Assessment of Human Anthropometry With a Markerless Motion Capture System

Christopher Riccitelli, Jenna Mowad & James Moore

Department of Biology- Sacred Heart University

INTRODUCTION

We compare linear anthropometric measurements of human subjects taken by the Theia 3D Markerless Motion Capture System to those taken by manually to determine accuracy and consistency. If the markerless system shows low intra-observer error and strong similarity to manually collected measurements, we will use it in the future for faster and more efficient data collection.

METHODS

- Anthropometric linear measures were manually collected from **five** individuals using the following protocol (**Table 1, Figure 1**):

    1. Recorded weight and height of subject (stadiometer)
    2. Measured **right & left** upper arm length, forearm length, hand length (measuring tape)
    3. Measured **right & left** thigh length, shank length, foot length (measuring tape)
    4. Measured thorax length, thorax width, pelvic width (measuring tape)

- The same anthropometric linear measures were collected from the Theia Markerless Motion Capture system using the following protocol:

    1. Eight synchronized cameras collected video of the subject from different views (**Figure 2**)
    2. The 3-dimensional position of the segment endpoints was determined using Theia3D, which reconstructs 3D position from the 2D videos
    3. Segment lengths were calculated as the distance between the proximal and distal endpoints of each segment

- Once all data were processed, results between manual and the markerless system measurements were assessed by examining a B-A plot (**Figure 3**), the intraclass correlation coefficient (ICC, **Figure 4**), and percent difference across measures (**Figure 5**)

- **Statistical analyses were limited by the small sample size (N=5) of this pilot study**

STUDY OBJECTIVE

Determine and evaluate the accuracy and repeatability of the Theia markerless motion capture system when taking anthropometric measurements. If demonstrated, accuracy and repeatability of measures will allow the markerless motion capture system to be used to further analyze human subjects slope walking patterns.

Figure 1. The manual Anthropometric Measurement Method measuring a subject's forearm length

Figure 2. The Theia Markerless Measurement System, used to measure segment lengths
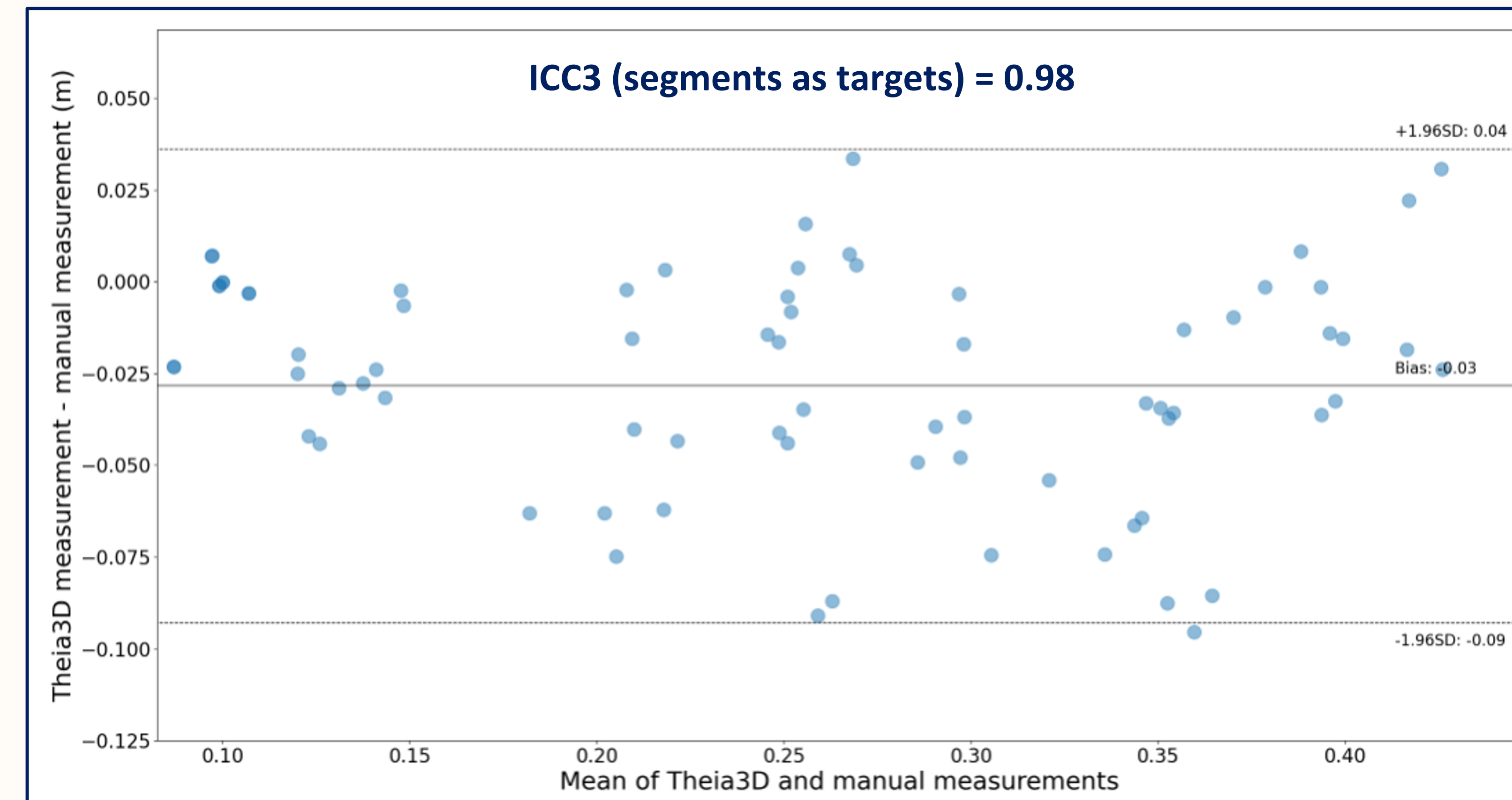

Figure 3. A Bland-Altman Difference Plot of the Segment Lengths of our 5 subjects.
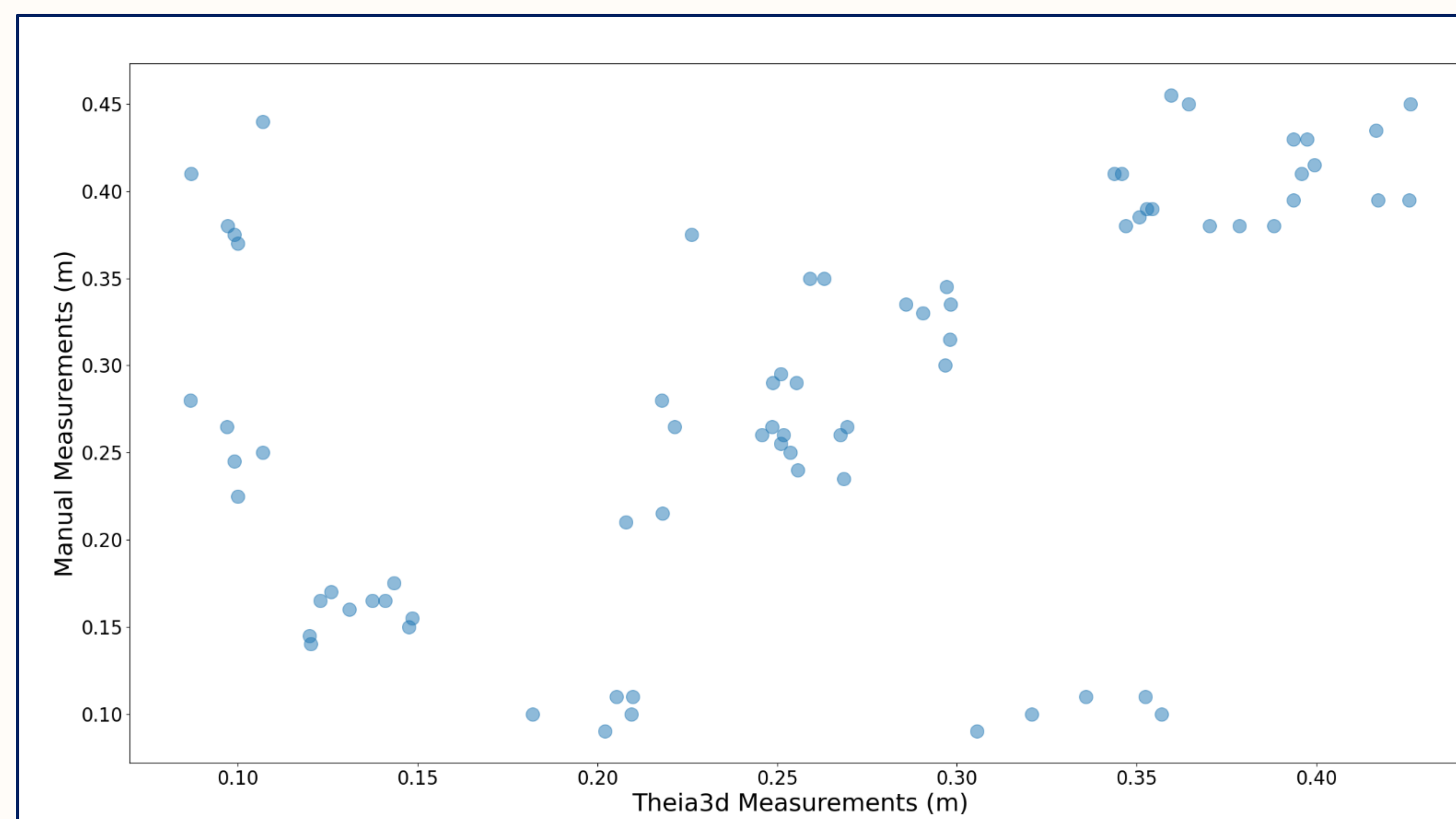

Figure 4. Plot Comparing Segment Measurements of 5 Subjects on the Theia Markerless System Versus Anthropogenic Measurements.

Table 1: Anthropometric Linear Measures

| Segment	Description
Upper Arm Length	Acromion process to lateral epicondyle
Forearm Length	Lateral epicondyle to styloid process
Foot Length	Lateral malleolus to top metatarsal II
Hand Length	Styloid process to metacarpal III knuckle
Shank Length	Lateral condyle to lateral malleolus
Thigh Length	Greater trochanter to lateral condyle
Thorax Height	Vertebrae C7 to T10
Thorax Width	L acromion process to R acromion process
Pelvis Width	L to R Anterior superior iliac spines
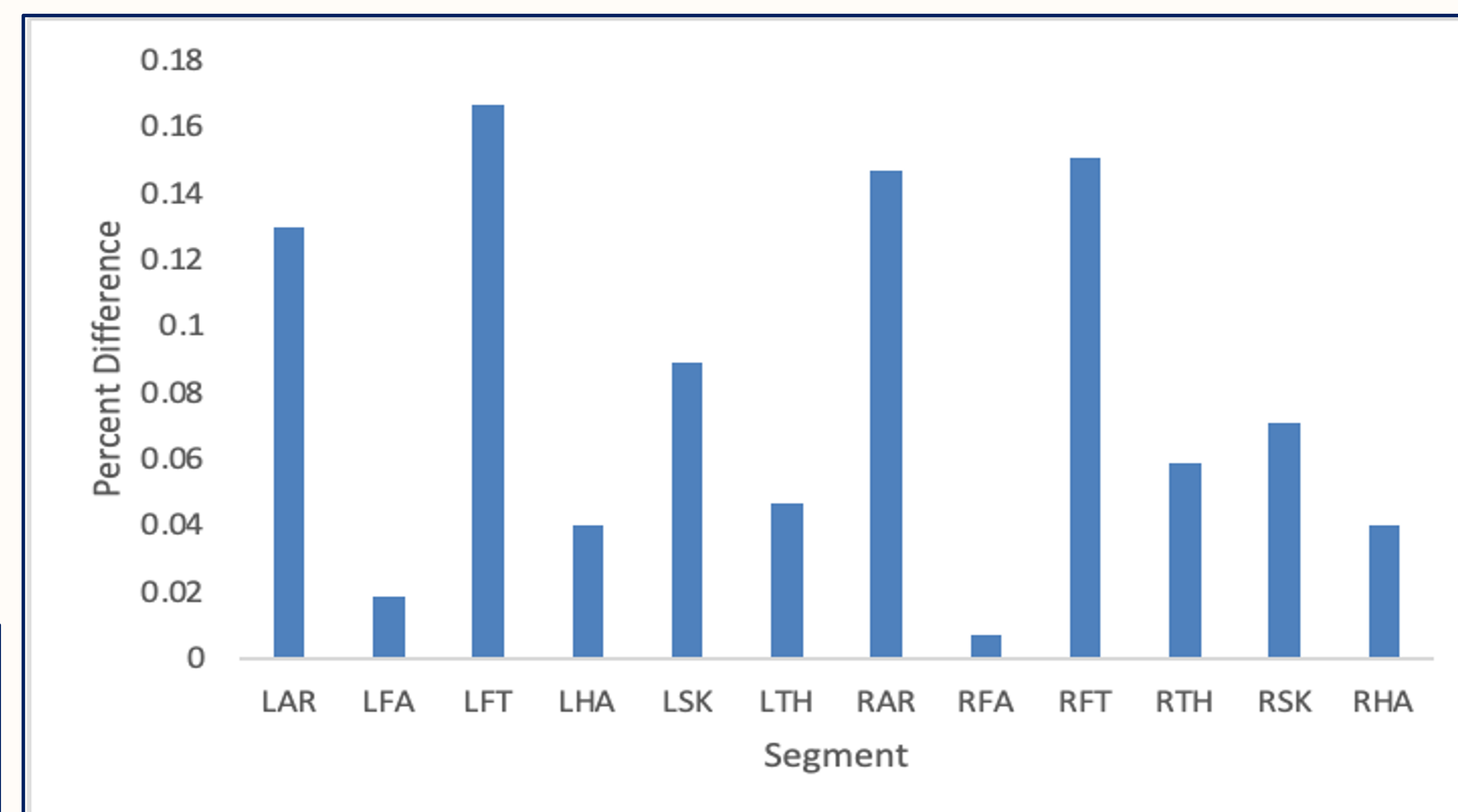
Figure 5. Percent Differences of the Mean Segment Lengths of our 5 subjects. The percent difference for all mean segment lengths was under 0.18, or 18%. This means that the markerless values were relatively consistent with the anthropogenic measurements on the five subjects.

RESULTS & CONCLUSIONS

In this small sample (N=5), there were minimal differences between the manually collected anthropometric measures and those taken by the markerless system. If this pattern holds when assessed with a larger sample size, the markerless system will be a good option for efficient data collection in our upcoming study on the mechanics and metabolics of human slope-walking.