the greater prevalence, severity, and impact of chronic pain, and the reduced access to and receipt of high-quality pain care among African Americans relative to White adults in the United States.[22,26,30] Race differences in health outcomes, including pain, are in part driven by social factors such as discrimination and bias, which have led to inequities in neighborhood environment, medical care, and socioeconomic position across the lifespan (ie, African Americans report more difficult socioeconomic circumstances relative to White Americans in the early life, midlife, and late life).[36] Professional American-style football (ASF) players represent a racially diverse group in which a majority of active professional players identify as

Sponsorships or competing interests that may be relevant to content are disclosed at the end of this article.

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Supplemental digital content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's Web site (www.painjournalonline.com).

http://dx.doi.org/10.1097/j.pain.0000000000002948

Black or African American. American-style football players are exposed to high levels of physical trauma during their playing years, putting them at risk of persistent pain, lasting physical impairment, and substantial psychosocial distress.

In the present study, we examined race differences in pain and in the biopsychosocial correlates of pain in a large cohort of former professional ASF players in the United States. We specifically evaluated differences between Black and White former players in pain intensity (ie, a sensory measure of the perceived severity of daily pain) and pain interference, defined as the extent to which pain functionally interferes with daily activities of life. We also investigated the contribution of race on associations between pain and biopsychosocial risk and resilience factors. It is important to investigate whether particular biopsychosocial variables are more or less strongly associated with pain in disparate racial groups, given that previous studies have documented unique pain experiences across such groups.[4,8] Moreover, several previous studies have suggested that the contribution of pain-related risk factors may differ across racial groups in the United States.[3,13] Accordingly, analyses of group differences in pain and its correlates in the present study controlled for critical factors such as exposures during and after participants' playing years. Such exposures included the number of seasons of play, field position, self-reported concussion symptoms during active play, BMI, and current use of pain medication. Overall, we hypothesized that Black former ASF players would likely report a greater impact of pain relative to White former players, and that the patterns of biopsychosocial contribution to the experience of pain would differ as a function of race.

2. Methods

2.1. Study population

The Football Players Health Study (FPHS) at Harvard University recruited men who held a National Football League (NFL) contract in 1960 or later. A questionnaire was sent to over 13,000 men with email or residential addresses available from the NFL Players Association database. This study includes the data from the 3995 men who responded to the survey; previous studies have suggested that this subset of respondents are highly representative of the full group.[48] Participants in the survey provided oral and written informed consent; the Harvard School of Public Health Institutional Review Board approved the study. Additional details regarding the FPHS are available in previous publications.[48]

2.2. Measures

Demographic data were collected, including age and race. For the assessment of race, players were asked "Which category best describes your race? Mark all that apply" with response options: Black/African American, White, American Indian/Alaskan Native, Native Hawaiian/Pacific Islander, Asian, and other. Participants who endorsed only "Black" or "White" were assigned to that racial category. Participants who endorsed "Black/African American" in addition to another race were assigned to "Black," based on studies that show minority bias such that perceivers tend to categorize multiracial individuals as belonging to a minority group.[6,24,28] The main study analyses include only those who selected Black/African American or White. A sensitivity analysis was conducted that analyzed 116 study respondents who endorsed multiple racial categories as compared with those who endorsed a single race designation of either White or Black/African American.

2.2.1. Football exposure variables

Players were asked to indicate the number of seasons they played professionally and to select from the following field positions: defensive back, defensive line, kicker/punter, linebacker, offensive line, quarterback, running back, special teams, tight end, and wide receiver. In addition, we queried the frequency of 10 football-related concussion symptoms that were summed across items; this concussion symptom score has been used in previous FPHS studies and has shown strong correlations with a variety of health-related and quality of life-related outcomes.[18,19,40,42]

2.2.2. Pain outcomes

Pain intensity over the past week was characterized using the single-item Patient-Reported Outcomes Measurement Information System (PROMIS) pain intensity (0-10) scale. The PROMIS Pain Interference Scale 6b, which is comprised of 6 items, assessed the past 7-day pain interference in daily life activities such as working and socializing. The Pain Interference Scale shows good psychometric properties and has well-established national norms[1]; pain interference scores are presented as T-scores.

2.2.3. Psychosocial factors

The Patient Health Questionnaire (PHQ)-4 queried 2 depression symptoms and 2 anxiety symptoms over the past 2 weeks.[27] Responses were dichotomized at $\geq$3 for each. Study participants were categorized as having clinically significant anxiety symptoms only, clinically significant depressive disorder only, both, or neither, according to whether they met the PHQ-4 cutoffs or were currently taking medications for management of depressive or anxiety symptoms. Social support was assessed with a single item querying satisfaction with social relationships using a 5-point Likert response scale from "poor" to "excellent."

2.2.4. Current health-related factors

Current body mass index (BMI) was calculated from self-reported weight and height. Smoking was assessed by participant's self-report as "never," "past," or "current" smoker. Participants also self-reported the number of surgeries they had undergone during their playing career. Exercise habits were quantified broadly with the average number of days each week in which participants engaged in walking, running, other aerobic activity (eg, bicycling), and/or weight training. Fatigue over the past week was assessed with a single item using a 5-point Likert response scale from "none" to "very severe." Lifetime medical provider's diagnosis of hypertension, diabetes, and sleep apnea was assessed by participant's self-report. Current prescription pain medication use was assessed by participant self-report (yes/no).

2.3. Statistical analyses

Descriptive statistics were reported as mean $\pm$ SD with Pearson χ^2 test for group comparisons for continuous variables or as percentages with Wilcoxon rank sum test for categorical variables. To understand the cumulative impact of demographic, football-related, and clinical factors on participant-reported pain intensity and pain interference, we used 3 generalized linear models for pain intensity and pain interference. These were: (1) a

"baseline" model with age, race, and BMI as independent variables, (2) a "fully adjusted" model with demographic, football-related, social, and clinical variables, and (3) a "final" model where independent variables were selected among those included in the full model via a routine variable selection based on Akaike information criterion (AIC). In the final model, some of the initial independent/predictor variables were omitted based on AIC criteria. The contribution of the independent variables left after variable selection were estimated based on the standardized coefficients. For all models, any missing values were treated as missing at random without imputation.

To assess the impact of race on all models, we included race as a separate interacting term, akin to an analysis of covariance (ANCOVA) model where each variable's contribution was assessed for differential contributions across racial groups. Statistical models that included pain severity and pain interference separately as dependent variables were identical except for the dependent variable. R Language for Statistical Computing (version 4.2.x)[39] was used to conduct all statistical analyses and create final figures representing the data. Conformity of the data to statistical assumptions were checked and verified by standard tests. Effects were considered significant at $P < 0.05$ level.

3. Results

Of the 3995 respondents included in the main analyses, 1623 (40.6%) self-identified as Black, and 2372 (59.4%) self-identified as White. Nearly all included variables differed significantly when comparing Black and White former players (**Table 1**). The groups did not differ in the number of seasons played, or in the number of reported surgeries during active play, but playing position differed strongly by race, with Black players more than twice as likely as White players to have been running backs or defensive backs, and White players much more likely to have been quarterbacks or offensive linemen. On health-related measures, although Black players were substantially younger than White players, they reported higher BMIs and were more likely to report chronic medical conditions such as hypertension, diabetes, and sleep apnea (all $P < 0.001$). Black players reported a greater burden of concussion symptoms, more severe fatigue, a higher frequency of smoking, and lower frequencies of exercise. Rates of comorbid anxiety and depression were higher among Black players as well, along with lower endorsement of social support. Finally, on pain-related measures, Black players reported more intense pain and a higher burden of pain-related interference (all $P < 0.001$).

3.1. Findings related to pain intensity

In the baseline, fully adjusted, and final models, Black players continued to report higher levels of pain intensity when controlling for other potential confounding or contributing factors including age, exercise, comorbidities, BMI, and football-related factors (see Supplementary Table 1, available at http://links.lww.com/PAIN/B849; and **Fig. 1**). A number of factors included in the model were significantly associated with high-intensity pain, including older age, more professional ASF seasons, higher BMI, elevated fatigue scores, a greater burden of concussion symptoms, hypertension, and the presence of significant anxiety and depression. A higher degree of social support was associated with reduced pain intensity.

We next stratified by race to explore the differential contributions of pain-related variables in Black vs White players in the fully adjusted model. We observed several significant moderating effects of race, in that significant interactions of race on pain intensity were seen with BMI ($P < 0.01$), fatigue ($P < 0.01$), and mood ($P = 0.01$; see **Table 2** and **Fig. 1**). BMI was significantly associated with pain intensity only among White players (not among Black players), whereas fatigue was more strongly associated with pain intensity among Black players relative to White players. The presence of depression was associated with more intense pain among Black players and less intense pain among White players. Collectively, the model explained a larger degree of variance in pain intensity among Black players (44% variance explained) than in White players (33% variance explained).

3.2. Findings related to pain interference

Race-related differences were also observed in baseline, fully adjusted, and final models of pain interference. In adjusted models, Black players continued to report higher levels of pain interference when controlling for other potential confounding or contributing factors. A number of factors included in the model were significantly associated with a greater functional impact of pain (ie, higher scores on the PROMIS Pain Interference scale). These factors included older age, higher BMI, elevated fatigue scores, a greater burden of concussion symptoms, the presence of hypertension, sleep apnea, and clinically significant symptoms of anxiety and depression. Higher levels of social support and a greater frequency of weekly exercise were associated with reduced pain interference (see **Fig. 2** and Supplementary Table 2, available at http://links.lww.com/PAIN/B849) in models that combined both Black and White former players.

We examined potential moderating effects of race on these associations with pain interference. Significant interactions of race with BMI ($P < 0.05$) and fatigue ($P < 0.01$) were observed in the fully adjusted model, with near-significant interactions for anxiety (significantly associated with more pain interference only among Black players), social support (more strongly protective against pain interference among Black players), and exercise frequency (significantly associated with less pain interference only among White players). BMI was significantly ($P < 0.05$ for the interaction) more strongly associated with pain interference among White players (indeed, no association of BMI with pain interference was evident among Black players), whereas fatigue was more strongly associated with pain interference among Black players ($P = 0.003$ for the interaction). Collectively, the model explained a larger degree of variance in pain interference among Black players (56% variance explained) than in White players (44% variance explained; **Table 3** and **Figure 2**).

When re-estimating the same model while controlling for pain intensity, many of the same factors emerged as significant correlates of pain interference, although the direction of the association with race was reversed. As expected, pain intensity is by far the strongest predictor of pain interference (**Fig. 3**). Older age, concussion symptoms, fatigue, the presence of sleep apnea, and significant anxiety and depressive symptomatology remain significant predictors of higher levels of pain interference. Social support remains a statistically significant protective factor, with higher levels of social support associated with lower pain interference. In this model, race is significantly associated with pain interference, although Black players report less pain interference in this model, when pain intensity is statistically controlled (**Fig. 3**).

3.3. Sensitivity analysis

To determine whether self-identified multiracial individuals differed from those who were categorized into a single race designation of White or Black, we conducted a sensitivity analysis

Table 1

Descriptive data.

Characteristic	Black (n = 1623)	White (n = 2372)	*P*
Age	48.3 ± 12.6	54.4 ± 15.0	<0.001
Missing	0	0	
Current BMI	32.1 ± 5.5	30.6 ± 4.4	<0.001
Missing	11	17	
PROMIS pain intensity (0–10)	5.1 ± 2.6	4.0 ± 2.3	<0.001
Missing	6	12	
PROMIS pain interference (T-score)	57.4 ± 9.4	55.0 ± 8.2	<0.001
Missing	2	0	
Primary NFL position			<0.001
Defensive back	393 (24%)	183 (7.7%)	
Defensive line	232 (14%)	268 (11%)	
Kicker	2 (0.1%)	120 (5.1%)	
Linebacker	236 (15%)	368 (16%)	
Offensive line	145 (8.9%)	705 (30%)	
Quarterback	12 (0.7%)	173 (7.3%)	
Running back	240 (15%)	142 (6%)	
Special teams	6 (0.4%)	26 (1.1%)	
Tight end	91 (5.6%)	222 (9.4%)	
Wide receiver	266 (16%)	165 (7%)	
Missing	0	0	
Seasons in NFL	6.5 ± 3.6	6.8 ± 4.1	0.5
Missing	0	2	
Concussion symptom score	32.2 ± 28.2	29.3 ± 25.9	0.005
Missing	35	50	
No. of surgeries during active play	1.4 (1.3)	1.4 (1.2)	0.90
Missing	0	0	
Smoking status			<0.001
Never smoked	1394 (87%)	1927 (82%)	
Current smoker	138 (8.6%)	380 (16%)	
Former smoker	71 (2.2%)	52 (2.2%)	
Missing	20	13	
Exercise frequency (days per week)			<0.001
0-1	212 (13%)	231 (9.9%)	
2-3	1088 (68.5%)	1425 (61.3%)	
4+	288 (18.1%)	666 (28.7%)	
Missing			
Depression and anxiety symptom status			<0.001
Neither	1168 (72%)	1913 (81%)	
Depression only	48 (3.0%)	71 (3.0%)	
Anxiety only	74 (4.6%)	109 (4.6%)	
Both	328 (20%)	277 (12%)	
Missing	5	2	
Current pain medication prescription	514 (32%)	597 (25%)	<0.001
Missing	0	0	
Hypertension	659 (41%)	829 (35%)	<0.001
Missing	14	23	
Sleep apnea	401 (25%)	498 (21%)	<0.001
Missing	0	0	
Diabetes	185 (12%)	168 (7.3%)	<0.001
Missing	40	58	
Social support score (1-5)			<0.001
1 (poor)	199 (12%)	123 (5.2%)	
2	394 (24%)	346 (15%)	
3	459 (29%)	702 (30%)	
4	377 (23%)	796 (34%)	
5 (excellent)	180 (11%)	389 (17%)	
Missing	14	16	

(*continued on next page*)

Table 1 (*continued*)

Characteristic	Black (n = 1623)	White (n = 2372)	*P*
Fatigue severity (1-5)			<0.001
1 (none)	222 (14%)	423 (18%)	
2	488 (30%)	925 (39%)	
3	697 (43%)	853 (36%)	
4	172 (11%)	130 (5.5%)	
5 (very severe)	35 (2.2%)	24 (1.0%)	
Missing	9	17	

NFL, National Football League.

that separately predicted pain intensity and pain interference. In these analyses, 1542 individuals (38.2%) self-identified as Black, 2372 (58.9%) self-identified as White, and 116 (2.9%) identified as multiracial. As with the dichotomized data in the main analysis, most demographic, football-related, and clinical variables differed significantly among the 3 race designation categories (Supplemental Table 3, available at http://links.lww.com/PAIN/B849). For fully-adjusted models of pain interference and pain intensity, findings from the main analysis remained the same for Black and White players (Supplemental Tables 4 and 5, available at http://links.lww.com/PAIN/B849). Given the relatively small number of participants in the multiracial group, which falls short of the required proportions of observations to predictors, the predictive models for the multiracial group should be considered exploratory.

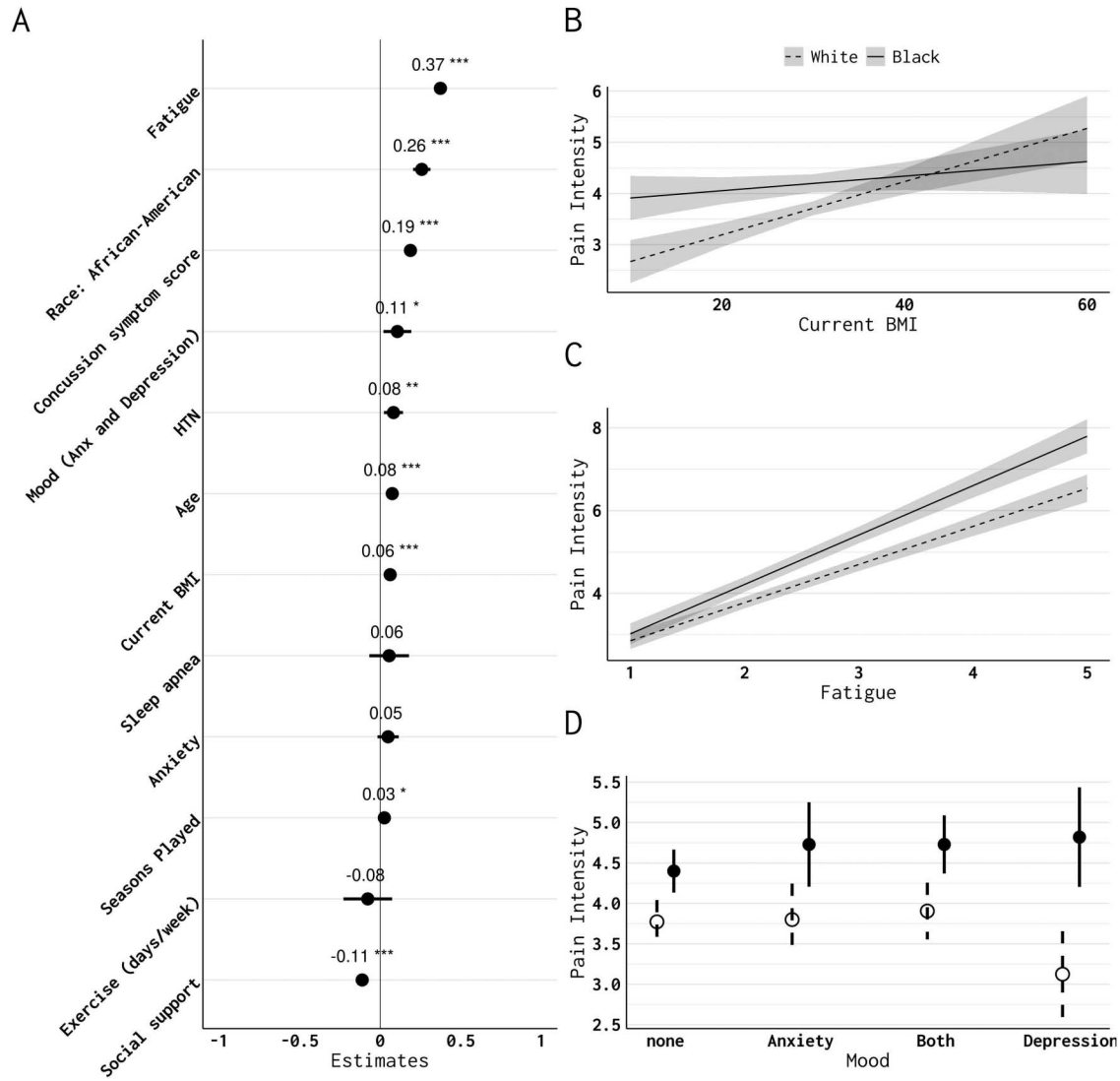

Figure 1. Fully adjusted model for predicting pain intensity (Panel A) and significant race × predictor interactions for BMI (Panel B), fatigue (Panel C), and mood (Panel D). *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$. BM, body mass index; HTN, hypertension.

Table 2

Race-stratified final multivariate models of association with pain intensity.

Variable	Model 1: Black players	Model 2: White players
Age	0.02*** (0.01, 0.03)	0.01*** (0.01, 0.02)
Current BMI	0.01 (−0.01, 0.03)	0.05*** (0.03, 0.07)
Concussion symptom score	0.02*** (0.01, 0.02)	0.02*** (0.01, 0.02)
Social support	−0.22*** (−0.34, −0.11)	−0.24*** (−0.33, −0.15)
Fatigue	1.20*** (1.06, 1.34)	0.92*** (0.81, 1.03)
Depression and anxiety symptom status		
Anxiety	0.30 (−0.19, 0.79)	0.0 (−0.38, 0.38)
Depression	0.43 (−0.16, 1.01)	−0.65** (−1.13, −0.17)
Anxiety + depression	0.31* (0.01, 0.63)	0.12 (−0.17, 0.40)
Exercise frequency	0.0 (−0.11, 0.12)	−0.02 (−0.10, 0.07)
Hypertension	0.09 (−0.14, 0.32)	0.28** (0.09, 0.46)
Sleep apnea	0.19 (−0.07, 0.44)	0.06 (−0.15, 0.27)

Parameter estimates and 95% CI. *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$. BMI, body mass index.

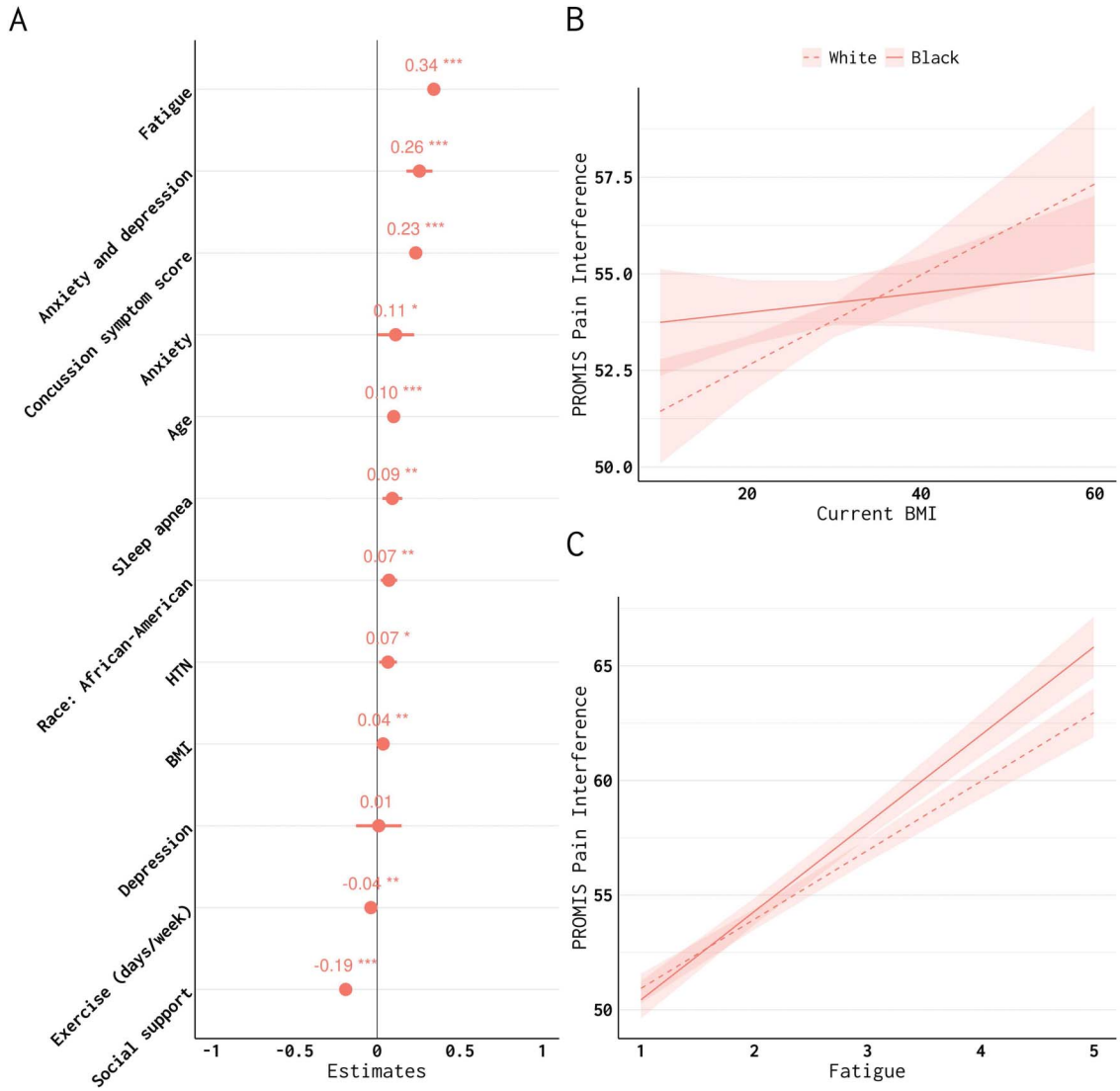

Figure 2. Fully adjusted model for predicting pain interference (Panel A) and significant race × predictor interactions for BMI (Panel B) and fatigue (Panel C). *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$. BMI, body mass index; HTN, hypertension; PROMIS, Patient-Reported Outcomes Measurement Information System.

Table 3

Race-stratified final multivariate models of association with pain interference.

Variable	Model 1: Black players	Model 2: White players
Age	0.07*** (0.04, 0.09)	0.06*** (0.04, 0.08)
Current BMI	0.02 (−0.04, 0.09)	0.12*** (0.05, 0.18)
Concussion score	0.07*** (0.06, 0.09)	0.08*** (0.07, 0.09)
Social support	−1.65*** (−2.0, −1.29)	−1.27*** (−1.56, −0.97)
Fatigue	3.86*** (3.41, 4.31)	2.98*** (2.62, 3.33)
Depression and anxiety symptom status		
Anxiety	2.16** (0.61, 3.71)	0.30 (−0.38, 0.38)
Depression	0.67 (−1.20, 2.54)	−0.43 (−1.99, 1.13)
Anxiety + depression	2.40*** (1.37, 3.42)	1.81*** (0.88, 2.74)
Exercise frequency	−0.10 (−0.46, 0.26)	−0.42** (−0.69, −0.15)
Hypertension	0.27 (−0.46, 1.0)	0.84** (0.24, 1.45)
Sleep apnea	0.82* (0.01, 1.64)	0.75*(0.07, 1.42)

Parameter estimates and 95% CI. *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$. BMI, body mass index.

4. Discussion

The present findings suggest that the burden of pain falls unequally on Black versus White ASF players after their careers as professional athletes. Black players reported more intense pain and higher levels of pain interference relative to White players, even after controlling for age, football history, medical comorbidities, and psychosocial factors. These factors were important to include as covariates because on each measure, Black players experienced a greater burden than White players, with higher rates of smoking, depression, anxiety, diabetes, hypertension, and sleep apnea, and more severe fatigue. It is noteworthy that a much larger group difference was observed on the measure of pain intensity relative to pain interference. Indeed, in the model controlling for pain intensity, Black players actually demonstrated lower pain interference than White players, suggesting that per unit of pain intensity, Black players reported less of a detrimental functional impact of pain. This finding is consistent with previous reports of race differences in coping with pain,[13,29,31,44] along with previous work on the concept of John Henryism, a term describing a high-effort coping state in which Black Americans have to work especially hard to persist in the face of adversity and high-stress environments, which results over time in an increasing toll on physical and mental health.[11,21,43] Sensitivity analyses that included a separate multiracial designation showed similar associations with concussion symptoms and fatigue as Black former ASF players on pain interference, although the small number of participants in this category preclude our ability to draw conclusions with certainty from these data. Future studies would benefit from examining the health and experience of multiracial individuals in larger cohorts.

In addition to findings of Black–White group differences in the reported experience of pain, race differentially moderated the associations between several biopsychosocial factors and pain intensity and interference. Higher BMI was associated with more pain among White players but not among Black players. We are not aware of previous reports that BMI is selectively associated with pain in White adults, although prior studies of former football players have noted that weight gain during periods of active football participation was independently associated with risk of multiple later-life health afflictions.[7] However, past epidemiologic research has suggested that the association between elevated BMI and adverse physical health outcomes (including mortality) is much weaker among Black adults compared with White adults.[25] Furthermore, studies in Black-predominant chronically painful conditions such as sickle cell disease have reported no association between BMI and pain severity.[37]

In contrast to the BMI findings, fatigue and psychosocial factors were more strongly related to pain among Black players relative to White players. The associations between pain and fatigue are well-established,[16] and the relationship is likely to be bidirectional in nature.[15,45] Because of the cross-sectional nature of the study, the causal pathways are uncertain, but it appears that pain and fatigue covary to a stronger degree in Black players compared with White players. Future studies in this area should include longitudinal designs that allow for the exploration of causal relationships between pain, fatigue, and related factors. Similarly, the interaction of race and mood seems to be complex in nature. Depression is associated with elevated pain intensity among Black players but reduced pain intensity among White players. This may follow from the well-established finding that in the United States, White Americans are far more likely than Black Americans to be screened and treated for depression.[10,38] Because a number of antidepressants are efficacious analgesics (ie, tricyclic antidepressants and serotonin–norepinephrine reuptake inhibitors), it may be that White former professional ASF players who are depressed are more frequently managed with these medications, which tends to reduce the intensity of their pain; interestingly, however, although we do not have data on antidepressant treatment, White participants in this study were actually less likely than Black participants to report taking medication for their pain. Collectively, in this sample, the potential social and economic advantages of working as a professional athlete (which are not universal and which do not necessarily accrue equally to White and Black former players) did not seem to erase race-related disparities in pain. This may reflect in part the burden of lifetime disparities faced by Black players (ie, Black ASF players may have experienced lower socioeconomic status, greater trauma, and a higher incidence of pain-related risk factors prior to their playing career). Indeed, in the present sample, pain was more strongly associated with other disabling symptoms such as depression, anxiety, and fatigue among Black players, which may be partially driven by such long-standing disparities. Such findings may have implications for policies regarding pain

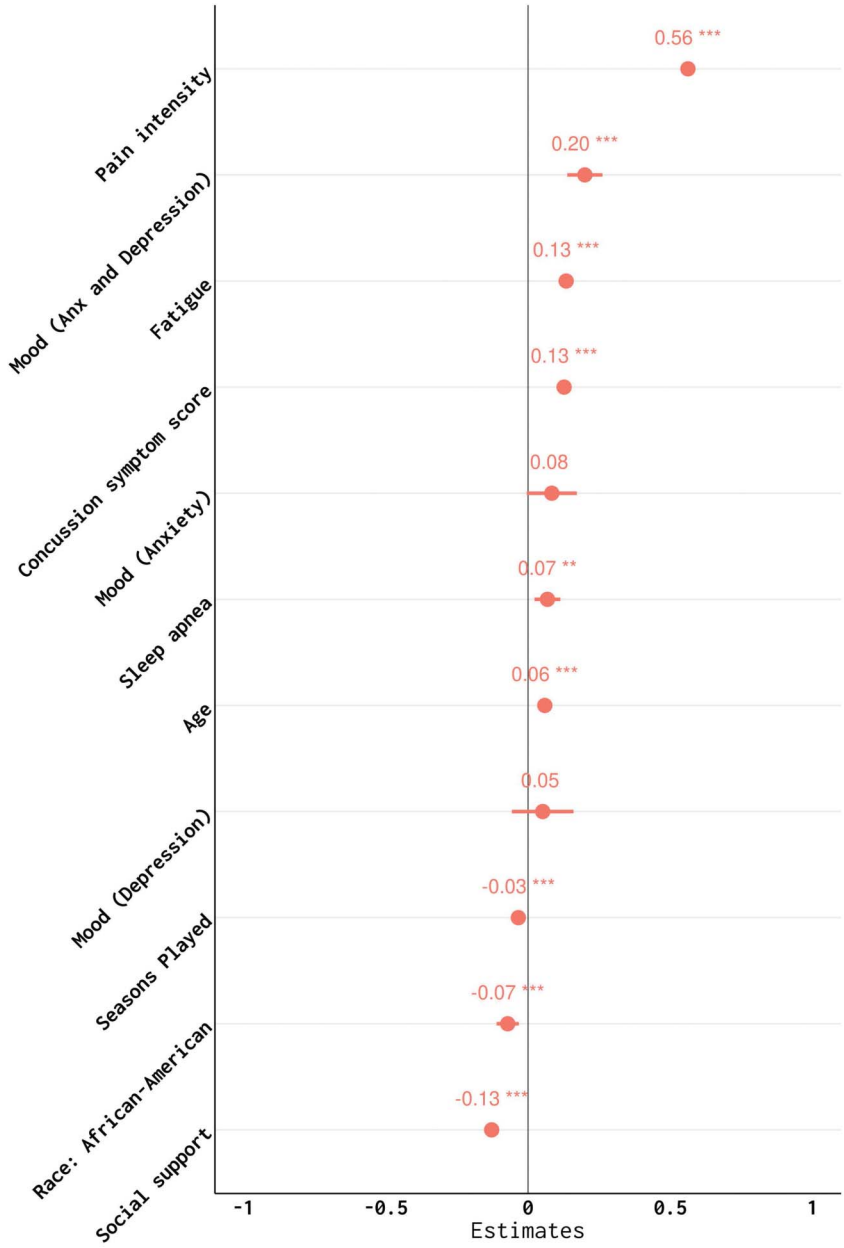

Figure 3. Full model for predicting pain interference, including pain intensity in the model. *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$. PROMIS, Patient-Reported Outcomes Measurement Information System.

management in former ASF players, highlighting the potential benefits of personalized, tailored interventions based on pain-related risk factors.[12,14,30]

Although this cross-sectional survey-based study is not designed to definitively identify mechanisms underpinning ethnic differences in the experience of pain, a number of processes may have contributed to the observed effects. One factor that prior reviews have highlighted as a contributor to racial disparities in pain outcomes involves group differences in pain assessment and treatment, which are widespread across settings.[22,30,36] For example, minority patients are consistently less likely to receive comprehensive diagnostic and treatment approaches for pain and more likely to have their pain underestimated by providers.[20,23,30] In previous studies of football players, injured Black professional ASF players (compared with their White peers) were deemed more likely to be able to play in a subsequent game with the assumption that they felt less pain than White players.[47] Interestingly, the present findings suggest that, in this sample, Black former players are more likely to self-report taking medications for pain than White former players (**Table 1**). It remains possible that systemic and interpersonal barriers to optimal pain care for patients from minority ethnic and racial groups may have contributed to the present findings of amplified pain among Black players; however, we do not have direct evidence for this effect in the present data. Future work in this area may benefit from studying approaches to facilitate improved pain care for minoritized patients in the face of ongoing systemic biases.[2,5,30] For example, enhancing access to empirically supported treatments for chronic pain,[30] improving assessment and intervention approaches that address psychosocial risk

factors such as high levels of distress,[34,35] and using diverse teams of healthcare providers to support culturally competent care[26] all have the potential to universally improve pain outcomes, with the largest effects on patients from minority and underserved backgrounds, which could aid in reducing the existing pain-related disparities.

A number of limitations should temper interpretations of these findings. First, the study response rate for the FPHS was moderate. If the decision to participate in the survey was influenced by both current health (especially pain-related health) and race, our findings may be impacted by those selection factors. However, the race distribution of this sample is similar to previous studies of former professional ASF players, suggesting that differential participation by race may not be a major limitation.[42,48] In addition, football exposures, health outcomes, and medical covariates were all measured by self-report, although we used well-validated and widely accepted measures. The most central limitation is the cross-sectional nature of the study. We are unable to evaluate the causal direction or temporal dynamics of the observed associations (eg, the relationship between pain and fatigue could plausibly take a number of forms). Finally, the study was not designed to fully evaluate the multidimensional mechanisms contributing to pain disparities. For example, we did not have information on players' current or past economic and financial situations, on the duration of their pain complaints, on body composition measures, or on their full history of analgesic treatments. Despite these limitations, the study does have significant strengths, including a large sample size and a rarely studied target population of former professional athletes. Future research may seek to examine other possible mechanisms of racial and ethnic differences in pain such as the influence of familial models of pain, perceived injustice, pain coping, alterations in central nervous system pain processing, healthcare accessibility, and more fine-grained information on psychosocial protective and risk-related processes, especially those related to negative affect and stress. Such research may aid in the development of effective and culturally sensitive interventions for pain.

In general, we observed multiple race-related health disparities in this sample, despite the sociocultural advantages enjoyed by some former professional athletes playing the most popular sport in the United States. It bears mentioning, however, that a substantial minority of former ASF players report significant socioeconomic hardship during retirement.[40,48] Moreover, such postcareer (as well as early life) hardship may fall disproportionately on Black players.[41] In the present study, Black former ASF players, despite being younger than their White counterparts, reported worse health, more intense pain, more pain-related risk factors, and lower scores on measures of previously identified pain-protective factors. It is likely that patient-, provider-, and system-level mechanisms contribute to the racial and ethnic disparities that we observe here, and that these mechanisms operate across the lifespan of these professional athletes. Further understanding of the experiences of minorities before, during, and after their time as professional ASF players may potentially lead to interventions to protect their physical, psychosocial, and neuropsychiatric health.

Conflict of interest statement

Dr. Zafonte reported receiving royalties from Springer/Demos publishing for serving as coeditor of the text Brain Injury Medicine; serving on the scientific advisory board of Myomo Inc., and onecare.ai Inc; evaluating patients in the Massachusetts General Hospital Brain and Body-TRUST Program, which is funded by the NFL Players Association; and receiving grants from the NIH and NIDILRR. Dr. Taylor reported receiving grants from the NFL Players Association outside the submitted work and grants from the NIH. Dr. Weisskopf reported receiving grants from the NFL Players Association and the NIH during the conduct of the study. Drs. Grashow and Whittington received grant funding from the NFL Players Association. Mr. Thomas is a member of the Society for Neurosports and serves on the FPHS Player Advisory Board. No other disclosures were reported.

Acknowledgements

This work was supported by the Football Players Health Study at Harvard University, which is funded by the National Football League Players Association (NFLPA). In addition, support for RRE was provided by the National Institute of Neurological Disorders and Stroke under award K24NS126570. The content is solely the responsibility of the authors and does not necessarily represent the official views of Harvard Medical School, Harvard University, and its affiliated academic healthcare centers. The NFLPA had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and the decision to submit the manuscript for publication.

Ethical committee approvals: All research activities were approved by the ethical review committees at the Harvard T. H. Chan School of Public Health, the Beth Israel Deaconess Medical Center, and Harvard Medical School. Informed consent from all participants was obtained as required prior to participation.

Supplemental digital content

Supplemental digital content associated with this article can be found online at http://links.lww.com/PAIN/B849.

Article history:
Received 29 December 2022
Received in revised form 17 March 2023
Accepted 3 April 2023
Available online 9 June 2023

References

[1] Amtmann D, Cook KF, Jensen MP, Chen WH, Choi S, Revicki D, Cella D, Rothrock N, Keefe F, Callahan L, Lai JS. Development of a PROMIS item bank to measure pain interference. PAIN 2010;150:173–82.
[2] Bakhshaie J, Penn TM, Doorley J, Pham TV, Greenberg J, Bannon S, Saadi A, Vranceanu AM. Psychosocial predictors of chronic musculoskeletal pain outcomes and their contextual determinants among Black individuals: a narrative review. J Pain 2022;23:1697–711.
[3] Bartley EJ, Hossain NI, Gravlee CC, Sibille KT, Terry EL, Vaughn IA, Cardoso JS, Booker SQ, Glover TL, Goodin BR, Sotolongo A, Thompson KA, Bulls HW, Staud R, Edberg JC, Bradley LA, Fillingim RB. Race/Ethnicity moderates the association between psychosocial resilience and movement-evoked pain in knee osteoarthritis. ACR Open Rheumatol 2019;1:16–25.
[4] Booker SQ, Tripp-Reimer T, Herr KA. "Bearing the pain": the experience of aging African Americans with osteoarthritis pain. Glob Qual Nurs Res 2020;7:233339362092579.
[5] Carlisle SK. Perceived discrimination and chronic health in adults from nine ethnic subgroups in the USA. Ethn Health 2015;20:309–26.
[6] Chen JM, Pauker K, Gaither SE, Hamilton DL, Sherman JW. Black + white = not white: a minority bias in categorizations of black-white multiracials. J Exp Soc Psychol 2018;78:43–54.
[7] Churchill TW, Krishnan S, Weisskopf M, Yates BA, Speizer FE, Kim JH, Nadler LE, Pascual-Leone A, Zafonte R, Baggish AL. Weight gain and

health affliction among former national football League players. Am J Med 2018;131:1491–8.
[8] Cousin L, Johnson-Mallard V, Booker SQ. "Be strong my sista": sentiments of strength from black women with chronic pain living in the deep south. Adv Nurs Sci 2022;45:127–42.
[9] Dahlhamer J, Lucas J, Zelaya C, Nahin R, Mackey S, DeBar L, Kerns R, Von Korff M, Porter L, Helmick C. Prevalence of chronic pain and high-impact chronic pain among adults—United States, 2016. MMWR Morb Mortal Wkly Rep 2018;67:1001–6.
[10] Dean KE, Long ACJ, Trinh NH, McClendon J, Buckner JD. Treatment seeking for anxiety and depression among black adults: a multilevel and empirically informed psycho-sociocultural model. Behav Ther 2022;53:1077–91.
[11] DeAngelis RT. Striving while Black: race and the psychophysiology of goal pursuit. J Health Soc Behav 2020;61:24–42.
[12] Edwards RR, Dworkin RH, Sullivan MD, Turk DC, Wasan AD. The role of psychosocial processes in the development and maintenance of chronic pain. J Pain 2016;17:T70–92.
[13] Edwards RR, Moric M, Husfeldt B, Buvanendran A, Ivankovich O. Ethnic similarities and differences in the chronic pain experience: a comparison of African American, Hispanic, and White patients. Pain Med 2005;6:88–98.
[14] Edwards RR, Schreiber KL, Dworkin RH, Turk DC, Baron R, Freeman R, Jensen TS, Latremoliere A, Markman JD, Rice ASC, Rowbotham M, Staud R, Tate S, Woolf CJ, Andrews NA, Carr DB, Colloca L, Cosma-Roman D, Cowan P, Diatchenko L, Farrar J, Gewandter JS, Gilron I, Kerns RD, Marchand S, Niebler G, Patel KV, Simon LS, Tockarshewsky T, Vanhove GF, Vardeh D, Walco GA, Wasan AD, Wesselmann U. Optimizing and accelerating the development of precision pain treatments for chronic pain: IMMPACT review and recommendations. J Pain 2023;24:204–25.
[15] Finan PH, Goodin BR, Smith MT. The association of sleep and pain: an update and a path forward. J Pain 2013;14:1539–52.
[16] Fishbain DA, Cole B, Cutler RB, Lewis J, Rosomoff HL, Fosomoff RS. Is pain fatiguing? A structured evidence-based review. Pain Med 2003;4:51–62.
[17] Foster NE, Anema JR, Cherkin D, Chou R, Cohen SP, Gross DP, Ferreira PH, Fritz JM, Koes BW, Peul W, Turner JA, Maher CG, Buchbinder R, Hartvigsen J, Cherkin D, Foster NE, Maher CG, Underwood M, van Tulder M, Anema JR, Chou R, Cohen SP, Menezes Costa L, Croft P, Ferreira M, Ferreira PH, Fritz JM, Genevay S, Gross DP, Hancock MJ, Hoy D, Karppinen J, Koes BW, Kongsted A, Louw Q, Öberg B, Peul WC, Pransky G, Schoene M, Sieper J, Smeets RJ, Turner JA, Woolf A. Prevention and treatment of low back pain: evidence, challenges, and promising directions. Lancet 2018;391:2368–83.
[18] Grashow R, Tan CO, Izzy S, Taylor HA Jr., Weisskopf MG, Wasfy MM, Whittington AJ, Speizer F, Zafonte R, Baggish AL. Association between concussion burden during professional American-style football and post-career hypertension. Circulation 2023;147:1112–4.
[19] Grashow R, Weisskopf MG, Miller KK, Nathan DM, Zafonte R, Speizer FE, Courtney TK, Baggish A, Taylor HA, Pascual-Leone A, Nadler LM, Roberts AL. Association of concussion symptoms with testosterone levels and erectile dysfunction in former professional US-style football players. JAMA Neurol 2019;76:1428–38.
[20] Green CR, Anderson KO, baker TA, Campbell LC, Decker S, Fillingim RB, Kaloukalani DA, Lasch KE, Myers C, Tait RC, Todd KH, Vallerand AH. The unequal burden of pain: confronting racial and ethnic disparities in pain. Pain Med 2003;4:277–94.
[21] Gupta S, Belanger E, Phillips SP. Low socioeconomic status but resilient: panacea or double trouble? John Henryism in the international IMIAS study of older adults. J Cross Cult Gerontol 2019;34:15–24.
[22] Hamilton TM, Reese JC, Air EL. Health care disparity in pain. Neurosurg Clin North Am 2022;33:251–60.
[23] Hampton SB, Cavalier J, Langford R. The influence of race and gender on pain management: a systematic literature review. Pain Manag Nurs 2015;16:968–77.
[24] Ho AK, Sidanius J, Levin DT, Banaji MR. Evidence for hypodescent and racial hierarchy in the categorization and perception of biracial individuals. J Personal Soc Psychol 2011;100:492–506.
[25] Jackson CL, Wang NY, Yeh HC, Szklo M, Dray-Spira R, Brancati FL. Body-mass index and mortality risk in U.S. blacks compared to whites. Obesity (Silver Spring) 2014;22:842–51.
[26] Knoebel RW, Starck JV, Miller P. Treatment disparities among the Black population and their influence on the equitable management of chronic pain. Health Equity 2021;5:596–605.
[27] Kroenke K, Spitzer RL, Williams JB, Lowe B. An ultra-brief screening scale for anxiety and depression: the PHQ-4. Psychosomatics 2009;50:613–21.
[28] Krosch AR, Berntsen L, Amodio DM, Jost JT, Van Bavel JJ. On the ideology of hypodescent: political conservatism predicts categorization of racially ambiguous faces as Black. J Exp Soc Psychol 2013;49:1196–203.
[29] Krupić F, Čustović S, Jašarević M, Šadić S, Fazlić M, Grbic K, Samuelsson K. Ethnic differences in the perception of pain: a systematic review of qualitative and quantitative research. Med Glas (Zenica) 2019;16:108–14.
[30] Meints SM, Cortes A, Morais CA, Edwards RR. Racial and ethnic differences in the experience and treatment of noncancer pain. Pain Manag 2019;9:317–34.
[31] Meints SM, Miller MM, Hirsh AT. Differences in pain coping between black and white Americans: a meta-analysis. J Pain 2016;17:642–53.
[32] Murray M, Stone A, Pearson V, Treisman G. Clinical solutions to chronic pain and the opiate epidemic. Prev Med 2019;118:171–5.
[33] Nahin RL, Sayer B, Stussman BJ, Feinberg TM. Eighteen-year trends in the prevalence of, and health care use for, noncancer pain in the United States: data from the medical expenditure panel survey. J Pain 2019;20:796–809.
[34] Newman AK, Kapoor S, Thorn BE. Health care utilization for chronic pain in low-income settings. Pain Med 2018;19:2387–97.
[35] Newman AK, Van Dyke BP, Torres CA, Baxter JW, Eyer JC, Kapoor S, Thorn BE. The relationship of sociodemographic and psychological variables with chronic pain variables in a low-income population. PAIN 2017;158:1687–96.
[36] Patel M, Johnson AJ, Booker SQ, Bartley EJ, Palit S, Powell-Roach K, Terry EL, Fullwood D, DeMonte L, Mickle AM, Sibille KT. Applying the NIA health disparities research framework to identify needs and opportunities in chronic musculoskeletal pain research. J Pain 2022;23:25–44.
[37] Pells JJ, Presnell KE, Edwards CL, Wood M, Harrison MO, DeCastro L, Johnson S, Feliu M, Canada S, Jonassaint JC, Barker C, Leach-Beale B, Mathis MJ, Applegate K, Holmes A, Byrd G, Robinson E. Moderate chronic pain, weight and dietary intake in African-American adult patients with sickle cell disease. J Natl Med Assoc 2005;97:1622–9.
[38] Perez NB, Lanier Y, Squires A. Inequities along the depression care cascade in African American women: an integrative review. Issues Ment Health Nurs 2021;42:720–9.
[39] R Core Team. R: a language and environment for statistical computing. Vienna, Austria: R Foundation for Statistical Computing, 2019.
[40] Roberts AL, Pascual-Leone A, Speizer FE, Zafonte RD, Baggish AL, Taylor H Jr., Nadler LM, Courtney TK, Connor A, Grashow R, Stillman AM, Marengi DA, Weisskopf MG. Exposure to American football and neuropsychiatric health in former national football League players: findings from the football players health study. Am J Sports Med 2019;47:2871–80.
[41] Roberts AL, Taylor HA Jr., Whittington AJ, Zafonte RD, Speizer FE, Pascual-Leone A, Baggish A, Weisskopf MG. Race in association with physical and mental health among former professional American-style football players: findings from the Football Players Health Study. Ann Epidemiol 2020;51:48–52.e2.
[42] Roberts AL, Zafonte RD, Speizer FE, Baggish A, Taylor HA, Nadler L, Weisskopf MG. Modifiable risk factors for poor cognitive function in former American-style football players: findings from the Harvard Football Players Health Study. J Neurotrauma 2021;38:189–95.
[43] Robinson MN, Thomas Tobin CS. Is John Henryism a health risk or resource?: exploring the role of culturally relevant coping for physical and mental health among Black Americans. J Health Soc Behav 2021;62:136–51.
[44] Shavers VL, Bakos A, Sheppard VB. Race, ethnicity, and pain among the U.S. adult population. J Health Care Poor Underserved 2010;21:177–220.
[45] Smith MT, Quartana PJ. The riddle of the sphinx: sleep, pain, and depression. Sleep Med 2010;11:745–6.
[46] Sullivan W, Hirst M, Beard S, Gladwell D, Fagnani F, Lopez Bastida J, Phillips C, Dunlop WC. Economic evaluation in chronic pain: a systematic review and de novo flexible economic model. Eur J Health Econ 2016;17:755–70.
[47] Trawalter S, Hoffman KM, Waytz A. Racial bias in perceptions of others' pain. PLoS One 2012;7:e48546.
[48] Zafonte R, Pascual-Leone A, Baggish A, Weisskopf MG, Taylor HA, Connor A, Baker J, Cohan S, Valdivia C, Courtney TK, Cohen IG, Speizer FE, Nadler LM. The football players' health study at Harvard University: design and objectives. Am J Ind Med 2019;62:643–54.