

Associations of Neuromechanical and Behavioral Factors with Musculoskeletal Injury History

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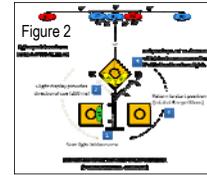
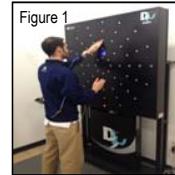


BACKGROUND AND PURPOSE

- An estimated 1.6 million to 3.8 million sport-related traumatic brain injuries occur each year in the United States¹
- Concussion has been defined as a complex pathophysiological process affecting the brain²
 - Manifests as deficits in cognitive processing speed, reaction time and altered psycho-emotional status^{2,3}
 - Poor sleep quality associated with slower reaction times and poor psycho-emotional state in athletes⁴
 - Reaction time (RT) appears to be a critical component of athletic performance and may relate to injury risk⁴
- Associations among concussion history, sleep quality, psycho-emotional status, and injury risk are largely unknown
- The purpose of this study was to assess whether or not concussion history, psycho-emotional status, and sleep quality are associated with neuromechanical performance capabilities and musculoskeletal injury history

PARTICIPANT AND PROCEDURES

- 204 participants recruited from college population
 - Females: (n=126) 21.23 ±2.99 years, 166.08 ±6.97 cm; 65.71 ±12.21 kg
 - Males: (n=78) 22.60 ±3.57 years, 178.60 ±7.92 cm; 80.44 ±14.86 kg
- Well-validated survey instruments used to evaluate sleep quality, depression, anxiety, and stress
 - Pittsburgh Sleep Quality Index (PSQI) and Depression, Anxiety, and Stress Scale (DASS)
- Sports Fitness Index (SFI) used to quantify persisting effects of injuries sustained over last several years
 - Includes inventory of self-reported time-loss injuries sustained during the previous 12-month period
 - Injury defined as a core or lower extremity (Core/LE) sprain or strain
- Visuomotor performance assessed by Dynavision D2™ system (Dynavision International; West Chester, OH)
 - One 30-s practice trial preceded a single 60-s test trial for two test modes:
 - Proactive: targets remain illuminated until hit
 - Reactive: targets illuminate for 1 s with simultaneous verbal recitation of text scrolling across LED screen
- Unilateral Reactive Hop (URH) RT measured with FITLight Trainer™ system (FITLight Corp; Aurora, Ontario)
 - Correct hopping direction determined by specified color pattern displayed by an array of lights (Figure 2)
 - One practice trial and one test trial for both right and left extremities, each consisting of 6 hops
- Analyses performed to assess associations between screening measures and injury history
 - Receiver-operating characteristic (ROC) analyses identified cut points for binary classifications of injury status
 - Cross-tabulation analyses used to assess univariable associations
 - Logistic regression analysis used to identify the strongest multivariable set of predictor variables
- Secondary analysis focused on associations between sleep quality and measures of psycho-emotional status



RESULTS

- 12.3% (25/204) of participants reported having sustained a Core/LE sprain or strain
 - Cross-tabulation and logistic regression analyses identified a 5-factor model (Table 1)
 - ≥ 2 of 5 factors: OR=6.50 (CLE₉₅ 2.56); Sensitivity= 84%; Specificity= 54%; Relative Risk= 5.35
 - ≥ 3 of 5 factors: OR=11.38 (CLE₉₅ 5.23); Sensitivity= 53%; Specificity= 90%; Relative Risk= 6.84
 - Distributions of values for SFI, PSQI, and Reactive Outer/Inner Hit Ratio presented in Figures 4-6
- 10% (13/126) of females who participated in high school sports reported having sustained Core/LE sprain or strain
 - Cross-tabulation and logistic regression analyses identified a 4-factor model (Table 2)
 - ≥ 3 of 4 factors: OR=7.01 (CLE₉₅ 2.53); Sensitivity= 62%; Specificity= 81%; Risk Ratio= 5.31
 - All 4 factors: OR=∞ (perfect specificity); Sensitivity= 46%; Specificity= 100%; Risk Ratio= 17.14
 - Table 3 presents a 2-factor model showing associations between sleep quality and psycho-emotional factors
 - 8 X greater odds for poor sleep quality (PSQI ≥ 6) with ≥ 2 of 3 psycho-emotional factors positive (Table 3)

Table 1

Predictor	Cut-Point	Sensitivity	Specificity	RR	OR (CLE ₉₅)	Exp(B) (CLE ₉₅)
Pitt. Sleep Quality Index	≥ 8	40	83	2.73	3.31 (1.57)	3.12 (1.32)
Reactive Outer/Inner Hits	≤ 0.41	40	86	3.11	3.92 (1.84)	8.44 (3.11)
Concussion History	Yes	36	78	1.78	1.98 (0.93)	3.46 (1.32)
Unilateral Reactive Hop RT	≥ 1260	52	63	1.71	1.86 (0.92)	---
Sex	M/F	40	75	1.81	1.99 (0.96)	2.36 (1.02)
Sport Fitness Index	≤ 80	96	40	13.09	15.78 (2.89)	11.86 (2.09)

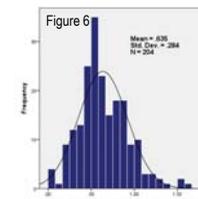
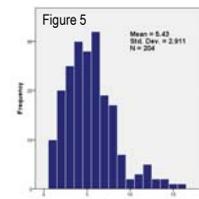
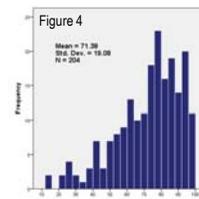


Table 2

Predictor	Cut-Point	Sensitivity	Specificity	RR	OR (CLE ₉₅)	Exp(B) (CLE ₉₅)
Pitt. Sleep Quality Index	≥ 6	62	55	1.82	1.95 (0.72)	---
Reactive Outer/Inner Hits	≤ 0.41	54	85	4.96	6.59 (2.40)	7.90 (2.32)
Concussion History	Yes	15	74	0.09	0.53 (0.02)	---
Unilateral Reactive Hop RT	≥ 1260	85	66	8.14	10.44 (2.75)	10.13 (2.53)
Body Mass Index	≥ 22	77	51	3.13	3.52 (1.14)	3.81 (0.99)
Sport Fitness Index	≤ 80	92	34	5.58	6.32 (1.11)	4.71 (0.77)

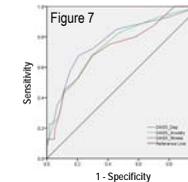


Table 3

Factor	Cut-Point	Sensitivity	Specificity	OR
Depression	≥ 8	68	79	7.94
Anxiety	≥ 6	68	71	5.02
Stress	≥ 12	68	70	4.87
≥ 2 of 3 Factors OR=8.00; Sensitivity= 70%; Specificity= 78%				

CLINICAL RELEVANCE

- Strong associations with recent time-loss Core/LE injury documented for variables measured by screening tests
 - SFI, Reactive Outer/Inner Hits, Concussion History, PSQI, and Sex
- Stratified analysis limited to female participants who were high school athletes identified a different set of variables
 - URH-RT, Reactive Outer/Inner Hits, SFI, and BMI
- Both analyses suggest that perception-action may be an important indicator of injury effect and/or predisposition
 - Self-reported persisting effects of recent injury (SFI) and sleep quality (PSQI) may relate to injury risk status
- Very strong associations of self-reported depression, anxiety, and stress with sleep quality were apparent
 - Psycho-emotional factors and concussion history may interact with perception-action capabilities
- The findings clearly support injury risk screening that includes measures of neuromechanical factors, which are likely to identify individuals who have the greatest potential to benefit from training for injury risk reduction

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