Profiling Skeletons Using Long Bones from Medieval Burials in Central Kenya

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INTRODUCTION

One thousand years ago, she walked the highlands—now, her bones tell her story. This study profiles Kalulu 1, a human skeleton recovered from a medieval burial in the Central Highlands of Kenya. Nestled in a high-altitude, environment, this region presents a unique opportunity to explore how ancient populations may have adapted biologically to their surroundings. Through long bone analysis, this research investigates sex, stature, and ecogeographic adaptation, offering a rare window into the lives and bodies of individuals from the African Medieval Period.

Fig 1: Kalulu 1 specimen in situ during excavation in 2020.

METHODS

The Kalulu 1 skeletal remains (Figure 1), along with other archaeological specimens from the Central Highlands of Kenya (CHK), are curated at the National Museums of Kenya. Comparative materials were sourced from the Biological Anthropology Labs at SUNY Potsdam and Binghamton University, as well as published datasets.

Sex Estimation: performed using multiple osteometric indicators, including the humerus head diameter, maximum and minimum diameters of the radial head, femur head diameter, and midshaft circumferences. A decision table (Table 1) was employed to resolve conflicting indicators and produce a final sex assessment.

Stature Estimation: utilized the long bone regression formulas developed by Sjøvold (1990), applied to measurements of the femur, tibia, humerus, radius, and ulna. Estimated heights were categorized following Martin and Saller's (1957) stature classes for recent Homo sapiens (Table 3).

Ecogeographic Adaptation: assessed via the crural index (CI), calculated as CI = (tibia length/femur length) × 100, following traditional osteological standards. Comparative crural index data were drawn from Auerbach (2008) to contextualize results within broader climatic adaptation models.

Fig 2: Femur measurement using an osteometric board.

RESULTS

The Kalulu 1 specimen is most likely female, with an estimated stature of 174.1 cm (5'7" ft) and a crural index of 85 (Table 1 and Table 4). These measurements indicate that Kalulu 1 falls within the range of modern African populations for "very tall" female stature and exhibits limb proportions consistent with tropical climatic adaptation. While the radial head diameter initially suggested a male classification, this may be attributed to the individual's robusticity rather than biological sex. The overall pattern of skeletal metrics supports the interpretation of a female individual with a tall and lean body shape.

Table 1: The results of sex estimation using various long bone measurement dimensions.

Specimen	Height Estimate	HHD	RMaxD	RMinD	FSC	FHD	Estimated Sex
Kalulu 1	174.1	Probable Female	Male	Female	Male	Female	Female
Githira	173.4	Probable Female			Male		Ambiguous
Kisima Farm	168.9	Female	Ambiguous	Ambiguous	Male	Probable Male	Male
KNM-ER 5306	175.3	Probable Female	Ambiguous	Female	Male	Probable Male	Ambiguous
SP5	147.1	Female	Female	Female	Female	Female	Female
SP3	166.3	Female	Male	Male	Male	Male	Male

Table 2: Stature estimation formula Sjøvold (1990).

Bone	Formula[a]
Humerus	4.62 x HL + 19.00 +/- 4.89
Radius	3.78 x RL + 74.70 +/- 5.01
Ulna	4.61 x UL + 46.83 +/- 4.97
Femur	2.71 x FEL + 45.86 +/- 4.49
Tibia	3.29 x TL + 47.34 +/- 4.10

Table 3: Height classes defined by Martin and Saller (1957) for recent populations of *Homo sapiens.*

Height categories (cm)	Men	Women
Giants	>200	>187
Very tall height	180-199.9	168-186.9
Tall height	170-179.9	159-167.9
Above-medium height	167-169.9	156-158.9
Medium height	164-166.9	153-155.9
Below-medium height	160-163.9	149-152.9
Short height	150-159.9	140-148.9
Very short height	130-149.9	121-139.9
Midget	<130	<121

RESULTS CONTINUED

The crural index of 85 is comparable to other African populations such as the Dynastic Egyptians, Sudanese Kerma, and Sayala groups, and contrasts with circumpolar populations like the Alaskans and Aleutians (Table 4; Auerbach, 2008; Seguchi et al., 2017). These African groups, located in low to mid latitudes, typically show high crural indices (84–86), consistent with longer limbs and warm climate adaptation. In contrast, high-latitude populations show lower indices (80–81), reflecting shorter limbs adapted to cold environments, as predicted by Bergmann's and Allen's ecological rules. Kalulu 1's values fit within the expected tropical pattern.

Table 4: Crural Index results. The Kalulu 1 results is from this study, the other populations are gleaned from Auerbach (2007) and Seguchi et al.(2017).

	Crural Index (CI)			
	Min.	Max.	Mean	*(n)*
Alaskan	73	86	80	81
Aleutian (Aleutian Island)	77	84	81	52
Egyptian (Dynastic)	81	97	84	33
Sudan (Kerma)	81	88	84	18
Sudan (Sayala)	82	90	86	34
Kalulu 1	85	85	85	1

DISCUSSION & CONCLUSION

The Kalulu 1 specimen provides important insight into past human biological variation in eastern Africa. Despite being recovered from the high-altitude, cooler environment of the Mt. Kenya region, the individual exhibits a high crural index consistent with tropical limb proportions. This suggests that Kalulu 1 retained body shape adaptations associated with warmer climates, possibly indicating recent migration from lower, warmer areas or that tropical body proportions were maintained despite the colder local environment.

These findings raise the possibility that limb segment proportions in the Kalulu population were influenced not only by mean ambient temperature, as predicted by Bergmann's and Allen's rules, but also by other factors such as altitude or population history. The robusticity of the specimen further highlights the complexity of interpreting sex and body form in paleoanthropological contexts. Overall, Kalulu 1 contributes to a broader understanding of environmental adaptation and human variability in prehistoric Africa, especially as it is the first human skeleton studied from the Central Highlands of Kenya.

Fig 3: From left to right, Kalulu 1 humerus, femur, and tibia used in the study.

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