

CORE MUSCLE ENDURANCE TESTS AND JOINT FUNCTION SURVEYS FOR INJURY PREDICTION

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BACKGROUND AND PURPOSE

- Pre-participation identification of modifiable injury risk factors has the potential to reduce injury incidence¹
- Little evidence exists to guide efforts for development of individualized injury prevention programs
- Poor core muscle endurance has been associated with susceptibility to lower extremity (LE) and low back injury²
- Joint function scores derived from surveys have predicted core / LE sprains and strains in football players³
- Core endurance test results and joint function scores may also predict core / LE sprains and strains in other sports
- The purpose of this study was to predict the likelihood of core / LE sprain or strain among college athletes participating in various sports on the basis of pre-participation core muscle endurance and joint function scores

SUBJECT CHARACTERISTICS

- Participants were 198 NCAA Division I collegiate athletes from 10 different teams (Table 1)
 - 154 male athletes
 - 44 female athletes
- Exclusionary criteria
 - Unavailability on date of team pre-participation physical examination
 - Discontinuation of participation in sport prior to end of season for reason other than injury

Table 1

Sport	Gender	n	Injured	Age (years)	Height (cm)	Weight (kg)
Football	M	87	32	19.6 ± 1.4	184.62 ± 8.02	101.77 ± 19.80
Wrestling	M	26	19	19.5 ± 1.7	173.94 ± 6.56	76.12 ± 13.17
Basketball	M	14	8	20.1 ± 1.6	193.46 ± 6.84	87.49 ± 10.54
Cross Country	M	12	6	20.2 ± 1.3	176.53 ± 7.41	63.68 ± 11.89
Tennis	M	9	3	20.3 ± 0.5	177.80 ± 13.52	77.46 ± 9.39
Golf	M	6	0	20.0 ± 1.6	180.85 ± 3.77	74.14 ± 20.61
Basketball	F	16	9	19.4 ± 1.2	177.17 ± 7.90	76.58 ± 15.21
Cross Country	F	15	6	19.5 ± 1.5	167.44 ± 6.18	57.83 ± 8.55
Tennis	F	8	2	19.8 ± 1.3	167.64 ± 6.37	66.15 ± 8.42
Golf	F	5	4	19.4 ± 1.7	173.36 ± 5.63	68.65 ± 7.72

METHODS

- Potential predictors of injury quantified at pre-participation physical examination prior to first practice session
 - Core muscle endurance tests: Wall Sit Hold (WSH), Trunk Flexion Hold (TFH), Horizontal Trunk Hold (HTH)
 - Joint function surveys: Foot and Ankle Ability Measure - Sport (FAAM), Oswestry Disability Index (ODI), International Knee Documentation Committee knee survey (IKDC)
 - Anthropometric factors: Estimated mass moment of inertia (MOI), Body mass index (BMI)
 - History of core and/or LE sprains and strains (Hx Core / LE)
- Electronic injury documentation system used for injury surveillance throughout sport season
 - A sprain or strain that required evaluation by athletic trainer and modification of sport activity to any extent
- Receiver operating characteristic (ROC) analysis utilized to establish dichotomization cut-point for each variable
- Fisher's exact test, odds ratio (OR), and relative risk (RR) were used to assess associations with injury occurrence
- Logistic regression analysis used to identify a set of the 3-5 strongest predictors of core / LE sprains and strains

RESULTS

- A total of 89 of the 198 athletes sustained a core / LE sprain or strain
 - Foot: 9, Ankle: 25, Leg: 3, Knee: 18, Thigh: 9, Hip: 12, Low Back / Sacroiliac: 13
- Results of univariable analyses presented in Table 2 for statistically significant exposure–outcome association
 - Comparison of injury occurrence for high-risk versus low-risk status rank-ordered by RR value
- Logistic regression analysis yielded a 4-factor prediction model: 1) FAAM, 2) HTH, 3) TFH, 4) WSH-Dominant
 - 190 cases had values for each of the 4 predictors; 85 injured
- ROC analysis demonstrated ≥ 3 positive factors as the best model for high-risk versus low-risk discrimination

Table 2

Predictor	Cut-Point	n	P-value	Sn	Sp	OR	RR
TFH	≤ 135	196	.029	.89	.22	2.28	1.66
FAAM	≤ 95	193	.015	.19	.93	2.90	1.63
HTH	≤ 26	195	.004	.42	.77	2.43	1.56
WSH-D*	≤ 29	197	.025	.64	.51	1.85	1.41
Hx Core / LE	≥ 1	194	.040	.62	.51	1.75	1.38

* Dominant extremity

Table 3

Risk Factors	Core / LE sprains and strains			Injury Incidence
	Injury	No Injury	Total	
0	2	11	13	15.4%
1	24	40	64	37.5%
2	24	37	61	39.3%
3	31	17	48	64.6%
4	4	0	4	100.0%
Total	85	105	190	

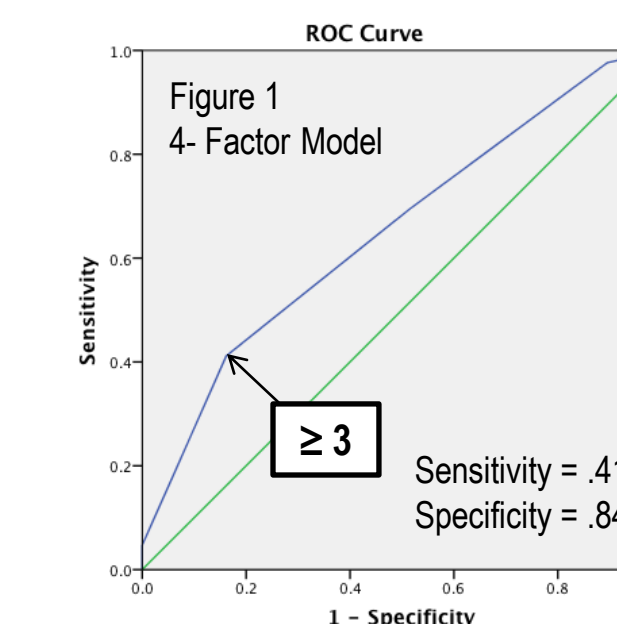


Table 4

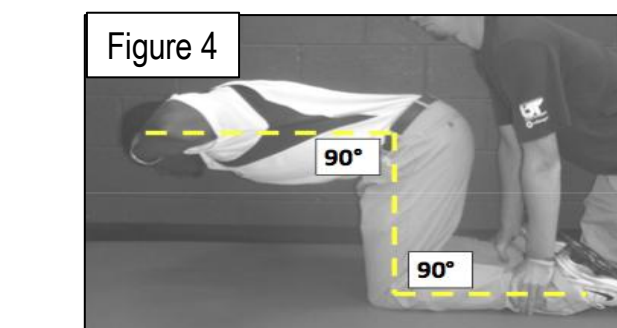
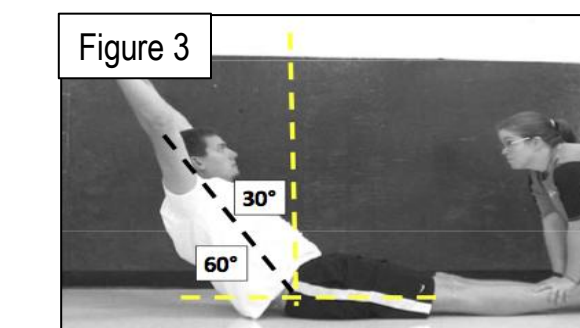
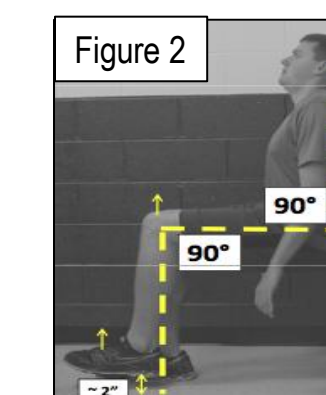
4-Factor Model		
Factors +	Injury	No Injury
≥ 3	35	17
0 - 2	50	88
Total	85	105

Table 5

4-Factor Model ≥ 3 vs. 0-2 Positive Factors	
Fisher's Exact One-Sided	p < .001
+LR = 2.543	-LR = .702
Odds Ratio = 2.543 / .702 = 3.62	90% CI: 2.06 – 6.39
Relative Risk = .673 / .362 = 1.86	90% CI: 1.45 – 2.37

Table 6

Predictor	P-value	Adj. OR
FAAM	.021	2.43
HTH	.004	2.06
TFH	.047	1.88
WSH-D	.053	1.61



CLINICAL RELEVANCE

- The FAAM survey score and all 3 of the core muscle endurance tests provided exceptionally strong predictive value for identification of athletes who possessed elevated injury risk
- The results of this research strongly support the applicability of methods previously developed for assessment of risk in football players to athletes who participate in other sports
 - For this cohort of 190 athletes, 27% were identified as having elevated injury risk (≥ 3 risk factors)
 - Among those identified as having elevated risk, 67% subsequently sustained an injury
- Pre-participation assessment of risk for core / LE sprain or strain can identify a subset of athletes who would derive maximum benefit from a program to address modifiable risk factors

REFERENCES

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3. Wilkerson GB, et al. Prediction of core and lower extremity strains and sprains in college football players: a preliminary study. *J Athl Train.* 2012;7 (in press).