Athletics Performance Analytics

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Introduction

Research Question : How do the five metrics: system weight, peak velocity, jump height, peak propulsive force, and average propulsive force outputs vary across athletes from multiple collegiate sports, and how do these values compare to known normative ranges?

Hypothesis :
Athletes competing in strength and power-dominated sports (e.g., basketball, football) will exhibit higher propulsive forces and greater jump heights, whereas athletes from speed and endurance focused sports (e.g., soccer, track) will demonstrate higher peak velocities during jump assessments.

Introduction

Significance:

- Most studies focus on one sport or small lab samples.
- Very little research compares these metrics across multiple collegiate teams.
- Few studies use real-world force-plate + GPS data.
- Our dataset fills this gap by providing large, repeated, multi-sport measurements.

Selected Metrics:

- Jump Height (m) – outcome variable
- Peak Velocity (m/s) – velocity profile
- Peak Propulsive Force (N) – force production
- System Weight (N) – load context
- Propulsive Net Impulse (N·s) – force–time characteristic

Methods

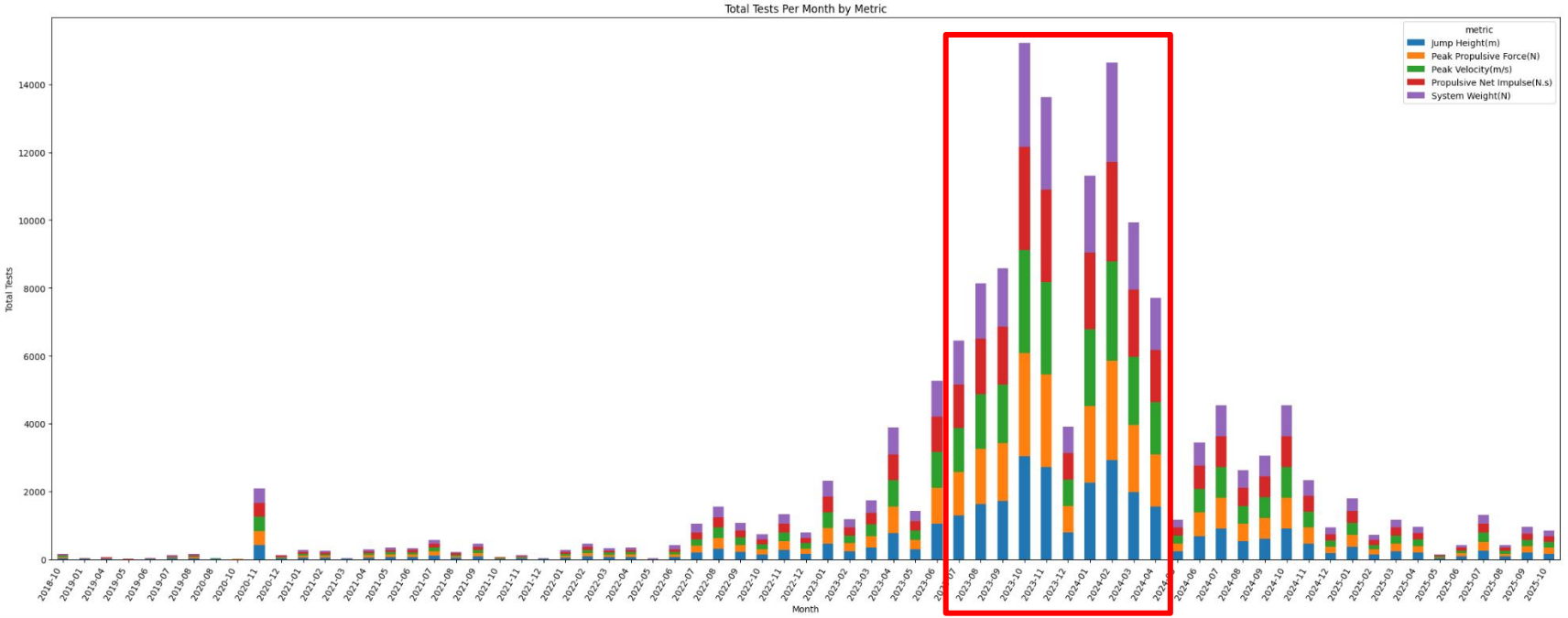
Data Overview & Quality Assessment

- System Weight contained 78 zero values (0.24%)
- All other selected metrics had no NULL or zero values
- All teams met the ≥5 tests per athlete requirement, supporting reliable trend analysis
- 829 athletes had no tests within the last 6 months, informing readiness/flagging analyses

Analysis Approach

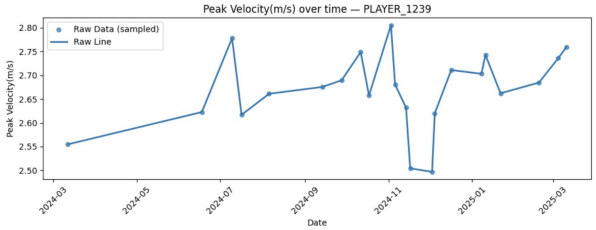
- Filtered data to selected metrics
- Assessed measurement density to ensure stability for longitudinal modeling
- Identified athletes with large testing gaps for Performance Monitoring Flag criteria

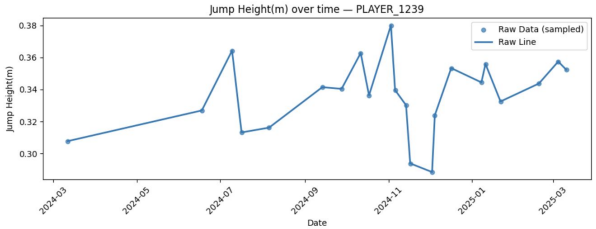
Key Findings : Testing Volume & Data Quality Insights

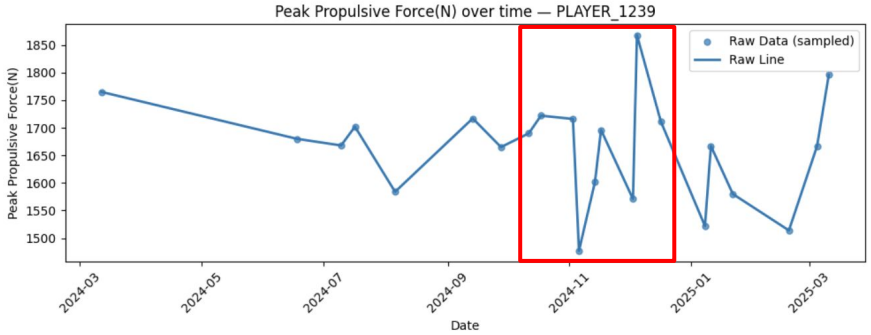


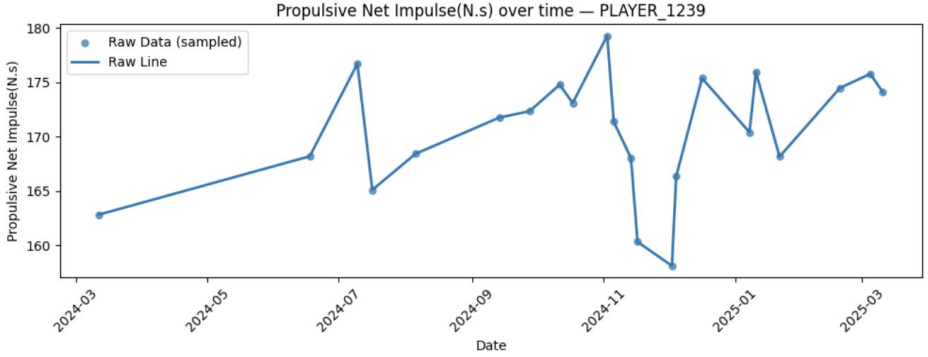
- Testing frequency low before 2022 → inconsistent data
- High, stable testing volume from 2023–2024 enables reliable trend analysis
- Gaps correspond to workflow/sensor use changes
- Consistent testing required for accurate readiness monitoring

Key Findings: Player 1239 — Improving Performance Profile





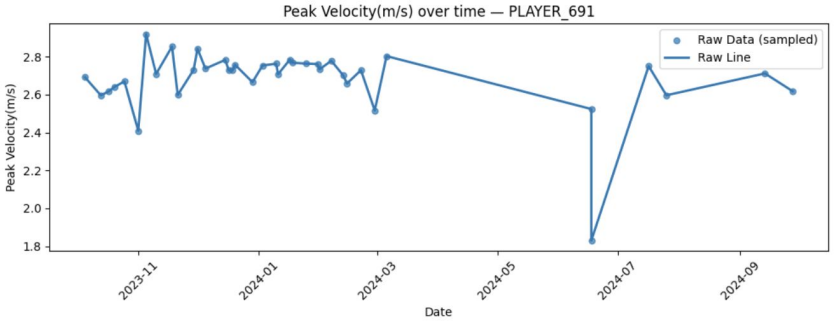


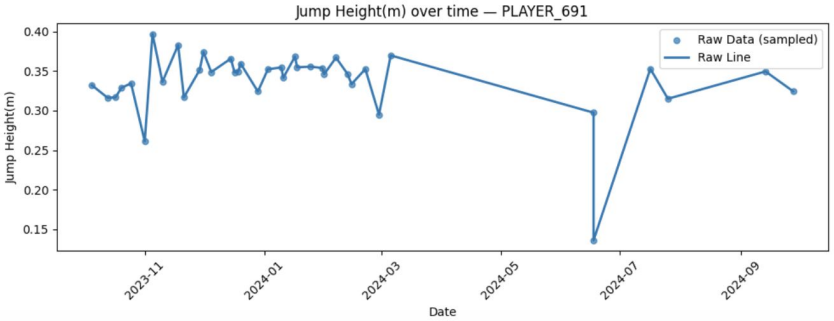


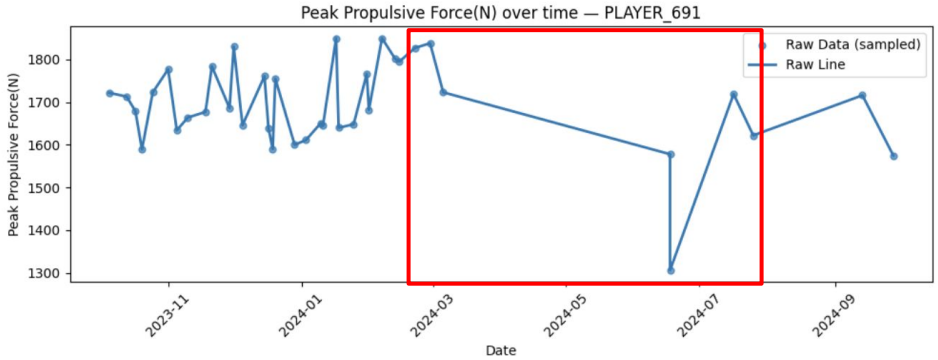
- All 5 metrics show improving or stable trends
- Best performances clustered in late 2024
- Positive trend slope
- Stable system weight → changes reflect true neuromuscular improvement

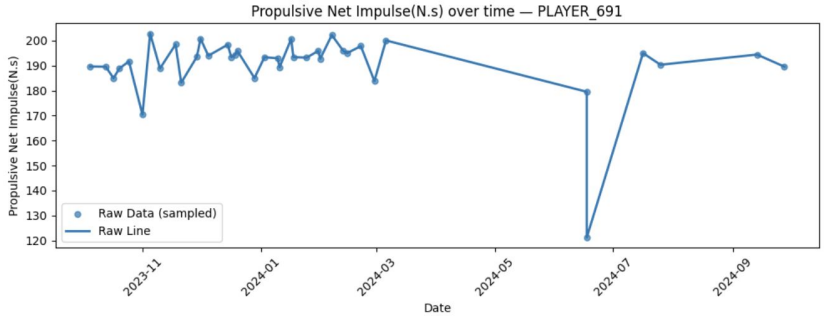
	Metric	Best Value	Best Date	Worst Value	Worst Date	Trend Slope	R	p_value
0	Peak Velocity(m/s)	2.8368	2024-11-02 16:28:31	0.6460	2025-01-10 17:42:48	0.0004	0.1266	0.3190
1	Jump Height(m)	0.3889	2024-11-02 16:28:31	0.0069	2025-01-10 17:42:48	0.0001	0.2149	0.0882
2	Peak Propulsive Force(N)	2006.0000	2025-03-04 21:05:03	1258.0000	2025-01-10 17:42:48	0.1546	0.0931	0.4643
3	System Weight(N)	658.1960	2024-08-05 16:20:57	635.8380	2024-10-04 16:31:38	0.0005	0.0078	0.9505
4	Propulsive Net Impulse(N.s)	183.2571	2024-11-07 21:24:33	25.0760	2025-01-10 17:42:48	0.0309	0.1231	0.3323

Key Findings: Player 691 — Declining Neuromuscular Trends









- Negative slopes across velocity, height, force, and impulse
- Sharp decline between Mar-Jul 2024
- Statistical significance supports meaningful performance drop
- Stable system weight → declines linked to fatigue or readiness issues

	Metric	Best Value	Best Date	Worst Value	Worst Date	Trend Slope	R	p_value
0	Peak Velocity(m/s)	2.9488	2023-11-17 22:48:13	1.7629	2024-06-17 12:40:13	-0.0005	-0.2848	0.0021
1	Jump Height(m)	0.4102	2023-11-17 22:48:13	0.1237	2024-06-17 12:40:13	-0.0001	-0.2845	0.0022
2	Peak Propulsive Force(N)	1873.0000	2024-02-12 16:09:22	1306.0000	2024-06-17 12:40:22	-0.2125	-0.2208	0.0182
3	System Weight(N)	746.1670	2024-07-25 14:09:05	678.4780	2024-01-03 20:33:06	0.0278	0.2410	0.0098
4	Propulsive Net Impulse(N.s)	203.2519	2023-11-17 22:48:13	115.8740	2024-06-17 12:40:13	-0.0270	-0.2242	0.0165

Key Findings

- 1239 aligns with research on improvement from consistent training and healthy SSC function
- 691 aligns with literature on fatigue, reduced neural drive, and jump-mechanics deterioration
- Confirms reliability of force-plate metrics in monitoring readiness
- Reinforces individualized load management strategies

Practical Applications: Performance Monitoring Flag System

Rule-based flags using performance standards

- Jump Height < 0.30 m → “below performance standard”
- Peak Propulsive Force < 1200 N → “below performance standard”

Covers the whole department

- Flags athletes across women’s basketball, men’s basketball, women’s soccer, WLAX, softball, swimming & diving, volleyball, tennis, football, T&F, and staff groups

Applications

- Uses force-plate (Hawkins) metrics to identify meaningful changes in athlete performance.
- Flags highlight sharp declines (e.g., PLAYER_691), prompting load reduction or added recovery.
- Supports continuous, individualized readiness monitoring across teams and seasons.

Practical Applications: Performance Monitoring Flag System

Most recent test date

	playername	team	flag_reason	metric	metric_value	last_test_date
0	PLAYER_001	Group: WLAX , Group: WLAX Spring '24, Team: SB...	Jump Height < 0.30 m (below performance standard)	Jump Height(m)	0.2395	2024-05-01 17:03:13
1	PLAYER_002	Team: Stony Brook Men's Basketball	Jump Height < 0.30 m (below performance standard)	Jump Height(m)	0.0798	2025-07-07 11:58:04
2	PLAYER_006	Team: Stony Brook Women's Volleyball	Jump Height < 0.30 m (below performance standard)	Jump Height(m)	0.1440	2024-11-06 21:16:20
3	PLAYER_007	Team: Stony Brook Womens Soccer	Jump Height < 0.30 m (below performance standard)	Jump Height(m)	0.2870	2025-07-14 12:35:13
4	PLAYER_009	Group: WLAX , Group: WLAX Spring '24, Team: SB...	Jump Height < 0.30 m (below performance standard)	Jump Height(m)	0.2799	2025-01-18 18:43:51
...	...	...	...	...	...	...
313	PLAYER_971	Team: Stony Brook Swimming and Diving	Jump Height < 0.30 m (below performance standard)	Jump Height(m)	0.1966	2023-12-08 17:39:54
314	PLAYER_979	Team: Stony Brook Womens Soccer	Jump Height < 0.30 m (below performance standard)	Jump Height(m)	0.2493	2019-08-06 10:56:05
315	PLAYER_979	Team: Stony Brook Womens Soccer	Peak Propulsive Force < 1200 N (below performa...	Peak Propulsive Force(N)	1136.0000	2019-08-06 10:56:05
316	PLAYER_981	Group: WLAX , Group: WLAX Spring '24, Team: SB...	Jump Height < 0.30 m (below performance standard)	Jump Height(m)	0.2367	2024-05-07 16:36:59
317	PLAYER_983	Team: Stony Brook Swimming and Diving	Jump Height < 0.30 m (below performance standard)	Jump Height(m)	0.2761	2025-10-14 12:50:32

318 rows × 6 columns

- Currently, flags are driven by individual athletes' single extreme event

The current flag system only works for 2 selected metrics: Jump Height (m) and Peak Propulsive Force (N)

Practical Applications

Recommendations for Coaches/Trainers

- Use automated flagging system to identify underperforming athletes
- Adjust training loads when metrics decline; highlight overperformers
- Increase testing frequency
- *Example*: If an athlete is undering perform in their Jump Height, system will flag to bring to attention, coaches can then alter their training guide to strengthen their leg strength

Filling in the literature gap

- Most studies use small samples and lab-based testing; few show real-world, department-level flag systems
- Consistent force-place metrics can track individual adaptation over time

Limitations

- Uneven testing frequency → biased trend analysis
- The wide date range (2018–2025) → inconsistency with potential external factors influencing the data trends
    - Potential external factors: Fatigue, training load, injury status

Future Directions

- Use body-mass–normalized metrics for fairer comparisons
- Automated flag system → speed up training plans
- Analyze sport-specific or position-specific groups

Q&A
Thank you