Relationships between older adult foot structure and intrinsic foot muscles using musculoskeletal ultrasound imaging

Erin Futrell, Julia Chevan, Daryl Lawson

Presented at the Combined Sections Meeting of the American Physical Therapy Association, February 2025

The intrinsic foot muscles (IFMs) contribute to foot stability and overall balance and have largely been unexplored in older adults. The IFMs' strength is difficult to measure, but ultrasound (US) is a useful indirect measure, providing muscle size and possibly muscle tissue composition or quality. Sparse past research found differences in IFM size between healthy younger and older adults and in older adults with and without hallux valgus and lesser toe deformities. Age is associated with a more pronated foot posture and reduced arch height, which could be partly due to the lack of support and function of the IFMs. These common foot disorders are related to pain and fall risk in older adults. Whether these foot deformities are related to muscle size or other factors, such as muscle quality, biomechanics, or footwear, is not well-known.

Purpose/hypothesis: To determine relationships between IFM size and structural integrity of the foot via navicular drop (NV) and hallux valgus (HV) measures in older adults with fall risk. We hypothesized those with greater HV or greater ND would have a smaller cross-sectional area of the IFMs. Number of Subjects: 98 older adult volunteers (78F)

Materials and methods: 5 IFMs (abductor hallucis, flexor hallucis brevis, flexor digitorum brevis, quadratus plantae, and abductor digiti minimi) of the right foot were measured using a standardized US protocol. ND was measured as navicular height in subtalar joint neutral in sitting compared to relaxed bilateral stance. HV angle was measured in sitting with a hand-held goniometer. Pearson correlation analysis was performed for each IFM and foot structure measure (ND, HV).

Results: The correlation matrix found none of the IFMs were strongly correlated with ND or HV. Some of the IFMs sizes were correlated to each other.

Conclusion: No relationships existed between IFM size and foot structure in our cohort of older adults. The only published study that observed muscle size in older adults with toe deformities found those with HV and lesser toe deformities had reduced muscle size of the IFMs compared to healthy controls. Although muscle size and foot structure were not related in the present analysis, *muscle quality* was not analyzed, and is a possible factor related to foot structure.

Clinical relevance: In addition to a natural decline in muscle size with age, fat infiltration of skeletal muscle (myosteatosis) can occur and is associated with muscle quality and function. Researchers found greater amounts of myosteatosis in lower extremity muscles of older adult fallers compared to non-fallers (foot muscles were not included in their analysis). US can reliably measure muscle thickness and tissue echogenicity. Increased echogenicity (brightness) indicates increased myosteatosis and reduced muscle quality. The results of the present analysis will lead us to use US to measure muscle quality as a possible correlate to foot structure, and as a tool to measure the effects of IFM exercises. Moderate physical activity that includes IFM exercises may be necessary for foot health and fall prevention.