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The Ischium/Pubic Index for Sex Determination from Fragmentary Pelvic Material in Prehistoric New Zealand Populations

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ABSTRACT

The use of an ischium/pubis index for sex determination in fragmentary pelvic material is an effective technique when the osteometric parameters have already been established for a genetically similar, larger population. The index for prehistoric New Zealand populations and the implications of the New Zealand data are discussed.

Keywords: ISCHIUM/PUBIC INDEX, SEX DETERMINATION, NEW ZEALAND PREHISTORIC SKELETAL MATERIAL.

INTRODUCTION

The use of quantitative osteometric techniques for sex determination has to be restricted to populations genetically similar to those for which parameters have already been established. Such techniques are highly population-specific (Iscan 1983). It is possible to achieve a consistency in sex determination of fragmentary pelvic material using an ischium/pubis index as long as the index has already been established from a larger group of individuals of a genetically similar population. The following method of sex determination for prehistoric New Zealand skeletal material using an ischium/pubis index may be useful, as it is a technique which can be used when the remains of other parts of the pelvis are marginal or inadequate for other methods of sex determination.

METHODS AND MATERIALS

The method is based on calculating the ischium/pubis index, expressed as:

$$(\text{pubic length} \times 100) / \text{ischial length}$$

Pubic length is measured from the centre of the acetabulum to the most medial point on the front edge of the symphysis. *Ischial length* is measured from the centre of the acetabulum to the most distal point on the ischial body; the axes of the ischium and pubis are those of Weidenreich (1913) (Fig. 1).

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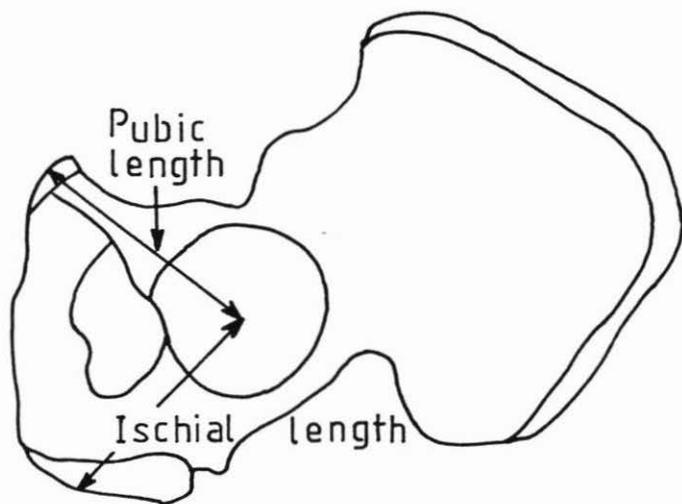


Figure 1: Measurements of the pubic and ischial lengths are taken from the centre of the acetabulum. Ischium/Pubic index = (Pubic length x 100) / Ischial length.

This index was established by Washburn (1948) as a primary index for sex determination. He considered that the lengths of the pubis and ischium were easier to measure than the sub-pubic angle, which had often been used for sex determination; and that the sub-pubic angle was secondary to the relative lengthening of the pubic bone in females. Ideally, the ischium/pubis index should only be used when the range for male and female indices has been established on individuals of known sex, as occurred from studies of the large anatomy dissecting room collections in the United States.

The term ischium/pubis index has caused some confusion. It was erroneously taken as ischial length x 100/pubic length by Wood (1976) and Baker (1975), although the error was corrected by Mobb and Wood (1977). The term pubo-ischial index has been proposed to avoid such an error (Williams and Warwick 1980: 390), but has not been widely accepted.

A further problem arises with comparison of the index between different studies, because Washburn originally measured from the fusion point of the pubis, ilium and ischium within the acetabulum, and Mobb and Wood measured from the rim of the acetabulum. However, it is consistent with current metrical studies (Berge *et al.* 1984; Steudal 1984) to take the pubic and ischial lengths from the centre of the acetabulum, irrespective of the actual fusion point of the bones within the socket.

The ischium/pubis index can be used on isolated skeletal material when the range of 'male' and 'female' indices have already been established for a similar population, as long as it is remembered that the sex determination is only consistent with that undertaken on a larger prehistoric population, and is only as accurate as the sex determination in the larger group.

TABLE 1
THE SAMPLE USED IN THIS STUDY

Reference no	Origin	Sub pubic angle	Ischium/pubis Index	
			left	right
FEMALES				
E24	Otago	93.00	120.00	121.50
E27	Chatham Is	104.00	113.25	121.50
E28	Otago	87.00	110.30	114.80
E32	Chatham Is	113.00	120.00	N/A
E35	Gisborne	108.00	122.00	127.50
E42	Otago	90.00	105.80	112.50
E45	Otago	96.00	123.00	116.20
E48	-	88.00	113.00	116.00
E74	Otago	86.00	N/A	112.00
E82	Stewart Is	126.00	N/A	116.00
E122	Wairarapa	97.00	N/A	115.40
E193	Northland	97.00	107.50	109.00
E221	Hawkes Bay	91.00	111.00	115.10
Average		98.15	114.59	116.46
St. dev.		11.74	6.21	4.96
Average for both sides:			115.61	
St. dev.			5.51	
MALES				
E21	Otago	86.00	103.85	106.20
E22	Otago	68.00	99.35	96.90
E25	Chatham Is	105.00	N/A	105.00
E36	Gisborne	63.00	N/A	96.80
E41	Otago	70.00	N/A	104.85
E44	Otago	73.00	102.50	103.50
E75	Otago	77.00	97.65	99.70
E76	Gisborne	67.00	98.20	98.80
E92	Otago	61.00	101.00	102.00
E160	Auckland	65.00	98.20	103.00
E171	Chatham Is	80.00	97.30	100.00
E172	Chatham Is	87.00	95.75	98.40
E174	Chatham Is	75.00	97.80	101.50
E192	Northland	65.00	98.70	N/A
E223	Horowhenua	70.00	103.00	N/A
E238	Canterbury	55.00	102.00	96.80
Average		72.94	99.64	100.96
st. dev.		12.20	2.54	3.23
Average for both sides			100.46	
st. dev.			2.91	

The material used to establish the range of 'male' and 'female' indices in prehistoric New Zealand populations in this study is in the General New Zealand Collection of the Anatomy Department in the Otago University Medical School. The study was not extended to other collections in New Zealand as the data were originally collected as part of Ph.D. research

to apply different classification systems to the pelvis, and this study of the ischium/pubis index was secondary to the main objective of the research. The collection was treated as a wholly prehistoric New Zealand population, although one individual had musket wounds from warfare last century. All post-cranial material was examined, and 29 individuals were complete enough for the study (Table 1). The population was very diverse chronologically and geographically, and is not sufficiently homogeneous for complex biometrical studies. However, I consider it sufficient to provide osteometric parameters for a simple study of this type.

Much of this collection was first studied at the end of the nineteenth century. Sex identification, using the traditional method of sexing, was undertaken by different scholars at different times as the collection was increasing early this century. In recent re-assessment of cases in which there had been some disagreement about the sex determination, femoral head diameter was used, as this is considered to be sharply discriminate in New Zealand prehistoric populations (Schofield 1959). The possibility still has to be allowed that tall robust females may be classified as 'males', and short or gracile males classified as 'females'. The only solution to this would be a study, possibly by X-ray, on individuals of known sex, but this has not been undertaken.

In this study, left and right sides were treated as separate measures, so 49 indices were taken from the group of 16 males and 13 females. In some cases, both sides were not present in the collection.

RESULTS

In the 13 'females', the ischium/pubis index ranged from 105.8 to 127.5. The mean from the total of both sides was 115.6. In the 16 'males', the ischium/pubis index ranged from 95.75 to 106.2. The mean was 100.5.

An assessment of sex of prehistoric New Zealand material consistent with this population could be made from fragmentary pelvic material if the index was below 105 ('male') or above 107 ('female'). If the index was within the overlap area, other means of sex determination may be more appropriate.

DISCUSSION

OVERLAP IN THE INDICES

When Richman *et al.* (1979) discussed the ischium/pubis index, they noted that there was always an overlap when it was used on individuals of known sex. In the Howard University skeletal collection, 28 of the 95 were in the overlap area. In the Thieme and Schull (1957) sample from the Terry collection, 40 of the 200 were in the overlap area. If, for this New Zealand collection, ischium/pubis indices between 105.0 and 107.0 are taken as lying in the overlap zone, only 3 of the 49 measurements fall within this area. The more discrete nature of the index in this population should not be assumed to reflect a more pronounced degree of sexual dimorphism; it may be a reflection of the methods of making the initial sexual identification. It is likely that some estimation of the sub-pubic angle, which is secondary to pubic length, was used in the initial sex determination.

DIFFERENCE BETWEEN THE MALE AND FEMALE MEANS

Washburn established that when different ethnic groups were treated separately, the ischium/pubic index was higher by 15 percent in over 90 percent of the females. The difference between the 'male' mean (100.5) and the 'female' mean (115.6) in the New Zealand population also reflects a difference of 15 percent.

RELATIONSHIP BETWEEN SUB-PUBIC ANGLE AND ISCHIUM/PUBIC INDEX

The illustration of the clear relationship between these two measures, as graphed in Figure 2, was included in this study because the sub-pubic angle has long been favoured as a significant criterion in making sex determination. Traditionally a sub-pubic angle close to or above 90° has been considered female, and significantly less than 90° male. From obstetric literature, Llewellyn Jones (1982) cites the normal female pelvis to show a sub-pubic angle of about 85°. Smout *et al.* (1969: 33) cite a normal female angle of about 80°, and a male of about 58°, but a contracted female pelvis may show an angle of as little as 67°. In this New Zealand skeletal collection, all the 'female' pelves showed an angle within the range of 86°–126°, and the 'males' 55°–87°, except for Number 4, which had an angle of about 105°, although only the right side was present and it was difficult to measure. The disadvantages of use of the sub-pubic angle for sex determination in marginal cases is the necessity of achieving the correct articulation at the pubic symphysis, and at the sacro-iliac joints, and the need to have both innominates and a sacrum present. Because of the fragmentary nature of the material, this is often impossible, even if all surfaces are preserved.

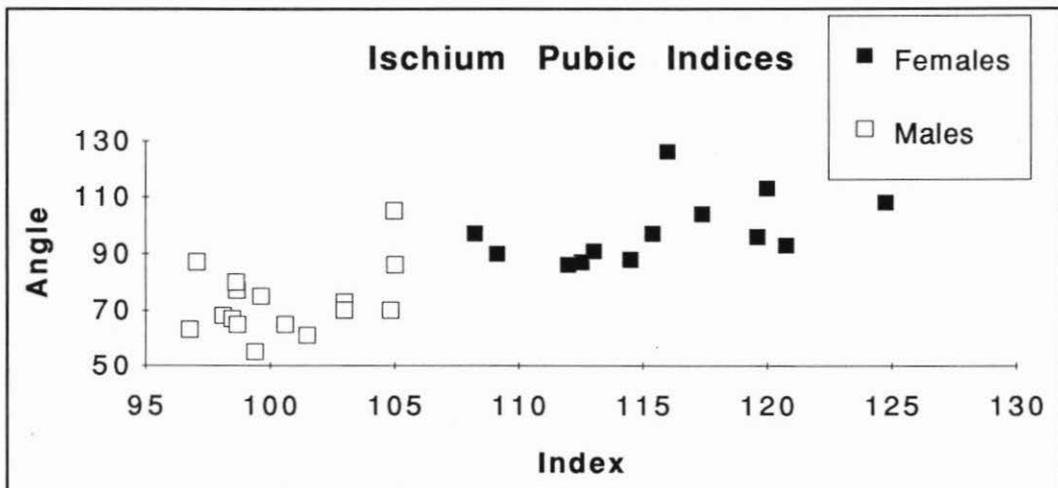


Figure 2: The relationship between the sub-pubic angle and the ischium/pubic index.

Use of the ischium/pubis index would be preferable to use of the sub-pubic angle, as observer error was found to be reduced (Appendix 1), and only one unarticulated innominate need be present.

COMPARISON OF RESULTS WITH OTHER RACIAL GROUPS

Washburn's data from Negro and White populations are reproduced in Table 2. It is useful to compare these data with body proportions. Both males and females in racial groups with longer trunk length relative to total stature show a relative elongation of the pubic bone, reflected in a higher ischium/pubis index. This might be taken as confirmation of Rosenberg's (1988) study of the relationships between stature and pelvic proportions in different racial groups, but she considered body weight to be more significant than stature in determining the relative pubic bone length. She apparently did not consider whether the different body proportions in shorter populations with a greater trunk length relative to total stature might account for the longer pubic bones, rather than total body weight.

TABLE 2

COMPARISON OF THE NEW ZEALAND DATA ON ISCHIUM/PUBIS INDICES WITH WASHBURN'S STUDY

Group	Females Range	Females Mean	Males Range	Males Mean
Negroes	84-106	95	71-88	79.9
Whites	91-115	99.5	73-94	83.6
New Zealand	105-127	115.6	95-106	100.5

These findings would be consistent with the functional biomechanical explanation of the Polynesian physique attributed to cooler climate adaptations, as suggested by Houghton (1990). Both males and females show relative elongation of the pubic bone, compared with other groups. I would suggest that this occurs secondarily to great trunk size relative to stature and overall muscular development in both sexes.

CONCLUSION

It is relatively straightforward to utilise osteometric parameters from an ischium/pubis index for sex determination; results using the criteria described would be consistent with the sex identification of this existing collection of prehistoric New Zealand material.

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APPENDIX 1

RESULTS OF THE F-TEST ON THE SMALL DIFFERENCES WHICH APPEARED IN THE DATA WHEN COMPARING TWO SETS OF MEASUREMENTS RECORDED BY THE SAME OBSERVER THREE OR MORE DAYS APART

The differences between each measure were expressed as a proportion of the mean for the whole group. A variance was then derived from this data set. The variance of the sub-pubic angle measurements was compared with the variance of pubic and ischial length measure by means of a two-tailed F-test. The value for F was obtained by dividing the larger variance by the smaller variance in each of the four comparisons:

Sub-pubic angle/right ischium length 5.66 (25 d.f.)

Sub-pubic angle/left ischium length 6.28 (28 d.f.)

Sub-pubic angle/right pubic length 16.34 (24 d.f.)

Sub-pubic angle/left pubic length 6.61 (26 d.f.)

In all four cases this F value was higher than the 99% confidence limit on the F table. This shows a significant difference in the variability in results, and quantifies the opinion that ischium/pubis indices are less susceptible than the sub-pubic angle to user-error, or variability, between different readings.

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