ADAPTATIONS OF PATELLAR TENDON THICKNESS IN WOMEN ATHLETES AND ASSOCIATIONS BETWEEN EXTERNAL WORKLOAD AND NEUROMUSCLAR PERFORMANCE ACROSS A COMPETITIVE VOLLEYBALL SEASON

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BACKGROUND

- Patellar tendon morphology is influenced by high volumes of mechanical load experienced during high-impact sports.
- Monitoring tendon thickness using ultrasound (US) imaging, athlete workload, and neuromuscular performance provides valuable insights into tissue-specific adaptations and injury risk.
- Maladaptation indicate heightened risk for patellar tendinopathy and increase risk of injury

PURPOSE

- Investigate how neuromuscular performance and internal/external load affect changes in patellar tendon thickness (PTT) across a competitive season using hierarchical linear modeling (HLM).

METHODS

- National Collegiate Athletic Association Division I women volleyball athletes (n=16; mean ± SD; age: 19.59 ± 1.50, height: 176.73 ± 7.37 cm, weight: 75.35 ± 9.40 kg, %bodyfat: 28.75 ± 3.59) participated across a 16-week competitive season.
- *Daily Measures* were collected via inertial measurement units (IMU) worn at the waist. And data included the following:
  - *External Load:* IMU-based jump counts, elevated landings (ELS) (>15 Gs), Number of Jumps +15 and +20 inches
  - *Internal Load:* Session Rating of Perceived Exertion (sPRE)
- *Weekly Measures* were collected on the same day each week and included the following:
  - PPT via 2D ultrasound at three locations: Proximal (PPTT), Middle (MPTT), and Distal (DPTT) on the dominant (D) and Nondominant (ND) limb (Figure 1.)

KEY FINDINGS

Ultrasound imaging combined with athlete load monitoring can identify structural and performance changes across a competitive season.

Ultrasound Image of the Patellar Tendon

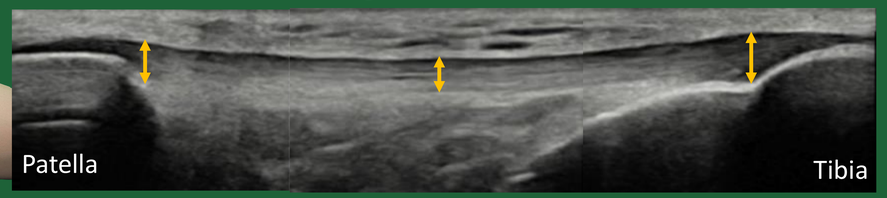
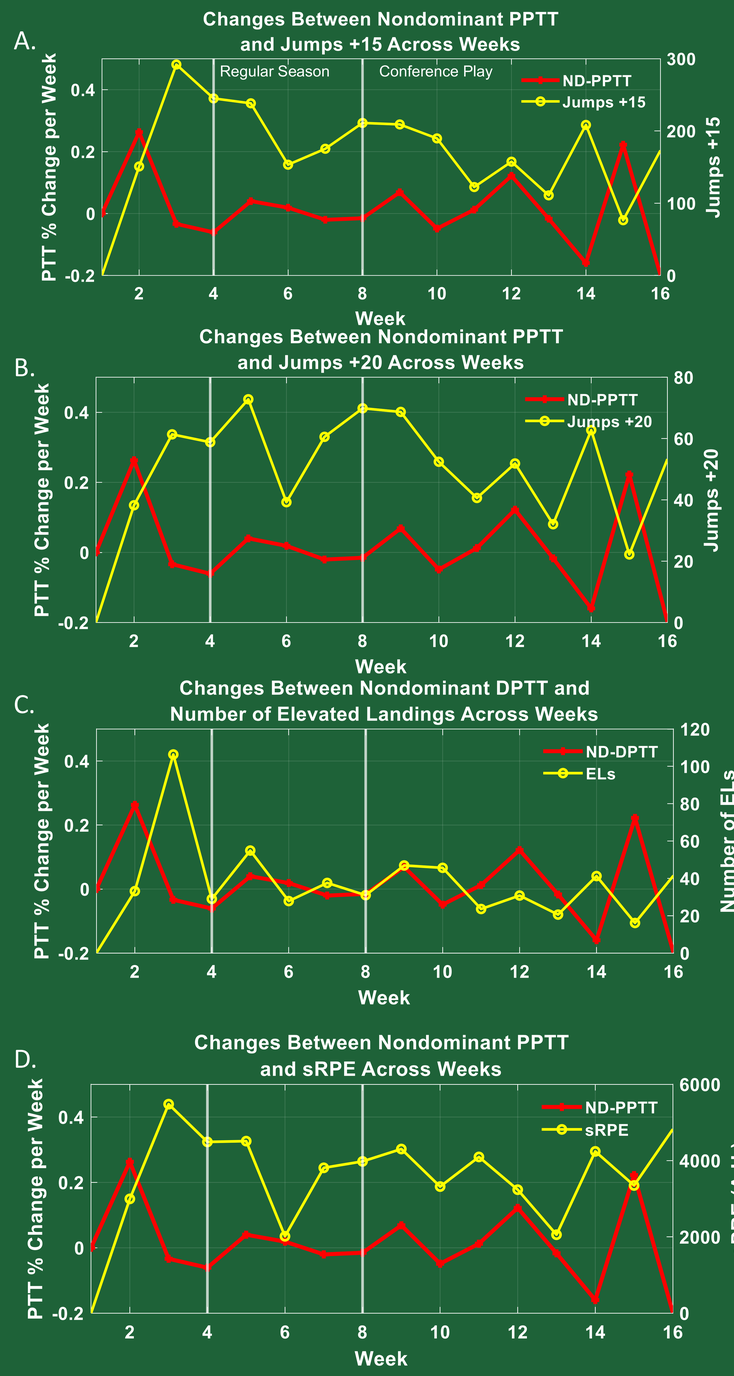


Figure 1. Weekly ultrasound protocol to obtain patellar tendon thickness measurements at the proximal, middle, and distal end



Nondominant PPTT → Number of Jumps + 15 inches

Nondominant PPTT → Number of Jumps + 20 inches

Nondominant DPTT → Number of Elevated Landings

Nondominant PPTT → sRPE

Figure 2. Results of HLM Models.

STATISTICAL ANALYSIS

- Hierarchical Linear Modeling (HLM) was used to assess weekly changes in patellar tendon thickness
- Random intercepts for each athlete and random slopes for time (week) were included to model individual variation.
- Statistical significance was set at $p < 0.05$. All analyses were performed in R.

RESULTS

- Figure 2A: As ND-PPTT increases the number of jumps +15 inches decreases ($p<0.05$).
- Figure 2B: As ND-PPTT increases the number of jumps +20 inches decreases ($p<0.05$).
- Figure 2C: As ND-DPTT increases number of elevated landings decreases ($p<0.05$).
- Figure 2D: As ND-PPTT increases sRPE decreases ($p<0.05$).

CONCLUSIONS and PRACTICAL APPLICATIONS

- High jump intensity (>20”) led to increased PTT, suggesting site-specific vulnerability and the potential for overload in response to repeated high-stress activities.
- The ND limb was most affected due to high load, and which could be caused by sport specific jump mechanics.
- Jump loads decreased when PPT was high; possibly due to proactive load management or accumulated fatigue.
- Weekly monitoring using ultrasound and workload metrics provides actionable insights, allowing for individualized recovery strategies to reduce injury risk and enhance performance sustainability across the season.

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Effort sponsored by the Government under Other Transactions Number HT9425-24-9-0019