Douglas H. Ubelaker,[1] *Ph.D. and Crystal G. Volk*[1]

A Test of the Phenice Method for the Estimation of Sex

ABSTRACT: The Phenice method for the estimation of sex of an individual from the pelvis was tested on 198 individuals of known sex from the Terry collection by an individual with training in the technique, but no additional training in forensic anthropology. Sex was correctly estimated in 88.4% of all individuals and more accurately estimated in females than in males. In a subsequent test of the same individuals by the same investigator utilizing additional non-metric pelvic indicators, overall accuracy increased to 96.5%, with slightly greater accuracy for males. The study suggests that experience likely contributes to the accuracy of the Phenice method and that for inexperienced investigators, consultation of all pelvic indicators offers an advantage over using just the three variables in the Phenice method.

KEYWORDS: forensic science, forensic anthropology, sex estimation, Phenice, skeletal

The reliable estimation of sex from the skeleton represents an important contribution of forensic anthropology to the investigation of death. Although many bones of the skeleton present size related sexual differences, those of the pelvis usually display marked sex differences in morphology independent of size (1–4). Areas of the pelvis well known for such differences include the subpubic angle, sciatic notch, preauricular sulcus, auricular area, and pubis.

In 1969, Phenice called attention to three aspects of the pelvis that he felt were especially useful to estimate sex from skeletal remains; the ventral arc, the subpubic concavity, and the medial aspect of the ischio-pubic ramus.

The ventral arc refers to a "slightly elevated ridge of bone which extends from the pubic crest and arcs inferiorly across the ventral surface to the lateral most extension of the subpubic concavity . . . where it blends with the medial border of the ischio-pubic ramus (5)." Phenice reported that the ventral arc as described above had only been detected in females. He suggested that whereas males may present a similar ridge, it does not match the above definition when the bone is oriented properly.

The subpubic concavity refers to a lateral recurve in the dorsal ischio-pubic ramus a short distance below the lower margin of the pubic symphysis. Phenice describes this as a female characteristic, noting, however, that some males display a "slight hint" of the trait.

Phenice also noted that in males, the medial aspect of the ischio-pubic ramus displays a broad, flat surface. In contrast, in females, this area more frequently presents a ridge.

[1] Department of Anthropology, NMNH, MRC 112, Smithsonian Institution, Washington, D.C.

To examine the usefulness of these traits in estimating sex, Phenice examined pelvic bones of 275 individuals from the Terry Collection; all representing adults of known sex. This large collection contains the skeletal remains of dissecting-room cadavers that were assembled at Washington University School of Medicine in St. Louis and subsequently transferred to the Smithsonian Institution in Washington, D.C.

Of the 95 females examined, 43 were of European ancestry and 52 of African ancestry. Of the 180 males, 160 were of European ancestry and 20 of African ancestry.

Using the three criteria discussed above, Phenice was able to estimate the sex with an accuracy of 96%. His procedure was slightly more accurate for females than for males and slightly more accurate for individuals of European ancestry than for those of African ancestry. Phenice recommended using all three of the criteria noting "when there is some ambiguity concerning one, or rarely two of the criteria, there is almost always one of the criteria which is obviously indicative of male or female (5).

A key attraction of the Phenice technique has been its claim of high accuracy even with inexperienced researchers. According to Phenice, "The method described here is simple and objective enough to allow the beginning researchers to sex hip bones accurately . . ." (p. 297).

Many researchers have found the Phenice technique to be useful (1,4) and it has stimulated additional research. In 1978, Kelley (6) tested it on 362 California Indian skeletons with generally favorable results. He found close congruence with other pelvic indicators of sex and that the approach produced clear distinctions between the sexes. He reported that the ventral arc was the least ambiguous feature and that intermediate examples were noted mostly in what he judged to be females.

Lovell (7) tested the technique on 50 pubic bones of 36 individuals of presumed European ancestry, 13 males and 23 females. Sex was estimated by 12 participants ranging in experience from none to considerable and in education from undergraduate students to one professional physical anthropologist. All participants were instructed in the technique. The bones utilized had been removed from cadavers with sections made through the superior ramus of the pubis and the ischio-pubic ramus. While this had the advantage of preventing participants from considering other relevant features elsewhere on the pelvis, the location of the inferior section limited observations of the subpubic concavity and perhaps also the medial aspect of the ischio-pubic ramus. Despite these limitations, participants estimated sex with an average accuracy of about 83% with no significant differences among experience levels. Although this study failed to reproduce the high accuracy originally reported by Phenice, it supported his suggestion that the technique required a careful reading of his article but minimal previous experience.

Using dissection techniques Budinoff and Tague (8) and Anderson (9) clarified anatomical aspects of the features employed in the Phenice technique. They also stressed the relationship of the features to sex differences in growth of the pelvis.

In a 1990 study, MacLaughlin and Bruce (10) tested the Phenice method on three European samples of known sex. Following Lovell (7), they failed to duplicate the high accuracy reported by Phenice. In contrast to the Lovell study, they suggested that experience was a factor in the accuracy of the application of the method.

Sutherland and Suchey (11) tested aspects of the Phenice technique on 1284 pubic bones of known sex. Since the pubic bones had been removed from cadavers in a manner similar to the sample studied by Lovell (7), not all of the Phenice features could be observed easily. Using just the ventral arc, they were able to estimate sex with an accuracy of 96%.

A significant issue raised in the literature discussed above is the extent to which experience affects accuracy in the use of the Phenice method. Is experience in studying pelvic morphology necessary to properly interpret the three features involved in the Phenice method? If so, this would suggest that in a strict application of the Phenice method an experienced worker would estimate sex more accurately than an inexperienced one.

An additional question is the extent to which experience with other pelvic indicators of sex may influence the application of the Phenice technique. As noted above, the anatomical features examined in this technique are highly correlated with other pelvic indicators. Is it possible that an experienced worker may be influenced by other pelvic indicators in applying the Phenice method, especially in applications when the entire pelvis or other aspects of the skeleton are present? The research reported here attempts to address this problem. Previous tests of the Phenice method have presented somewhat conflicting results regarding the key issues of overall accuracy of the technique and the role experience plays in its application.

Materials and Methods

In the academic year 1999–2000, the second author (hereafter referred to as CV) was a high school senior with an excellent academic record but no previous exposure to skeletal anatomy. After studying the Phenice article, she received instruction in the technique from the first author (hereafter referred to as DHU) using comparative pelvic bones. Although she became comfortable judging the three features of the Phenice technique, she had no knowledge of other anatomical features of the pelvis useful for estimating sex.

After CV was trained in the Phenice technique as outlined above, the pelvic bones of 99 adult females and 99 adult males were removed from the Terry Collection and brought to the laboratory of DHU at the Smithsonian Institution. Although this represents the same general collection utilized in the original Phenice study, it is not known how many, if any, of the actual specimens were examined in both efforts. CV did not participate in the removal process and thus had no opportunity to view the pelvic bones in the context of the complete skeletons. Information on the age, sex and ancestry distribution of the sample is presented in Table 1 and Fig. 1.

Without any knowledge of information regarding the individuals represented by the pelvic bones (other than that they originated from the Terry Collection) CV estimated the sex of each individual using the Phenice technique. Both innominates of each individual were examined together. Since this sample represents the same one utilized by Phenice the study offers an opportunity to examine the role of investigation experience in the application of the technique.

TABLE 1—*Age distribution of the Terry collection sample utilized in this study.*

	N	Mean	Standard Deviation	Range
Total Sample	198	55.4	16.76	18–91
Female	99	60.0	16.17	20–91
Male	99	50.8	16.09	18–84
African	82	49.0	17.53	18–91
European	115	59.9	14.62	27–89
Hindu	1	65.0	0	65
African				
Female	44	54.5	16.99	20–91
Male	38	42.6	15.91	18–76
European				
Female	55	64.4	14.01	34–89
Male	60	55.8	13.97	27–84
Hindu				
Male	1	65.0	0	65

Upon completion of the application of the Phenice technique as outlined above, DHU instructed CV on other features of the pelvis useful to estimate sex such as the morphology of the sciatic notch, subpubic angle, auricular area, preauricular sulcus, acetabulum, and dorsal pubic pitting, as well as general pubic morphology (1–4). CV studied relevant literature and practiced with comparative skeletal material until she was comfortable judging sex of the individual from all available nonmetric methods (including the Phenice procedures). Pelvic bones from the same 198 individuals that were utilized in the previous examination were then separated from the remainder of their skeletons and made available for examination. As before, CV did not participate in the removal of the pelvic bones and had no additional knowledge about the individuals they represented. She also did not know at that time the results of her previous application of the Phenice technique and she did not consult her previous results. As before, she estimated the sex of each individual, this time observing all aspects of the pelvis, including the three features of the Phenice technique. When the estimates of sex of all 198 individuals had been completed, they were compared with the known information regarding sex of the individuals.

Results

Using just the Phenice method, CV correctly estimated the sex of 175 of the 198 individuals for an overall accuracy of 88.4%. Accuracy was much greater for females (97.0%) than for males (79.8%). Of the 23 individuals who were not judged correctly, 20 were actual males (Table 2) and three were actual females (Table 3). Of the 20 males, four were of African ancestry, 15 were of European ancestry, and one was listed as "Hindu." The ages at death of these 23 individuals ranged from 27 years to 73 years with a mean of 44.1 years. The mean age at death of those of African ancestry was 35.6 years with a range between 32 years and 43 years. The mean age at death for the 15 males of European ancestry was 45.0 years with a range between 27 and 73 years.

The three female individuals who were incorrectly judged to be male using the Phenice method consisted of two individuals of African ancestry and one of European ancestry. The former ranged in age from 79 to 62 years with a mean of 71 years and the latter was of age 66.

Using the combined criteria for the pelvis, the accuracy of sex estimation increased to 96.5%. In contrast to the results reported
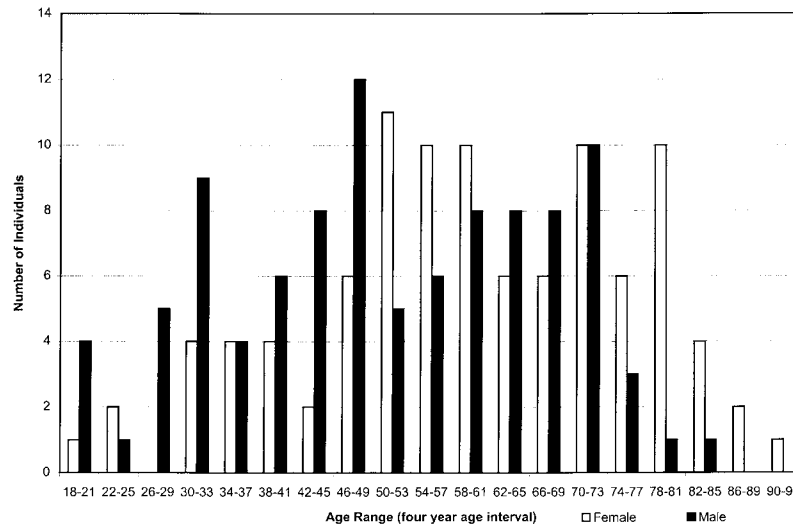
FIG. 1—*Age distribution of the Terry collection sample utilized in this study.*

TABLE 2—*Actual male individuals from the Terry collection judged to be female using the Phenice method.*

Specimen No.	Sex Estimated Using Phenice Method	Actual Sex	Ancestry	Actual Age
111R	Female	Male	European	38
126R	Female	Male	European	50
182	Female	Male	African	43
187R	Female	Male	European	29
195	Female	Male	European	49
196	Female	Male	European	27
216	Female	Male	European	45
230	Female	Male	European	38
260	Female	Male	European	48
261	Female	Male	European	50
290R	Female	Male	Hindu	65
303R	Female	Male	European	30
308	Female	Male	African	35
318	Female	Male	European	45
333	Female	Male	European	67.5
406	Female	Male	European	73
448	Female	Male	European	47
62RR	Female	Male	European	38
84	Female	Male	African	32.5
89R	Female	Male	African	32

TABLE 3—*Actual female individuals from the Terry collection judged to be male using the Phenice method.*

Specimen No.	Sex Estimated Using Phenice Method	Actual Sex	Ancestry	Actual Age
110R	Male	Female	European	66
218R	Male	Female	African	79
40	Male	Female	African	62

TABLE 4—*Actual male individuals from the Terry collection judged to be female using the combined method.*

Specimen No.	Sex Estimated Using Combined Method	Actual Sex	Ancestry	Actual Age
111R	Female	Male	European	38
187R	Female	Male	European	29

TABLE 5—*Actual female individuals from the Terry collection judged to be male using the combined method.*

Specimen No.	Sex Estimated Using Combined Method	Actual Sex	Ancestry	Actual Age
20R	Male	Female	European	78
218R	Male	Female	African	79
26R	Male	Female	African	50
304	Male	Female	African	20
357R	Male	Female	African	24

European ancestry with an age range from 29 years to 38 years with a mean age of 33.5 years. The five females ranged in age from 20 to 79 years and consisted of one individual of European ancestry (age 78 years) and four of African ancestry. The four males of African ancestry ranged in age from 20 years to 79 years with a mean age at death of 43.3 years.

Of the 20 males who were incorrectly judged to be females using the Phenice method, 18 were correctly assessed as male using the combined method. The two males (specimen numbers 111R and 187R) incorrectly judged to be females by both methods were both of European ancestry and ages 29 and 38 years. Both of these individuals displayed very small pelvic bones with characteristics normally associated with female sex (Figs. 2 to 5).

Of the three known female individuals who were judged to be male using the Phenice method, only one (No. 218R) was also judged male using the combined method. The combined procedure correctly estimated the sex of the other two individuals (Nos. 110R and 40), but incorrectly estimated sex for four known females (Nos. 20R, 26R, 304, and 357R) who were correctly estimated using just the Phenice method.

above with the Phenice method, sex was estimated for males and females with similar accuracy using all nonmetric pelvis information.

Through study of all nonmetric characteristics of the pelvis, CV was able to correctly estimate the sex of 191 of the 198 individuals. Of the seven incorrect estimates, two were of actual males (Table 4) and five of actual females (Table 5). The two males were both of

FIG. 2—*View of the ventral surface of the pubic bones of the male individual 111R.*

FIG. 3—*View of the dorsal surface of the pubic bones of the male individual 111R.*

Specimen 20R was extremely large with relatively narrow sciatic notches. No 357R displayed moderate size sciatic notches but otherwise presented characteristics suggestive of female sex. Number 26R was somewhat robust appearing but otherwise presented female characteristics. Number 304 presented a relatively large acetabulum but no other apparent male characteristics.

The erroneous diagnosis of the female 218R as male using both procedures seems largely to have been influenced by the unusually large size of the pelvis. The very large size and a relatively flat medial border of the ischio-pubic ramus suggest male, however, the female traits of the ventral arc, wide sciatic notch and subpubic concavity are also present.

Discussion

The application of the Phenice technique to the 198 individuals in the Terry collection by CV estimated the sex with an accuracy of 88.4%. This suggests that the technique offers a useful approach to sex estimation even with an inexperienced participant. However, this figure falls considerably short of the 96% reported by Phenice

in his original study. Since both studies were conducted on samples derived from the same Terry collection, it seems logical that the difference in accuracy reflects differences in the experience of the investigators rather than population-based differences in the samples studied. At the time of his study, Phenice was an advanced graduate student at the University of Kansas who had already gained considerable experience with pelvic skeletal anatomy and the examination of many skeletons from both forensic and archeological contexts. The differences in accuracy documented here may reflect his greater experience and/or his consideration (either consciously of unconsciously) of features of the pelvis beyond those described in his method.

This study also suggests that at least with an inexperienced investigator, the use of all information from the pelvis produces more accurate estimates than just using the traits defined in the Phenice method. Consideration of all information from the pelvis enabled the inexperienced investigator in this study to estimate sex with an accuracy of over 96%. The detection of two males in the Terry collection showing pelvic characteristics usually associated with female sex illustrates the inherent difficulty of devising morphological-based techniques that approach an accuracy of 100%. The fact that three known females were correctly evaluated using the Phenice methods but incorrectly judged using the combined approach demonstrates the importance of the Phenice technique in

FIG. 4—*View of the ventral surface of the pubic bones of the male individual 187R.*

FIG. 5—*View of the dorsal surface of the pubic bones of the male individual 187R.*

evaluating female pelvic bones of unusually large size and/or robusticity.

Note also that with the inexperienced investigator reported here, the Phenice technique was more accurate in diagnosing females than males. The errors in estimating sex of known females were all with older individuals, suggesting that age changes may negatively impact the success of evaluation of females using the Phenice technique. Age was less of a factor in the accuracy of estimating sex in females when all features of the pelvis were considered.

Clearly experience plays an important role in the application of the Phenice technique. It is also clear that the Phenice technique is most effective when used within a comprehensive approach that considers all information relative to the estimation of sex.

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Additional information and reprint requests:
Douglas H. Ubelaker, Ph.D.
Curator of Physical Anthropology
Department of Anthropology, MRC 112
National Museum of Natural History
Smithsonian Institution
Washington, D.C., 20560-0112
Phone: (202) 786-2505
E-mail: Ubelaker.Doug@nmnh.si.edu