

PMHS Use in Biomechanical Testing for the Ankle-Foot Complex

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INTRODUCTION

- Common PMHS use in lower limb testing scenarios to help protect living populations
 - Frontal car crashes, underbody blasts, sports
- Currently no validation for PMHS use as surrogates for living populations in these scenarios
 - Lack of evidence that PMHS are suitable representations of living populations for ankle-foot complex
- Potential limitations of PMHS include:
 - Activity level of PMHS before death
 - Change in soft tissue properties (arch of the foot → distribution of loading during testing)
- Objectives:**
 - to establish a procedure for extensive lower limb anthropometric measurements of PMHS
 - to compare lower extremity PMHS measurements with published values for living populations to determine if PMHS are a suitable surrogate

MATERIALS & METHODS

- 33 PMHS: 23 males, 10 females
- Measurement protocol developed based on published anthropometric databases to ensure valid comparisons between PMHS and living populations
- Lower limb anatomical landmarks marked on each PMHS foot to follow defined protocols of previous studies



Figure 1: Anatomical Landmarks (Lateral Malleolus, Navicular Tuberosity, and 1st Metatarsophalangeal Protrusion)

- Each PMHS moved to seated position
 - Bathroom scale was used to obtain equal weight distribution across feet
 - ~16 descriptive anthropometric measurements taken for lengths, breadths, and heights on both feet

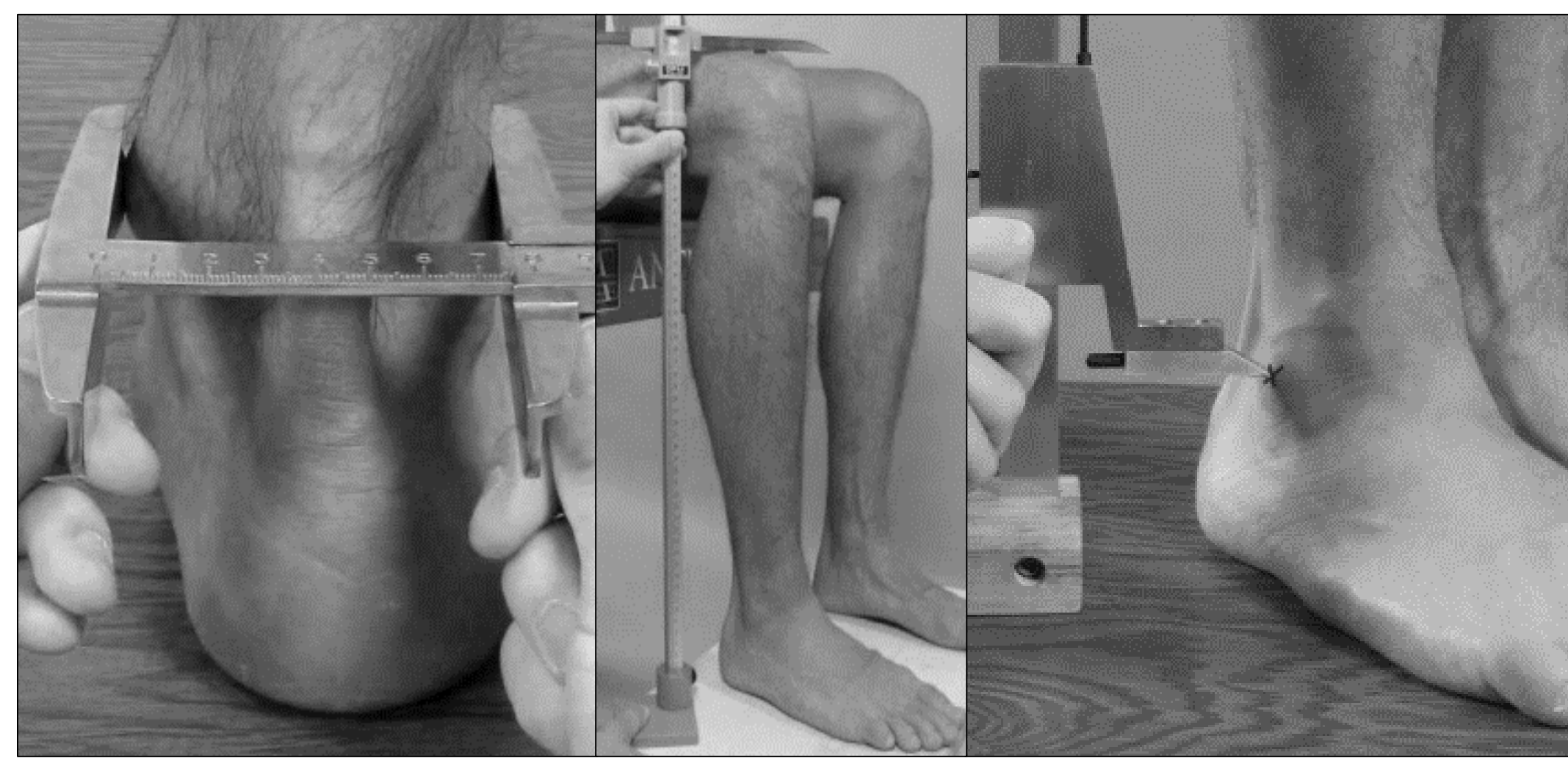


Figure 2: Anthropometric Measurements with Tools

- Each PMHS moved to standing position on custom tilt table (Figure 3)
 - Straps placed at locations around the knee, thigh, abdomen, and axilla
 - A Tekscan pressure mat was used to obtain equal weight distribution with at least 80% body weight using the Tekscan software iScan
 - All seated measurements excluding buttock-knee length, buttock-popliteal length, and knee height were repeated while standing with the addition of several circumferential measurements with flexible measuring tape
- Analysis performed on measurements common to seated and standing positions



Figure 3: Tilt Table

RESULTS & DISCUSSION

Measurement	Left vs Right (Seated) (p-value)	Left vs Right (Standing) (p-value)	Male vs Female (Seated) (p-value)	Male vs Female (Standing) (p-value)	Seated vs Standing (p-value)	PMHS vs Living Measurements (percent error)
Bimalleolar breadth	0.570	0.639	0.000	0.000	0.220	3.25
Heel Breadth	0.883	0.957	0.022	0.071	0.000	4.06
Navicular height (medial prominence)	0.109	0.165	0.000	0.000	0.002	55.28
Navicular height (inferior medial border)	0.578	0.555	0.950	0.168	0.001	4.84
Talar head height	0.336	0.336	0.000	0.009	0.000	69.43
Plantar curvature height	0.138	0.985	0.000	0.004	0.001	36.95
Lateral malleolus height	0.984	0.535	0.063	0.017	0.001	2.05
Medial malleolus height	0.740	0.801	0.037	0.015	0.071	9.77
Acropodion foot length	0.079	0.140	0.000	0.000	0.000	3.45
Hallux foot length	0.059	0.146	0.000	0.000	0.000	0.04
Horizontal foot breadth	0.237	0.269	0.000	0.000	0.000	6.53
Ball of foot length	0.826	0.702	0.000	0.000	0.002	3.75
Dorsum height	0.245	0.465	0.001	0.000	0.000	3.84

- Seated vs standing (Figure 4):
 - 85% show significant differences → seated not interchangeable with standing
 - Researchers should consider adding mass to PMHS lower extremity so standing weight is replicated and anthropometry aligns with the standing position
- PMHS (subsample to match literature) vs Living Population measurements (Figure 5):
 - 77% agreement indicates PMHS anthropometry exemplifies living populations
 - Disagreements (navicular height, talar head height, and plantar curvature height) illustrate possible limitations of PMHS use:
 - Changes in soft tissue of plantar foot
 - Challenge of obtaining full body weight with standing fixture

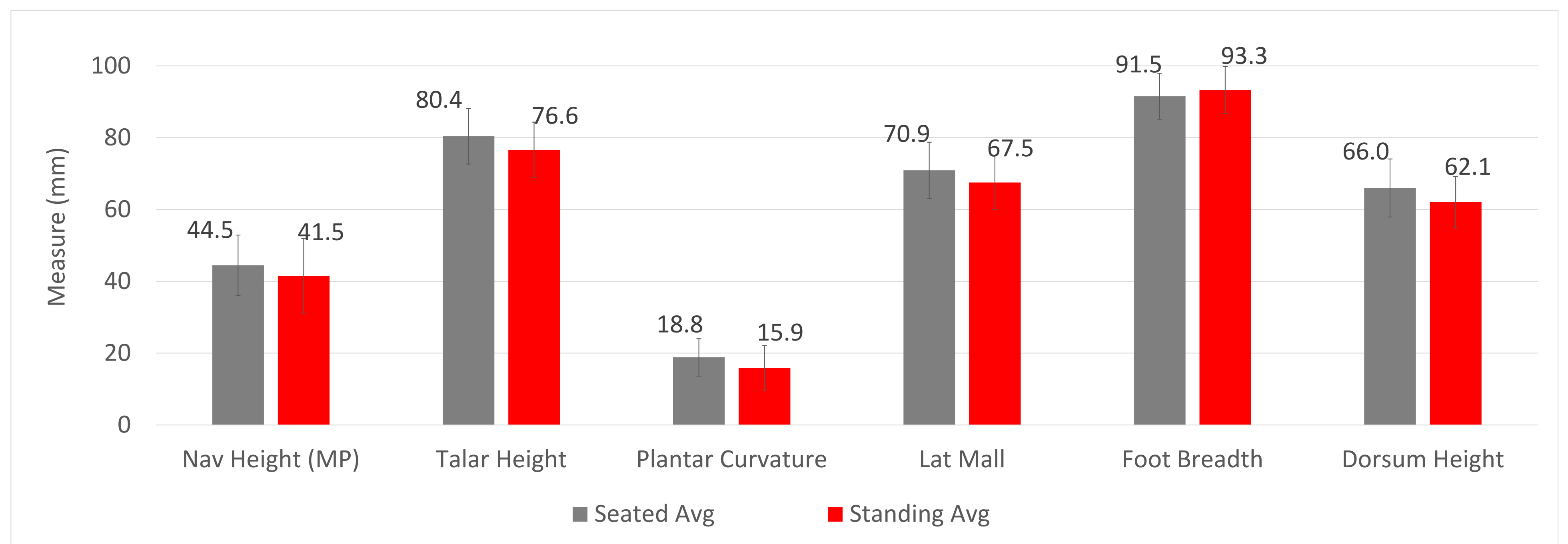


Figure 4: PMHS Seated vs Standing Measurements

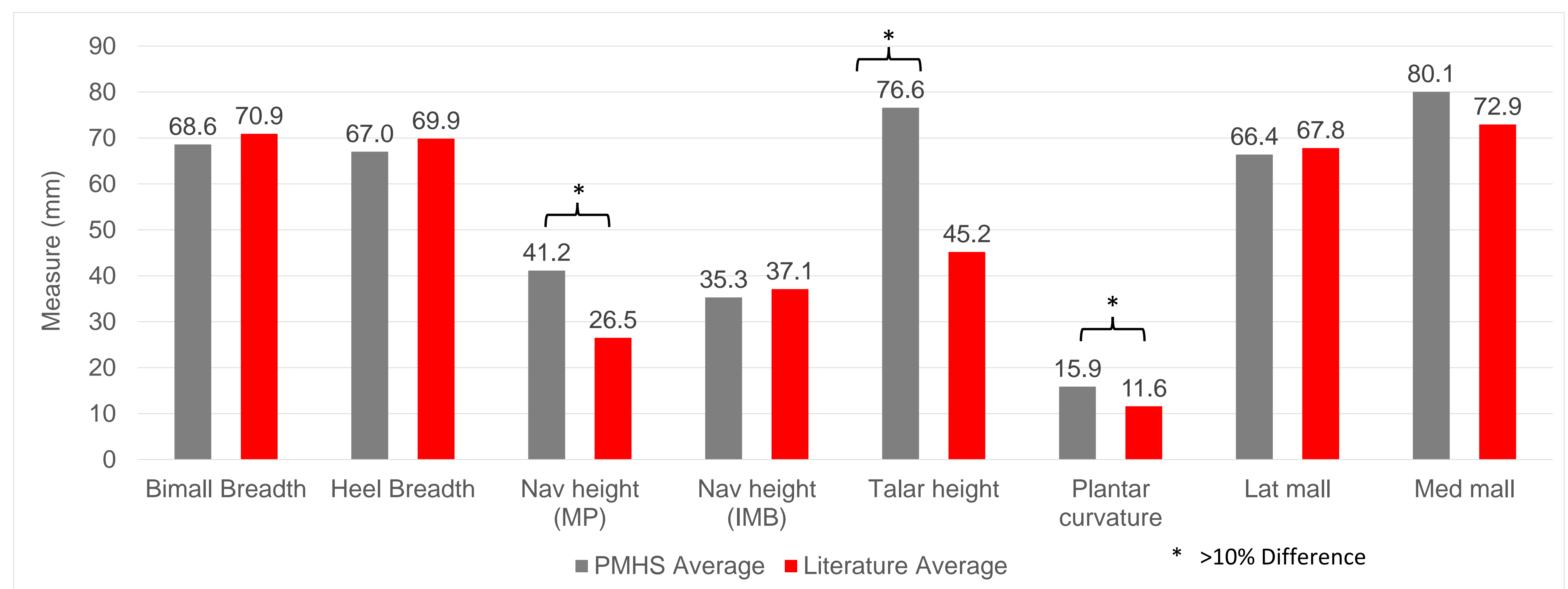


Figure 5: PMHS vs Living Populations

CONCLUSIONS

- This procedure for lower limb anthropometric measurements presents an extensive methodology encompassing several approaches performed in varying studies on living populations for more holistic lower limb anthropometry of PMHS.
- 77% of anthropometric measurements for PMHS show values that are not significantly different from measurements of living populations.
 - Anthropometry for the lower extremities of PMHS can be applied to living populations assuming sex and seated or standing position is accounted for

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