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Previous Knee Injury and Health-Related Quality of Life in Collegiate Athletes

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Context: Patient-rated outcome measures (PROMs) capture changes that are important and meaningful to patients, such as health-related quality of life (HRQOL). Although group differences in HRQOL have been reported, little is known about the effect of injury history on HRQOL in collegiate athletes.

Objective: To determine whether knee-specific function (International Knee Documentation Committee Subjective Knee Evaluation Form [IKDC]) and HRQOL (Short Form 12 [SF-12]) differs in collegiate athletes based on sex and the severity of a previous knee injury.

Design: Cross-sectional study.

Setting: Athletic training facilities.

Patients or Other Participants: Healthy collegiate athletes (n = 263) were grouped based on self-report of a previous knee injury: severe (n = 47), mild (n = 40), and no (n = 176) knee injury.

Intervention(s): Participants completed the IKDC and SF-12 during their preparticipation examinations.

Main Outcome Measure(s): Generalized linear models were used to assess interactions and main effects of all scores.

Results: An interaction effect was observed for the SF-12 role physical subscale ($P = .02$), with men in the mild- and severe-injury groups reporting worse scores than men with no injury history. We noted a main effect for injury group for the IKDC total score ($P < .001$) and SF-12 physical functioning ($P = .04$) and role emotional ($P = .04$) subscales, with the severe-injury group reporting worse scores than the mild- and no-injury groups. No main effects of sex were reported ($P > .05$).

Conclusions: Despite returning to full participation, collegiate athletes who previously sustained severe knee injuries tended to report worse knee-specific function and less ability to complete activities due to physical health. In addition, individuals with a history of severe knee injury tended to report more emotional concerns than athletes with a history of mild or no knee injury. Region-specific PROMs may be more sensitive in detecting deficits than generic PROMs after return to full participation. Researchers should investigate the role of PROMs, particularly region-specific PROMs, as potential screening tools for clinical care.

Key Words: patient-centered care, clinical outcome assessment, International Knee Documentation Committee form

Key Points

- Previous knee injury can negatively affect knee-specific function and health-related quality of life in collegiate athletes despite their return to full participation.
- A region-specific patient-rated outcome measure may be more sensitive in detecting deficits than a generic patient-rated outcome measure after return to participation.
- Clinicians should consider using patient-rated outcome measures during preparticipation examinations to identify deficits in health-related quality of life, help optimize patient-centered care, and establish a baseline measurement for patient care after future injury.

Over the last several decades, sport participation has increased steadily in collegiate athletics, resulting in an increased number of sport-related injuries.[1] An estimated 50% to 66%[1–4] of all sport-related injuries affect the lower extremity, with 30% to 45% of these injuries[2,4] occurring at the knee. Whereas knee injuries occur less frequently than ankle injuries,[1,2] they account for the largest percentage of severe sport-related injuries or injuries that result in extended time missed from sport participation.[5] In addition, beyond their immediate physical presentation, knee injuries have been associated with long-term complications, including increased pain, decreased function, and higher risk of knee osteoarthritis.[6,7]

Health-related quality of life (HRQOL) is a multidimensional concept that brings together several health domains, including physical, psychological, and social functioning.[8–10] These health domains can be affected by the experiences, expectations, and beliefs of a patient, making HRQOL an important component of patient-centered, whole-person health care.[8,9] With growing evidence[11–15] to suggest that a sport-related injury affects a person beyond the physical presentation of the injury, researchers have placed increased attention on understanding the effect of sport-related injury, such as knee injury, on self-report of function and HRQOL. Gaining insight into the effect of sport-related knee injuries on the

self-report of function and HRQOL of athletes would support the best health care management on these individuals.

In previous studies of athletes,[15–19] researchers have identified sex differences in HRQOL, with females generally reporting lower HRQOL than males, but little is known about how the severity of a previous knee injury affects HRQOL. For example, investigators assessing the effect of previous knee ligament[19] and musculoskeletal[11] injuries have suggested that a history of sport-related injury reduces region-specific and generic HRQOL, respectively. However, these researchers did not consider the effect of injury severity on HRQOL. Sauers et al[20] reported that a history of a severe upper extremity injury was associated with pain, functional limitations, disability, and decreased overall region-specific HRQOL despite athletes participating in their sports without restrictions. Although investigators have suggested that previous injuries negatively affect HRQOL and that severity of injury may play a role, few studies have been conducted to determine whether the severity of the previous knee injury factors into the current evaluation of function and HRQOL.

Therefore, the purpose of our study was to determine whether knee-specific function, as measured by the International Knee Documentation Committee Subjective Knee Evaluation Form (IKDC), and HRQOL, as measured by the Short Form 12 (SF-12), differs in collegiate athletes based on the severity of a previous knee injury. We hypothesized that athletes who had sustained severe injuries would report worse knee-specific function and HRQOL than athletes who had sustained mild or no knee injuries. Furthermore, given the growing evidence to support sex differences in specific and generic HRQOL[11,15–19] and the possibility that the athlete's sex may confound the relationship between injury severity and HRQOL, we investigated the potential effect of sex on IKDC and SF-12 scores. We hypothesized that women would report lower levels of knee-specific function and HRQOL than men.

METHODS

Participants

A convenience sample of 263 intercollegiate athletes participated in the study. Participants competed at a National Collegiate Athletic Association Division II institution (n = 133) or a community college (n = 130) in the greater Phoenix, Arizona, area. Volunteers were included if they were medically cleared for full participation in collegiate athletics and able to read and speak English. Individuals were excluded from the study if they reported previous injuries in other body regions, such as the ankle, hip, or head (concussion), or they had an injury at the time of the study. We used a questionnaire to capture injury-history information, and participants were grouped based on self-report of a previous knee injury. We defined the severity of the knee injury on the basis of the number of days missed from participation, as described by Dick et al.[21] Individuals without previous knee injuries were placed in the no-injury group. A *mild injury* was defined as a knee injury resulting in missed participation for at least 1 day but fewer than 10 days, and a *severe injury* was defined as a knee injury resulting in missed participation for 10 or more days. All participants provided written informed consent, and the study was approved by the institutional review board of A.T. Still University.

Procedures

Data were collected as part of a larger prospective study regarding lower extremity injury prevention and the effect of lower extremity injuries on self-report of function and HRQOL. Participants completed an injury-history questionnaire, the IKDC, and the SF-12 in a single testing session during their preparticipation examinations. They completed all forms at a desk in a quiet area and were given as much time as they needed to complete the paperwork. Most participants completed the forms in 5 to 10 minutes.

Injury-History Questionnaire

The injury-history questionnaire was described in a previous study.[22] Our questionnaire did not instruct participants to identify whether they had multiple injuries to the lower extremity or to classify their injuries as a single injurious event or a recurrent injury.

International Knee Documentation Committee Form

The IKDC is a region-specific patient-rated outcome measure (PROM) that has been used to assess knee-specific function in patients with a variety of knee conditions, including ligamentous, meniscal, and articular cartilage injuries and patellofemoral pain.[23,24] The 18-item IKDC assesses the effect of impairments (4 items), functional limitations (13 items), and disabilities (1 item) on knee-specific function.[23] Items are scored on binary and Likert-type scales, and the total score ranges from 0 to 100, with higher scores indicating better knee-specific function.[23] The IKDC is valid (construct: >75% hypotheses matched; content: >75% relevant items), reliable (intraclass correlation coefficient = 0.93), and responsive (minimal clinically important difference = 11.5 points).[23,25,26] The minimal detectable change (MDC) for the IKDC is 9 points.[27]

Short Form 12

The SF-12 (version 2) is a valid and reliable generic measure of HRQOL.[28] The measure was created for quick completion (ie, 2 minutes or less), yet capturing the same information (91% variance overlap) as the longer Short Form 36 (SF-36).[28] It consists of 12 items measuring 8 subscale domains of physical and mental health. The recall period for each item is 4 weeks. The subscales are physical function, role physical, bodily pain, general health, vitality, social functioning, role emotional, and mental health. The physical function, role physical, role emotional, and mental health subscales consist of 2 items each, and the bodily pain, general health, vitality, and social function subscales consist of 1 item each.[28] The questions are scored on a 5-point Likert scale, with the scores ranging from 0 to 100 and higher scores indicating better HRQOL.[28]

Data Analysis

We used descriptive statistics to report participant and injury demographics. A visual inspection of the IKDC total and SF-12 subscale scores revealed negatively skewed

Table 1. Participant Demographics by Injury Group and Sex (Mean ± SD)

Injury Group	n	Age, y	Height, cm	Mass, kg
No				
Men	102	19.5 ± 1.5	180.9 ± 8.3	76.5 ± 9.7
Women	74	19.1 ± 1.3	167.5 ± 8.5	62.7 ± 9.2
Mild				
Men	22	19.3 ± 1.7	182.0 ± 6.1	77.9 ± 14.1
Women	18	19.4 ± 1.2	164.8 ± 8.2	61.8 ± 8.5
Severe				
Men	17	20.0 ± 2.1	186.3 ± 8.0	84.6 ± 13.6
Women	30	18.8 ± 1.1	167.7 ± 7.3	66.0 ± 9.2

distributions. To account for the nonnormal distribution of scores, we used generalized linear models (gamma with log link) after reflection transformation of all scores to assess interactions and main effects of the IKDC total and the SF-12 subscale scores. Pairwise comparisons with sequential Bonferroni corrections were used to determine differences across groups, with the α level set at .05. To further aid in the interpretation of group differences, we estimated effect sizes using partial η^2 to account for all levels of our 2 factors. The magnitude of the group effect was interpreted as a *trace* ($\leq$0.01), *small* (>0.01), *medium* (>0.06), or *large* (>0.14) effect. We used SPSS software (version 22.0; IBM Corporation, Armonk, NY) for all data analyses.

RESULTS

Participant demographics, primary sport, and injury demographics are reported in Tables 1, 2, and 3, respectively. Among all participants, 15.2% (n = 40) reported a previous mild injury, and 17.9% (n = 47) reported a previous severe injury. The most common mild injuries were classified as anterior knee pain (n = 14, 35.0%) and first-degree ligament sprains (n = 9, 22.5%), whereas most severe injuries were classified as second-degree or third-degree ligament sprains (n = 21, 44.7%), cartilaginous injuries (n = 9, 19.1%), or a combination of ligamentous and cartilaginous injuries (n = 7, 14.9%).

No interaction effects were identified for the IKDC total scores (Table 4). We observed an interaction effect for the SF-12 role physical subscale ($P = .02$, partial $\eta^2 = .02$), with men in the mild- and severe-injury groups reporting worse scores than men with no injury history (Table 4). No other interaction effects were reported for the remaining SF-12 subscales (Table 4). Injury group showed a main effect for the IKDC total score ($P < .001$, partial $\eta^2 = .16$) and the physical functioning ($P = .04$, partial $\eta^2 < .01$) and role emotional ($P = .04$, partial $\eta^2 = .02$) subscales of the SF-12 (Table 5). The severe-injury group reported worse IKDC total scores than the mild- and no-injury groups, but we did not observe a difference between the mild- and no-injury groups. The severe-injury group also reported worse scores than the no-injury group on the physical functioning and role emotional subscales of the SF-12. No main effects of sex were noted for the IKDC total or SF-12 subscale scores (Table 6). Large and small effect sizes were observed for the IKDC total score when comparing among injury groups (Table 5) and between sexes (Table 6), respectively. Remaining effect sizes for all subscales except role physical (Table 4) and role emotional (Table 5) were trace.

Table 2. Primary Sports of Participants

	Sex, No. (%)[a]	
Primary Sport	Men	Women
Baseball	36 (25.5)	0 (0.0)
Basketball	17 (12.1)	14 (11.5)
Cross-country	4 (2.8)	6 (4.9)
Golf	14 (9.9)	12 (9.8)
Soccer	35 (24.8)	31 (25.4)
Softball	0 (0.0)	23 (18.9)
Track and field	25 (17.7)	9 (7.4)
Volleyball	0 (0.0)	24 (19.7)
Wrestling	7 (5.0)	0 (0.0)
Missing	3 (2.2)	3 (2.5)
Total	141 (100.0)	122 (100.0)

[a] Indicates percentages were rounded.

Table 3. Self-Reported Injuries by Injury Group

	Injury, No. (%)	
Injury Type	Mild	Severe
Anterior knee pain (patellofemoral pain syndrome)	14 (35.0)	0 (0.0)
Bony condition (Osgood-Schlatter disease, osteochondroma)	2 (5.0)	1 (2.1)
Cartilaginous (medial or lateral meniscus)	2 (5.0)	9 (19.1)
Contusion	3 (7.5)	2 (4.3)
Fracture (tibial)	0 (0.0)	1 (2.1)
Ligament and cartilaginous (anterior cruciate ligament, medial collateral ligament, meniscus)	0 (0.0)	7 (14.9)
Ligament sprain (anterior cruciate ligament, posterior cruciate ligament, lateral collateral ligament, medial collateral ligament)	9 (22.5)	21 (44.7)
Tendinitis (patellar, iliotibial band syndrome)	7 (17.5)	4 (8.5)
No official diagnosis reported[a]	3 (7.5)	2 (4.3)
Total	40 (100.0)	47 (100.0)

[a] Either no formal diagnosis was provided by a medical professional or participant could not recall a formal diagnosis.

DISCUSSION

The purpose of our study was to determine whether sex and the presence and severity of previous knee injury negatively affected knee-specific function and HRQOL in collegiate athletes. Our primary observation suggested that collegiate athletes who sustained severe or mild knee injuries reported worse knee-specific function and less ability to complete moderate activities due to physical health. In addition, individuals with a history of severe knee injury tended to report more emotional concerns than athletes with a history of mild or no knee injury. Last, we did not find that sex affected knee-specific function or HRQOL.

Our results that were related to the IKDC total, physical functioning, and role physical scores suggest that collegiate athletes with a history of a severe knee injury experienced more functional limitations and pain than those with a

Table 4. Interaction Effects for International Knee Documentation Committee Subjective Knee Evaluation Form and Short Form 12 Scores

Score	Injury Group, Mean ± SD			*P* Value	Partial η^2
	No	Mild	Severe		
International Knee Documentation Committee Subjective Knee Evaluation Form total score					
Men	96.5 ± 10.1	85.7 ± 12.1	82.2 ± 18.8	.57	<.01
Women	91.0 ± 14.4	84.5 ± 15.2	74.7 ± 19.5		
Short Form 12 scores					
Physical functioning					
Men	95.8 ± 18.0	90.1 ± 22.6	91.2 ± 24.9	.65	<.01
Women	92.1 ± 22.4	91.7 ± 24.5	87.5 ± 26.9		
Role physical					
Men	95.0 ± 13.0	85.8 ± 17.8	86.8 ± 16.2	.02[a]	.02
Women	90.0 ± 16.6	92.3 ± 18.8	90.0 ± 15.5		
Bodily pain					
Men	90.4 ± 21.4	86.4 ± 20.0	79.4 ± 26.9	.39	<.01
Women	83.2 ± 29.5	81.9 ± 29.5	83.3 ± 21.1		
General health					
Men	86.1 ± 17.1	86.8 ± 11.0	86.5 ± 12.1	.76	<.01
Women	83.0 ± 16.5	83.0 ± 16.5	81.7 ± 20.2		
Vitality					
Men	71.1 ± 20.4	70.5 ± 16.6	72.1 ± 24.8	.87	<.01
Women	67.4 ± 21.1	69.4 ± 18.3	64.2 ± 17.0		
Social functioning					
Men	93.1 ± 13.7	85.2 ± 25.1	89.7 ± 21.8	.43	<.01
Women	85.3 ± 22.4	84.2 ± 25.9	85.0 ± 21.4		
Role emotional					
Men	93.5 ± 14.8	86.4 ± 21.4	85.3 ± 22.2	.51	<.01
Women	91.1 ± 13.6	90.3 ± 13.9	86.7 ± 18.6		
Mental health					
Men	81.1 ± 17.8	76.7 ± 18.6	74.5 ± 24.0	.35	.01
Women	73.5 ± 16.7	79.9 ± 17.2	70.8 ± 19.5		

[a] Indicates difference.

history of mild or no knee injury. These findings are not surprising considering the common long-term complications related to anterior cruciate ligament and meniscal injuries, which were reported by 78% of the individuals in the severe-injury group. Specifically, researchers[6,7,29–31] have suggested that patients who sustain anterior cruciate ligament or meniscal injuries are more likely to report long-term pain, functional limitations, and disability than their uninjured counterparts. Furthermore, Cameron et al[19] recently evaluated knee-specific HRQOL in military cadets using the Knee Injury and Osteoarthritis Outcome Score and Western Ontario and McMaster Universities Osteoarthritis Index and reported that individuals who had sustained knee-ligament injuries tended to report more symptoms, more pain, and worse knee-specific HRQOL than those who reported no knee-ligament injury. Despite

Table 5. Main Effect of Injury for International Knee Documentation Committee Subjective Knee Evaluation Form and Short Form 12 Scores

Score	Injury Group, Mean ± SD			*P* Value	Partial η^2
	No	Mild	Severe		
International Knee Documentation Committee Subjective Knee Evaluation Form total score	93.7 ± 14.0	85.1 ± 12.6	78.4 ± 13.9	<.001[a]	.16
Short Form 12 scores					
Physical functioning	94.1 ± 22.3	91.3 ± 22.1	90.2 ± 23.1	.04[a]	<.01
Role physical	92.4 ± 15.6	89.1 ± 14.1	88.4 ± 16.1	.09	.01
Bodily pain	86.8 ± 25.0	84.1 ± 24.8	81.4 ± 25.9	.30	.01
General health	84.5 ± 16.3	83.4 ± 16.1	83.5 ± 16.8	.96	.01
Vitality	69.3 ± 20.4	69.9 ± 20.2	68.1 ± 21.1	.97	<.01
Social functioning	89.2 ± 20.0	85.0 ± 19.8	87.4 ± 20.8	.58	<.01
Role emotional	92.3 ± 16.3	88.3 ± 16.1	86.0 ± 16.8	.04[a]	.02
Mental health	77.3 ± 18.4	78.3 ± 18.2	72.5 ± 19.0	.39	.01

[a] Indicates difference.

Table 6. Main Effect of Sex for International Knee Documentation Committee Subjective Knee Evaluation Form and Short Form 12 Scores

Score	Sex, Mean ± SD		*P* Value	Partial η^2
	Men	Women		
International Knee Documentation Committee Subjective Knee Evaluation Form total score	88.1 ± 19.0	83.4 ± 16.5	.06	.02
Short Form 12 scores				
Physical functioning	92.7 ± 28.0	91.0 ± 27.3	.15	<.01
Role physical	89.2 ± 20.6	90.8 ± 18.1	.76	<.01
Bodily pain	85.4 ± 33.1	82.8 ± 29.0	.38	<.01
General health	86.5 ± 21.5	81.2 ± 18.9	.09	.01
Vitality	71.2 ± 27.0	67.0 ± 23.7	.36	<.01
Social functioning	89.4 ± 26.5	85.0 ± 23.3	.15	<.01
Role emotional	88.4 ± 21.6	89.3 ± 18.9	.79	<.01
Mental health	77.4 ± 24.4	74.7 ± 21.3	.43	<.01

being cleared for military service, individuals with previous knee-ligament injuries continued to experience impairments and decreased knee-specific HRQOL. Our results support these findings because we observed that despite being medically cleared for full sport participation, collegiate athletes with previous severe injuries reported worse knee-specific function and more difficulties related to their physical health than individuals with no injuries.

Self-report of impairments and functional deficits while fully participating in sport activities has been described in the literature and does not appear to be limited to the lower extremity. For example, Soldatis et al[32] investigated the shoulders of athletes who were fully participating in their respective sports (ie, baseball, basketball, football, swimming, tennis, volleyball) and noted that athletes reported deficits in their shoulders related to pain (46% of all shoulders), strength (25%), instability (12%), and function (12%). Similarly, Sauers et al[20] found that 60% of high school and collegiate softball players reported mild to severe pain during the last half of their competitive seasons. Taken together, these findings indicate that despite fully participating in their respective sports, athletes may compete with some level of impairment or functional limitation during their seasons and that injury history may affect overall pain levels. Unlike Soldatis et al[32] and Sauers et al,[20] we studied athletes at the beginning of their seasons, suggesting that some athletes may participate in their sports with some level of impairment or functional limitation throughout their competitive seasons.

Patient-rated outcome measures may play an increased role in athletic training clinical practice and sport health care. Traditionally, PROMs have been used to measure the end result of care associated with a specific injury. However, our observations support the use of PROMs during preparticipation examinations to capture baseline measurements of athletes during their respective "healthy" states, particularly for individuals who have an injury history but are otherwise healthy. One benefit of using PROMs as a form of clinical screening is that clinicians may be able to identify deficits beyond the physical presentation of a previously injured body part, which is integral to the delivery of patient-centered, whole-person health care.[12,33,34] For example, PROMs may assist in identifying subtle deficits in self-report of function and HRQOL that otherwise might go unnoticed and, thus, unaddressed.

In addition, the use of PROMs during preparticipation examinations can help establish baseline measurements that can be used to guide treatment and return-to-participation decisions for subsequent injuries. We have learned from our study and previous studies[19,32] that active individuals may report symptoms or functional limitations even when they are healthy and cleared to participate. Therefore, "normal" for these individuals should not be assumed to be the highest or best score on a PROM. Ideally, effective patient care and treatment after injury would result in patients returning to their respective baseline values before medical clearance for unrestricted participation. With increased attention on sport-related concussions, the use of a baseline measurement to guide clinical decisions is becoming a common approach in sport health care.[35] In the case of the IKDC, the measure would provide the clinician with a baseline measure of a patient's self-report of impairments, function, and disability regarding the knee and may assist clinicians in making more informed treatment and return-to-participation decisions after a knee injury.

Despite differences reported in the physical functioning and role emotional subscales of the SF-12, it appears that the presence and severity of a previous knee injury do not generally affect generic HRQOL. Subscale scores showed only small or trace effect sizes, suggesting that the difference may not be clinically meaningful. Our findings about generic HRQOL contrast with the findings of Huffman et al.[15] They noted that collegiate athletes who indicated injury histories were cleared to participate but reported lower scores across all subscales of the SF-36, except for role emotional. That is, in these athletes, a history of injury affected a variety of areas of their health as opposed to only the role physical and bodily pain domains. We focused our study on knee injuries, whereas Huffman et al[15] studied all sport-related injuries, which suggests that different types or locations of injuries may affect generic HRQOL differently. For example, Kuehl et al[14] observed that collegiate athletes with a history of 3 or more sport-related concussions displayed lower scores on the social functioning, bodily pain, and vitality subscales of the SF-36, with no differences on the other subscales. Another consideration is the version of the Short Form instrument used. Huffman et al[15] used the SF-36, whereas we chose the SF-12 because it is a relatively short PROM with established measurement properties and can be completed quickly, a benefit from a clinical practice perspective. Whereas Ware et al[36] reported that the SF-12 reproduces

the SF-36 physical and mental summary scores with at least 90% accuracy, a potential disadvantage of using a measure with 12 items rather than 36 items is that the shorter measure may not capture subtle deficits in HRQOL. In the future, investigators should seek to further understand the potential effect of instrument length in capturing HRQOL deficits in collegiate athletes.

Our observations also suggested that sex generally did not affect knee-specific function or generic HRQOL. Recently, Cameron et al[19] reported that female military cadets showed lower scores for symptoms, pain, and knee-specific HRQOL on the Knee Injury and Osteoarthritis Outcome Score and Western Ontario and McMaster Universities Osteoarthritis Index than their male peers. Although we did not report differences in the IKDC total score, female athletes did show lower scores than male athletes, and group differences trended toward a difference ($P = .06$). From a generic HRQOL standpoint, Huffman et al[15] reported sex differences in collegiate athletes, but the only difference was for the general health subscale of the SF-36. In combination with our sex findings, this would indicate that sex generally does not affect generic HRQOL in college-aged athletes. However, more research is needed to support this notion, and researchers should consider sex as an important variable when investigating HRQOL in active individuals.

We conveyed injury group differences for IKDC total scores, but we do not know whether these differences are clinically meaningful. For example, it appears that IKDC total scores demonstrated an ordered effect of worse scores reported with an increase in injury severity (severe injury = 78.4, mild injury = 85.1, no injury = 93.7), but ascertaining the meaning of these differences is difficult. The MDC, a distribution-based value that represents error within the instrument,[37] is a plausible candidate for interpreting score differences and may serve as a better frame of reference for comparing scores than the minimal clinically important difference because the MDC characterizes instrument error. For example, the MDC of the IKDC is 9 points.[27] Therefore, a separation of 2 scores by more than 9 points suggests that the 2 scores are different from each other. When comparing IKDC scores among injury groups in our study, we found that differences between the severe- and no-injury groups were more than 9 points, which indicates that these group differences exceeded the measurement error of the IKDC. In addition, these group differences were highlighted by a large effect size, further suggesting the existence of group differences. However, it is difficult to ascertain when the magnitude of difference in these types of scores is clinically meaningful, and additional studies are needed to better understand these differences.

Our study had several limitations. First, we relied on patients to self-report previous injuries and grouped our participants according to these reports. In some cases, participants may have misclassified themselves into the wrong group, particularly if they sustained injuries around the 10-day threshold (eg, 8–12 days). However, researchers[20,38] have used this approach, and the number of potential misclassifications is likely to be low. Furthermore, a misclassification would make rejecting our null hypothesis of no difference more difficult. Second, although we asked several questions about knee-injury history, we did not instruct participants to identify whether they had sustained multiple or recurrent injuries. It is unclear whether multiple previous injuries to the lower extremity affect HRQOL differently than a single previous injury. Researchers should investigate the role of multiple or recurrent injuries on HRQOL. Furthermore, we were limited to a fixed sample size for this study because participants were part of a larger prospective study. Thus, the potential for a type II error existed, but we identified group differences within our study that were in agreement with previous literature, particularly with the IKDC total score. Last, our sample included individuals participating in contact and noncontact sports but not collision sports. It is unclear whether sport types may affect HRQOL differently, but researchers should consider including all types of sports to gain a more comprehensive understanding of the effect of previous injuries on HRQOL.

CONCLUSIONS

Our observations suggested that a previous knee injury can negatively affect knee-specific function and HRQOL despite the athlete being cleared for full participation and having returned to participation. A region-specific PROM may be more sensitive in detecting deficits than generic PROMs after return to participation. This is not surprising considering that region-specific PROMs are developed within the context of the body region or condition of interest. Our observations indicate that clinicians should consider using region-specific PROMs during preparticipation examinations to capture deficits related to HRQOL, help optimize patient-centered care, and establish baseline measurements for use in patient care after a future injury.

REFERENCES

1. Hootman JM, Dick R, Agel J. Epidemiology of collegiate injuries for 15 sports: summary and recommendations for injury prevention initiatives. *J Athl Train*. 2007;42(2):311–319.
2. Baquie P, Brukner P. Injuries presenting to an Australian sports medicine centre: a 12-month study. *Clin J Sport Med*. 1997;7(1):28–31.
3. Gabbe B, Finch C. A profile of Australian football injuries presenting to sports medicine clinics. *J Sci Med Sport*. 2001;4(4):386–395.
4. Majewski M, Susanne H, Klaus S. Epidemiology of athletic knee injuries: a 10-year study. *Knee*. 2006;13(3):184–188.
5. Darrow CJ, Collins CL, Yard EE, Comstock RD. Epidemiology of severe injuries among United States high school athletes: 2005–2007. *Am J Sports Med*. 2009;37(9):1798–1805.
6. Lohmander LS, Englund PM, Dahl LL, Roos EM. The long-term consequence of anterior cruciate ligament and meniscus injuries: osteoarthritis. *Am J Sports Med*. 2007;35(10):1756–1769.
7. Oiestad BE, Holm I, Aune AK, et al. Knee function and prevalence of knee osteoarthritis after anterior cruciate ligament reconstruction: a prospective study with 10 to 15 years of follow-up. *Am J Sports Med*. 2010;38(11):2201–2210.
8. Guyatt GH, Feeny DH, Patrick DL. Measuring health-related quality of life. *Ann Intern Med*. 1993;118(8):622–629.
9. Clancy CM, Eisenberg JM. Outcomes research: measuring the end results of health care. *Science*. 1998;282(5387):245–246.
10. Testa MA, Simonson DC. Assessment of quality-of-life outcomes. *N Engl J Med*. 1996;334(13):835–840.
11. McAllister DR, Motamedi AR, Hame SL, Shapiro MS, Dorey FJ. Quality of life assessment in elite collegiate athletes. *Am J Sports Med*. 2001;29(6):806–810.

12. Valovich McLeod TC, Snyder AR, Parsons JT, Bay RC, Michener LA, Sauers EL. Using disablement models and clinical outcomes assessment to enable evidence-based athletic training practice: part II. Clinical outcomes assessment. *J Athl Train*. 2008;43(4):437–445.
13. McGuine TA, Winterstein A, Carr K, Hetzel S, Scott J. Changes in self-reported knee function and health-related quality of life after knee injury in female athletes. *Clin J Sport Med*. 2012;22(4):334–340.
14. Kuehl MD, Snyder AR, Erickson SE, McLeod TC. Impact of prior concussions on health-related quality of life in collegiate athletes. *Clin J Sport Med*. 2010;20(2):86–91.
15. Huffman GR, Park J, Roser-Jones C, Sennett BJ, Yagnik G, Webner D. Normative SF-36 values in competing NCAA intercollegiate athletes differ from values in the general population. *J Bone Joint Surg Am*. 2008;90(3):471–476.
16. Lam KC, Valier AR, Bay RC, McLeod TC. A unique patient population? Health-related quality of life in adolescent athletes versus general, healthy adolescent individuals. *J Athl Train*. 2013; 48(2):233–241.
17. Snyder AR, Martinez JC, Bay RC, Parsons JT, Sauers EL, Valovich McLeod TC. Health-related quality of life differs between adolescent athletes and adolescent nonathletes. *J Sport Rehabil*. 2010;19(3): 237–248.
18. Tanabe T, Snyder AR, Bay RC, Valovich McLeod TC. Representative values of health-related quality of life among female and male adolescent athletes and the impact of gender. *Athl Train Sports Health Care*. 2010;2(3):106–112.
19. Cameron KL, Thompson BS, Peck KY, Owens BD, Marshall SW, Svoboda SJ. Normative values for the KOOS and WOMAC in a young athletic population: history of knee ligament injury is associated with lower scores. *Am J Sports Med*. 2013;41(3):582–589.
20. Sauers EL, Dykstra DL, Bay RC, Bliven KH, Snyder AR. Upper extremity injury history, current pain rating, and health-related quality of life in female softball pitchers. *J Sport Rehabil*. 2011; 20(1):100–114.
21. Dick R, Agel J, Marshall SW. National Collegiate Athletic Association Injury Surveillance System commentaries: introduction and methods. *J Athl Train*. 2007;42(2):173–182.
22. Lam KC, Valovich McLeod TC. The impact of sex and knee injury history on jump-landing patterns in collegiate athletes: a clinical evaluation. *Clin J Sport Med*. 2014;24(5):373–379.
23. Irrgang JJ, Anderson AF. Development and validation of health-related quality of life measures for the knee. *Clin Orthop Relat Res*. 2002;402:95–109.
24. Collins NJ, Misra D, Felson DT, Crossley KM, Roos EM. Measures of knee function: International Knee Documentation Committee (IKDC) Subjective Knee Evaluation Form, Knee Injury and Osteoarthritis Outcome Score (KOOS), Knee Injury and Osteoarthritis Outcome Score Physical Function Short Form (KOOS-PS), Knee Outcome Survey Activities of Daily Living Scale (KOS-ADL), Lysholm Knee Scoring Scale, Oxford Knee Score (OKS), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), Activity Rating Scale (ARS), and Tegner Activity Score (TAS). *Arthritis Care Res (Hoboken)*. 2011;63(suppl 11):S208–S228.
25. Irrgang JJ, Anderson AF, Boland AL, et al. Responsiveness of the International Knee Documentation Committee Subjective Knee Form. *Am J Sports Med*. 2006;34(10):1567–1573.
26. van Meer BL, Meuffels DE, Vissers MM, et al. Knee injury and Osteoarthritis Outcome Score or International Knee Documentation Committee Subjective Knee Form: which questionnaire is most useful to monitor patients with an anterior cruciate ligament rupture in the short term? *Arthroscopy*. 2013;29(4):701–715.
27. Irrgang JJ, Anderson AF, Boland AL, et al. Development and validation of the International Knee Documentation Committee Subjective Knee Form. *Am J Sports Med*. 2001;29(5):600–613.
28. Ware J Jr, Kosinski M, Keller SD. A 12-item short-form health survey: construction of scales and preliminary tests of reliability and validity. *Med Care*. 1996;34(3):220–233.
29. Lohmander LS, Ostenberg A, Englund M, Roos H. High prevalence of knee osteoarthritis, pain, and functional limitations in female soccer players twelve years after anterior cruciate ligament injury. *Arthritis Rheum*. 2004;50(10):3145–3152.
30. Oiestad BE, Engebretsen L, Storheim K, Risberg MA. Knee osteoarthritis after anterior cruciate ligament injury: a systematic review. *Am J Sports Med*. 2009;37(7):1434–1443.
31. Friel NA, Chu CR. The role of ACL injury in the development of posttraumatic knee osteoarthritis. *Clin Sports Med*. 2013;32(1):1–12.
32. Soldatis JJ, Moseley JB, Etminan M. Shoulder symptoms in healthy athletes: a comparison of outcome scoring systems. *J Shoulder Elbow Surg*. 1997;6(3):265–271.
33. Evans TA, Lam KC. Clinical outcomes assessment in sport rehabilitation. *J Sport Rehabil*. 2011;20(1):8–16.
34. Snyder AR, Parsons JT, Valovich McLeod TC, Bay RC, Michener LA, Sauers EL. Using disablement models and clinical outcomes assessment to enable evidence-based athletic training practice: part I. Disablement models. *J Athl Train*. 2008;43(4):428–436.
35. McCrory P, Meeuwisse W, Aubry M, et al. Consensus statement on concussion in sport: the 4th International Conference on Concussion in Sport held in Zurich, November 2012. *Clin J Sport Med*. 2013; 23(2):89–117.
36. Ware JE, Kosinski M, Dewey JE. *How to Score Version Two of the SF-36 Health Survey*. Lincoln, RI: Quality Metric Inc; 2000:1–30.
37. Beaton DE, Bombardier C, Katz JN, Wright JG. A taxonomy for responsiveness. *J Clin Epidemiol*. 2001;54(12):1204–1217.
38. Valovich McLeod TC, Bay RC, Lam KC, Chhabra A. Representative baseline values on the Sport Concussion Assessment Tool 2 (SCAT2) in adolescent athletes vary by gender, grade, and concussion history. *Am J Sports Med*. 2012;40(4):927–933.

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