Effect of increased dietary protein intake and source on resistance training-induced changes in skeletal muscle and patellar tendon properties in older women

Nathan WC. Campbell1, Sarah E. Preston1, Rebecca L. Lewis3, Chloé M. Garret1,2, Hannah M. Winestone1, Anna Barker1, Camila Reyes1, Lucas S. Stouder1, Johnny M. Vanos3, Wayne W. Campbell2, and Chad C. Carroll1

1Department of Health and Kinesiology and the 2Department of Nutrition Sciences, Purdue University, West Lafayette, IN campbell303@purdue.edu

Disclosures: None

INTRODUCTION: The objective of this study was to assess the effects of consuming a higher protein, predominantly from lean beef, compared to normal protein or higher protein with less beef on skeletal muscle responses after 12-weeks resistance training (RT). Tendons are strong, flexible tissues connecting muscles to bones. Musculoskeletal function and injury risk are dependent, in part, on the biomechanical and morphological properties of tendons. Sarcopenia, loss of muscle mass and strength, remains a well-established consequence of normal aging. In addition, tendon pain and injury are among the most common musculoskeletal disorders and a significant healthcare problem, especially in older adults. We hypothesized that a healthy diet high in protein emphasizing lean beef would augment improvements in skeletal muscle and tendon responses to RT compared to a healthy diet with normal or high protein and less total red meat. Our primary outcomes were changes in quadriceps skeletal muscle volume and strength, patellar tendon cross-sectional area (CSA), and magnetic resonance imaging (MRI) T2-star (T2*) signal.

METHODS: For this investigator-blinded study (Purdue University IRB 2019-218; ClinicalTrials.gov (NCT04347447)), 36 women (age: 66±1y, BMI: 28±1 kg/m²) were randomized to consume a U.S.-Style Healthy Dietary Pattern (all foods provided) with: 1) high-protein emphasizing unprocessed lean beef (1.4g protein/kg body weight/day-beef); 2) HP with mixed protein sources (1.4g/kg body weight/day-mixed); or 3) lower-protein (0.8g protein/kg body weight/day-mixed). All participants performed supervised progressive RT 3x/week (~70% of 1 repetition maximum) for 12 weeks focusing on the quadriceps muscles. Pre- and post-intervention, we measured maximum knee extension strength via 1-repetition maximum and quadriceps muscle volume via MRI. Patellar tendon images were collected immediately following thigh muscle scans. Images were obtained using the Siemens MAGNETOM PRISMA 3T whole-body MRI system combined with a 15-channel Tx/Rx Knee Coil (Siemens, Munich, Germany). T2-star* images were obtained in 4-mm axial slices (no gap) from the distal pole of the patella to the tibial tuberosity, with no interslice gap (TR: 900 ms, TE: 4.3 ms; Field of View: 160x160, Resolution: 320x320, Voxel Size:0.5x0.5x4, Flip Angle: 60°). Tendon CSA was determined by manually circumscribing the patellar tendon at each slice along the tendon length (Horos v3.3.6, www.horosproject.org).

RESULTS SECTION: Adherence to consuming the study foods was high (greater than 90% in all groups) and not different between groups (p>0.05). Blood urea nitrogen concentration (mg/dL) increased (p<0.05) in the 1.4 g protein/kg/day mixed (Pre: 16±2, Post: 20±2) and 1.4 g protein/kg/day beef (Pre: 18±1, Post: 16±1) but not in the group consuming 0.8 g protein/kg/day (p>0.05, Pre: 16±1, Post: 15±1). Quadriceps muscle strength increased with RT regardless of dietary group (Figure 1, *p<0.0001, main effect of RT). Quadriceps muscle volume increased with RT (*p<0.0001, main effect, Figure 2). The change in quadriceps volume was not different between dietary groups (p>0.05, Figure 2). We noted a trend for a RT effect on mean tendon CSA (p=0.07, main effect), but the change with RT was not different between dietary groups (p>0.05). In contrast, proximal tendon CSA increased with RT (p<0.05, Figure 3) with no statistical difference in the response between dietary groups (p>0.05, Figure 3). There was a trend for an increase in mid-tendon CSA with RT (p=0.05, main effect). The increase in mid tendon CSA tended to be greater in the group consuming 1.4 g protein/kg/day with beef than 0.8 g protein/kg/day (#p<0.1, Figure 4). No difference between the two higher protein groups in the change in mid tendon CSA was observed (p>0.05). Lastly, we found an interaction effect for distal patellar tendon CSA (p<0.05, Figure 5). Post-hoc analysis revealed a decrease in distal CSA in the 0.8 g protein/kg/day (*p<0.05, Figure 5) but no change with training in the 1.4 g protein/kg/day groups (p>0.05, Figure 5). The patellar tendon T2* signal was not different with RT in any dietary group (p>0.05).

DISCUSSION: This is the first report examining the impact of a combined dietary intervention and resistance exercise on skeletal muscle and tendon parameters. Although 1.4 g protein/kg/day beef did not result in additional muscle-centric training-induced outcomes, adults who followed a US Health Dietary Pattern increased quadriceps volume and strength. Further, we demonstrate that a chronic resistance training program for older adult women induced region-specific patellar tendon hypertrophy. We also noted a trend towards the benefit of higher protein intake when considering mid and distal tendon CSA.

SIGNIFICANCE/CLINICAL RELEVANCE: These results do not change the current Dietary Guidelines for Americans, which recommends that older women habitually consume a high-protein diet to promote skeletal muscle health. Our results suggest that further studies on protein intake and tendon health are warranted.

ACKNOWLEDGEMENTS: Funding Beef Checkoff to CCC and WC. Purdue University EVPRP COVID-19 Disruption Funds to CCC.