AJSM PreView, published on December 6, 2013 as doi:10.1177/0363546513510393

Current Health-Related Quality of Life Is Lower in Former Division I Collegiate Athletes Than in Non–Collegiate Athletes

Janet E. Simon,*† MS, ATC, and Carrie L. Docherty,† PhD, ATC
Investigation performed at Indiana University, Bloomington, Indiana

Background: College athletes participate in physical activity that may increase chronic stress and injury and induce overtraining. However, there is little known about how previous injuries that have occurred during college may limit current physical activity and/or decrease their subsequent health-related quality of life (HRQoL).

Purpose: To evaluate HRQoL in former United States National Collegiate Athletic Association Division I athletes and nonathletes with the Patient-Reported Outcomes Measurement Information System (PROMIS) and a demographics questionnaire.

Study Design: Cohort study (prognosis); Level of evidence, 2.

Methods: The study sample was recruited through alumni databases at a large Midwestern university and consisted of 2 cohorts: (1) former Division I athletes and (2) nonathletes who participated in recreational activity, club sports, or intramurals while attending college. Participants answered a survey constructed with a web-based system. All individuals contacted were between the ages of 40 and 65 years. Study participants responded to the questions on the PROMIS scales for sleep, anxiety, depression, fatigue, pain interference, physical function, and satisfaction with participation in social roles. The PROMIS was developed to fill the void of HRQoL being evaluated by multiple instruments. An additional questionnaire was constructed to record demographic and exercise information.

Results: Initially, 1280 former Division I athletes and nonathletes were contacted; 638 surveys were returned (49.8%). Surveys eligible for analyses (71.6%) were completed by 232 former Division I athletes (mean age ± SD, 53.36 ± 7.11 years) and 225 nonathletes (mean age ± SD, 53.60 ± 6.79 years). Univariate analyses for the effect of group was significantly related to PROMIS scales for physical function, depression, fatigue, sleep disturbances, and pain interference ($P < .05$). The overall scores were significantly worse for the former Division I athletes than for the nonathletes on 5 of the 7 scales. In addition, the former Division I athletes reported significantly more limitations in daily activities and more major and chronic injuries than did the nonathlete controls.

Conclusion: According to these data, former Division I athletes have decreased HRQoL compared with nonathletes.

Clinical Relevance: Sports encourage physical activity, which help promote a healthy lifestyle. Moderate activity and exercise should be encouraged. However, the demands of Division I athletics may result in injuries that linger into adulthood and possibly make participants incapable of staying active as they age, thereby lowering their HRQoL.

Keywords: health-related quality of life; Patient-Reported Outcomes Measurement Information System; college athletes; limitations; injuries

Of the general population in the United States, 11.8% report having limitations in activities of daily life, such as personal hygiene, eating, doing housework, or completing activities at work, because of a chronic condition.[1] Chronic conditions vary in the severity of symptoms and limiting factors accompanying the disease. For middle-aged and older adults, musculoskeletal disorders and arthritis are the conditions commonly reported to cause restrictions in activity.[23] Medical conditions negatively influence not only one's daily life but also one's perceptions of quality of life. The effect on quality of life may be different across the many components (psychological, social, and physical) of health-related quality of life (HRQoL), defined as the physical, psychological, and social domains of health, as influenced by personal experience, beliefs, preferences, and expectations[37] and embodied by personal and societal levels.[34] With the general population advancing in age, illness has become a burden to society by requiring

*Address correspondence to Janet E. Simon, MS, ATC, Indiana University, 1025 East Seventh Street, Bloomington, IN 47405 (e-mail: jesimon@indiana.edu).
†Indiana University, Bloomington, Indiana.
The authors declared that they have no conflicts of interest in the authorship and publication of this contribution.

The American Journal of Sports Medicine, Vol. XX, No. X
DOI: 10.1177/0363546513510393

more health care resources.[27] During 2000 and 2010, the population aged 45 to 64 years grew 31.5% to 81.5 million. This age group now makes up 26.4% of the total US population.[38] This large growth is primarily a result of the aging baby boomer population.

Evaluating an individual's health with a whole-person perspective, assessing all spectrums of health (injury, impairments, and limitations), is important for proper patient management.[44,45] Participation in regular physical activity is important for preventing injury and chronic disease.[39] Athletes at the college level undertake training schedules that put them under continued stress and increased vulnerability to injury and overtraining. Previous research has shown that former athletes have an increase in degenerative changes in their joints and spine compared with nonathletes.[18,42] However, individuals who have maintained muscle function and tone (fitness) may be able to ward off the effects of decreased health and disability; with proper muscle function and tone, health may be maintained after college.[18,42] Additionally, research has shown that muscle deterioration among athletes occurs much later in life and evolves at a slower rate than in nonathletes, if the athlete continues to stay active.[18,42] Injuries that happen during college may limit athletes' capacity to partake in exercise or physical activity and may decrease their HRQoL as they age.[19,20] Intense physical activity and exercise may increase the risk of developing osteoarthritis in the lower limb. However, when the same activity or exercise is completed in moderation, the risk of developing an illness or disability may not be as great.[31]

Research has shown that regular physical activity produces many health benefits for people of all ages.[39] For example, partaking in physical activity decreases the risk of developing diabetes, hypertension, cancer, obesity, cardiovascular, and bone and joint diseases.[40,43] Research investigating adolescents has shown similar results and can translate into young adulthood. In adolescents, participation in physical activity has shown improvement in psychological and social factors.[41] Improvement in mental well-being, academic performance, parental relationships, and self-esteem and decreased anger, anxiety, and depression have also been established in adolescents who take part in physical activity.[41] Keeping adolescents active promotes lifelong physical and psychosocial health. However, a tipping point may be reached where exercise may actually decrease HRQoL in the long term and increase risk of injury, weaken an individual's immunity, and therefore reduce the potential health benefits.

To assess the whole person, a broadly defined construct such as HRQoL is valuable. HRQoL is usually assessed through self-reporting. There is a clear relationship between chronic illness/injury and its detrimental effect on HRQoL.[‡] Evaluating HRQoL is complex and has necessitated assessment via multiple instruments.[8,16,17] The Patient-Reported Outcomes Measurement Information System (PROMIS) was developed to fill the void of HRQoL being evaluated by multiple instruments. The PROMIS is a "National Institutes of Health Roadmap Initiative" to build and validate commonly used item banks to measure symptoms and health impressions relevant to a variety of chronic conditions. This instrument allows for effective and interpretable clinical trials and practical applications of patient-reported outcomes.[12] The PROMIS measures were constructed from the "joint knowledge of network investigators" using current HRQoL instruments,[3,5,6,8,12,14-17] patient-reported outcome measurements, analytic expertise, and published guidelines about measures of self-reported health.[28] Therefore, the purpose of this article is to measure HRQoL utilizing the PROMIS measures and a demographics questionnaire in former United States National Collegiate Athletic Association (NCAA) Division I athletes and nonathletes. Hypotheses were that former Division I athletes would (1) suffer limitations in daily activities because of a prior injury compared with nonathletes, (2) have lower HRQoL than that of nonathletes, and (3) report competing or practicing with an injury during college more so than nonathletes.

MATERIALS AND METHODS

Procedure

The sample was recruited through alumni databases at a large Midwestern US university. Individuals were contacted through e-mail from their respective alumni affiliations, with date of birth as inclusion criterion for contact. All individuals who were contacted, regardless of group, were between the ages of 40 and 65 years. For the purposes of this study, a former Division I athlete was defined as a person who competed in an NCAA Division I–sanctioned sport. There were no other inclusion or exclusion criteria for former Division I athletes. A nonathlete was defined as one who did not participate in a NCAA Division I–sanctioned sport but who played intramurals, club, or other recreational activity on a regular basis (3-5 times per week) while in college. The survey was constructed with a web-based survey system (Qualtrics, Provo, Utah). The potential participants were e-mailed a link to the survey with instructions and a brief summary of the research. By choosing to click on the link to participate in the survey, participants provided informed consent based on the minimal risk of this study. These procedures and investigation were approved by the university's Institutional Review Board. Former Division I athletes were directed to the athletes' survey, while noncollegiate athletes (controls) were directed to the nonathletes' survey. One survey per e-mail address was allowed so that duplicate surveys were not submitted. All data collection was computer based and utilized a secure server.

Participants

For the former Division I athletes, 535 individuals were originally contacted. A total of 275 responses were received (response rate, 51.4%), of which 232 responses (167 men, 65 women; mean age, 53.36 ± 7.11 years) were usable for analysis; 43 surveys were not usable, because they were

[‡]References 1, 8, 13, 16, 17, 22, 23, 30, 32, 33, 36, 46.

TABLE 1
Description of Each PROMIS Scale[a]

Scale	Description
Anxiety	Fear (fearfulness, panic), anxious misery (worry, dread), hyperarousal (tension, nervousness, restlessness), and somatic symptoms related to arousal (racing heart, dizziness)
Depression	Negative mood (sadness, guilt), views of self (self-criticism, worthlessness), and social cognition (loneliness, interpersonal alienation), as well as decreased positive affect and engagement (loss of interest, meaning, and purpose)
Fatigue	Mild subjective feelings of tiredness to an overwhelming, debilitating, and sustained sense of exhaustion that decreases one's ability to execute daily activities and function normally
Pain interference	Consequences of pain on one's life; this includes how pain hinders engagement in social, cognitive, emotional, physical, and recreational activity
Sleep disturbance	Sleep quality, sleep depth, and restoration associated with sleep
Physical function	Capability of physical activities
Satisfaction with social roles	Contentment with social roles (work and family responsibilities)

[a]PROMIS, Patient-Reported Outcomes Measurement Information System.

TABLE 2
Demographic Questionnaire

Previous Injury History	Current History	Limitations
Any major injury	Have you been diagnosed with osteoarthritis (after college)?	Injury sustained while practicing/competing in college athletics limits your current ability to perform everyday activities in your life
Any chronic (overuse) injury	Do you currently participate in aerobic exercise?	Injury sustained while practicing/competing in college athletics limits your current ability to perform physical activity or exercise
Issues with overtraining	How many hours, days/week, and length for aerobic exercise?	
Compete with an injury or illness	Do you currently participate in anaerobic exercise?	
	How many hours, days/week, and length for anaerobic exercise?	

incomplete. For the non-collegiate athletes, 745 individuals were originally contacted, from which 363 surveys were returned (response rate, 48.7%) and 225 responses (104 men, 121 women; mean age, 53.60 ± 6.79 years) were used for analysis. Of the returned surveys, 105 were excluded because they did not meet the inclusion criteria of participating in substantial physical activity on a regular basis in college, and 33 were excluded because they were incomplete.

Measures

The PROMIS was constructed with 5 generic HRQoL domains: physical function, fatigue, pain, emotional distress, and social function. Items were sorted into each domain through expert reviewers, cognitive interviews, and focus groups with patients.[4,9,10] The initial PROMIS items were then given to a large sample representing the US general population and to samples of people who had been diagnosed with one of several specific diseases.[7] The final PROMIS scores range from 0 to 100 and are calibrated using a *T*-score metric with the mean of the US general population equal to 50 and a standard deviation fixed at 10.[9] For the purposes of this article, 7 subscales are used that fit into the 5 generic domains of quality of life: physical function, fatigue, pain, emotional distress, and social function. The questionnaires can be located at http://www.nihpromis .org/measures/availableinstruments. Higher scores for sleep, anxiety, depression, fatigue, and pain interference indicate poorer health, while higher scores for physical function and satisfaction with participation in social roles indicate better health. See Table 1 for a description of each PROMIS instrument utilized. An additional questionnaire collected demographic information and information regarding injuries sustained due to participation in athletics or exercise (Table 2).

Statistical Analysis

Participants were excluded if they had repetitive strings of 10 or more identical responses.[21] The justification for this exclusion was to ensure that individuals did not just click the same response down the entire survey and not read each question and then answer.[21] Statistical analysis

included descriptive statistics and frequency distributions, chi-square tests, and cross-tabulations. The alpha level was set at $P < .05$. Chi-square tests were employed to evaluate significant differences between former Division I athletes and nonathletes. Chi-square was also used to determine if there was a difference between former Division I athletes and nonathletes for current exercise and injuries. Multivariate analysis of variance was used to analyze the difference between groups (former Division I athletes and nonathletes) on PROMIS scales. The alpha level was set at $P < .05$.

To further explore the differences between the former Division I athletes and nonathletes, minimally important differences were calculated. Minimally important differences were also calculated between former Division I athletes and nonathlete controls, former Division I athletes and US population, and nonathlete controls and published data on the general US population.[4,7,12] There are multiple strategies for calculating a minimally important difference.[29] It has been suggested that approximately a 0.5–standard deviation difference between groups on a HRQoL instrument is a significant threshold.[24] Quantifying a minimally important difference makes the results more clinically applicable. A minimally important difference is defined as the "effect that might be considered important." The minimally important difference is the smallest difference in score between groups that is important to make decisions. The final PROMIS scores are calibrated through a *T*-score metric with the mean of the US general population equal to 50 and a standard deviation fixed at 10. Subsequently, additional comparisons were made to the general US population.

RESULTS

Chi-square results are located in Table 3. Former Division I athletes reported the total number of years that they competed at the college level and afterward (professionally). Of all former Division I athletes, 60% indicated that they competed for 4 years in college. The next-highest percentage of former Division I athletes competing was 3 years (17%); then, 12% reported competing for 5 years, while only 11% indicated that they competed for 2 years. Of all former Division I athletes, 22% indicated that they spent between 1 and 7 years competing in professional athletics after college; however, the majority of all former Division I athletes reported that they never competed professionally (78%). In the evaluation of the effect of length played professionally and frequency of injury, there were no significant chi-square results.

The majority of former Division I athletes indicated that they had practiced with an injury during competition or practice (70%). However, only 33% of controls reported participating in physical activity or exercise with an injury. At the individual sport level, for the percentage of major injuries, cross-tabulations indicated that football represented 43% of the major injuries reported by all sports. Of the former football players who responded, 65% reported a major injury. Pearson chi-square for sport × major injury was 40.01 ($df = 11$, $P < .001$). Participants also responded "yes" or "no" if they had ever been diagnosed with osteoarthritis after college for any joint. Of former Division I athletes, 40% indicated that they had osteoarthritis, compared with 24% of the nonathletes ($\chi^2 = 7.24$, $P = .007$).

TABLE 3
Chi-Square Results: Former NCAA Division I Athletes Versus Nonathletes[a]

	Athletes	Nonathletes	Pearson Chi-Square	*P*
Major injuries	67	28	35.26[b]	<.001
Chronic injuries	50	26	12.22[b]	<.001
Daily limitations	21	9	5.64[b]	.01
Physical activity limitations	45	18	16.89[b]	<.001

[a]Values are expressed as percentages per group. NCAA, National Collegiate Athletic Association.
[b]$P < .05$.

Between-subjects multivariate analysis of variance was performed on 7 dependent variables: the PROMIS scales for physical function, anxiety, depression, fatigue, sleep disturbance, satisfaction with social roles, and pain interference. The independent variable was group (former Division I athletes and nonathletes). Evaluation results of assumptions of normality, homogeneity of variance-covariance matrices, linearity, and multicollinearity were satisfactory. With the use of the Wilks criterion, we found that the combined dependent variables were significantly affected by group, $F_{7,449} = 113.25$, $P < .001$, $\eta_p^2 = 0.636$, $1 - \beta = 0.999$.

Univariate analyses for the effect of group was significantly related to the scales for physical function, depression, fatigue, sleep disturbances, and pain interference. However, there were no significant differences between groups on the scales for anxiety and satisfaction with social roles. Former Division I athletes had a worse score than did nonathletes by a mean difference of 17.51 points on the physical function scale, $F_{1,455} = 357.99$, $P < .001$, $\eta_p^2 = 0.504$, $1 - \beta = 0.999$; 7.31 points on the depression scale, $F_{1,455} = 72.89$, $P < .001$, $\eta_p^2 = 0.137$, $1 - \beta = 0.999$; 5.25 points on the fatigue scale, $F_{1,455} = 43.85$, $P < .001$, $\eta_p^2 = 0.087$, $1 - \beta = 0.999$; 5.88 points on the sleep disturbances scale, $F_{1,455} = 38.08$, $P < .001$, $\eta_p^2 = 0.076$, $1 - \beta = 0.999$; and 10.17 points on the pain interference scale, $F_{1,455} = 147.28$, $P < .001$, $\eta_p^2 = 0.243$, $1 - \beta = 0.999$. Overall, the responses were statistically significantly worse for former Division I athletes than for the nonathletes for these 5 scales ($P < .05$) (Figure 1). Group comparisons evaluating minimally important differences are displayed in Table 4.

DISCUSSION

The primary purpose of this study was to determine the physical, psychological, and social costs of sport participation. Being disabled is often thought of as the reduced ability to perform day-to-day activities. From a HRQoL perspective, being disabled may include a decrease in

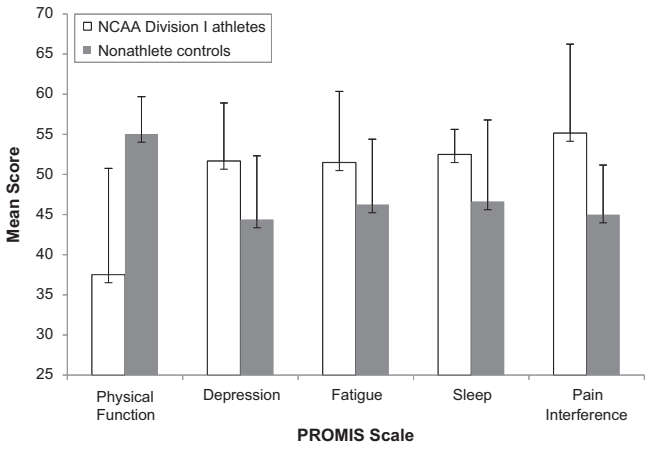

Figure 1. Areas of the Patient-Reported Outcomes Measurement Information System (PROMIS) showing statistically significant difference in outcomes ($P < .05$) between former United States National Collegiate Athletic Association Division I athletes and nonathletes. A higher score indicates better outcome on the physical function scale; on the remaining scales, a lower score indicates a better outcome. Error bars indicate standard deviations.

ability to carry out physical activity or exercise, as well as reduced psychological and social roles. Overall, scores were significantly worse for the former Division I athlete cohort compared with the nonathlete cohort for the PROMIS scales measuring physical function, depression, fatigue, sleep disturbance, and pain interference. In addition, former Division I athletes reported considerably more limitations in daily activity and exercise as well as more major and chronic injuries than did the nonathletes.

Calculating a minimally important difference between groups allows for practical application of these data. First, when we compared former Division I athletes and the nonathletes, we identified that in 5 of the PROMIS scales (physical function, depression, fatigue, sleep disturbances, and pain interference), the former Division I athletes scored worse than the nonathlete controls. However, when we compared the former Division I athletes to the general US population, we found that the former Division I athletes scored worse in only 2 of the 7 scales—those for physical and pain interference. To further illustrate this point, when the nonathlete controls were compared with the US population, our nonathlete cohort scored better on the physical, depression, and pain interference scales. Therefore, it appears that individuals who were active in college 3 to 5 times per week or who played recreational sports may have better HRQoL scores when compared with the general US population (Table 4). One may conclude that being active to some extent will increase one's HRQoL; however, being a former Division I athlete may be detrimental to one's HRQoL—perhaps because former Division I athletes may suffer more serious or long-lasting injuries and are unable to continue an active lifestyle later in life to have an increased HRQoL.

TABLE 4
Minimally Important Differences Among Former NCAA Division I Athletes, Nonathlete Controls, and General US Population[a]

PROMIS Scale	Division I Athletes vs Nonathlete Controls	Division I Athletes vs US Population	Nonathlete Controls vs US Population
Physical	1.75 SD[b]	1.25 SD[b]	0.51 SD[b]
Depression	0.73 SD[b]	0.17 SD	0.56 SD[b]
Fatigue	0.52 SD[b]	0.15 SD	0.38 SD
Sleep	0.58 SD[b]	0.25 SD	0.34 SD
Pain Interference	1.02 SD[b]	0.52 SD[b]	0.50 SD[b]

[a]NCAA, National Collegiate Athletic Association; PROMIS, Patient-Reported Outcomes Measurement Information System; SD, standard deviation.
[b]$P < .05$.

The hypothesis was supported that former Division I athletes would suffer limitations in daily activities because of a prior injury, with 2 times more athletes reporting limitations during daily activity and exercise compared with nonathletes. Similarly, our hypothesis was supported that former Division I athletes would be hindered in their sport. Compared with nonathletes, 2.5 times more former Division I athletes reported physical activity limitations with activities of daily living or exercise, thus suggesting that former Division I athletes sustain more injuries because of former sport participation. This is confirmed with data showing that 67% of all former Division I athletes sustained a major injury and 50% reported chronic injuries, a finding that was approximately 2.4 times higher than that seen in nonathletes who reported acute injuries (28%) and 1.8 times higher than that in nonathletes who reported chronic injuries (26%).

Our hypothesis was also confirmed that former Division I athletes would report competing or practicing with an injury during college (70%) more so than nonathletes (33%). Former Division I athletes often feel outside pressure or the want or even need to return to their sports as soon as possible. Former Division I athletes reported "yes" to practicing with an injury or illness approximately 2.1 times more than controls. In addition, consider that college athletics are usually more vigorous than a typical college student's physical activity. This may contribute to athletes not having adequate time to heal, which could lead to future or unresolved injury.[18] Osteoarthritis has been linked with previous joint injury.[19] This could be a contributing factor in limitations (activity in daily life or physical activity) that athletes may experience.[19] According to our data, 40% of former Division I athletes indicated being diagnosed with osteoarthritis after college regardless of joint, compared with 24% of the nonathlete controls.

The total number of former Division I athletes who reported injury was high; it is possible that the physical cost of their previous injuries may be very high in the future. A good portion of these former Division I athletes might be sacrificing their future physical activity and

HRQoL by participating, on average, 4 years as a collegiate athlete. Paffenbarger et al[25] reported that being a college athlete did not protect against developing cardiovascular disease without continuing an active lifestyle after one's competitive years in college. Interestingly, inactive students who started participating in exercise later in life had a decreased risk of developing cardiovascular disease as compared with former athletes who reduced or stopped activity.[25] It appears that current physical activity is more important than previous participation in athletics to prevent cardiovascular disease.[25] Wyshak[47] compared the long-term health of women college graduates, college athletes, and nonathletes. Participants who were not engaging in regular physical exercise at the time of the study had a higher risk of disease regardless of group.

Research has shown that prior participation in athletics is not protective against disease[20,25,26,31,47]; that is, the cost that a former athlete pays to participate in collegiate athletics may be higher than presumed. If former athletes are not able to exercise because of physical limitations, they may be unable to exercise as they were once able. This may increase their risk of becoming overweight or obese. Additionally, they may be occupationally or professionally limited if they experience a lingering disability. They may further experience the effects of their limitations in their personal lives. For example, they may not be able to teach their children the sports they love or just play with them outside. It is difficult to quantify HRQoL; if all things are identical, chronic injury, with its associated limitations and pain, reduces not only productivity but also overall satisfaction with one's life.

Participating in sports promotes physical activity, which helps combat obesity; however, the possibility of a career-ending injury of some individuals should be considered. If individuals do sustain serious injury during college, they may be unable to stay active as they get older. Activity and exercise in moderation should be encouraged. The problem is whether one should be placed in rigorous sport involving year-round training and competition. Again, the physical, psychological, and social costs of partaking in sports may be higher than realized.

Limitations

All PROMIS scales, former injury reporting, and current health status were self-reported. While there is reasonably good evidence to suggest that people are reliable reporters of medical diagnosis and other medical information,[2,11,35] it would be ideal to follow up with all participants to confirm what they reported or obtain physicians' diagnoses/prognoses. Additional study limitations also exist; athletes perform at a high level, so former athletes may want to perform at the same level. This may create a much different idea about what amount of physical activity should be performed and what is typically performed for the average older adult. Athletes who previously trained intensely may continue to train at a higher level than that of nonathletes, and they may have a much different perspective on what is the "normal" amount of activity for their age group. Problems with sampling also occurred; there were problems with obtaining a large enough sample to compare each sport or sex. Additionally, these participants were sampled years after participating in athletics and exercise in college. There may be several confounding variables that may influence their answers, such as aging, current socioeconomic status, and employment status.

Future Research

Future studies should focus on the increase in disability that former athletes reported. In addition, physical measurements taken in the laboratory may be beneficial to establish what physical limitations actually exist (standardized physical fitness testing, body composition). Disease-specific analyses that address issues of disease severity and progression are also warranted. This may include measures of disease-specific questionnaires, including the Knee injury and Osteoarthritis Outcome Score; Hip dysfunction and Osteoarthritis Outcome Score; Disabilities of the Arm, Shoulder, and Hand; and the Identification of Functional Ankle Instability.

CONCLUSION

The price that many athletes may pay to compete is high. On the basis of these data, some former Division I athletes may sacrifice their future HRQoL for their relatively short athletic careers in collegiate sports. Specifically, former Division I athletes scored worse on the PROMIS scales measuring physical function, depression, fatigue, sleep disturbance, and pain interference compared with their nonathlete counterparts. In addition, in the comparison of former Division I athletes, nonathletes, and the general US population, it appears that, in rank order of the 3 groups, nonathletes who were recreationally active in college had better HRQoL, followed by the general US population and then the former Division I athletes. This may be because former Division I athletes sustain more injuries and possibly more severe injuries due to the rigor of their sport. Also, former Division I athletes reported more limitations during daily activity and exercise, more chronic injuries, and more major injuries than did nonathletes. Participation in sports is a significant part of American culture; this is especially seen at the youth level, with athletics starting at a younger age—even specialization in a specific sport. However, the long-term risks are rarely considered. Increased risk of diminished HRQoL may be what a competitive athlete, especially in more demanding sports, will face because of an inability to stay active.

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