

EXPLORING RELATIONSHIPS BETWEEN FORCE PLATE AND INJURY DATA

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THE GOAL IS TO TURN
DATA INTO
INFORMATION, AND
INFORMATION INTO
KNOWLEDGE THAT
GUIDES DECISION-
MAKING.



SOFT TISSUE INJURIES & INCIDENCE

- INJURIES TO THE MUSCLES, TENDONS, AND LIGAMENTS
 - CONTUSIONS, SPRAINS, TENDONITIS, STRAINS
 - TRAUMA, OVERLOAD, AND OVERUSE¹⁰
 - SEVERITY RELATED TO TIME BETWEEN INITIAL EVENT AND FULL PARTICIPATION⁵
- LOWER BODY STI INJURIES ACCOUNT FOR 47 TO 89.6 PERCENT¹¹

BACKGROUND

- PEAK POWER OUTPUT (PPO) GREATEST PRODUCTION OF WORK OVER TIMEFRAME⁸
 - REPRESENTS BALANCE BETWEEN FORCE VELOCITY BALANCE
- MODIFIED REACTIVE STRENGTH INDEX (RSIMOD) NORMALIZES JUMP HEIGHT BY CONTRACTION TIME FROM START TO TAKEOFF²
 - $RSIMOD = \text{FLIGHT TIME} / \text{CONTRACTION TIME}$
- TRAINING ADAPTATIONS AND FATIGUE CAN IMPACT PPO AND RSIMOD^{2-3, 8}



METHODS



DATA CLEANING AND ORGANIZATION

Removed irrelevant injury report variables

- Duplicate observations
- Cheer and dance
- "Illness" reports
- Non-STI and above the trunk injuries

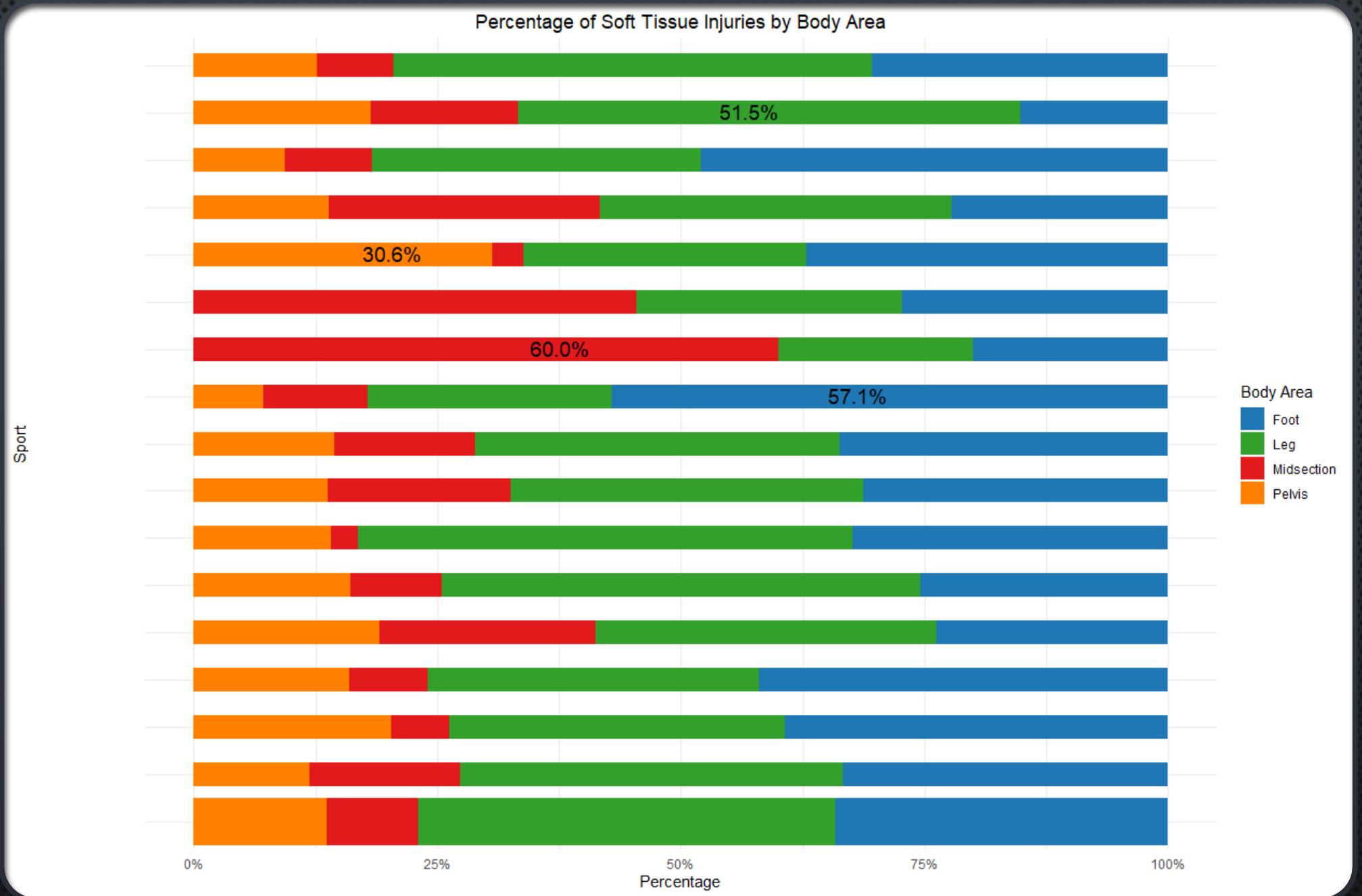
Assigned data to injury regions based on classifications

- Injury Groups (Foot, Leg, Pelvic, Midsection)

Standardized athlete names as well as test and injury dates

Matched injury reports to force plate data

- Included injury observations that had jump testing trials
- Average force plate trials for each testing day



All Injury Data												Lower Body (LB) Soft Tissue Injury (STI) Data				
Sport	Observations	Percentage (%)												# of Days		
		LB.STI	STI	LB	Recurring	Foot.Area	Leg.Area	Pelvic.Area	Midsection	Acute	Chronic	Until.Medically.Cleared	Until.Examination			
Football	830	0.609	0.811	0.662	0.093	0.304	0.492	0.127	0.078	0.873	0.116	46.0	1.6			
	66	0.353	0.733	0.422	0.091	0.152	0.515	0.182	0.152	0.833	0.167	76.5	19.6			
	344	0.675	0.865	0.708	0.154	0.480	0.337	0.093	0.090	0.837	0.134	78.3	11.6			
	36	0.571	0.952	0.571	0.194	0.222	0.361	0.139	0.278	0.694	0.278	52.5	1.8			
	62	0.747	0.783	0.904	0.129	0.371	0.290	0.306	0.032	0.339	0.548	163.9	2.2			
	11	0.268	0.561	0.341	0.364	0.273	0.273	0.000	0.455	0.455	0.455	35.2	5.2			
	5	0.208	0.792	0.375	0.400	0.200	0.200	0.000	0.600	0.600	0.400	20.3	4.5			
	56	0.483	0.750	0.578	0.268	0.571	0.250	0.071	0.107	0.696	0.250	262.8	41.5			
	166	0.572	0.821	0.610	0.096	0.337	0.373	0.145	0.145	0.699	0.283	100.2	11.4			
	80	0.541	0.764	0.635	0.212	0.312	0.362	0.138	0.188	0.762	0.237	110.9	12.1			
	355	0.727	0.869	0.770	0.186	0.324	0.507	0.141	0.028	0.893	0.090	67.9	10.5			
	106	0.469	0.801	0.518	0.170	0.255	0.491	0.160	0.094	0.632	0.358	113.3	6.9			
	63	0.377	0.683	0.449	0.302	0.238	0.349	0.190	0.222	0.841	0.127	94.6	15.1			
	100	0.559	0.872	0.626	0.190	0.420	0.340	0.160	0.080	0.710	0.290	143.7	7.9			
	84	0.857	0.908	0.939	0.095	0.393	0.345	0.202	0.060	0.607	0.274	161.7	3.4			
	84	0.571	0.830	0.653	0.250	0.333	0.393	0.119	0.155	0.726	0.226	52.8	4.0			
	2448	0.593	0.817	0.649	0.145	0.341	0.428	0.136	0.094	0.800	0.177	75.8	7.4			

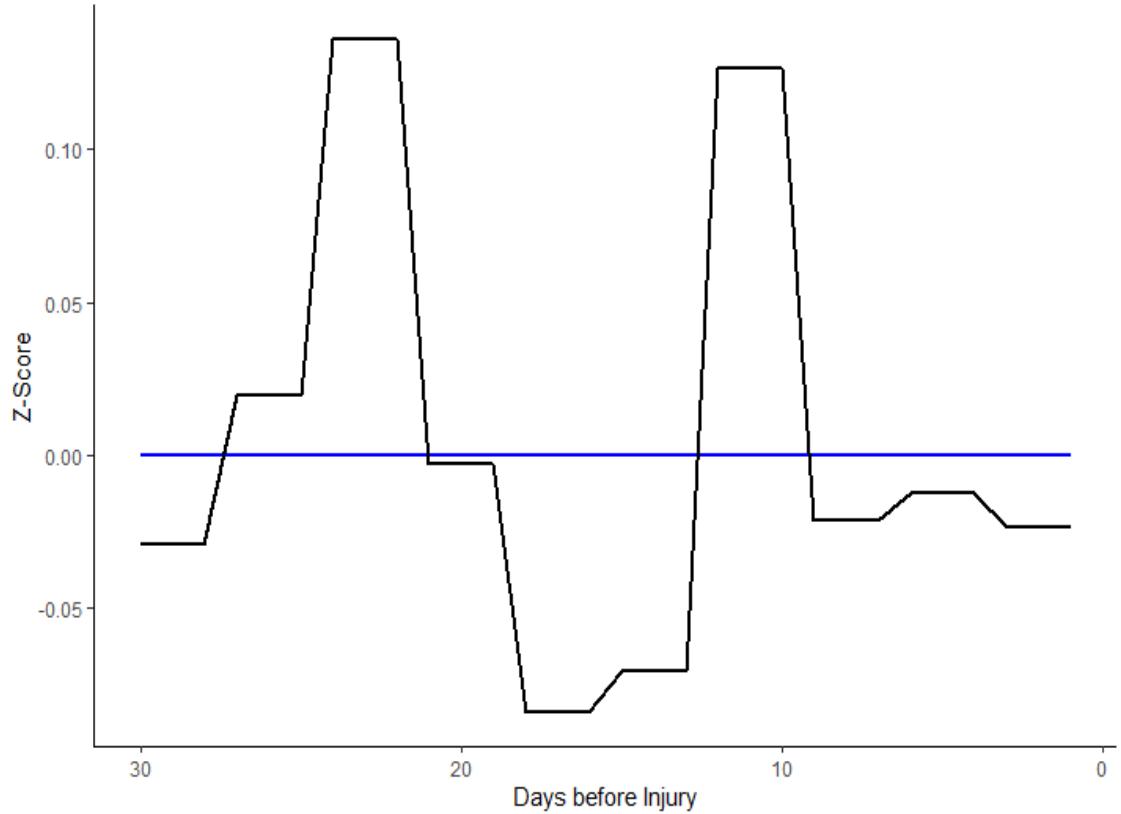
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RELATIONSHIP BETWEEN FORCE PLATE METRICS AND LOWER BODY STI

- FORCE PLATE METRICS:
 - PEAK POWER / BM [W/KG]
 - RSI-MODIFIED [M/s]
- 6-MONTH TIME FRAME (BEFORE INJURY OCCURRENCE)
 - AVERAGE OF PREVIOUS 5 MONTHS AS REFERENCE (EXCLUDED MOST RECENT MONTH TO AVOID MATHEMATICAL COUPLING)⁴
 - FORCE PLATE TRIALS COMPLETED A MONTH BEFORE ARE COMPARED TO THE ACTING AVERAGE
 - Z-SCORES ARE HOW MANY STANDARD DEVIATIONS AWAY FROM MEAN (5-MONTH AVG.)
 - CALCULATED BY REGRESSION (TRIALS WITH MIN MAX, MANUAL CALCULATION, ETC.)
- CHARTS ARE AVERAGED BY 3-DAY PERIODS
 - REDUCES MAGNITUDE OF Z-SCORES, BUT EVENS OUT TRENDS

Average Peak Power a month before an Injury Occurred

Grouped and Averaged in 3 day increments

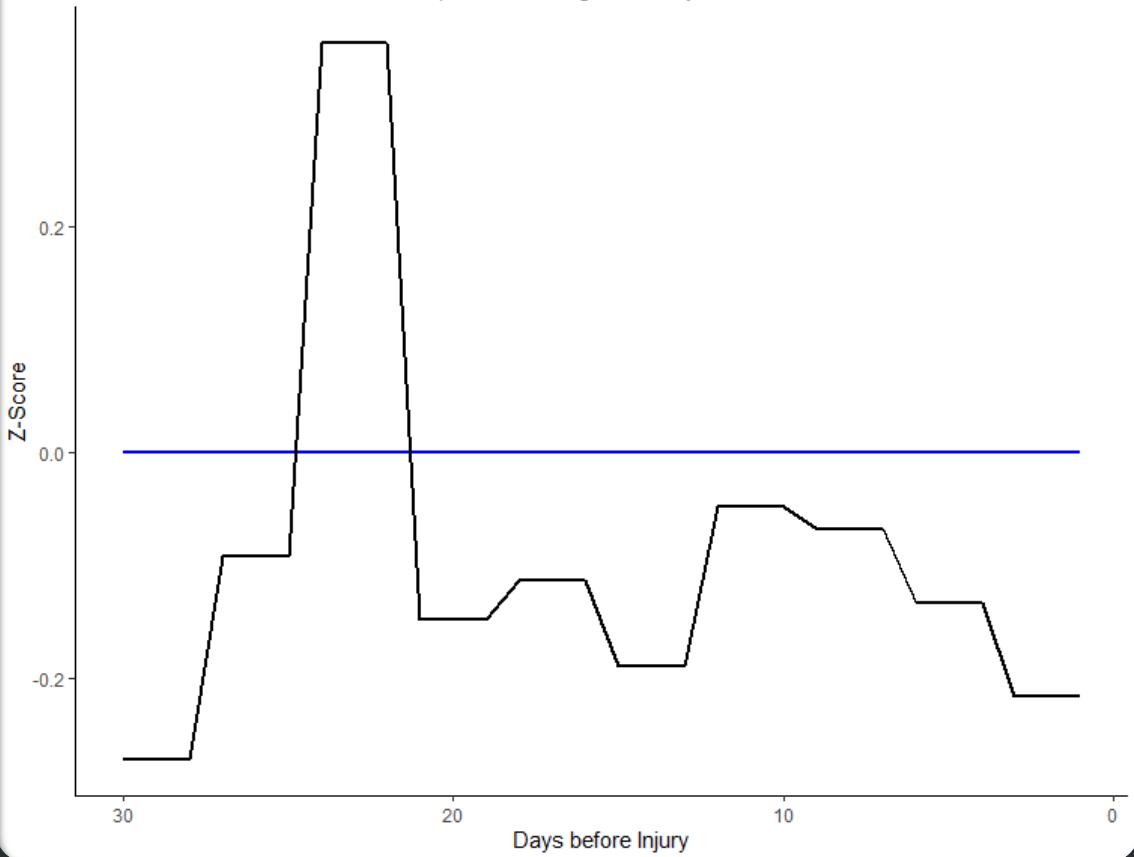


PEAK POWER

- LOW Z-SCORE MAGNITUDES
- FLUCTUATES OVER 0
 - LACKING INSIGHTS
 - GREAT STARTING POINT

Average Peak Power a month before an Ankle Injury Occurred

Grouped and Averaged in 3 day increments

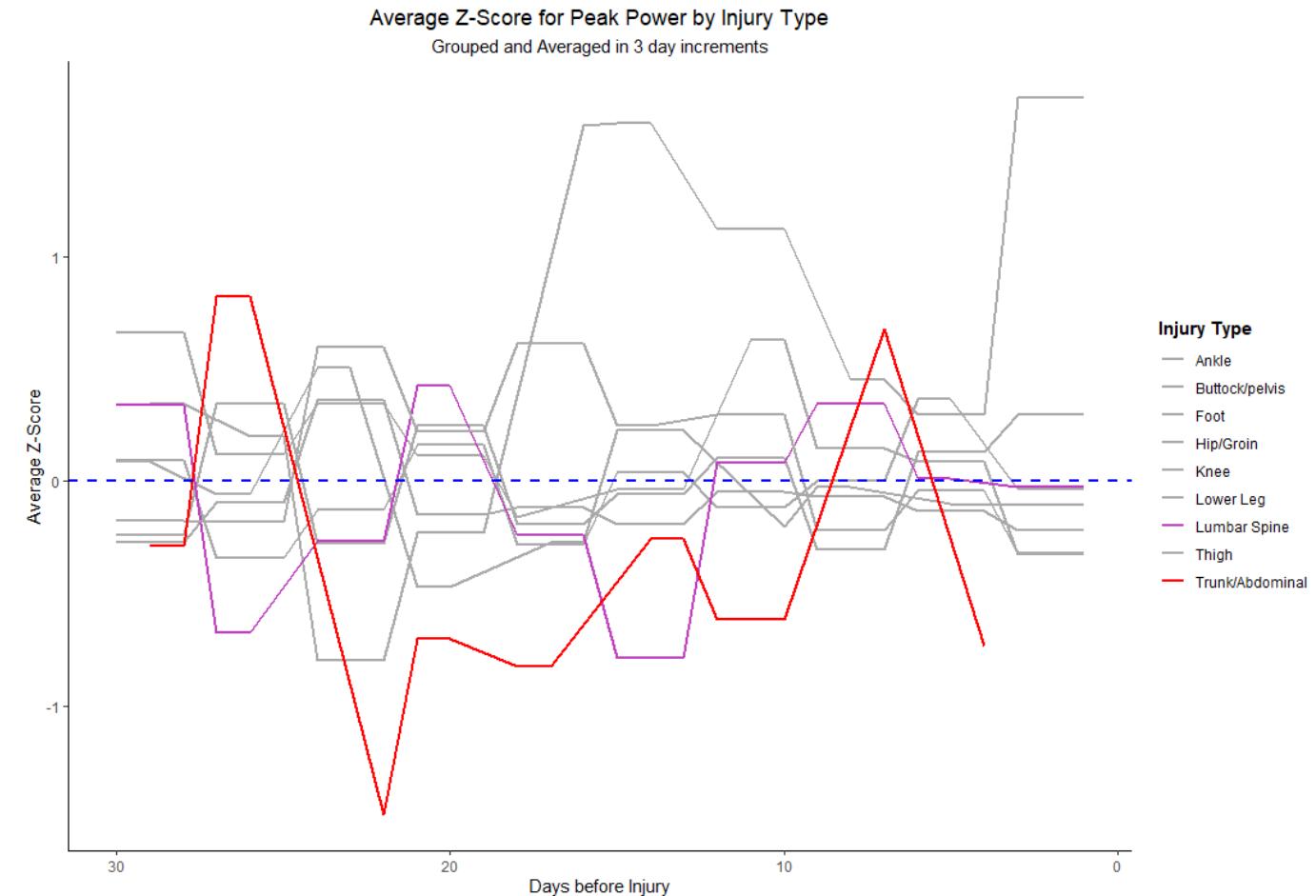


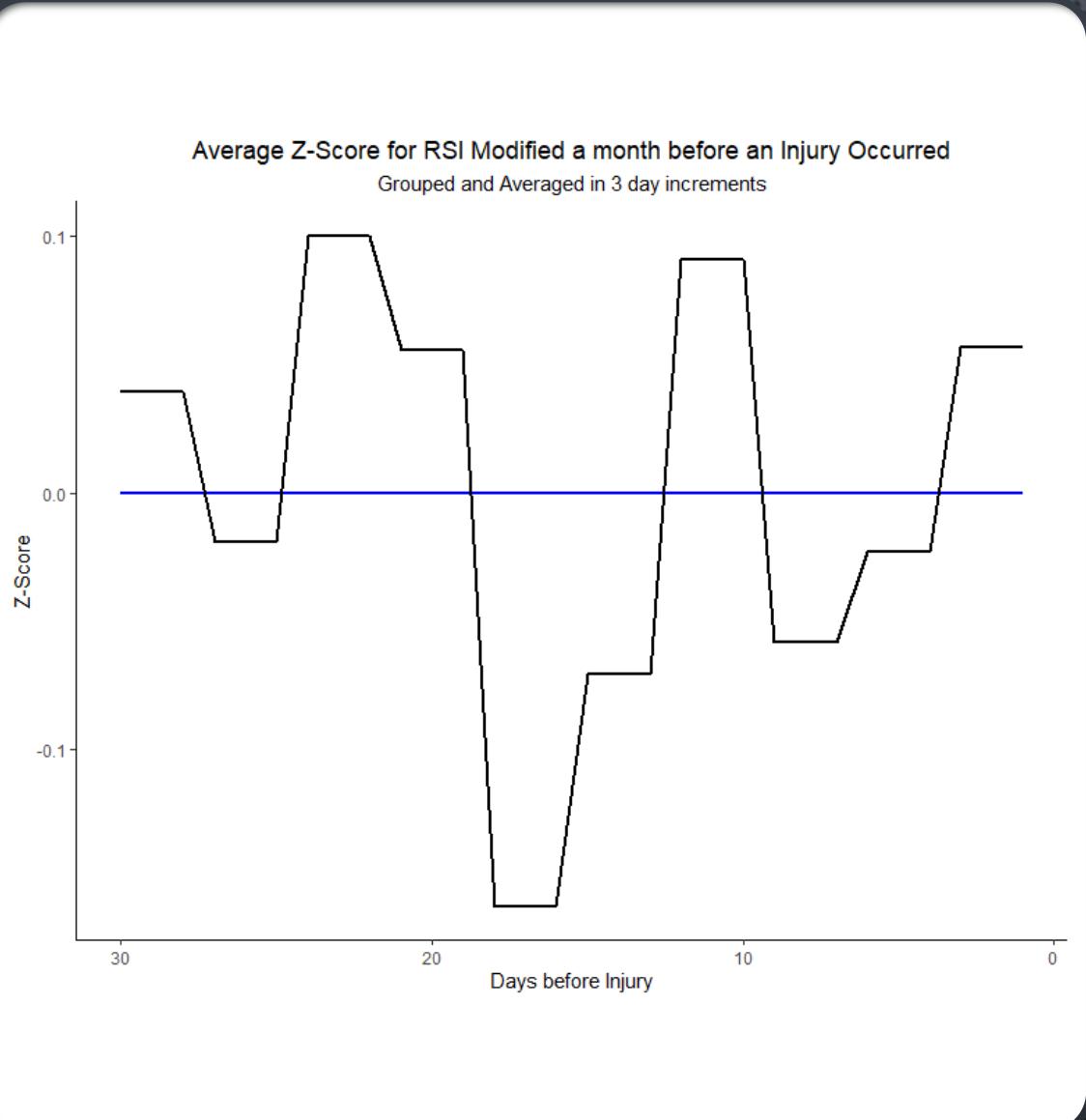
PEAK POWER BY ANKLE INJURIES

- GREATER Z-SCORE MAGNITUDES
- ALL BUT ONE PERIOD UNDER 0
- ADDING A PARAMETER PROVIDES MORE CLARITY
- DECREASE IN PEAK POWER PRE-INJURY

PEAK POWER BY INJURY GROUP

- Z-SCORE MAGNITUDES CONTINUE TO INCREASE
- ANKLE, LUMBAR, AND TRUNK ARE MOSTLY NEGATIVE
- PEAKS RELATED TO LOW OBSERVATIONS



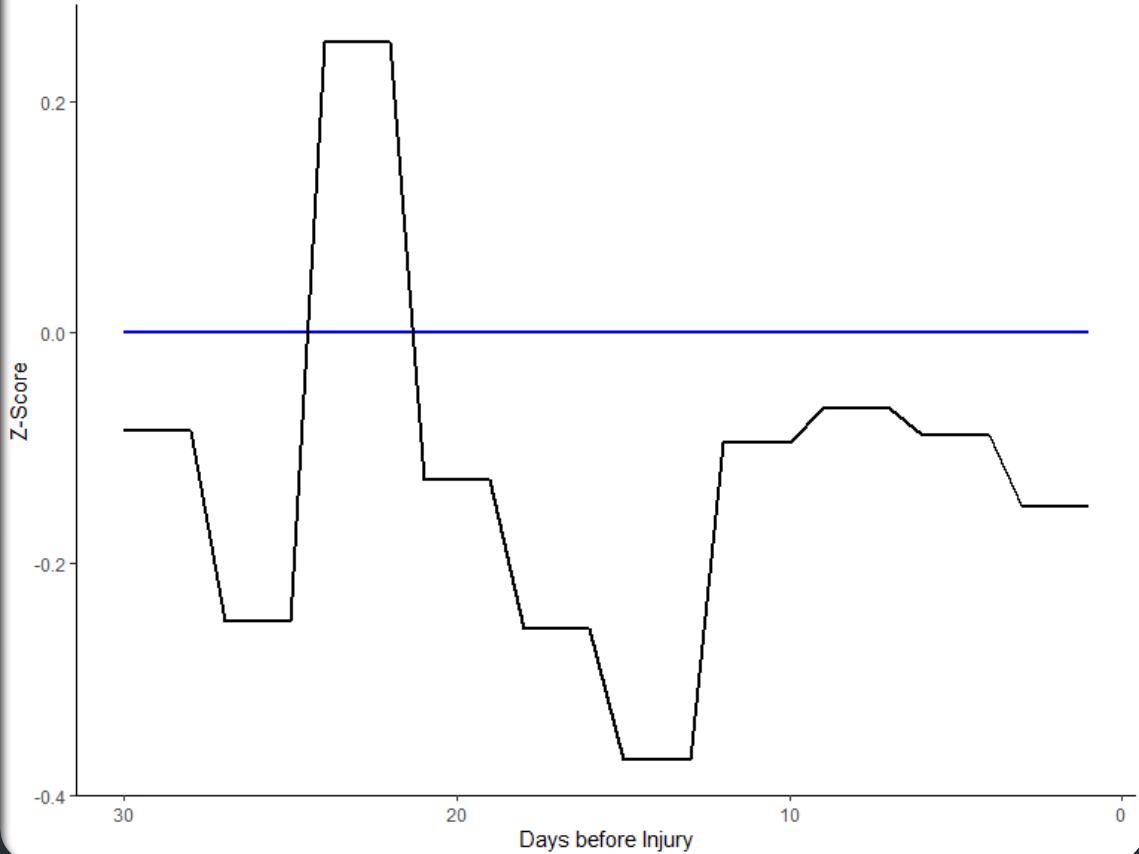


RSI MODIFIED

- FLUCTUATES OVER 0
 - LACKING INSIGHTS
 - GREATER MAGNITUDES COMPARED TO PEAK POWER

Average Z-Score for RSI Modified a month before an Ankle Injury Occurred

Grouped and Averaged in 3 day increments

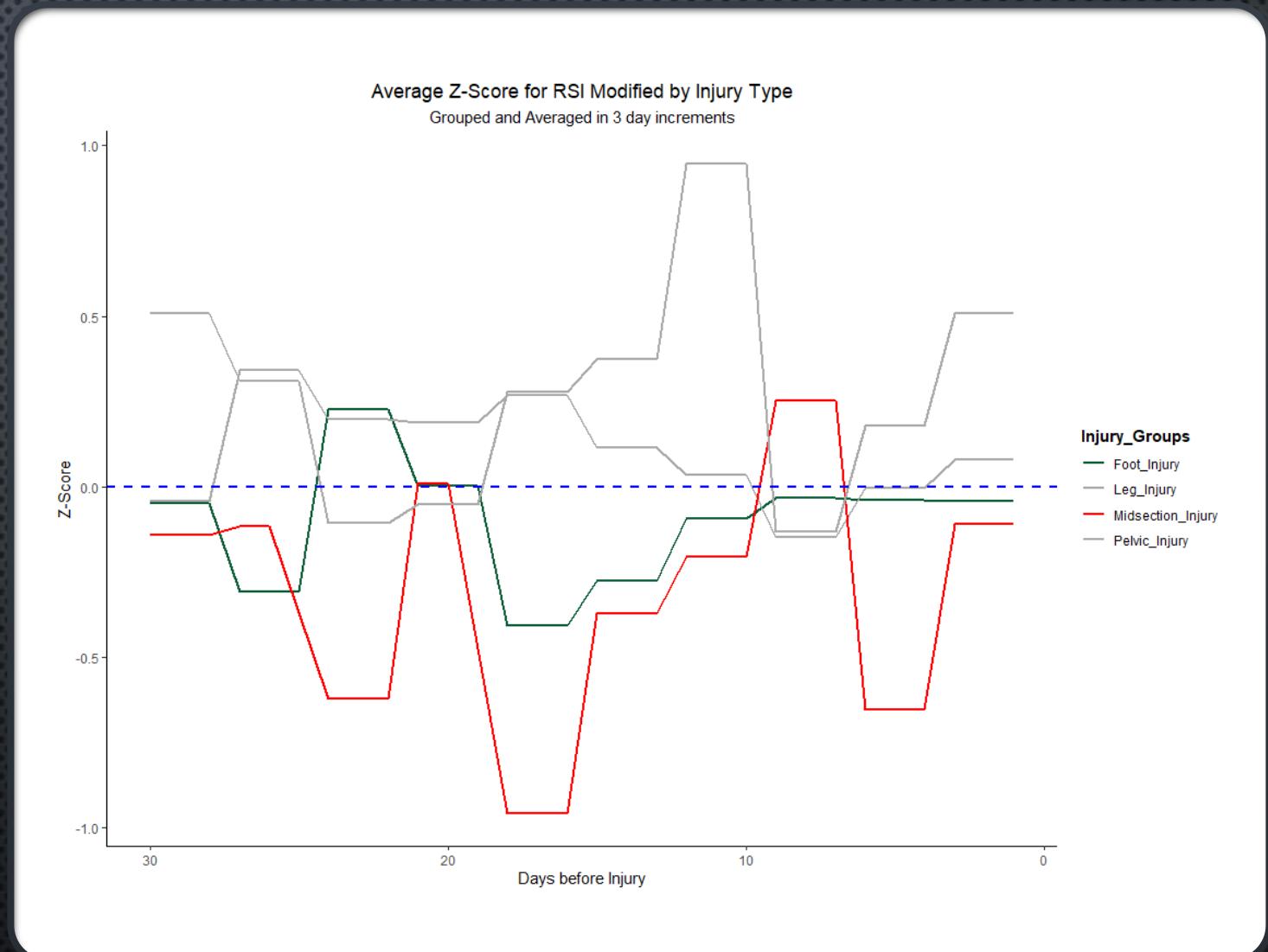


RSI MODIFIED BY ANKLE INJURY

- COMPARABLE TO PEAK POWER BY ANKLE
- SLIGHT INCREASE IN Z-SCORE MAGNITUDES
- ALL BUT ONE PERIOD UNDER 0
- ADDING PARAMETER ONCE AGAIN PROVIDES CLARITY
- DECREASE IN RSI MOD PRE-INJURY

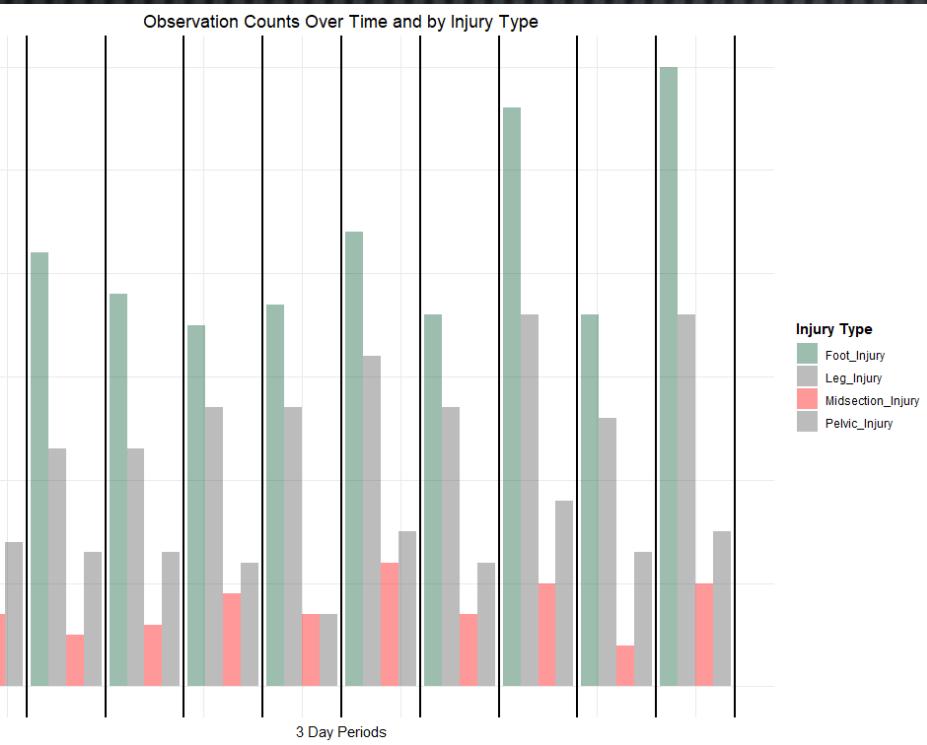
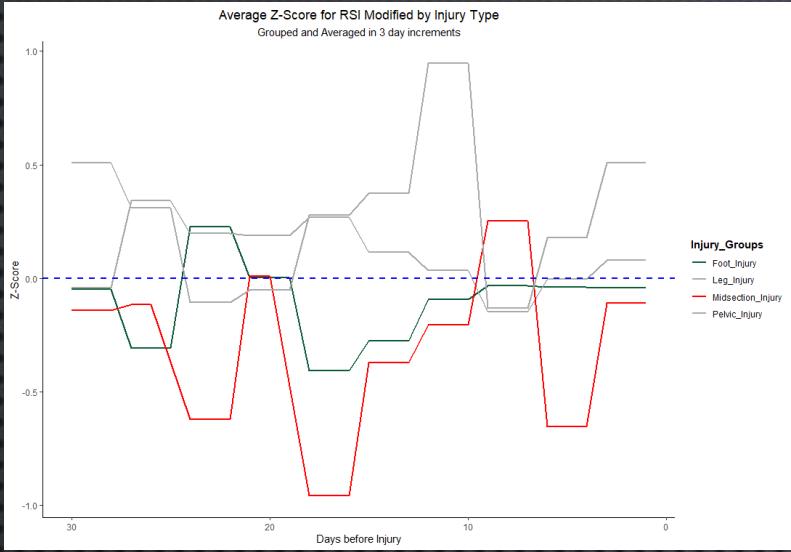
RSI MODIFIED BY INJURY GROUP

- LARGE Z-SCORE MAGNITUDES
- INJURY SIGNIFICANCE
 - MIDSECTION: AVG OF - 0.25 SD BELOW THE MEAN
 - FOOT: AVG OF - 0.10 SD BELOW THE MEAN
 - SD \approx 0.05 CHANGE IN RSI MOD
- MIRRORS PEAK POWER BY ANKLE AND MIDSECTION INJURIES INDICATING NEGATIVE TRENDS



FINDINGS & SIGNIFICANCE

- BEING CONSISTENTLY BELOW THE AVERAGE IN A MONTH CAN INDICATE INJURY DANGER
- REGRESSION USED TO CALCULATE Z-SCORE HAS R-SQUARED OF .8294 (LOOK FOR ABOVE .50)
 - REGRESSION = MONTH BEFORE INJURY REGRESSED ON 5-MONTH AVERAGE AND TIME BETWEEN INJURY AND TEST
 - 5-MONTH AVERAGE WAS STATISTICALLY SIGNIFICANT IN PREDICTING RSIMOD ON TEST DATES. SHOWS WE CAN USE THIS AS A BASELINE AND WORK OFF OF THAT



DATA LIMITATIONS

- OBSERVATIONS FOR GROUPED TIMES
- FOOT INJURIES HAVE 3-4X GREATER OBSERVATIONS COMPARED TO OTHER INJURY TYPES
- LESS CONFIDENT IN MIDSECTION RESULTS COMPARED TO FOOT INJURIES

CONSIDERATIONS

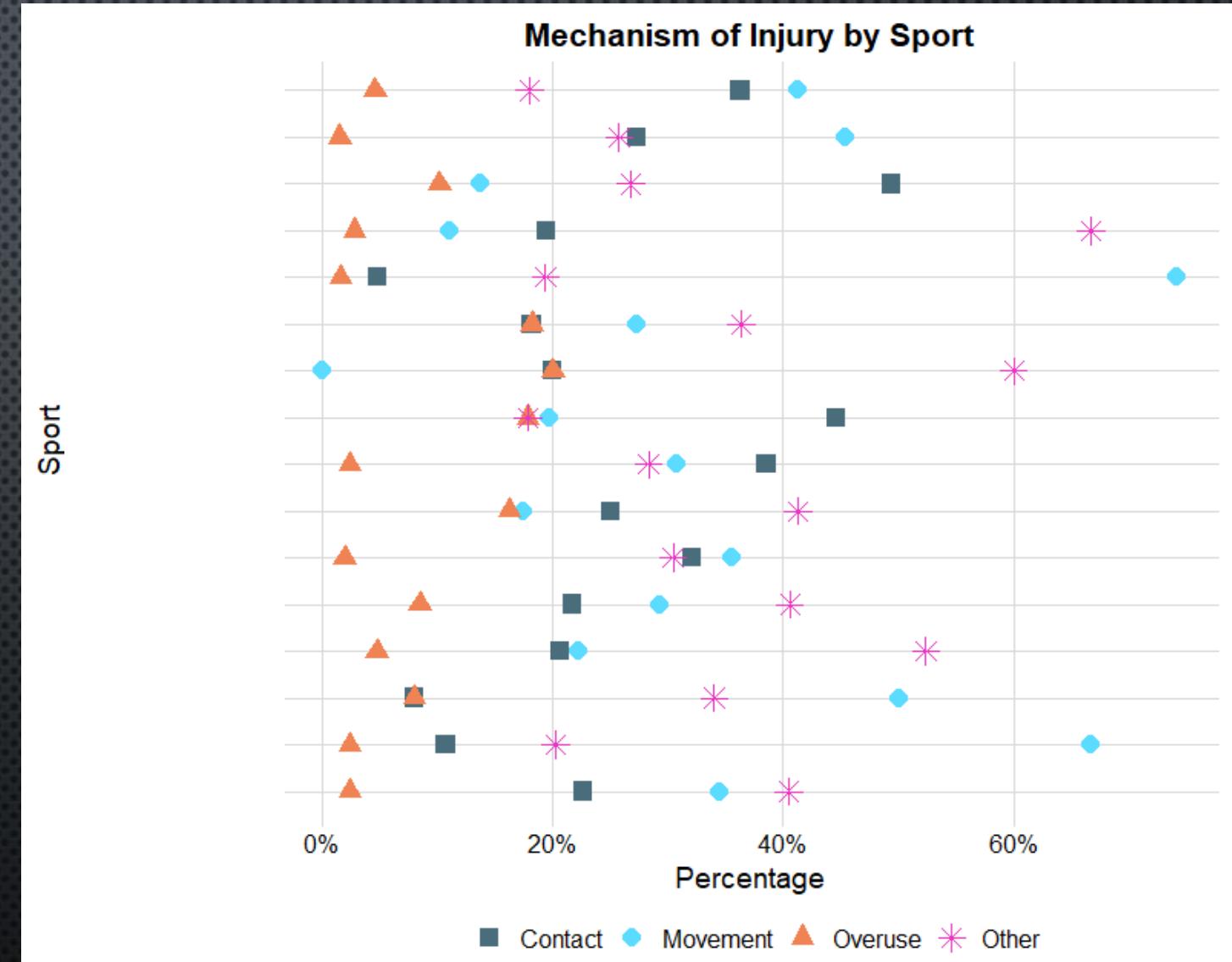
VARIATIONS IN PAIN TOLERANCE AND SUPPORT

RECALL AND INCONSISTENT REPORTING PROCEDURES

STATISTICAL VS PRACTICAL SIGNIFICANCE

INJURY MECHANISM

- MECHANISM HELPS EXPLAIN WHAT CONTRIBUTED TO MECHANICAL OVERLOAD¹
- **MOVEMENT**
JUMP, RUN, ACCELERATION, CHANGE OF DIRECTION
- **CONTACT**
WITH GROUND, TACKLED, FALL, LANDING, WITH PLAYING DEVICE
- **OVERUSE**
OVERLOAD, REPETITIVE TRAUMA
- **OTHER**
UNKNOWN, MISC., OTHER, NO SPECIFICS



FUTURE DIRECTIONS

- EXPLORE ADDITIONAL JUMP METRICS CONSIDERING SENSITIVITY AND CONFOUNDING
 - RATE OF FORCE DEVELOPMENT^{6, 9}
 - TIME CONSTRAINED (FORCE AT ZERO VELOCITY, TIME TO PEAK POWER)⁶⁻⁷
 - ISOLATE COMPONENTS OF RSIMOD (ECCENTRIC VS CONCENTRIC CONTRACTION)^{3, 6-7}
- RECURRING INJURIES AND ASYMMETRIES

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