Athletics Performance Analytics

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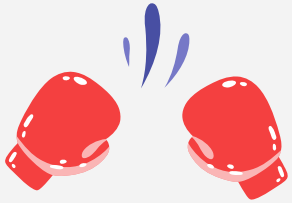

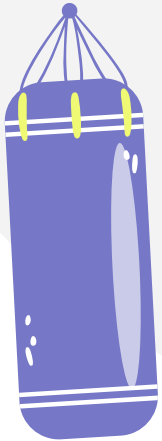

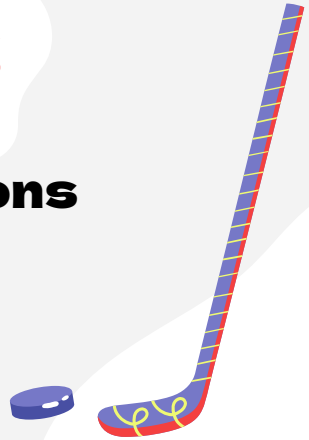

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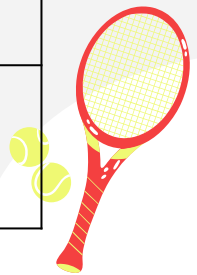
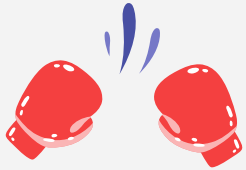
Introduction:

Metrics Chosen and Research Question

Metrics

Metric	Metric unit	Why Choose this metric?
Jump Height	Meters (m)	Strong Correlation with Athletes' Performance
Avg. Braking Force	Newtons (N)	Shows eccentric strength, landing control, and force absorption ability
Avg. Propulsive Force	Newtons (N)	Represents explosive strength and athlete's ability to produce upward strength for maximal jump height
Braking Phase	Seconds (s)	Critical phase that moves the body downward to absorb Force and store it
Propulsive Phase	Seconds (s)	Utilizes stored energy to propel the body upwards and attain maximum upward velocity

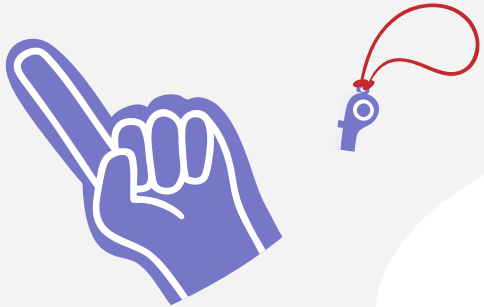




Research Question & Hypothesis

"To what extent do average braking power, average propulsive power, and the durations of both the braking and propulsive phases predict jump height in Basketball athletes?"

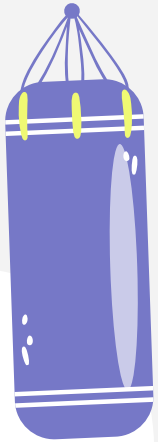
Hypothesis:"Jump height in Basketball athletes is positively influenced by average propulsive power and negatively influenced by average braking power and the duration of the braking phase, with propulsive phase duration also contributing. Athletes who produce higher propulsive power and efficiently manage braking power will achieve greater jump heights."



What Research Gap Are we Addressing?

The unreliable jump height calculation model

A key gap in current literature is the lack of standardized methods for calculating jump height, with different approaches often yielding inconsistent results. These inconsistencies make it difficult to determine how braking force, propulsive force, braking phase, and propulsive phase units can be used to predict jump height.



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Methods

Data Overview & Analysis Approach

Data Overview

- Used data obtained by Stony Brook Athletics via Hawkins technology
- Large amount of data for our metrics (minimum 32107 across all teams)
- Sufficient data for both Men's and Women's basketball
- No null values identified for our metrics (Long Format)
- Outliers identified, excluded when necessary (20-80)

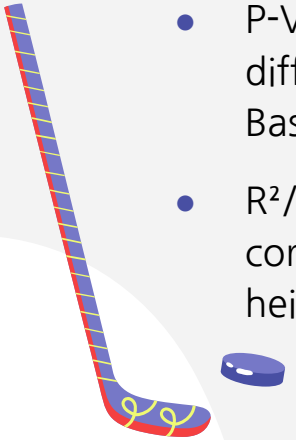
```
>>> null_metric_df = pd.read_sql(null_metric_sql, conn)
>>> null_metric_df
                    metric  null_count
0     Avg. Braking Force(N)         0.0
1  Avg. Propulsive Force(N)         0.0
2          Braking Phase(s)         0.0
3            Jump Height(m)         0.0
4       Propulsive Phase(s)         0.0
```

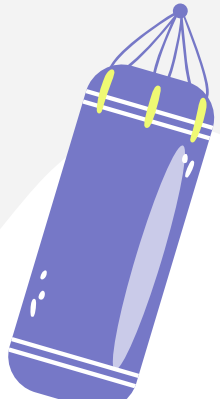
```
>>> jump_height_df_sorted
       playername                                team           timestamp      value
0      PLAYER_1140  Team: Stony Brook 2018-10-31 16:42:47  14885.0212
1      PLAYER_1140  Team: Stony Brook 2018-10-31 16:43:18   2269.1413
```

Analysis Performed

- Means - Summarize the data for different teams
- T-Test - Compare means of all metrics between Men's and Women's Basketball teams
- P-Value - See statistical significance difference between Men's and Women's Basketball teams
- R^2/Scatterplot - Test and visualize correlation between metrics and jump height

```
tstat, pval = ttest_ind(team1_vals, team2_vals, equal_var=False)
stats_results.append({
    "metric": metric,
    f"{team1}_mean": team1_vals.mean(),
    f"{team2}_mean": team2_vals.mean(),
    "t-statistic": tstat,
    "p-value": pval
})
```





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Key Findings

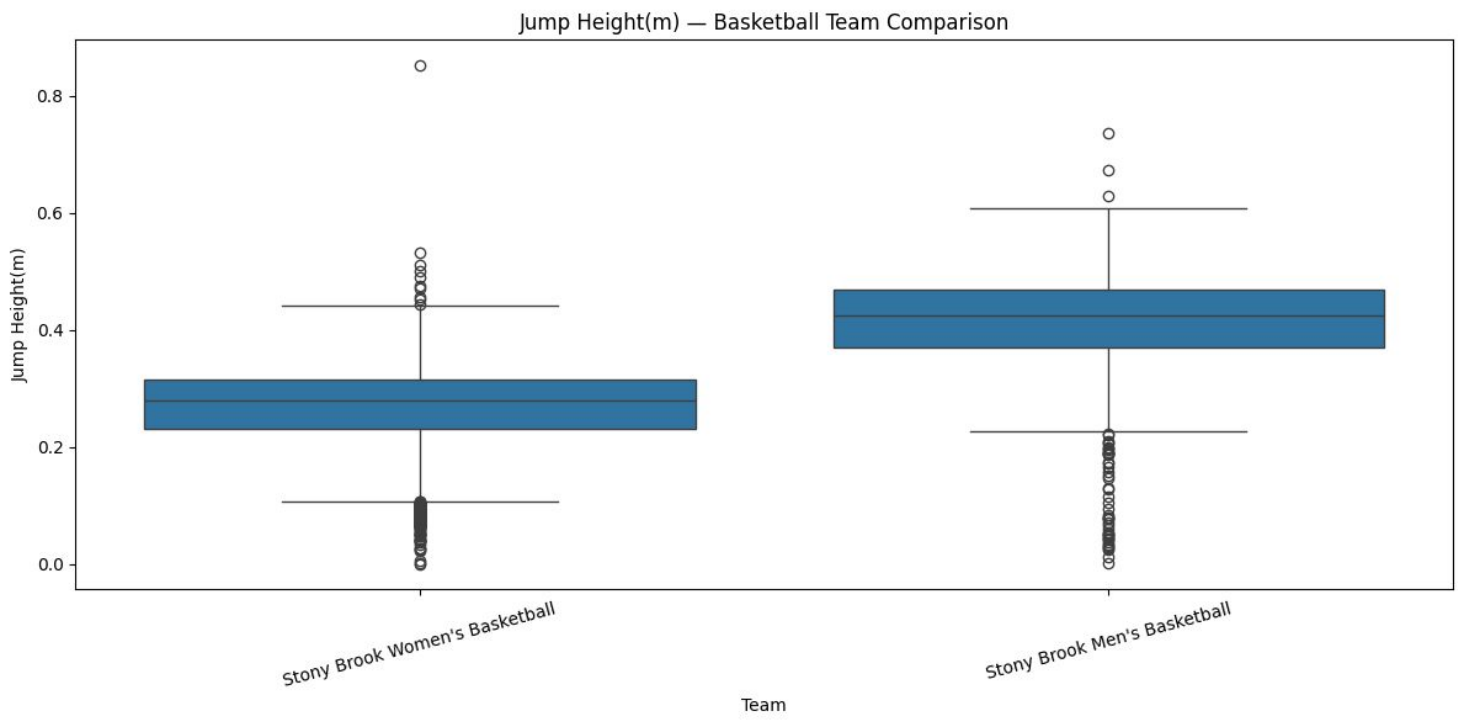
Graphs (Lots of them!)

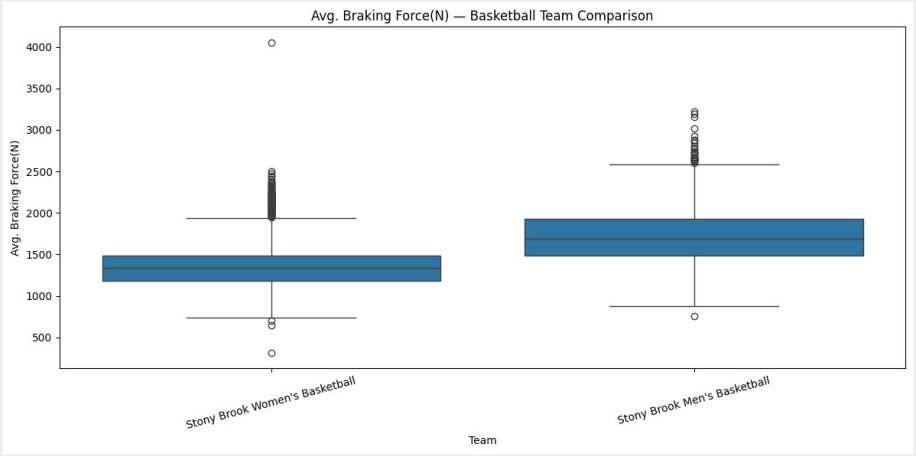
Table(s)

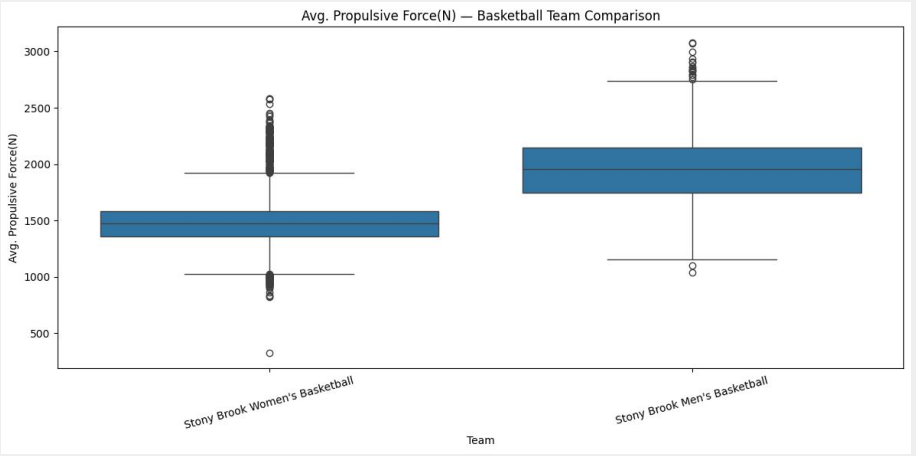
metric	Stony Brook Women's Basketball_mean	Stony Brook Men's Basketball_mean	t-statistic	p-value
Jump Height(m)	0.267054	0.418863	-76.571251	0.000000e+00
Avg. Braking Force(N)	1345.841291	1722.304665	-49.220017	0.000000e+00
Avg. Propulsive Force(N)	1490.434218	1967.248065	-70.671967	0.000000e+00
Propulsive Phase(s)	0.251447	0.249461	1.866438	6.202809e-02
Braking Phase(s)	0.157813	0.164150	-5.661737	1.566170e-08

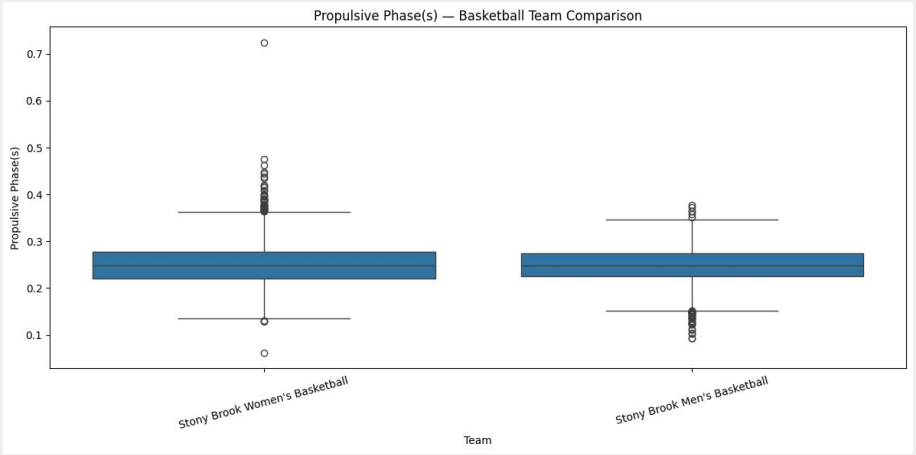
Women’s Basketball vs. Men’s Basketball

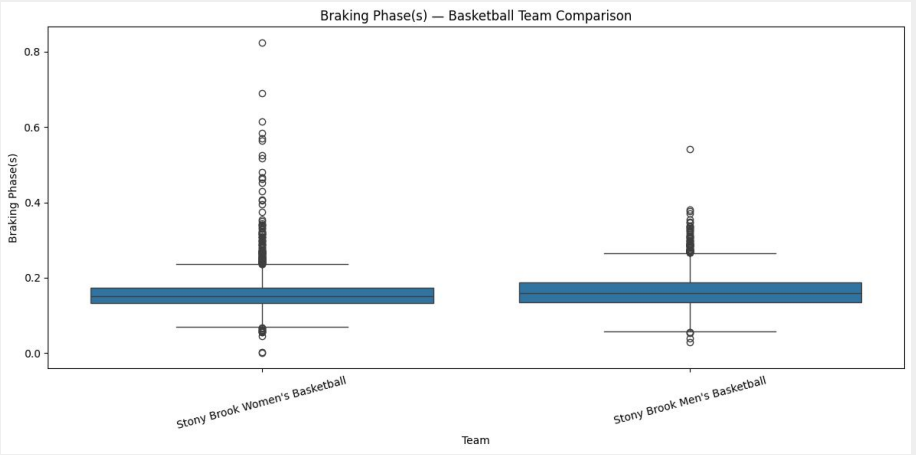
Boxplot comparison between teams for each metric



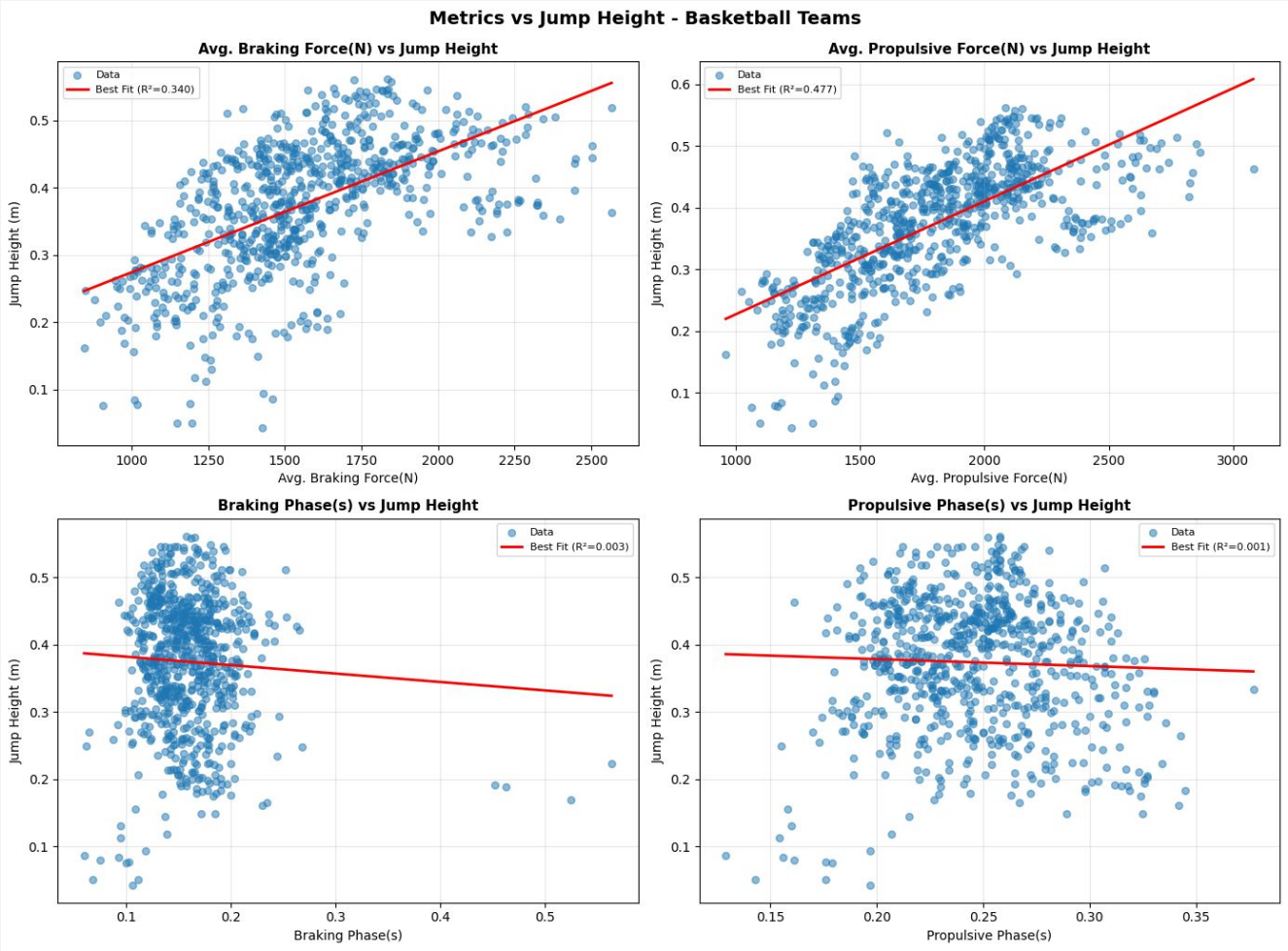

Avg. Braking Force(N) — Basketball Team Comparison
Avg. Braking Force(N)
4000
3500
3000
2500
2000
1500
1000
500
Stony Brook Women's Basketball
Stony Brook Men's Basketball
Team


Avg. Propulsive Force(N) — Basketball Team Comparison
Avg. Propulsive Force(N)
3000
2500
2000
1500
1000
500
Stony Brook Women's Basketball
Stony Brook Men's Basketball
Team

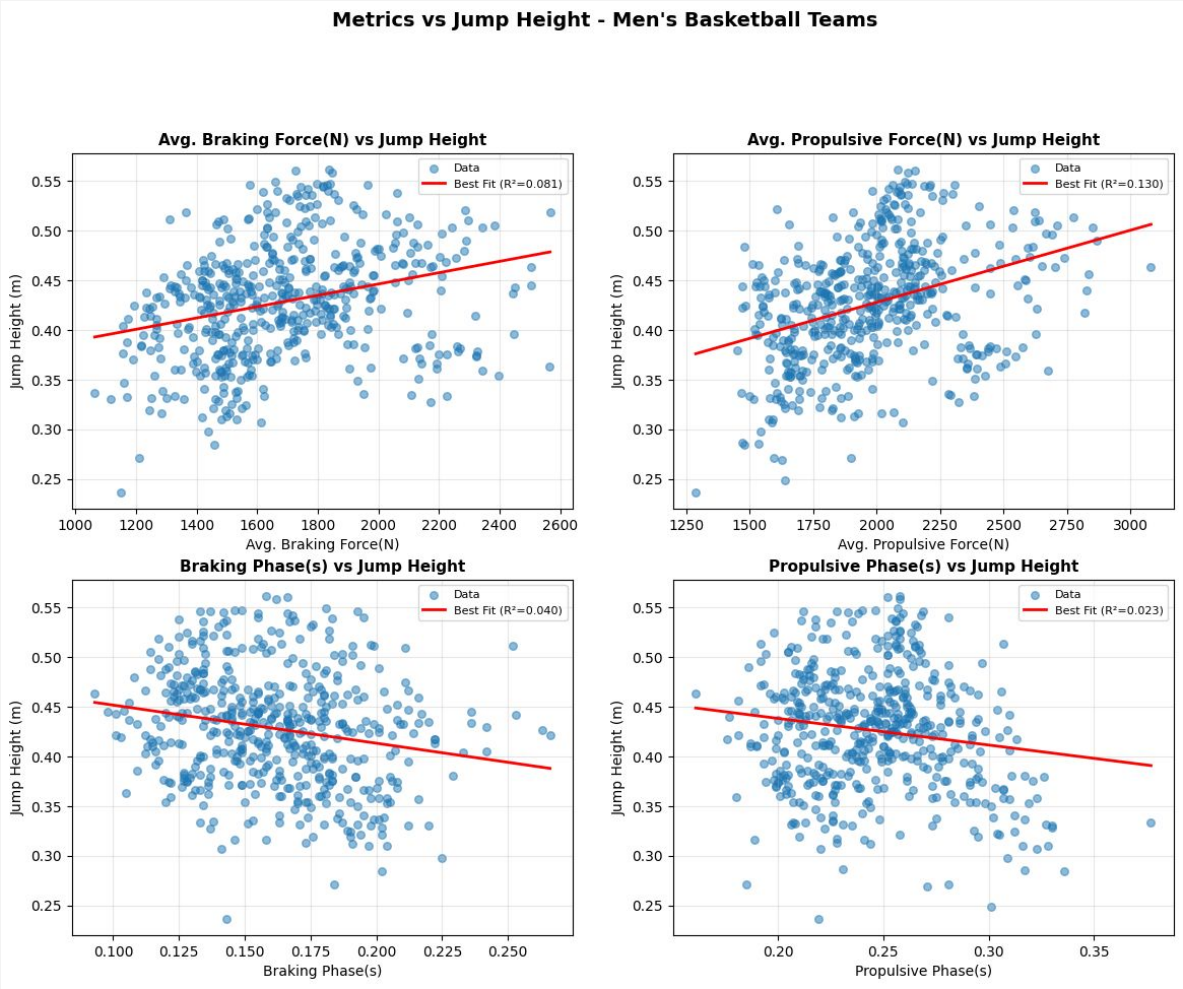

Propulsive Phase(s) — Basketball Team Comparison
Propulsive Phase(s)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
Stony Brook Women's Basketball
Stony Brook Men's Basketball
Team


Braking Phase(s) — Basketball Team Comparison
Braking Phase(s)
0.8
0.6
0.4
0.2
0.0
Stony Brook Women's Basketball
Stony Brook Men's Basketball
Team

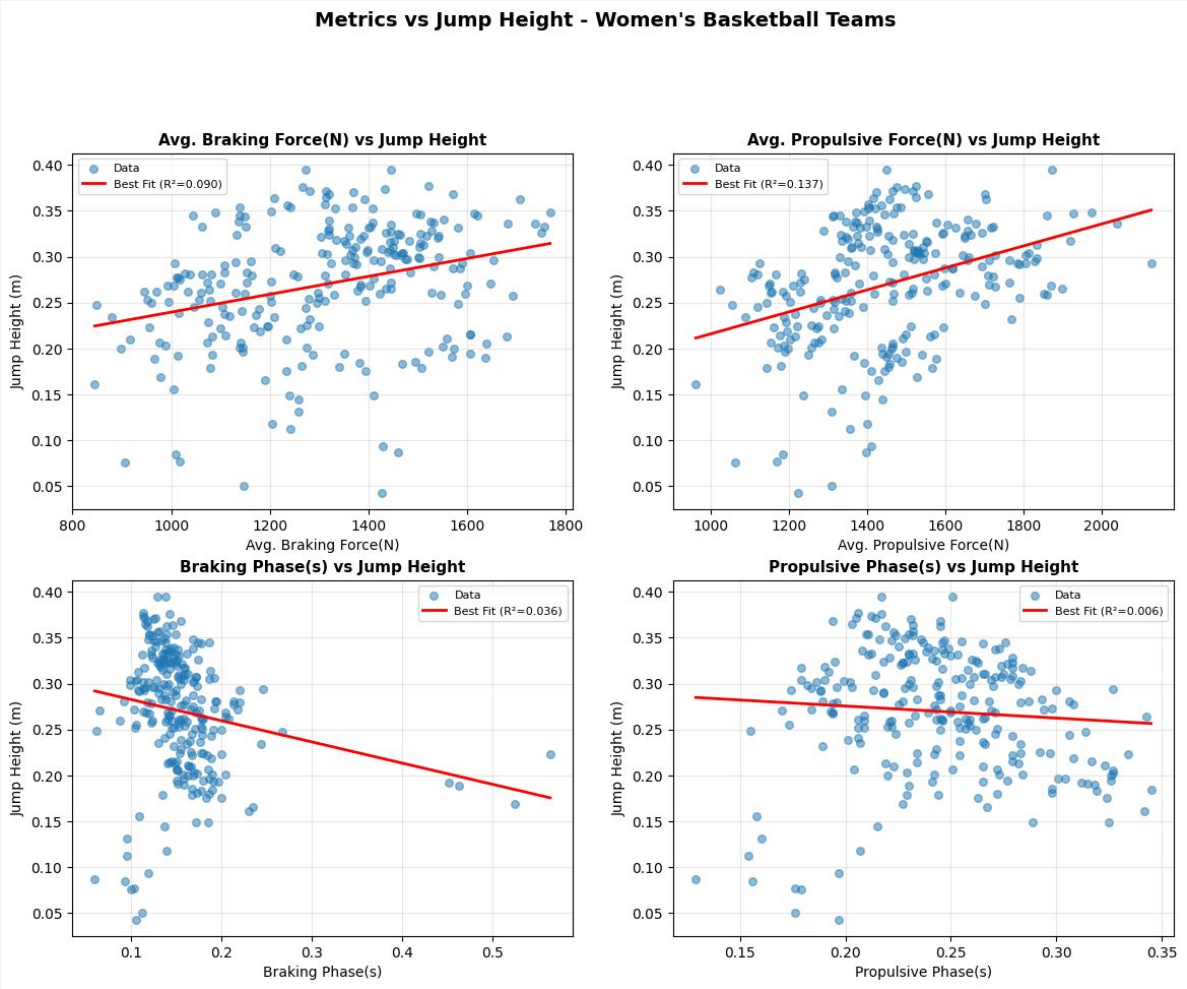
All Basketball Scatterplots (Past Year)



Men’s Basketball Scatterplots (Past Year)



Women's Basketball Scatterplots (Past Year)



Statistical Findings & Comparison to Literature

- Force production was the primary predictor of jump height ($R^2 = 0.34$-0.48), while movement timing showed no significant correlation ($R^2 < 0.01$). This suggests that strength-focused training targeting maximal force generation will be more effective than speed-oriented approaches for improving athletes' jumping ability.
- Men's basketball athletes generated significantly more force than women's athletes across both force metrics ($p < 0.001$), resulting in higher jump heights. This aligns with existing research demonstrating that sex-based physiological differences play an important role in vertical jump performance.
- The duration of propulsive and braking phases seems to have no impact on jump height performance, nor did these timing metrics differ significantly between male and female athletes ($p > 0.05$).

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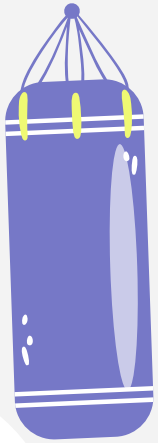
Practical Applications

Performance Monitoring & Recommendations



Flagging system and Coaching Recommendations

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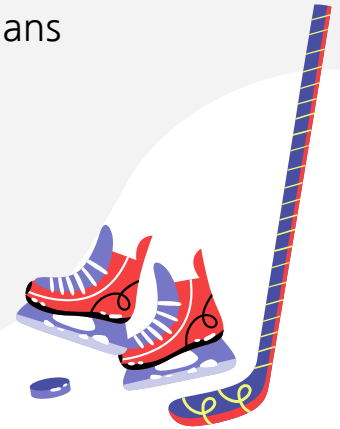
- Maximizing propulsive and braking force training to increase jump performance of athletes
- Take into consideration gender differences when creating training plans for the athletes



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Limitations & Future Work

Challenges & Additional Research

Challenges

- Large and Complex Data Set
- Differences in Athlete Testing Frequency
- Missing or Zero Valued Data
- Limited Insight into Testing Conditions

Limitations

- Inconsistent Jump Height Calculations
- Missing or uneven data across teams
- No Control for Athlete Context
- Correlational, not causation

Future Work

- Expand Sample Size & Include more sessions
- Longitudinal Athlete Monitoring
- Build Predictive Machine Learning models
- Compare Men’s vs. Women’s biomechanics more deeply

06

Questions

Thank You

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