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Prediction Model of Injuries in College–Aged Army ROTC Cadets

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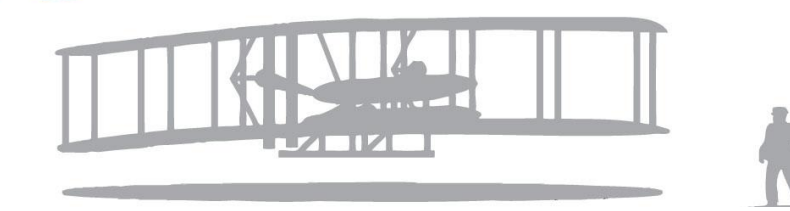
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BACKGROUND AND PURPOSE

- Anecdotally, military personnel have an unspoken rule of not discussing their injuries if and when they occur
- A history of previous lower extremity injuries has been associated with elevated injury risk in military personnel¹
- Injury prediction models have been used in intercollegiate athletics to identify individuals at high risk for injury²
 - Prediction models have utilized core resistance, muscular endurance tests and joint specific surveys²
- Dynavision (Dynavision International, West Chester, OH) is a large board with 64 buttons with randomly illuminating lights, and is used to train, improve & develop reaction time, as well as central & peripheral vision^{3,5}
 - Is a visual-motor & neurocognitive rehabilitation & training device used by medical, athletic & tactical patients
- The purpose of this study is to determine an injury prediction model to identify those Army Reserve Officer Training Corps (ROTC) cadets at high-risk for injury from a series of baseline tests and a multi-specific joint survey

PARTICIPANT CHARACTERISTICS

- 54 Army ROTC cadets volunteered for this study: 39 males, 16 females (Table 1)
- Relative predictive power of exposure to active conditions and pre-participation measures of injury risks compared
 - Core muscle endurance: Wall Sit Hold (WSH) & Unilateral Squat Hold (USH), both tests performed on self-identified dominant leg followed by non-dominant leg & Horizontal Trunk Hold (HTH)
 - Sport Fitness Index (SFI) survey for self-perceived functional joint dysfunction⁴
 - Army Physical Fitness Test (APFT) at baseline including: Number of push-ups in 2 mins., Number of sit-ups in 2 mins, time for a 2-mile run⁴
 - Neuromuscular function: Visuomotor reaction time (RT) as assessed on the Dynavision (DV)³
 - Central & peripheral visual detection time (VDT) assessed via outside rings (4&5) / inside rings (1,2,&3) ratio
- No ATC was assigned to provide health care to ROTC cadets
 - Musculoskeletal injuries were self-reported by cadets to research team
- A musculoskeletal injury was operationally defined as any condition suffered by a cadet that affected either their ADLs or ROTC physical training activities
- Data analysis methods:
 - Receiver operating characteristic (ROC) analyses identified cut-points for binary classifications of risk status
 - Cut-points derived from both retrospective (previous injury) and prospective (season injury) data
 - Dichotomous variables were analyzed separately & collectively to assess predictive value in terms of Fisher's Exact 1-sided *p*-value, sensitivity (Sn), specificity (Sp), odds ratios (OR), & relative risk (RR)
 - Logistic regression analysis used to identify the strongest set of predictor variables
- Interaction effects for each possible combination of predictors was examined:
 - 2 X 2 cross-tabulation analysis of 2-factor combination (Sn, Sp, OR, RR & Fisher's Exact Test)
 - Stratified analysis & graphic representation of the potential interaction
 - Stratum-specific ORs were compared to the Mantel-Haenszel (M-H) OR estimate and the Breslow-Day (B-D) test were done to confirm or reject homogeneity of the stratum-specific ORs

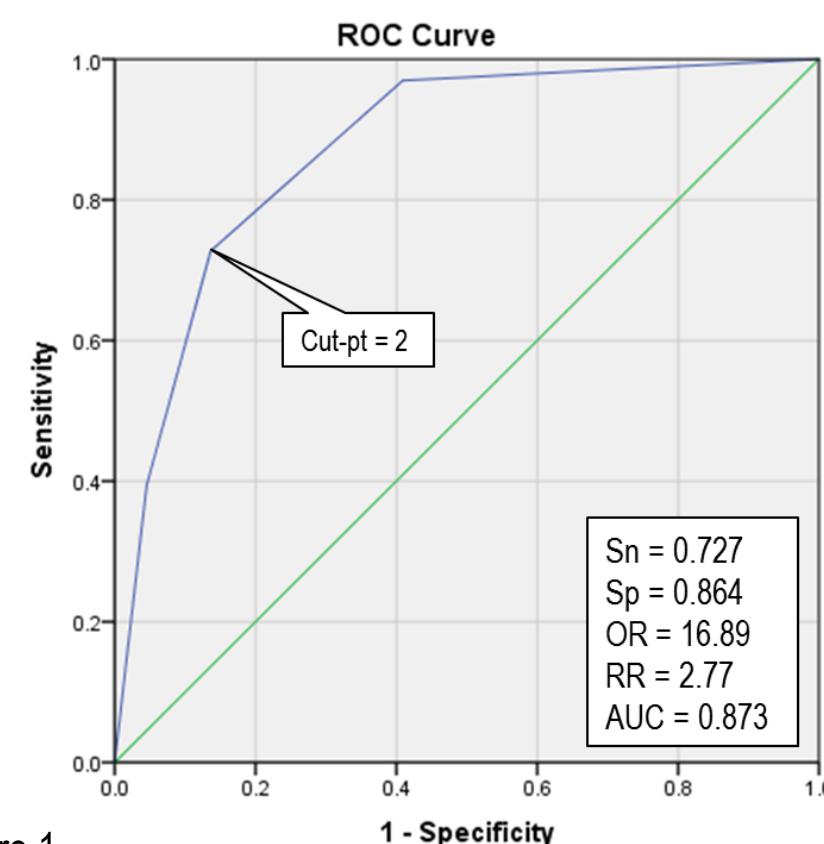


Figure 1.

	Males (n = 39)	Females (n = 16)	Overall (N = 55)
Age	21.1 (± 3.84)	20.1 (± 1.18)	20.80 (±3.32)
Height (cm)	177.67 (± 7.43)	161.29 (± 9.99)	172.90 (± 11.09)
Weight (kg)	79.25 (± 10.79)	62.43 (± 8.73)	74.36 (± 12.75)
BMI	25.12 (± 3.20)	24.15 (± 3.97)	24.84 (± 3.43)

	OR	Multivariable Adj. OR
Previous Hx	14.57	0.243
SFI	7.88	0.185
DV - O/I Ratio	8.33	0.144

Prediction of Injury	M-H Test	B-D Test
DV Hits Ratio – Injury for SFI Total strata	$\chi^2_{(1)} = 6.87$; $p = 0.009$	$\chi^2_{(1)} = 0.019$; $p = 0.891$
PMHx of Injury – Injury for DV Hits Ratio strata	$\chi^2_{(1)} = 5.77$; $p = 0.016$	$\chi^2_{(1)} = 7.79$; $p = 0.005$
PMHx of Injury – Injury for SFI Total strata	$\chi^2_{(1)} = 1.59$; $p = 0.207$	$\chi^2_{(1)} = 0.733$; $p = 0.392$

Number of Predictors	Yes	No	Total	Injury Incidence	Combined Incidence
0	1	13	14	7.14%	32.1%
1	8	6	14	57.1%	
2	11	2	13	84.6%	88.9%
3	13	1	14	92.9%	
Total	33	22	55	60.0%	

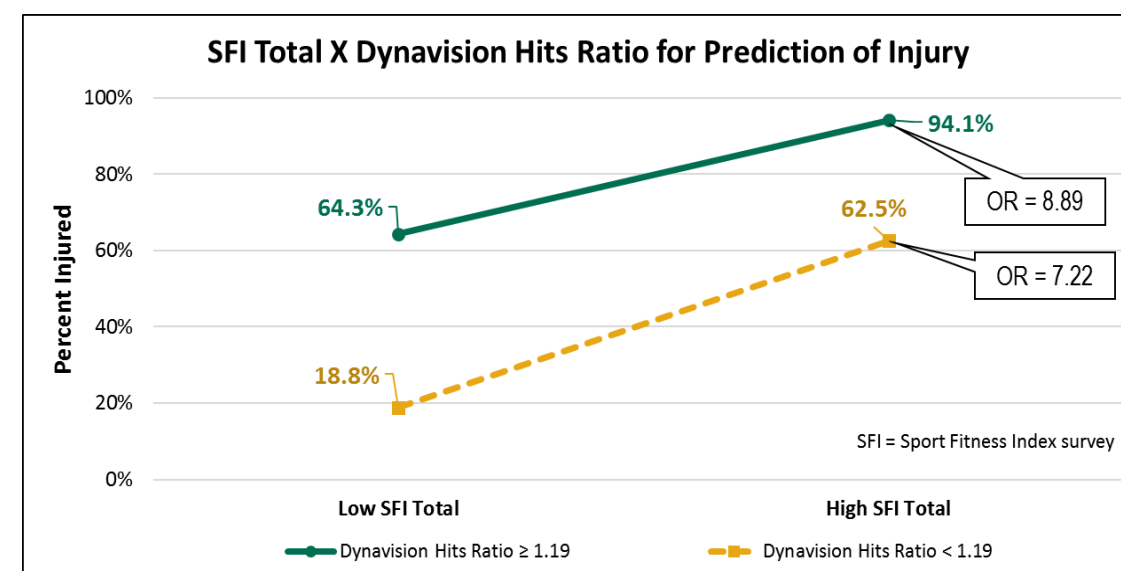


Figure 2.

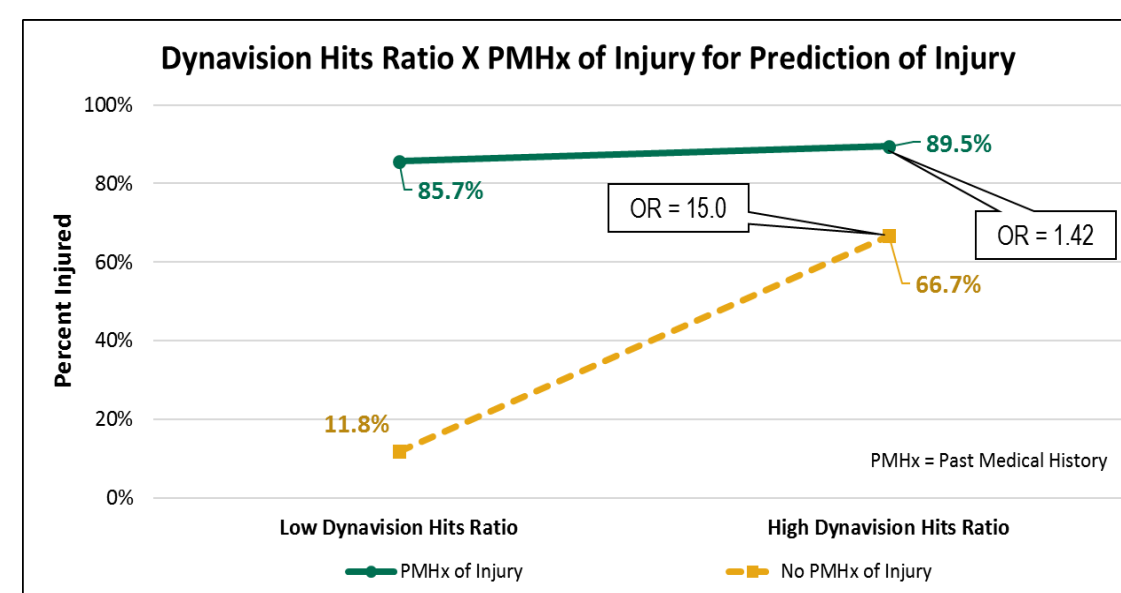


Figure 3.

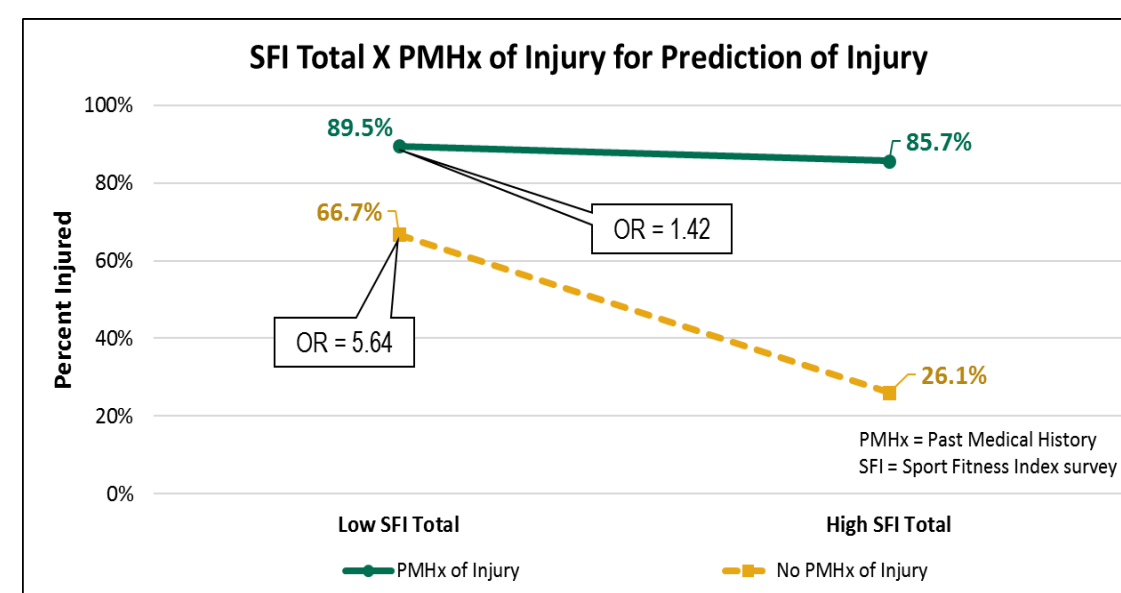


Figure 4.

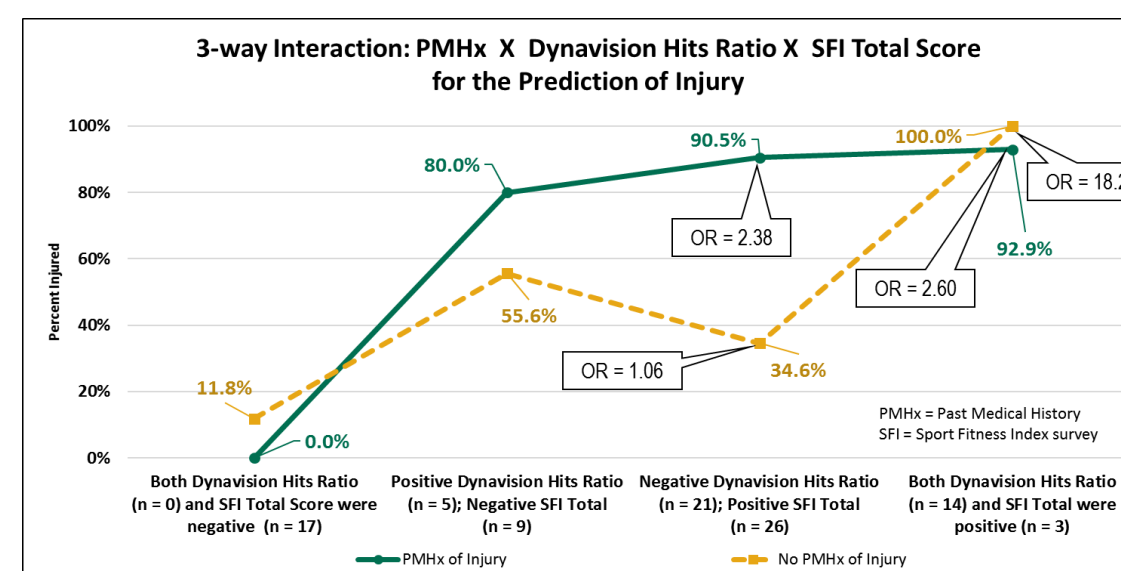


Figure 5.

RESULTS

- A total of 33 injuries were reported throughout the season; 60% injury incidence (33/55)
 - Female injury incidence = 56.3% (9/16); Male injury incidence = 61.5% (24/39)
- Of the original 27 predictors, univariable ROC analyses identified the nine strongest predictors
 - Univariable to multi-variable analysis if $OR \geq 2.0$ or Fisher Exact test – one-sided $p \leq 0.20$
- Logistic regression analysis identified a multivariable 3-factor prediction model
 - Dynavision hits, Outside Rings/Inside Rings ratio ≤ 1.19 ; Baseline SFI survey score ≤ 79.0 ; Past medical history of musculoskeletal injury
 - Hosmer-Lemeshow $\chi^2_{(5)} = 2.57$; $p = 0.765$; Nagelkerke $R^2 = 0.503$
- ROC analysis identified 2 factors as optimal number of predictors for predicting injury (Figure 1)
- Interactions are suggested by the differences between univariable & multivariable adj. ORs for all 3 variables (Table 2)
 - Lines do not cross via graphic representations, therefore, no interactions appear to be present (Figures 2-4)
 - Lines cross in 3-way interaction, but only if DV Hits Ratio & SFI Total are both positive or both negative (Figure 5)
- M-H OR demonstrated significant associations high-risk for injury for DV Hits Ratio X SFI Total & PMHx of Injury X DV Hits Ratio strata (Table 3)
 - B-D Test of effect of PMHx of Injury for injury prediction found to be significantly different for DV Hits Ratio strata
 - B-D Test for effect DV Hits Ratio and PMHx of Injury for injury prediction not significantly different for SFI Total strata
- Table 4 demonstrates injury incidence for LE injury based on the number of positive predictors

EVIDENCE-BASED RECOMMENDATIONS / CLINICAL RELEVANCE

- Pre-participation screening and injury history enable the clinician to quantify injury risk level in Army ROTC cadets.
- Retrospectively derived cut-points provide good Sn (73%) and good Sp (86%)
- ≥ 2 of 3 factors identified 89% (24/27) ROTC cadets who sustained an injury
- Results are consistent with previous prediction models created for injury risk of intercollegiate student-athletes²
- Limitations:
 - Absence of certified athletic trainer to provide for cadets' healthcare needs made injury identification & documentation problematic
 - Indolent participants possibly skewed injury reporting data
- Certified athletic trainer services have the potential to provide individualized training targeting remediation of bilateral performance asymmetries which may reduce injury risk and aid in mission readiness for Army ROTC cadets

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