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ORIGINAL RESEARCH

Assessment of Sexual dimorphism of femur bone

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ABSTRACT

Introduction: Sexual dimorphism in the femur refers to the observable differences between male and female femurs in terms of size, shape, and structural characteristics. Generally, male femurs are larger and more robust than their female counterparts, exhibiting greater overall length, width, and thickness, which is attributed to greater muscle mass and body size in males. **Materials and methods:** The present study focused on 50 adult right femora, consisting of 25 from males and 25 from females, collected from various medical colleges' Anatomy departments. Specific measurements were taken to assess the morphological characteristics of the femur. This included weight, measured using an electronic weighing machine with a sensitivity of 0.1 grams; maximum length, calculated as the straight distance from the highest point of the femoral head to the deepest point on the medial condyle using an osteometric board; maximum head diameter, measured with a Vernier caliper; and head circumference, determined at the border of the articular surface using a flexible measuring tape. Additionally, midshaft measurements were taken, including the anteroposterior diameter at the midpoint of the diaphysis at the highest elevation of the linea aspera, the transverse diameter taken perpendicular to the anteroposterior measurement, and midshaft circumference assessed with a flexible measuring tape. Lastly, the distal epiphyseal breadth was measured as the distance between the most prominent points on the epicondyles with a Vernier caliper. These measurements aim to provide detailed data on femoral morphology and contribute to the understanding of sexual dimorphism, with implications for clinical applications and orthopedic research. Data analysis was done using SSPS software. **Results:** The study found that male femurs had significantly greater dimensions than female femurs across all measured parameters, including maximum length, mid-shaft diameter, condylar width, and head circumference. **Conclusion:** This study confirms significant sexual dimorphism in femoral dimensions, with males showing larger and more robust measurements than females. While valuable, further research with larger, diverse samples is needed to enhance forensic and orthopaedic applications.

Keywords: Dimorphism, Femur, Morphology

INTRODUCTION

Sexual dimorphism in the femur refers to the observable differences between male and female femurs in terms of size, shape, and structural characteristics. Generally, male femurs are larger and more robust than their female counterparts, exhibiting greater overall length, width, and thickness, which is attributed to greater muscle mass and body size in males. Key distinctions include variations in the dimensions of the femoral head and neck, with males typically having a larger femoral head and different neck angles. Additionally, the morphology of the femoral shaft can differ, as males often present a straighter shaft, while females may demonstrate a more pronounced curvature. These characteristics not only aid in biological profiling for forensic purposes but also inform clinical practices, such as the design of gender-specific orthopedic implants and prosthetics. Understanding these differences is essential for applications in both forensic anthropology and orthopedic surgery.[1,2]

The hip joint is the largest and one of the most stable joints in the human body, primarily due to the anatomy of its articulating surfaces and ligaments. It functions as a multiaxial ball and socket joint, achieving maximum stability through the deep insertion of the femoral head into the acetabulum[3]. The femur, as one of the largest bones, is subject to substantial weight-bearing; its characteristic geometric structure is crucial for both strength and stability. Metrics such as hip axis length and femoral

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head width are significantly associated with the mechanical strength of the proximal femur.

Research into the morphology of the proximal femur—particularly the interactions between the head, neck, and proximal shaft—has been extensive. Several medical conditions, including avascular necrosis, osteoporotic fractures, and osteoarthritis, highlight the importance of understanding this anatomy, potentially refining treatment options.[4,5]

This information is invaluable for anatomists and forensic experts when determining the sex of femora, which can assist in the design of appropriately sized prosthetic devices and improve outcomes in orthopedic surgeries. Enhanced understanding of these gender-specific anatomical variations can also facilitate the development of tailored implant designs for male and female patients.

MATERIALS AND METHODS

The present study focused on 50 adult right femora, consisting of 25 from males and 25 from females, collected from various medical colleges' Anatomy departments. Specific measurements were taken to assess the morphological characteristics of the femur. These included weight, measured using an electronic weighing machine with a sensitivity of 0.1 grams; maximum length, calculated as the straight distance from the highest point of the femoral head to the deepest point on the medial condyle using an osteometric board; maximum head diameter, measured with a Vernier caliper; and head circumference, determined at the border of the articular surface using a flexible measuring tape. Additionally, midshaft measurements were taken, including the anteroposterior diameter at the midpoint of the diaphysis at the highest elevation of the linea aspera, the transverse diameter taken perpendicular to the anteroposterior measurement, and midshaft circumference assessed with a flexible measuring tape. Lastly, the distal epiphyseal breadth was measured as the distance between the most prominent points on the epicondyles with a Vernier caliper. These measurements aim to provide detailed data on femoral morphology and contribute to the understanding of sexual dimorphism, with implications for clinical applications and orthopedic research. Data analysis was done using SSPS software.

RESULTS

Mean maximum length of males and females was 47.3 cm and 42.9 cm respectively. Mean mid shaft length among males and females was 3.2 cm and 2.7 cm respectively. Mean condylar width among males and females was 8.9 cm and 7.9 cm respectively. Mean head circumference among males and females was 16.1 cm and 13.3 cm respectively. Significant results were obtained while comparing femur dimensions among males and females.

Table 1: Comparison of femur dimensions among males and females

Variable	Males	Females	p-value
Maximum length (cm)	47.3	42.9	0.002*
Mid shaft (cm)	3.2	2.7	0.000*
Condylar width (cm)	8.9	7.9	0.000*
Head circumference (cm)	16.1	13.3	0.001*

The table compares femur dimensions between males and females, highlighting statistically significant differences across all measured variables. Males have a greater maximum femur length (47.3 cm) compared to females (42.9 cm), with a p-value of 0.002, indicating a significant difference. Similarly, the mid-shaft diameter is larger in males (3.2 cm) than in females (2.7 cm), with a highly significant p-value of 0.000. The condylar width, which measures the distal end of the femur, is also greater in males (8.9 cm) versus females (7.9 cm), with a p-value of 0.000, signifying a significant disparity. Additionally, femoral head circumference is larger in males (16.1 cm) than in females (13.3 cm), with a p-value of 0.001, again reflecting a significant difference. These findings suggest that male femurs are consistently larger in length, mid-shaft diameter, condylar width, and head circumference compared to female femurs.

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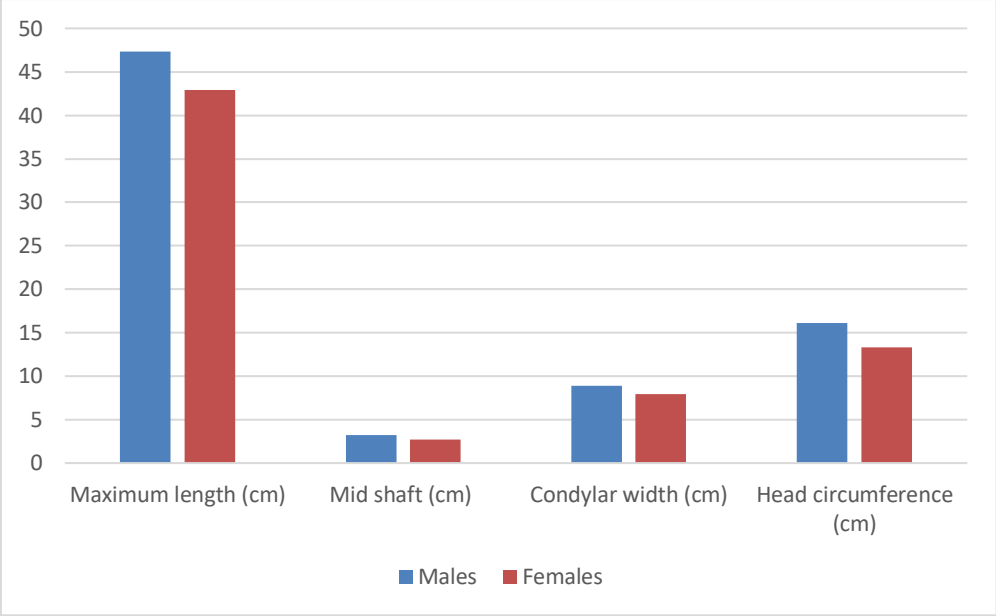

Fig 1: Comparison of femur dimensions among males and females

DISCUSSION

The assessment of sexual dimorphism in the femur bone plays a crucial role in fields such as forensic anthropology, osteology, and orthopedic medicine. Sexual dimorphism refers to the systematic differences in size, shape, and structural characteristics between male and female femurs, often resulting from biological, genetic, and hormonal influences. Generally, male femurs are larger, more robust, and have specific morphological traits that distinguish them from female femurs, which tend to be smaller and exhibit features adapted for childbirth, such as a wider pelvic structure. Key factors assessed include the dimensions of the femoral head, neck, and shaft, as well as geomorphological attributes that influence biomechanics[6,7]. Understanding these differences not only aids in accurate sex estimation of skeletal remains, but also informs the design of orthopedic implants and prosthetics tailored to each sex's anatomical variations. By studying the sexual dimorphism of the femur, researchers can enhance their understanding of human variation, improve forensic identification processes, and contribute to the development of more effective medical treatments.

In our study

The study by Jha VK et al.[8] aimed to evaluate gender differences in femoral measurements within the North Indian population of the Bihar region. It was conducted using 48 human adult femoral bones of known gender, consisting of 25 males and 23 females. A digital vernier caliper was employed for all measurements, focusing on seven specific parameters. The results indicated that the metric values for males and females were highly significant across all parameters, with female bones consistently showing lower values compared to their male counterparts. This study further confirmed the presence of sexual dimorphism in the femoral bone, reinforcing previous findings in this area of research.

In our study, the primary drawback was the limited sample size, which consisted only of 50 adult femora divided equally between males and females. While this size provides some insights, it may not be representative of the broader population, potentially affecting the generalizability of the findings. Other potential limitations include variations in measurement techniques and potential human error during data collection using instruments such as Vernier calipers and weighing scales. These constraints suggest that while our findings contribute valuable information to the understanding of sexual dimorphism in the femur, further research with larger, more diverse samples and comprehensive methodologies is necessary to validate and expand upon these results.

CONCLUSION

In conclusion, this study reinforces the presence of significant sexual dimorphism in the femur, with males generally exhibiting larger and more robust femoral measurements than females. These findings align with established research, underscoring how biological, genetic, and hormonal factors contribute to distinct male and female femoral characteristics. Although the study provides valuable insights, the relatively small sample size and measurement limitations may affect the generalizability of the results. Nevertheless, this research contributes to forensic anthropology, osteology, and orthopedic medicine by enhancing our understanding of human skeletal variation. Further studies with larger and more diverse samples are recommended to build on these findings, aiding in more accurate forensic identification and improving the design of sex-specific orthopedic treatments.

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LIMITATIONS

The relatively small sample size of 50 femora may limit the generalizability of the findings, as it may not fully represent the variability within broader populations. Additionally, the study's population-specific focus on a North Indian group restricts the applicability of the results to other ethnic or geographical populations, as sexual dimorphism can vary significantly across different groups. The reliance on manual measurement techniques, such as digital vernier calipers, introduces the possibility of human error and measurement inconsistency, which, coupled with limitations in the precision of these instruments, could impact the accuracy of the data. The study's emphasis on quantitative morphometric parameters also overlooks qualitative features and structural markers that might further enrich the understanding of sexual dimorphism in the femur. Furthermore, the sample consisted only of adult femora, which may not account for variations across age groups that could shed light on developmental aspects of sexual dimorphism. Lastly, environmental and lifestyle factors, such as nutrition, physical activity, and occupational demands, were not considered in the study, though these factors may influence bone robustness and morphology. These limitations suggest that while the study contributes valuable preliminary findings, further research with larger, more diverse samples and refined methodologies is needed to validate and expand upon these results.

REFERENCES

1. Irdesel J, Ari I. The proximal femoral Morphometry of Turkish women on radiographs. Eur. J. Anat. 2006;10(1):21–26.
2. Toogood PA, Skalak A, Cooperman DR. Proximal femoral anatomy in the normal human population. Clin. Orthop. Relat. Res. 2009;467:876–85. doi: 10.1007/s11999-008-0473-3.
3. Sreenivasan M., Nawaz Ahmed S. K. Osteometric Gender Determination from Head Diameters in Adult Femur. Indian Journal of Forensic Medicine & Toxicology. 2019;13(3):169–173.
4. Maruyama M, Feinberg JR, Capello WN, D'Antonio JA. The Frank Stinchfield Award: Morphologic features of the acetabulum and femur: anteversion angle and implant positioning. Clin Orthop Relat Res. 2001 Dec;393:52–65.
5. Kulkarni GS. Text book of orthopedics and trauma. 1999;4:2921–2922.
6. Loth SR, Iscan MY. Sex determination. In: Siegel J, Saukko PJ, Knupfer GC, editors. Encyclopedia of forensic sciences. Vol 1. San Diego: Academic Press, , 2000; 252-60.
7. Pons J. Sexual diagnosis of isolated bones of the skeleton. Human Biology, 1955; 27: 12-21.
8. Jha VK, Omar S, Jha RN. DETERMINATION OF THE SEX OF FEMUR-A MORPHOMETRIC STUDY. Int J Acad Med Pharm. 2022;4(5):115-7.