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Sex Determination of Prehistoric New Zealand Polynesian Scapulae

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ABSTRACT

Discriminant function analysis was utilised for sex determination of prehistoric adult New Zealand Polynesian scapulae (34 male and 38 female). Four scapular measurements were taken, using conventional osteometric techniques. Six discriminant functions were derived using the direct method in the SPSS subprogram DISCRIMINANT. The accuracy of sex determination ranged from 85.7% to 93.6%. Reduction in error over random assignment by sex ranged from 71% to 87%. These discriminant functions provide a useful tool for the assessment of human remains in the forensic and archaeological context because they incorporate measurements which can be taken on incomplete bones.

Keywords: FORENSIC ANTHROPOLOGY, DISCRIMINANT ANALYSIS, SEX DETERMINATION, NEW ZEALAND, POLYNESIANS, SCAPULA.

INTRODUCTION

Multivariate discriminant function analysis is amongst the many techniques used in sexing skeletal remains. Determination of sex forms part of the process of identification in the forensic and archaeological sciences. Little research has been undertaken using this method of sex determination of New Zealand Polynesian skeletal remains. In the two previous studies, Houghton and de Souza (1975) utilised long bone lengths, and Murphy (1994) used clavicular measurements. To compensate for this paucity of information, sexing by discriminant function analysis has been undertaken in the present study using adult New Zealand Polynesian scapulae.

MATERIALS AND METHODS

Adult scapulae (34 male and 38 female) from the collection in the Department of Anatomy and Structural Biology, Otago Medical School, Dunedin, New Zealand were examined. This material had been recovered from isolated burials and archaeological sites throughout New Zealand. It is believed to be from the prehistoric period.

The criterion chosen to establish adult status was complete fusion of all epiphyses. No adult bone or major fragment capable of providing a measurement was excluded, unless affected by gross pathological or post-mortem distortion.

Since the skeletal remains were archaeological in origin, none of the material was of known sex. Thus, in order to evaluate this new method of sex determination, it was necessary to establish the sex of the individuals initially by some other means. In expert

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hands, the conventional pelvic morphological criteria which were used can achieve 95% accuracy in assignment of sex. Discriminant function number one, derived by Houghton and de Souza (1975), was also utilised in the initial sexing with a reported accuracy of 97.6%.

The measurements were chosen for their potential utility in assessment of poorly preserved remains, commonly encountered in forensic cases and archaeological excavations. Four scapular measurements were taken in this study, utilising sliding calipers.

Maximum height of the glenoid cavity (GLENH). The fixed arm of the caliper was applied to the area where the glenoid cavity contacts the infraglenoid tubercle. The movable arm was brought into contact with the area where the lateral border of the root of the coracoid process joins the supraglenoid tubercle. The arms of the caliper were rotated from side to side until the maximum diameter was determined. The two points used in this measurement were marked on the bone in pencil. The maximum height may not lie in the true coronal plane.

Maximum breadth of the glenoid cavity (GLENB). The arms of the caliper were applied to the points on the glenoid cavity at right angles to those of the previous measurement and the maximum diameter determined.

Maximum length of the spine (MAXSP) (Bainbridge and Genovés 1956). The medial point for this measurement was defined by the junction of the vertebral border and the prolongation of that segment of the inferior lip of the crest of the spine lying medial to the deltoid tubercle. The fixed arm of the caliper was applied to this medial point. The movable arm was placed against the acromion and rotated until the most distant point in any direction was located and the maximum length determined.

Minimum length of the spine (MINSP). The fixed arm of the caliper was applied to the medial point described in the previous measurement. The movable arm was placed in contact with the lateral border of the spine within the spino-glenoid notch, and rotated until the minimum length was obtained.

Six discriminant functions were derived utilising the DISCRIMINANT procedure of SPSS, METHOD=DIRECT (Nie *et al.* 1975; Hull and Nie 1981). Three of these functions used measurements from left side bones, and the remainder utilised those from the right side. Each function was generated using a specified combination of variables likely to be available from incomplete skeletal material. Thus, a single discriminant function was derived during each of six separate analyses. Such an approach is identical to that of Houghton and de Souza (1975) and Murphy (1994). The sectioning point for assignment of sex was designated as the midpoint between the male and female mean discriminant scores (Giles and Elliot 1963; Kajanoja 1966; Steele 1976).

To express the improvement achieved by the discriminant functions over random assignment by sex, a proportional reduction in error statistic termed *tau* (Klecka 1980) was calculated. The maximum value for *tau* is one, and occurs when there are no errors in assignment. A value of zero indicates no improvement over random assignment.

RESULTS

Univariate statistics for the four scapular variables are shown in Tables 1 and 2. All dimensions were significantly greater in males than females.

TABLE 1[1]
NEW ZEALAND POLYNESIAN LEFT SCAPULAE

	Male			Female			
Variable	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**Significance[2]**
GLENH	17	44.06	2.14	22	38.59	2.38	***
GLENB	15	29.40	1.59	22	25.45	1.74	***
MAXSP	11	137.55	5.99	11	122.45	9.66	***
MINSP	11	84.55	4.52	11	75.73	6.47	**

[1] All dimensions in millimetres
[2] Significance levels (t-test) of the difference between male and female means: * 5%, ** 1%, *** 0.1%

TABLE 2[1]
NEW ZEALAND POLYNESIAN RIGHT SCAPULAE

	Male			Female			
Variable	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**Signifiance[2]**
GLENH	16	45.75	2.57	16	39.31	2.47	***
GLENB	16	30.69	1.40	15	25.87	2.10	***
MAXSP	11	138.45	7.13	13	123.00	8.96	***
MINSP	13	84.15	5.27	13	75.23	7.03	**

[1] All dimensions in millimetres
[2] Significance levels (t-test) of the difference between male and female means: * 5%, ** 1%, *** 0.1%

For each function, Tables 3 and 4 indicate the variables utilised in its derivation, the unstandardised discriminant coefficients, the sectioning point, the value for *tau* and the expected accuracy of sex determination. The accuracy of sex determination ranged from 85.7% to 93.6%, and values for *tau* ranged from 0.71 to 0.87.

TABLE 3
DISCRIMINANT FUNCTIONS DERIVED FROM LEFT SCAPULAE

Variable	Discriminant Function Number 1	2	3
GLENH	-0.041173	-0.059188	-0.002925
GLENB	0.660852	0.747848	0.761988
MAXSP	0.155025	-	-
MINSP	-0.134862	0.047622	-
Constant	-26.11070	-22.26287	-21.21178
Accuracy	85.7%	85.7%	86.5%
Tau	0.71	0.71	0.73
Sectioning Point	0	0	0

TABLE 4
DISCRIMINANT FUNCTIONS DERIVED FROM RIGHT SCAPULAE

Variable	Discriminant Function Number 1	2	3
GLENH	0.071883	0.055076	0.095361
GLENB	0.341718	0.343641	0.476806
MAXSP	-0.039697	-	-
MINSP	0.237883	0.186197	-
Constant	-26.75921	-27.14325	-17.80074
Accuracy	87.0%	88.0%	93.6%
Tau	0.74	0.76	0.87
Sectioning Point	-0.40031	-0.39787	-0.25703

As an example of utilising a function: if the maximum height of the glenoid cavity of a right scapula is measured as 48 mm, the maximum breadth of the glenoid cavity is measured as 30 mm, and no other measurements can be taken, discriminant function 3 (Table 4) can be applied as follows:

Discriminant score = (48 x 0.095361) + (30 x 0.476806) - 17.80074 = 1.080768

Since this score is above the sectioning point of -0.25703, the scapula is assumed to be from a male individual. This classification has an expected accuracy of 93.6%.

DISCUSSION

The accuracy of sex prediction demonstrated by the discriminant functions derived in this study indicates that they will be of considerable value to archaeologists and forensic investigators throughout New Zealand. Size of articular surfaces of bones has long been

regarded as a useful indicator of sex (Dwight 1905). This has been confirmed by the present study in which the diameters of the glenoid cavity are amongst the useful sexual discriminators.

Black (1978) commented that many of the techniques available for sex determination of human skeletal remains could be utilised only on well preserved bones from relatively complete skeletons. He noted that few reliable methods were available to the investigator confronted with incomplete bones.

The discriminant functions derived in the present study have the practical advantage of permitting sexual assessment of poorly preserved remains, commonly encountered in archaeological excavations and forensic casework. Inclusion in the discriminant functions of measurements that can be taken on preservationally favoured portions of the scapula reduces the likelihood of investigators being unable to locate a function which incorporates the measurements possible on their specimens.

Because of the well-documented population specificity of the discriminant function method (Kajanoja 1966; Steele 1976; Calcagno 1981), the functions derived in this study are unsuitable for use on non-Polynesian skeletal populations in New Zealand. It is intended to examine the applicability of these discriminant functions to other Polynesian samples from the Pacific region in a subsequent study.

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