Collegiate Men's Basketball Team and Fatigue

Objective

- Tasked with determining how to identify/flag players who may be physically unprepared for a game
- Data from a variety of tests and software systems
  - Make data insights accessible to coaches and staff
- Goal was to create an application/dashboard that would allow strength and conditioning coaches to see which players may be fatigued

Background: Force Plate Testing

- Challenges with STRIVE technology
  - EMG sensors not as reliable across a season
- Men's basketball team force plate tests twice a week
  - Usually Monday/Wednesday
  - Countermovement jump
- Research focused in finding associations between fatigue and variables from countermovement jumps
- Performed a principal component analysis on variables that were commonly associated with fatigue

Variables of Interest

- **Peak Power / BM**
- **RSI Modified**
- CMJ Stiffness
- Concentric Impulse 100ms
- Concentric Mean Power / BM
- Concentric Peak Force / BM
- Concentric RPD / BM overall, 100ms, 50ms
- Contraction Time
- **Eccentric Duration**
- Eccentric Peak Force / BM
- Eccentric Peak Power / BM
- Force at Zero Velocity
- **Jump Height (Impulse Momentum in inches)**
- **3 Asymmetry Variables, Concentric Mean Force, Eccentric Braking RFD, Force at Zero Velocity**

Analysis

- Individual athlete vs positional average
  - Performed a linear regression
- Correlation analysis
  - Compiled a list of variables that relates strongly to metrics of interest
  - Labeled games home and away to add variables to account for this
- Determined "best" force plate trial

  Verification
  - Incorporated data from STRIVE and the available +/- from basketball sports scientist

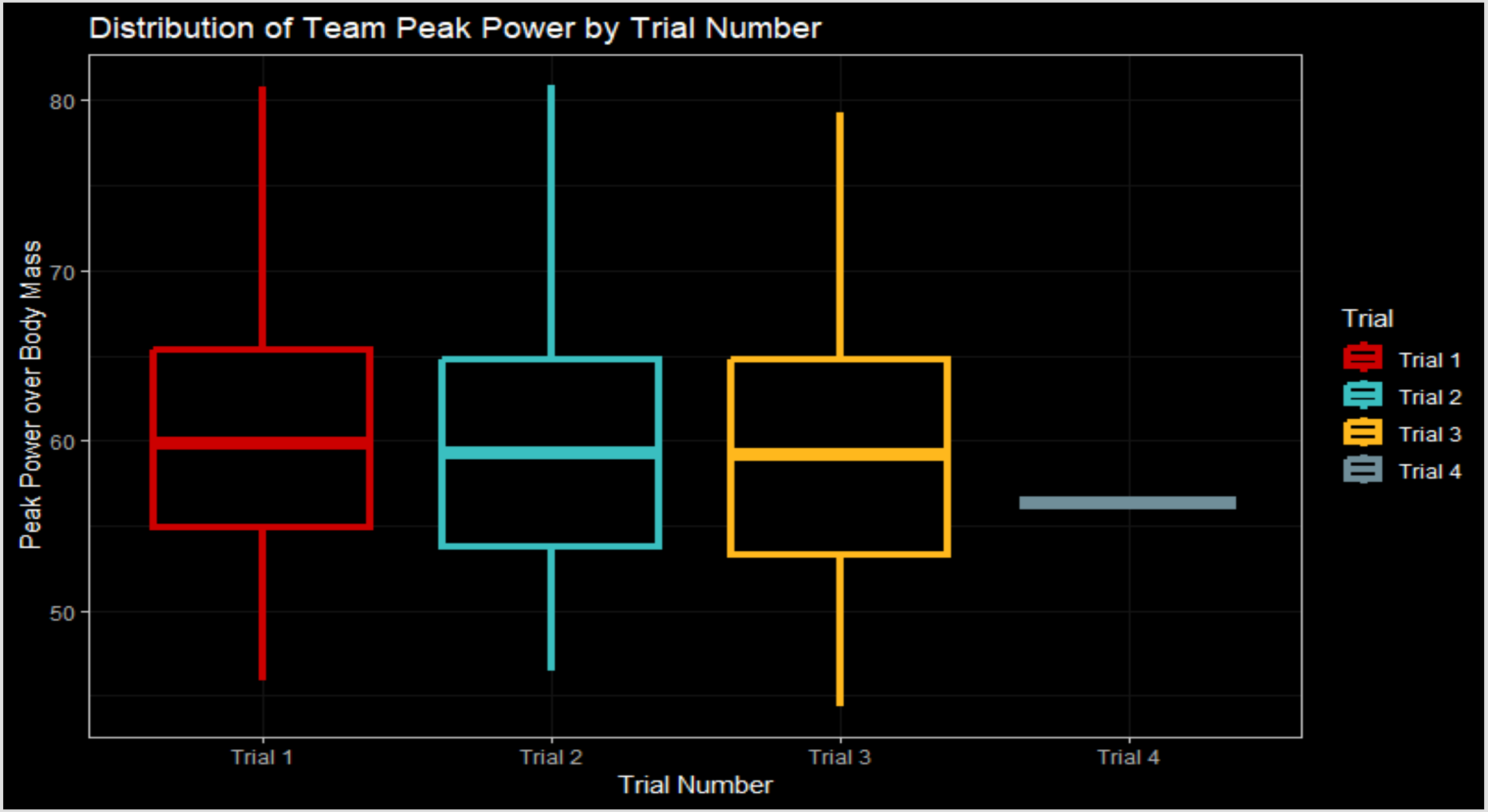
```
Call:
lm(formula = `CMJ_Stiffness_.N/m.` ~ ., data = game.train.df)

Residuals:
    Min      1Q  Median      3Q     Max
-1725.5  -206.3   -10.2   190.1  4519.7

Coefficients: (5 not defined because of singularities)
                Estimate Std. Error t value Pr(>|t|)
(Intercept)   -5.996e+04  5.324e+03 -11.262  < 2e-16 ***
PositionGuard  2.690e+02  7.684e+01   3.501 0.000481 ***
PositionWing   8.649e+02  8.795e+01   9.834  < 2e-16 ***
```

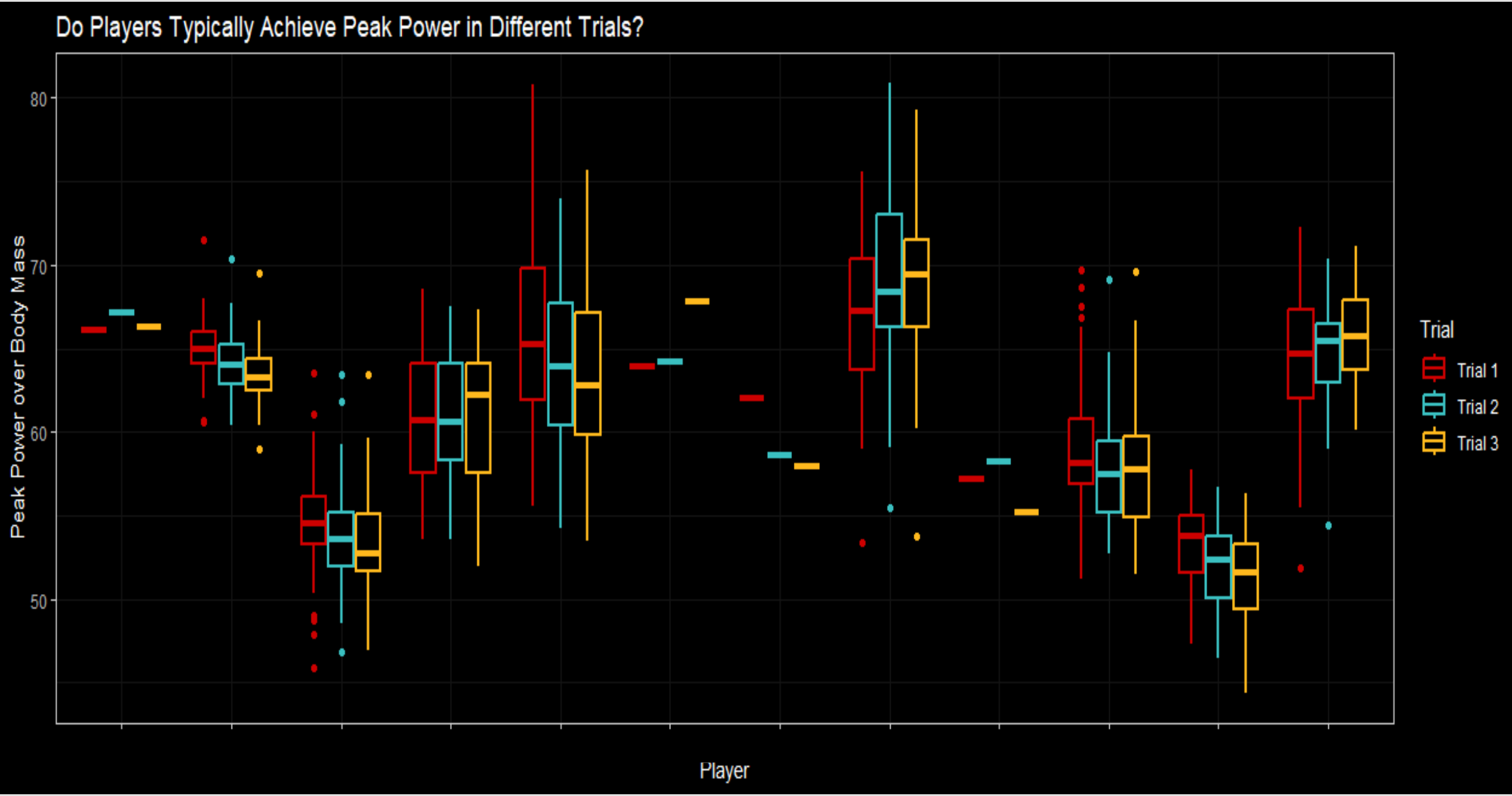
- Linear Regression Insights: Positional Significance
  - CMJ Stiffness N/m shows significance across positions: Big, Guard and Wing
  - Similarly, during linear regression analysis for positional significance, notable observations were made

Position	Most Significant	Significant	Least Significant
Big	CMJ Stiffness, RSI Modified, Peak Power / BM, Eccentric Peak Force, Eccentric Peak Power	Eccentric duration, Jump Height – Impulse Momentum	Concentric Mean Power
Guard	CMJ Stiffness, RSI Modified, Concentric Mean Power, Concentric Impulse, Peak Power/ BM, Eccentric deceleration	Jump Height – Impulse Momentum	Eccentric Peak Force
Wing	CMJ Stiffness, Jump Height – Impulse Momentum, Concentric Mean Power	Eccentric Peak Force	

Analysis

- Began with determining what data from force plate testing would be included in analysis
  - How to quantify the "best jump" from each day rather than averaging across trials and missing changes between dates
  - Determined which force plate test dates were close enough to a game to provide useful information


Distribution of Team Peak Power by Trial Number
Peak Power over Body Mass
80
70
60
50
Trial 1
Trial 2
Trial 3
Trial 4
Trial Number
Trial
Trial 1
Trial 2
Trial 3
Trial 4

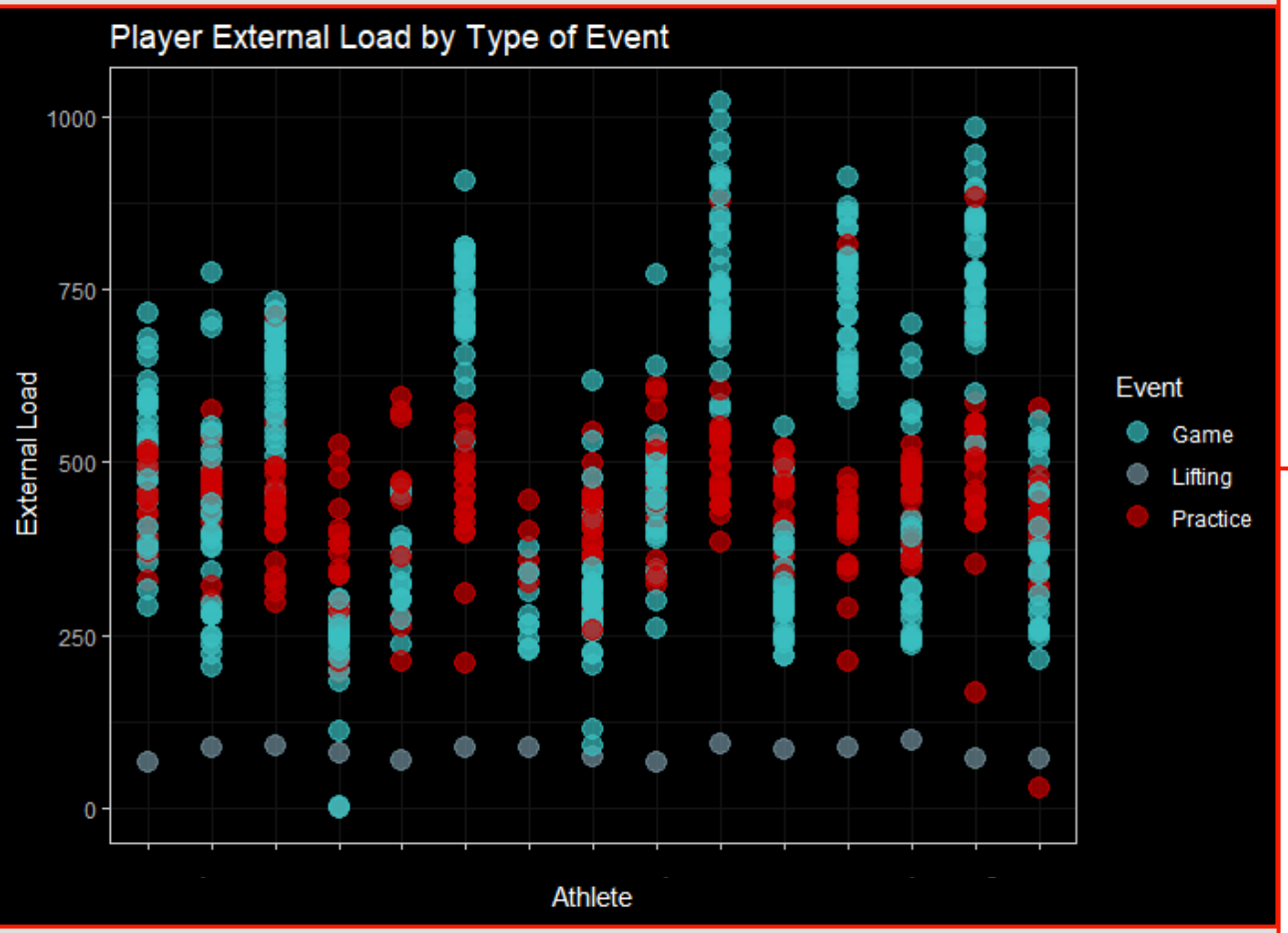

Do Players Typically Achieve Peak Power in Different Trials?
Peak Power over Body Mass
80
70
60
50
Player
Trial
Trial 1
Trial 2
Trial 3

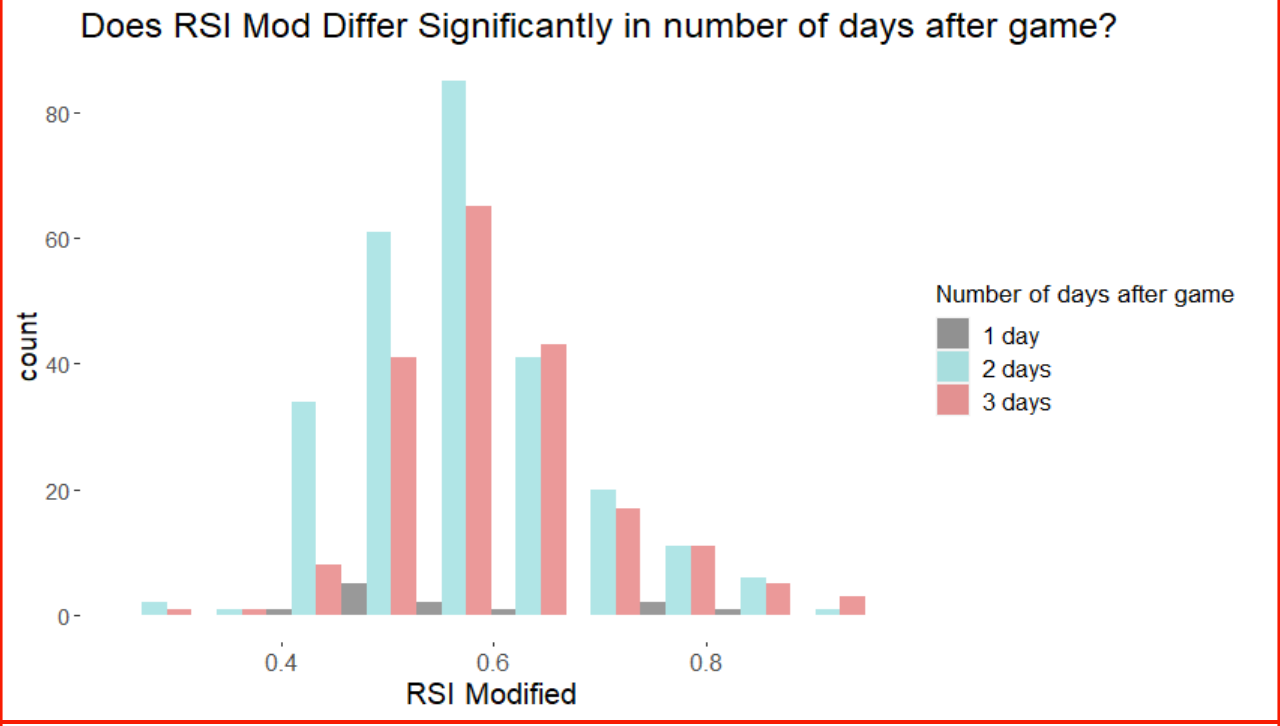
Trial Analysis Conclusion

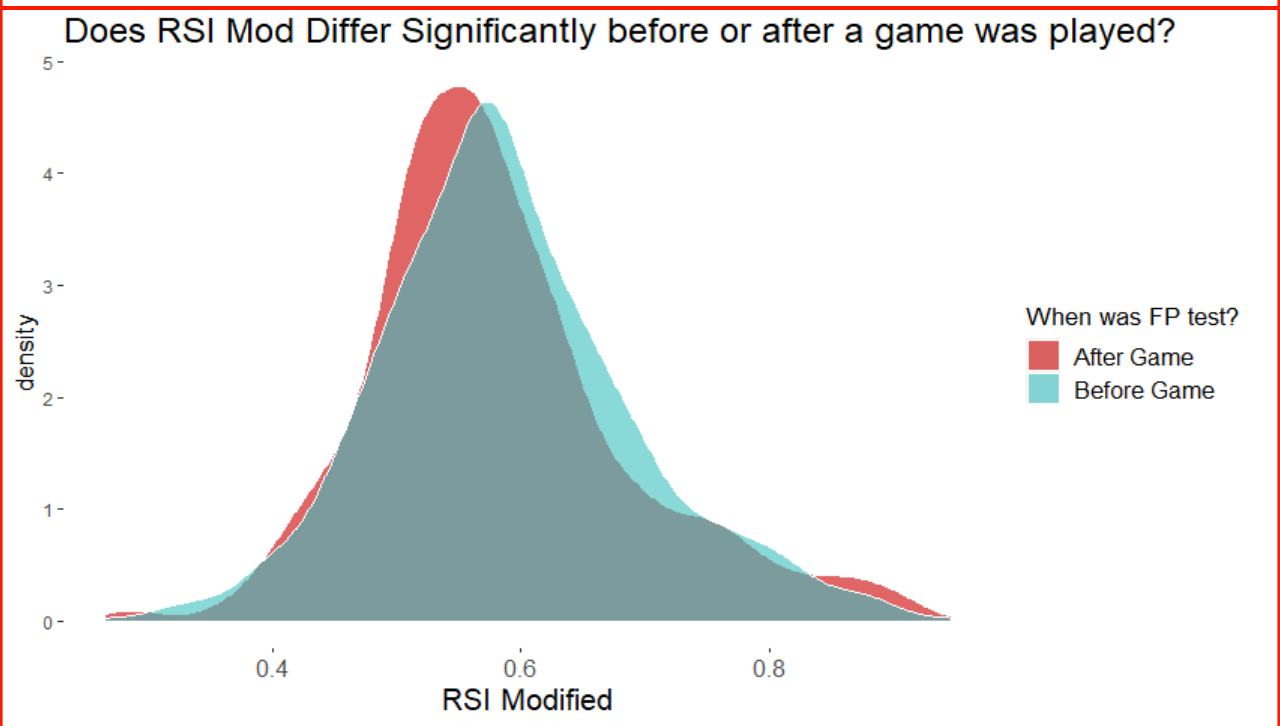
- Determined how many days max of both RSI Modified and Peak Power/BM occurred in same trial on individual basis
  - **Team average: 48%**
- Calculated difference in Peak Power and RSI for test dates where variables maxed in different trials
- Determined how many test dates a player's RSI mod was outside of one standard deviation of mean if max Peak Power trial was used
  - **91%** of the time, using only trial where **Peak Power/BM is maximized** will capture **maximum RSI Mod value** or value **within one standard deviation of max** on that day

Analysis

- Created summary graphs for each variable we chose to show the results from each jump
- Determined data that is useful
  - Streamlined STRIVE data into two files that have dates that relate to the highest load of the week for each game week
    - Accelerometer and muscle load files

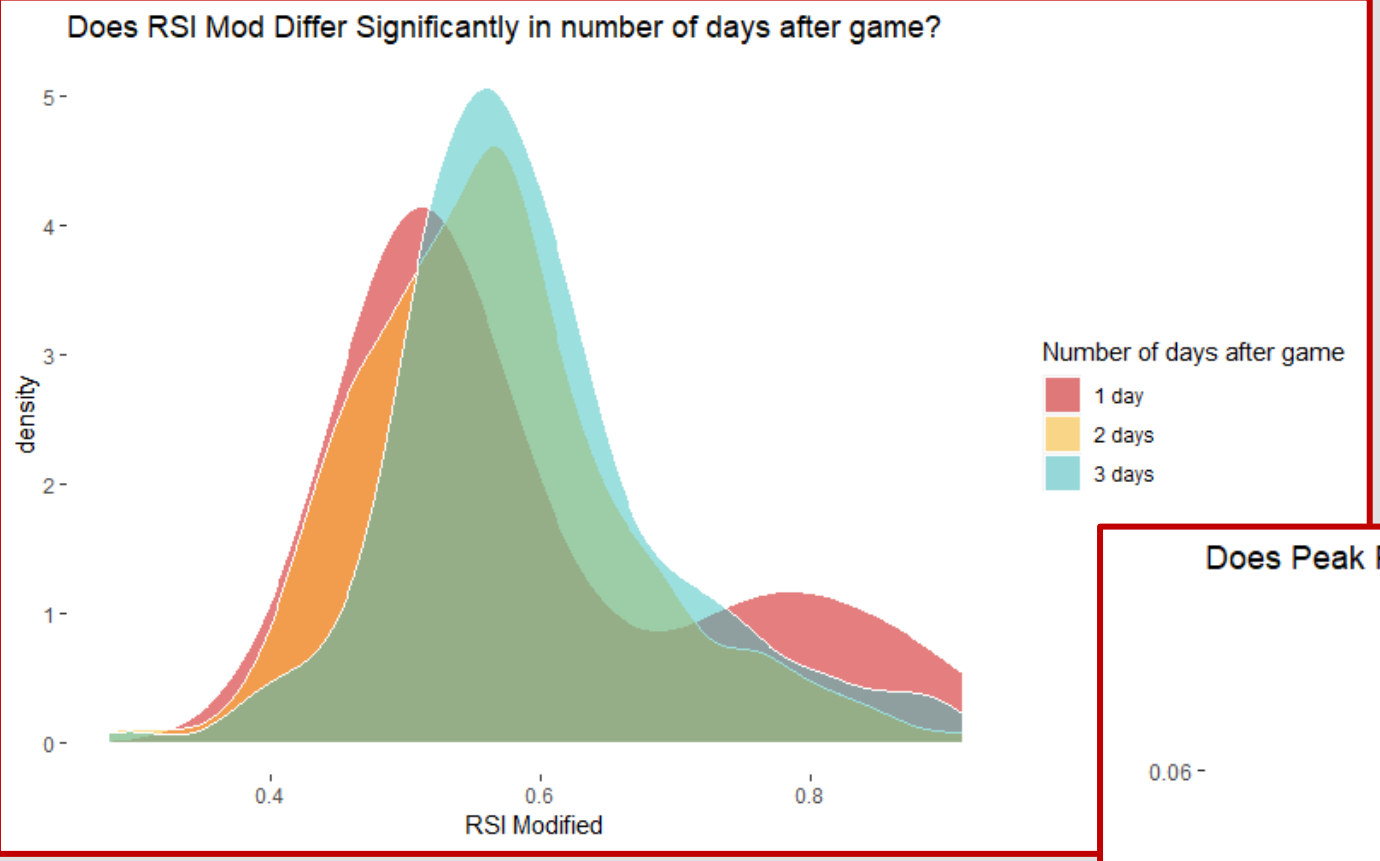

Player External Load by Type of Event
External Load
1000
750
500
250
0
Athlete
Event
Game
Lifting
Practice

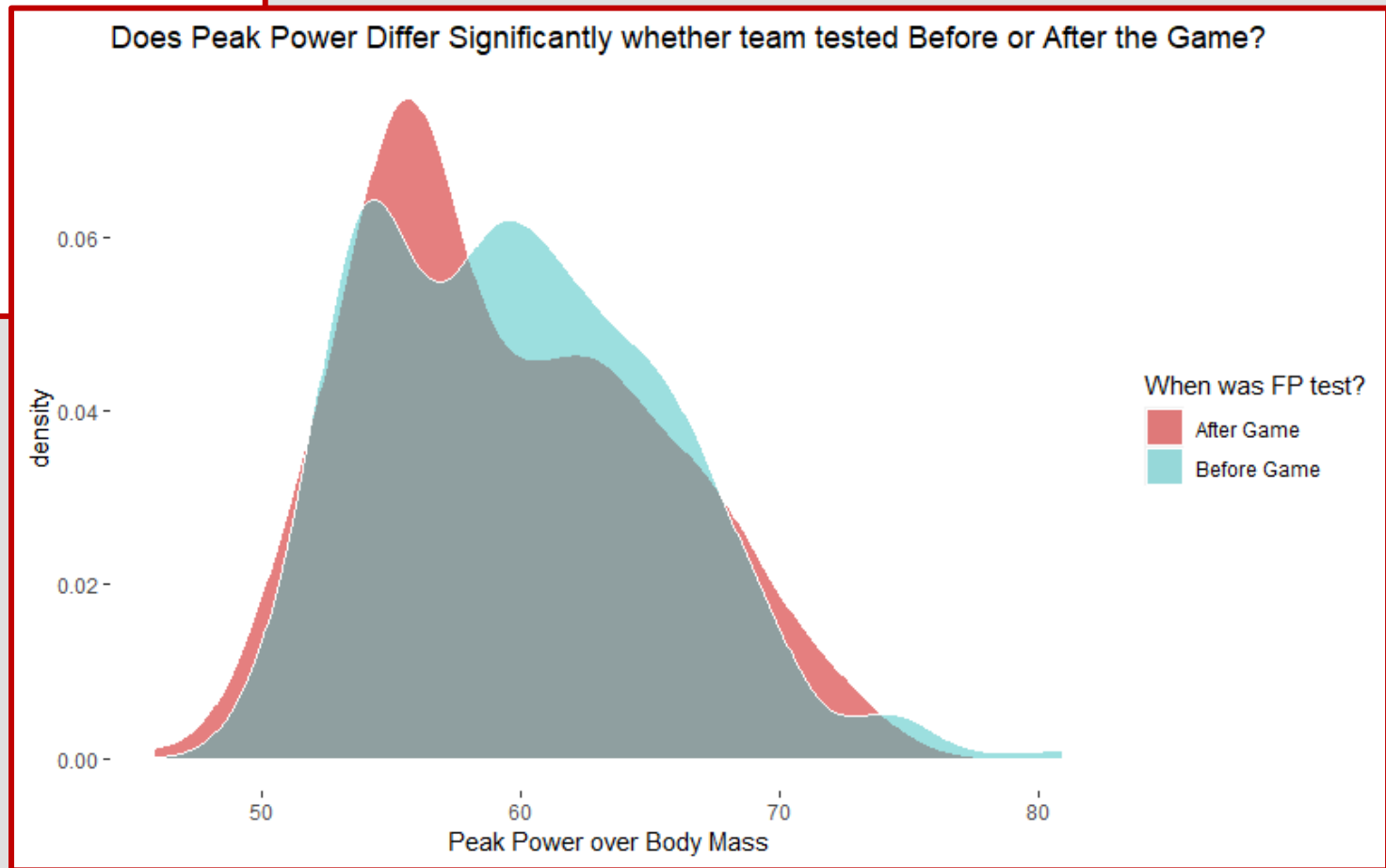

Does RSI Mod Differ Significantly in number of days after game?
count
80
60
40
20
0
0.4
0.6
0.8
RSI Modified
Number of days after game
1 day
2 days
3 days

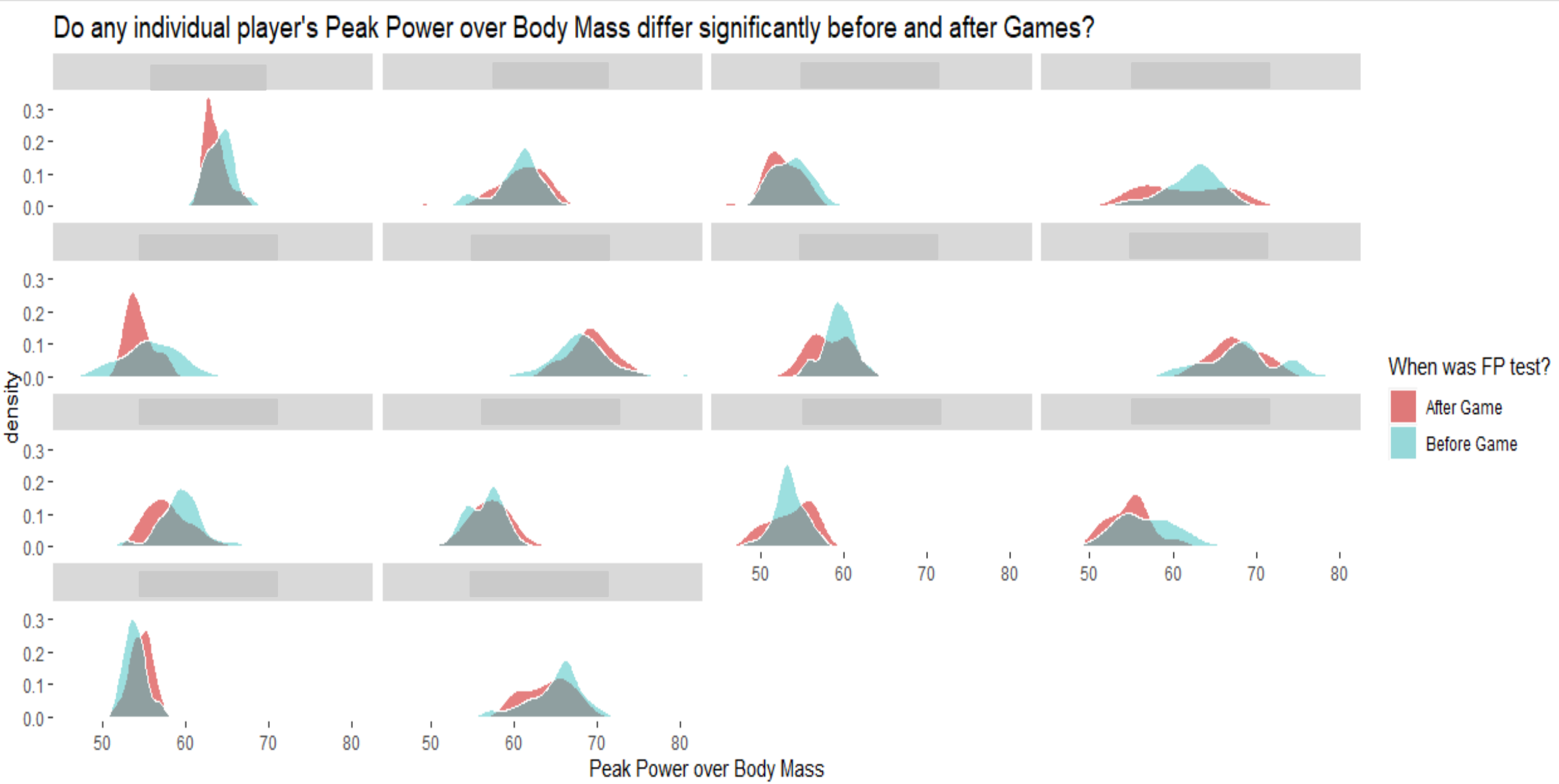

Does RSI Mod Differ Significantly before or after a game was played?
density
5
4
3
2
1
0
0.4
0.6
0.8
RSI Modified
When was FP test?
After Game
Before Game

Analysis

- Performed significance tests to see which variables differed significantly between Force Plate tests that occurred before and after games
  - Peak Power over Body Mass, RSI Modified, Concentric Impulse
  - Also performed on number of days test was carried out before and after games


Does RSI Mod Differ Significantly in number of days after game?
density
5
4
3
2
1
0
0.4
0.6
0.8
RSI Modified
Number of days after game
1 day
2 days
3 days


Does Peak Power Differ Significantly whether team tested Before or After the Game?
density
0.06
0.04
0.02
0.00
50
60
70
80
Peak Power over Body Mass
When was FP test?
After Game
Before Game


Do any individual player's Peak Power over Body Mass differ significantly before and after Games?
density
0.3
0.2
0.1
0.0
50
60
70
80
Peak Power over Body Mass
When was FP test?
After Game
Before Game

Implementation into Dashboard

- Chose PowerBI because it is accessible for coaches and can link easily with SharePoint datasets along with future APIs
- Dashboard went through many iterations before we landed on a final design
- Experimented with using R visualizations in PowerBI

Player Fatigue Monitoring Dashboard Demo

Moving forward

- Implement other data sources into dashboard
  - Strive, Motion Capture, Lift data
- Implement R-Studio visualizations and trial analysis into PowerBI dashboard
- Aggregate +/- scores to use in modeling process for important variables across data sources
  - Increased ability to help performance
- Increase accuracy as more data for new players is added
  - Better data collection processes

Men's Basketball

Position

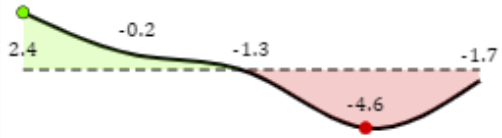
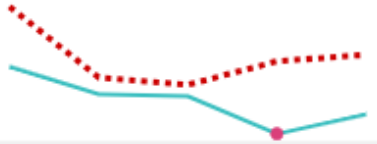
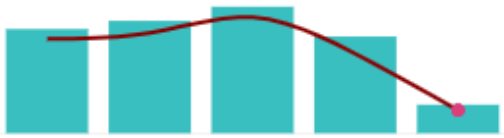
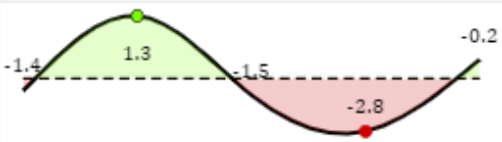
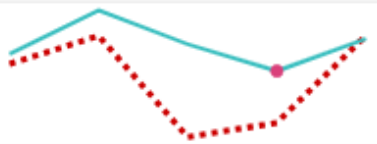
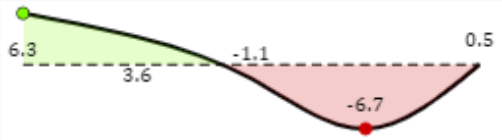
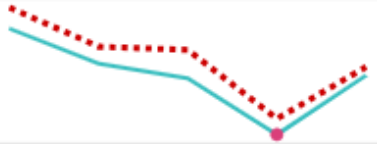
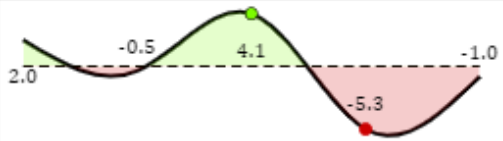
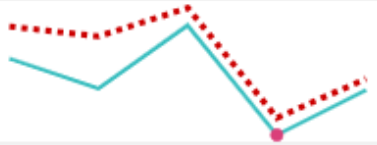
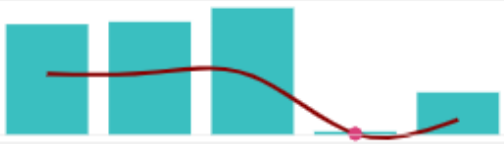
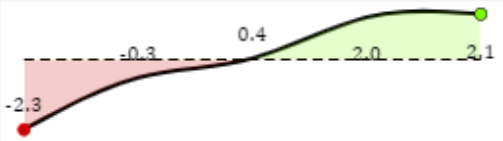
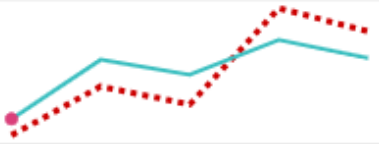
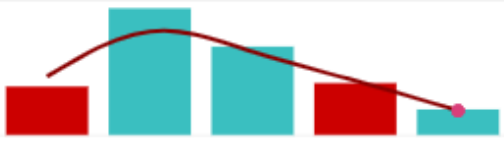
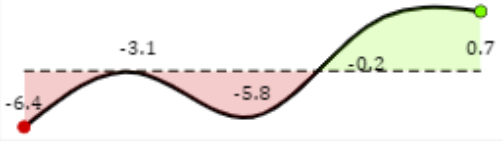
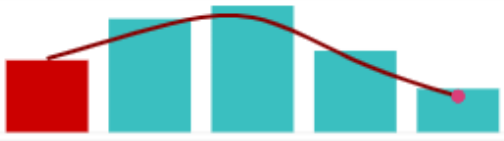
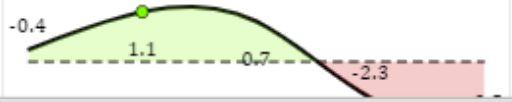
- Big
- Guard
- Wing

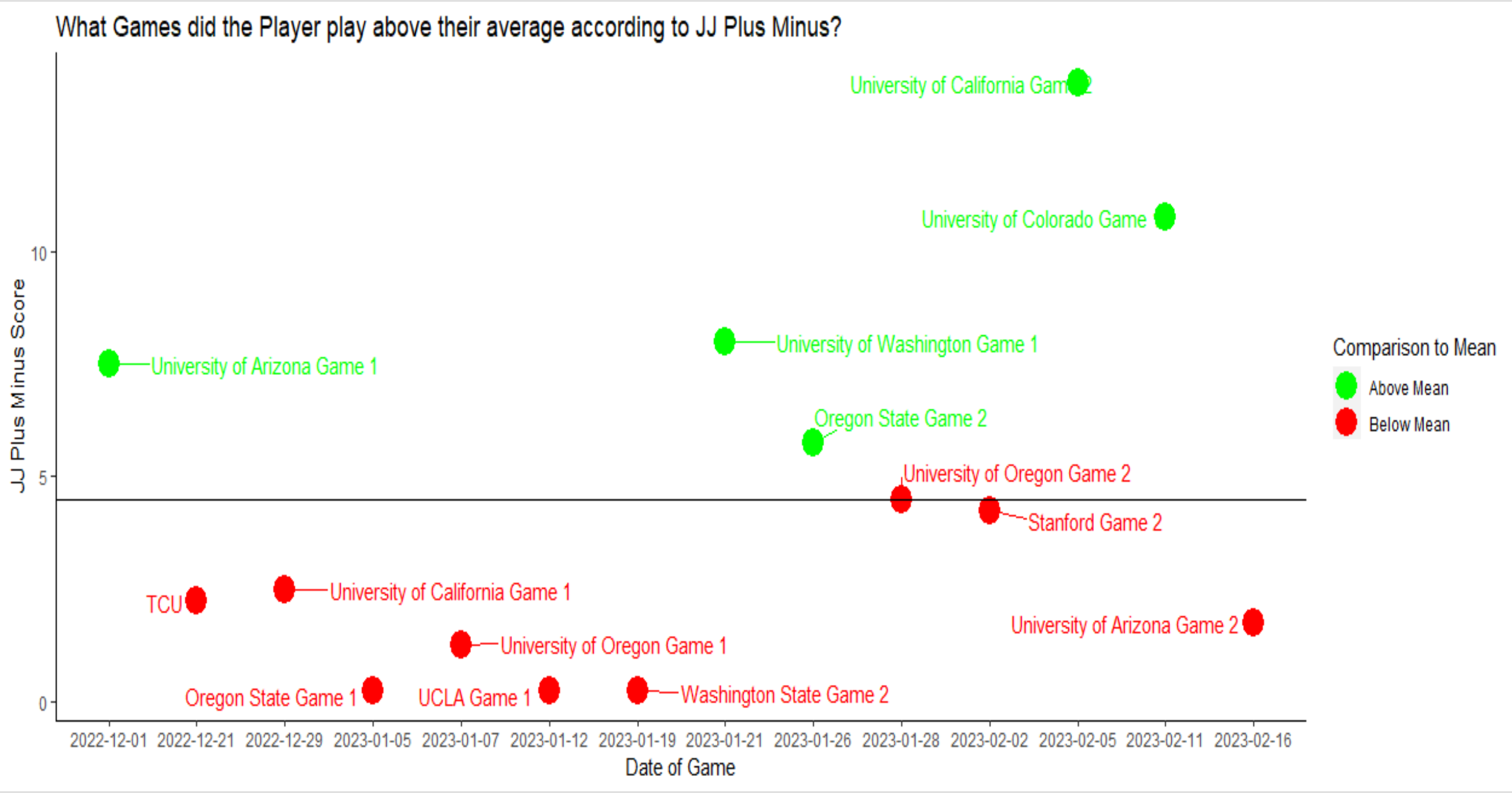
Date Filter

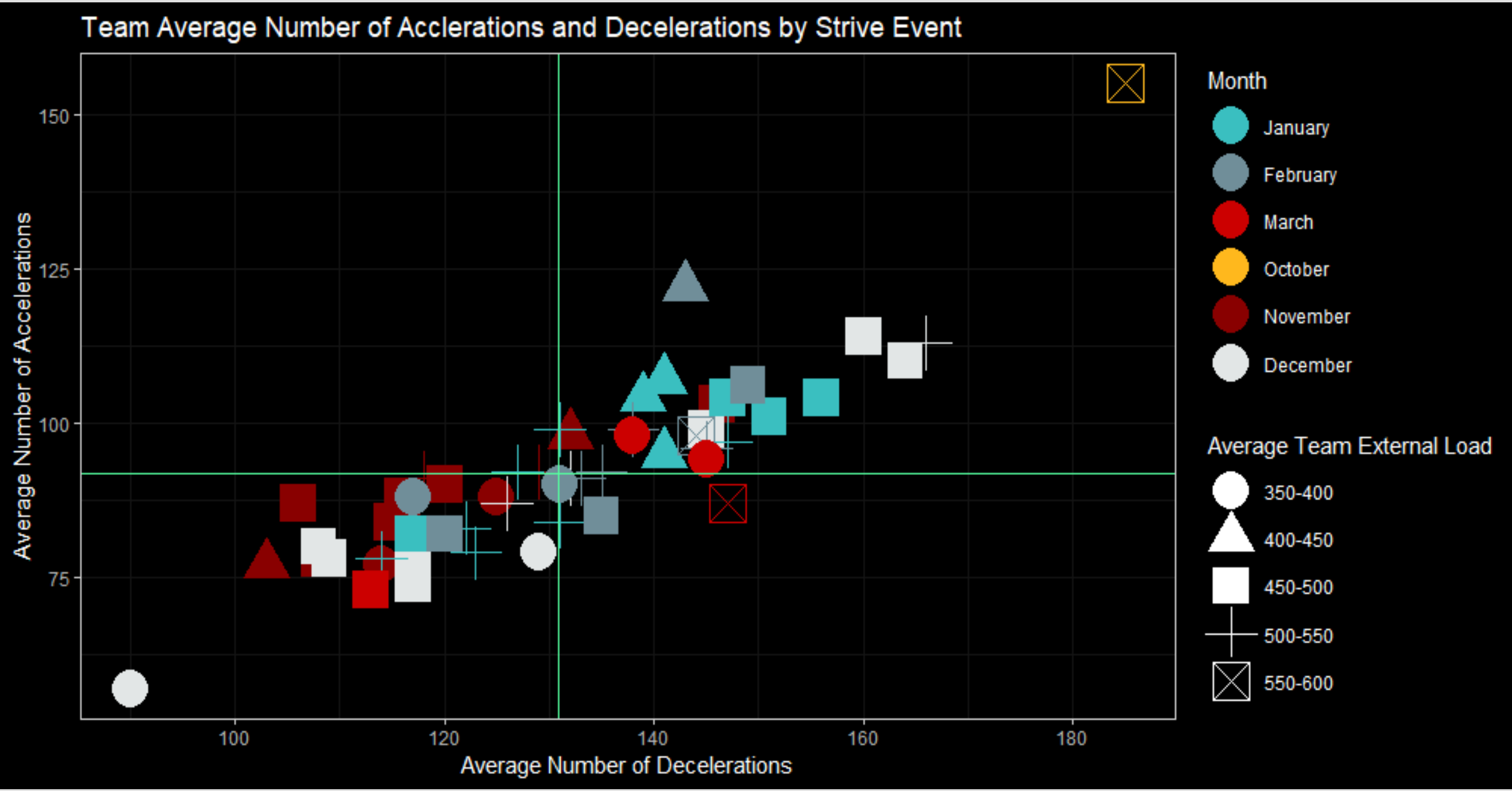
10/15/2022 — 3/23/2023

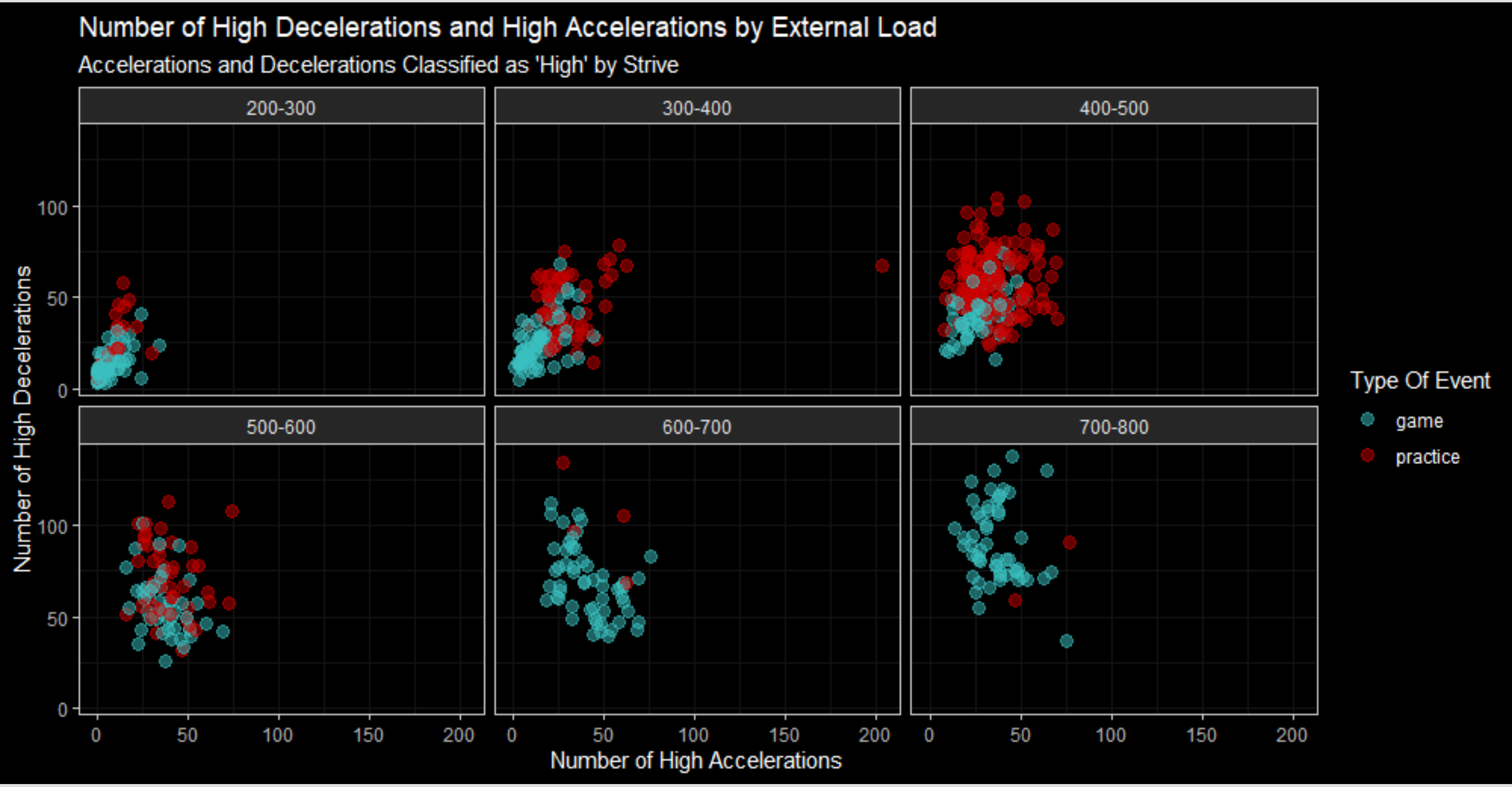
Average External Load from Previous Strive Session

Percentage of **"High" Accelerations and Decelerations**

Player Name	Avg Peak Power	Average of ZScore_PP/BM	Average of Z-Score_RSImod	RSI ZScore / Peak Power/BM ZScore	Average Number Accelerations / Average Number Decelerations
Athlete 1	64.0				
Athlete 2	53.4				
Athlete 3	62.0				
Athlete 4	68.3				
Athlete 5	68.2				
Athlete 6	56.6				
Athlete 7	54.1				


What Games did the Player play above their average according to JJ Plus Minus?
University of California Game 2
University of Colorado Game
University of Washington Game 1
University of Arizona Game 1
Oregon State Game 2
University of Oregon Game 2
Stanford Game 2
TCU
University of California Game 1
University of Arizona Game 2
University of Oregon Game 1
Oregon State Game 1
UCLA Game 1
Washington State Game 2
JJ Plus Minus Score
10
5
0
2022-12-01
2022-12-21
2022-12-29
2023-01-05
2023-01-07
2023-01-12
2023-01-19
2023-01-21
2023-01-26
2023-01-28
2023-02-02
2023-02-05
2023-02-11
2023-02-16
Date of Game
Comparison to Mean
Above Mean
Below Mean


Team Average Number of Acclerations and Decelerations by Strive Event
Average Number of Accelerations
150
125
100
75
100
120
140
160
180
Average Number of Decelerations
Month
January
February
March
October
November
December
Average Team External Load
350-400
400-450
450-500
500-550
550-600


Number of High Decelerations and High Accelerations by External Load
Accelerations and Decelerations Classified as 'High' by Strive
200-300
300-400
400-500
500-600
600-700
700-800
Number of High Decelerations
Number of High Accelerations
0
50
100
150
200
Type Of Event
game
practice

Thank You