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Forensic Anthropology: Sex Estimation and Intersex Remains

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Intersexuality has been defined as an “umbrella term used to describe a wide range of innate bodily variations in sex characteristics” (Monro et al., 2021). In life, these characteristics are often limited to soft tissue sex organs; in forensic anthropology, the focus is on an individual's bone structure. This is because the bones of males and females have distinct differences attributed to the biological mechanisms for which they are tailored, such as childbirth or walking, and on account of the effects different hormones have on bone growth and development. It is understood that an estimate of "female" would eliminate all "male" individuals from a pool of potential matches, thereby streamlining the identification process of a descendant. These methods can be as simple as visual analysis or as complex as metric analysis and population statistics (Christensen et al., 2014; Moore, 2013). However, intersex people may not have distinct traits from either sex, or they may have a mix of male and female traits. They can therefore present an interesting challenge to sex estimation. Recent anthropological studies have examined the topic of intersex remains, revealing blind spots in many of the standard methods and our own understanding of sex.

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SEX ESTIMATION

When assessing skeletal sex, forensic anthropologists rely on the presence and appearance of specific markers. While there are many methods used to estimate the sex from skeletal remains, the methods themselves take either a morphological or anthropometric approach, as described by Bašić et al. (2013) in a study to determine if humerus measurements could be used for sex estimation in skeletons from the Eastern Adriatic Coast.

Morphological examination relies on visual assessment of certain features of the bones; anthropologists observe what features they do or do not have and which sex these features most align with (Christensen et al., 2014; Krishan et al., 2016). This approach is most common when observing the pelvis or skull. Due to their different functions and how different hormones affect bone growth and development between sexes, these bones have sexually dimorphic features that are relatively easy to assess without formal measurements (Christensen et al., 2014). Of all the bones that can be assessed this way, the pelvis is the best. It has the most obvious sexual dimorphism between male and female bodies because they were designed with different purposes in mind (Spradley, 2016). Female pelves need to be able to sustain childbirth and, as such, tend to be larger and wider with a rounder pelvic inlet (Libtexts, 2023). Male pelves are

designed for optimal locomotion, especially in humans' unique bipedal situation; they tend to have higher iliac crests as well as longer and narrower sacrums (Christensen et al., 2014). The skull can also be used for morphological examination, typically reliant upon the fact that male skulls are overall larger than female skulls, especially when considering the mastoid process, the supraorbital ridge, and the jaw (Christensen et al., 2014). One of the major pitfalls of morphological examination is that it is quite subjective, relying on a person's individual criteria for words like dull, angled, prominent, etc. This, however, has been shown to have a minimal effect on the accuracy of these observational methods. Based on intraobserver tests using the skull and pelvis, less than a 10% discrepancy was noted with morphological methods that utilized common sex markers on the bones (Rogers & Saunders, 1994; Williams & Rogers, 2006).

Anthropometric examination involves metric evaluation of the bones, measuring the dimensions to account for size and shape differences between male and female bones. The complexity of these evaluations can vary as this method is most commonly used with bones that cannot be effectively evaluated morphologically, such as the postcranial bones (Christensen et al., 2014). The postcranial bones, such as the ribs and humeri, are usually assessed using measurements entered into a "discriminant function formula that yields a score indicating male or female" (Spradley, 2016). What that essentially means is the data collected from measurements is put into an equation which assigns the individual to a certain group, such as male or female (Moore, 2013). Anthropometric analyses have been successfully applied to a number of bones including the tarsals, clavicles, and long bones of the limbs (Albanese, 2013; Harris & Case, 2011). Furthermore, Spradley and Jantz (2011) suggest that this is a more accurate estimate of sex than morphological assessment of the skull. Concurrently, there is little room for interobserver error as this method is based on objective analysis regarding the dimensions of the bones. However, because anthropometric examination is based on quantitative assessment, the data tends to be population specific; different ancestral groups have different degrees of sexual dimorphism.

Some bones which can be used for sex estimation, such as the skull and pelvis, are assessed on a scale of 1 to 5. 1 and 2 mean the feature is more typically female and 4 and 5 mean the feature is more typically male (Bearman, 2016; Christensen et al., 2014). However, in every spectrum there is a middle, and bones which average out in this middle area between male and female are typically labeled "indeterminate". Many anthropologists will see this and end the analysis there, but this is a disservice both to the individual and the field. The existence of this sliding scale approach to analyzing the pelvis and skull acknowledges the spectrum within which an individual can fall. However, professionals often do not question the variability and overlap in this "indeterminate category" (Weitzel et al., 2022).

INTERSEXUALITY

Everyone is born with a set of chromosomes which dictate their sex; XX indicates female and XY indicates male, usually. However, not everyone fits neatly into these boxes. While intersex individuals may have a more unique chromosomal pairing such as XXY or XO, some have XX or XY chromosomes and their intersexuality is expressed through hormone levels (Kralick, 2018). These hormone levels can cause intersex traits to manifest even in individuals with more "typical" chromosomal pairings. For example, someone may have XX chromosomes but have an intersex condition like polycystic ovarian syndrome (PCOS) that may cause them to produce significantly more testosterone than the average female (Sheehan, 2004). While there is no clear number on how many intersex people there are relative to population demographics, data from the 2020-2021 Behavioral Risk Factor Surveillance System estimated the figure at 700,000 in the US; others believe it to be much higher (Bearman, 2016). Intersexuality can present itself in many ways; it is therefore important to understand that a biological profile of a decedent based on their skeletal remains may not accurately reflect intersexuality. It is equally important to note that being intersex is not the same as being transgender, which is when someone's gender identity does not align with their assigned sex at birth.

Manifestations of intersexuality are typically viewed in people's reproductive organs; sometimes people will have more than one or not have the reproductive systems that is conducive to their perceived sex (Kaneshiro et al., 2023). Because of this, hormone levels for intersex people can vary and cause different traits associated with either sex

to emerge to varying degrees. Unfortunately, studies on how intersexuality can affect the bones are largely non-existent. However there are plenty of studies that show how different hormones affect bone development, especially in elderly people who tend to have lower levels of testosterone and estrogen than when they were young. Using these studies, we can understand how these hormones affect the bones and apply that knowledge to predict how they may affect intersex people.

HORMONES

There are four (4) main sex hormones, sometimes called sex steroids: estrogen, progesterone, testosterone, and dihydrotestosterone (DHT) (Mirabito, 2023). Each of these has an effect on how the body will develop, especially during puberty when the body is reaching sexual maturity. Many people tend to view estrogen and progesterone as female sex hormones, and testosterone and DHT as male sex hormones. This is a gross oversimplification of the complexities that exist within the human body. Both males and females will have all four hormones as they all play crucial roles in different parts of bodily development and organ function. The main difference between the two sexes in regards to these hormones is the amount the body will naturally produce (Hammes & Levin, 2019).

Estrogen plays an important part in the growth of male and female bones, as it is required for the growth plates to close. Estrogen promotes the activity of osteoblasts, which make new bone, and estrogen deficiency has been observed to cause osteoclasts, the cells which reabsorb bone, to increase production (Väänänen et al., 1996). During menopause, estrogen levels drop.

Because of the role estrogen plays in bone production and maintenance, menopausal women are at a higher risk of osteoporosis, a condition related to cortical bone loss and a lower bone mineral density that can often result in brittle bones and a higher risk of injury (Geng, 2023). In males, estrogen also plays a role in bone maintenance by regulating reabsorption of the bone by osteoclasts (Khosla et al., 2001). Mutations in the male estrogen receptors has also been associated with an increased risk of osteoporosis and, in one particular case, incomplete fusion of the epiphyseal plates (Smith et al., 1994).

Androgens, like testosterone and DHT, sometimes bind to estrogen receptors; the estrogen receptor is essentially regulating and directing the androgens functions (Fuentes et al., 2019). A study by Mohammed et al. (2016) showed that androgen increases the production of preosteoblasts, which are the cells that eventually turn into mature osteoblasts. In that same study, testosterone was shown to increase the width of the growth plate in growing rats, which can cause the mature bones to be longer and wider. DHT has been observed stimulating osteoblast production and limiting bone resorption, which causes the bones to become more dense (Thu et al., 2017). Androgen deficiency can also affect the bones, causing decreased bone mineral density that can lead to more fragile bones. One study, performed on 12 men who had undergone judicial castration, showed that their rate of bone turnover had increased and their bone mineral density had fallen significantly, with most of the loss happening in the first 5 years (Anderson et al., 1997). This is significant, as it means that not only does testosterone build up bone mineral density, but it maintains it; if testosterone levels suddenly drop, so will the bone mineral density of the individual. Other studies on men with hypogonadism correlate with these findings, even showing that synthetic testosterone can help reverse some of these effects (Behre, 1997).

HOW INTERSEXUALITY IS TIED TO THE DISCIPLINE OF FORENSIC ANTHROPOLOGY

The idea that our bodies fit neatly into one of two categories is not only outdated, but incorrect. In many people that express intersex traits, their hormone levels may not be typical of what is expected in that of males or females. The reproductive organs that create these hormones may be mixed and matched in intersex bodies or have conditions which affect their performance (Payne, 2018). Because of this, forensic anthropology and its current binary approach to sex estimation is failing the intersex population. It is very possible that their bones may not neatly fit into our binary assessment of male or female, resulting in the bones being labeled “indeterminate” or even mislabeled. Without a sex estimation, identification of a decedent is more difficult. Considering that gender-nonconforming individuals are nearly four times as likely to be victims of violent crime (Williams Institute, 2021), this is an egregious oversight.

In 2022, the FBI reported that 4% of all hate crimes in the U.S. were motivated by the victim's gender identity or expression; this is likely an under-estimate, as not all jurisdictions track hate crimes motivated by gender identity and not all of them report their data to the FBI (Human Rights Campaign Foundation, 2023). Additionally, the category of "indeterminate" is vague, since it is also applied to bones that are broken, fractured, or missing, and not just to possibly intersex individuals (Bearman, 2016). Ultimately, a lack of research and training is affecting forensic anthropology's ability to serve this community. This is a significant shortcoming in our current system, and as society moves forward, it is no longer an issue the field can ignore.

At the same time, intersex people represent a small percentage of the overall population; no statistics identifying the percentage of intersex individuals are accepted as accurate. However, the concerns and questions raised here can also apply to non-intersex individuals, as sex is a spectrum (Flaherty et al., 2023). Hormone levels can vary between people of the same biological sex for many reasons, ranging from traumatic events and anxiety disorders to medications and medical conditions (Moyer et al., 2019; Weber & Reynolds, 2004). Not everyone's bones will fit perfectly into the category of male or female. The more we understand these variations, the better we can be at asserting the sex of bones that may simply be more androgynous. As stated before, many bones are assessed on a scale; the lower numbers being attributed to female traits and higher numbers being attributed to male traits. But the middle of that spectrum hides a significant amount of natural variation. When we understand how our bones can naturally vary from the norm, we can expand our knowledge of sex and make more inclusive, and potentially even more accurate, methods for sex estimation.

To start, we can include intersex individuals in future studies on sex estimation and sexual dimorphism. Additionally, forensic anthropologists can partner with people in fields such as endocrinology to understand how intersexuality can affect the bones' development and appearance. Understanding how different hormone levels affect bone development and how synthetic hormone use affects the bones after puberty, and measuring its long term effects on bones like the pelvis, would be a strong place to start. Forensic anthropologists already know that sex is more of a spectrum than a clear binary, as seen by the very existence of the "indeterminate" label. Expanding this acceptance into action will likely make major strides in the field.

CONCLUSION

Sex estimation is based on identifying sexually dimorphic traits using either visual or metric methods, however, our current systems only separate these bones into male or female. While some bones are labeled as indeterminate, this classification can lump intersex remains with broken or missing bones. This exclusion can make matching the bones to a decedent much more difficult, demonstrating a need for sex estimation to be expanded beyond the binary. Our current classification system is convenient, as it avoids nuance; however, this impedes its ability to be applied to the very nuanced world in which we live.

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