Analysis of Biomechanical Data for Gymnast Landing Trials

CS435: Computational Science || Professor: Haiyan Cheng
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Introduction

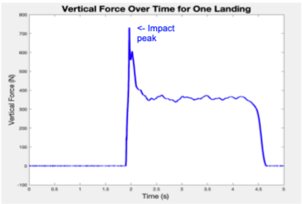
For our project we are analyzing the landing trials for gymnasts using signal processing and ground reaction force data. The gymnasts performed one legged landings on a force platform for both their dominant and non-dominant legs. Data representing stiffness of landing and balance was examined as they relate to performance and injury risk.

Research Questions

- How can we visualize the stiffness of a landing?
- Is there a difference between Dominant and Non-Dominant landings?
- How the stiffness of the gymnasts' landings compare to their peers?

Data

- This data consists of **18 gymnast trials**
- Each gymnast has a dataset for their body weight trial and two trials using both feet
- Variables we used:
  - Fz = Vertical loading rate with respect to time
    - This represents stiffness of the Landing. Stiffer landings are more dangerous than softer landings
  - COPx = The displacement of the figurative point of application of the resultant ground reaction force
    - This represents the stability of the landing

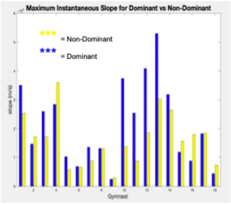


Calculations

We used MATLAB to loop through files and make the following calculations for each landing:

- Maximum instantaneous slope of Fz (Stiffness)
  - This is the maximum rate of force increase during a landing
- Maximum Fz or impact peak (Stiffness)
  - This is the maximum force applied to the body during an impact event like landing from a jump
- Maximum mediolateral CoP displacement (Balance)
  - This was calculated by subtracting maximum and minimum x-axis points on the force platform

Stiffness of Dominant vs Non-Dominant Leaps

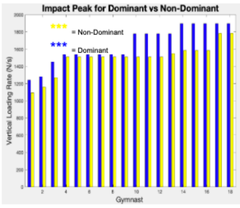


Comparing instantaneous slope for dominant vs non-dominant

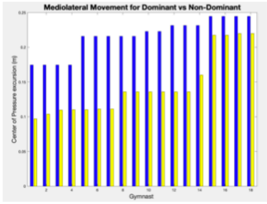
Most gymnasts have little difference between maximum instantaneous slope for dominant and non-dominant landings, however gymnasts 10, 11, 12 and 13 have a much higher stiffness for their dominant leg.

Comparing impact peak for dominant vs non-dominant

The Impact peaks for dominant vs. non-dominant landings show that there is a higher maximum vertical loading rate for the gymnasts' dominant landing. Therefore, there is a higher stiffness for their dominant leg.



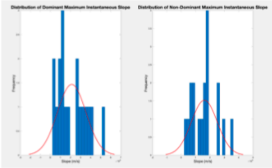
Balance of Dominant vs Non-Dominant Leaps



This graph shows the difference in mediolateral center of pressure excursion for dominant and non-dominant landings. This tells us that landings on the dominant foot tended to have higher instability.

Distribution of Stiffness of Landings

Both the left and right graph show a right skew, meaning a majority of the gymnasts performed with a maximum instantaneous slope between 0 - 2 m/s. We have outliers that performed with a significantly stiffer landing than the others.



Summary

- Overall, gymnasts had stiffer landings and less balance on their dominant leg. This was derived through calculations of instantaneous slope, impact peak, and difference in mediolateral center of pressure.
- The difference in dominant and non-dominant landings could be due to differences in strength. These gymnasts likely use their dominant leg more often, possibly giving them more confidence and strength on that leg.

Acknowledgments

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