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FEMORAL NON-METRIC TRAITS RECONSIDERED

ABSTRACT: Non-metric variations of the proximal male femur were recorded from two broadly contemporary skeletal groups in England. Analysis showed that these variations were related to age and to patterns of activity, rather than to biological affinity or distance. It is suggested that many such traits are strongly influenced by environment, rather than genetics.

KEY WORDS: Non-metric variations – Male femur – Age – Activity – Environment – Statistical analysis

INTRODUCTION

Non-metric skeletal variations are by definition impossible to measure, unlike their metric counterparts, and are therefore recorded on a present/absent basis for skeletal samples; they are usually known as morphological or non-metric traits. Interest has been shown in these traits by many previous workers and traditionally they have been used as an indicator of biological affinity within, and distance between, skeletal populations (see Saunders 1989 for an excellent review). The majority of such work has concentrated on the cranium, but variations have been recorded also on the infracranial skeleton, and Finnegan (1978) described and illustrated these. However, recent work (Saunders 1989, Prowse, Lovell 1995) has demonstrated the problems associated with the use of such traits to estimate the biological affinities and/or distances of skeletal populations.

In the course of recent research on asymmetry in the male skeleton, non-metric traits of the proximal femur were recorded and analysed (Stirland 1992). This work is reported here.

MATERIALS AND METHODS

The skeletal samples used in this study came from two archaeological sites. Whilst not contemporary, these sites are separated by a *terminus ante quem* of less than 100 years. The first sample consisted of the commingled remains from the excavation of King Henry VIII's flagship the *Mary Rose* which sank off the south English coast on the morning of 19 July, 1545 AD, with the loss of all but about thirty five of the crew of 415. Based on a count of frequencies of individual bones, the number of individuals excavated was not less than 179. All the skeletal remains studied were those of males and, since the burials were mixed, matched pairs of femora were selected for study (Stirland 1992). The bone was in such an excellent state of preservation that it was possible to match paired bones with confidence. For the purposes of the research, all matched pairs were re-checked and any that were either of uncertain matching or pathological were rejected.

The second sample consisted of the paired male femora from the site of the cemetery of St. Margaret *incombusto ubi suplienta suspensi*, Magdalen Street, Norwich, eastern England. The church and cemetery were in use from 1240 to 1468 AD, when the cemetery was closed and the church amalgamated with another close by. The total number of excavated articulated inhumations was 413, of whom 283 were male.

Ageing and sexing were undertaken using standard multifactorial techniques. In the case of the bones from the *Mary Rose*, the pairs had to be aged independently. It was, therefore, decided that broad age categories should be used rather than specific age ranges, and these categories were also applied to the males from the Norwich site. They were:

Young adult (YA) in which the epiphyseal line is clearly defined at the proximal end of the bone; for the femur, this places males in their late teens' or early twenties.

Mature adult (MA) in which the proximal epiphyseal line is clearly obliterating or is absent, thus placing males in their late twenties or older.

The whole sample consisted of 112 pairs of femora from both age ranges and from both archaeological sites. There were 64 pairs of YA femora and 48 pairs of MA femora; there were 55 pairs of femora from the *Mary Rose* (MR) and 57 pairs from Norwich (780N).

The non-metric traits which were recorded for the femur were those occurring on the proximal bone. They were:

1. The third trochanter;
2. The hypotrochanteric fossa;
3. Allen's fossa;
4. Poirer's facet;
5. Plaque on the neck;
6. Exostoses in the trochanteric fossa.

All are described and illustrated in Finnegan (1978).

RESULTS

The recorded traits were analysed by application of the *chi* square test (*Table 1*) and by side. The results showed that all the traits demonstrated a significant difference ($p < 0.05$) between the age groups on both sides, with the exception of Poirier's facet. The third trochanter was significantly more frequent in the Young Adults ($p = 0.001$ on the left side and 0.03 on the right). The hypotrochanteric fossa was also signifcantly more frequent in the Young Adults (p = 0.01 on the left and 0.05 on the right side), as was Allen's fossa (p = 0.04 on the left and 0.02 on the right side). Both plaque and the exostoses in the trochanteric fossa were statistically significant for the Mature Adults. The former reached the same levels of significance for each side as Allen's fossa, while the latter reached p = 0.01 on the left side and 0.02 on the right.

TABLE 1: *CHI* square for femoral traits.

LEFT SIDE BY AGE					
No	Age	Absent	Present	X^2	p
1	YA	44	20	10.51	0.001
	MA	45	3		
2	YA	34	30	6.78	0.009
	MA	37	11		
3	YA	47	17	4.32	0.037
	MA	42	5		
5	YA	52	12	4.26	0.039
	MA	30	17		
6	YA	46	17	6.68	0.01
	MA	23	24		

RIGHT SIDE BY AGE					
1	YA	45	19	4.67	0.031
	MA	42	6		
2	YA	38	26	3.89	0.048
	MA	37	11		
3	YA	49	15	5.80	0.016
	MA	44	3		
5	YA	52	12	5.25	0.022
	MA	29	18		
6	YA	45	18	5.77	0.016
	MA	23	24		

BOTH SIDES BY SITE							
No	Site	L	R	Absent	Present	X^2	p
1	780N	x		48	9	1.60	0.205
	MR	x		41	14		
1	780N		x	49	8	4.60	0.032
	MR		x	38	17		
2	780N	x		35	22	0.20	0.656
	MR	x		36	19		
2	780N		x	38	19	0.005	0.944
	MR		x	37	18		

Note: traits are in the order listed in the text.
x signifies the trait present by side.

DISCUSSION AND CONCLUSIONS

Angel (1964) discussed the area of the femoral neck in which plaque, Allen's fossa and Poirier's facet occur and called it the "reaction area". He suggested that this area does not develop in the femur as a result of any specific body posture or structure but is the result of the interaction of certain dynamic factors. These factors are:

"Primarily in the interaction of muscles (iliopsoas) and ligaments (zona) with gravity and leverage in extreme extension and secondarily in arrangement of ligament fibers in the capsule (crossing the zona and the iliofemoral ligament)" (*sic*, p. 139). The fossa is thus formed as a result of the dynamic relationships between the muscles and ligaments involved in the joint capsule. Angel argued that the fossa is formed in younger individuals by friction caused by ligamentous irregularity and that plaque is a later, often middle-aged hypertrophic response. He considered that Poirier's facet was related to "more vigorous muscle function" in males and was a separate feature from the reaction area. It may, therefore, be a sexually dimorphic variable and has been excluded from any further discussion here.

In their study of Native American and cadaver femora Pitt *et al.* (1982) demonstrated the existence of a "herniation pit" which underlies the reaction area in some femora. They discussed the origin of the area. Support for Angel's idea of mechanical abrasion was provided by a positive correlation between the frequency of the anomaly and the thickness and roughness of the overlying capsule. The present results clearly support these earlier findings. Allen's fossa is significantly more frequent in the Young Adults and plaque is significantly more frequent in the Mature Adults. Assuming that these traits do have a mechanical explanation, as suggested by previous work, their biological significance would appear to be related to age rather than to affinity or distance.

The "third trochanter" or gluteal tuberosity is variable in its position at the top of the gluteal ridge. *Gluteus maximus*, which acts as an extensor of the hip and trunk, inserts on this ridge. The third trochanter can be oblong, rounded or conical in shape (Aiello, Dean 1990: 465). It has no epiphysis and is clearly not a separate trochanter. Given its association with the gluteal ridge and the insertion of *gluteus maximus*, it may be an expression of increased activity.

When compared by archaeological site in the present work, the third trochanter showed statistically significant differences between the groups. The *Mary Rose* sample demonstrated a higher frequency on the right side than did the sample from Norwich (*Table 1*). This trait was also more frequent, although not statistically significant, on the left side in the *Mary Rose* sample. In addition, both the greater and the lesser trochanter were measured for all femoral pairs (see Stirland 1992 for technique and table 5.8 for results). The greater trochanter was larger on both sides ($p = 0.01$) in the *Mary Rose* men than in the Norwich men. It is probable that this is attributable to increased activity by *gluteus medius* and *gluteus minimus* in the ship's crew. As the controllers of pelvic tilt these muscles would have to work hard on a ship with a small keel and little ballast as the crew were striving to keep their balance. Since both muscles insert onto the greater trochanter, the increased dimensions of this trochanter for the *Mary Rose* sample suggest the greater use of these muscles by this group and, hence, increased activity. The increase in size of the 'third trochanter' in the ship's crew supports this notion; it appears to have a functional, rather than a congenital significance.

The hypotrochanteric fossa occurs on the posterior lateral side of the femur, lying between the gluteal ridge and the lateral border. Finnegan (1978) stated that it was often found in close association with the gluteal ridge and the third trochanter. Aiello and Dean (1990) found that it occurred more frequently in children and juveniles than in adults. Whilst there are no juveniles in the present sample, the fossa is more frequently present in the Young Adults than in the Mature Adults.

Exostoses in the trochanteric fossa occur at the site of the insertion of the tendon of the *obturator externus* muscle. Resnick and Niwayama (1981) have described such exostoses at osseous sites of tendon attachment as "degenerative enthesopathies" (p. 1297). They are common in older individuals. In the present sample, the exostoses demonstrate a significant increase in the Mature Adults.

The results of the present work suggest that the morphological 'non-metric traits' of the proximal femur are strongly influenced in their expression by a number of environmental factors. Those of the head and neck, Allen's fossa and plaque, appear to be age-related phenomena, with the former having a higher frequency in young males, and the latter in older ones. Poirier's facet seems to be a function of increased male muscle function. Exostoses in the trochanteric fossa are degenerative enthesopathies; these can be a widespread feature of the ageing skeleton but they may also be related to activity (Waldron 1994: 101).

Of the two variations on the shaft, the hypotrochanteric fossa occurs predominantly in the young. The 'third trochanter', which is variable in shape and does not have an epiphysis, is undoubtedly related to activity. Its association with the gluteal ridge and the insertion of *gluteus maximus* and, in the present work at least, the increased size of the greater trochanters, all show this to be the case. This tuberosity, like others in the skeleton, has functional significance. Like others, it should not be regarded as a 'non-metric trait'.

All morphological variations in the skeleton which cannot be measured are 'non-metric'. They do not all have biological significance in the sense of expressing either genetic similarities or differences in cemetery groups. The variations of the proximal femur discussed here should be classed as differences between individuals which are related to age or to activity. They seem to be under environmental rather than genetic influence, at least in males. A similar study of two comparable groups of female skeletons would provide a further dimension to this discussion.

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