

Sport-Specificity of Knee Scoring Systems to Assess Disability in Anterior Cruciate Ligament-Deficient Athletes

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We compared the outcome measures of three knee scoring systems currently used to measure disability in anterior cruciate ligament (ACL)-deficient athletes. Twenty-nine ACL-deficient athletes completed three scoring systems (the Lysholm Knee Scoring System, a modified version of the Cincinnati Knee Scoring System, and the Knee Outcome Survey). Results demonstrate statistically significant mean differences and linear relationships between the outcome measures for the three scoring systems. The Knee Outcome Survey appears to provide valid measures of disability and indicates that our subjects functioned well with activities of daily living but became symptomatic and functionally limited with sports. The outcome measures also indicate that the Lysholm system is more specific to activities of daily living, while the modified Cincinnati is more specific to sports. We recommend that standard scoring systems be developed to provide measures of functional disability in athletes who experience knee injuries.

The use of self-administered knee scoring systems is becoming more widespread in the reporting process for the functional outcome of anterior cruciate ligament (ACL) tears both before and after reconstructive surgery (4-13). The knee scoring systems are used to numerically rate symptoms such as pain, swelling, instability, and other related functional limitations during both sports and activities of daily living. The knee scoring systems provide an initial measurement of disability and may be used temporally throughout the rehabilitation process, providing a time-series comparison of symptomatic resolution and functional pro-

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gression (2, 4). In addition, with the advent of managed care, the outcome measure may also be used by insurance companies to monitor progress and justify reimbursement privileges for athletes undergoing rehabilitation.

Original knee scoring systems used binary point scoring systems for measuring disability (8), while more current models use cumulative point scoring systems (4, 6, 9-11, 13). The Lysholm Knee Scoring System (LKS) and the Cincinnati Knee Scoring System (CKS) are used widely, whereas the Knee Outcome Survey (KOS) is a relatively new scoring system developed at the University of Pittsburgh (4, 6). Scoring systems function as questionnaires, and each question is numerically graded with more points allotted for less symptoms and greater function. The outcome measure for these scoring systems provides a measure of disability for the ACL-deficient limb. Clinicians then use this measure to categorize the limb as excellent (91-100 points), good (82-90 points), fair (60-81 points), and poor (≤ 59 points) (7, 13). Comparisons between types of scoring systems have revealed discrepancies in measures with ACL-deficient athletes (1). These discrepancies have created considerable difficulty when researchers attempt to categorize outcome measures (1). The purpose of this retrospective clinical investigation was to compare and correlate the outcome measures of three knee scoring systems currently used to measure functional disability in ACL-deficient athletes. We hypothesized that the outcome measures of the three knee scoring systems would demonstrate statistically significant mean differences and linear relationships.

Materials and Methods

Subjects

Sample size was determined a priori using a power analysis for a projected alpha of .05 and medium effect size. A sample size of 30 subjects was found to be adequate to attain a power of .80; however, 1 subject was discounted due to a misdiagnosis of an ACL tear. Twenty-nine ACL-deficient athletes (15 males, 14 females) participated in this investigation. Prior to their injury, 21 of the subjects were recreational athletes (72%), whereas 8 (28%) participated competitively. The subjects ranged in age from 18 to 50 years (mean 28.7 \pm 1.7 years) and were tested at an average of 41.7 \pm 11.7 months (3.5 \pm 1.0 years) after injury. Subjects spent an average of 2.4 \pm 0.33 months in postinjury rehabilitation. Twenty-four subjects (83%) indicated that they had significantly decreased their level of sport activity as a result of the injury, although Tegner activity ratings indicated that the sample remained physically active (Levels 0-3 activities of daily living, $n = 12$; Levels 4-6 recreational sports, $n = 13$; Levels 7-10 competitive sports, $n = 4$).

Objective measures of knee status were assessed prior to completion of the knee scoring systems by a certified athletic trainer. These data are listed in Table 1. Objective tests included anterior laxity, thigh atrophy, strength, function, and episodes of instability. The bilateral difference for anterior laxity was measured using

Table 1 Descriptive Data for Subjects

Objective measure	Value			
Anterior laxity (bilateral difference, mm)	5.6 ± 2.7			
Thigh girth (bilateral difference, cm)	0.87 ± 1.3			
Strength index (%)	87 ± 18			
Hop index (%)	84 ± 14			
Episodes of instability				
0 episodes	1-5 episodes	6-15 episodes	> 15 episodes	
9 (31%)	8 (28%)	5 (17%)	7 (24%)	

the Stryker Knee Laxity Tester (Stryker, Kalamazoo, MI). Quadriceps strength was assessed isometrically as peak force generation (foot-pounds) using a dynamometer (Cybex II dynamometer, Lumex, Inc., Ronkonkoma, NY). The measure was recorded as the quotient between ACL-deficient and uninjured limbs and will be referred to as the strength index. Function was assessed using the one-legged hop for distance test. The measure was recorded as the quotient between the ACL-deficient and uninjured limbs and is referred to as the hop index. Episodes of instability were measured as the absolute number of times the knee gave way after sustaining the initial injury. All ACL tears were sport related. Nine (31%) subjects underwent arthroscopic exploratory surgery; 5 (17%) had a partial medial meniscus, and 2 had a Grade III medial collateral ligament (MCL) tear, with one of these tears being repaired.

The initial clinical diagnosis of ACL deficiency in each athlete was made by an orthopedic surgeon who used contemporary diagnostic procedures. The subjects were tested in the postacute stage after the initial injury and were then completing or had completed a consistent rehabilitation protocol for ACL deficiency emphasizing hamstring strengthening with functional progression. The postacute stage was characterized by the subject having no acute symptoms of inflammation, pain, or limitations in range of motion. Subjects reviewed and signed a consent form approved by the Human Subjects Committee.

Knee Scoring Systems

The scoring systems used in this study were self-administered, and each patient randomly completed three separate knee scoring systems with standardized instructions provided. The scoring systems used in this study were the Lysholm Knee Scoring System (LKS), a modified version of the Cincinnati Knee Scoring System (CKS), and the Knee Outcome Survey (KOS), which consists of two separate scoring systems: the Activities of Daily Living Scale (ADLS) and the Sports Activity Scale (SAS). The cumulative score (mean ± SD) for each system provides a measure of disability or indicates the functional outcome for the ACL-deficient limb, compar-

ing the status of the limb prior to injury or surgery to the current status of the limb. Higher mean scores indicate a lower level of disability.

Lysholm Knee Scoring System (LKS). The LKS is a popular scoring system used following knee injury and/or surgery (Figure 1). The system consists of eight items related to common symptoms and functional limitations experienced by individuals who sustain a knee ligament injury (7, 12, 13).

Modified Cincinnati Knee Scoring System (CKS). The modified CKS is a questionnaire that measures the patient's level of activity (intensity and frequency) as well as symptoms and functional limitations associated with both sports and activities of daily living (Figure 2) (9-11).

Limp (5 points)	None	5	Pain (25 points)	None	25
	Slight or periodical	3		Inconstant and slight during heavy exertion	20
	Severe and constant	0		Marked during heavy exertion	15
Support (5 points)	None	5	Weight-bearing impossible	Marked on or after walking more than 2 km	10
	Cane or crutch	2		Marked on or after walking less than 2 km	5
		0		Constant	0
Locking (15 points)	No locking or no catching sensations	15	Swelling (10 points)	None	10
	Catching sensations but no locking	10		On heavy exertion	6
	Occasional locking	6		On normal exertion	2
	Frequently	2		Constant	0
	Locked on exam.	0		Stair-climbing (10 points)	No problems
		Slightly impaired	6		
		One step at a time	2		
		Impossible	0		
Instability (25 points)	No giving way	25	Squatting (5 points)	No problems	5
	Rarely, during sports or heavy exertion	20		Slightly impaired	4
	Frequently, during sports or heavy exertion	15		Not beyond 90°	2
	Occasionally in daily activities	10		Impossible	0
	Often in daily activities	5			
	At every step	0			

Figure 1 — Lysholm Knee Scoring System. From "Ratings Systems in the Evaluation of Knee Ligament Injuries" by Y. Tegner and J. Lysholm, 1985, *Clinical Orthopaedics*, 198, pp. 43-49. Permission granted by Lippincott-Raven Publishers, Philadelphia.

SPORTSACTIVITY

Last name _____ SS# _____

Please check the boxes that indicate your level of sports activity before and after your injury, your highest level after surgery, and your current level of sports activity.

Before Injury	After Injury	Highest Post-op	Current Level	
100 <input type="checkbox"/>	100 <input type="checkbox"/>	100 <input type="checkbox"/>	100 <input type="checkbox"/>	Level 1 (4-7 days/week)
95 <input type="checkbox"/>	95 <input type="checkbox"/>	95 <input type="checkbox"/>	95 <input type="checkbox"/>	Jumping, hard pivoting, cutting
90 <input type="checkbox"/>	90 <input type="checkbox"/>	90 <input type="checkbox"/>	90 <input type="checkbox"/>	Running, twisting, turning
				No running, twisting, jumping
85 <input type="checkbox"/>	85 <input type="checkbox"/>	85 <input type="checkbox"/>	85 <input type="checkbox"/>	Level 2 (1-3 days/week)
80 <input type="checkbox"/>	80 <input type="checkbox"/>	80 <input type="checkbox"/>	80 <input type="checkbox"/>	Jumping, hard pivoting, cutting
75 <input type="checkbox"/>	75 <input type="checkbox"/>	75 <input type="checkbox"/>	75 <input type="checkbox"/>	Running, twisting, turning
				No running, twisting, jumping
65 <input type="checkbox"/>	65 <input type="checkbox"/>	65 <input type="checkbox"/>	65 <input type="checkbox"/>	Level 3 (1-3 times/month)
60 <input type="checkbox"/>	60 <input type="checkbox"/>	60 <input type="checkbox"/>	60 <input type="checkbox"/>	Jumping, hard pivoting, cutting
55 <input type="checkbox"/>	55 <input type="checkbox"/>	55 <input type="checkbox"/>	55 <input type="checkbox"/>	Running, twisting, turning
				No running, twisting, jumping
40 <input type="checkbox"/>	40 <input type="checkbox"/>	40 <input type="checkbox"/>	40 <input type="checkbox"/>	Level 4 (no sports)
20 <input type="checkbox"/>	20 <input type="checkbox"/>	20 <input type="checkbox"/>	20 <input type="checkbox"/>	Jumping, hard pivoting, cutting
0 <input type="checkbox"/>	0 <input type="checkbox"/>	0 <input type="checkbox"/>	0 <input type="checkbox"/>	Running, twisting, turning
				No running, twisting, jumping <input type="checkbox"/>

Note on activity levels
Jumping, hard pivoting, cutting includes basketball, football, gymnastics, soccer.
Running, twisting, turning includes tennis, hockey, skiing, wrestling.
No running, twisting, jumping includes cycling, swimming, golf.

If your level of sports activity now is less than that before your injury, is this because of your knee? Yes No

Do you currently wear a knee brace when participating in sports? Yes No

Figure 2 — Modified Cincinnati Knee Scoring System. From "A Rationale for Assessing Sports Activity Levels and Limitations in Knee Disorders" by F.R. Noyes, S.D. Barber, and L.A. Mooar, 1989, *Clinical Orthopaedics and Related Research*, 264, pp. 238-249. Permission granted by Lippincott-Raven Publishers, Philadelphia. The original Cincinnati Knee Scoring System was published in "Functional Disability in the Anterior Cruciate Insufficient Knee Syndrome: Review of Rating Systems and Projected Risk Factors in Determining Treatment" by F.R. Noyes, G.H. McGinniss, and L.A. Mooar, 1984, *Sports Medicine*, 1, 278-302.

SPORTS FUNCTION

Please indicate any difficulty you have during

Straight running	Jumping/landing on leg	Hard twists/cuts/pivots
<input type="checkbox"/> Fully competitive	<input type="checkbox"/> Fully competitive	<input type="checkbox"/> Fully competitive
<input type="checkbox"/> Some limitations	<input type="checkbox"/> Some limitations	<input type="checkbox"/> Some limitations
<input type="checkbox"/> Definite limitations	<input type="checkbox"/> Definite limitations	<input type="checkbox"/> Definite limitations
<input type="checkbox"/> Unable to perform	<input type="checkbox"/> Unable to perform	<input type="checkbox"/> Unable to perform

SYMPTOMS

Last name _____ SS# _____

Directions: Using the key (at right), check the appropriate boxes on the scales below which indicate the highest level you can reach without having symptoms.

Key Scale	Description
10	Normal knee, no limitations
8	Able to do moderate activities with running, turning, or jumping; symptoms with strenuous activities
6	Able to do light activities with no running, turning, or jumping; symptoms with moderate activities
4	Able to do activities of daily living; symptoms with light activities
2	Moderate symptoms (frequent, limiting) with activities of daily living
0	Severe symptoms (constant) with activities of daily living

Pain

10	8	6	4	2	0	<input type="checkbox"/>
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Swelling (actual fluid in knee; obvious puffiness)

10	8	6	4	2	0	<input type="checkbox"/>
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Partial giving way (no fall to the ground)

10	8	6	4	2	0	<input type="checkbox"/>
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Full giving way (knee collapses and you fall to the ground)

10	8	6	4	2	0	<input type="checkbox"/>
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Figure 2 — (continued).

Following my last visit to the doctor, I am

Making good progress Slowly progressing
 Staying the same Having worse symptoms Does not apply

On a scale of 1 to 100, I would rate my knee as a _____.

Would you be willing to undergo this procedure again? Yes No

Name _____ SS# _____

Date of exam _____

Sports activity (20 points) _____ /5 _____

Sports function (30 points)

Straight running	_____	_____
Jumping/landing on leg	_____	_____
Hard twists/cuts/pivots	_____	_____

Symptoms (50 points)

Pain	_____	_____
Swelling	_____	_____
Partial giving way	_____	× 1.5 _____
Full giving way	_____	× 1.5 _____

Subjective knee rating /100

Personal rating /100

Figure 2 — (continued).

The Knee Outcome Survey (KOS). The Knee Outcome Survey (KOS) is a self-report instrument consisting of two separate scales to assess disability during activities of daily living and sports. The scales are separated in an attempt to delineate between symptoms and functional limitations that occur during sports and activities of daily living.

The KOS—Activities of Daily Living Scale. The Activities of Daily Living Scale (ADLS) includes items related to symptoms and functional limitations during activities of daily living that are a direct result of an individual's knee injury (Figure 3) (4, 6). Symptoms on the scale include pain, crepitus, stiffness, swelling, instability, and weakness. Responses for each item are graduated in terms of

Knee Outcome Survey—Activities of Daily Living Scale

The following questionnaire is designed to determine the symptoms and limitations that you experience because of your knee while you perform your usual *daily activities*. Please answer each question by *checking the one statement that best describes you over the last 1 to 2 days*. For a given question, more than one of the statements may describe you, but please mark only the statement that best describes you during your usual daily activities.

Symptoms:

- To what degree does pain in your knee affect your daily activity level?
 - I never have pain in my knee.
 - I have pain in my knee but it does not affect my daily activity.
 - Pain affects my activity slightly.
 - Pain affects my activity moderately.
 - Pain affects my activity severely.
 - Pain in my knee prevents me from performing all daily activities.
- To what degree does grinding or grating of your knee affect your daily activity level?
 - I never have grinding or grating in my knee.
 - I have grinding or grating in my knee, but it does not affect my daily activity.
 - Grinding or grating affects my activity slightly.
 - Grinding or grating affects my activity moderately.
 - Grinding or grating affects my activity severely.
 - Grinding or grating in my knee prevents me from performing all daily activities.
- To what degree does stiffness in your knee affect your daily activity level?
 - I never have stiffness in my knee.
 - I have stiffness in my knee, but it does not affect my daily activity.
 - Stiffness affects my activity slightly.
 - Stiffness affects my activity moderately.
 - Stiffness affects my activity severely.
 - Stiffness in my knee prevents me from performing all daily activities.
- To what degree does swelling in your knee affect your daily activity level?
 - I never have swelling in my knee.
 - I have swelling in my knee, but it does not affect my daily activity.
 - Swelling affects my activity slightly.
 - Swelling affects my activity moderately.
 - Swelling affects my activity severely.
 - Swelling in my knee prevents me from performing all daily activities.
- To what degree does slipping of your knee affect your daily activity level?
 - I never have slipping of my knee.
 - I have slipping of my knee, but it does not affect my daily activity.
 - Slipping of my knee affects my activity slightly.
 - Slipping of my knee affects my activity moderately.
 - Slipping of my knee affects my activity severely.
 - Slipping of my knee in my knee prevents me from performing all daily activities.

Figure 3 — Knee Outcome Survey: Activities of Daily Living Scale. From "The Knee: Ligamentous and Meniscal Injuries" by J.J. Irrgang, M.R. Safran, and F.H. Fu, in *Athletic Injuries and Rehabilitation* (pp. 623-692) by J.E. Zachazewski, D.J. Magee, and W.S. Quillen (Eds.), 1996, Philadelphia: W.B. Saunders Co.

6. To what degree does buckling in your knee affect your daily activity level?
- I never have buckling in my knee.
 - I have buckling in my knee, but it does not affect my daily activity.
 - Buckling in my knee affects my activity slightly.
 - Buckling in my knee affects my activity moderately.
 - Buckling in my knee affects my activity severely.
 - Buckling in my knee prevents me from performing all daily activities.

7. To what degree does weakness or lack of strength of your leg affect your daily activity level?
- My leg never feels weak.
 - My leg feels weak, but it does not affect my daily activity.
 - Weakness affects my activity slightly.
 - Weakness affects my activity moderately.
 - Weakness affects my activity severely.
 - Weakness of my leg prevents me from performing all daily activities.

Functional Disability with Activities of Daily Living

8. How does your knee affect your ability to walk?
- My knee does not affect my ability to walk.
 - I have pain in my knee when walking, but it does not limit my ability to walk.
 - My knee prevents me from walking more than 1 mile.
 - My knee prevents me from walking more than 1/2 mile.
 - My knee prevents me from walking more than 1 block.
 - My knee prevents me from walking.
9. Because of your knee, do you walk with crutches or a cane?
- I can walk without crutches or a cane.
 - My knee causes me to walk with one crutch or a cane.
 - My knee causes me to walk with two crutches.
 - Because of my knee, I cannot walk, even with crutches.
10. Does your knee cause you to limp when you walk?
- I can walk without a limp.
 - Sometimes my knee causes me to walk with a limp.
 - Because of my knee, I cannot walk without a limp.
11. How does your knee affect your ability to go up stairs?
- My knee does not affect my ability to go up stairs.
 - I have pain in my knee when going up stairs, but it does not limit my ability to go up stairs.
 - I am able to go up stairs normally, but I need to rely on use of a railing.
 - I am able to go up stairs one step at a time with the use of a railing.
 - I have to use crutches or a cane to go up stairs.
 - I cannot go up stairs.
12. How does your knee affect your ability to go down stairs?
- My knee does not affect my ability to go down stairs.
 - I have pain in my knee when going down stairs, but it does not limit my ability to go down stairs.
 - I am able to go down stairs normally, but I need to rely on use of a railing.
 - I am able to go down stairs one step at a time with the use of a railing.
 - I have to use crutches or a cane to go down stairs.
 - I cannot go down stairs.

Figure 3 — (continued).

13. How does your knee affect your ability to stand?
- My knee does not affect my ability to stand. I can stand for unlimited amounts of time.
 - I have pain in my knee when standing, but it does not limit my ability to stand.
 - Because of my knee, I cannot stand for more than 1 hour.
 - Because of my knee, I cannot stand for more than 1/2 hour.
 - Because of my knee, I cannot stand for more than 10 minutes.
 - I cannot stand because of my knee.
14. How does your knee affect your ability to kneel on the front of your knee?
- My knee does not affect my ability to kneel on the front of the knee. I can kneel for unlimited amounts of time.
 - I have pain when kneeling on the front of my knee, but it does not limit my ability to stand.
 - I cannot kneel on the front of my knee for more than 1 hour.
 - I cannot kneel on the front of my knee for more than 1/2 hour.
 - I cannot kneel on the front of my knee for more than 10 minutes.
 - I cannot kneel on the front of my knee.
15. How does your knee affect your ability to squat?
- My knee does not affect my ability to squat. I can squat all the way down.
 - I have pain when squatting, but I can still squat all the way down.
 - I cannot squat more than 3/4 of the way down.
 - I cannot squat more than halfway down.
 - I cannot squat more than 1/4 of the way down.
 - I cannot squat at all.
16. How does your knee affect your ability to sit with your knee bent?
- My knee does not affect my ability to sit with my knee bent. I can sit for unlimited amounts of time.
 - I have pain in my knee when sitting with my knee bent, but it does not limit my ability to sit.
 - I cannot sit with my knee bent for more than 1 hour.
 - I cannot sit with my knee bent for more than 1/2 hour.
 - I cannot sit with my knee bent for more than 10 minutes.
 - I cannot sit with my knee bent.
17. How does your knee affect your ability to rise from a chair?
- My knee does not affect my ability to rise from a chair.
 - I have pain when rising from the seated position, but it does not affect my ability to rise from the seated position.
 - Because of my knee, I can only rise from a chair if I use my hands and arms to assist.
 - Because of my knee, I cannot rise from a chair.
18. How would you rate your current level of knee function during your usual daily activities on a scale from 0 to 100, with 100 being your level of knee function prior to your injury?
- _____
19. How would you rate the overall function of your knee during your usual daily activities?
- _____ normal
 - _____ nearly normal
 - _____ abnormal
 - _____ severely abnormal

Figure 3 (continued).

20. As a result of your knee injury, how would you rate your *current level of daily activity*?

_____ normal
 _____ nearly normal
 _____ abnormal
 _____ severely abnormal

21. Since initiation of treatment for your knee, how would you describe your progress?

_____ greatly improved
 _____ somewhat improved
 _____ neither improved/worsened
 _____ somewhat worse
 _____ greatly worse

Changes in Daily Activity Level

Please use the following scale to answer questions A-C below.

1 = I was able to perform *unlimited physical work*, which included lifting and climbing.
 2 = I was able to perform *limited physical work*, which included lifting and climbing.
 3 = I was able to perform *unlimited light activities*, which included walking on level surfaces and stairs.
 4 = I was able to perform *limited light activities*, which included walking on level surfaces and stairs.
 5 = I was *unable to perform light activities*, which included walking on level surfaces and stairs.

A. _____ *Prior to your knee injury*, how would you describe your usual daily activity? Please indicate only the HIGHEST level of activity that described you before your knee injury.

B. _____ *Prior to surgery or treatment of your knee*, how would you describe your usual daily activity? Please indicate only the HIGHEST level of activity that described you prior to surgery or treatment to your knee.

C. _____ How would you describe your *current level of daily activity*? Please indicate only the HIGHEST level of activity that describes you over the last 1 to 2 days.

Figure 3 — (continued).

the functional limitations that each symptom imposes upon the individual during activities of daily living. Functional limitations on the scale include difficulty with walking on level ground, ascending and descending stairs, standing, kneeling, squatting, sitting, and rising from sitting. Alternatives for each item are graduated from no limitation in performing the activity to the inability to perform the activity.

The KOS—Sports Activity Scale. The Sports Activity Scale (SAS) consists of items related to symptoms and functional limitations during sports (Figure 4) (4, 6). The same symptoms included on the ADLS are included on the SAS; however, the responses are graduated in terms of limitations imposed during sports activities. Functional limitations on the SAS include running, stopping, starting, jumping, landing, cutting, and pivoting. Responses for each item are graduated from no limitation in performing the activity to the inability to perform the activity.

The ADLS and SAS were scored by summing the point value associated with an individual's response for each item on the scale. The sum of the points

Knee Outcome Survey—Sports Activities Scale

The following questionnaire is designed to determine the symptoms and limitations that you experience because of your knee while you perform your usual sports activities. Please answer each question by *checking the one statement that best describes you over the last 1 to 2 days*. For a given question, more than one of the statements may describe you, but please mark **ONLY** the statement that best describes you when you participate in sports activities.

Symptoms:

- To what degree does pain in your knee affect your sports activity level?
 - I never have pain in my knee.
 - Knee pain does not affect my daily activity.
 - Slightly.
 - Moderately.
 - Severely.
 - Prevents me from performing all sports activities.
- To what degree does grinding or grating of your knee affect your sports activity level?
 - I never have grinding or grating in my knee.
 - Grinding/grating does not affect my activity.
 - Slightly.
 - Moderately.
 - Severely.
 - Prevents me from performing all sports activities.
- To what degree does stiffness of your knee affect your sports activity level?
 - I never have stiffness in my knee.
 - Knee stiffness does not affect my activity.
 - Slightly.
 - Moderately.
 - Severely.
 - Prevents me from performing all sports activities.
- To what degree does swelling in your knee affect your sports activity level?
 - I never have swelling in my knee.
 - Knee swelling does not affect my activity.
 - Slightly.
 - Moderately.
 - Severely.
 - Prevents me from performing all sports activities.
- To what degree does partial giving way or slipping of your knee affect your sports activity level?
 - I never have partial giving way or slipping of my knee.
 - Partial giving way does not affect my activity.
 - Slightly.
 - Moderately.
 - Severely.
 - Prevents me from performing all sports activities.

Figure 4 — Knee Outcome Survey: Sports Activity Scale. From "The Knee: Ligamentous and Meniscal Injuries" by J.J. Irrgang, M.R. Safran, and F.H. Fu, in *Athletic Injuries and Rehabilitation* (pp. 623-692) by J.E. Zachazewski, D.J. Magee, and W.S. Quillen (Eds.), 1996, Philadelphia: W.B. Saunders Co.

6. To what degree does complete giving way or buckling of your knee affect your sports activity level?

- I never have complete giving way or buckling in my knee.
- Knee buckling does not affect my daily activity.
- Slightly.
- Moderately.
- Severely.
- Prevents me from performing all sports activities.

Functional Disability with Sports Activities

1. How does your knee affect your ability to run straight ahead?

- I am able to run straight ahead full speed without limitations.
- I have pain in my knee but it does not affect my ability.
- Slightly.
- Moderately.
- Severely.
- Prevents me from running.

2. How does your knee affect your ability to jump and land on your involved leg?

- I am able to jump and land on my involved leg without limitations.
- I have pain in my knee but it does not affect my ability.
- Slightly.
- Moderately.
- Severely.
- Prevents me from jumping and landing.

3. How does your knee affect your ability to stop and start quickly?

- I am able to start and stop quickly without limitations.
- I have pain in my knee but it does not affect my ability.
- Slightly.
- Moderately.
- Severely.
- Prevents me from stopping and starting quickly.

4. How does your knee affect your ability to cut and pivot on your involved leg?

- I am able to cut and pivot on my involved leg without limitations.
- I have pain in my knee but it does not affect my ability.
- Slightly.
- Moderately.
- Severely.
- Prevents me from cutting and pivoting.

Figure 4 — (continued).

associated with the individual's responses was divided by the total possible points for all of the items on the scale. We multiplied the number by 100 to express it as a percentage. Higher scores are associated with lower levels of disability.

Data Analysis

An analysis of variance (ANOVA) was used to compare mean values for the three knee scoring systems, and a Scheffé post hoc analysis was used to identify statistically significant differences in the presence of significant main effects. Pearson

product moment correlation coefficients were used to identify statistically significant relationships between the three scoring systems. The level of statistical significance was set at .05. All data were reduced and analyzed using Statview® 4.02 statistical software for the Macintosh (Abacus Concepts, Inc., Berkeley, CA).

Results and Discussion

ANOVA demonstrated statistically significant mean differences between the scoring systems, $F(3, 112) = 10.2, p < .0001$ (Figure 5). Post hoc analysis revealed statistically significant mean differences in the presence of significant main effects (Table 2). Pearson product correlations revealed significant relationships between all scoring systems (Table 3).

The results of this study demonstrated statistically significant differences in outcome measures between the three scoring systems. We hypothesize that these differences are attributable to inconsistencies of items presented within the questionnaire portion of the scoring systems. The items include level of sport activity (type, intensity, and frequency of activity), symptoms such as pain and instability, and functional limitations such as stair climbing and running. The LKS and CKS vary concerning the relative allocation of points for each item. For example, the LKS allocates 25 points each to the symptoms of instability and pain. This accounts for 50% of the total points of the system. In contrast, the modified CKS allocates 10% of points to

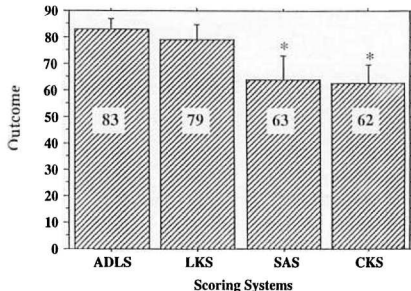


Figure 5 — Mean (\pm SD) differences for the outcome measures for the four knee scoring systems. *Significantly different from ADLS and LKS ($p < .01$).

Table 2 Mean Differences and *p* Values Between the Four Knee Scoring Systems

	Mean difference	<i>p</i> value
ADLS vs. LKS	4.10	.852
ADLS vs. SAS	19.31	.001**
ADLS vs. CKS	20.48	<.001**
LKS vs. SAS	15.21	.015*
LKS vs. CKS	16.38	.008**
SAS vs. CKS	1.17	.996

p* < .05 level. *p* < .01 level

Table 3 Correlation Matrix for the Four Knee Scoring Systems

	ADLS	SAS	LKS	CKS
ADLS				
SAS	.67**			
LKS	.83**	.67**		
CKS	.73**	.87**	.66*	

p* < .01. *p* < .001

pain and 30% to instability. Furthermore, scoring systems are greatly influenced by the patient's level of activity (3, 4, 9, 10). The CKS allocates 20% of total points for identifying activity level, while the LKS and KOS do not allocate points for this item.

The degree to which symptoms and functional limitations affect the athlete daily is a reflection of whether the athlete is taking part in activities of daily living or sports activities. Neither the LKS nor the CKS delineates between symptoms and functional limitations that arise due to activities of daily living or sports activity. Sports activity imposes more rigorous functional demands on the ACL-deficient limb than activities of daily living and therefore should be measured separately. For example, using the CKS to rate a nonathletic individual would provide an invalid measure of disability. For this reason, the KOS was designed to measure disability that is specific to the athlete's activities of daily living or sports activities.

Preliminary research indicates that the KOS is a valid measure of disability following knee injury (4, 6). The outcome measures for the ADLS and SAS indicate that our patient population functioned well with activities of daily living (ADLS = 83) but became symptomatic and functionally limited when participating in sports activities (SAS = 64). The ADLS mean outcome measure of 83 was comparable and demonstrated a moderately high relationship with the LKS = 79, while the

SAS mean outcome measure of 64 was comparable and demonstrated a moderately high relationship with the CKS = 63. Due to the close proximity in mean outcome measures and statistically significant relationships between the ADLS and the LKS and between the SAS and CKS, we conclude that the LKS is more related to activities of daily living and the CKS is more related to sports.

Bollen and Seedhom were the first to recognize this quandary by demonstrating that patients consistently scored higher on the LKS than the CKS (1). They reported a 13-point median difference between the two systems, which is similar to our findings of a 16-point mean difference between the LKS and the CKS (Table 2). Bollen and Seedhom suggested that the disparity in outcome measures was due to a greater emphasis placed on functional disability by the CKS (1). This is evident by the number of questions directly related to function between the two scoring systems. Each system has eight total items with six (30% of total points) in the CKS pertaining to function and only three (20% of total points) in the LKS pertaining to function (1). These findings question the content validity of the LKS and CKS when disability is indiscriminately assessed without direct reference to activities of daily living or sports.

It is our contention that the items within the questionnaires should be specific to those symptoms and functional limitations that result from activities of daily living and those symptoms and functional limitations that result from sports. This delineation permits a more accurate assessment of disability that is specific to and reflects those symptoms and functional limitations experienced during activities of daily living and/or sports. The Knee Outcome Survey appears to provide a practical alternative to measuring disability in athletes who sustain knee ligament injuries.

Conclusion

The results of this study indicate that statistically significant mean differences in outcome measures exist between the three knee scoring systems. The ADLS and SAS appear to provide valid measures of disability and indicate that our sample functioned well with activities of daily living but became symptomatic and functionally limited with sports. The outcome measures indicate that the LKS is more specific to activities of daily living, while the CKS is more specific to sports. We recommend that standard scoring systems be developed that can be used to provide patient-reported measures of functional disability in patients who experience knee injuries. The standard scoring systems should delineate between activities of daily living and sports. Therefore, we recommend the use of the KOS as a viable alternative to other scoring systems.

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Author Notes

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