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Sex Determination with Fragmented Skeletal Remains

It is well established that the adult human pelvis offers a high degree of reliability in sexing skeletal remains. The ischiopubic index devised by Schultz [*1*] and tested by Washburn [*2,3*] and Hanna and Washburn [*4*] is generally reliable for 90% or more of cases tested. The ischiopubic index is derived by measuring the lengths of the pubis and ischium from a common point in the acetabulum. The success of this technique rests on the fact that, as a rule, the pubis is absolutely longer in females while the ischium is absolutely longer in males. A second and perhaps more important sexing technique elucidated by Phenice [*5*] is a nonmetrical method employing three features of the pubic bone. The first and generally most reliable feature is the ventral arc, followed by the subpubic concavity and, finally, the medial aspect of the inferior pubic ramus. The use of all three features gave Phenice in excess of 95% reliability in American whites and blacks. Kelley [*6, 7*] obtained similar results with this technique in California Indian material. In terms of time, energy, and reliability Phenice's visual sexing technique seems preferable over the ischiopubic index.

Both of these techniques are applicable only when the complete innominate bone is available. Phenice's method [*5*] is rendered largely ineffective if even 1 cm of the anterior pubic region is damaged or destroyed. The ischiopubic index is also inapplicable under these circumstances. Many archeologists and medical examiners are all too familiar with the fact that the pubic region is the most delicate part of the pelvis. Breakage occurs frequently along the superior and inferior rami, leaving only the ilium, acetabulum, and posterior portion of the ischium intact [*6*]. Such agents as soil pressure, root and animal activity, and soil acidity may be responsible for the breakage and subsequent destruction or displacement of the pubic region. The investigator is then faced with the problem of sexing skeletal remains with less reliable methods. Given fragmentary skeletal remains, how can one best go about deriving maximum reliability? The technique described below is one attempt to derive more reliable results using less perishable portions of the pelvis.

Sciatic Notch/Acetabular Index

Two important features present on the more durable portions of the pelvis are the greater sciatic notch and acetabulum (hip socket). These features have been described and analyzed for their usefulness in sex determination on numerous occasions [*6,8-13*]. The width of the greater sciatic notch has been shown to be highly variable in males and females [*6,11-13*] and some ambiguity has arisen as to how it should be measured [*14*]. Nevertheless, Washburn [*2*] estimated that correct sex determination was possible in 75% or more of pelves observed for the sciatic notch. Results generally confirming this figure were obtained in the present study, but it is clear that this feature is not sufficiently reliable when considered alone. The acetabulum is fairly useful in sex determination since it is usually larger and deeper in males as a result of body size and weight-bearing factors. However, the

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amount of overlap is frequently such that it is only of minor value in sexing pelvic material [*10,15*]. Since neither of these features is sufficiently reliable on the basis of individual merit, it is suggested that an index derived from the two might result in a more reliable and objective sexing technique.

Material and Methods

From the Hamann-Todd skeletal collection housed at the Cleveland Natural History Museum, 400 pelves of known age and sex were inspected and measured for greater sciatic notch and acetabular dimensions. In addition, 200 archeologically derived California Indian pelves were also included. These remains are stored at the University of California at Berkeley.

Accurate measurement of the greater sciatic notch was initially a major obstacle. It was decided that the delicate ischial spine could not be used as a reference point in measuring the notch width since this sexing technique is aimed at fragmented pelves that are likely to be missing this feature. This problem was resolved by measuring from the base of the spine (that is, where it usually breaks off) to the pyramidal projection of the posterior border (see Fig. 1). The acetabulum is considerably easier to measure, and the vertical diameter was utilized as shown in Fig. 1. The index is computed as follows:

$$\frac{\text{greater sciatic notch width (mm)}}{\text{vertical diameter of acetabulum (mm)}} \times 100$$

Results

The results in Table 1 list the pertinent data for the greater sciatic notch, acetabulum, and the sciatic notch/acetabular index. Males and females are separated by a comfortable 15- to 20-point margin in their respective means for this index. Racial differences are poorly defined in all three groups, as indicated by the index means. Table 2 summarizes the distribu-

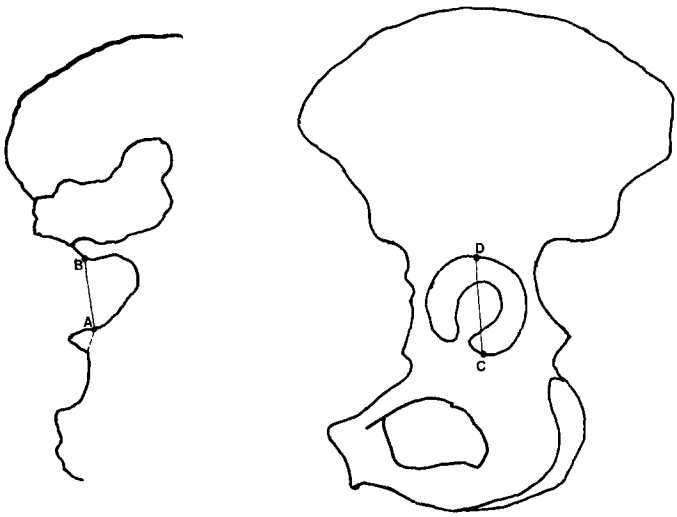

FIG. 1—*The greater sciatic notch* (left) *is measured from the base of the ischial spine* (A) *to the pyramidal process* (B). *The dashed line through the ischial spine indicates where it commonly breaks off. The vertical distance between the inferior* (C) *and superior* (D) *margins of the acetabulum* (right) *is measured as shown. Sliding calipers were used for both measurements.*

TABLE 1—*Pertinent data for three skeletal samples measured.*

Race and Sex	*n*	Sciatic Notch Width				Acetabular Width				Sciatic Notch/Acetabular Index			
		$\bar{X}$	Range	Standard Deviation	Coefficient of Variation	$\bar{X}$	Range	Standard Deviation	Coefficient of Variation	$\bar{X}$	Range	Standard Deviation	Coefficient of Variation
White													
Males	100	4.28	2.9–5.7	0.50	11.68	5.63	4.9–6.5	0.29	5.15	76.16	50–97	8.93	11.73
Females	100	4.67	3.6–6.3	0.47	10.06	4.84	4.3–5.7	0.25	5.16	96.46	76–122	9.37	9.72
Black													
Males	100	3.94	3.1–5.0	0.41	10.41	5.52	4.9–6.3	0.28	5.07	71.54	55–89	8.10	11.32
Females	100	4.53	3.6–5.9	0.46	10.15	4.84	4.1–5.5	0.27	5.58	93.74	73–118	8.96	9.56
Indian													
Males	100	3.90	3.2–5.4	0.35	9.16	5.10	4.6–5.6	0.25	4.94	76.95	62–94	7.56	9.85
Females	100	4.40	3.5–5.2	0.36	8.20	4.60	4.2–5.2	0.21	4.55	96.23	76–114	7.90	8.20

TABLE 2—*Number of cases of overlap between males and females.*

Race	*n*	Male/Female Cutoff Point	Male/Female Overlap	Total Overlap
American whites	200	87	9/12	21
American blacks	200	86	3/16	19
American Indians	200	87	9/8	17

tion and degree of overlap for the sciatic notch/acetabular index. With 87 as the cutoff point for American whites, nine males and twelve females overlap. The cutoff point for American blacks is one point lower, with only 17 of 200 individuals in question. The range of variation is approximately equal for males and females in each group.

Discussion

The sciatic notch/acetabular index should correctly sex at least 90% of skeletal remains investigated. This is a respectable figure if one is dealing with fragmentary remains. Furthermore, as indicated in Table 2, the cutoff points for all three samples are sufficiently similar that no major allowances are necessary to determine sex from group to group. As a general rule of thumb, pelves with an index of 88 or more will be female while those with 86 or less will be male.

In addition to the greater sciatic notch/acetabular index, the investigator should certainly use any other information available from the pelvis, including the preauricular sulcus when it is well developed [*16-18*], the visual form of the greater sciatic notch [*10,19*], pelvic robustness, the degree of ruggedness or smoothness on pelvic surfaces, and sacral dimensions. Other postcranial bones should be inspected for their degree of muscle markings, joint size, and overall dimensions [*20*]. The skull frequently offers 70 to 80% reliability to the trained observer [*21*]. Features to consider in the skull are overall larger dimensions in males, rugged muscle markings, pronounced supraorbital ridges, larger mastoid processes, orbital shape, and numerous other features commonly described (for example, see Ref *9*).

The greater sciatic notch/acetabular index is as of yet untested on subadult material because of the paucity of skeletal samples of suitable size. It is likely, however, that this index would be of reduced usefulness in these instances.

Conclusions

In fragmentary adult skeletal remains, sex determination is frequently more difficult and reliability is lowered. The greater sciatic notch/acetabular index uses more durable portions of the pelvis and offers 90% or better reliability. When used in conjunction with other skeletal features and available artifacts, its reliability will be reinforced.

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