The Association of Habitual Shoe Wear with Ultrasound Defined Foot Muscle Morphology in Ugandan Participants

GEORGE FOX UNIVERSITY DOCTORATE OF PHYSICAL THERAPY PROGRAM

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INTRODUCTION

Our study proposes to look at Ugandan individuals who have ambulated barefoot for the continuum of their lives to analyze if there are any structural differences when compared to habitually shod individuals with the use of ultrasound imaging. Though other biomechanical principals have been analyzed, no study has been done to measure intrinsic and extrinsic foot muscles of habitually unshod individuals to detect the possible presence of morphological adaptations.[3]

Ultrasound imaging has been found to be a reliable measurement tool for quantifying parameters of intrinsic and extrinsic foot muscles. Reliability studies have shown excellent inter-rater reliability among ultrasound operators, showing it to be a desirable measurement tool.[2, 4]

HYPOTHESES

1. Habitually barefoot participants will demonstrate increased cross sectional area of abductor hallucis and flexor digitorum brevis due to the decreased support of the medial-longitudinal arch while barefoot.
2. Barefoot participants will also demonstrate increased muscle thickness of the peroneal muscles and the Achilles tendon due to increased plantar flexion during gait.[3]
3. Individuals with a forefoot (FFS) and mid-foot (MFS) strike pattern will have morphological changes compared to rear-foot strikers (RFS) due to the altered mechanism of strike pattern.

METHODS

IMAGING PROTOCOL

Subjects: 59 subjects (age 30.9 ± 10.2) were recruited with the assistance of Uganda Christian University in Kampala, Uganda. Two ultrasonographers analyzed 27 participants who self-reported themselves as habitually barefoot and 32 habitually shod participants. Each participant performed a preferred single-limb stance test to determine dominant leg for imaging. A portable Terason® t3200 ultrasound system was utilized to obtain images.

Reliability Analysis (n=10)

	ICC	Lower Bound	Upper Bound	Significance
PER Thickness	**0.989**	**0.944**	**0.998**	**<0.001**
AbH	**0.779**	**-0.105**	**0.956**	**0.032**
Achilles	**0.787**	**-0.062**	**0.957**	**0.029**
FDB	**0.762**	**-0.189**	**0.952**	**0.039**
FHB	**0.932**	**0.659**	**0.986**	**0.001**

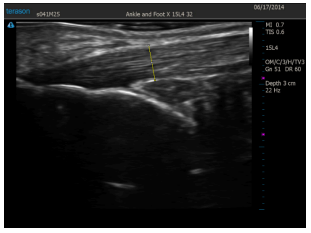
DATA ANALYSIS

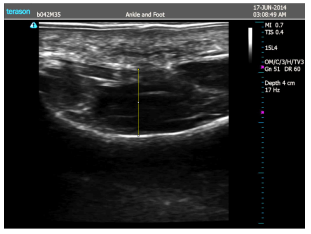
ImageJ software was used to analyze the five structures by two trained physical therapy students. A cross-sectional area measurement was taken for the abductor hallucis muscle and structure thickness measurements were taken for the Achilles tendon, FHB, FDB, and peroneal muscles.

One-way ANOVA models were used to analyze:

1. Muscle parameters between the shod and unshod samples
2. Morphological differences between FF/MF grouping (n=15) and individuals who strike with RFS (n=44) while running
3. Correlation variables including age, weight, and distance walked

RESULTS

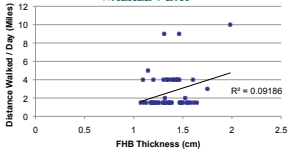




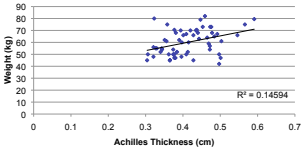
- No significant difference was found between between shod and unshod groups for any of the structures analyzed (FHB, FDB, Achilles, peroneals, AbH).
- FHB was measurably larger in FFS/MFS subjects compared to RFS subjects, p = 0.034.
- Significant correlations:

Correlation	Correlation Coefficient	Significance
FHB Thickness and Distance Walked / Day	0.303	0.020
PER Thickness and Weight	0.258	0.049
Achilles Thickness and Weight	0.382	0.003

FHB THICKNESS VS. DISTANCE WALKED / DAY



ACHILLES THICKNESS VS. WEIGHT



- Distance walked is more influential than foot strike pattern in FHB thickness.

FHB Thickness	
Co-variable	**Significance**
Distance Walked / Day	0.019
Foot Strike Pattern	0.065

DISCUSSION

We were unable to conclude that there are morphological differences between habitually shod vs. unshod individuals in our study using ultrasound imaging. This was likely due to the types of shoes worn in the shod group, as most shoes worn in Uganda lack the conventional arch-support and heel rise commonly found in the United States. This possibly led to undetectable morphological differences between groups in this population.

When foot strike pattern was considered, a significant difference in FHB thickness for those who ran with a forefoot or mid-foot strike as compared to rear-foot strikers. This may be attributed to the role of the FHB during eccentric and concentric loading, as well as the more pronated foot posture that occurs during landing. However, complete knowledge of the role of FHB during loading phase is still unknown.[5]

Distance walked per day was found to be more significant than foot strike pattern in determining FHB thickness. This indicates that the volume of ambulation plays a role in the morphology of this particular intrinsic muscle.

Lastly, an individual's mass significantly influenced the thickness of both the Achilles tendon and peroneal muscles. Both of these structures are involved in plantarflexion during the gait cycle. It can be hypothesized that because most individuals in our study had minimal to no heel rise shoes, more forces are required to go through the whole plantarflexion range resulting in hypertrophy of these structures in higher massed individuals.[3]

DECLARATIVE STATEMENT

The findings in this study can not guide clinical practice due to inconclusive evidence and clinically insignificant data.

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