



Introduction

Biological sex is very important to determine when remains are found, since it helps the identification by reducing the pool of potentially matching identities and allows other sex-dependent estimations.

Though techniques for sexing adults are well-established, sexing subadults still remains as a difficult practice, since sexual morphological traits do not emerge until puberty. Because of this, some authors declare that the probability to assess sex on subadults correctly is the same as in a coin flip.

The aim of this work is to prove the error of this statement through a review of different studies that used different techniques with high accuracy rates.

Methodology

Research in different journals of physical anthropology and forensic sciences, and databases such as PubMed using keywords like "subadults", "osteological remains" and "sexual assessment/sex estimation".

Used for the review only articles from maximal the year 2000 and with high accuracy rates in their studies.

Results and discussion

Ilium

Ilium is the most dimorphic bone of the subadults' unfused pelvis.

Non-metric studies show differences in:

- the auricular surface: raised above the plane its entire perimeter in girls and raised only on the anterior edge in boys, yielding to accuracy rates of 40% and 90% respectively.
- the greater sciatic notch shape: shallow for girls and deep for boys, yielding to accuracy rates of 62% and 95% respectively.

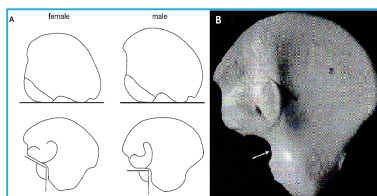


Fig. 1. (A) Diagram of the greater sciatic notch depth and angle. (B) Ilium of a subadult male; notice the greater sciatic notch (arrow) and the auricular surface (1).

Metric studies with an accuracy 96% show significant differences in:

- the iliac crest curvature: a marked S-shape for males and a faint S-shape for females.
- the greater sciatic notch angle: greater in females than in males.

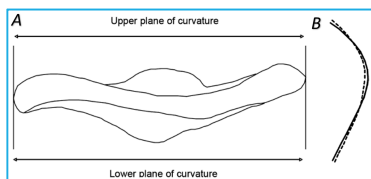


Fig. 2. (A) Outline of the iliac crest illustrating the division of the crest into two separate planes. (B) Meanshape models of the greater sciatic notch; male represented by a solid line, female represented by a dashed line (2).

Molecular techniques

- Most recent and with the highest accuracy rates.
- Based on the differences within the sexual chromosomes: amelogenin and SRY genes, and other Y-specific STRs.
- Automated full demineralization protocol developed by Amory et al., based on the complete destruction of a little portion of the bone and its posterior molecular study (6), gives good results.

Conclusions

- Assessing sex in subadults' remains is not as chancy as it was thought.
- The studies of the ilium, cranium, mandible and teeth become an important tool to sex assessment. Each study is not enough to assess sex only by itself, but they all are useful tools to increase the amount of available data and improve the accuracy rates.
- Population variability is great and carefulness is very important when these methods are applied.
- New molecular techniques centered on the sexual chromosomes have been developed and they have the highest accuracy rates.

Cranium

- Glabella and mastoid process may be dimorphic even at young ages.
- Occipital bone dimensions are larger in males than in females.
- Differences in the neurocranium are well established at early ages, being boys' neurocranium larger than girls'.

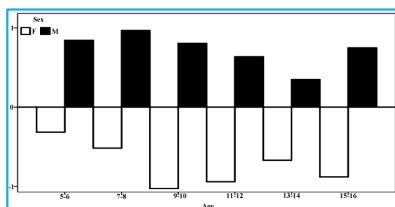


Fig. 3. Canonical discriminant function developed through neurocranium measurements that shows the presence of sex differences in the neurocranium (3).

- Development and growth in girls is faster at young ages (5 to 8 years) and slower at older ages (11 to 14 years) compared to boys.

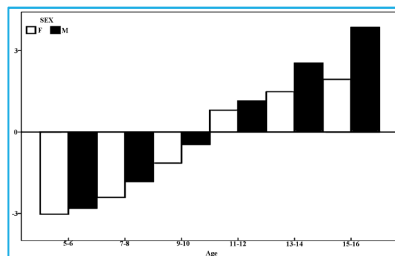


Fig. 4. Canonical discriminant function developed through facial measurements that shows facial growth changes through development (3).

- Studies of the cranium yielded to accuracy rates between 78 and 89%.

Mandible

- Sexually morphological traits can be found in the corpus shape of the mandible until the age of 6, leading to an accuracy of 81%.

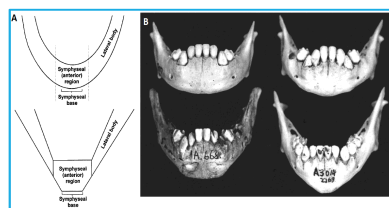


Fig. 5. (A) Representation of the dimorphic immature mandibular corpus shapes; female model on the top and male model on the bottom. (B) Symphyseal shapes in immature mandibles (1.5 years); females on the top and males on the bottom (4).

Teeth

- The most sexually dimorphic deciduous teeth are the first and second molars in both mandible and maxilla, yielding to an accuracy of 78,1-93,1%.
- The most sexually dimorphic permanent teeth are the canines in both maxilla and mandible, yielding to an accuracy of 79,4-92,6%.

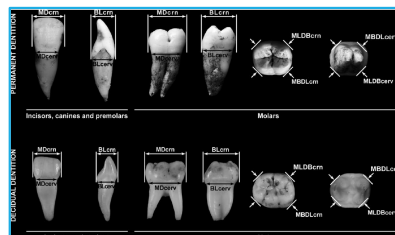
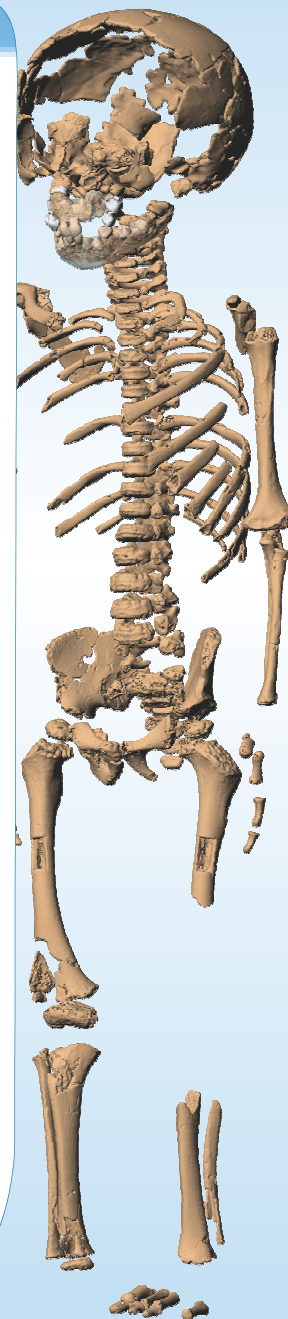


Fig. 6. Locations of the measurements in permanent and deciduous dentition (5).

- Differences between ages derived from the comparison between teeth and other skeletal structures are more likely to indicate male than female.



References

- Viak D et al. Am J Phys Anthropol. 2008 Nov;137(3):309-15.
- Wilson LA et al. J Forensic Sci. 2008 Mar;53(2):269-78.
- Gonzalez RA. J Forensic Sci. 2012 Jan;57(1):24-34.
- Loth SR et al. Am J Phys Anthropol. 2001 Jun;115(2):179-86.
- Viciano J et al. Am J Phys Anthropol. 2013 Sep;152(1):31-43.
- Amory S et al. Forensic Sci Int Genet. 2012 May;6(3):398-406.