*Original Article*

# Radiological Determination of the Femoral Neck Axis Length and its Male-Female Variations in Adult Bengali Bangladeshis

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**Abstract**

***Background:*** *A neck femur fracture is one of the common fractures in osteoporotic people. It produces physical and economic burdens due to its adverse consequences. There is a correlation between the femoral neck length and a fractured neck femur. It is existent that there is significant gender-specific differences in the geometrical parameters of the proximal femur. Proximal femur exhibits important sexual dimorphism and has considerable potential for forensic purposes. The objective of the present study is to measure and compare the radiological femoral neck axis length between males and females in adult Bengali Bangladeshi Population.* ***Materials and Methods:*** *This cross-sectional analytical study was carried out in the Department of Anatomy, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh, from March 2019 to February 2020 with ethical clearance from respective IERB. For this study, A total of 100 femoral necks were analyzed where 50 subjects were males and 50 were females.* ***Results:*** *The average Femoral neck axis length (FNAL) was 10.65±0.57 cm and 9.59±0.47 cm in adult Bengali Bangladeshi males and females respectively. The mean femoral neck axis length (FNAL) was 10.09±0.74 cm for the right femur and 10.15±0.76 cm for the left femur.* ***Conclusion:*** *The femoral neck axis length in adult Bengali Bangladeshi males was significantly higher than the females. There were no significant differences of femoral neck axis length between the right and left femur.*

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## Introduction

In the human body, the femur is the longest and strongest bone[1]. The head and shaft of the femur are joined by the femoral neck[2]. The neck's two ends expand to connect with the rest of the bone[3]. The hip joint can move more easily due to the neck-shaft angle, allowing the limb to swing free of the pelvis[4]. Many studies were conducted to observe the variations in the proximal femur geometry using direct measurements from the cadaveric femur, computed tomography and direct radiography[5-9]. However, standard radiography techniques such as plane X-rays have become widespread viewing tools for radiologists, orthopaedic surgeons and forensic anthropologists to measure linear dimensions, angles and deformities[10]. Several authors studied proximal femur geometry by radiographs because it is a most available, cost-effective and less time-consuming procedure[2, 10-13].

The femoral head and neck mainly consist of cancellous bone, so they are vulnerable to osteoporosis[14]. An older person with severe osteoporosis is susceptible to proximal femur fracture[8]. Bagaria, et al. conducted a radiographic study of the hip joint in the Indian population[15]. They highlighted the differences between Indian anthropometric data and available Western anthropometric data for better design of the hip replacement prosthesis for the people of the Indian subcontinent. According to radiological studies if there is a longer femoral neck and larger neck axis there is an increased risk of fracture due to the increased length of the lever arm. There are the existences of significant gender-specific differences in the geometrical parameters of the proximal femur in the Danish population and the hip parameters were found to be larger in men compared with women[16].

Nihat, et al.[10] conducted a study on three hundred eighty anteroposterior radiograms in the Turkish population and found a higher mean value of proximal femur parameters in males than females, also providing a database for surgeons and manufacturers who deal with proximal femur bone surgery. Also, Farias, et al.[11] conducted a

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radiographic study on the proximal femur on 500 Brazilians. They concluded that there was a statistically significant mean difference between men and women for all the variables, both on the left and the right side and that the men had greater means than the women. Caiaffo, et al.[5] also demonstrate that the proximal femur exhibits important sexual dimorphism and has considerable potential for forensic purposes.

The measurements performed on the femoral neck axis length can serve as the basis for the identification of gender and may also serve as the basis for the formation of a reference standard for the Bengali Bangladeshi Population.

**Materials and Methods**

The research was conducted from March 2019 to February 2020 at Bangabandhu Sheikh Mujib Medical University (BSMMU), in Bangladesh, in the Department of Anatomy. Data was collected from the Department of Radiology and Imaging, BSMMU, Bangladesh after taking ethical approval from IRB (Ref: BSMMU/2019/7606). Purposive sampling was used to select the participants. 100 adult Bengali Bangladeshis between the ages of 25 and 45 were included in the study: 50 of them were male and the other 50 were female who had X-ray pelvis in the Department of Radiology and Imaging of the BSMMU.


**Figure-1: The length of the femoral neck axis from point A to point B.**

The patient was positioned supine on the X-ray table for the anteroposterior pelvic radiographs. These pelvic radiographs were obtained using the standardized protocol. Both lower extremities are oriented in 15° of internal rotation to maximize the length of the femoral neck[17]. The X-ray tube was positioned perpendicular to the table and the distance between tube and the film was 120 cm[17-19]. For this research, a 100% digital X-ray of the pelvis (AP view) was taken. Measurements were taken after placing the X-ray film on the view box.

The axes of the femoral neck are defined by a line passing through the midpoint of the isthmus and the head centre[20]. Femoral neck axis length AB (Figure-1) is the distance along the femoral neck axis from the lateral margin of the base of the greater trochanter A to the apex of the femoral head B (Figure-1)[21].

The femoral neck axis is needed for studying the orientation of the femur head. A mid-diaphyseal line of the femoral neck represents the orientation of the femur head. This is generally drawn using the centre of the femur head as one point and the mid-diaphyseal width of the neck as the second point[22]. A template was placed on the femoral neck, the long axis of the circles was aligned along with the femoral head centre C (Figure-2), second point D was given on the centre of the best-matched circle around the minimum diameter of the neck, and the third point A was given on the outermost margin of the femur just below the greater trochanter. A straight line was drawn by joining these three points and extending up to the outer margin of the femoral head B, and the AB line represents the femoral neck axis length.

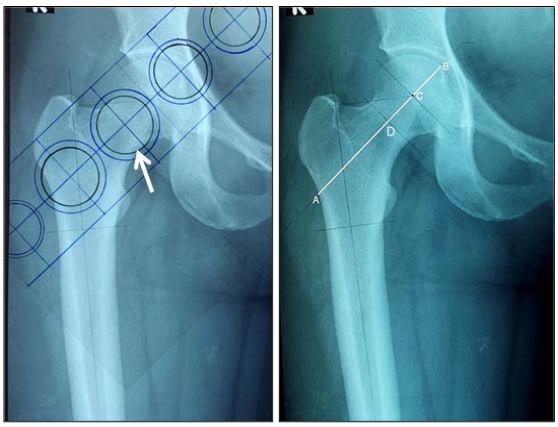


**Figure-2: Identification of femoral neck axis i) Circular template on a transparency sheet placed along the long axis of the femoral neck, best matched circle around the minimum diameter of the femoral neck (arrow) ii) Pointed out and drawn the femoral neck axis (AB), 'C' represents the femoral head centre and 'D' represents mid-point of minimum diameter of the neck.**

The ranges, means and standard deviations of the femoral NSA were calculated. The significance of the difference between the male and female values was tested by an unpaired t-test. Distribution was tested by the Shapiro-Wilk test. The Statistical Package for Social Sciences (SPSS) version 25.0 program was used to enter the data. When interpreting the data, $p<0.05$ was considered significant.

## Results

Two hundred (200) femoral necks were analyzed from 100 patient radiographs comprising 50 males and 50 females. The age distribution was 25-45 years, with a mean age of 33.47±5.61 years. The mean femoral neck axis length of males was found to be significantly higher than that of females ($p<0.05$) (Table-I). The difference in the mean femoral neck axis length of males and females was found to be statistically significant for the right ($p=0.000$) and left sides ($p=0.000$) (Table-II).

**Table-I: Femoral neck axis length (in cm) in males and females irrespective of side**

| Gender | Number | Minimum | Maximum | Mean | SD | p-value |
|---|---|---|---|---|---|---|
| Male | 100 | 9.56 | 12.50 | 10.64 | 0.57 | 0.000 |
| Female | 100 | 8.60 | 10.80 | 9.58 | 0.47 | (Significant) |

**Table-II: Bilateral variations of the femoral neck axis length (in cm) according to gender**

| Side | Gender | Number | Minimum | Maximum | Mean | SD | p-value |
|---|---|---|---|---|---|---|---|
| Right | Male | 50 | 9.70 | 12.50 | 10.60 | 0.60 | 0.000 |
| | Female | 50 | 8.60 | 10.60 | 9.57 | 0.45 | (Significant) |
| Left | Male | 50 | 9.56 | 12.45 | 10.69 | 0.56 | 0.000 |
| | Female | 50 | 8.64 | 10.80 | 9.60 | 0.50 | (Significant) |

**Table-III: Bilateral variations of the femoral neck axis length (in cm) irrespective of gender**

| Side | Number | Minimum | Maximum | Mean | SD | p-value |
|---|---|---|---|---|---|---|
| Right | 100 | 8.60 | 12.50 | 10.08 | 0.73 | 0.80 |
| Left | 100 | 8.64 | 12.45 | 10.14 | 0.75 | (Not Significant) |

There was no significant difference found between right and left femoral neck axis length (NAL) ($p=0.803$) in this study (Table-III). The frequency distribution of the right femoral neck axis length in males shows a rightward tendency compared to that in the females in adult Bengali Bangladeshis (Figure-3). The frequency distribution of the left femoral neck axis length in males shows a rightward tendency compared to that in the females in adult Bengali Bangladeshis (Figure-4).

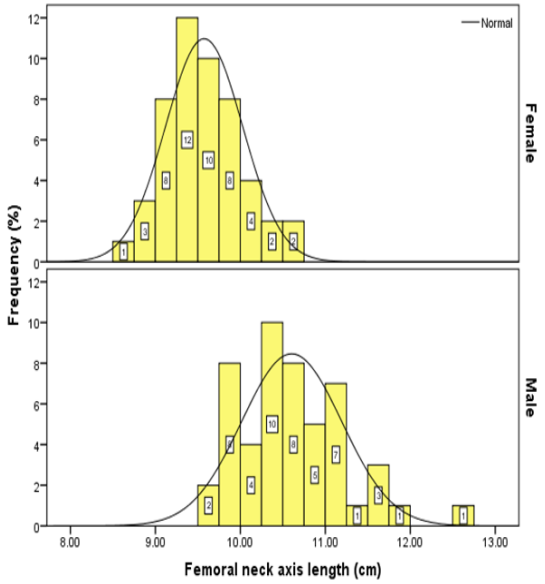


**Figure-3: Comparison between frequency distribution of the right femoral neck axis length of adult Bengali Bangladeshi males and females (n=100).**

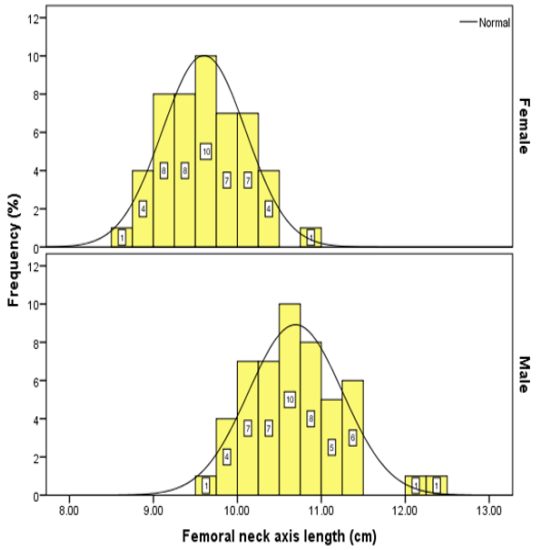


**Figure-4: Comparison between frequency distribution of the left femoral neck axis length of adult Bengali Bangladeshi males and females (n=100).**

## Discussion

In the present study, the mean values of the right and left femoral neck axis length in the male population were 10.60 cm and 10.69 cm, respectively, whereas in the female population were 9.57 cm and 9.60 cm, respectively. As a result, a statistically significant difference between men and women was found. In the present study, the mean value of the femoral neck axis length in the Bengali Bangladeshi population, irrespective of gender and side, was similar to those of a Turkish population[21] and in a

Dutch population[16]. It was higher than the means of the Brazilian population[23]. This difference can be explained by the average Brazilian being taller than the average Bengali Bangladeshi. Still, it was lower than the means of a Turkish population in another study[10].

This study revealed that the femoral neck axis length of the male Bengali Bangladeshis was significantly greater than the corresponding length of the female. A similar type of observation was found by different authors in Dutch[16], Brazilian[11,23] and Turkish populations[10]. This suggests that femoral neck axis length is one of the values in gender differentiation among the inhabitants of this region. However, in the right and left femoral neck axis length, irrespective of gender, there were no statistically significant differences in the Bengali Bangladeshi population. This was consistent with the observation reported by de Sousa, et al. in a Brazilian population[23] and a Turkish population[10].

**Conclusion**

Statistically significant larger femoral neck axis length was found in adult Bengali Bangladeshi male population than females. However, further studies must be conducted to find out the clinical significance of the present study findings.

**Conflict of Interest**

The authors declared that they have no conflicts of interest.

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