Journal of Athletic Training 2021;56(3):331–338
doi: 10.4085/107-20
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Health-Related Quality of Life in Former National Collegiate Athletic Association Division I Collegiate Athletes Compared With Noncollegiate Athletes: A 5-Year Follow-Up

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Context: The effect of athletic participation on lifelong health among elite athletes has received increasing attention, as sport-related injuries can have a substantial influence on long-term health.

Objective: To determine the current health-related quality of life (HRQoL) of former National Collegiate Athletic Association Division I athletes compared with noncollegiate athletes 5 years after an initial assessment.

Design: Cohort study.

Setting: Online survey.

Patients or Other Participants: From the former Division I athletes, 193 responses were received (response rate = 83.2%; 128 men, 65 women; age = 58.47 ± 6.17 years), and from the noncollegiate athletes, 169 surveys were returned (response rate = 75.1%; 80 men, 89 women; age = 58.44 ± 7.28 years).

Main Outcome Measure(s): The independent variables were time (baseline, 5 years later) and group (former Division I athlete, noncollegiate athlete). Participants completed 7 Patient-Reported Outcomes Measurement Information System scales: sleep disturbance, anxiety, depression, fatigue, pain interference, physical function, and satisfaction with participation in social roles.

Results: Sleep disturbance, depression, fatigue, pain, and physical function were significant for time × group interactions (*P* values < .05), with the largest differences seen in pain and physical function between groups at time point 2 (22.19 and 13.99 points, respectively). Former Division I athletes had worse scores for depression, fatigue, pain, and physical function at follow-up (*P* values < .05), with the largest differences seen on the depression, fatigue, and physical function scales (8.33, 6.23, and 6.61 points, respectively).

Conclusions: Because of the competitive nature of sport, the long-term risks of diminished HRQoL need to become a priority for health care providers and athletes during their athletic careers. Additionally, physical activity transition programs need to be explored to help senior student-athletes transition from highly structured and competitive collegiate athletics to lifestyle physical activity, as it appears that individuals in the noncollegiate athlete cohort engaged in more physical activity, weighed less, and had increased HRQoL.

Key Words: PROMIS, retired athletes, patient-reported outcomes

Key Points

- Former Division I athletes scored worse on the Patient-Reported Outcomes Measurement Information System scales than their noncollegiate athlete counterparts.
- Compared with the noncollegiate athletes former Division I athletes experienced greater declines in health-related quality of life at 5 years after the initial assessment.
- Former Division I athletes reported more limitations during daily activities and exercise, engaged in less physical activity, weighed more, and had an increased prevalence of osteoarthritis.

Competitive sports are known to have both health benefits and health risks. Participation in athletics can lead to improved cardiorespiratory fitness, enhanced muscular strength and function, and decreased risk of disease.[1–5] Additionally, most former athletes have a lower overall morbidity risk and better self-rated physical health in later years than their nonathlete counterparts.[6] On the other hand, sports expose participants to the possibility of acute, chronic, and even career-ending injury.[7] The effect of athletic participation on lifelong health among elite athletes has received increasing attention, as sport-related injuries can have a substantial influence on the long-term health of student-athletes.[8–12] However, because of the competitive nature of collegiate sports, many athletes subject themselves to unhealthy behaviors (eg, repetitive overtraining) that can negatively affect their health long after they have retired from competitive athletics. Possible long-term outcomes of engaging in unhealthy behaviors include the potential for developing an inactive lifestyle,[13–15] chronic disease

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(ie, diabetes, hypertension, heart disease, osteoarthritis),[6,16,17] and reduced life satisfaction.[18] Furthermore, exposure to repetitive overtraining and high-intensity exercise at the collegiate level may actually increase the risk of traumatic injury, reduce health benefits, and impair immunity because of the extreme stress put on the body, leading to an increased risk for injury and complications.[3,19]

According to the National Collegiate Athletic Association (NCAA) Injury Surveillance Program from the 2009–2010 through 2013–2014 academic years, 1 053 370 injuries were estimated to have occurred during an estimated 176.7 million athlete-exposures.[9] Injury incidence varies by sport, and although more injuries are estimated to have occurred during practices, injuries incurred during competition were more severe in nature (ie, incurred more time lost from sport).[9] The long-term consequences of participation in athletics may not be considered by some athletes if the drive to win supersedes other factors.[20,21] Athletes may become blinded to the harm they could be causing to their bodies that could affect multiple aspects of health in the years to come.[20] Specifically, previous researchers[10,21,22] found that former Division I athletes had decreased health-related quality of life (HRQoL) after retirement from sports compared with noncollegiate athletes. However, these 3 studies[10,21,22] were cross-sectional in nature and did not track how HRQoL can change over time in former Division I athletes and noncollegiate athletes. The authors postulated that former Division I athletes may continue to experience decreases in HRQoL, whereas noncollegiate athletes may not.

Researchers[20,21,23] who investigated how collegiate athletes transition from college proposed that the collegiate athletic experience should include plans for lifelong health and wellbeing. However, before interventions can be developed, an understanding of the progression of HRQoL in former Division I athletes is needed. The lack of longitudinal studies was detailed in a recent meta-analysis[8] in which the authors called for long-term studies on the quality of life and life satisfaction in former athletes. In 2014, a study[22] of HRQoL in former NCAA Division I athletes and noncollegiate athletes that used the Patient-Reported Outcomes Measurement Information System (PROMIS) showed that former Division I athletes displayed decreased HRQoL compared with noncollegiate athletes. The researchers emphasized that the demands of Division I athletics may result in injuries that persist into adulthood and may render participants incapable of staying active as they age, thereby lowering their HRQoL.[22] Our plan was to perform a 5-year follow-up study involving the same participants as in the original investigation. We chose the 5-year follow-up because this time point has been linked to changes in physical activity and health outcomes and because it is a common initial follow-up time point in studies of HRQoL outcomes in other athletic populations.[24–28] Therefore, the purpose of our study was to determine the current HRQoL of former Division I athletes compared with noncollegiate athletes as they continued to age. Our hypothesis was that former Division I athletes would experience a decrease in HRQoL compared with noncollegiate athletes at the 5-year follow-up.

METHODS

Participants

For this prospective cohort study, former Division I athlete and noncollegiate athlete respondents from the original study[22] were eligible to participate in the 5-year follow-up. The sample was originally recruited from an alumni database at a large midwestern US university in the Big Ten Conference. The university is a public research university with more than 40 000 students. Of those students, 392 male and 376 female student-athletes play on 24 varsity teams each year. Regardless of group, participants were between the ages of 45 and 70 years, with the date of birth used as the inclusion criterion. Individuals either (1) participated in an NCAA-sanctioned Division I sport or (2) attended the university but were not involved in sanctioned athletics (ie, the same groups as in the original study). A *former Division I athlete* was previously defined as a person who competed in an NCAA Division I–sanctioned sport for at least 1 season.[22] A *noncollegiate athlete* was defined as an individual who did not pursue an NCAA Division I–sanctioned sport but who participated in intramural, club, or other recreational activity on a regular basis (meeting the physical activity guidelines supported by the Department of Health and Human Services[29]) while attending the university.[22] All 457 individuals from the previous study were contacted.

Procedures

The university's institutional review board approved all procedures for this study. Each individual was emailed a description of the study and a link to the survey. The survey was constructed using Qualtrics (Seattle, WA), a web-based survey tool. Based on the minimal risk associated with this study, participants provided informed consent by clicking on the link. Volunteers were excluded from the study if they submitted an incomplete survey. Former Division I athletes were directed to the former Division I athletes' survey, and noncollegiate athletes (control group) were directed to the noncollegiate athletes' survey. The 2 surveys deviated slightly in the demographic information that was captured; those differences are outlined in the subsequent paragraph. To prevent duplicate submissions, only 1 survey per email address was permitted. All participants completed the demographic questionnaire and PROMIS scales.

After clicking on the survey link, participants completed the demographic questionnaire by providing sex, age, current weight, and height. Former Division I athletes indicated their primary sport, the number of years they competed in college, and the number of years they competed postcollege (professionally). Both groups answered questions on current lifestyle (limitations with activity), physical activity (self-reported hours per week), and osteoarthritis diagnosis. The specific questions are shown in Table 1. All individuals completed the PROMIS after the demographic questionnaire. The PROMIS was created by the National Institutes of Health (Bethesda, MD) to encompass 5 generic HRQoL domains: physical function, fatigue, pain, emotional distress, and social function.[30] Items were sorted into domains via expert reviewers, cognitive interviews, and focus groups with patients.[31,32] For the purposes of this follow-up study, the

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Table 1. Questions Included on the Demographic Questionnaire[a]

Questions	Answers
Current lifestyle	
Injury sustained while practicing/competing in college athletics limits your current ability to perform everyday activities in your life	Yes/no
Injury sustained while practicing/competing in college athletics limits your current ability to perform physical activity or exercise	Yes/no
Osteoarthritis	
Have you been diagnosed with osteoarthritis (after college)?	Yes/no
Physical activity	
How many hours per week for aerobic exercise?	No. written
How many hours per week for anaerobic exercise?	No. written

[a] Items are presented in their original format.

same 7 subscales were used as in the original publication[22]: sleep, anxiety, depression, fatigue, pain interference, physical function, and social. The scales are located at http://www.nih-promis.org/measures/availableinstruments. Higher scores for sleep disturbance, anxiety, depression, fatigue, and pain interference imply worse health, whereas higher scores for physical function and satisfaction with participation in social roles suggest better health. The PROMIS item banks have demonstrated good to excellent reliability and construct validity.[30,33,34] The survey was open for 6 weeks, and email reminders were sent every 2 weeks.

Statistical Analysis

All questions were checked for missing data. No data were missing and, therefore, no participants were excluded. Descriptive statistics and Cohen d effect sizes were calculated for each dependent variable by group and time. Effect sizes were interpreted as *small* (d = 0.2), *medium* (d = 0.5), or *large* (d = 0.8).[35] A repeated-measures multivariate analysis of variance was conducted for the combined dependent variables with the between-participants factor group (former Division I athletes and noncollegiate athletes) and the within-participants factor time (baseline and 5-year follow-up). If the overall repeated-measures multivariate analysis of variance was significant for the group × time interaction, follow-up repeated-measures univariate analyses of variance were conducted for each dependent variable. Independent *t* tests between groups for the variables current weight and hours per week for self-reported aerobic and self-reported anaerobic activity were performed. Chi-square analyses were used to determine the relationships between groups (former Division I athletes and noncollegiate athletes) and over time (baseline and 5-year follow-up) for daily limitations, physical activity limitations, and osteoarthritis diagnosis. The α level was set at $<.05$ for all analyses. Lastly, minimally important differences were calculated using the same strategy used in the previous study.[22] Minimally important differences between former Division I athletes and noncollegiate athletes, former Division I athletes and the general US population, noncollegiate athletes and the general US population, former Division I athletes at baseline and follow-up, and former noncollegiate athletes at baseline and follow-up were calculated.[31,33,36] The *minimally important difference* was defined as a difference of 0.5 SD between groups or time points on an HRQoL instrument, indicating a significant and meaningful difference.[37,38] The PROMIS is scored using a T-score metric with a mean of 50 for the US general population and an SD of 10 (for the US general population comparison).[33,36] All analyses were conducted in SPSS (version 25; IBM Corp, Armonk, NY).

Table 2. Sport Participation of Former Division I Athletes

Sport	No. (%)
Baseball	5 (3)
Men's basketball	9 (4)
Women's basketball	10 (5)
Men's cross-country	4 (2)
Women's cross-country	4 (2)
Football	60 (31)
Men's gymnastics	6 (3)
Women's gymnastics	6 (3)
Field hockey	8 (4)
Men's rifle	3 (2)
Women's rowing	3 (2)
Men's soccer	7 (4)
Women's soccer	10 (5)
Softball	6 (3)
Men's swimming and diving	8 (4)
Women's swimming and diving	5 (3)
Men's tennis	6 (3)
Women's tennis	6 (3)
Men's track and field	6 (3)
Women's track and field	8 (4)
Women's volleyball	6 (3)
Wrestling	7 (4)

RESULTS

Demographics

For the former Division I athletes, 232 participants were contacted. A total of 193 responses were received (response rate = 83.2%; 128 men, 65 women; age = 58.47 ± 6.17 years, mass = 91.49 ± 19.76 kg, height = 1.77 ± 0.09 m, self-reported aerobic exercise = 1.89 ± 1.5 h/wk, self-reported anaerobic exercise = 0.65 ± 0.25 h/wk) for the follow-up. For the noncollegiate athletes, 225 participants were contacted, from whom 169 surveys were returned (response rate, 75.1%; 80 men, 89 women; age = 58.44 ± 7.28 years, mass = 79.46 ± 20.30 kg, height = 1.70 ± 0.08 m, self-reported aerobic exercise = 4.36 ± 2.08 h/wk, self-reported anaerobic exercise = 2.05 ± 1.82 h/wk) for the follow-up. The frequency breakdown for sport participation of the former Division I athlete group is shown in Table 2. This group averaged 3.93 ± 0.6 years participating in collegiate athletics, and 19% (n = 36) played professionally between 1 and 10 years postcollege. Differences were present between groups for weight ($t = 5.71$, $P = .001$), height ($t = 8.05$, $P = .001$), self-reported aerobic activity ($t = 13.07$, $P = .001$), and self-reported anaerobic activity ($t = 10.57$, $P = .001$). Specifically, the former Division I athletes weighed more, were taller, and performed less aerobic and anaerobic activity than their noncollegiate athlete counterparts.

At the follow-up time point, 46% of former Division I athletes and 27% of noncollegiate athletes indicated they

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Table 3. Descriptive Statistics and Effect Sizes for Patient-Reported Outcomes Measurement Information System Scales by Group and Time[a]

	Mean ± SD				Effect Size		
	Baseline		5-Year Follow-Up				
Patient-Reported Outcomes Measurement Information System Scale	Former Division I Athletes	Noncollegiate Athletes	Former Division I Athletes	Noncollegiate Athletes	Between Groups at Follow-Up	Between Time Points: Former Division I Athletes	Between Time Points: Noncollegiate Athletes
Sleep disturbance	52.64 ± 3.07	47.25 ± 6.78	57.48 ± 4.42[b,c]	49.13 ± 5.41	1.70	1.29	0.30
Anxiety	45.04 ± 7.45	46.06 ± 7.68	46.13 ± 7.18	47.66 ± 8.63	0.19	0.15	0.20
Depression	51.42 ± 10.39	46.91 ± 9.29	59.75 ± 4.89[b,c]	45.91 ± 6.71	2.38	1.00	0.12
Fatigue	51.65 ± 8.69	47.47 ± 8.97	57.87 ± 5.32[b,c]	49.65 ± 8.04	1.22	0.84	0.25
Pain interference	54.41 ± 8.59	46.32 ± 8.71	59.46 ± 5.74[b,c]	45.47 ± 5.74	2.44	0.68	0.11
Physical function	38.46 ± 14.66	54.19 ± 6.49	31.85 ± 6.95[b,c]	54.05 ± 4.06	3.84	0.56	0.03
Social roles	56.06 ± 5.28	54.99 ± 7.67	57.61 ± 6.08	58.07 ± 3.77[c]	0.09	0.33	0.49

[a] Higher scores for sleep disturbance, anxiety, depression, fatigue, and pain interference indicate poorer health, and higher scores for physical function and satisfaction with participation in social roles indicate better health. Effect sizes were interpreted as *small* (d = 0.2), *medium* (d = 0.5), or *large* (d = 0.8).

[b] Indicates a difference between groups at the follow-up time point ($P < .05$).

[c] Indicates a difference between time points within the group ($P < .05$).

had been diagnosed with osteoarthritis ($\chi^2 = 17.35$, $P < .001$), 44% of former Division I athletes and 20% of noncollegiate athletes felt limited in their daily life ($\chi^2 = 23.37$, $P < .001$), and 88% of former Division I athletes and 49% of noncollegiate athletes felt limited during physical activity ($\chi^2 = 65.02$, $P < .001$). Across time points, the former Division I athletes displayed an increase in feeling limited during daily life (21% baseline, 44% follow-up; $\chi^2 = 25.64$, $P < .001$) and during physical activity (45% baseline, 88% follow-up; $\chi^2 = 86.06$, $P < .001$) but not with respect to an osteoarthritis diagnosis (40% baseline, 46% follow-up; $\chi^2 = 1.56$, $P = .21$). The same was true for the noncollegiate athletes across time, with an increase in feeling limited during daily life (9% baseline, 20% follow-up; $\chi^2 = 10.29$, $P = .01$) and during physical activity (18% baseline, 49% follow-up; $\chi^2 = 30.59$, $P < .001$) but not in terms of an osteoarthritis diagnosis (24% baseline, 27% follow-up; $\chi^2 = 0.53$, $P = .47$).

The PROMIS Scales

Regarding the PROMIS scales analysis, assumption checking revealed that the data were normally distributed, as assessed by Shapiro-Wilk tests ($P > .05$); no univariate or multivariate outliers were present, as assessed by box plots and Mahalanobis distance; linear relationships, as assessed by scatterplots were noted; no multicollinearity occurred (all r values between dependent variables were less than 0.7); and homogeneity of variance-covariance matrices, as assessed by Box M test ($P = .01$), existed. The combined PROMIS dependent variables were significant for the interaction of time × group ($F_{7,354} = 18.21$; $P < .001$). Follow-up univariate analyses indicated that sleep disturbance ($F_{1,360} = 8.81$; $P = .001$), depression ($F_{1,360} = 58.82$; $P < .001$), fatigue ($F_{1,360} = 12.21$; $P < .001$), pain interference ($F_{1,360} = 30.46$; $P < .001$), and physical function ($F_{1,360} = 22.99$; $P < .001$) were significant for the interactions of time × group. The descriptive statistics and effect sizes for all PROMIS measures by group and time point are contained in Table 3.

Post hoc testing revealed that the largest between-groups differences at follow-up were for depression (13.84 points, $P < .001$, large effect size [2.38]), pain interference (13.99 points, $P < .001$, large effect size [2.44]), and physical function (22.12 points, $P < .001$, large effect size [3.84]), with the former Division I athletes scoring worse (ie, poorer functioning in the domains) on all scales. Between the 2 time points, the largest differences were seen for the former Division I athletes for depression (8.33 points, $P < .001$, large effect size [1.0]), fatigue (6.23 points, $P < .001$, large effect size [0.84]), and physical function (6.61 points, $P < .001$, medium effect size [0.56]), with a decrease in scores (poorer functioning within the domains) between time points. For the noncollegiate athletes, the only scale that demonstrated a difference between time points was the satisfaction with social roles scale, with an increase of 3.08 points ($P = .002$) indicating an improvement; however, the effect size was small (0.49). The group and time comparisons for the minimally important differences appear in Table 4.

DISCUSSION

Our main findings were that scores were worse for the former Division I athletes compared with the noncollegiate athlete cohort at the 5-year follow-up for the PROMIS sleep disturbance, depression, fatigue, pain interference, and physical function scales. Furthermore, Division I athletes also indicated worse scores 5 years after their baseline assessment for the PROMIS physical function, depression, fatigue, sleep disturbance, and pain interference scales. Lastly, former Division I athletes reported substantially more limitations in activities of daily living and physical activity, a higher prevalence of osteoarthritis, and less aerobic and anaerobic activity compared with noncollegiate athletes at the follow-up time point. However, over time across both cohorts, the number of individuals feeling limited during daily life and during physical activity increased.

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Table 4. Minimally Important Differences Among the Former National Collegiate Athletic Association Division I Athletes, Nonathlete Control Group, and General US Population[a]

Patient-Reported Outcomes Measurement Information System Scale	Follow-Up			Time 2 Versus Time 1	
	Division I Athletes Versus Collegiate Nonathletes	Division I Athletes Versus US Population	Noncollegiate Athletes Versus US Population	Division I Athletes	Noncollegiate Athletes
Sleep disturbance	0.67 (–)[b]	0.75 (–)[b]	0.09	0.48	0.19
Anxiety	0.13	0.39	0.23	0.11	0.16
Depression	0.92 (–)[b]	0.98 (–)[b]	0.41	0.83 (–)[b]	0.1
Fatigue	0.62 (–)[b]	0.79 (–)[b]	0.04	0.62 (–)[b]	0.22
Pain interference	1.11 (–)[b]	0.95 (–)[b]	0.45	0.51 (–)[b]	0.09
Physical function	1.89 (–)[b]	1.82 (–)[b]	0.41	0.66 (–)[b]	0.01
Social roles	0.02	0.76 (+)[b]	0.87 (+)[b]	0.16	0.31

Abbreviations: (–) worse score for the first group in the comparison; (+) better score for the first group in the comparison.

[a] Minimally important differences are expressed as multiples of SD.

[b] Clinically meaningful change.

Not surprisingly, 2 times more former Division I athletes reported suffering from osteoarthritis: 46% specified that they had been diagnosed with osteoarthritis, compared with 27% of noncollegiate athletes. This may be attributed to the fact that athletes are cumulatively exposed to high training loads and aggressive physical stressors during their careers that leave them prone to recurrent injury. The literature[3,6,7,39–43] has shown that injury, and specifically joint injury, may eventually result in the adverse consequence of osteoarthritis, which could lead to reduced function and activity limitations. Prior researchers[40] have shown similar findings: 65% of former elite athletes experienced moderate or severe problems with mobility and performing everyday activities. More relevant to our former-athlete population, Kujala et al[6] determined that the prevalence of osteoarthritis was increased after the age of 65 but not at middle age. It is interesting to note that of the former Division I athletes who stated they had been diagnosed with osteoarthritis, 40% were football athletes, and in the current sample, approximately 50% of all football athletes stated they had been diagnosed with osteoarthritis. Based on the sample size, we were unable to investigate the role of sport and osteoarthritis; future investigators should examine this relationship. Although many in the general population might assume that former competitive athletes continue to be active later in life, our results indicated that former Division I athletes performed less aerobic and anaerobic activity than did noncollegiate athletes. In fact, on average, the former Division I athlete group did not meet current physical activity recommendations,[29] whereas the noncollegiate athletes did. This may provide a rationale as to why the Division I athletes weighed more than the noncollegiate athletes and had decreased HRQoL.

Comparatively, former Division I athletes reported greater limitations in both activities of daily living and physical activity. Forty-four percent of former Division I athletes described being limited in activities of daily living, whereas only 20% of noncollegiate athletes expressed this sentiment. In terms of physical activity, 88% of former athletes admitted experiencing limitations, compared with 49% of noncollegiate athletes. Although noncollegiate athletes still reported notable limitations, their prevalence of limitation in performing usual activities due to 1 or more chronic conditions typically increased with age and was comparable with that of the general US population.[44] Specifically, in the US population, 24% of adults aged 65 to 74 and 42% of adults aged 75 and over reported limitation in performing usual activities.[44] It is clear that the prevalence of having limitations in performing usual activities because of 1 or more chronic conditions generally increases with age, and our noncollegiate athlete cohort had similar deficits when compared with the US population. However, former Division I athletes had substantially worse self-reported limitations during physical activity than the general US population based on their PROMIS scores.[33,36] This could further explain why former athletes face such limitations in daily life and exercise, as they are hindered by the influences of both age and a possible injury history from their time as collegiate athletes.

Scores were significantly worse for the former Division I athletes on the PROMIS sleep disturbance, depression, fatigue, pain interference, and physical function scales compared with the noncollegiate athletes and over time. Prior researchers[7,12,22] have shown similar results, noting a lower HRQoL in former athletes when using other patient-reported outcome measures. When the PROMIS scale results of the 5-year follow-up study were compared with those from the initial study,[22] the findings were similar. Specifically, group differences were seen on the same 5 PROMIS scales (sleep disturbances, depression, fatigue, pain interference, and physical function), with worse scores for the former Division I athletes. However, the noncollegiate athlete cohort did not display worse scores on any of these scales over the 5 years. Thus, the former Division I athletes were possibly declining at a faster rate than the noncollegiate athletes.

Even though we observed significant differences between groups and across time, it is imperative to establish clinical significance by calculating minimally important differences and effect sizes between groups and across time. First, when comparing former Division I athletes and noncollegiate athletes, we identified that the former Division I athletes scored worse than the noncollegiate athletes on 5 of the PROMIS scales (sleep disturbances, depression, fatigue, pain interference, and physical function), with large effect sizes. Furthermore, when comparing the former Division I athletes with the general US population (with a mean score of 50 and SD of 10 for all PROMIS scales), we demonstrated that the former Division I athletes scored worse on the same 5 scales but better on the social roles

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scale (Table 3). To further illustrate this point, compared with the US population, our noncollegiate athlete cohort scored better on the social roles scale but similarly to the US population (with a mean score of 50 and SD of 10 for all PROMIS scales) on all other scales.

Between time points, the former Division I athletes illustrated a clinical difference, with worse scores on the depression, fatigue, pain interference, and physical function scales (with medium to large effect sizes), whereas the noncollegiate athletes experienced no clinically significant differences (with small effect sizes) between time points. Therefore, it appears that individuals who were active in college had similar HRQoL scores as the general US population even 5 years after their initial assessment (Table 4).[33,36] One may conclude that staying active, as our noncollegiate athletes indicated, will maintain one's HRQoL to some extent. Over time, the noncollegiate athletes remained active across the lifespan, and this may be the critical component in maintaining a good HRQoL. However, being a former Division I athlete may be detrimental to one's HRQoL, perhaps because the individual may suffer more serious or long-lasting injuries and therefore be unable to continue an active lifestyle later in life and have an increased HRQoL. The decreased HRQoL in former athletes could be explained by the participants' having subjected themselves to unhealthy circumstances of competitive sports, resulting in more serious or long-lasting injuries that eventually affected them physically, psychologically, and socially.

This study had several limitations. All data were self-reported, and although self-reporting has been proven to be reliable, participants may not always report truthfully or within reason; as such, recall bias may have been present.[45] Former athletes may also have very different perceptions of their limitations. Individuals may be satisfied with different amounts of physical function, creating differences in the quality of life that they report. Further limitations include possible confounding variables that influenced participants' answers, including the sport played (a large portion of this sample were football athletes); however, our sample size did not allow for such comparisons. Lastly, we were not able to link surgical history to the development of osteoarthritis.

Future researchers should obtain objective measurements to characterize impairments (specifically osteoarthritis), their severity, and if they align with the limitations reported in this study. Future authors should also aim to obtain a large enough sample size so that data can be analyzed by subgroups such as injury history, sex, and sport while statistical power is retained. In addition, more specific patient-reported outcomes should be used to focus on disabilities of certain joints due to prior sport participation. Appropriate questionnaires include the Knee Injury and Osteoarthritis Outcome Score; the Hip Dysfunction and Osteoarthritis Outcome Score; and Disabilities of the Arm, Shoulder, and Hand. Moreover, different interventions with the goal of improving HRQoL and lifetime physical activity at the collegiate level should be explored. Both subjective and objective interventions involving physical activity transition programs are designed to help senior student-athletes shift from highly structured and competitive collegiate athletics to lifestyle physical activity (eg, Moving On! intervention: https://www.ncaa.org/about/resources/research/moving-physical-activity-transition-program-student-athletes) and should be considered, as the noncollegiate athlete cohort appeared to engage in more physical activity, weigh less, and have increased HRQoL.[20,23] Aside from self-reported data, previous researchers attempted to evaluate the use of objective measures for monitoring current athletes. Finally, tracking these athletes over time should be a priority, and we plan to follow up in another 5 years.

CONCLUSIONS

The demands of Division I athletics may lead to lifelong physical limitations and a lower HRQoL. Because of the competitive nature of sport, the long-term risks of diminished HRQoL need to become a priority for health care providers and athletes. Former Division I athletes scored worse on the PROMIS scales than their noncollegiate athlete counterparts. However, more alarming was that the former Division I athletes experienced greater declines in HRQoL 5 years after their initial assessment compared with the noncollegiate athletes. Noncollegiate athletes who were recreationally active in college appeared to have better HRQoL, maintained that HRQoL over time, and had similar scores as the general US population. Also, former Division I athletes reported more limitations during daily activity and exercise, performed less physical activity, weighed more, and had an increased prevalence of osteoarthritis. An elite athlete could face an increased risk of reduced HRQoL and faster decline in HRQoL. These possible outcomes need to be considered during participation and when athletes transition to retirement from collegiate sports.

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