IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 19, Issue 9 Ser.7 (September. 2020), PP 10-15
www.iosrjournals.org

Femoral Neck Diameter: Dimorphic Variation and Correlation with the Stature from the Radiological Perspective

Md. Riadul Zannat Riad[1], Khalada Akter[2], Nahid Farhana Amin[3]

[1] *(Resident, Department of Anatomy, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh)*
[2] *(Resident, Department of Physiology, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh)* [3] *(Associate Professor, Department of Anatomy, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh)*

Abstract:
Background: *Femoral neck diameter as an assessor of sex has been previously investigated in a small proportion, but its relationship with stature has not investigated yet in Bengali Bangladeshis.*
Objectives: *To find out the sexual difference of femoral neck diameter (FND) in adult Bengali Bangladeshi population as well as its correlation with stature.*
Materials and Methods: *This cross sectional study was carried out in the Department of Anatomy, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka which involved measuring the femoral neck diameter of the anterior-posterior views of pelvic radiographs of adult patients reported "normal study" by the registered radiologist. A total of 100 femoral necks were analyzed from 100 patients' radiographs comprising of 50 males and 50 females. Data were expressed as mean ± SD. Statistical analysis was done by unpaired t- test and Pearson's correlation coefficient test. In the interpretation of results, ≤ 0.05 level of probability (p) was accepted as significant.*
Results: *The average FND for an adult Bengali Bangladeshi is 3.33 ± 0.39 cm with mean value of the FND is 3.33 ± 0.37 cm for the right and 3.34 ± 0.41 cm for the left. The mean value of the FND for an adult male is 3.61 ± 0.32 cm, whereas the mean value for an adult female is 3.06 ± 0.23 cm. There were significant positive correlations found between the stature and femoral neck diameter in both sexes.*
Conclusion: *The results of present study elucidate that femoral neck diameter of male is significantly higher than female and stature is correlated with femoral neck diameter.*
Key Words: *Stature, femoral, neck, diameter, Bengali, Bangladeshi, radiological*

Date of Submission: 05-09-2020 Date of Acceptance: 20-09-2020

I. Introduction

The femoral neck unites the head of the femur with the shaft and the two ends of the neck expanding to form the connection with the rest of the bone. The diameter of the neck is found minimum in the middle of the process, whereas lateral portion of femoral neck is of greater diameter than the medial[1]. A considerable amount of literature has been found to study the skeletal sex in which conventional methods focuses on an anatomical landmark of bone, which typically rely on the cranial and the pelvic regions, which are in risk of considerable deterioration[2]. Stature can be assessed from the length of the femur and it also depends on the length of various segments of the body including skull, spine, pelvis, and lower limbs[3, 4]. As far as we searched, very few studies were found to investigate sexual difference by FND from radiograph as well as no study was found to correlate FND with stature. Therefore this study aimed to investigate the sex difference using the minimum supero-inferior diameter of the femoral neck and to find out its correlation with the stature.

II. Material and Methods

The study was carried out in the Department of Anatomy, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh in the year 2019. Data collection was done from the Department of Radiology and Imaging, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh, after taking Institutional ethical clearance.

Sample size:
The study was carried out on 100 adult Bengali Bangladeshi individuals, fifty males and fifty females, between the ages of 25 and 45 years who undergo X-ray pelvis in the Department of Radiology and Imaging of the BSMMU.

Deciding on the age limit of the participant

The age limit was a very important factor for selecting the participants. Athawale[5] stated that all limb bones are completely ossified at the age of 25. The bone length and stature are related to ossification and epiphyseal fusion with diaphysis and both these events are age-dependent. Ossification of the long bones is completed by the age of 25 years[6]. So, in the present study, the lower limit of age was selected at the age of 25 years. On the other hand, as age advances, stature or height become reduced due to shrinkage of the intervertebral disc, osteoporotic vertebral collapse and anatomical distortion of the skeleton[7]. Thus it can give a misleading index of stature. So in this study the upper limit of age was selected at the age of 45.

Inclusion criteria

1. Bengali by mother language
2. Bangladeshi by nationality
3. Aged between 25 and 45 years
4. Male or female by sex
5. X-ray pelvis anteroposterior view showing „normal" proximal femur as identified by a registered radiologist

Exclusion criteria

1. Mixed in origin- if there is any history of marriage with any other ethnic group other than Bengali within the previous three generations
2. Radiographic evidence of metastatic disease, previous trauma
3. Any congenital or acquired abnormality that may affect the stature, for example, Turner syndrome, Klinefelter syndrome, kyphosis, lordosis, scoliosis.
4. Common genetic, endocrine or neurological disorders that might affect the stature (Down's syndrome, acromegaly)
5. Pathological conditions that can affect the features of the extremities of an individual
6. Pregnancy

Radiographic techniques

The anteroposterior pelvic radiographs were made with the supine position on the X-ray table. These pelvic radiographs obtained using the standardize protocol. Both lower extremities oriented in 15° of internal rotation in order to maximize the length of the femoral neck[8].The X-ray tube-to-film distance was 120 cm, with the tube oriented perpendicular to the table[8-10]. For this research, 100% digital X-ray of pelvis anteroposterior view was taken.

Procedure of measuring the stature

The participant was asked to stand with her heel together, toes apart and her back as straight as possible. So that, her heels, buttocks, shoulders and the head touched the wall to measure the stature. The participant was requested to be barefooted and to remove any hair ornaments, jewelry, buns, or braids from the top of the head. The participant's head was positioned in the Frankfort horizontal plane and the arms were hung freely by the sides with the palm facing towards the thighs. After taking a deep breath and holding it, a steel plate was placed against the head and wall to determine maximum height or stature on the wall, and this was marked by soluble marker. The participant was then told to breathe and to step away from the wall. The stature was then measured from the floor to the marked point on the wall with a measuring steel tape.

Procedure of measuring the femoral neck diameter

It is the shortest distance between the superior and the inferior borders of the femoral neck[11]. Femoral neck diameter AB was drawn perpendicular to the femoral neck axis CD (Figure 2).Measurements were taken after placing the X-ray film on the viewing box. Fit the contour of the narrow end of the neck (Figure 1) with a circle (Arrow). The diameter of the circle (Figure 1) is defined as a minimum femoral neck diameter[12].

In this study stature and femoral neck diameter on X-ray film were measured twice. The average value of the two measurements was taken, as the true value of the participant. A third reading was taken, if the initial two measurements greatly differed and the two closer readings would then be used.

Figure 1: Identification of femoral neck diameter: 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)

Figure 2: Femoral neck diameter from point A to point B, femoral neck axis CD.

Statistical analysis

The range, mean and standard deviation of the FND were calculated. Significance of the difference between the male and female values were tested by unpaired t- test. Distribution was tested by Shapiro-Wilk test. Correlations were tested between the stature and FND by Pearson's correlation coefficient test, as the data were normally distributed. The data was entered into the software statistical package for social sciences (SPSS) version 25.In the interpretation of results ≤ 0.05 level of probability (p) was accepted as significant.

III. Results

A total of 200 femoral neck diameters were analyzed from 100 patient's radiographs comprising of 50 males and 50 females. The age range was from 25 to 45 years with the mean age of 33.47± 5.61years. The mean FND of males were found significantly higher than the females ($p < 0.05$) (Table 1). Also the difference in the mean FND of males and females found to be statistically significant for the right and left sides ($p < 0.05$) (Table 2). There are no significant difference found between right and left FND ($p = 0.750$) (Table 3).The frequency distribution of the right femoral neck diameter in males shows rightward shift compared to that in the females (Figure 4) and also the left femoral neck diameter in males shows rightward shift compared to that in the females (Figure 5).

Pearson's correlation coefficient test was done to see the correlation, as data was normally distributed. Correlation of the stature with femoral neck diameter were assessed and displayed using scatter diagrams (Figure 3-5).Femoral neck diameter in both sexes also in total population showed significant positive correlation with the stature of adult Bengali Bangladeshis(Table 4).

Table no 1: Femoral neck diameter (in cm) according to gender

	N	Minimum	Maximum	Mean	SD	p
Male	100	2.95	4.63	3.61	0.32	0.001
Female	100	2.39	3.65	3.06	0.23	
Total	200	2.39	4.63	3.33	0.39	

$p \leq 0.05$ was considered as significant

Table no 2: Bilateral variations of the femoral neck diameter (in cm) according to gender

		N	Minimum	Maximum	Mean	SD	p
Right	Male	50	2.95	4.28	3.59	0.26	0.001
	Female	50	2.39	3.65	3.07	0.23	
	Total	100	2.39	4.28	3.33	0.37	
Left	Male	50	3.00	4.63	3.63	0.34	0.001
	Female	50	2.52	3.57	3.05	0.22	
	Total	100	2.52	4.63	3.34	0.41	

$p \leq 0.05$ was considered as significant

Table no 3: Bilateral variations of the femoral neck diameter (in cm)

	N	Minimum	Maximum	Mean	SD	p
Right	100	4.23	5.86	4.90	0.39	0.750
Left	100	4.21	5.81	4.89	0.40	

$p \leq 0.05$ was considered as significant

Table no 4: Correlation coefficient of the stature with the FND in adult Bengali Bangladeshis

	N	Correlation coefficient (r)	Coefficient of determination (r^2)	Significance *(p) of correlation with the stature	
Male	100	+0.730	0.533	0.001	**S**
Female	100	+0.511	0.261	0.001	**S**
Total	200	+0.282	0.080	0.001	**S**

* $p \leq 0.05$, was considered as significant
S, Significant

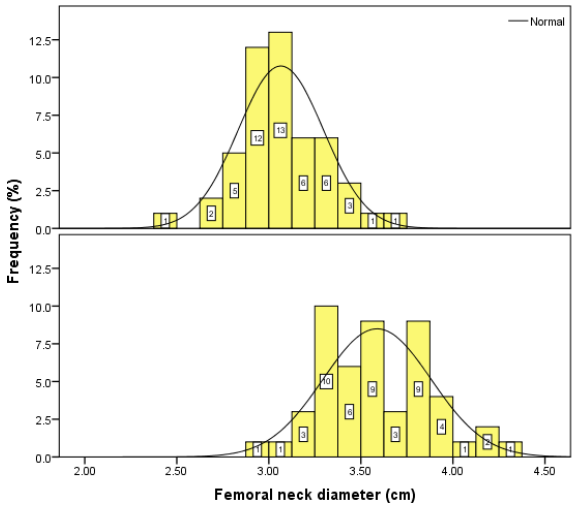

Figure 3: Frequency distribution of the right FND

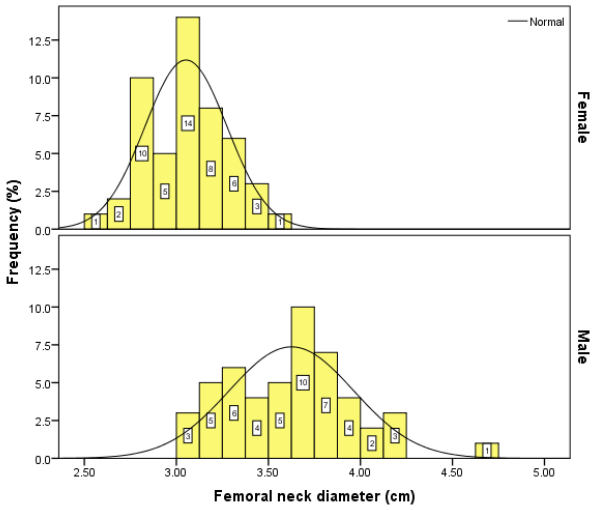

Figure 4: Frequency distribution of the left FND

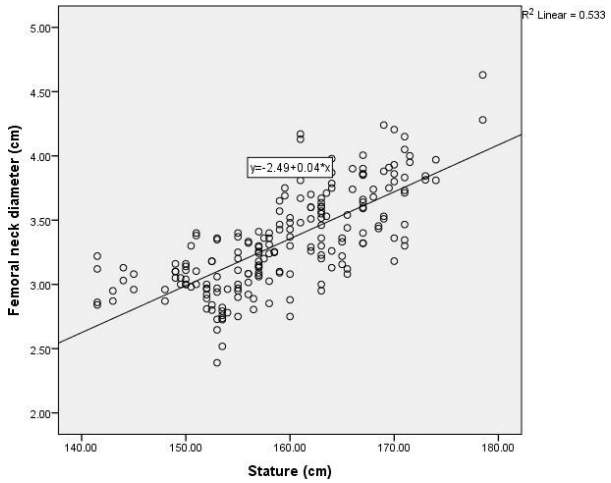

Figure 5: Correlation between the FND and stature in adult Bengali Bangladeshis in regression analysis.

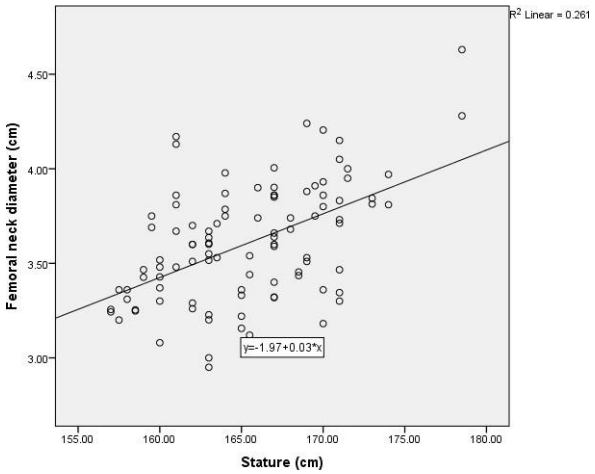

Figure 6: Correlation between the FND and stature in males in regression analysis.

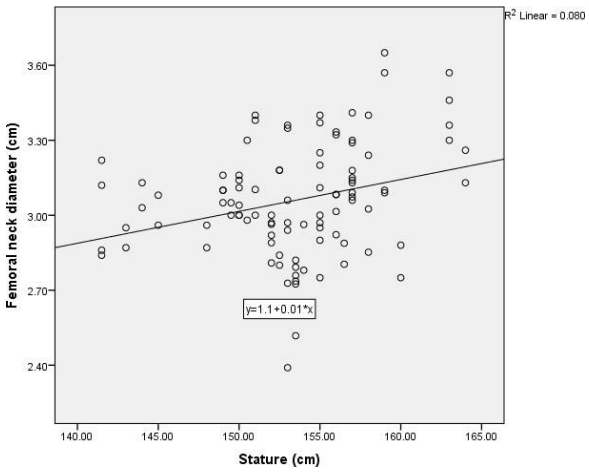

Figure 7: Correlation between the FND and stature in females in regression analysis.

IV. Discussion

In the present study, the average of right and left femoral neck diameter in male population was 3.59 cm and 3.63 cm respectively, whereas right and left femoral neck diameter in female population was 3.07 cm and 3.05 cm respectively. A statistically significant difference was detected between males and females ($p < 0.05$).Many studies had focused on the femoral neck diameter for different ethnic populations. There are several possible reasons for the differences between the results of this study with others. These include interobserver error and differences in sample size, the mean age of the sample, ancestry, selection criteria, and methods used to obtain the femoral neck diameter.

The existence of significant sex-specific differences in the femoral neck diameter was found from the results chapter. As expected, the femoral neck diameter was larger in male compared with the female; it is not surprising that the femoral neck diameter differed, since males are generally taller than females. The value of the femoral neck diameter in the present study was less than that in some other studies[13-15]. However, these observations were in line with Acar et al.[16], de Sousa et al.[13]and Nissen et al.[17]. However femoral neck diameter increased with age only in men. This is in accordance with earlier findings demonstrating that appositional growth of the femoral neck continues throughout life in men but not in women[18].In the present study, femoral neck diameter measured on X-ray pelvis correlate significantly with the stature, which is consistent with the observation was reported in Dutch population[17].

V. Conclusion

Significant positive correlations were found between the stature and femoral neck diameter in both sexes. There was a significant difference found in femoral neck diameter between males and females, but no significant difference found between right and left sides. The result of the present study can provide the basic framework for formulating standards of the femoral neck diameter and the stature and their interrelations for Bengali Bangladeshi population. Availability of such data can help to construct the best possible prosthesis for patients of total hip replacement. This study will prove to be useful along the broad spectrum of medical science such as anatomy, radiology, orthopedics and forensic medicine.

Acknowledgement

The authors acknowledge Prof. Dr. Md. Iqbal Hossain, Professor and Chairman, Department of Radiology and Imaging, BSMMU for his support and for permission to use X-rays facilities during the course of the study.

References

[1]. Bašić Ž, Anterić I, Vilović K, Petaros A, Bosnar A, Madžar T, et al. Sex determination in skeletal remains from the medieval Eastern Adriatic coast–discriminant function analysis of humeri. Croatian medical journal. 2013;54(3):272-278.
[2]. Seidemann RM, Stojanowski CM, Doran GH. The use of the supero-inferior femoral neck diameter as a sex assessor. American Journal of Physical Anthropology: The Official Publication of the American Association of Physical Anthropologists. 1998;107(3):305-313.
[3]. Kumar P, Shahnawaz K, Varma G. Study of Estimation of Stature by the Length of Femur. Journal of Evolution of Medical and Dental Sciences. 2014;3(12):3166-3173.
[4]. AlQahtani F. Prediction of stature from radiographic study of foot and hand in modern Saudi at Baha Province. International Journal of Medical Science and Public Health. 2015;4(8):1035.
[5]. Athwale M. Anthropological study of height from length of forearm bones. A study of one hundred Maharashtrian male adults of ages between 25 and 30 years. Am J Phys Anthropol. 1963;21:105-112.
[6]. El A, Din SM, Elkholy S, Yousef MI. Prediction of stature based on upper limb measurements among Egyptian population. Eur J Forensic Sci. 2016;3(2):1.
[7]. Das R, Smith D, Timilsinha N. Prospective study on body mass index, stature and demispan of elderly population of Pokhara valley in Nepal. Indian J Gerontol. 2007;21:9-19.
[8]. Clohisy JC, Carlisle JC, Beaule PE, Kim YJ, Trousdale RT, Sierra RJ, et al. A systematic approach to the plain radiographic evaluation of the young adult hip. The Journal of bone and joint surgery American volume. 2008;90 Suppl 4:47-66.
[9]. Tannast M, Murphy SB, Langlotz F, Anderson SE, Siebenrock KA. Estimation of pelvic tilt on anteroposterior X-rays--a comparison of six parameters. Skeletal radiology. 2006;35(3):149-155.
[10]. Polesello GC, Nakao TS, de Queiroz MC, Daniachi D, Ricioli W. Proposal for standardization of radiographic studies on the hip and pelvis. Revista brasileira de ortopedia. 2011;46(6):634.
[11]. Sugano N, Noble PC, Kamaric E. Predicting the position of the femoral head center. The Journal of Arthroplasty. 1999;14(1):102-107.
[12]. Lv L, Meng G, Gong H, Zhu D, Zhu W. A new method for the measurement and analysis of three-dimensional morphological parameters of proximal male femur. 2012.
[13]. De Sousa E, Fernandes RMP, Mathias MB, Rodrigues MR, Ambram AJ, Babinski MA. Morphometric study of the proximal femur extremity in Brazilians. Int J Morphol. 2010;28(3):835-840.
[14]. Caiaffo V, de Albuquerque PPF, de Albuquerque PV, de Oliveira BDR. Sexual Diagnosis Through Morphometric Evaluation of the Proximal Femur. International Journal of Morphology. 2019;37(2).
[15]. Pomeroy E, Mushrif-Tripathy V, Kulkarni B, Kinra S, Stock JT, Cole TJ, et al. Estimating body mass and composition from proximal femur dimensions using dual energy x-ray absorptiometry. Archaeological and anthropological sciences. 2019;11(5):2167-2179.
[16]. Acar N, Unal M. Radiological Evaluation of the Proximal Femoral Geometric Features in the Turkish Population. SDÜ Tıp Fakültesi Dergisi. 2017;24(4):127-134.
[17]. Nissen N, Hauge EM, Abrahamsen B, Jensen JE, Mosekilde L, Brixen K. Geometry of the proximal femur in relation to age and sex: a cross-sectional study in healthy adult Danes. Acta radiologica. 2005;46(5):514-518.
[18]. Mosekilde L. Normal age-related changes in bone mass, structure, and strength-consequences of the remodelling process. Acta Obstetricia et Gynecologica Scandinavica. 1993;72(5):409-410.

Md. Riadul Zannat Riad, et. al. "Femoral Neck Diameter: Dimorphic Variation and Correlation with the Stature from the Radiological Perspective." *IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)*, 19(9), 2020, pp. 10-15.