# Femur Subtrochanteric Shape and Ancestry Assessment in Modern Japanese and Thai Individuals*

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## Introduction

The paucity of cranial remains presents a significant problem to bioarchaeologists and forensic anthropologists in the determination of ancestry. While postcranial ancestry methods generally lack the accuracy attained from cranial methods, morphoscopic and morphometric approaches have been applied to the proximal, diaphyseal, and distal femur with varying success. Notably, femur subtrochanteric size and shape have been employed to differentiate between broad ancestral groups using anterior-posterior (A-P) and medial-lateral (M-L) sectioning lines (Gilbert and Gill 1990; Gill and Rhine 1990), in addition to the platymeric index (PI; Wescott 2005). The PI is calculated by dividing the A-P by M-L subtrochanteric diameter and multiplying by 100, with individuals exhibiting platymeric (medio-laterally broad; PI ≤ 84.9), eurymeric (rounded; PI 85.0 - 99.9), or stenomeric (antero-posteriorly broad; PI ≥ 100.0) subtrochanteric regions (Fig. 1). While the traditional sectioning line positions and PI thresholds are population dependent, they achieve success rates in excess of 80% when differentiating between Native Americans (generally platymeric) and pooled Afro- and Euro-Americans (generally eurymeric). Though it is often assumed that East Asian groups also exhibit similarly platymeric subtrochanteric morphologies, this assumption is based mainly on data derived from Native American archaeological assemblages. However, recent work has demonstrated that some East Asian groups are less platymeric than Native Americans (Tallman and Winburn 2015), while some Eastern European populations exhibit unexpectedly high rates of platymeria (McIlvaine and Schepartz 2015). As such, population-specific subtrochanteric ancestry methods should be used.

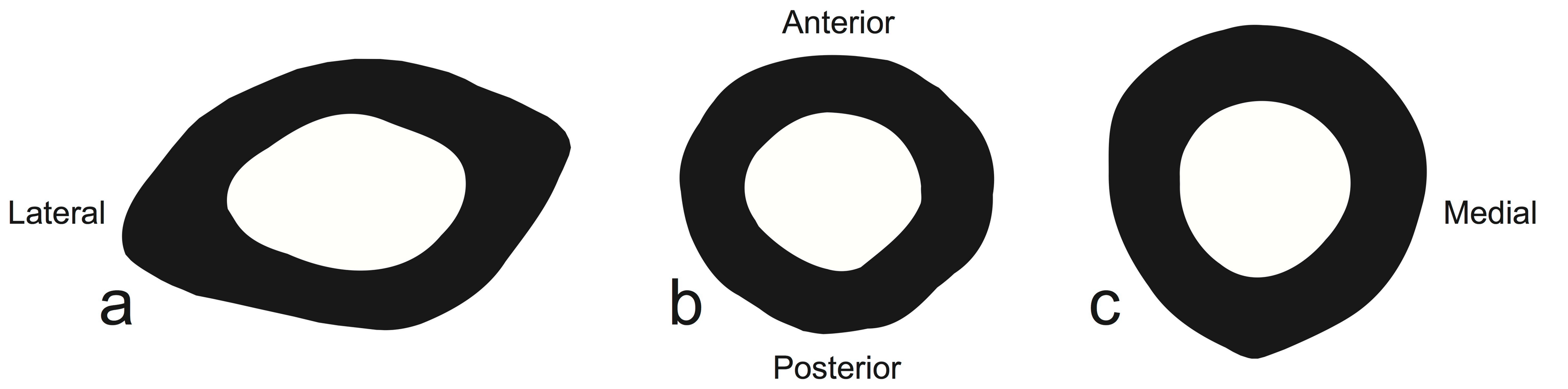


**Figure 1.** Cross sections of platymeric (a), eurymeric (b), and stenomeric (c) femora (Tallman and Winburn 2015).

Several methodological issues and inherent assumptions have been identified with the use of the proximal femur in ancestry assessment. In particular, the A-P and M-L subtrochanteric measurements generally exhibit high intra- and inter- observer error rates (Adams and Byrd 2002). Further, subtrochanteric methods assume: that there is minimal sexual dimorphism within populations; that populations are temporally and geographically homogenous; and that population differences in subtrochanteric form are attributable to genetic variation rather than biomechanical stress (Wescott and Srikanta 2008). While Wescott and Srikanta found that dimorphism, intrapopulation variance, and biomechanical stresses do affect subtrochanteric form, these factors do not significantly impede discriminating between Native American and Afro-/Euro- American individuals.

The current study further explores femur subtrochanteric size and shape variability and its use in forensic ancestry assessment by testing Wescott's (2005), Gill and Rhine's (1990), and Tallman and Winburn's (2015) femur subtrochanteric methods and associated assumptions on modern Japanese and Thai individuals aged 17-96 years.

## Materials and Methods

The Japanese sample consists of **287** known individuals from the greater Tokyo region who died during the late 19th/early 20th centuries (Chiba University) and those who died during the 1960s/1970s (Jikei University). The Thai sample is composed of **149** known individuals from northern Thailand who died in very recent decades (Khon Kaen University). A Euro-American sample of **77** males identified by the Department of Defense was used to help test the discriminatory power of subtrochanteric size and shape. To examine intra- and inter- observer error rates, 45 Chiba femora were re-measured; to examine the effects of body size, femur maximum length (FML) and maximum femoral head diameter (MHD) were measured for a subsample of 136 Thai individuals. Intraclass correlation coefficients, discriminant functions, descriptive statistics, t-tests, and ANOVAs were calculated in the SPSS statistical software package.

## Results

**Table 1.** Intraclass correlation coefficients for 45 re-measured Chiba femora.

| Test | A-P | M-L |
|---|---|---|
| Intraobserver | .989 | .963 |
| Interobserver | .981 | .957 |

**Table 2.** Cross-validated discriminant function classification rates for Japanese and Euro-American males.

| Group | N | Mean PI | PI | | AP and ML | |
|---|---|---|---|---|---|---|
| | | | Correct | Incorrect | Correct | Incorrect |
| Japanese males | 77 | 81.72 | 68.8% | 31.2% | 80.5% | 19.5% |
| Euro-American males | 77 | 91.36 | 58.4% | 41.6% | 62.3% | 37.7% |

**Table 3.** Descriptive statistics for Japanese and Thai with traditional (T) and adjusted (A) PI definitions*.

| Sample | N | Mean PI | SD | PI Range | Platymeric | Eurymeric | Stenomeric |
|---|---|---|---|---|---|---|---|
| Japanese females | 70 | 80.21[1,2] | 6.45 | 57.44-99.22 | T: 80.0%[4] A: 90.0% | T: 20.0% A: 10.0% | T: 0% A: 0% |
| Japanese males | 217 | 82.16[1,3] | 7.43 | 55.65-103.72 | T: 62.7%[4] A: 79.7% | T: 35.9% A: 20.3% | T: 1.4% A: 0% |
| Thai females | 45 | 79.71[1] | 7.14 | 64.29-93.55 | T: 75.6%[4] A: 95.6% | T: 24.4% A: 4.4% | T: 0% A: 0% |
| Thai males | 104 | 83.51[1] | 7.13 | 64.71-110.71 | T: 60.6%[4] A: 82.7% | T: 36.5% A: 15.4% | T: 2.9% A: 1.9% |

*T: Platymeric (PI ≤ 84.9), Eurymeric (85.0 ≤ PI ≤ 99.9), Stenomeric (PI ≥ 100.0) (Wescott 2005);
A: Platymeric (PI ≤ 88.9), Eurymeric (89.0 ≤ PI ≤ 103.9), Stenomeric (PI ≥ 104.0) (Tallman and Winburn 2015).

[1] Japanese females differ from Japanese males (p=0.038); Thai females differ from Thai males (p=0.004).

[2] Japanese females who died during the early 19th/20th century (n=35) differ (more platymeric) from those who died during the 1960s/1970s (n=35; p=0.001).

[3] Japanese males who died during the early 19th/20th century (n=134) differ (more platymeric) from those who died during the 1960s/1970s (n=83; p=0.001).

[4] The Japanese and Thai females and males are less platymeric than Wescott's (2005) Native American females (85%) and males (79%) using traditional PI thresholds.

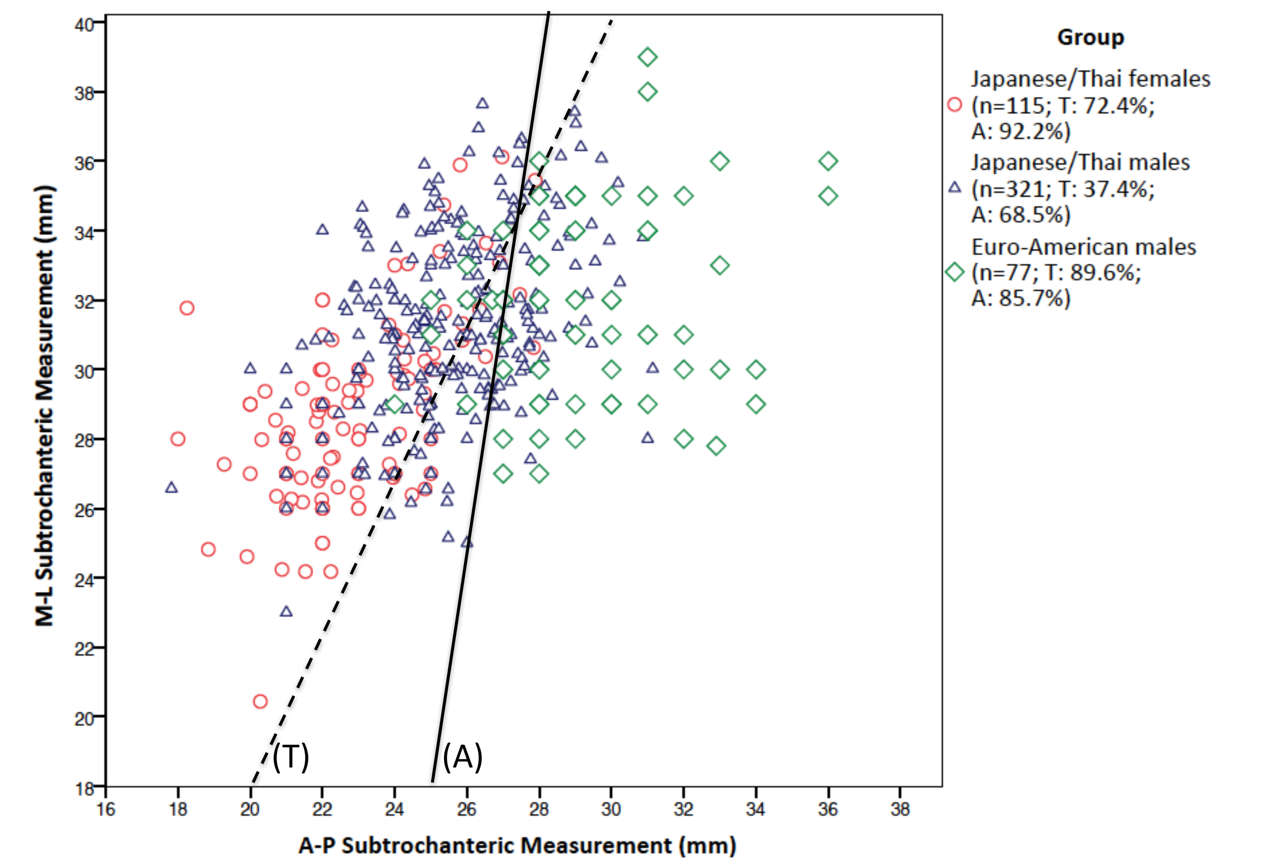


**Figure 2.** Scatterplot of Japanese, Thai, and Euro-American A-P and M-L measurements with traditional (T) Gill and Rhine (1990) and amended (A) Tallman and Winburn (2015) sectioning lines.

**Table 4.** ANOVA: Age effects on PI for 8 Japanese groups and 7 Thai groups.

| Test | Sample | Sum of squares | df | Mean square | F | Sig. |
|---|---|---|---|---|---|---|
| Between groups | Japanese | 623.170 | 7 | 89.024 | 1.716 | .105 |
| | Thai | 538.511 | 6 | 89.752 | 1.698 | .126 |
| Within groups | Japanese | 14471.572 | 279 | 51.869 | | |
| | Thai | 7505.363 | 142 | 52.855 | | |
| Total | Japanese | 15094.743 | 286 | | | |
| | Thai | 8043.874 | 148 | | | |

**Table 5.** ANOVA: FML and MHD effects on PI for 136 Japanese individuals.

| Test | Meas. | Sum of squares | df | Mean square | F | Sig. |
|---|---|---|---|---|---|---|
| Between groups | FML | 773.479 | 7 | 110.497 | 2.035 | .055 |
| | MHD | 544.093 | 3 | 181.364 | 3.335 | .021* |
| Within groups | FML | 6948.492 | 128 | 54.285 | | |
| | MDH | 7177.878 | 132 | 54.378 | | |
| Total | FML | 7721.971 | 135 | | | |
| | MDH | 7721.971 | 135 | | | |

*Bonferonni test shows significant difference (.024) in mean PIs between MHD ≤ 40 mm and MHD 47 - 50 mm.

## Discussion and Conclusions

Japanese and Thai individuals display considerable variability in subtrochanteric size and shape. Subtrochanteric ancestry assessment methods derived from Native American data exhibit reduced discriminatory power when applied to these two modern Asian groups, therefore underscoring the importance for the ongoing development and testing of population-specific methods. As such, the amended sectioning lines and PI thresholds should be used over those derived from Native Americans when presented with remains potentially originating from East or Southeast Asia.

Intra- and inter- observer variation introduces 1.2-4.3% error to measurements. Additionally, sex, time period, and MHD affect PI, while FML and age do not. This suggests that subtrochanteric form is not entirely under genetic control, but is also under the influence of intrapopulation variation, biomechanical stresses, secular change, and/or body size/proportions, potentially complicating its use in ancestry assessment. Despite these complications, this study demonstrates that population-specific PI thresholds and A-P and M-L sectioning lines are useful and appropriate in discriminating modern Japanese and Thai individuals from some non-Asian groups when cautiously applied.

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