Baseline Associations of HR-pQCT Muscle Size with Muscle Function in Older Adults from the BEACON Trial

Nina Z. Heilmann[1], Joshua R. Stapleton[1], Eric Zeng[1], Kristin Cattell[1], Marjorie J. Howard[1], Daniel P. Beavers[1], Christine M. Swanson[2], Sarah J. Wherry[2], Kristen M. Beavers[1], Ashley A. Weaver[1]
[1]Wake Forest University School of Medicine, Winston-Salem, NC. [2]University of Colorado Anschutz Medical Campus, Aurora, CO.
Email of Presenting Author: Nina.Heilmann@AdvocateHealth.org

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INTRODUCTION: Greater muscle size generally correlates with higher muscle strength and power, though this relationship is rarely explored and appears inconsistent in obesity, likely due to the complex interplay of fat and muscle, and limitations in conventional methods for assessing muscle size. High-resolution peripheral quantitative computed tomography (HR-pQCT), traditionally used to measure bone, can be leveraged to precisely quantify muscle cross-sectional area (CSA), offering a novel approach for muscle evaluation in research settings. We aimed to investigate calf muscle CSA associations with leg strength and power in older adults living with overweight and obesity.

METHODS: Data come from the Bone, Exercise, Alendronate, and Caloric Restriction (BEACON) trial (NCT05764733; IRB00077185), which is enrolling older adults (age ≥60 years) with low bone mass (-2.5< DXA T-score ≤-1.1) and an indication for weight loss (BMI ≥30 kg/m^2 or BMI 25 to <30 kg/m^2 plus at least one obesity-related risk factor).[1] At the baseline visit, HR-pQCT scans were acquired at a 30% offset distance computed by percentage of the limb length from the distal tibia plafond. These scans were used to quantify calf muscle CSA (**Figure 1**). Participants' maximum leg strength (Newton meters, Nm) was assessed using an isokinetic dynamometer on the same limb as HR-pQCT scans when possible, and peak stair climb power (Watts, W) was measured via a 12-stair climb test.[2] Pearson correlations between calf muscle CSA and muscle function measures were calculated. Separate multivariable linear regression models were used to examine associations of calf muscle CSA with leg strength and stair climb power, with adjustments for age (years), sex (female vs. male), race (White vs. Black vs. other), BMI (kg/m^2), and self-reported time spent in moderate-intensity exercise (CHAMPS),[3] categorized as inactive, >0 to <150 min/week, and ≥150 min/week (current physical activity guidelines).[4]

RESULTS SECTION: As of 07/30/2025, a total of 106 participants at the Wake Forest University site had baseline HR-pQCT and muscle function data collected and analyzed. The mean ± standard deviation age was 68.1±5.3 years, with 77.4% female, 74.5% White, and 23.6% Black participants. The mean BMI was 32.4±4.8 kg/m^2, and 54% of participants reported ≥150 min/week of moderate-intensity exercise-related activities. On average, participants had a calf muscle CSA of 28.9±5.9 cm^2, leg strength of 94.7±30.0 Nm, and stair climb power of 293.6±72.1 W. Calf muscle CSA was moderately and positively correlated with both leg strength and stair climb power (r=0.44-0.45, p<0.001; **Figure 2**). In fully adjusted models controlling for age, sex, race, BMI, and moderate-intensity exercise, every 1 cm^2 higher calf muscle CSA was associated with 0.24 Nm greater leg strength and 0.84 W greater stair climb power, though results did not reach statistical significance (both p>0.05; **Table 1**).

DISCUSSION: In this sample of older adults living with overweight/obesity and low bone mass, calf muscle CSA is positively correlated with leg strength and power, though associations are attenuated after adjustment for demographic and lifestyle factors. Strengths of this study include the novel application of HR-pQCT for muscle analysis and the inclusion of both strength and power measures to capture distinct aspects of muscle function at the lower limbs. Limitations include imaging at the 30% tibia site, which does not capture the anatomical belly of the calf muscle and may therefore underestimate its relationship with muscle function. Additionally, findings may not be generalizable to younger populations or those with different body compositions. Future research should confirm these results in larger, more diverse cohorts, extend assessments to upper-extremity sites, and evaluate longitudinal changes in muscle CSA and function following weight-loss interventions.

SIGNIFICANCE/CLINICAL RELEVANCE: Obesity affects nearly 40% of older US adults and is associated with reduced mobility, higher risk of many chronic conditions, and substantial healthcare costs.[5] HR-pQCT-derived calf muscle CSA at the 30% tibia site is correlated with muscle strength and power in overweight and obese older adults, supporting its potential utility for identifying and targeting individuals at risk of functional decline in this population.

REFERENCES: 1) Beavers KM et al. (2024). PMID: 39293778. 2) Bean JF et al. (2007). PMID: 17466729. 3) Stewart A et al. (2001). PMID: 11445760. 4) Elgaddal et al. (2022). PMID: 36043905. 5) Carroll DG. (2025). PMID: 39425961.

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IMAGES AND TABLES:

Figure 1. From HR-pQCT scans, muscle CSA at 30% tibia was calculated as total muscle volume divided by the height of the segmented muscle region

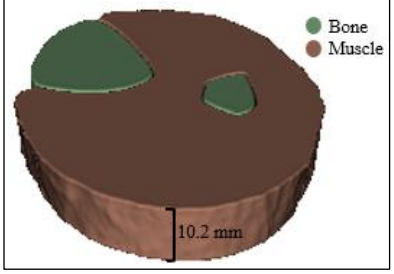

Figure 2. Pearson correlations of calf muscle CSA with (A) leg strength and (B) stair climb power

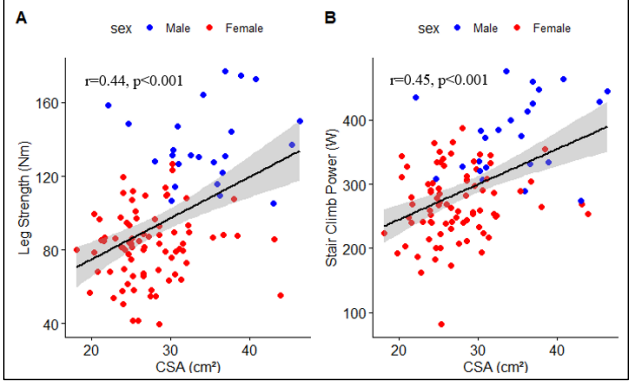

Table 1. Multivariable linear regression models of calf muscle CSA associations with muscle function (N=106)

Calf muscle CSA, cm^2		
	β	p-value
Leg strength, Nm	0.24	0.54
Stair climb power, W	0.84	0.40

Note. Models adjusted for age (years), sex (female vs. male), race (White vs. Black vs. Other), BMI (kg/m^2), and moderate-intensity exercise (inactive vs. >0 to <150 min/week vs. ≥150 min/week)