THE UNIVERSITY of TENNESSEE CHATTANOOGA

LONGITUDINAL CHANGES IN COUNTERMOVEMENT JUMP PERFORMANCE IN A DIVISION I WOMEN'S SOCCER TEAM

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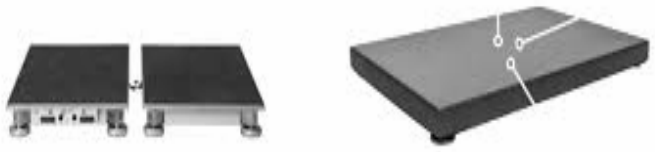
Disclosure

Authors have no conflicts of interest to disclose.

Introduction

- The ability to quantify jump performance and lower limb muscle function in athletes would be beneficial for both training and rehabilitation purposes.[1]
- Measures of movement quality may be an effective method for identifying individuals who are at a high risk of injury.[2]
- Analyzing the relationship between training loads and key performance measures can help guide training plans and assess an athlete's readiness to compete.[3]
- The Countermovement Jump is the most common test of lower body neuromuscular function in peer-reviewed studies involving athletes.[3]



https://www.hawkindynamics.com/blog/what-is-a-force-plate

Introduction

- An important thing to consider is the comparison between single and double leg tasks. Single-leg landings present a greater challenge to maintaining proper mechanics.[5]
- Waveform (force-time) analysis, rather than analyzing discrete variables, may have implications for injury screening and intervention.[5]
- The countermovement jump possesses qualities that can be best analyzed by waveform analysis.[5]

https://moticon.com/the-counter-movement-jump-relevance-outcome-metrics-and-tips-for-trainers

Purpose Statement

To analyze single- and double-leg CMJ force-time waveforms before and after a single soccer season to assess jump performance in each limb.

Participants & Study Design

- Demographics
  - 22 Division I Women's Soccer Athletes
  - 19.2 ± 1.15 years
  - 167.62 ± 5.86 cm
  - 63.61 ± 7.10 kg
- Inclusion criteria
  - Varsity athlete
  - Female
  - Ability to complete jumping task
- Each participant provided written informed consent (IRB #: 23-052)

Longitudinal Within-Subjects Study

- Independent Variables
  - Session: Pre/Post test
  - CMJ Task: Single/Double
  - Limb: Left/Right

Methods

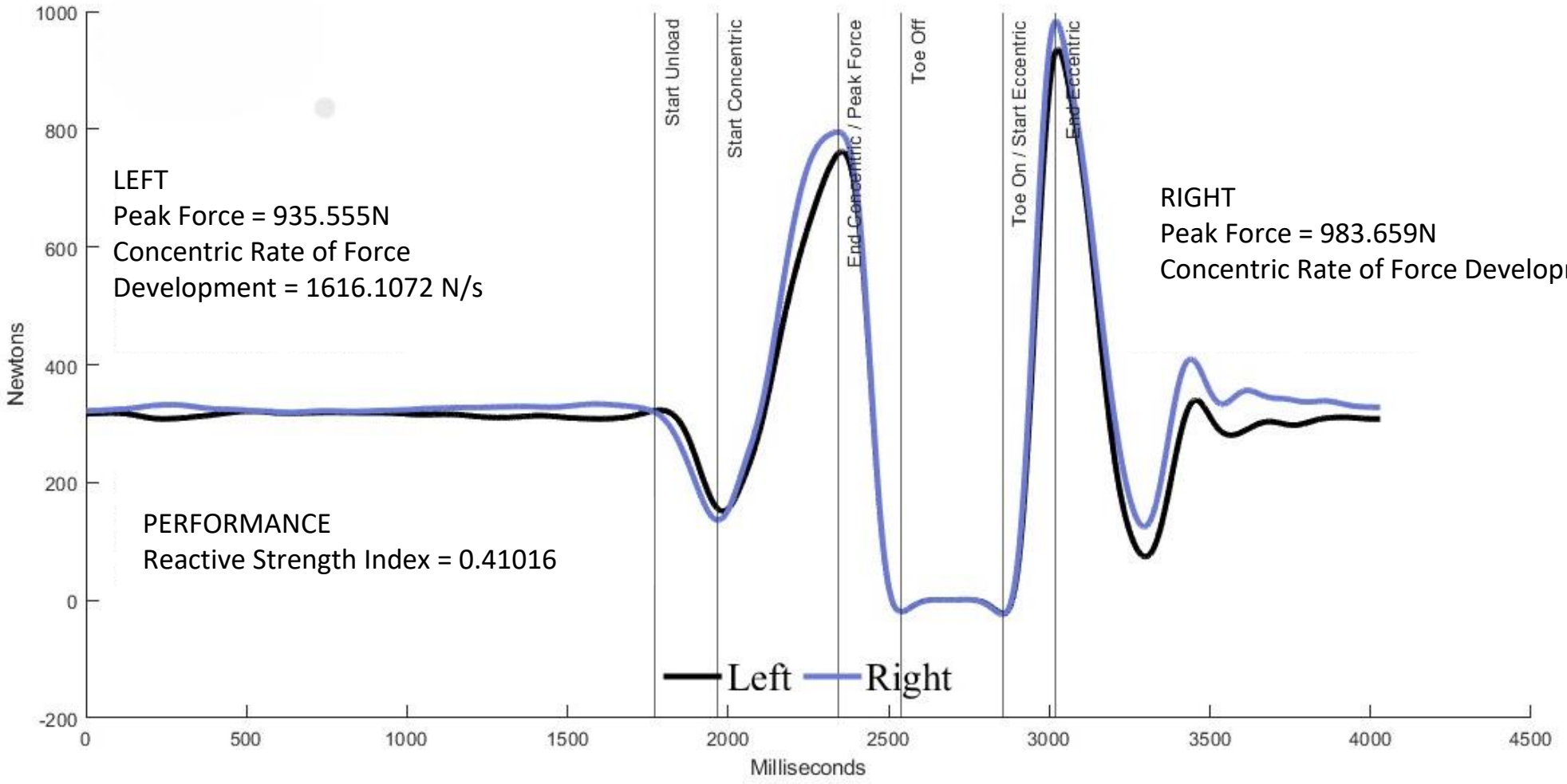
- 22 female soccer players performed 3 different jumps before and after the season.
  - Double leg, followed by right and then left single-leg countermovement jumps.
    - Told to stand with one foot on each force plate
    - Told to put hands on hips
    - Quick load
    - Minimize time on the ground
    - Maximize time in air
    - Given familiarization rounds
    - One maximal jump was collected for subsequent analysis

https://www.sportsmith.co/articles/guide-to-using-force-plates-in-sports-performance/

Data Handling

- Triaxial side-by-side embedded force plates (Bertec, Columbus, OH, USA) captured force plate data at 1000 Hz.
- Data were low-pass filtered at 5 Hz and exported from Vicon Nexus.
- Custom MATLAB script was generated to process force plate data and generate waveforms.
  - Landmark registered to toe-off
  - One second before toe-off to one second following toe-off
  - Interpolated to 202 data points
- Discrete data were assembled using values from the waveforms.
  - Peak force (PF)
  - Concentric rate of force development (CRFD)
  - Reactive strength index (RSI)

Descriptive Waveform—Dependent Variables

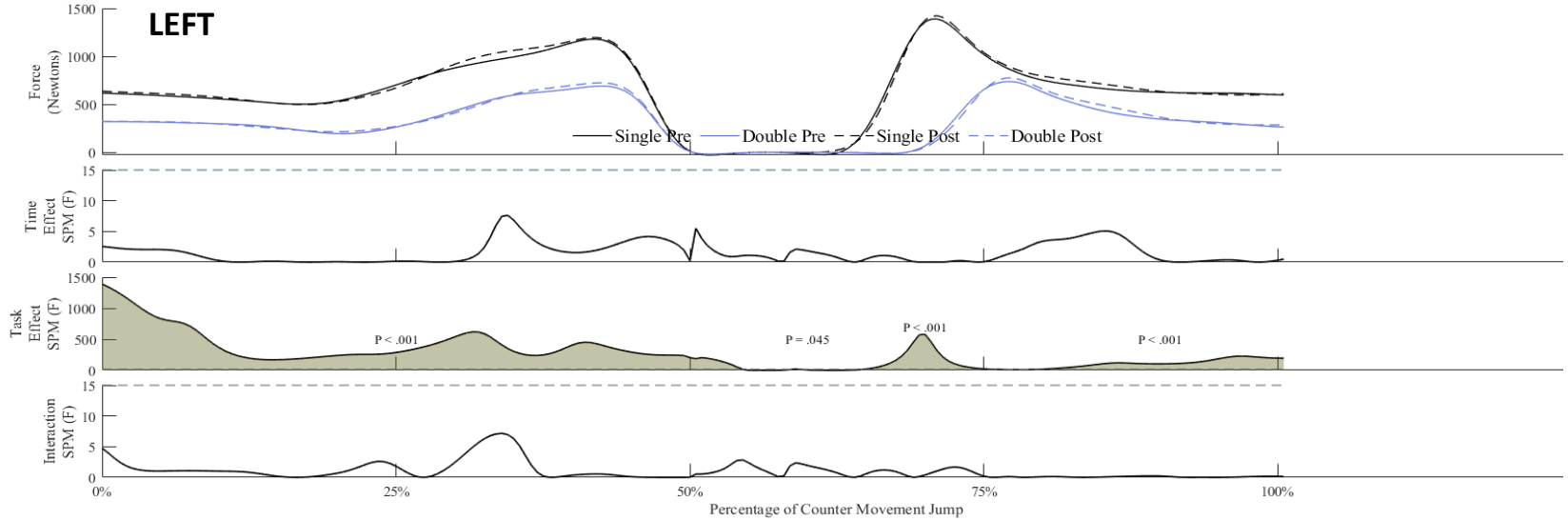


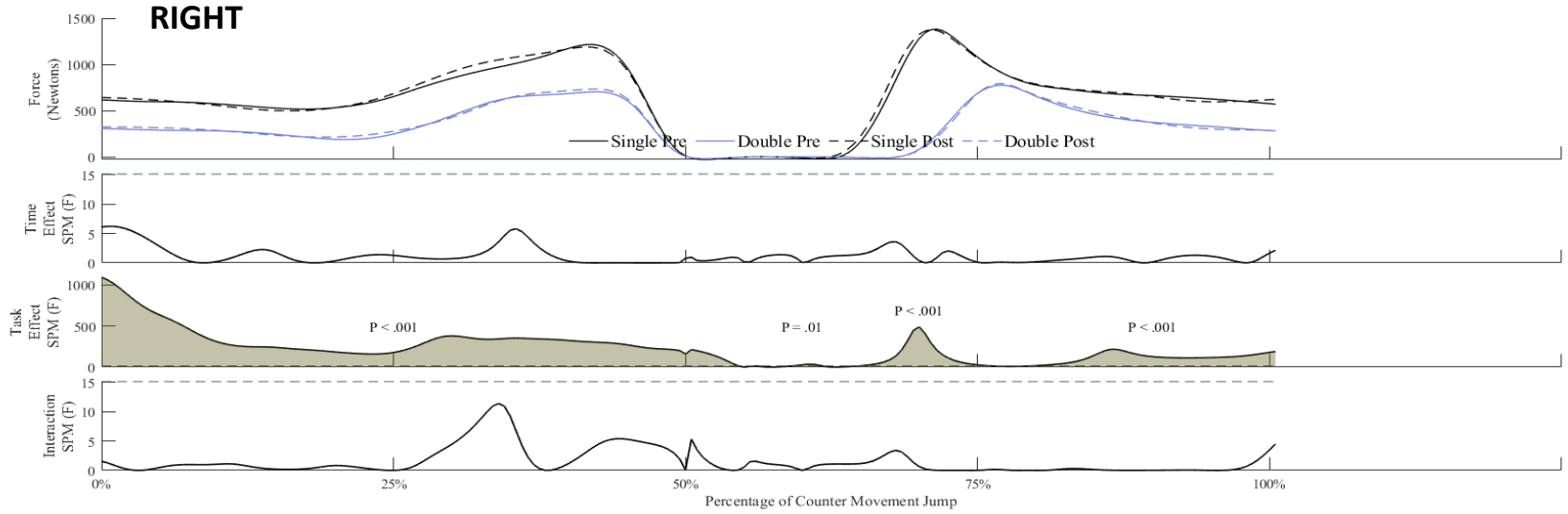
Statistical Analyses

- **Waveform analyses**—4 separate 2x2 statistical parametric mapping (SPM) RMANOVAs
  - For each limb, task (single leg CMJ / double leg CMJ) x time (pre / post)
  - For each task, limb (right / left) x time (pre / post)
- **Discrete analyses**—7 2x2 RMANOVAs for discrete variables
  - Task by Time – peak force for each limb (left / right)
  - Limb by Time – peak force, CRFD for each task (single leg CMJ / double leg CMJ)
  - For single leg CMJ, RSI was also inspected in a limb by time analysis

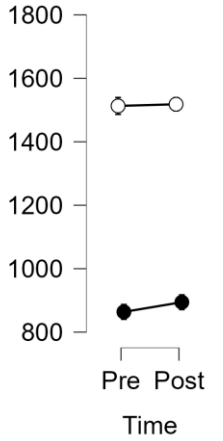
- A priori significance level ($p < .05$)
- Partial η^2 were interpreted as .01 (small), .06 (medium), and .14 (large)[7]
- MATLAB (R2022a, Mathworks, Natick, MA, USA) was used to run SPM (spm1d.org) code
- JASP (0.16.2.0) was used for all discrete analyses

Results—Task x Time





LEFT SIDE PEAK FORCE

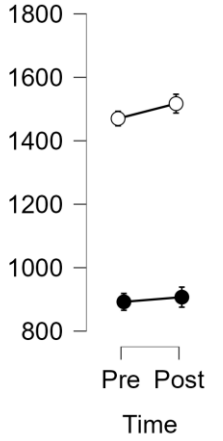


Task P = <.01: Partial η^2 = 0.96

Time P = 0.43: Partial η^2 = 0.03

Task x Time P = 0.49: Partial η^2 = 0.02

RIGHT SIDE PEAK FORCE



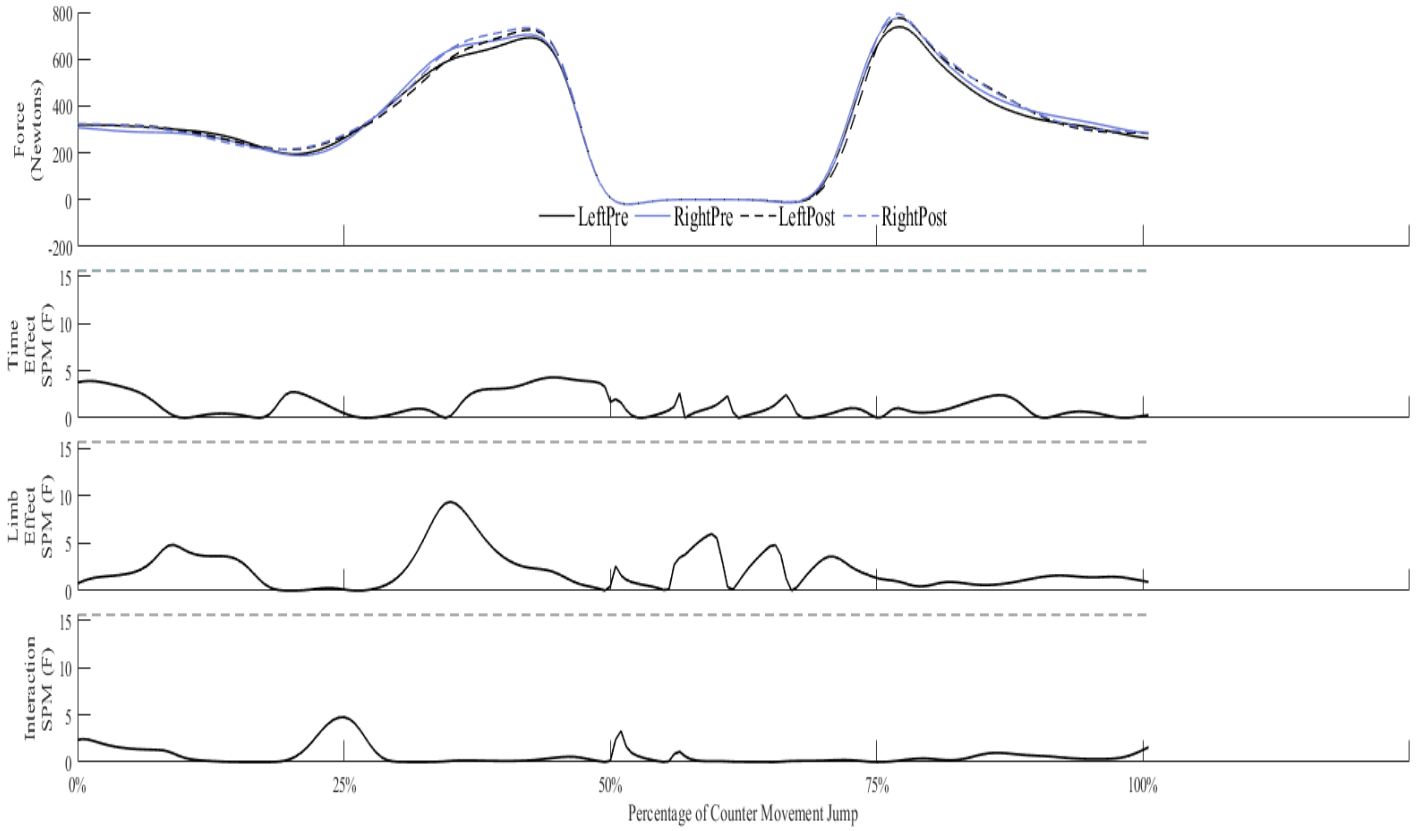
Task P = <.01: Partial η^2 = 0.94

Time P = 0.25: Partial η^2 = 0.06

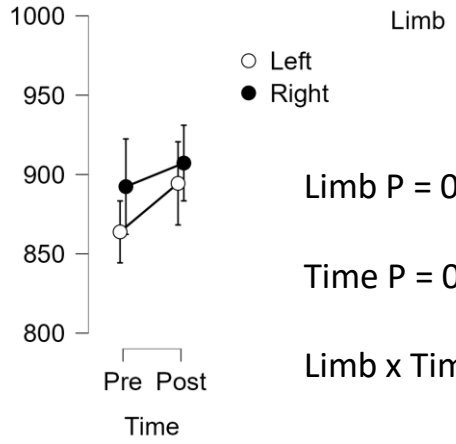
Task x Time P = 0.47: Partial η^2 = 0.03

Results—Limb x Time Double Leg

DOUBLE LEG CMJ



PEAK FORCE

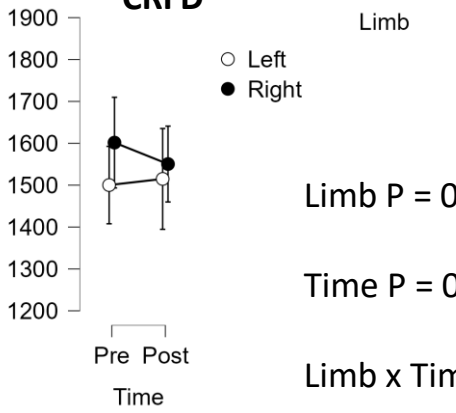


Limb P = 0.48: Partial $\eta^2 = 0.02$

Time P = 0.31: Partial $\eta^2 = 0.05$

Limb x Time P = 0.76; Partial $\eta^2 = 0.01$

CRFD



Limb P = 0.19: Partial $\eta^2 = 0.08$

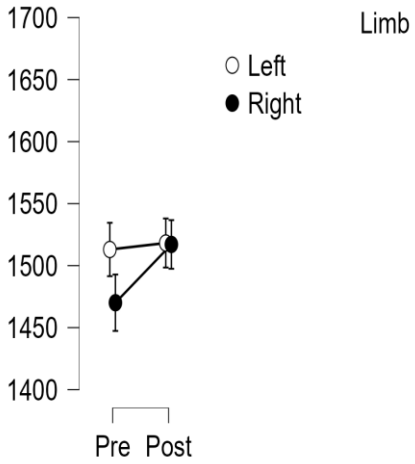
Time P = 0.92: Partial $\eta^2 = < .01$

Limb x Time P = 0.25: Partial $\eta^2 = 0.06$

Results—Limb x Time Single Leg

SINGLE LEG CMJ

PEAK FORCE

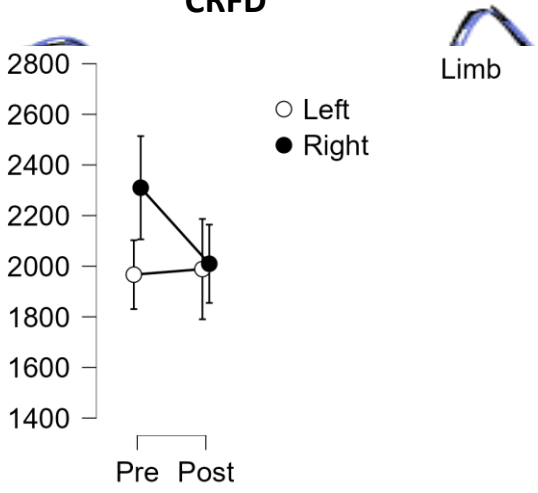


Limb P = 0.30: Partial η^2 = 0.05

Time P = 0.34: Partial η^2 = 0.04

Limb x Time P = 0.12: Partial η^2 = 0.11

CRFD

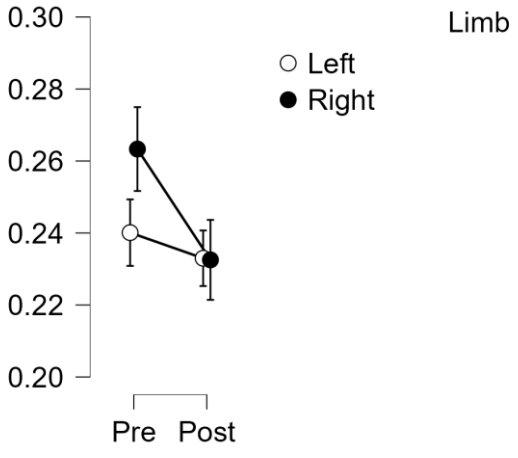


Limb P = 0.23: Partial η^2 = 0.07

Time P = 0.56: Partial η^2 = 0.02

Limb x Time P = 0.23: Partial η^2 = 0.07

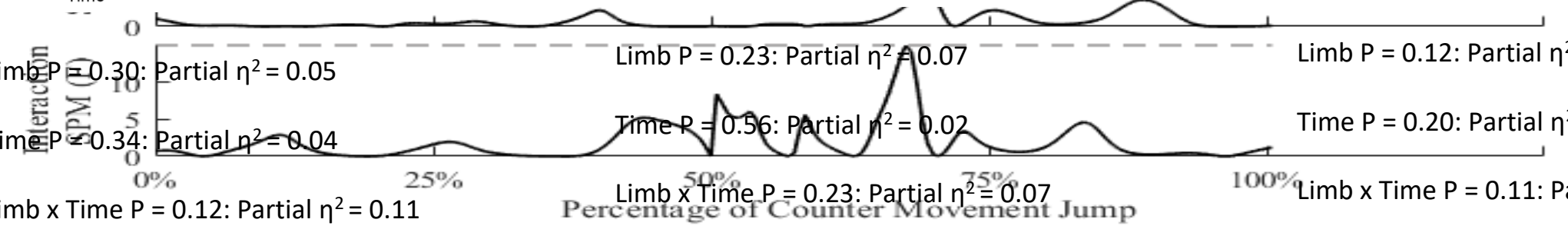
RSI



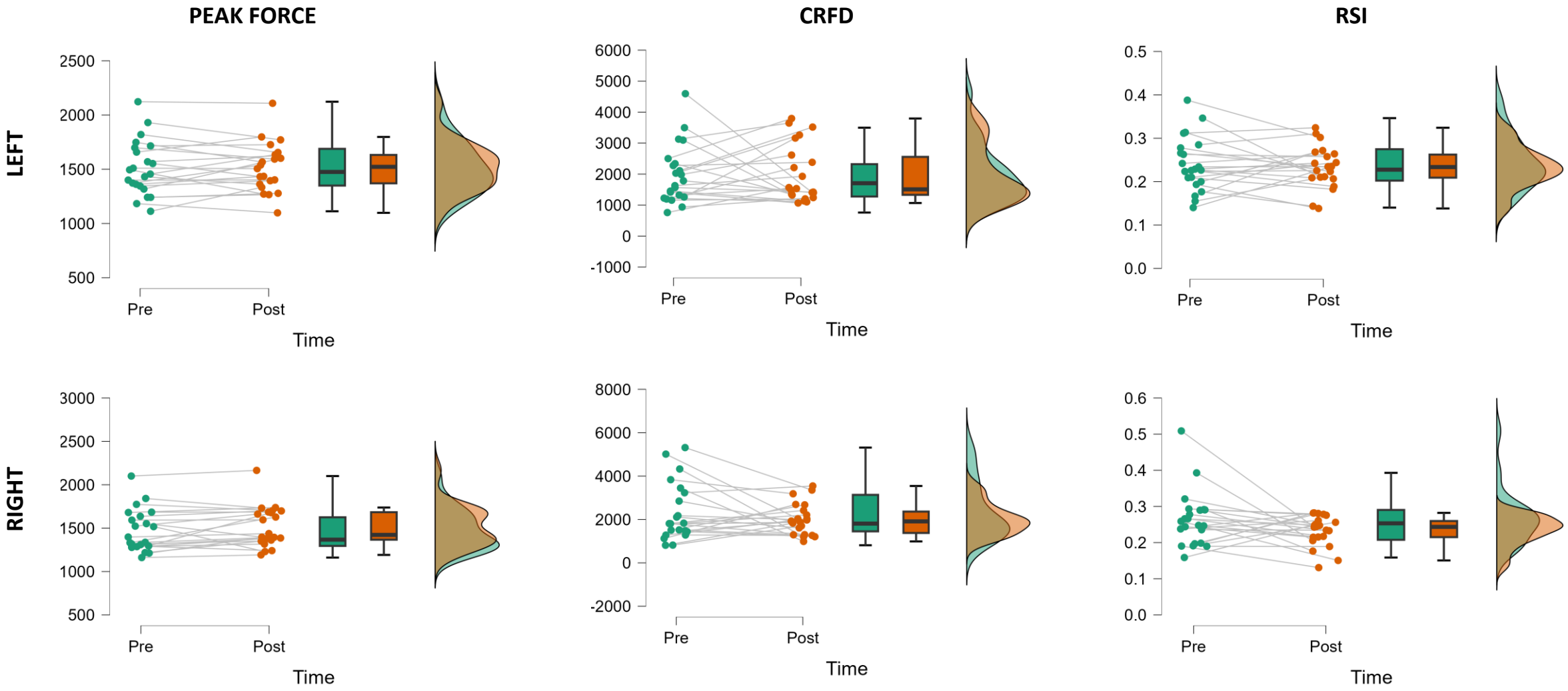
Limb P = 0.12: Partial η^2 = 0.11

Time P = 0.20: Partial η^2 = 0.08

Limb x Time P = 0.11: Partial η^2 = 0.12



Results—Limb x Time Single Leg – Raincloud Plots



Discussion

- Single-leg CMJ exposes more differences than double-leg CMJ
  - Single leg does not allow for compensation
  - This has been observed with double and single-leg forward hopping.

- Pre – Post single leg CMJ differences
  - Decrease in R leg CRFD (Cohen's d = -0.23)[5]
  - Increase in R leg Peak Force (Cohen's d = 0.33)[5]
  - Discrete vs Waveform Analysis

- Dominant leg and time
  - There are asymmetries between dominant and non-dominant limbs.[8]
  - Kicking leg is an open kinetic chain movement
  - Plant leg is a closed kinetic chain movement

Clinical Relevance

- Single-leg assessment
  - Asymmetry measurements
  - Closed vs Open kinetic chain movement analysis
  - Concentric vs Eccentric strength

- Closed-chain kinetic movements for dominant kicking leg
  - Right leg is getting weaker eccentrically and slower concentrically

- Vald Force plate data:
  - Force x Time curves
  - Analyzes waveform data automatically
  - Peak landing force (Vald) = peak force (current data)

Limitations of the Study

- Small sample size – underpowered for injury analysis
  - May not have everyone complete pre/post data due to injury
  - 26 --> 22 athletes
  - Difficult to match injuries to uninjured appropriately

- Unable to control for other potentially salient variables
  - Position
  - Year in school
  - Height/Mass
  - Starter/Non-starter

Future Research

- Further research is needed to explore single-leg asymmetries between dominant and non-dominant limbs using waveform and discrete force-plate data.
  - Look at single-leg data
  - Dominant leg

- Injury data can be difficult to gather
  - Bigger sample size
  - Match comparisons as close as possible
  - More in-season single-leg limb assessments

References

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