

Pre-Participation Risk Screening Metrics Predict Core or Lower Extremity Injury Occurrences among College Football Players

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Background and Purpose

- Previous injury prediction models have used pre-participation examination (PPE) data¹
 - Mass moment of inertia, computer-based neurocognitive tests, and front plank holds²
 - Research links concussion history with lower extremity injury³
 - Limited research has assessed dual-task whole-body reactive agility⁴
- 54% of college football injuries are lower extremity sprains and strains⁵
- NFL players with history of severe lower extremity injury play less than those without⁶
- Our purpose was to identify factors associated with subsequent occurrence of core or lower extremity injury (CLEI)



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Procedures

- N = 75 NCAA Division 1-FCS college football players
 - age = 20.1 ± 1.5 years, height = 1.85 ± 0.07 m, mass = 102.85 ± 19.53 kg
- Potential injury risk factors assessed prior to participation in pre-season practice sessions
 - Sport Fitness Index (SFI) survey relating to persisting effects of prior injuries
 - Overall Wellness Index (OWI) survey relating to physical and mental problems
 - Dual-task whole-body reactive agility (WBRA) - lateral and diagonal movements
 - TRAZER motion analysis system (Traq Global Ltd, Cleveland, OH)
- CLEI defined as any joint sprain or muscle strain that interrupted participation in a practice session or game and resulted in administration of any therapeutic procedures



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Procedures

- SFI: 10 items; self-ratings of persisting impairments from prior musculoskeletal injuries
- OWI: 10 items; self-ratings of frequency and temporal proximity of 82 physical, cognitive, emotional, and sleep related problems

Sport Fitness Index

- Over the past several years, how often have moderate-to-severe muscle and/or joint injuries limited your ability to participate fully in sports-related activities?
 Never Rare Infrequent Occasional Frequent Persistent
- Over the past several years, how often has PAIN in any body part limited your OVERALL sport performance capabilities?
 Never Rare Infrequent Occasional Frequent Persistent
- To what extent do you feel that previous muscle and/or joint injuries currently limit your speed, power output, and/or endurance?
 Not at all Insignificant Marginal Moderate Substantial Severe
- To what extent is your OVERALL ability to perform weightlifting exercises and/or activities that require explosive force output (such as maximum-effort jumping) currently limited by PAIN?
 Not at all Insignificant Marginal Moderate Substantial Severe
- To what extent is your ability to perform any SPORT-SPECIFIC SKILL (such as throwing, swinging, or kicking accuracy) currently limited by PAIN?
 Not at all Insignificant Marginal Moderate Substantial Severe

Overall Wellness Index

Check (✓) each of the problems listed below that have ever interfered with your ability to function in a normal manner during normal day-to-day activities. Also, indicate how recently and how frequently the checked problems within the category have been experienced.

- Physical Problems** (check all that apply)
 - Headaches Pressure in head Neck Pain Muscle aches
 - Nausea/vomiting Light sensitivity Noise sensitivity Joint aches
 - Urinary incontinence Bowel incontinence General discomfort

Most recent occurrence/frequency of any **Physical Problems** (choose one):
 Current Week Past 12 Months Past 12 Months > 1 Year Ago > 1 Year Ago None
 Any Extent Frequently Infrequently Frequently Infrequently
- Sleep/Stamina Problems** (check all that apply)
 - Sleeping less Sleeping more Trouble falling asleep
 - Fatigue/lethargy Drowsiness Feeling slowed down

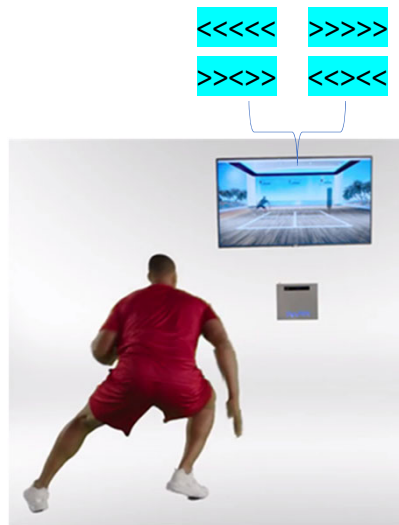
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 Current Week Past 12 Months Past 12 Months > 1 Year Ago > 1 Year Ago None
 Any Extent Frequently Infrequently Frequently Infrequently



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Procedures

- The whole-body reactive agility with cognitive demand imposed by flanker test
- Proper movement direction indicated by center arrow
- Performance metrics
 - Reaction Time
 - Speed
 - Acceleration
 - Deceleration



Procedures

- Receiver operating characteristic (ROC) analysis used to differentiate injured from non-injured players
- Cut points used to create binary risk categories for potential predictive variables (high-risk vs low-risk)
- Cross-tabulation analysis for calculation of sensitivity, specificity, and odds ratio (OR)
- Logistic regression used to identify the set of variables (risk factors) that provided greatest predictive power

Results: Game Exposure

		Core or LE Injury		Incidence
		Yes	No	
Participation In Games	≥ 1	39	21	65%
	0	2	13	13%
Total		41	34	

Sensitivity 95% Specificity 38%

$\chi^2(1)=12.93$
1-Sided P<.001

OR=12.07
95% CI: 2.49, 58.63



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Results: WBRA Avg RT

		Core or LE Injury		Incidence
		Yes	No	
WBRA Avg RT	≥ 885ms	37	23	62%
	<885ms	4	11	27%
Total		41	34	

Sensitivity 90% Specificity 32%

$\chi^2(1)=5.93$
1-Sided P=.016

OR=4.42
95% CI: 1.26, 15.55



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Results: SFWI*

* Combined SFI and OWI scores

		Core or LE Injury		Incidence
		Yes	No	
SFWI ≤ 89	Yes	29	11	73%
	No	12	23	34%
Total		41	34	

Sensitivity 71% Specificity 68%

$\chi^2(1)=11.00$
1-Sided P=.001

OR=5.05
95% CI: 1.89, 13.52



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Results: Concussion History

		Core or LE Injury		Incidence
		Yes	No	
Concussion History	Yes	15	6	71%
	No	26	28	48%
Total		41	34	

Sensitivity 37% Specificity 82%

$\chi^2(1)=3.31$
1-Sided P=.058

OR=2.69
95% CI: 0.98, 7.98



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Results: Logistic Regression 4-Factor Model

	Injury	No Injury	% Injured	Risk Factors	Injury	No Injury	Incidence
≥ 3 Factors	28	9	76%	0	0	5	0%
0, 1, or 2	13	25	34%	1	0	7	0%
Total	41	34		2	13	13	50%
Fisher's Exact One-Sided p < .001				3	18	8	69%
Sensitivity= 68%		Specificity= 74%		4	10	1	91%
OR = 5.98 (95% CI: 2.19 – 16.37)				Total	41	34	55%



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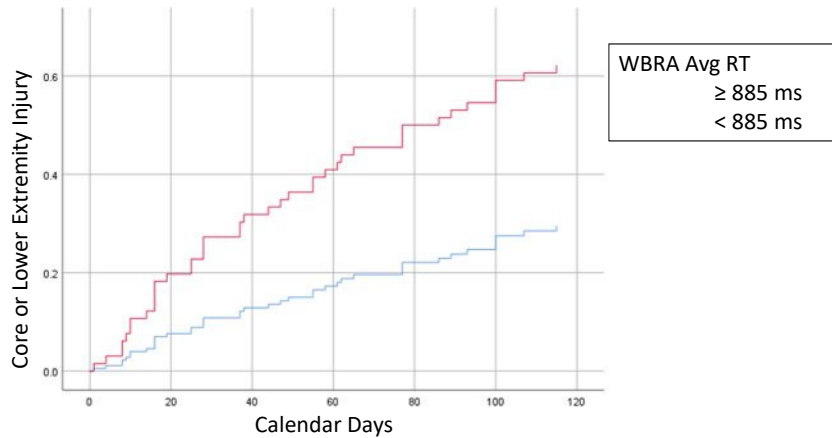
Results: Time to Event (CLEI) Analysis

Factor	P-value	Hazard Ratio	95% CI
Game Exposures ≥ 1	.044	4.48	1.040, 19.304
Concussion History ≤ 12 months	.042	1.96	1.025, 3.764
SFWI ≤ 89	.061	1.95	.762, 6.080
WBRA Avg RT ≥ 885ms	.148	2.15	.970, 3.935



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Results: Time to Event (CLEI) Analysis WBRA Avg RT effect adjusted for effects of the other 3 risk factors



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Clinical Relevance

- This predictive model clearly differentiated players with high risk from those with low risk for CLEI
- Game exposures and concussion history substantially contribute to CLEI risk but are not modifiable
- WBRA Avg RT represents the risk factor that is potentially modifiable through training
- Individual player responses to SFWI items might also guide efforts to reduce injury risk



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