

Original article

Osteometric Analysis of Mid-Shaft Dimensions of Fully Ossified Dry Adult Human Fibulae in a Bangladeshi Population

Received: 14.07.2025

Accepted: 12.11.2025

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Abstract:

Background: The fibular shaft provides extensive surface area for muscle attachment that supports ankle and foot movements. **Objectives:** To measure the mid-shaft circumference, anterior–posterior, and transverse diameters of fully ossified dry adult human fibulae in a Bangladeshi population. **Methodology:** A total of 300 fibulae (152 right and 148 left) were examined in a descriptive cross-sectional study conducted in the Department of Anatomy, Mymensingh Medical College, Bangladesh (January–December 2023). Samples with deformity, fractures, or incomplete ossification were excluded. Measurements were taken using flexible measuring tapes and sliding calipers, and analyzed with SPSS software. **Results:** The mean (\pm SD) mid-shaft circumference was 4.22 ± 0.49 cm (right) and 4.21 ± 0.53 cm (left). The mean anterior–posterior diameters were 13.77 ± 1.73 mm (right) and 13.71 ± 1.67 mm (left), while transverse diameters were 10.34 ± 1.58 mm (right) and 10.60 ± 1.70 mm (left). **Conclusion:** The fibular shaft, being thin and vascular, is suitable for bone grafting procedures, particularly in reconstructive surgeries.

Keywords: Fibula, Osteometry, Mid-shaft, Circumference, Diameter, Bone graft

Introduction:

The fibula is a long bone and consists of three parts: upper end, lower end, and intervening shaft¹. The fibula (Latin clasp/pin) is the lateral and smaller bone of the leg. It is very thin as compared to the tibia. It is homologous with the ulna of the upper limb. It forms a mortice of the ankle joint⁵. It gives the calf its structure and helps to form a stable ankle

joint. Its shape is like a three-sided prism. The shaft has three borders and surfaces, each associated with a particular group of muscles³. The shaft is described to have anterior, interosseous, and posterior borders; and medial, lateral, and posterior surfaces. The shaft of the fibula provides surface area for the attachment of most of the extensor, flexor and

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How to cite this article: Biswas TR, Jahan N, Kar T, Haque SMA, Latif MS, Tanzem S. Osteometric Analysis of Mid-Shaft Dimensions of Fully Ossified Dry Adult Human Fibulae in a Bangladeshi Population. Ad-din Med J. 2026;4(1):4-8

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peroneal muscles⁴. Shaft of fibula is triangular in cross-section⁶. The shaft of the fibula is also important for tendons and ligaments attachment. The shaft forms the outer part of the calf contribute to the overall structural support of the lower leg. The interosseous membrane of the leg is a tough fibrous sheet of connective tissue that spans the distance between facing interosseous borders of the tibial and fibular shafts. Middle tibiofibular joint is formed by the interosseous membrane which is a fibrous connective tissue that connects the shaft of the tibia and fibula. The interosseous membrane not only links the tibia and fibula together, but also provides an increased surface area for muscle attachment⁷. The cortical bone of the shaft of the fibula is a valuable source of bone grafting. Fracture of the shaft of the fibula can be associated with instability of the ankle joint, especially if the distal tibiofibular syndesmosis is also disrupted. Despite several osteometric studies conducted in other populations, data on fibular shaft dimensions in the Bangladeshi population remain limited. Understanding these measurements is crucial for orthopedic and reconstructive surgical applications. Therefore, this study aimed to evaluate the mid-shaft circumference and diameters of fully ossified dry human fibulae in a Bangladeshi sample.

Materials & Methods:

This cross-sectional descriptive study was conducted on 300 fully ossified dry human fibulae collected from the Department of Anatomy, Mymensingh Medical College (MMC), Mymensingh, Bangladesh. Among the samples, 152 were from the right side and 148 from the left. The study was carried out over a one-year period, from January to December 2023. Samples were selected using a non-random purposive sampling technique. Ethical approval was obtained from the Institutional Review Board (IRB) of MMC (Memo No. MMC/IRB/2023/575, dated 24 June 2023).

Only fully ossified, intact fibulae without deformity, fracture, or pathology were included. Three osteometric parameters were measured: mid-shaft circumference, mid-shaft anterior-posterior diameter, and mid-shaft transverse diameter.

To measure the mid-shaft circumference, the midpoint of the total length of each fibula was marked with a pencil, and the circumference at that point was measured using a flexible measuring tape and recorded in centimeters (cm). The mid-shaft anterior-posterior diameter was measured at the same midpoint using sliding calipers, by placing the fixed jaw on the anterior border and the movable jaw on the posterior border of the bone; the value was expressed in millimeters (mm). The mid-shaft transverse diameter was also measured with sliding calipers, by placing the fixed jaw on the medial border and the movable jaw on the lateral surface at the midpoint of the bone; the distance was recorded in millimeters (mm).



Figure 1: Procedure for measuring mid-shaft circumference using a flexible measuring tape.



Figure 2: Procedure for measuring mid-shaft anterior-posterior diameter using sliding calipers.



Figure 3: Procedure for measuring mid-shaft transverse diameter using sliding calipers.

Results:

The mid-shaft circumference of the right-sided fibulae ($n = 152$) ranged from 3.0 cm to 5.5 cm, with more than 83% of the samples measuring between 3.5 cm and 4.5 cm. The left-sided fibulae ($n = 148$) also showed a range of 3.0 cm to 5.5 cm, with more than 78% falling within the 3.5–4.5 cm range.

The mid-shaft anterior–posterior diameter of the right-sided fibulae varied between 9.62 mm and 18.32 mm, with over 82% of the samples measuring within 11–16 mm. For the left-sided fibulae, the range was 9.78 mm to 17.76 mm, and more than 77% of the samples were within 11–15 mm.

The mid-shaft transverse diameter of the right-sided fibulae ranged from 4.53 mm to 14.45 mm, with over 83% of the bones measuring between 8.75 mm and 11.25 mm. The left-sided fibulae showed a range of 6.8 mm to 16.17 mm, and more than 76% were within 8.75–12.50 mm.

The mean (\pm SD) mid-shaft circumference was 4.22 ± 0.49 cm on the right side and 4.21 ± 0.53 cm on the left side. The mean (\pm SD) mid-shaft anterior–posterior diameters were 13.77 ± 1.73 mm (right) and 13.71 ± 1.67 mm (left). The mean (\pm SD) mid-shaft transverse diameters were 10.34 ± 1.58 mm (right) and 10.60 ± 1.70 mm (left).

Table 1. Mean and Range of Fibular Mid-Shaft Measurements ($n = 300$)

Parameter	Side	Range	Mean \pm SD
Mid-shaft circumference (cm)	Right	3.0–5.5	4.22 ± 0.49
	Left	3.0–5.5	4.21 ± 0.53
Mid-shaft anterior–posterior diameter (mm)	Right	9.62–18.32	13.77 ± 1.73
	Left	9.78–17.76	13.71 ± 1.67
Mid-shaft transverse diameter (mm)	Right	4.53–14.45	10.34 ± 1.58
	Left	6.80–16.17	10.60 ± 1.70

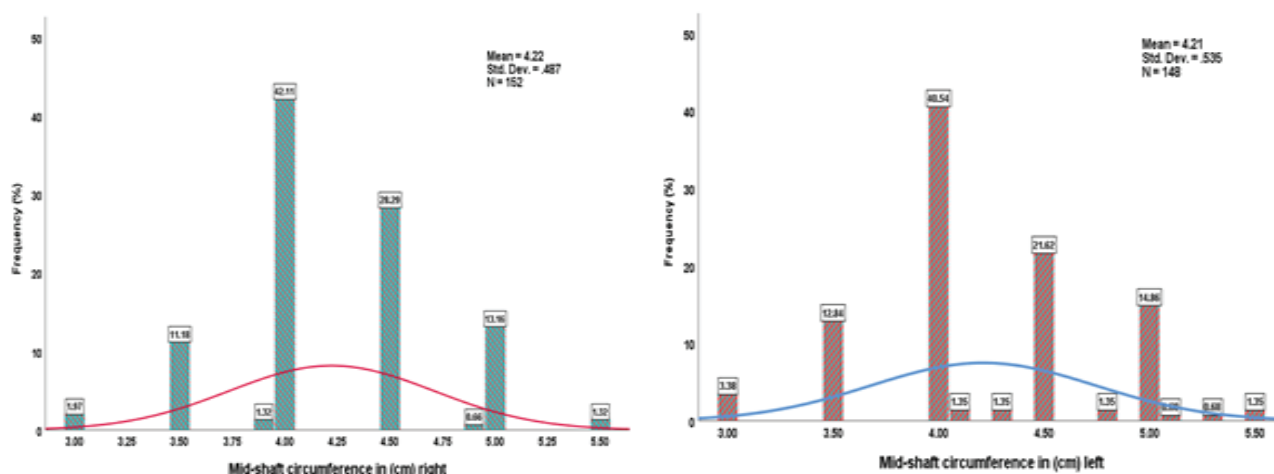


Figure 4: Histogram showing frequency distribution of mid-shaft circumference of both right and left fibulae.

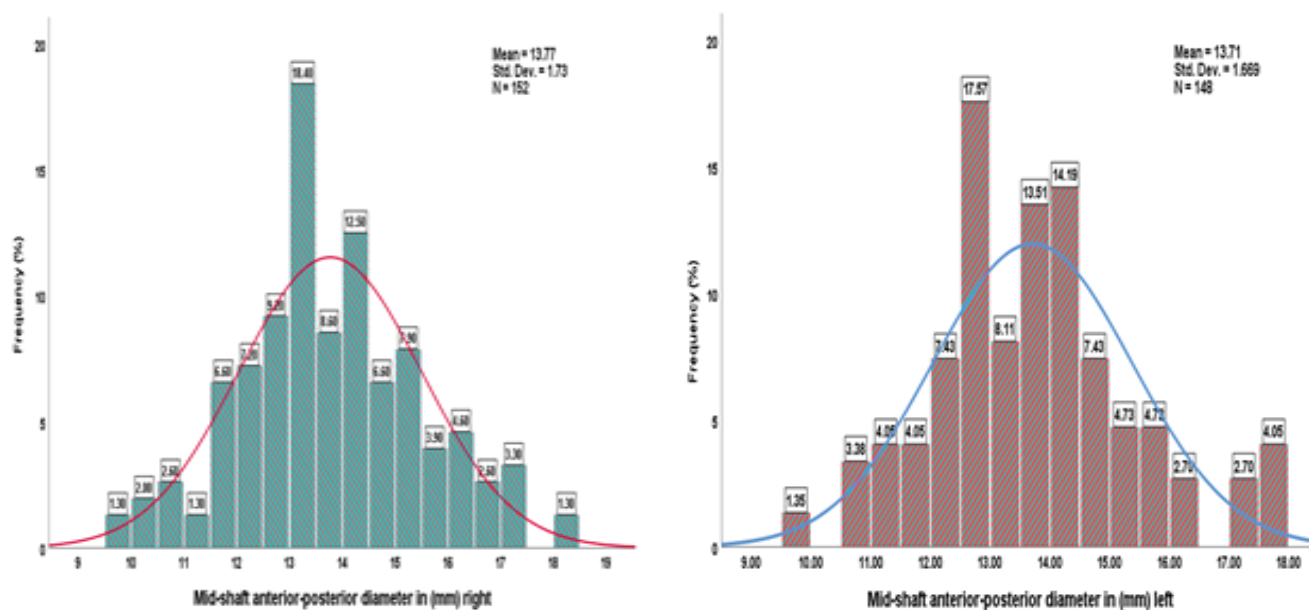


Figure 5: Histogram showing frequency distribution of mid-shaft anterior-posterior diameter of both right and left fibulae.

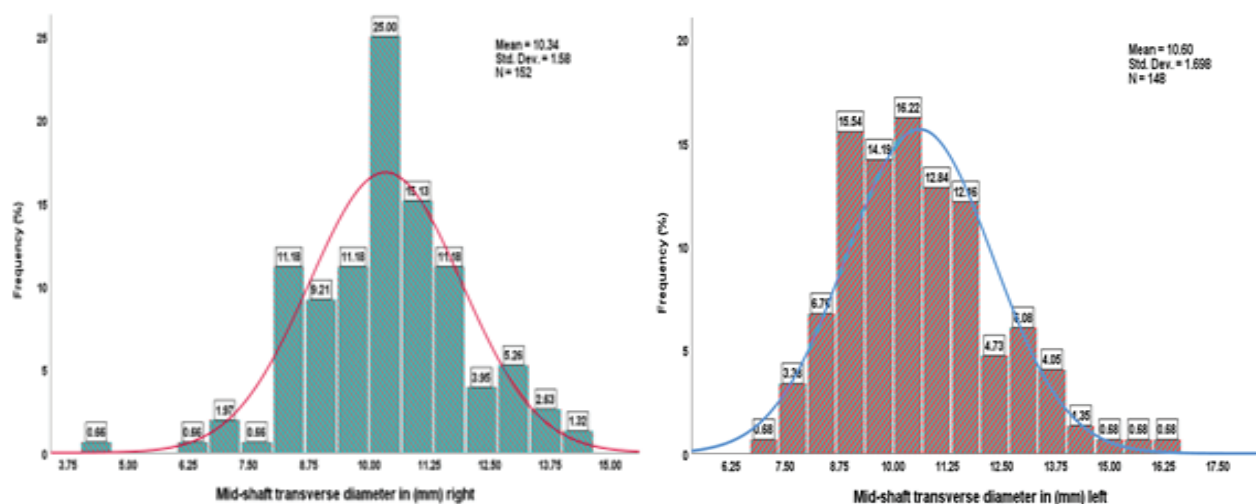


Figure 6: Histogram showing frequency distribution of mid-shaft transverse diameter of both right and left fibulae.

Discussion

In the present study, the mean (\pm SD) mid-shaft circumference of the fibula was 4.22 ± 0.49 cm on the right side and 4.21 ± 0.53 cm on the left. The mean (\pm SD) mid-shaft anterior-posterior diameter was 13.77 ± 1.73 mm on the right and 13.71 ± 1.67 mm on the left. The mean (\pm SD) mid-shaft transverse diameter was 10.34 ± 1.58 mm on the right and 10.60 ± 1.70 mm on the left. These findings indicate minimal side-to-side variation, suggesting bilateral symmetry of fibular dimensions in the Bangladeshi population.

The present results are comparable to those reported by Lingamdenne (2019) [2], who observed a mean mid-shaft circumference of 3.94 ± 0.50 cm, a mean anterior-posterior diameter of 13.67 ± 2.07 mm, and a mean transverse diameter of 10.86 ± 1.63 mm in a population from Telangana,

India. The small discrepancies between populations may reflect differences in genetics, nutrition, and habitual physical activity influencing bone morphology.

Osteometric analyses of long bones are valuable for both clinical and anthropological purposes. In orthopedics and reconstructive surgery, the fibular shaft is widely recognized as a reliable donor site for cortical bone grafts due to its favorable shape, adequate length, and limited functional loss after harvest [3,6]. According to Standring (2016) [3] and Moore et al. (2018) [6], the fibula provides an excellent source of vascularized cortical bone, suitable for reconstructive procedures such as mandibular or long-bone defect repair.

The findings of this study are consistent with established anatomical data demonstrating that fibular shaft dimensions are relatively stable across populations, with minor regional

variations [2–4,6]. Such consistency enhances its applicability in forensic identification and reconstructive planning. Furthermore, the osteometric data obtained in this study may serve as a reference for anthropological research and educational purposes, as well as for developing population-specific morphometric standards.

Overall, this study provides important baseline data on the morphometry of the fibular shaft in the Bangladeshi population. These findings contribute to the existing anatomical database and have potential implications in forensic anthropology, orthopedic surgery, and academic anatomy.

Conclusion

The fibular shaft serves as an important source of cortical bone for grafting in various reconstructive surgical procedures, particularly for mandibular and long bone defects. The findings of this osteometric study demonstrate that the mid-shaft circumference and diameters of the fibula are bilaterally symmetrical, with minimal variation between the right and left sides in the Bangladeshi population.

Its thin cortical structure, adequate vascularity, and limited functional compromise after harvest make the fibula one of the most reliable donor bone for reconstructive applications.^{3,6} The osteometric data presented in this study enrich the anatomical database for the Bangladeshi population and can serve as a reference for anthropological research, orthopedic surgery, and forensic identification. Future studies with larger sample sizes and comparative analyses across diverse populations are recommended to validate these findings.

Acknowledgement

The author expresses sincere gratitude to Dr. Shah Md. Atiqul Haque, Assistant Professor, Department of Anatomy, Mymensingh Medical College, Mymensingh, for his valuable guidance, encouragement, and continuous support throughout the study and manuscript preparation. Profound thanks are also extended to all faculty members and staff of the Department of Anatomy, Mymensingh Medical College, for their kind cooperation and assistance during the research process. Above all, the author expresses deep gratitude to Almighty Allah, the Most Merciful, for granting the strength, patience, and perseverance to complete this work successfully.

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