Przegląd Antropologiczny – Anthropological Review • Vol. 65, 3-16 (2002)

Sexual dimorphism in the robusticity of long bones of infants and young children

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ABSTRACT It is difficult to determine the sex of subadult skeletal remains because there is little sexual dimorphism present pre-pubertally. In a historic sample of 24 children aged 0-4 years from St. Mary's Anglican Church, Marion, South Australia, the robustness of femora and of humeri was correlated with sexually dimorphic mandibular morphology. Ratios of midshaft circumference to diaphyseal length of humeri and femora and the ratio of minimum circumference to diaphyseal length of the humerus showed correlation with sex determined by mandibular morphology, male indices being greater than the female ones. The humerus midshaft circumference index showed the greatest difference between sexes (*P* value=0.0002). The results need confirmation on known-sex skeletal remains, but for the moment this robusticity dimorphism seems to be a new discovery for osteological practice.

KEY WORDS male, female, mandible, humerus, femur

Prz. Antropol. – Anthropol. Rev. (2002), vol. 65, pp. 3-16, Figs. 3, Tables 3. ISBN 83-86969-80-6, ISSN 0033-2003

Introduction

The largest problem associated with the analysis of immature skeletal remains is the lack of reliable methods to determine sex. Inability to determine sex of subadults limits seriously usefulness of palaeodemographic analyses, interpretation of roles of immature males and females in prehistoric societies, and of parental investment in upbringing of boys and girls and, finally, efficiency of forensic identifications of skeletons of infants and children. Efficient methods for sex determination of adult skeletons exist, but most prove unsuccessful for infant remains. There have been attempts to develop methods appropriate for subadult skeletons, but most are unable to classify individuals more than 50% [WEAVER 1980; ST. HOYME and ISCAN 1989; HUNT 1990; SCHUTKOWSKI 1993]. A method using discriminant functions generated from adult remains to infer

sex from subadult permanent dentition has been suggested [RÖSING 1983], with high levels of reliability (85-95%). These figures, however, are based on the percentage of adults correctly classified, as the sex of the subadults in the study was unknown. It is obviously applicable only to the skeletal material with sufficiently well preserved dentition.

Limited availability of large skeletal samples of subadult remains of known age and sex is a hindrance to developing accurate methods and many studies are based on small sample sizes [SCHUTKOWSKI 1993; WEAVER 1980; SUNDICK 1977, STEYN and HENNEBERG 1996; MOLLESON and CRUSE 1998]. Recently, LOTH and HENNEBERG [2001] proposed a method of sexing skeletal remains of young children with 81% accuracy using the mandible, based on a collection of known age and sex (the Dart Collection at the University of the Witwatersrand). This method has yet to be tested.

The fragmentary nature of subadult skeletons may limit efficiency of sexing by dentition, mandibular or pelvic morphology alone. Furthermore, sexual dimorphism in children is slight and the more ways there are of determining sex, the more likely a positive classification can be made [RATHBUN and BUIKSTRA 1984]. This is of specific importance for (1) forensic cases, where sex determination will reduce the uncertainty of the identification process by about half, and (2) by adding to the limited information associated with subadult samples, allowing reasonable conclusions to be drawn regarding the organization of past populations [SCHEUER and BLACK 2000].

DNA analysis of ancient bones has been used to provide sexual diagnosis of subadult remains [FAERMAN *et al*. 1997; PALMIROTTA *et al*. 1997; CIPOLLARO *et al*. 1998]. However, these methods are still in development and sex determination of subadult remains proves less successful than that of adults. Sex determination is based on nuclear DNA that is preserved in smaller quantities than mitochondrial DNA and thus is often unrecoverable from archeological remains. It is also an expensive procedure that is not routinely available to archeologists. Therefore, although developments in DNA analysis provide new methods of determining sex of subadult remains, there is still the need for quick, skeletal-based methods.

Individuals experience two periods of sexual differentiation throughout their lives. The initial stage is during fetal development to primarily differentiate secondary sexual characteristics while tertiary sexual characters may be less strongly altered. The second is during puberty and this has a much greater effect on skeletal morphology [SCHEUER and BLACK 2000]. Both of these periods of change are associated with endocrine activity. In fetal males, sex differentiation of soft tissues is a direct result of significant prenatal testosterone secretion [WEAVER, 1980]. These hormone differences could therefore produce differences in male and female skeletons due to the hormone receptors at various skeletal sites being exposed to fluctuating hormone levels *in utero* [LOTH and HENNEBERG 2001].

It has been suggested [WEAVER 1980] that characteristics used for sex differentiation in adults could present, though in a slightly modified version, in subadults and therefore similar methods to those used for adults could be successful in subadults. These particularly include

characteristics that are not associated with modifications for reproduction at puberty: e.g., robusticity, mandibular morphology, dental development. Since the sexual dimorphism of long bone robusticity is well recognized in adults [SAFONT *et al*. 2000], it may be of value to investigate its presence in children.

In subadults, individual growth plays a greater role in size determination than sex does [MALINA and BOUCHARD 1991], so most of the adult metric methods using absolute dimensions of bones are not appropriate to use on subadults. The robusticity index of a bone is a relative geometric property rather than a size characteristic, such as length. It is described as the percentage of shaft circumference to bone length ratio [ST. HOYME and ISCAN 1989]. At birth, differences between sexes are seen in the greater muscle mass and higher average birth weight of males [MALINA and BOUCHARD 1991]. Boys are continually heavier and taller than girls from birth until about the age 9 years, when girls enter puberty. The greater weight and muscle mass of males may be significantly reflected in their skeletons, with males having a higher robusticity index than females.

Sex determination of adult skeletons achieved by metric analysis of postcranial skeletal elements reduces the subjectivity of sexual diagnosis based on descriptive traits even though these latter may produce rather reliable diagnoses [ST. HOYME and ISCAN 1989]. The use of robusticity analysis should allow for the determination of sex from any type of fragment, however, those of greater density are usually better preserved [SAFONT *et al*. 2000] and these include the diaphyses of long bones.

Any method that could possibly separate the youngest males and females to provide a valuable tool when assessing immature skeletal remains must be investigated. This study therefore examined the possibility that sexual dimorphism is exhibited in the robusticity index of long bones, specifically the femur and humerus, of infants and young children.

Materials and methods

This study is based on 24 historical subadult skeletons from St Mary's Anglican Church (1847-1925), Marion, South Australia. Individual graves were unmarked thus not allowing for individual identification. There are, however, written records of burials at the Church's Office. The graves were known as 'pauper' burials and belonged to new white settlers of Adelaide who could not afford to buy a burial plot. Hence skeletons of children analyzed here are those of Europeans of low socio-economic status. The records indicate that both male and female infants were buried in unmarked graves. As this study examined skeletal dimensions, it is important that the age of the remains was determined by the eruption and formation of teeth [UBELAKER 1989], which are morphological traits. If age was determined by examining ossification centres [FRANCIS 1939] or diaphyseal lengths of bones, circular reasoning would result, as long bones would be providing both age and experimental data. Since the sex of the remains was not known, the only way to study sexual dimorphism in bone robusticity was to observe a coincidence of values of the robusticity indices with sex determined by another method. The chosen method was sexually dimorphic

mandibular morphology [LOTH and HENNEBERG 2001]. The shape of the inferior border of the mandibular corpus is a descriptive morphological trait which is clearly different from any metric property of the long bones. Although this method only produced 81% accuracy of sexing on a known sex and age sample, the coincidence of higher robusticity indices with male mandibular morphology, and *vice versa* for female traits, should be indicative of the existence of sexual dimorphism in bone robusticity.

Of the 37 children present in the sample, 24 have both an intact mandible and at least one long bone present (Table 1 and 2); these became the basis of the study. Their age did not exceed 24 months, with the exception of one individual whose dental age was 3-4 years. Not every individual in the sample had complete preservation of all four long bones. Dentitions were incomplete due to young age or poor preservation, thus we were unable to use sex determination methods based on dental traits [RÖSING 1983].

ST. HOYME and ISCAN [1989] state that robusticity is calculated as 100×midshaft circumference/maximum length ratio (C:ML) or 100×epiphyseal width/maximum length ratio (EW:ML). In subadults the long bone epiphyses do not start to fuse with diaphyses until around the age of puberty [BASS 1987], so the metaphyseal width (MW) was used instead. SAFONT *et al*. [2000] showed that the minimal circumference of the humerus (HMC) was the most sexually dimorphic circumference of a long bone in adults. Therefore a robusticity index was also calculated for the humerus as HMC:ML. The femur was measured for maximum diaphyseal length (ML), metaphyseal width (MW) and midshaft circumference (C), while the humerus had these three measurements plus HMC taken. Measurements were taken for both antimeres, where bones of both sides were preserved. All the circumferences were measured in millimeters by a standard tape, and length and width by sliding calipers, following standard anthropometric techniques. Only intact bones were measured. Therefore, some skeletons may not have had all five indices calculated due to poor preservation of particular bones.

The linear regression of age against robusticity index for a single sex for each bone was calculated, keeping antimeres separate. Results indicated no significant change with age within the range studied (Fig. 1). Therefore age was not taken into account in further analyses. Histograms were created to determine if the indices show asymmetry for each bone and sex (Fig. 2). Since no asymmetry was evident, the mean of left and right sides was calculated for each individual who had bones of both antimeres present. Ultimately, each individual was thus represented by one value of each index for each bone.

The mean, median and standard deviation for each index was calculated in groups determined as having male or female mandibular morphology. As not every individual had each index calculated, most mean comparisons were only based on 20 individuals. The significance of differences between group means was tested by unpaired Student's *t*-test. Histograms were created for robusticity indices for each group to indicate the amount of possible discrimination between sexes.

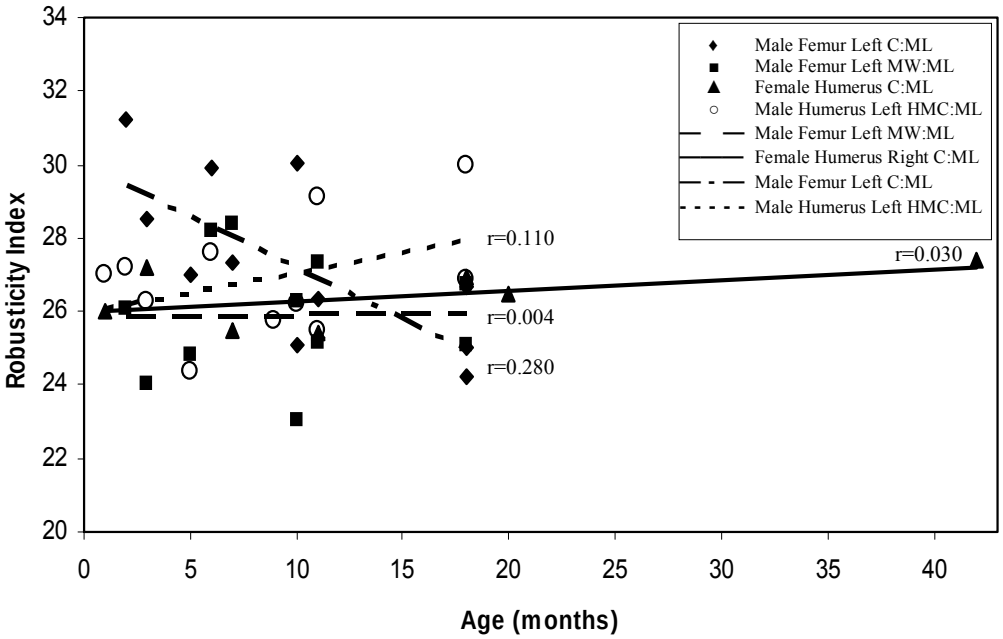

Fig. 1. Plot of selected robusticity indices against age. Note that none of the indices shows significant correlation with age.

Results

Tables 1 and 2 present a list of the skeletal remains and the measurements taken for each individual. Also listed are the calculated robusticity indices for each antimere and their means. Individuals are listed by mandibular sexually dimorphic morphology and sorted into increasing mean robusticity index of either the femur C:ML or humerus HMC:ML.

Within each putative sex group there is considerable variation, but when listed in order of increasing robusticity index there is an apparent sexual difference. The lowest value for all "female" indices is always smaller than that of the "males" and the largest "male" indices are always larger than those of the "females", with the exception of the femur MW:ML index.

Table 3 shows the mean, standard deviation and median for each of the five indices for male and female bones and the result of the Student's *t*-test. The only means that did not show sexual differentiation were for the humerus metaphyseal (MW:ML) robusticity index. Although the males had a slightly higher mean and median to that of the females, which follows the trend, they were not significantly differentiating. This could be due to the very small sample size, incorrect sex determination through mandibular morphology or just inability of that index to differentiate sex.

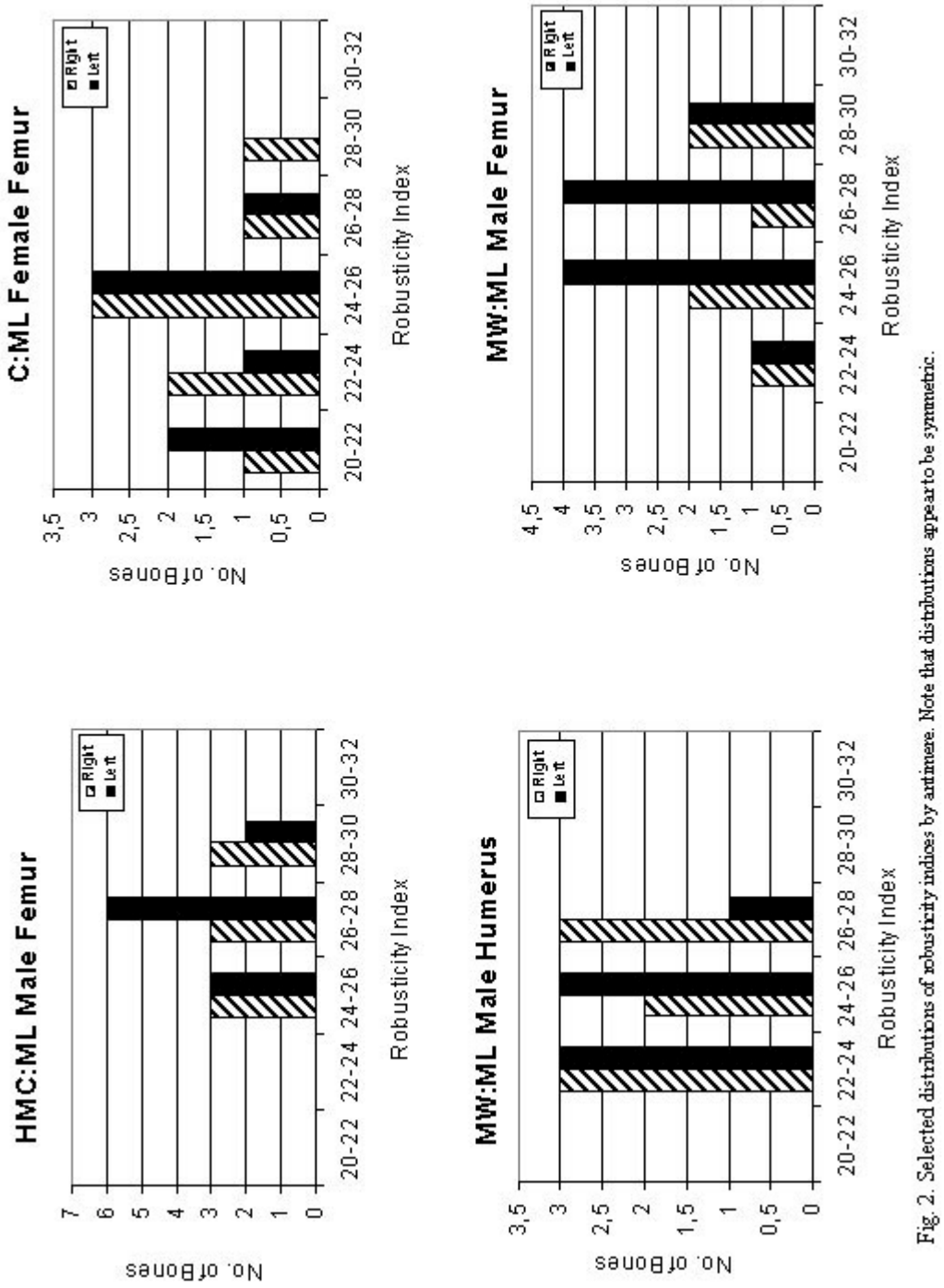

Fig. 2. Selected distributions of robusticity indices by antimere. Note that distributions appear to be symmetric.

Table 1. Metric characteristics of humeri of infants and children whose mandibular morphology indicates female and male sex

Burial #	Age	Sex*	Diaphyseal Width (ML)		Metaphyseal Width (MW)		MW/ML×100 Robusticity Index		Mean MW/ML	Midshaft Circumference (C)		C/ML×100 Robusticity Index		Mean C/ML	Minimal Circumference (HMC)		HMC/ML×100 Robusticity Index		Mean HMC/ML
			R	L	R	L	R	L		R	L	R	L		R	L	R	L	
69	9-12m	F	82.6	83.7	-	-	-	-	-	21.0	21.0	25.4	25.1	**25.3**	20.0	20.0	24.2	23.9	**24.1**
77	6-9m	F	62.8	64.7		17.1	-	26.4	**26.4**	16.0	18.0	25.5	27.8	**26.6**	15.0	16.0	23.9	24.7	**24.3**
11	20m	F	121.0	120.5	-	-	-	-	-	32.0	31.0	26.4	25.7	**26.1**	30.0	29.0	24.8	24.1	**24.4**
32	18m	F	100.3	99.3	22.7	21.9	22.6	22.1	**22.3**	27.0	26.0	26.9	26.2	**26.6**	25.0	24.0	24.9	24.2	**24.5**
2	1m	F	63.4	-		-	-	-	-	16.5	-	26.0	-	**26.0**	16.0	-	25.2	-	**25.2**
27	0-3m	F	66.2	66.4	15.7	16.4	23.7	24.7	**24.2**	18.0	18.0	27.2	27.1	**27.1**	17.0	17.0	25.7	25.6	**25.6**
4	3-4y	F	142.5	-			-	-	-	39.0	38.0	27.4	-	**27.4**	37.0	36.0	26.0	-	**26.0**
53b	3-6m	M	65.1	65.7		16.8	-	25.6	**25.6**	17.0	17.0	26.1	25.9	**26.0**	16.0	16.0	24.6	24.4	**24.5**
71	10m	M	72.2	-	16.5	-	22.9	-	**22.9**	20.0	20.0	27.7	-	**27.7**	18.0	18.0	24.9	-	**24.9**
67	9-12m	M	83.5	82.4	22.4	-	26.8	-	**26.8**	22.0	23.0	26.3	27.9	**27.1**	21.0	21.0	25.1	25.5	**25.3**
53	10m	M	-	72.5	-	17.0	-	23.4	**23.4**	-	21.0	-	29.0	**29.0**	-	19.0	-	26.2	**26.2**
13	9m	M	85.7	85.5	-	19.6	-	22.9	**22.9**	24.0	24.0	28.0	28.1	**28.0**	23.0	22.0	26.8	25.7	**26.3**
38	0-3m	M	58.7	59.0	13.8	-	23.5	-	**23.5**	16.0	16.0	27.3	27.1	**27.2**	15.5	15.5	26.4	26.3	**26.3**
55	0-1m	M	-	63.0	-	15.5	-	24.6	**24.6**	-	19.0	-	30.2	**30.2**	-	17.0	-	27.0	**27.0**
82	18m	M	99.5	100.5	22.5	-	22.6	-	**22.6**	28.0	28.0	28.1	27.9	**28.0**	27.0	27.0	27.1	26.9	**27.0**
17	2m	M		73.5	17.3	17.3	-	23.5	**23.5**	21.0	21.0	-	28.6	**28.6**	20.0	20.0	-	27.2	**27.2**
76	6m	M	79.5	79.7	21.0		26.4	-	**26.4**	24.0	23.0	30.2	28.9	**29.5**	23.0	22.0	28.9	27.6	**28.3**
66	11m	M	89.3	89.4	23.2	23.4	26.0	26.2	**26.1**	28.0	28.0	31.4	31.3	**31.3**	26.0	26.0	29.1	29.1	**29.1**
56	6-9m	M	80.8	-	21.6	-	26.7	-	**26.7**	25.0	-	30.9	-	**30.9**	24.0	-	29.7	-	**29.7**
8	18m	M	100.2	100.2	24.9	24.9	24.9	24.9	**24.9**	31.0	31.0	30.9	30.9	**30.9**	30.0	30.0	29.9	29.9	**29.9**

* As determined from mandibular morphology

Table 2. Metric characteristics of femora of infants and children whose mandibular morphology indicates female and male sex

Burial #	Age	Sex *	Diaphyseal Length (ML)		Metaphyseal Width (MW)		MW/ML×100 Robusticity Index		Mean MW/ML	Midshaft Circumference (C)		C/ML×100 Robusticity Index		Mean C/ML
			R	L	R	L	R	L		R	L	R	L	
11	20m	F	155.0	156.0	-	33.8	-	21.7	**21.7**	34.0	34.0	21.9	21.8	**21.9**
4	3-4y	F	189.5	191.5	46.1		24.3	-	**24.3**	42.0	42.0	22.2	21.9	**22.0**
32	18m	F	126.1	127.5	26.5	-	21.0	-	**21.0**	29.0	29.0	23.0	22.7	**22.9**
77	6-9m	F	72.1	72.6			-	-	-	18.0	18.0	25.0	24.8	**24.9**
69	9-12m	F	100.0	99.5		20.6	-	20.7	**20.7**	25.0	25.0	25.0	25.1	**25.1**
27	0-3m	F	74.6	74.7	18.4	18.5	24.7	24.8	**24.7**	19.0	19.0	25.5	25.4	**25.5**
24	1.5-2y	F	132.6	132.2	38.3	38.1	28.9	28.8	**28.9**	37.0	37.0	27.9	28.0	**27.9**
82	18m	M	126.4	128.1	32.1	32.1	25.4	25.1	**25.2**	31.0	31.0	24.5	24.2	**24.4**
40	18m	M	128.0	-	-	-	-	-	-	32.0	32.0	25.0	-	**25.0**
71	10m	M	-	83.7	19.0	19.3	-	23.1	**23.1**	21.0	21.0	-	25.1	**25.1**
67	9-12m	M	-	99.0	-	24.9	-	25.2	**25.2**	-	25.0	-	25.3	**25.3**
41	18m	M	129.3	131.8	-	-	-	-	-	33.0	33.0	25.5	25.0	**25.3**
66	11m	M	106.8	106.4	28.4	29.1	26.6	27.3	**27.0**	28.0	28.0	26.2	26.3	**26.3**
8	18m	M	127.6	127.6		34.1	-	26.7	**26.7**	34.0	34.0	26.6	26.6	**26.6**
56	6-9m	M	95.1	95.1	27.0	27.0	28.4	28.4	**28.4**	25.0	26.0	26.3	27.3	**26.8**
38	0-3m	M	67.6	66.6	15.5	16.0	22.9	24.0	**23.5**	19.0	19.0	28.1	28.5	**28.3**
53b	3-6m	M	74.0	74.1	18.1	18.4	24.5	24.8	**24.6**	22.0	20.0	29.7	27.0	**28.4**
76	6m	M	93.7	93.7	26.4	26.4	28.2	28.2	**28.2**	27.0	28.0	28.8	29.9	**29.3**
53	10m	M	-	79.9	-	21.0	-	26.3	**26.3**	-	24.0	-	30.0	**30.0**
17	2m	M	83.7	83.3		21.7	-	26.1	**26.1**	26.0	25.0	31.1	30.0	**30.5**

* As determined from mandibular morphology

Table 3. Sexual dimorphism of long bone robusticity indices

	Humerus MW:ML		Humerus C:ML		Humerus HMC:ML		Femur MW:ML		Femur C:ML	
	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males
N	3	13	7	13	7	13	6	11	7	13
Mean	24.3	24.6	26.4	28.8	24.9	27.1	23.5	25.8	24.3	27.0
Median	24.2	24.6	26.6	28.6	24.5	27.0	23.0	26.1	24.9	26.6
SD	2.0	1.6	0.7	1.7	0.7	1.8	3.1	1.7	2.2	2.1
t Stat	0.2		4.4		3.9		1.7		2.7	
P(T<=t) one-tail	0.4176		0.0002		0.0006		0.0696		0.0096	

t-test: two-sample assuming unequal variances. All the abbreviations are the same as in Tables 1 and 2.

The mean femoral metaphyseal index (MW:ML), though clearly indicating a difference between male and female means, has a large standard deviation for the females, which overlaps into the mean of the males. This produces a *P* value of 0.07, which is slightly greater than 5% and reduces the significance of this result. However, there is one female (aged 1.5-2.0 years) who has a large index value and this distorts the results.

Both circumference indices for the humerus clearly indicated sexual differentiation with *P* values of 0.0002 and 0.0006 for midshaft and minimal circumferences, respectively. The median values were very similar to the means, showing that even in this small sample, indices are represented evenly and no one value has distorted the means. They also have the greatest number of standard deviations separating the means of both sexes, being nearly two standard deviations in both cases, clearly indicating a difference between males and females as determined by mandibular morphology. For HMC:ML, females consistently show smaller values than the males, with only three males overlapping into the female range out of 13.

The means for the femur C:ML robusticity index were also significantly differentiating between sexes with the *P* value of the *t*-test being 0.0096. The means were separated by more than one standard deviation and the medians were also similar to the means, although the difference was slightly larger than it was for the humerus. Also, the *P* value for the femur was higher than that of the humerus and this could be due to the one problematic female in the sample, which increased the standard deviation.

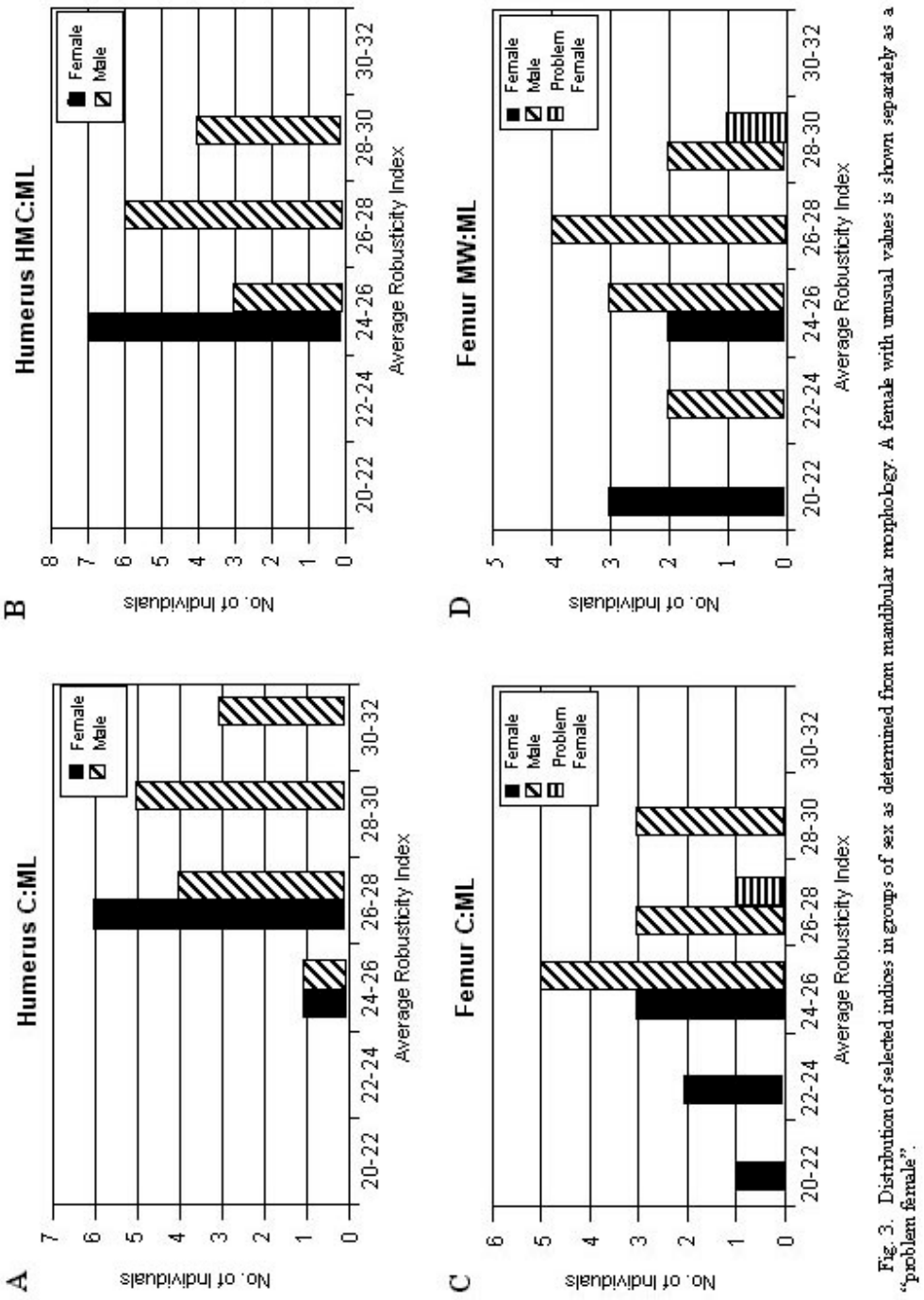

Fig. 3. Distribution of selected indices in groups of sex as determined from mandibular morphology. A female with unusual values is shown separately as a "problem female".

Figure 3 shows distribution graphs for the four differentiating indices, though the femur MW:ML is not statistically significant. Overlap is seen in all four graphs, however, there are also significant areas where only one sex is represented. The femur C:ML best separates females and males. It suggests that a femur with a robusticity index less than 24 will be from a female and greater than 28 will be from a male. Femur MW:ML suggests an index less than 22 represents a female and those greater than 26 are males. However, the one problematic female appears in this region. The humeral index is less capable of identifying females, but any value above 26 could indicate a male for the HMC:ML index and any index for C:ML above 28 will suggest the individual is a male.

Discussion

One problem addressed when dealing with immature skeletal remains is that the collections, which are available, are usually of sick or diseased children. However, these diseases are most likely to be acute conditions of short duration [STEYN and HENNEBERG 1996] and therefore the effect would normally not be exhibited in the osteological pattern of the bones. If an individual had endocrine abnormalities, this would distort the basis of the mechanism that is proposed to lead to differences in robusticity between sexes. Receptors for specific hormones in susceptible skeletal sites would therefore not experience normal hormonal levels and could produce differences that do not reflect what is seen in healthy children. There is no evidence that such endocrine abnormalities were common in the past.

Studies of skeletal material are often hampered by small sample sizes [SCHEUER and BLACK 2000] and this is also the case here. The results of the age correlation with robusticity index and the antimere comparison allowed the pooling of all age groups and a mean for the antimeres to be calculated, keeping males and females separated. This allowed for the creation of a larger sample size thereby increasing statistical power. The size of this sample is still low and the unequal proportion of males and females leads to gaps in the results and conclusions. Despite those reservations, results obtained show in many cases high levels of significance indicating good diagnostic value of indices studied here. It must be kept in mind that the tests used here are not only sensitive to differences in means but also to sample size. Were our sample sizes greater, the significance would increase even if differences between means remained as found here.

The results obtained from the St Mary's Anglican Church sample indicate that there is significant difference seen between female and male robusticity indices, with males having a higher robusticity index than females. On comparison of the indices those of the femur were most differentiating when the distribution of values was analyzed. However, the humerus circumference indices had the smallest *P* values.

Epiphyses are considered the best variable in adults for sex determination, but become a problem when there is poor preservation in ancient remains, preventing accurate measurement [BLACK 1978; SAFONT *et al*. 2000]. This was also found for this subadult sample when assessing metaphyses. The femur

MW:ML did show a difference in the means of females and males, however, the standard deviation was high and this resulted in a *P* value of 0.07. The same index mean for the humerus was even less significant. This could be due to the small female sample size, but could also be attributed to the deterioration of the bone and the difficulty experienced in obtaining accurate measurements. There is some indication that there is a difference between sexes, but it is suggested that these measurements be tested on a sample which is better preserved before conclusions are drawn.

The robusticity indices for midshaft circumference and minimal humerus circumference were significantly differentiating. HMC is the least subjective measurement as it is taken as the smallest circumference able to be measured, whilst a midshaft circumference is likely to change slightly depending on the exact proportions of the bone. This therefore suggests that the HMC robusticity index will present as the best index from which to judge sex. The initial results of this study do however indicate that the humerus C:ML is the most differentiating.

There was one problem female (burial #24), which distorted the femur robusticity values. There is no humerus available for this individual so this cannot be compared and therefore only the femur results are distorted. The mandible clearly suggests that this is a female, although its robusticity indices are placed clearly in the region where males are predominant (Fig. 3). The mandible method is only 81% accurate, so it is possible that this is a male, which emphasizes the usefulness of having additional methods which can be applied to either support or contradict sex estimations based on morphology, or dentition (if appropriate). It could also, however, represent variation that is present in human populations, indicating that a large sample size is needed before discriminant functions are created. Perhaps without this individual the femur could actually present as having the most sexually dimorphic indices. Therefore, further study should include all indices studied here.

This study is based on a sample where sex has been determined by a method that is only 81% accurate. Using this as a basis for robusticity comparison, significant differences have been found between males and females. This indicates that sexual dimorphism in robusticity indices can be even more pronounced when true sex of individuals studied is known.

The one limitation of this study is that the results are based on another method, which has yet to be proven by an outside source. The fact that robusticity indices appear to follow the proposed sex groupings of the mandible method indicates that the same factors are influencing these two traits. Clearly, there is a factor acting to create two distinct groups for two different characteristics and the most likely factor is sex hormones during development. The initial result of this study, showing robusticity indices are grouped into two statistically significant groups by mandibular morphology, therefore also supports mandibular morphology as a successful technique for sex determination.

In conclusion, the results presented here suggest strongly that there is a difference between the robusticity indices of the humerus and femur of boys and girls

aged 0-4 years. Further investigation should be carried out on larger samples of known sex, with the purpose of creating discriminant functions for the indices analyzed in this study. This should be carried out for samples from various populations and also include individuals aged older than 4 years to determine until what age this proposed method is successful.

Acknowledgements

We are grateful to Professor F.W. Rösing for comments on the original manuscript of this paper and to the late Dr Susan R. Loth for encouragement to undertake the study.

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Streszczenie

W okresie przedpokwitaniowym dymorfizm szkieletu ludzkiego jest nieznaczny toteż istnieje niewiele metod oznaczania płci na szczątkach szkieletowych małych dzieci i niemowląt. Ze względu na znany dymorfizm płciowy rozmiarów uzębienia i z powodu różnic w wydzielaniu i oddziaływaniu na szkielet hormonów płciowych w czasie życia wewnątrzmacicznego, daje się zaobserwować różnice płciowe w kształcie trzonu żuchwy dziewcząt i chłopców [LOTH, HENNEBERG 2001]. Wiarygodność oznaczania płci na podstawie trzonu żuchwy sięga zaledwie 81%, i należy poszukiwać innych metod oznaczania płci na szkieletach dziecięcych celem podwyższenia rzetelności ocen. Oznaczanie w materiale archeologicznym płci przy pomocy jądrowego DNA, jakkolwiek w niektórych przypadkach możliwe, jest mało użyteczne z powodu niejednakowej trwałości DNA w indywidualnych szczątkach szkieletowych i zróżnicowanego stopnia jego degradacji. Prowadzi to do braku możliwości oznaczania płci wielu osobników. Co więcej, analizy DNA są drogie i niemożliwe do przeprowadzenia w warunkach polowych.

W niniejszej pracy przedstawiamy prostą metodę oceny płci na podstawie masywności kości długich wyrażonej w postaci wskaźników ilorazowych. Wskaźniki te to stosunek obwodu w środku trzonu do długości maksymalnej trzonu kości (C:ML), stosunek minimalnego obwodu kości ramiennej do długości trzonu (HMC:ML) i stosunek szerokości końca trzonu (metafizy) do maksymalnej długości trzonu (MW:ML). Wskaźniki te zostały określone dla 23 szkieletów dzieci w wieku 0-24 miesięcy i jednego dziecka zmarłego w wieku 3-4 lat (Tab. 1 i 2). Każdy ze szkieletów miał zachowaną co najmniej jedną kość ramienną lub udową i żuchwę. Wszystkie szkielety zostały odkopane na cmentarzu przy anglikańskim Kościele Świętej Marii w Adelajdzie (południowa Australia). Na cmentarzu tym chowano kolonistów brytyjskich zmarłych w latach 1847-1925). Dla każdego dziecka określono płeć na podstawie morfologii żuchwy i obliczono wartości wskaźników (Tab. 1 i 2). Wartości te nie zmieniały się z wiekiem (Fig. 1) i nie wykazywały lateralizacji (Fig. 2). Średnie arytmetyczne i mediany wartości wskaźników różniły się pomiędzy szkieletami oznaczonymi jako dziewczęce i chłopięce (Tab. 3). W przypadku większości wskaźników różnice pomiędzy płciami są statystycznie istotne. W przypadku obwodów kości ramiennych średnie chłopców i dziewcząt różnią się niemalże o dwa odchylenia standardowe, a w przypadku obwodów kości udowych, o ponad jedno odchylenie standardowe. Rozkłady wartości wskaźników chłopców i dziewcząt są wyraźnie przesunięte względem siebie (Fig. 3). Istnienie wyraźnie większych wartości wskaźników masywności szkieletów oznaczonych jako chłopięce na podstawie morfologii żuchwy, w porównaniu ze wskaźnikami szkieletów posiadających żeńską morfologię żuchwy, wskazuje na: (1) istnienie dymorfizmu płciowego masywności kości długich niemowląt i małych dzieci i (2) wiarygodność ocen płci na podstawie morfologii żuchwy. Należałoby sprawdzić rzetelność oznaczeń płci przy pomocy wskaźników masywności uzyskanych na materiale szkieletowym dzieci o udokumentowanej płci. Taki materiał jednak jest trudno dostępny. Niniejsza praca sygnalizuje użyteczność wskaźników masywności do oznaczeń płci szkieletów dziecięcych i być może przyczyni się do zbadania pod tym względem materiału szkieletowego o udokumentowanej płci i o większej liczebności.