Let's Talk About Sex: Using Metric and Non-metric Features of the Subadult Ilium to Identify Males and Females

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INTRODUCTION

Metric and nonmetric sexing techniques were analyzed for subadult ilia of a commingled collection from Early Bronze Age II/III (EBII-III; 3000-2300 BCE) Bab edh-Dhra', located in present-day Jordan. The skeletons were exhumed from Charnel House A22, and the sexes of individuals unknown. This study utilized a multi-feature model to sex subadult ilia. Specifically, scores for auricular surface elevation, the arch criterion, greater sciatic notch (GSN) angle, and GSN depth were considered.

BACKGROUND

Charnel House A22 was the largest charnel house at the EBII-III site of Bab edh-Dhra (Schaub, 1993) and contained commingled, burned skeletons. These bones represent the only skeletal remains from EBII-III in the southern Levant, a period of agricultural intensification and social change. EBII-III settlements are noted as becoming increasingly "urban." Urbanization is often associated with demographic changes, particularly among younger individuals. The shift from smaller, multi-chambered shaft tombs in EBIA to larger, above-ground charnel houses in EBII-III at Bab edh-Dhra' has been associated with changing ideas about family and social group (Chesson and Schuab, 2007).

The sexing of subadult skeletal remains is a notoriously difficult task. Initial tests of methodologies involving the ilium as a subadult sex indicator reported high accuracy rates (Weaver 1980, Schutkowski 1987), but subsequent tests of those same methodologies reported lower levels of accuracy (Hunt 1990, Mittler and Sheridan 1992, Sutter 2003, Vlak et al. 2008). Despite this, Sutter (2003) found that the accuracy rates of GSN angle, GSN depth and the arch criterion, show these features to be acceptable for forensic applications.

This study considered scores for auricular surface elevation, the arch criterion, GSN angle, and GSN depth to sex each ilia. The goal of this multi-feature model was to combat the complications associated with the commingled nature of the collection as well as those associated with the accuracy rates of tests of the ilium as a subadult sex indicator.

METHODS

The study sample totaled 61 right ilia. Only those that lacked evidence of fusion with the ischium and pubis were used. Each feature was scored and analyzed separately by the first two authors. Arch criterion was assessed via Schutkowski's (1993) methodology. Auricular surface elevation was assessed using Sutter's (2003) development of Weaver's (1980) methodology (Table 1).

Table 1. Auricular surface scoring method

Score	Description
1	complete lack of elevation
2	minimal or partial elevation
3	intermediate/medium elevation
4	elevation over most of the auricular surface
5	complete elevation

GSN angles and depth ratios were measured using ImageJ computer software (Vlak et al. 2008). Female, male and indeterminate ranges were assigned via the graphical trends of each feature.

The final sex classification of each ilium was based on the compilation of the sex classifications from each ilial feature. Specifically, for a bone to be classified 'male,' at least 50% of its features had to separately identify it as male, and none could classify it as female. Conversely, females were identified as such when at least 50% of an ilium's features were "female," and none of its features could classify it as male. If a bone did not fall into either of these two categories, it was classified as indeterminate.

RESULTS

• Auricular surface:	21 (70%) males	9 (30%) females
• Greater sciatic notch angle:	20 (49%) males	21 (51%) females
• Greater sciatic notch depth ratio:	7 (58%) males	5 (42%) females
• Arch criterion:	25 (51%) males	21 (48%) females
• Final sex determination:	25 (54%) males	21 (48%) females

Concordance tests were performed between the individual sexing methods. When indeterminate sexes were excluded from the analysis, rates of concordance increased for all techniques. The greater sciatic notch angle and depth ratio features demonstrated 100% concordance. Concordance rates were consistently lower when comparing the auricular surface against the three other iliac features (Tables 2 and 3). Differences in sexing percentages between each pair of features were not statistically significant (Table 4).

Table 2. Concordance rates between features, excluding indeterminates

	GSN Angle	Arch Criterion	GSN Depth Ratio	Auricular Surface
GSN Angle	-			
Arch Criterion	89.5	-		
GSN Depth Ratio	100	91.7	-	
Auricular Surface	60	63.6	71.4	-

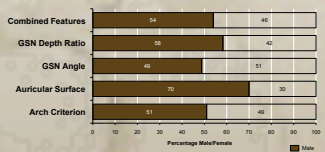

Figure 1. Sex determination by feature

Table 3. Concordance rates between features, including indeterminates

	GSN Angle	Arch Criterion	GSN Depth Ratio	Auricular Surface
GSN Angle	-			
Arch Criterion	69.4	-		
GSN Depth Ratio	65.0	55.0	-	
Auricular Surface	37.9	48.3	38.9	-

We then developed a series of 11 models to sex the collection using every possible combination of the four features. Within each model we ran concordance tests in order to assess agreement among the techniques (Table 5). When we compared the sexing ratio of each of the models with our overall sex determination, none of the models were significantly different. The models that best predicted our overall sex determination were:

- arch criterion
- arch criterion & greater sciatic notch angle, combined
- greater sciatic notch depth

Table 4. Comparison of significance between features

Feature Combination	mean	*p*
GSN Angle & Arch Criterion	0.04**	0.84
GSN Angle & GSN Depth	0.06*	0.81
GSN Angle & Auricular Surface	2.39*	0.12
Auricular Surface & GSN Depth	-	0.72***
Auricular Surface & Arch Criterion	2.03*	0.15
GSN Depth & Arch Criterion	0.02*	0.89

*Yates; ** Pearsonl ***Fischer, 2-tail

Table 5. Multi-feature model concordance test

Multi-Feature Model Combinations	*n*	Inter-feature Concordance (%)
AS & GSN Angle	15	60.0
AS & Arch Criterion	22	63.6
AS & GSN Depth	7	71.4
AS, GSN Angle, & Arch	14	88.1
GSN Angle & Arch Criterion	38	89.5
AS, GSN Depth, & Arch	7	90.5
GSN Depth Ratio & Arch Criterion	12	91.7
AS, GSN Angle, & GSN Depth	6	94.5
ALL Features	6	95.8
Angle, Depth, & Arch	10	100.0
GSN Angle & GSN Depth Ratio	11	100.0

DISCUSSION

Based on concordance and significance tests, we found that auricular surface elevation was not as useful as the GSN angle and depth in determining subadult sex for our sample. While a comparison of the male to female ratios produced by sex determinations from each single sexing technique does not produce any significant differences, the auricular surface technique may overestimate male ilia. The high accuracy rates of arch criterion and GSN angle and depth as subadult sex indicators (Schutkowski 1993, Sutter 2003) give weight to the sex classifications of this study, wherein those techniques provided very similar sex distribution frequencies.

The majority of GSN angle measurements in this sample were greater than 90°. These data may appear problematic in relation to the methods of other researchers (Schutkowski, 1987; Johnson, 2000; Sutter, 2003) who classified males as having a GSN angle of ~90° and females with an angle of greater than 90°. However, Walker (2005), following the method set forth by Buikstra and Ubelaker (1994), found that younger males and females had lower scores, or more feminine sciatic notches. This finding could explain why most of our angle measurements were obtuse. Looking at the size of the bones with ~90° angles showed them to be some of the larger ilia in the sample. This relation conforms to the idea that sexually dimorphic characteristics become more prominent with increased age (Walker, 2005).

Subadults were buried with adults in the larger charnel house A22, as opposed to all subadults being buried in a smaller charnel house or elsewhere. This reality may support Chesson's (1999) theory of a kinship-based society reflected by placement in ancestral structures at Bab edh-Dhra'. We found no significant difference between the number of male and female subadults represented in A22, suggesting that there was no differential treatment by sex during burial. Further research into taphonomic processes is needed to determine any spatial differences between adult and subadult locations in the charnel house.

CONCLUSIONS

The determination of subadult sex does indeed present complications. Overall, this study showed that:

- metric analysis can limit arbitrary factors associated with sexing subadults
- the use of multiple indicators as opposed to determination of sex from single ilial features increases reliability
- the auricular surface is not as useful as GSN angle and depth in determining subadult sex
- and, there was no differential treatment of subadults by sex at EB II/III Bab edh-Dhra'.

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