# Age and Gender Related Changes of Femoral Neck-Shaft Angle among Adult Bangladeshi Population by Plain Pelvic Radiograph Study

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## Abstract

**Background:** Femoral Neck-Shaft Angle (NSA) varies among humans but measurement problems and sampling limitations have precluded the identification of factors contributing to its variation at the population level. NSA varies in relation to age, gender, race, ethnicity lifestyle etc. The aim of the present study was to evaluate the femoral NSA of adult Bangladeshi population by plain pelvic radiograph to build up statistical database and find out any significant difference of femoral NSA among different age group and gender.

**Materials and methods:** This cross sectional observational study was conducted by Department of Anatomy, in the Chittagong Medical College which included 200 Bangladeshi adult came to Radiology Department of Chittagong Medical College and Hospital (CMCH) from different districts. After taking demographic data, plain pelvic X-ray were taken and report was done by an expert radiologist of CMCH. Only normal radiographs were included. Data were analyzed by SPSS version–25. For statistical analysis unpaired student's 't' test was done and $p<0.05$ was significant in 95% confidence interval.

**Results:** There is highly significant difference in mean femoral neck-shaft angle of both side in relation to age and gender among different age group of adult Bangladeshi population.

**Conclusion:** Considering the variation of femoral neck-shaft angle can help inmanagement of various pathological conditions and fractures of proximal femur, pre-operative selection of prosthetic implants that may improve the overall prognosis of the patients.

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*Submitted on : 29.09.2022*
*Accepted on : 16.11.2022*

**Key words:** Femur; femoral NSA; Pelvic radiograph.

## Introduction

The femoral Neck-Shaft Angle (NSA) is an obtuse angle formed by intersection of the axis of femoral shaft with the femoral neck.[1] The angle is necessary to enable the femoral shaft to swing clear of pelvis during mobility.[2] It is also important in the control of lateral balance during mobility.[3] During intra uterine life, the femoral head and the acetabulum of the hip bone grow independently but in such a way that they develop congruently. This mechanism is influenced by forces that act externally in these areas. The most important of these are body weight and muscle tension forces, which need to have magnitudes and directions for appropriate interactions. Any change to the compression forces or any joint congruence will lead to deformity. The pressure, arching and shearing stresses to which the femur is subjected are important for fracture production and also development of various pathological processes.[4-6] In early infancy the neck shaft angle is about 150º, in childhood 140º, in adult about 125º and in elderly about 120º.[7] There are several factors which also influence NSA in postnatal life such as epiphyseal cartilage activity, perfusion of femoral epiphysis, muscle actions, hormones, static factor, body weight and finally disease.[8]

The femoral neck-shaft angle was studied extensively by many authors and conclusions were made. It was found to be different in different races, in different ethnic groupsand at different ages, different lifestyle and patients with cerebral palsy.[9-13] The findings regarding to sex were inconsistent. However, it was described as greater in males than in females or greater in femalesor no sexual differences at all.[10,11,14]

Involvement of the proximal femur in various pathological conditions such as developmental dysplasia of hip, fibrous dysplasia, congenital coxavara, osteoarthritis of hip changes the neck-shaft angle and thereby alters the biomechanics of gait.[15,16] The neck-shaft angle is also important in

surgical intervention that involved fracture neck of femur, inter-trochanteric fractures, various osteotomies used in Perth's disease, slipped capital femoral epiphysis, during all types of osteotomies used in developmental dysplasia of hip, neuromuscular disorders of lower limb and during total hip arthroplasty.[17] The rotations and version of the femoral neck to the femoral condyles and its projection on the anterior posterior radiograph influences the implant choice during total hip arthroplasty.[18-19]

Keeping the above background and knowledge in mind, the present study was designed to evaluate femoral neck-shaft angle variation in relation to age and gender of adult Bangladeshi population and analyzed the data statistically to find out any significant difference of this angle within the study population.

**Materials and methods**

This cross-sectional observational study was conducted in the Department of Anatomy, Chittagong Medical College, Chattogram during the period from July 2020 to June 2021. After taking approval fromethical review committee of Chittagong Medical College, 200 adult Bangladeshi population of different districts who came in Department of Radiology, CMCH were included by convenient sampling as per enrollment criteria. Radiographs of fractured femur, deformity of femur, metabolic bone diseases, malignancy and the tribal were excluded from the study. The age of the respondents ranged from 21-75 years. Participants were divided into two groups. Group-A included participants of age <50 years male and female and Group-B included participants aging from ≥50 years male and female. After taking informed written consent demographic data of all participants and plain pelvic X-ray A/P view were taken, then report was done by an expert radiologist of CMCH. Plain Pelvic radiographs, A/P view was obtained from patients by using the standardized protocol that was 15-30 degrees of internal rotation of the hips in the supine position with a film-focus distance of 100 cm, and the beam centered on the symphysis pubis.[20-21] The NSA was the angle made by the intersection of the longitudinal axis of the neck with that of longitudinal axis of femoral shaft. The longitudinal axis of the neck was obtained by taking two points. First point taken at the center of the head. Then an oblique line drawn at the neck region and midpoint of the line was taken which is the second point. Now 1st and 2nd points are joined by an oblique line. Thus the neck axis is formed. The longitudinal axis of the shaft of the femur was found by drawing a transverse line on the proximal shaft of the femur below the lesser trochanter and taking the midpoint of the line and then draw a vertical line. The NSA axis formed by the intersection of the two lines[20] (Figure-1). The NSA of both sides was measured with the aid of view box, measuring scale and protractor[21]. All collected data entered into computer and analyzed by SPSS (Statistical Package for Social Science) version-25 software program. Relationship between numerical variables was found out by the unpaired student's "t" test and $p < 0.05$ was considered as statistically significant.

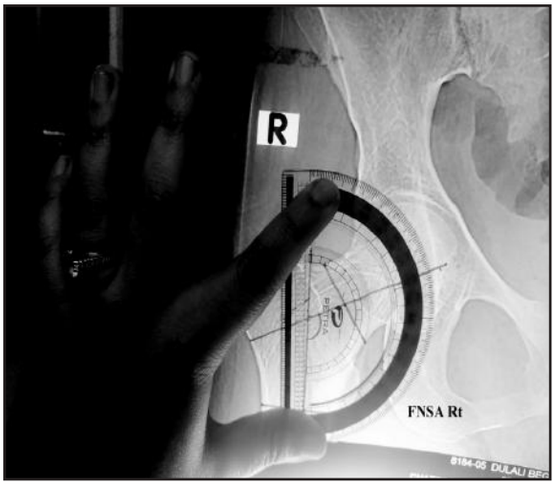


**Figure 1** Measurement of Femoral Neck-Shaft angle (Right side)

**Results**

The mean ± SD age of the respondents was 42.18 ± 13.197 years. There were 154 (77%) participants in age group of <50 years (Group-A) and 46 (23%) participants in the age group of ≥50 years (Group-B) (Figure-2). There were 91 male & 63 female participants in Group-A & 28 male & 18 female in Group-B (Figure-3).

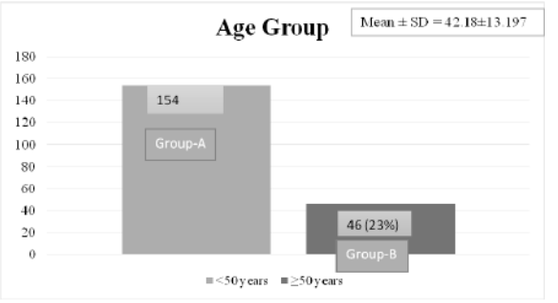


**Figure 2** Bar diagram showing age distribution of the respondents (n=200)

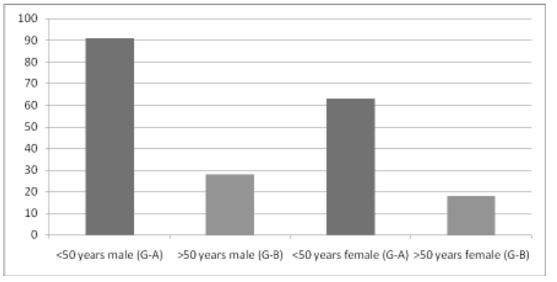


**Figure 3** Bar diagram showing sex distribution of the respondents according to age group

The comparison of femoral neck shaft angle in relation to age and sex are listed in Table I and II. Mean femoral neck-shaft angle of right side was 126.367 ± 2.968 degree &123.652 ± 2.869 degree among the respondents of age group <50 years and ≥50 years of both sexes respectively. Mean femoral neck-shaft angle of left side was 125.403 ± 2.921 degree in respondents of age group <50 years male and female and 122.739 ± 2.712 degree in respondents of age group ≥ 50 years male and female. There was a very highly significant difference of mean femoral neck-shaft angle among the different age groups (p<0.001) (Table I).

**Table I** Femoral neck-shaft angle of both side among different age group (n=200)

| Age | Right ($^0$) Mean±SD | Left ($^0$) Mean±SD | p-value |
|---|---|---|---|
| <50 Years (n=154) | 126.367±2.968 | 125.403±2.921 | p<0.001* |
| ≥50 Years (n=46) | 123.652±2.869 | 122.739±712 | |

*p<0.001 = statistically highly significant.

Mean femoral neck-shaft angle of right side was 126.632 ± 2.999 and 125.948 ± 2.903 degree among the respondents of age group <50 years male & female accordingly, mean femoral neck-shaft angle of right side of age group ≥50 years male were 124.393 ± 2.87 and female were 122.500 ± 2.526 degree.Mean femoral neck-shaft angle of left side was 125.648 ± 2.965 and 125.048 ± 2.842 degree among male and female respondents of age group <50 years and 123.393 ± 2.780 and 121.722 ± 2.321 degree among respondents of age group ≥50 years male and female. There was highly significant difference of mean femoral neck-shaft angle of male and female in different age groups (p<0.001) (Table- II).

**Table II** Femoral neck-shaft angle in different age group of male and female

| | Right side | | p-value | Left side | | p-value |
|---|---|---|---|---|---|---|
| Sex | Male | Female | | Male | Female | |
| Age group | (Degree) Mean±SD | (Degree) Mean±SD | | (Degree) Mean±SD | (Degree) Mean±SD | |
| <50 years | 126.632±2.999 | 125.948±2.903 | p<0.001* | 125.648±2.96 | 125.048±2.84 | p<0.001* |
| 50 years | 124.393±2.872 | 122.500±2.526 | | 123.393±2.78 | 121.722±2.32 | |

*p<0.001 = Statistically highly significant.

## Discussion

In the present study, the mean ± SD age of the respondents was 42.18 ± 13.197 years. There were 154 (77%) participants in age group of ≤50 years and 46 (23%) participants in the age group of >50 years (Figure-2). There were 91 male participants of <50 years and 28 male participants of ≥50 years. There were 63 female participants of <50 years and 18 female participants of ≥50 years. (Figure-3). Mean femoral neck-shaft angle of right side was 126.367 ± 2.968 degree in respondents of age group ≤50 years and 123.652 ± 2.869 degree in respondents of age group >50 years. Mean femoral neck-shaft angle of left side was 125.403 ± 2.921 degree in respondents of age group ≤50 years and 122.739 ± 2.712 degree in respondents of age group >50 years (Table-I). Mean NSA on both right and left side found higher in ≤50 years age group and it was very highly statistically significant (p<0.001). The result was similar to another study conducted by Rickels et al. where the average NSA for patients under-fifty age group was 127.0 degrees. The average NSA for patients over-fifty age group was 122.5 degrees. They confirmed that a statistically significantly higher NSA exists in under 50 age group (p<0.001).[22] Another retrospective study analyzed by dual energy X-ray images of the proximal femur by Elbuken et al. stated that there was a highly significant difference of mean NSA on both sides among different age groups (p<0.001).[11]

Fischer et al al so documented that the mean NSA of right side was 127.7 degree and left side was 126 degree in different age group and there was a statistically significant difference of mean NSA on both right and left side ($p<0.001$) among different age groups. They also revealed that the NSA decreases 1.40 degree per decade and this association might be due to decreasing bone mineral density and physiological changes.[23] Bhattacharya et al. described that, the average NSA of the study population was 125.12±2.22 degree and 124.96±1.93 degree on the right and left side and there was no correlation between the mean NSA on the right and left side along with age ($p=0.47$) which is dissimilar with the present study. The dissimilarity may be due to their small sample size.[21]

This study revealed mean femoral neck-shaft angle of right side was 126.632 ± 2.l999 and 125.948 ± 2.903 degree among male and female in respondents of age group ≤50 years and 124.393 ± 2.872 and 122.500 ± 2.526 degree among male and female in respondents of age group >50 years. Mean femoral neck-shaft angle of left side was 125.648 ± 2.965 and 125.048 ± 2.842 degree among male and female in respondents of age group ≤50 years and 123.393 ± 2.780 and 121.722 ± 2.321 degree among male and female in respondents of age group >50 years. There was a very highly significant difference of mean femoral neck-shaft angle of different age groups between male and female ($p<0.001$) (Table- II). Elbuken et al. found that, the mean NSA of male was 129.142 degree and female was 129.142 degree and there was a significant difference of mean NSA of male and female of different age groups on both sides ($p<0.05$).In this study the participants were categorized into age groups by decades (eg: 20, 30, 40, 50 and so on).[11] Nissen et al. described that, the mean NSA of male respondents were 131±50 degree and female respondents were 129±50 degree and a very significant difference of average NSA of male and female respondents on both sides ($p<0.001$) among various age group.[24] Kaur et al. showed that the mean neck shaft angle of the right side in males were 121.63 ± 2.41 degrees (112.1-127.4) The mean neck shaft angle of the right side in females were 121.16 ± 2.50 degrees (113.3-128.1). The difference in the mean neck shaft angle of males and females of different study group on the right side was found to be statistically insignificant (p value: 0.104). The mean neck shaft angle of the left side in males was 121.33° ± 2.36° degrees (111.8°-126.9°). The mean neck shaft angle of the left side in females was 120.94 ± 2.51 degrees (113.5°-130.8°). The difference in the mean neck shaft angle of males and females on the left side was also found to be statistically insignificant (p value: 0.183).[25] In the study by Lyidobi et al. male had a mean FNSA of 131.43 degree compared to females who had a mean FNSA of 130.78 degree among different age group although the difference was not statistically significant ($p>0.05$). In this study the ages of the subjects were categorized in a 10-year grouping from 20-99 years.[26] All these studies have shown similarity with the present study. According to Oduntan et al. the smaller angles in women might be attributed to a number of reasons including wider pelvis, greater bicondylar angle and shorter femur. Another study conducted by Sinha et al. revealed that the mean neck shaft angle in male was 130.28º and in female was 131.42º. Neck shaft angle was slightly greater in female bones than male bones but the result was statistically insignificant ($p>0.05$).[10] In the study by Rickels et al. had shown both of the female group's (Under 50 and over 50) average NSA were higher than the male NSA. A statistically significant difference ($p<0.001$) was observed between the males and females in the over 50 group. No significant difference could not be detected between the average NSA in the under 50 groups of males and females.[22] These results are dissimilar with this study.

**Limitation**

Due to resource limitation we conducted this study in a selected area and time and so the sample small was size. The study population might not be representative of the whole country. However, tribal were excluded which was also a limitation of the study.

**Conclusion**

The present study revealed very highly significant ($p<0.001$) difference of femoral neck-shaft angle between gender and among different age groups. The value of femoral NSA obtained from the study should be considered during surgical fixation of the neck of femur and hip prosthesis for adult Bangladeshi population.

**Recommendation**

Similar study can be done for long duration with large sample size selected from different parts of Bangladesh, for developing more acceptable standard femoral neck shaft angle value to make the study fully representative.

**Acknowledgement**

We acknowledge Head, Department of Radiology, Radiographer and other staffs under Radiology Department of CMCH for their kind and sincere co-operation for collection of samples and all the teachers and staffs of Department of Anatomy, Chittagong Medical College for their sincere support.

**Contribution of author**

BB- Conception, design, acquisition of data, interpretation of data, drafting and final approval.
MA- Conception, data analysis, critical revision and final approval.
SB- Design, critical revision and final approval.
UR- Acquisition of data, manuscript writing and final approval.
RR- Data collection, data analysis, manuscript writing and final approval.
SFS- Design, data collection, drafting and final approval.

**Disclosure**

All the authors declared no competing interests.

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